

# **Ukrainian Journal of Food Science**

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**Ukrainian Journal of Food Science** publishes original research articles, short communications, review papers, news and literature reviews dealing with all aspects of the food science, technology, engineering, nutrition, food chemistry, economics and management.

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## Ukrainian Journal of Food Science

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## Contents

<b>Preface</b> .....	6
<b>Food Technology</b>	
<i>Galina Polischuk, Sergii Ivanov, Tetiana Krupska, Volodimir Turov</i> Ice cream phase composition study using low temperature <sup>1</sup> H NMR spectroscopy .....	7
<i>Maksym Polumbryk, Sergii Ivanov, Oleg Polumbryk</i> Antioxidants in food systems. Mechanism of action .....	15
<i>Olga Rybak</i> Some aspects of the formation of emulsions and foams in food industry .....	41
<i>Volodimir Piddubniy, Mykola Sova, Oleksandr Shevchenko</i> Assessment of prospects using the latest technology stabilization of beverage .....	50
<i>Elena Deriy, Svitlana Litvynchuk, Anatoliy Meletev, Volodymyr Nosenko</i> Refinement of the physical and chemical methods for the determination of sugars.....	54
<i>Tetiana Silchuk, Anna Kovalenko</i> Rye-wheat bread production at the restaurants.....	59
<i>Marina Bilko, Alina Tenetka</i> The regulation doses of sulfur dioxide with the aid of preparations, based on glutathione of yeasts in the production of pink table wine.....	65
<i>Svitlana Litvynchuk, Inna Hutsalo, Tamara Nosenko, Volodymyr Nosenko</i> Using of infrared reflectance spectra of sunflower meal for determination its moisture content .....	71
<i>Tetiana Kalinovska, Vira Obolkina</i> Substantiation of using wine-making secondary products as alternative raw material for confectionery industry .....	77
<i>Irina Babich</i> The influence of technological treatments on physical and chemical structure of wine .....	81
<i>Victor Dotsenko, Oksana Arpul, Natalia Bondar, Tetiana Iemchuk, Olena Dudkina</i> The development of the restaurants' chain in the capital region of Ukraine.....	88
<i>Tamara Nosenko, Inna Hutsalo, Volodimir Nosenko, Irina Levchuk, Svitlana Litvynchuk</i> Analysis of near infrared reflectance spectrum of rape seed with different content of erucic acid.....	94
<i>Petro Shiyan, Yaroslav Boyarchuk</i> Investigation of organic impurities movement by accelerating column of alcohol which is under pressure lower than atmospheric.....	100
<b>Processes and Equipment of Food Productions</b>	
<i>Oleksandr Shevchenko, Romaniuk Artem, Volodimir Piddubniy</i> Features and benefits analysis of transient processes in food technology.....	105

<i>Sergii Samiyenko, Sergii Vasylenko, Vitaliy Shutyuk</i> Entropy analysis of heat exchanging appliances .....	111
<b>Automatization of technological processes</b>	
<i>Volodimir Shesterenko, Irina Sydorчук</i> Research of the features of reactive power compensation in the combined system of food industry.....	116
<b>Life Safety</b>	
<i>Olga Evtushenko, Igor Klepikov</i> Exploration of occupational injuries in food industry of Ukraine .....	123
<b>Economics and Management</b>	
<i>Irina Khamutovska</i> Attraction of foreign investment to Ukraine: problems and solutions .....	130
<b>Abstracts</b> .....	138
<b>Instructions for Authors</b> .....	155

## Preface

### Dear Colleagues!

You hold in your hands the first issue of «Ukrainian Journal of Food Science», initiated by National University of Food Technologies. The Journal is intended for the publication of original research papers, review articles, short communications, news, and reviews of the scientific literature on all aspects of food science: engineering, technology, nutrition, chemistry, economics and management.

Publication may be of interest to researchers, university teachers and management of the food industry.

Initiating publication of the Journal, we set an objective to inform the international scientific community about the achievements of scientists in Ukraine and other countries, to foster the exchange of knowledge in food science.

An International Editorial Board which includes leading European scientists in food science and economics has been created with the aim to promote the Journal itself and to provide the highest level of scientific expertise in the evaluation of materials submitted for publication.

The first issue of «Ukrainian Journal of Food Science» coincides with the Second North and the East European Congress of Food Science NEEFood-2013 which takes place in Kyiv.

The fact that the Congress takes place in the capital of Ukraine, at the leading higher education institution - the National University of Food Technologies, symbolizes recognition of our achievements by the international community of food specialists. Scientific results presented at the Congress will be published in the Ukrainian Journal of Food Science.

We are open to cooperation, scientific debate and discoveries.

We hope to receive support from all those who care for the development of food science. With our joint efforts we will be able to present our scientific achievements to the international community properly.

We wish the authors and readers every success in their scientific research and realization of creative ideas,

*Editor-in-Chief*  
*Professor*  
**Sergii Ivanov**  
*Ph. D. Hab., Prof.*



## Ice cream phase composition study using low temperature $^1\text{H}$ NMR spectroscopy

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### ABSTRACT

#### Keywords:

Ice cream  
Phase composition  
Bound water

The low temperature  $^1\text{H}$  NMR spectroscopy was used to study the aqueous phase of ice cream while its temperature was increasing from  $-60\text{ }^\circ\text{C}$  to  $0\text{ }^\circ\text{C}$ . It is an established fact that virtually no releasable water is present in low fat ice cream of typical chemical composition, whilst bound water is observed in a form of two fractions: strongly and weakly bound. The first fraction consists mostly of water as part of hydrated sugars, and the second one is generated through adsorptive action of bio-polymeric mix components.

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Radial distribution of ice crystals formed within mixtures is calculated through approximated view on the crystallization of water and sugars as separate substances. It was established that the gauges of crystals so formed are within the range of 1 to 16.6 nm, with two characteristic peaks conditioned by the different water binding energies.

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The difference in phase composition between ice creams containing wheat flour and stabilization systems was proved to be negligible. It was further established that gelatinized flour, 5 times exceeding in quantity the stabilization system, virtually equals the latter in water binding.

The results of undertaken studies can be used to calculate the actual sucrose and lactose concentrations in mixtures and ice cream through a wide range of low temperatures.

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### Introduction

Ice cream is a dispersed heterogenic system [1] consisting of biopolymer molecules and water-emulsified fat droplets. Different concentration water solutions of sugars are used as such system's dispersive medium. Water contained in solutions may be incorporated into hydrate coating of carbohydrate molecules or have the form of molecular poly-associates held in a grid with hydrogen bounds [2, 3]. A part of water is bound through hydrogen binds with biopolymer molecules, forming their hydrate coating into which low-molecular organic compounds can penetrate. Generally speaking, all of water contained in ice cream can be divided into free (not making part of any hydrate compounds) and bound water. Water is

regarded as bound if its free energy, compared to bulk water, is reduced either by adsorption action of macromolecules or hydrate interaction with organic molecules.

Bound water in nanostructured systems is not homogenous either, dividing into strongly and weakly bound. Such differentiation can be based on the criterion of freezing temperature depression due to reduction of Gibbs free energy. Water can be considered as weakly bound if its free energy ( $\Delta G$ ) is reduced by no more than 0.5 kJ/mole, corresponding to the freezing temperature depression  $\Delta T = 15$  K [4-6]. Freezing and thawing processes modify the phase composition of the mix since the free and a part of the bound water transfers to hexagonal ice phase, sugars crystallize and re-crystallize, and fat crystals are formed.

Y.A. Olenev et al., [7] studying the condition of water in the cream ice, proved that it is actively bound by hydro-colloids, sugars, and mineral substances of milk. Yet the phase composition of low fat ice containing up to 70% water received little attention so far. Moisture binding capacity provided by the classical stabilizing agent (wheat flour) compared to modern stabilization systems containing hydrocolloid complexes and surface-active additives, has not been studied. Additional studies of milk ice physical condition at low temperatures will be required to exclude uncontrolled ice crystallization in it.

This work purports to research the phase breakdown changes in the course of defrosting the milk ice containing traditional and modern stabilization systems.  $^1\text{H}$  NMR spectroscopy and NMR cryometry, widely applied for solid-phase heterogenic systems and biopolymers [4-6], were used in this research.

## **Material and methods**

Two samples were studied:

**Mix №1.** Milk ice containing the Cremodan stabilization system (by Danisco, Denmark).

Chemical composition, %: milk fat: 3.5; sugar: 15.5; dry skimmed milk solids: 10; water: 70; stabilization system: 0.6 % (fat acid mono- and diglycerides, guar gum, carrageenan, polysorbate).

**Mix №2.** Milk ice containing wheat flour.

The chemical composition of mix 2 is identical to that of mix 1, except for a slightly reduced water content, down to 68.26 %, and stabilizing system replaced with 3% of wheat flour.

**NMR Spectroscopy.** NMR specters were obtained using the 400 MHz Varian Mercury high-resolution NMR spectroscope.  $90^\circ$  probing impulse of 3  $\mu\text{s}$  was used. The temperature was controlled with a thermal module Bruker VT-1000 at  $\pm 1^\circ$  tolerance. The intensity of signals was determined by measuring the surface of peaks using (if needed) signal decomposition into components, on the assumption of Gaussian line form, and optimizing its zero line and phase with a tolerance which, for well resolved signals, was 5% or lower, and for overlaying signals,  $\pm 10$  %. To prevent liquid subcooling effects for the surveyed items, concentrations were measured in the course of heating the samples, previously cooled to 210 K [4-6].

Two key approach assumptions are used in the phase interaction theory: infinitely thin adsorption layer and Gibbs' finite thickness layer [8]. In the first case it is assumed that adsorbed substance forms nano-drops filling the cavities of the porous body. All of the excess energy due to the phase division is concentrated in the monomolecular film of adsorbed substance (e.g. water) bordering on the surface. Due to correlation between the freezing



temperature depression and the size of adsorbed substance drops, size distribution of water filled cavities can be obtained.

To determine the dimensions of inter-phase water clusters, the Gibbs-Thomson equation was used establishing connection between the radius of a spherical or cylindrical water cluster (R) and freezing temperature depression:

$$\Delta T_m = T_m(R) - T_{m,\infty} = \frac{2\sigma_{sl}T_{m,\infty}}{\Delta H_f \rho R}, \quad (1)$$

where  $T_m(R)$  is melting temperature of ice localized in R radius pores,  $T_{m,\infty}$  is bulk ice melting temperature,  $\rho$  is solid phase density,  $\sigma_{sl}$  is energy of interaction between a solid body and fluid, and  $\Delta H_f$  is volumetric enthalpy of melting.

This equation may be used to calculate the water aggregate size breakdown based on the temperature dependence for the quantity of un-freezing water ( $C_{uw}$ ) determined based on  $^1\text{H}$  NMR spectroscopy with laminar water freezing when the use of other analysis methods is problematic [6]. In practice equation (1) can be used in a form of  $\Delta T_m = (k/R)$ , where the  $k$  constant for many water containing heterogenic systems is close to 50 [8].

For complex solutions this approach is applicable only if the components in crystallization are viewed as separate substances.

The finite layer method [8] is based on the assumption that the influence of phase dividing surface spreads several layers deep into the liquid phase: then the freezing (thawing) of inter-phase water, localized within the solid porous matrix, will occur in accordance with the changes in Gibbs' free energy. It will fall pro rata to a specific water layer's distance from the surface. At  $T = 273 \text{ K}$ , water will freeze if its properties are identical to bulk water, and as the temperature falls further, the layers closer to the surface will freeze sooner, and the following equation will apply to inter-phase water:

$$\Delta G_{\text{ice}} = -0,036(273,15 - T), \quad (2)$$

in which the numeric ratio represents a parameter connected with the temperature factor of changes in Gibbs free energy for ice [9]. After deducing the temperature dependence of unfrozen water concentration  $C_{uw}(T)$  from the signal intensity, the method described in [5, 6, 9, 10] may be used to calculate the quantities of strongly and weakly bound water, as well as thermodynamic features of those layers.

Inter-phase energy of water, equivalent to the overall reduction of the system's free energy, which is due to presence of internal phase boundaries and solutes [4-6], can be calculated using the following formula:

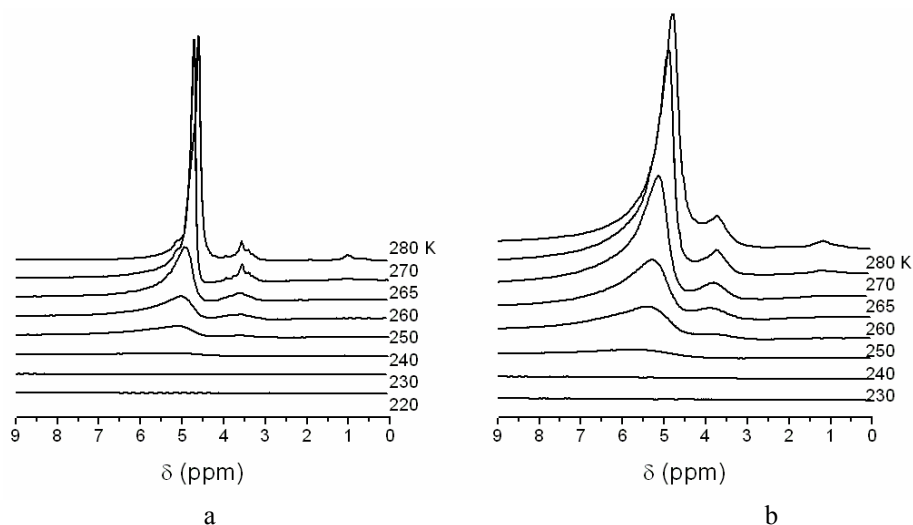
$$\gamma_s = -K \int_0^{C_{uw}^{\max}} \Delta G(C_{uw}) dC_{uw}, \quad (3)$$

where  $C_{uw}^{\max}$  means the total quantity of un-frozen water at  $T = 273 \text{ K}$ .

## Results and discussions

$^1\text{H}$  NMR specters taken at different temperatures within the range  $210 < T < 280 \text{ K}$  for mixes №1 and №2 are displayed on fig. 1 a, b respectively. On those specters three proton signals are observed with chemical shifts  $\delta_H = 5, 3-4$  and  $1 \text{ ppm}$  which can be identified as signals of water, mono- and disaccharides and fat, respectively. Protein and polysaccharide molecules are not observed within the specters due to low mobility of their molecules. As the

temperature falls, the intensity of all signals is reduced pro rata to freezing of the components in the solution. Frozen substances are not recorded on the specters due to the short time of transverse relaxation for protons in solid bodies [11]. The relatively large width of the signals is due to reduction of molecular mobility in viscous heterogenic systems. Although the proton specter in sugars is made of several signals of hydroxyl groups, non-equivalent magnetically, but the fine structure of sugar specter is observed only for mix №1. The temperature dependence of concentration of un-frozen water, sugar, and fats for mixes №1 and №2 are shown on fig. 2.



**Fig. 1.**  $^1\text{H}$  NMR specters at different temperatures for mix №1 (a) and №2 (b)

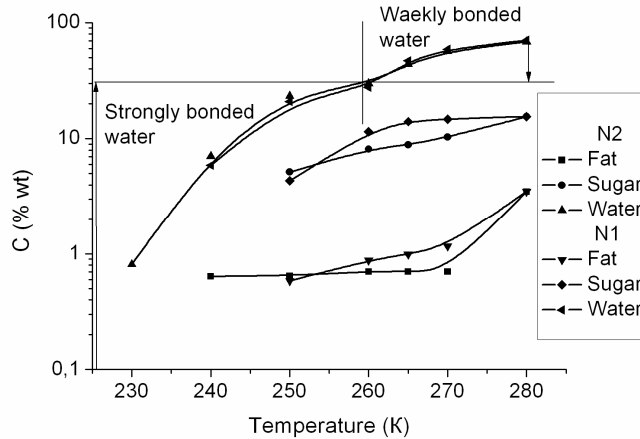
According to data on fig. 2, the water thawing curves are closely shaped for mixes №1 and №2. In both cases nearly no water is freezing in close proximity to 273 K. Therefore, nearly all of it is bound with biopolymer components or engaged in hydrate coating of carbohydrate molecules. The dependence curves  $C_{uw}(T)$  display an inflection point corresponding to a temperature of  $T = 260$  K. For the systems in question, water freezing above that temperature can be considered as weakly bound.

Water freezing in saccharide solutions in mix 1 occurs at  $T < 270$  K, and in mix 2, near  $T = 280$  K.

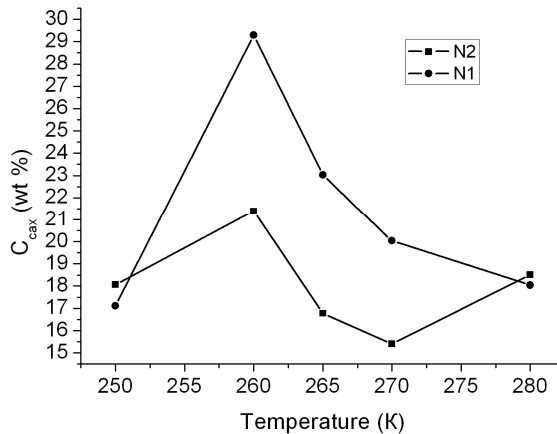
The difference in carbohydrate freezing curves (fig. 2) signals the difference of their concentrations in the non-frozen phase, which difference can be calculated based on proportions between the quantity of un-frozen water and saccharides (fig. 3).

Those dependences have a complex shape, which differs for mixes №1 and №2. For mix 1, as long as the temperature is descending to  $T = 260$  K, concentration of un-frozen phase sugars monotonously increases. For mix 2, sugar concentration growth is observed between  $260 < T < 270$  K. This growth is notably lower than for mix 1. At  $270 < T < 280$  K the concentration of sugars in non-frozen water is decreasing for mix 1. Both mixtures display falling sugar concentrations due to their freezing. Their signals in  $^1\text{H}$  NMR specters are not observed under  $T = 250$  K (fig. 1, 2). Whereas the temperature of  $T = 260$  K is a transition point delimiting

strongly and weakly bound water, it can be assumed that weakly bound water in mixes №1 and №2 is mainly present in a form of sugar hydrates.



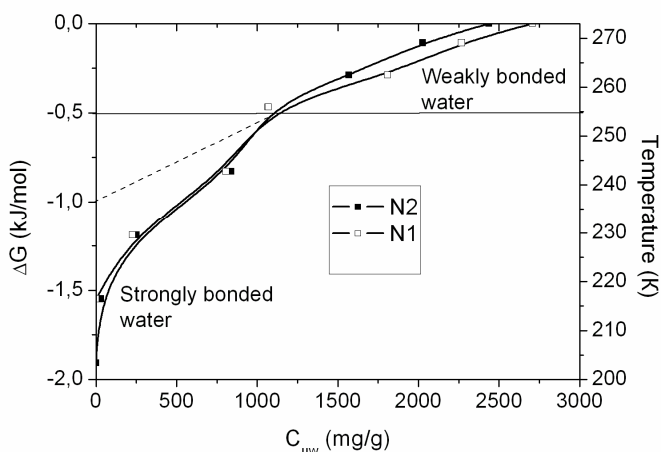
**Fig. 2. Temperature dependences of concentration of un-frozen water, sugar, and fats for mixes № 1 and № 2.**



**Fig. 3. Temperature dependences for concentration of un-frozen phase sugars in mixes №1 and № 2.**

On fig. 4 the dependences are shown for inter-phase Gibbs energy, calculated using formula (2), on the un-frozen water concentration per weight unit of aggregate concentrations of biopolymer components and sugars. The features of inter-phase water layers calculated as per method described in [4-6] are summarized in the table below.

The concentrations of strongly and weakly bound water,  $\Delta G^s$  and  $\Delta G^w$ , were determined in section points of curves  $\Delta G(C_{in})$  with the straight line on the level of  $\Delta G = 0.5$  kJ/mole (fig. 4), and the total quantity of water in mixtures prior to freezing.



**Fig. 4. The dependence of change in the inter-phase Gibbs energy on un-frozen water concentration per weight unit of biopolymers and sugars combined.**

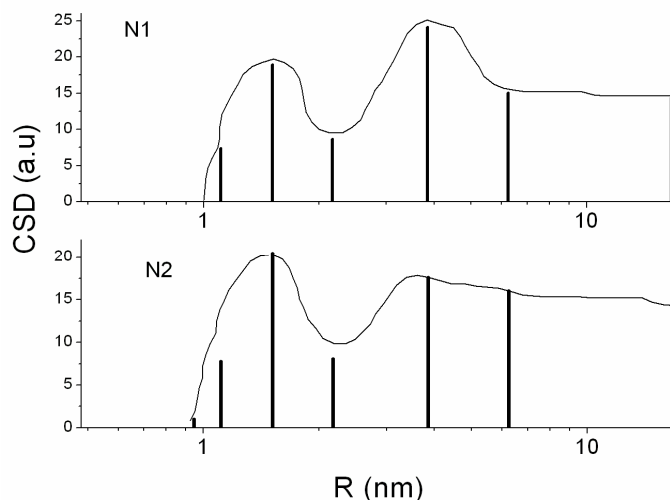
The maximal free energy drop within the layer of strongly ( $\Delta G^s$ ) and weakly ( $\Delta G^w$ ) bound water was determined in section points of the relevant curve parts  $\Delta G/C_{uw}$  with the Y axis. Considering that weakly bound water is mostly presented in a form of hydrated sugars, it can be speculated that the value of  $\Delta G^w$  is approximated to the free energy of sugar hydration. Strongly bound water in mixes 1 and 2 is seen as water bound to biopolymer components. The aggregate reduction of water's free energy due to presence of solutes and adsorption action of biopolymers, is expressed as  $\gamma^S$ . This quantity is slightly higher for mix 1, mainly due to a higher quantity of weakly bound water (see the table). Figure 5 shows the distribution of ice crystals per radius as obtained from equation (1).

**Table 1. Un-frozen Water Layer Features for Mixes №1 and №2**

Mix	$C_{uw}^s$ mg/g	$C_{uw}^w$ mg/g	$\Delta G^w$ kJ/mole	$\Delta G^s$ kJ/mole	$\gamma^S$ J/g
1	1100	1600	-1	-1.6	81
2	1070	1370	-1	-1.8	78

For both mixes the dimensions of ice crystals fall within the range of 1 to 16.6 nm. There are two peaks on distribution curves. The right peak, comprising the three right bars, pertains mostly to sugars freezing out of solutions. The left peak mainly reflects crystallization of water bound by biopolymer components of the mix.

Thus, it is evident that the differences in phase composition of ice mixtures containing the traditional and modern stabilizing agents are marginal. Gelatinized flour, 5 times exceeding in quantity the stabilization system, virtually equals the latter in water binding.



**Fig. 5. Distribution of ice crystals per radius in frozen mixes.**

Further studies should address the rheology of those mixes to achieve a deeper understanding of the ice cream structure formation and stabilization behavior.

### **Conclusions**

The low temperature  $^1\text{H}$  NMR spectroscopy enables to study the aqueous phase of ice cream while its temperature is increasing from  $-60\text{ }^\circ\text{C}$  to  $0\text{ }^\circ\text{C}$ .

In milk ice with low free water content, free water is observed in two fractions: strongly and weakly bound.

The calculated dimensions of ice crystals built within milk ice fall within the range between 1 and 16.6 nm.

Water crystallization in mixes containing wheat flour compared to those with stabilizing system, both in quantities recommended by the manufacturer, is virtually identical.

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## Antioxidants in food systems. Mechanism of action

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Oxidation  
Free radicals  
Activation of oxygen  
Photosensitizations  
Synergism  
Antagonism

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### ABSTRACT

The mechanisms of action of natural and synthetic antioxidants in food systems including lipids, proteins and carbohydrates have been discussed. It is essentially important and very useful in prediction of the antioxidants effectiveness in the processes of food storage. The main proposed mechanisms through which the antioxidants may play their protective role, including free radicals inactivating, the hydrogen atom transfer, prooxidative metals chelating, the single electron transfer, quenching of singlet oxygen as well as photosensitizers and lipoxygenase inactivation, have been analyzed and discussed in details. The majority attention was given to the antioxidants mixtures and most effective synergists.

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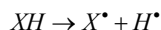
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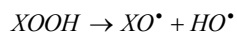
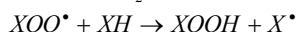
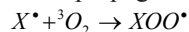
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## Introduction

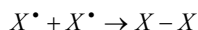
The main adverse effect of food oxidizing is a change in sensory quality, particularly development of off-flavors and toxic compounds, rancidity, vitamins destruction, color and food quality loss [1-3]. It is well known that lipid-containing food oxidizing mediated by free radical driven chain reactions, which involve alkyl  $R^\bullet$ , alkoxy  $RO^\bullet$ , peroxy  $ROO^\bullet$  radicals and active forms of oxygen – singlet oxygen and superoxide anion radical [1-4]. The mechanism of reaction can be divided into the three stages: initiation, propagation and termination. On the first stage of oxidation reaction from biological systems  $XH$  are formed radicals  $X^\bullet$  as a result of abstraction of a hydrogen atom  $H^\bullet$ :



After initiation, propagation of free radical chain occur, in which molecule of oxygen from environment react with reactive radical species, resulting in formation of peroxides and peroxy radical  $XOO^\bullet$ . These intermediates may further propagate free radical reactions:



On the last stage interact two radicals which may lead to formation of nonradical adduct and termination of free radical chain:



Thus termination result in interrupting the sequence of chain reactions and lead to a significant decrease of the total reaction rate.

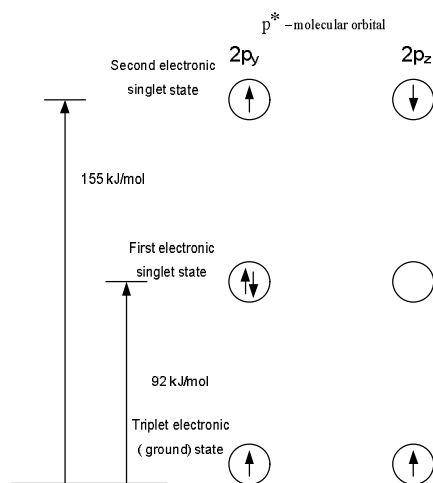
## Results and discussions

### Oxidizing factors. Oxygen activation

The molecules of oxygen are the main source of oxidizing in the food systems [1]. The other strong oxidants include hydrogen peroxide, benzoyl peroxide, potassium bromate, which consist atoms of Oxygen. These compounds either contained in food or accumulated during food processing.

The reactions between molecules of oxygen, which normally are in the ground state ( $^3\text{O}_2$ ), and organic compounds proceeded very slowly because of their high energy of activation, although they are thermodynamically favorable. In the ground state the molecule of oxygen consists two electrons on the outer shell and gave triplet signal in the magnetic field\*. The chemical bonds in the molecules of organic compounds are formed by means of pair of electrons with opposite spines on one orbital (singlet state). Therefore, a direct reaction between molecules of organic compounds and oxygen is highly improbable because of incompatibility or conflict with spine states. Since the values of energy of activation of organic compounds oxidation by triplet oxygen are within the range 146–273 kJ/mol, these reactions are hardly probable during food processing.

An activation of triplet oxygen, containing two unpaired electrons on the outer orbitals  $2p_y$  or  $2p_z$ , as an oxidant in redox reactions, consume too much energy. A one approach of oxygen activation is to transfer molecule of oxygen from ground ( $^3\text{O}_2$ ) to excited singlet state [2,3]. Another form of singlet oxygen (fig. 1) has a lesser lifetime and doesn't play an active role in oxidation processes [2]. The others active species of oxygen, which formed in result of reduction of oxygen triplet state, included superoxide anion-radical ( $\text{O}_2^{\cdot-}$ ), its conjugated acid ( $\text{HO}_2^{\cdot}$ ), hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) and hydroxyl radical  $\text{OH}^{\cdot}$ .

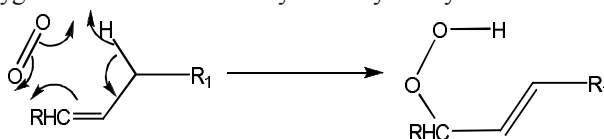


**Figure 1. The scheme of formation of oxygen active forms**

\* Generally, each level of non-zero spin shifted into  $2I+1$  sublevels, where  $I$  is a summary spin.



The strongest electrophilic agents and active forms of oxygen are  $^1O_2$  and  $OH^\bullet$ . [4].  
The singlet oxygen often reacts with fatty acids by the cycloaddition mechanism (fig.2).



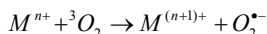
**Figure 2. The mechanism of cycloaddition of singlet oxygen to a molecule of fatty acid**

Some of these active species of oxygen can convert into others in the presence of specific catalysts. They also formed as a result of  $\gamma$ -radiation, light absorption by photosensitive pigments which contain food systems e.t.c. [4].

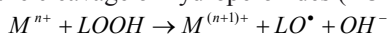
### Catalysts of oxidation in food systems

The catalysts of the reactions of oxidation divided into the two groups — enzymatical and nonenzymatical. Enzymatical catalysts usually cause oxidation in particular biological objects [2,3]. For example, enzymes lipooxygenase, polyphenoloxidase, sulphhydrylooxidase and xanthinoxidase, which generally can be found in food products, cause oxidation of unsaturated fatty acids, mono- and diphenyl- containing acids, fragments of cystein and xantine respectively. Glucoseoxydase converts glucose into gluconic acid as well as produces  $H_2O_2$ . Xanthinoxidase and peroxydase are able to produce  $H_2O_2$ ,  $O_2^{\bullet-}$  and  $^1O_2$  respectively [2,3].

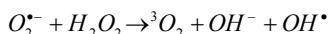
Cations of transitional metals are easily interacted with oxygen with formation of  $O_2^{\bullet-}/HO_2^\bullet$ :



The superoxide radical  $O_2^{\bullet-}$  can initiate an oxidation reactions. Transitional metals ion simulated oxidation of lipids by the cleavage of hydroperoxides (LOOH):

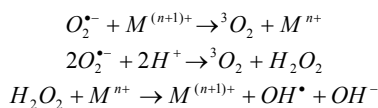


Alkoxy radicals  $LO^\bullet$ , formed by reaction described above, accelerate reactions of oxidation. The former process is very slow because of low concentration of LOOH in food products. Cations of transitional metals are also contributors in active oxygen species interactions by Huber-Weiss reaction:



The interaction is accelerated by means of three intermediate reactions [4,5]. On the first stage metals cations subtract electron from  $O_2^{\bullet-}$ , which act as a reducing agent. The former compound simultaneously playing a role both oxidizing and reducing agent on the second stage, promoting oxygen and oxygen peroxide formation.

On the third stage cations of transitional metals, primarily  $Fe^{2+}$ , induce lipid oxidation, favoring reactive radical  $OH^\bullet$  formation [5] through the Fenton reaction (reaction 3). The formation of oxidized cations leads to reinitiating the lipids oxidation by reaction with superoxide anion radical:



Ascorbic acid and thiols, which are consisted in several food systems, can act as a reducing agents instead of  $O_2^{\bullet-}$ .

The others nonenzymatical catalyzators included photosensitive pigments of food products. The absorption of light in visible or UV by photosensitizers leads to the transfer of these compounds to its electronically excited triplet state. Subsequently the formers are able to transfer their energy excess on the molecules of oxygen and others biological components. The energy transfer to organic compounds favoring by some pigments lead to the oxygen and hydrogen peroxide formation from  $O_2^*$ . The photosensitizers are able to convert triplet oxygen to the singlet form. Several of these compounds, such as riboflavin and chlorophyll are containing in food products [2,4,5].

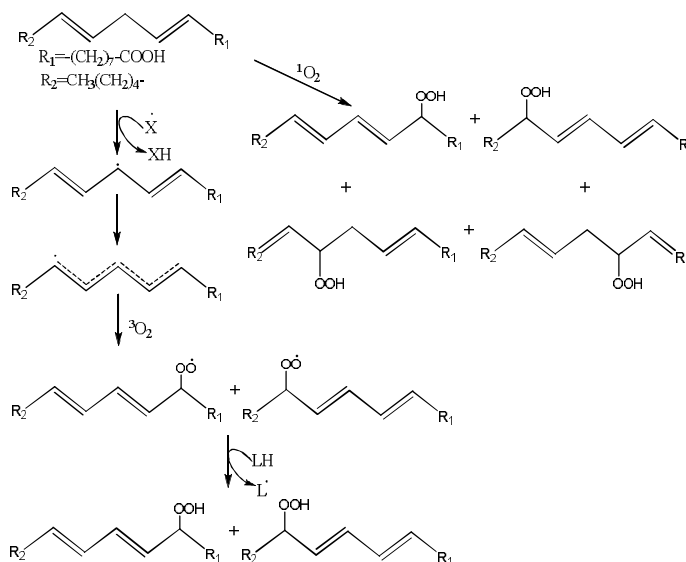
### Lipids oxidation

It is well known that fats (oils) stability during storage has rapidly decreased in the presence of light. It caused the lipids autooxidation. Certain compounds, are so-called sensitizers, favoring this process.

Sensitizers are divided into the two groups — so called type I and type II. The activated by light sensitizers of the type I are directly react with substrate, generating free radicals. The sensitizers of type II are transfer molecule of oxygen from ground to the excited (singlet) state  $^1O_2$ . There is a competition between these two processes in the photooxidation reactions, which depend on nature of sensitizer and substrate, and the formers concentration.

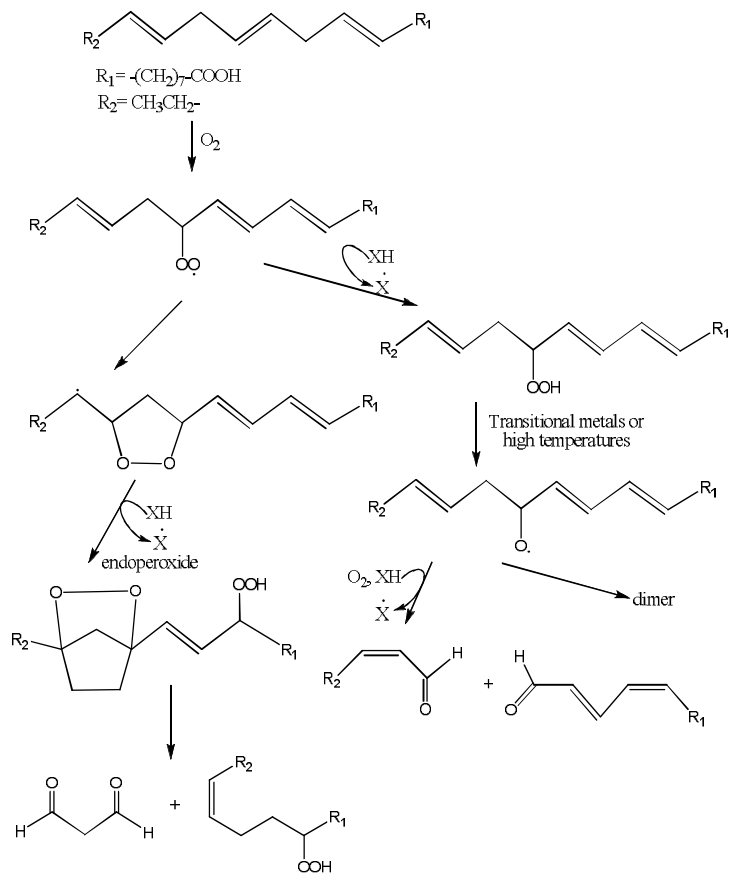
Fats rancidity is a common effect and one of the most known cases of the food deterioration, caused by autooxidation.

Polyunsaturated fatty acids, which containing 1,4-pentadienic functional fragments are particularly sensitive to oxidation\*. For example, linoleic acid oxidation, which consisted in several foods, realizes by two main mechanisms — abstraction of the atom of hydrogen and singlet oxygen addition (fig.3).



**Figure 3. Initial stages of linoleic acid oxidation.** Adapted from [4]

\* Lipids peroxidation in human organism is an important factor, which is necessary for the prostaglandins, leukotriens, biologically active compounds biosynthesis e.t.c.



**Figure 4. Mechanism of linolenic acid oxidation. Adapted from [4]**

\* Lipids peroxidation in human organism is an important factor, which is necessary for the prostaglandins, leukotriens, biologically active compounds biosynthesis e.t.c.

The processes of secondary oxidation have arisen as a result of the further oxidation of double bonds or formation of oxidized polymers. The cleavage of oxidized fragments of fatty acids leads to the formation of low molecular aldehydes and ketones [4,5]. These volatile products of secondary oxidation are responsible for appearance of undesirable off-flavors, which are the indicators of oxidation of foods or oxidative rancidity. In some cases, when specific secondary products were formed by enzymatical reactions, as an example at the hydroperoxydliases action in sliced fresh tomatoes and cucumbers, an aroma of volatile compounds appears to be a very pleasant [2,4].

Thermally induced reactions of oxidation may occur either with saturated and unsaturated lipids at the temperatures of frying process. Therefore, an oxidation has mainly occurred due to the initial formation of hydroperoxides. The high temperatures give rises to reactions of isomerisation and decomposition, resulted in the formation of products of secondary oxidation, including epoxides, dihydroperoxides, aldehydes and ketones e.t.c. [4,5].

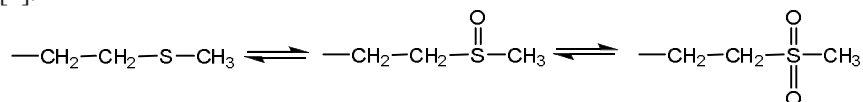
Malonic dialdehyde is a one of the most widespread end product of fats oxidation. It is often used is an indicator of oxidation degree of food lipids. It is accumulated in human organism due to the polyunsaturated fats decomposition, which has induced by action of active species of oxygen and serves as a marker of oxidative stress. It is well known that malonic dialdehyde is able to interact with DNA, forming mutagenic adducts.

### Proteins oxidation

The food peptides, aminoacides and proteins are oxidized during food processing [1-5]. It is considered that methionin, cystein (cystin), hystidin, tryptophan and in certain conditions tyrosin, serin and treonin are the most the sensitive aminoacids, which susceptible to oxidative decomposition. Proteins and aminoacids oxidation induced by action of light,  $\gamma$  radiation, peroxidized lipids, metals, products of enzymatic and nonenzymatic reactions and food ingredients, such as hydrogen peroxide, benzoyl peroxide, bromates and azodicarbonamide. The action of hydrogen peroxide on proteins resulted in the methioninsulfoxide oxidation (reversible) and further oxidation with methioninsulfone production (irreversible).

Cystein is an aminoacid, containing in foods of animal origin. This aminoacid favor food digestion, participated in reactions of interamination, removing several toxic compounds from human organism and protecting from deleterious radiation. It is one of the strongest natural antioxidants, which action increased in the presence of vitamin C and selenium. Cystein is a component of glutathione, which protect liver and brain cells from injuries, caused by alcohol, certain medicines, and tobacco toxic compounds.

Certain functional groups of cysteine could be oxidized by peroxides and active oxygen species with formation sulphenic (Cy-SOH), sulphinic (Cy-SO<sub>2</sub>H) and sulphonic (Cy-SO<sub>3</sub>H) acids. The cystein oxidation resulted in the formation of mono-, di-, three- and tetrasulphoxides (fig. 5) [4].



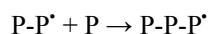
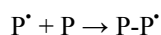
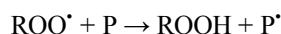
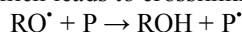
**Figure 5. Scheme of oxidation of cysteine functional groups**

Free thiol groups of proteins either rapidly oxidized by environmental oxygen with formation of cross-linked disulphidic bonds or catalize thiol-disulphidic interaction resulted in the proteins polymerization. Oxidizing agents, as an example KBrO<sub>3</sub>, or azodicarbonamide often utilized as the additives to wheat flour with purpose to improve properties of dough. It is considered that these compounds oxidized and blocked thiol groups of proteins and nonprotein components and thus prevented thiol-disulphidic interactions in dough. Redox reactions, occurring in dough, have been modulated by addition of ascorbic acid, dehydroascorbic acid and glutathion.

The presence of photosensitizers, such as riboflavin and chlorophyll, may cause the oxidation of certain aminoacids, including hystidin, cysteine, methionin, tryptophan and tyrozin by active oxygen species O<sub>2</sub><sup>•-</sup>, H<sub>2</sub>O<sub>2</sub> ra <sup>1</sup>O<sub>2</sub> due to the absorption of light.

Hydrogen peroxide has formed due to the water radiolysis caused by  $\gamma$  radiation of food products resulted in the oxidative changes of proteins. Tryptophan fragments of proteins may oxidize in case of presence of acid [2,4,5].

Peroxidized lipids play a major role in the oxidation of free aminoacids and fragments of proteins. Methionin, cystein, hystidin and lysin are the most sensitive aminoacids. The proteins and peroxidized lipids interact by two main mechanisms —first included participation of alkoxy (RO<sup>•</sup>) and peroxy (ROO<sup>•</sup>) radicals, and another occur due to the action of malonic dialdehyde and other carbonilic compounds. By the first mechanism free radicals of lipids react with proteins (P) resulted in the formation of protein radicals (P<sup>•</sup>), that cause polymerization of proteins molecules. Free radicals of lipids favor oxidation of methionin, cystein and tryptophan as well. Active dialdehyde of malonic acid, formed from peroxidized lipids, react with aminogroups of lysine fragments, which leads to crosslinking [2-4].



Thermal treatment of certain proteinous food products can cause oxidative changes of proteins. While moderate thermal treatment give rise to proteins denaturation, higher temperatures resulted in undesired chemical changes of aminoacids and complex reactions between proteins and other compounds, containing in foods, particularly with carbohydrates and lipids.

The thermal treatment at the temperatures more than 300 °C, which is usual in the frying and grilling processes, resulted in the thermal decomposition and pyrolysis of certain fragments of aminoacids. Several of these compounds are extremely mutagenic. Most of mutagenic (carcinogenic) compounds formed due to the decomposition of fragments of tryptophan, glutamate and lysine.

### **Oxidation of carbohydrates**

Carbohydrates are not as sensitive in reactions of oxidation as proteins and lipids, and the end products are not volatile. Oxidation of food carbohydrates, particularly in Maillard and caramelization reactions, generally occur at high temperatures [2,4,6].

Carbohydrates oxidation may occur in food products due to the enzymatical reactions. The enzyme glucose oxidase catalyze glucose oxidation yielding gluconic acid and simultaneously reduces oxygen resulted in formation hydrogen peroxide. Commercial enzyme glucose oxidase is effective at removing glucose concentration (in order to prevent nonenzymatical browning in dry egg-white manufacture) as well as to decrease oxygen pressure decrease (favoring salad dressing stabilization against oxidative deterioration).

The mechanisms of carbohydrates free radical oxidation are similar to those of lipids. It is well known that low molecular carbohydrates, including glucose, mannitol, deoxyribose interacted with HO<sup>•</sup>, producing oxidized intermediates, which doesn't influenced on the foods quality.

Caramel formation is an example of useful oxidation, occur due to the carbohydrates treatment at high temperatures. These transformations as well as Maillard reaction resulted to the brown pigments and volatile compounds formation [6]. Caramel, which has been formed during sucrose heating with sodium hydrosulfite is utilize in nonalcoholic beverages, such as Coca Cola, Diet Cola and others, and also in bakery and confectionery products as an ingredient contributing in color and aroma.

### Mechanisms of action of natural antioxidants

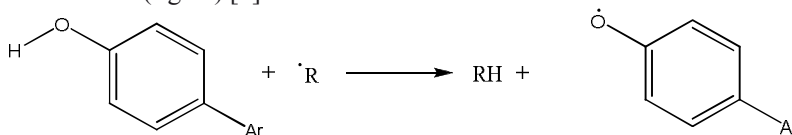
The main method of foods protection against oxidation is an overall utilization of special additives, inhibiting this process. Antioxidants delayed the rate of food oxidation by several mechanisms: playing a role of free radical scavenger (favor entrapment of radicals  $R^\bullet$ ,  $RO^\bullet$ ,  $ROO^\bullet$ ,  $HO^\bullet$  e.t.c.), formation of chelate complexes with prooxidant metals, singlet oxygen and photosensitizers quenching, suppression of radical  $NO^\bullet$  accumulation, peroxydinitrite and lipoxygenases deactivation. Certain compounds, which are called synergists are not the true antioxidants, but can increase an activity of other antioxidants [2,4-7].

Antioxidant activity depends on many factors in particular on lipids nature, antioxidants concentration, temperature, oxygen pressure, the presence of other antioxidants, water and nature of compounds of food products, mainly proteins. The antioxidants were first used after Second World War in order to increase storage stability of foods [8]. These compounds were natural compounds, which were gradually displaced on synthetic. Most of natural antioxidants usually contained in food products, which were consuming thousands years. Thus, it is considered that human organism has adapted to them.

#### Free radical scavengers

Antioxidants entrapped free radicals containing in foods by hydrogen binding, as well as producing relatively stable radicals with antioxidant properties, which characterized low reducing potential (less than 0,5 V) [7]. The increased stability of these antioxidant radical compared to those contained in foods has been linked to the resonance delocalisation of structures containing phenolic ring or sterical hindering of active sites with bulk substitutes [7]. The examples tocopherols, butylated hydroxytoluen (BHT), butylated hydroxyanisol (BHA), tert-butylhydroquinone (TBHQ), propylgallat (PG), lignines, flavonoids, phenolic acids, ubiquinone (coenzyme Q), carotenoids, ascorbic acid and aminoacids related to phenolic compounds, which serve as the effective free radical scavengers [7].

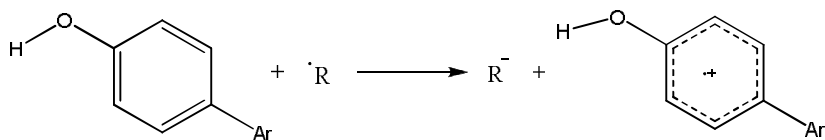
Polyphenols being primary antioxidants inactivated free radicals by mechanisms of atom of hydrogen transfer (AHT) and single electron transfer (SET). On the first mechanism an antioxidant  $ArOH$  interact with free radical  $R^\bullet$  as a result of transfer of atom of hydrogen due to dissociation O-H bond (fig. 6.) [9].



**Figure 6. Mechanism of action of free radical scavenger by hydrogen transfer**

The end products of this reaction are compounds with total formula  $RH$ , which more safe, than corresponding primary radical and oxidized  $ArO^\bullet$  radical as well. Even if reaction leads to the formation other radicals, they were less reactive compare to  $R^\bullet$ , due to the different effects of stabilization [9].

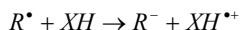
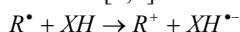
On the SET mechanism single electron transferred to a free radical or from this radical on the acceptor as follows (fig. 7):



**Figure 7. Mechanism of single electron transfer**

Anion  $R^{\cdot-}$  is an energetically stable intermediate with even quantity of electrons, and the activity of cation-radical, formed by above mentioned reaction is also reduced [2,7,9]. The aromatic structures  $Ar^{\cdot}$  та  $ArOH^{\cdot+}$ , formed during free-radical reactions contain unpaired electron, delocalized by aromatic structure, which contributes to stabilization of these compounds [9,10].

The enthalpy of O-H bond dissociation is an important factor in the above mentioned mechanism. The lesser  $\Delta H$  value the easier dissociation and thus the greater reaction rate with antioxidants. The alternative mechanism of interaction is SET, in which radical can act both as an acceptor and donor of electrons as follows [1,2]:



The bond O-H dissociation energy of phenolic antioxidants affected on the stability of corresponding antioxidant radicals: the lower it value the more stable antioxidant radical [7]. Therefore, the better antioxidants are those, which characterize by low energy dissociation of O-H bond. The strength of this bond of phenolic antioxidants depends on nature of substituents of benzolic ring. The antioxidant activity of phenol-type antioxidants depends on balance between electron donor effect of substituents and possible steric hindrance around O-H group caused by them [7]. The functional groups, which destabilize ground state of antioxidants or/and stabilize phenoxyl radical form, reduced strength of O-H bond. The intramolecular hydrogen bonds formation between phenolic hydrogen and oxygen-containing substituents, such as methoxy- groups in ortho position stabilize phenolic ring, and thus prevented the reducing of O-H bond strength. The presence of alkyl substituents or OH groups enhances the stability of the antioxidant radicals leading to increased phenols activity as free radical scavengers. Substitution with one methyl, tert-butyl or methoxy group at the ortho position decreases the energy of O-H bond on 1,75; 1,75 and 0,2 kcal/mol, whereas substitution with these functional groups of hydrogen atom in metha position of phenolic ring reduced bond strength on 0,5 kcal/mol.

The bond O-H energy dissociation of phenolic antioxidants lies in the range of 70-80 kcal/mol and for tocopherols decreases from  $\delta > \gamma > \beta > \alpha$ -tocopherol [9,10]. It depends on solute nature – higher for polar solutes, such as acetonitril ( $\epsilon = 37$ ) and tert-butyl alcohol ( $\epsilon = 12,3$ ), than for nonpolar, like benzene ( $\epsilon = 2,2$ ) [11]. Therefore an antioxidant activity as free radical scavengers being diminished by polar solutes due to formation of intramolecular hydrogen bonds between atom of oxygen or nitrogen and OH- group of phenolic antioxidants [7,12]. The OH-bond strength additionally is affected by double substitution of hydrogens at ortho position. Electron acceptor groups, like -COOH and -COOR in para position, enhance phenolic antioxidants stability and destabilize phenoxyl radical forms, increasing OH bond strength and thus reducing antioxidant activity [13]. The phenoxyl radicals are significantly stabilized if the substitute in para position is an unsaturated hydrocarbon with highly

delocalized electron. The hydrogen-donor ability of natural antioxidants in olive oil decreases as follows: hydroxytyrosol, oleuropein, caffeic, chlorogenic, ferulic acid [14].

In the SET mechanism the most important factor of the reaction rate is an ionization potential or electrode potential: the lower its value the easier electron detachment and correspondingly the faster reaction rate with free radicals.

Antioxidant activity of phenolic acids, particularly caffeic, procatechinic and chlorogenic depends on pH; in acidic environment their effectiveness of free radical scavengers is very little, whereas in pH 7-8 their activity significantly increased [7,15]. In alkaline media phenolic acids ionized with phenolate formation. The antioxidant capacity of the above compounds greater than common phenolic compounds, that enhanced their antioxidant activity [13]. The last has been caused by fast electron transfer from anions of phenolic acids to the peroxy radicals of lipids [7,14,15].

One of the most strong phenolic antioxidant is a chlorogenic acid, contained in coffee beans. Consumption of the above compound may prove beneficial in diabetes type 2, certain types of cancer and cardiovascular disease prevention [16,17]. The bulk quantity of coffee is harmful for pregnant women and those, suffering from hypertension, ischemic heart disease, gastritis and others. Furthermore it may cause dependence on instant coffee lovers.

Tirosol and hydroxytyrosol, contained in the olive oil as well as sesamol and sesaminol, which consisted in sesame oil scavenge free radicals according to the mechanism similar to that of tocopherol due to the presence of phenolic ring.

Reduction potential of antioxidant radicals is very useful to predict the ease of atom hydrogen transfer from certain compound to free radical; the lower reduction potential the higher ability of antioxidant to act as a donor of hydrogen atom [7]. Each compound having a lower reduction potential than food radicals may act as a hydrogen donor and thus it gain properties of antioxidant. The reduction potential of hydroxyl, alkyl, alkoxy, alkperoxy and superoxide anion-radical is approximately 2,3; 0,6; 1,6; 1,0 and 0,94 V, respectively [7]. The reduction potential values of tocopherol, ascorbic acid and quercetin radicals are 0,5; 0,33 and 0,33 V respectively, which are lower than peroxy, alkoxy and alkyl radicals [18]. Thus, food radicals readily abstract hydrogen atom from molecules of ascorbic acid and tocopherol, leading to the inhibition of free radicals formation. Phenolic compounds may play a role of the donor of hydrogen atom for alkperoxy radicals, and the new radical, which were formed doesn't catalyze an oxidation of other molecules, due to the low reduction potential [6]. Phenolic radicals react with other phenolic radicals with hydroquinone formation and phenolic antioxidants regeneration or resulted in the phenolic dimers formation. Phenolic radicals can also interact with lipid peroxy radicals, which lead to phenolperoxides formation, which further being decomposed [7].

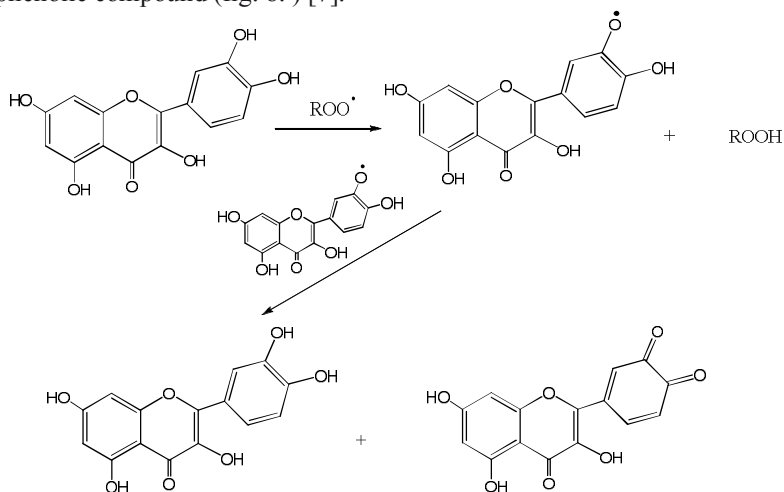
Hydrogen atoms of phenolic rings of tirosol and hydroxytyrosol molecules being coupled to food radicals give rise to the semiquinon radical formation. These intermediates can react with other radicals resulted in the quinon formation, while disproportionation between two radicals lead to the quinon and corresponding compound (tirosol and hydroxytyrosol) formation, or being interacted with molecule of oxygen producing quinon and hydroxyperoxy radical (fig.8). The phenol-semiquinon-quinon system acts as a ascorbic acid synergetic and play a significant role in redox equilibrium maintenance [19].

Flavonoids, particularly quercetin and luteolin are potential inhibitors of xanthinoxidase, which incorporated into the processes of oxidative injuries, especially after ischemic reperfusion since superoxide radical being produced as a result of interaction with molecular oxygen [9,20].



The property of flavonoids to depress growth of cancer cells is also related to their free radical scavenger function [21]. The growth of cancer cell being inhibited by flavonoids, which also can cause apoptosis of these cells [9,22].

Flavonoids must have characteristic structural features, particularly orthohydroxy or catechol groups in B-ring in order to scavenge free radicals (fig. 8) [7,23]. Quercetin, rutin and luteolin are completely fulfilled with these requirements and being known as the most effective free radical scavengers. Catechol is an effective scavenger of free radicals, which doesn't consist 2,3-double bond and 4-carbonyl group, but due to the number of hydroxyl groups, which are the source of hydrogen atom, also served as an acceptor of free radicals [23]. Flavonoids, having structures similar to that of catechol, capture lipid peroxy radicals, which, in turn can abstract hydrogen from flavonoid, yielding more stable phenoxyl radicals. The latter undergo reaction of disproportionation, producing phenolic quinone and dihydroxyphenolic compound (fig. 8.) [7].



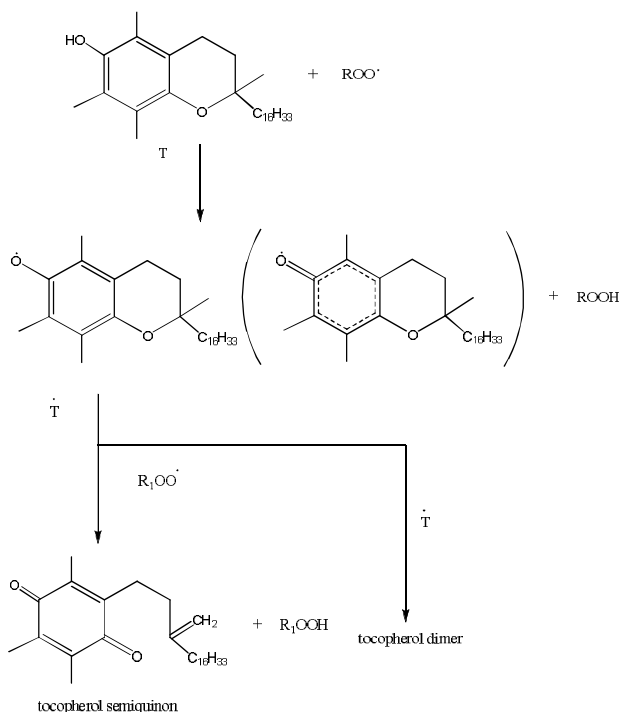
**Figure 8. Reaction between flavonoid catechol and peroxy radicals.** Adapted from [20]

$\alpha$ -Tocopherol react with alkylperoxy radicals much faster than with alkyl, because of the difference between reduction potential of tocopherol radical and alkylperoxy radical (0,5 V), which is a bigger than reduction potential value between tocopherol radical and alkyl radical (0,1 V). Tocopherol act as a donor substrate of hydrogen atom of 6-hydroxy from of chromanolic ring alkperoxy radical, resulted in the alkylperoxide formation and give rise to the realtively stable tocopherol radical due to the resonance structure of its molecules. Further it may being dimerised or interact with lipid peroxy radicals to obtain tocopherol semiquinon, which is not as active as vitamin E (fig. 9) [7]. Tocopherols can slowly and irreversibly react with superoxide anion radicals, but this process is not significant in aqueous solutions.

At high concentrations lipid peroxy radicals react with tocopherols give rise to the tocopherolperoxide, which produced two isomers of epoxy- $8\alpha$ -hydroperoxytocopherons as a result of atom hydrogen abstraction by alkoxy radical. These isomers undergo hydrolysis to form epoxyquinones, giving rise to the alkoxy radicals instead of peroxy with a loss of tocopherol. There was no significant decrease in quantity of the radicals, which lead to gradual

loss of a tocopherol activity. The tocopherol can be regenerated from tocopheryl quinone by the reducing agents addition, for example ascorbic acid [7].

Hydrogen atom being bounded with tocopherol radicals at their high concentration and low quantity of peroxy radicals, but the reaction rate is slow and as a result of reaction tocopherol and lipid radicals are accumulated [7,25]. Lipid peroxy radicals by this reaction can accelerate lipids peroxidation by interaction with triplet oxygen, whereas tocopherol act as a pro- rather than an antioxidant in this case. This type of lipid peroxidation, caused by tocopherol species would be inhibited by addition of ascorbic acid, which act as a reducing agent [26].

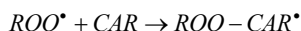


**Figure 9. Reaction between  $\alpha$ -tocopherol and lipid peroxy radicals.** Adapted from [24]

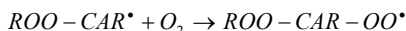
Carotenoids are the group of the most effective antioxidant, which are abundant in nature [2,7,27]. It has been known, that these compounds lose their color, than exposed to radicals or to oxidized species due to the interruption of conjugated double bonds system. The carotenoid crocin contained in the plant saffron. Lose of color of this water-soluble carotenoid serves as a measure for determining antioxidant capacity in serum plasma and plant extracts. One of the most potent product of carotenoid oxidation is retinoic acid, which participated in the processes of bones synthesis and embryo development, but it is considered a potent teratogen. There are at least three possible mechanisms for the reaction of carotenoids with radicals: 1) radical addition; 2) electron transfer to the radical; 3) allylic hydrogen abstraction [27].

**1. Radical addition: adduct formation.** Burton and Ingold first proposed the mechanism of addition reaction [28]. They supposed that lipid peroxy radical  $ROO\cdot$  would added to carotenoid polyene chain (CAR) with radical  $ROO\cdot$ -CAR $\cdot$  formation. Since this radical would

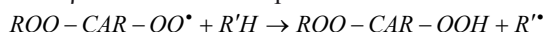
be resonance stabilized it would further interact with lipid radicals that would accounts for the antioxidant effect of carotenoids in solution:



However, the subsequent reactions of ROO-CAR<sup>•</sup> radical are not well understood. Antioxidant activity of carotenoids depends on oxygen tension. Therefore peroxy radical-carotenoid adduct ROO-CAR<sup>•</sup> could reversibly react with molecular O<sub>2</sub> to form a new peroxy radical as follows [27]:



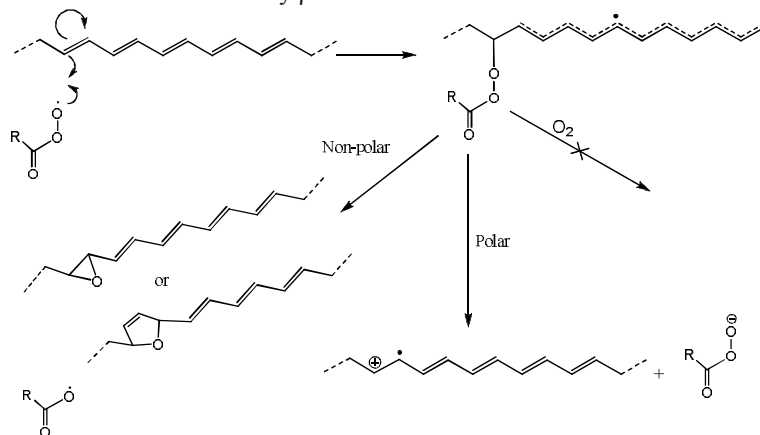
At sufficiently high partial oxygen tension ( $\geq 150$  mm Hg) this carotenoid peroxy radical can generate new radicals due to the cleavage of the resulting peroxy bond [27]. Thus, in this case carotenoids would act as a rather pro- than antioxidants since they could generate more radicals than capture. It is supposed that carotenoid peroxy radical can subtract atom hydrogen from R'H by ROO-CAR<sup>•</sup> giving rise to the new radicals [29]. They could further propagate lipids peroxidation and thus  $\beta$ -carotene act as a prooxidant:



Human blood plasma contains approximately 1-2  $\mu$ M carotenoids. At this concentrations and physiological oxygen pressure, a prooxidant ability of carotenoids is relatively low, whereas antioxidant activity have a big significance [27,30].

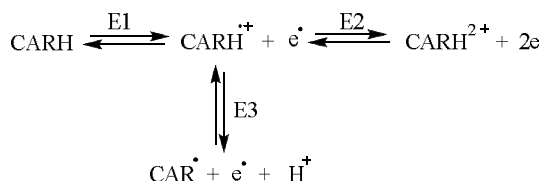
It has been reported by other authors that the carotenoid adduct does not react with molecular oxygen at certain conditions even at 100 % oxygen pressure [30]. The adduct, that being formed on the first stage due to the reaction between  $\beta$ -carotene and acylperoxy radicals, further being converted into the end products by two different ways dependently on the solvent polarity (fig.10).

Retinol (the first form of vitamin A, which was characterized) is a fat-soluble antioxidant, being converted from  $\beta$ -carotene by human organism. It is essential in appropriate amount for vision, bones functionality, immune system as well as for skin and hair health. Retinol and  $\beta$ -carotene are strong antioxidants, which being utilized as the therapeutic agents in cancer prevention, particularly they prevent recurrent tumor cells growth after operation. Retinol and  $\beta$ -carotene protect brain tissues against deleterious effect of free radical active species, most dangerous of them have neutralized by  $\beta$ -carotene.



**Figure 10. Scheme of interactions between carotenoids and acylperoxy radicals in both polar and non-polar solvents. From [31]**

2. **Electron transfer.** Reactions of this type give rise to the cation radical  $CAR^{\bullet+}$ , anion-radical  $CAR^{\bullet-}$  or radical  $CAR^{\bullet}$ . Carotenoid cation radical can be detected by laser flash photolysis [32]. The carotenoids in electron transfer reactions being acted as electron donors, while in certain conditions they play a role of atom hydrogen donors (fig. 11).



**Figure 11. Electron transfer reactions of carotenoids.** Adapted from [7]

The carotenoids are the donors of one or two electrons in electron reactions E1 and E2 respectively [7]. The easiness of electron elimination from carotenoid molecule depends on the nature of substituents [7]. The two carotenoids canthaxanthin and astaxanthin are distinguished by their reducing potential of transfer of two electrons ( $E1 < E2$ ), whereas for lycopene,  $\beta$ -carotene and zeaxanthin values of the reducing potential are almost equal [33]. Electron elimination from molecule of carotenoid, which have electron acceptor end group is very complicated. The lower electron acceptor degree of substitutes the smaller  $\Delta E$  (E1-E2) and cation radical would be reduced to carotenoid radical with reducing potential E3, which significantly lower than that E1 [7]. The values of standard reducing potential of cation radical of carotenoids (from 0,7 to 1,0 V) is not sufficiently low to serve as a hydrogen donor for alkyl ( $E^{\circ'} = 0,6$  V) or peroxy radicals ( $E^{\circ'} = 0,77 \dots 1,44$  V) of polyunsaturated fatty acids [34].

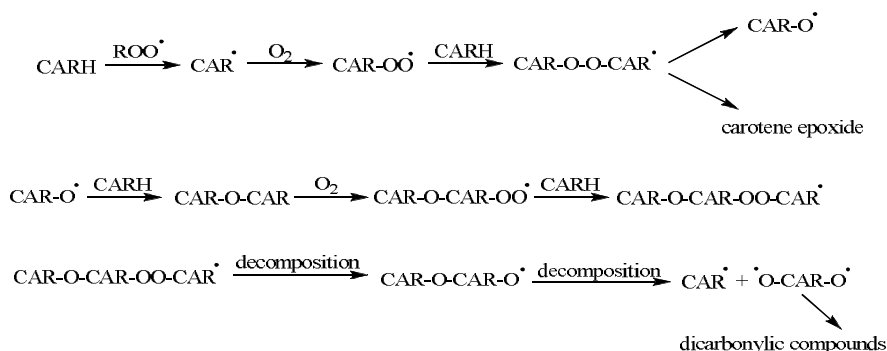
$\beta$ -Carotene can be a donor of electrons for free radicals resulted in  $\beta$ -carotene cation radical formation [7,35]. The carotenoid cation radical is resonance stable to such an extent that its reaction with molecular oxygen is negligible [36]. However, tocopherols, ubiquinones and also tyrosin and cysteine might be easily oxidized by  $\beta$ -carotene cation radical.

The hydroxyl radicals with high reducing potential (2,31 V) more easy abstracted atom hydrogen from carotenoids than alkylperoxy radicals [7]. Lycopene cation radical has the lowest value of reducing potential (0,748 V), it farther increased from cation of the  $\beta$ -carotene (0,78 V), zeaxanthin (0,812 V) and xanthaxantine (0,93 V). Astaxanthin is a weaker antioxidant than zeaxanthin [7,37].

When lycopene reacts with superoxide anion radical  $O_2^{\bullet-}$ , the anion radicals  $CAR^{\bullet-}$  were formed:

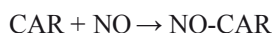


3. **Hydrogen abstraction.**  $\beta$ -Carotene with certain restrictions can play a role of donor of atom hydrogen for peroxy radicals give rise to the cation radical [7,27,28]. It is supposed that latter is relatively stable due to delocalization of unpaired electron within conjugated polyene. It can react with lipid peroxy radicals at low oxygen concentration resulted in the non-radical caroteneperoxide formation. The molecules of oxygen would be bounded to carotene-radical, and the formed adduct further interacted with other molecule of carotene producing, carotene epoxides and carbonyl compounds of carotene (fig. 12).



**Figure. 12. Reactions of β-carotene with peroxy radicals.** Printed from [7]

An example of hydrogen abstraction is an interaction between β-carotene and nitrogen monoxide contained in cigarette smoke resulted in the formation of 4-nitro-β-carotene:

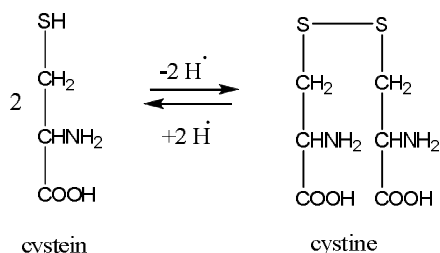


Thus, the carotenoids are potentially useful for smokers because of decreasing of quantity of toxic oxidants contained in tobacco smoke.

Single electron or hydrogen atom transfer from carotenoids to food radicals depends on their reducing potential and chemical nature of carotenoids, especially on presence of hydroxyl groups. Single electron transfer reaction between free radicals and carotenoids can be relieved if alkylperoxy radicals contain electron acceptor groups R.

Ascorbic acid, glutathion and cystein, which have properties of scavengers of free radicals, act as donors of atom hydrogen, producing more stable glutathion and ascorbic acid radicals. Further, ascorbic acid radical are converted to dehydroascorbic acid. Food free radicals are also inactivated by aminoacids, containing sulfhydryl and hydroxyl groups, such as cystein, phenylalanine and prolin. The competition between proteins and lipids for food free radicals may occur [7].

The cystin and cystein aminoacids are playing an active role in redox reaction occurring in biochemical processes of breathing, metabolism, nervous system due to the reversible cystine-cystein interactions (fig. 13).



**Figure. 13. Cystine-cystein interactions**

Trehalose is a thermodynamically and kinetically the most stable nonreducing disaccharide, which can perform specific function of a free radical scavenger for superoxide anion radical  $O_2^-$  and hydrogen peroxide [38].

### **Chelates formation**

The cations of transitional metals are good promoters of peroxidation favoring decomposition of peroxides, which were formed on the early stages [2,9]. It leads to the radicals formation, which being participated in the radical chain reactions of autooxidation. Fats, oils and other foods containing a traces of heavy metals, full removing of which is economically unsuitable. The most widely utilized metals in food industry are copper, cobalt and iron and in the lesser extent manganese, chromium and aluminium. They incorporated into the food products from raw materials and on food processing and packaging [2].

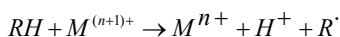
Metal ions are indispensable cofactors of many enzymes and metalloproteins. The proteins heme (contains ion  $Fe^{2+}$ ) and hemin (contains ion  $Fe^{3+}$ ) find widespread use in food products. Lipid peroxidation of animal foods can be accelerated by hemoglobin, myoglobin and cytochrome C. These reactions are responsible for rancidity development in meat and poultry food during storage. Peroxidase and catalase are the main sources of heme proteins in plant food [2].

Traces of transitional metals are solubilized during oils processing. These traces are passive physiologically, but are active prooxidants. Metal foils, cans and wrapping papers being served as a source of food contamination by metals, which diffuse into the oil phase [2]. Another source of transitional metals in food is the technological equipment. Metals can be incorporated into the oil phase during oilseed crushing.

The concentration of transitional metals depends on the nature of metal and fatty acids composition of fat. Edible oils, contained substantial quantities of linoleic acid, such as sunflower or corn oil, should contain no more than 0,03 ppm of Fe and 0,01 ppm of Cu, which is necessary to maintain oil stability. The concentration limit of Cu and Fe in fats with a high content of oleic or stearic acids is 0,2 and 2 ppm, respectively [2]. Raw oil contains transitional metals in a form of free cations or chelate complexes. Unrefined oils, such as olive and sesame contain significant quantity of metal cations [7]. Refinery of the oils leads to substantial drop of metals concentration.

The decomposition rates of hydroperoxides emulsified in water depends on pH. The optimal Fe and Cu activity lies in the pH range between 5,5 and 6. The presence of ascorbic acid accelerates the rate of hydroperoxides decomposition due to its ability to partially reduce cations of metals [2].

The direct oxidation of the unsaturated fatty acids by transitional metals with acyl radicals formation proceeds at very slow rate and doesn't affected on the initiation of autooxidation:



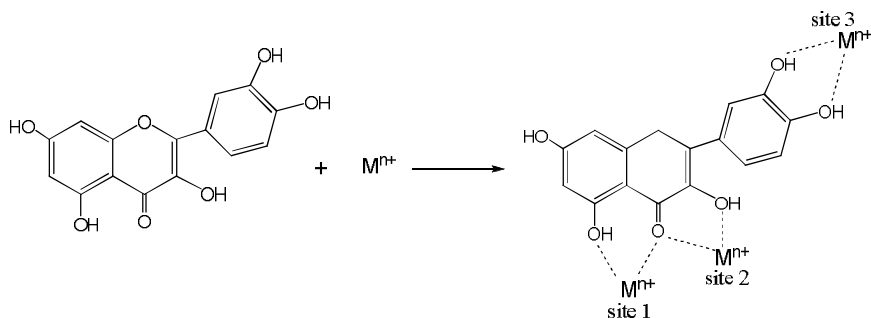
The activation energy for lipid oxidation, particularly on the initial stages was reduced by traces of metals resulted in the development of oils oxidation [7,39]. The values of activation energy for autooxidation of the refined, clarified and deodorized soy, sunflower and olive oils are 73,0; 79,5 and 52,3 kJ/mol, respectively [40]. Transitional metals are also catalyze food radicals formation by mechanism of atom hydrogen abstraction. Traces of Fe cations decrease oxidative stability of olive, favoring decomposition of phenolic antioxidants, such caffeic acid [41]. The metal cations, primarily  $Fe^{2+}$ , react with hydrogen peroxide by Fenton, producing reactive oxygen species, especially hydroxyl radicals [42]:

## — Food Technology —



The  $OH^\cdot$  radical is considered to be one of the most reactive radicals, its half-life in aqueous solution is approximately  $10^{-9}$  s. Unlike the hydroperoxides, which were metabolized by superoxide dismutase, the hydroxyl radicals cannot be removed during enzymatic reactions. Therefore, they react with all compounds of a substrate [7,43]. Transitional metals including copper, manganese and cobalt catalyze these reactions. Fenton reactions may lead to accumulation of the active radicals and so contribute to the initiation of biomolecules decomposition.

Chelate complexes formation inhibits the oxidation process due to: insoluble complexes formation, decreasing of the redox potential of metals, or providing sterical hindrance between metals and oxidized intermediates or components of food products. Citric acid and Ethylenediamine tetraacetic acid (EDTA) are the classical examples of chelate producers. The majority of the complexing agents are water soluble, while citric acid is a partially fat soluble. Phospholipids and flavonoids may also play a role of chelating agents [44]. Cations of transitional metals being bounded by flavonoids, activity of which depends on the structure features [45]. Presence of 3,4-dihydroxyl groups of B ring and 4-carbonyl and 3-hydroxy group of C ring, or 4-carbonyl group of C-ring and 5-hydroxyl group of A-ring can facilitate complex formation with metals at the certain available sites (fig. 14). Lignans, polyphenols, ascorbic acid and aminoacids, such as carnosine and histidine are bound to metals with chelate complexes formation.



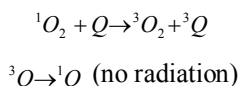
**Figure 14. The mechanism of flavonoids chelate complexes formation.** Adapted from [9]

The chelates formation with metals cations is an important process not only in food products. Fenton reaction occurs in the dopamine neurons of the nerve cells, where some quantity of hydrogenperoxide was formed by catabolism [9]. The formation of radicals is considered to be the main aetiological factor of the Parkinson's disease [42]. The significant accumulation of Fe cations in some brain tissues may be recognized as a marker of other neurodegenerative diseases, such as Alzheimer disease and Huntington's chorea [46,47]. Basal ganglia Fe content is increased in patient suffering from Alzheimer disease [48].

### Singlet oxygen quenching

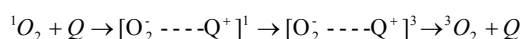
As it was mentioned above singlet oxygen is considerably more active than that of in triplet state. The cellular components (membrane lipids, enzymes, nucleic acids) e.t.c. may be imparted or destroyed by singlet oxygen. It can potentially transfer high energy to other molecules. Tocopherols, carotenoids, curcumin, phenols, urates and ascorbates are able to quench singlet oxygen [2,7,48]. Singlet oxygen quenching included both physical and chemical

components. Singlet oxygen deactivation and its transfer into the ground state is performed by physical quenching due to an energy loss or recharging. Quenching of singlet oxygen by energy transfer being occurred when energy level of a quencher (Q), is near or below that of a singlet oxygen:

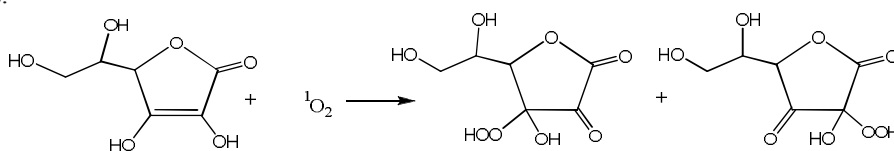


Carotenoids activity depends on number of conjugated double bonds in the molecule and the substituents in the  $\beta$ -ionone ring [7,50]. Carotenoids with 9, 10 and 11 conjugated double bonds quench single oxygen activity by energy transfer [2,7,9]. They are the better quenchers than those with 8 or less conjugated bonds.  $\beta$ -Carotene and lycopene, which contained 11 conjugated double bonds are the more effective quenchers of singlet oxygen, than lutein which has just 10 of these bonds [7,51]. These carotenoids can absorb the energy from the singlet oxygen, which further would be distributed over all the single and double bonds in the molecule. One molecule of  $\beta$ -carotene is estimated to quench up to 1000 molecules of singlet oxygen. The presence of conjugated keto groups or cyclohexaene ring favoring singlet oxygen quenching [7,52]. However,  $\beta$ -ionone ring substitution by hydroxyl, epoxy- and methoxy-groups resulted in the decrease of quenching activity of the carotenoids. The values of the rate constants of single oxygen quenching by canthaxanthin,  $\beta$ -apo-8'-carotenal,  $\beta$ -carotene and ethyl-apo-8'-carotenal are  $1,45 \cdot 10^{10}$ ;  $1,38 \cdot 10^{10}$ ;  $1,25 \cdot 10^{10}$  and  $1,2 \cdot 10^{10}$  l/mol·s, respectively [7].

The process is proceeded by charge transfer mechanism in the case of singlet oxygen quencher with high reducing potential and low triplet energy. These compounds included amines, phenols, sulfides, iodides, and azides and are the donors of electrons for singlet oxygen. They formed complex with singlet oxygen, which further would be transferred into the triplet state. In the last stage the triplet complex would be disrupted with quencher and triplet oxygen formation:



Chemical quenching is a chemical reaction between singlet oxygen and quencher with oxidized products formation [2,7,9,24].  $\beta$ -Carotene, aminoacids, tocopherols, ascorbic acid, peptides, and phenols can be oxidized by singlet oxygen, thus all of them are chemical quenchers [22].  $\beta$ -Carotene react with singlet oxygen at a rate of the  $5 \cdot 10^9$  l/mol s producing 5,8-endoperoxides [7]. The singlet oxygen and ascorbic acid react in an aqueous solution as follows:



**Figure. 15. Scheme of ascorbic acid hydroperoxides formation in the presence of singlet oxygen.**  
Printed from [7]

Tocopherol reversibly react with singlet oxygen, producing hydroxydienone, tocopherylquinone and quinonperoxide. The reaction rates for different isomers are:  $2,1 \cdot 10^8$



l/mol·s for  $\alpha$ -tocopherol;  $1,5 \cdot 10^8$  l/mol·s for  $\beta$ -tocopherol;  $1,4 \cdot 10^8$  l/mol·s for  $\gamma$ -tocopherol and  $5,3 \cdot 10^7$  l/mol·s for  $\gamma$ -tocopherol [7].

### **Photosensitizers deactivation**

Light radiation affected on the food quality [2,7,52,53]. Undesirable changes of food quality caused by milk oxidation resulted in deterioration, off-flavors development and profound reduction in the shelf life and nutritive value of food products [52]. Milk and dairy foods are the most sensitive food products to the light action due to the high concentration of riboflavin and vitamin B2, which are effective photosensitizers of oxidative processes.

The reducing of beer quality occurs by the same mechanism as a result of riboflavin oxidation [54].

Riboflavin is a water soluble vitamin, contained in meat and dairy food products, eggs, vegetables e.t.c. [52]. Flavines acted as photosensitizers due to their chemical interaction with substrate, components of which are in singlet or triplet state (I type mechanism), or physical interaction with triplet oxygen, producing singlet oxygen (II type mechanism) [7,53,55]. In the I type mechanism light radiation causes flavin excitation with further abstraction of atom hydrogen or electron transfer from corresponding compounds, such as aminoacids or flavonoids [56]. Its regeneration and superoxide anion  $O_2^{\cdot -}$  formation occur in the presence of oxygen [52,57]. In the II type mechanism triplet oxygen provokes formation of highly reactive singlet oxygen ( $E \sim 1,7$  V), which react with lipids and give rise to the hydroperoxides. It was reported earlier that milk and dairy products are oxidized by the type II mechanism [52]. Recently it has been found by some authors that the main mechanism is the second (type II) [52,58]. Aminoacids, purine bases, wheat proteins, phenols are certainly contained in foods in high amount supposed to be interacted with flavines in the excited state. The reaction rate between these compounds and flavines in the excited state is higher than that of flavines and oxygen [58]. Chlorophylles, contained in food products, are effective photosensitizers as well.

It is known that photosensitizers can be deactivated by vitamin C, carotenoids, flavonoids and uric acid [7,52]. Photosensitizers were deactivated mainly by carotenoids with less than 9 conjugated double bonds, while singlet oxygen was scavengered predominately by carotenoids with more than 9 conjugated double bonds [51]. The energy transferred to the surroundings by phosphorescence due to the interaction between carotenoid and photosensitizers. The distance between chlorophyll and carotenoid must be lesser 0,36 nm in order to overlap two electron orbitals between these pigments [37].

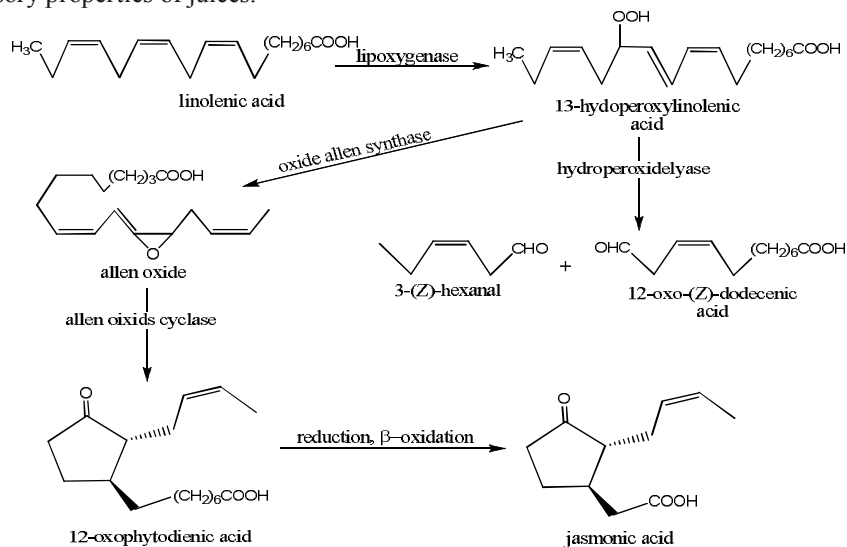
### **Lipoxygenase deactivation**

As it was mentioned above, the lipid peroxidation may be non-enzymatic and enzymatic. The latter is catalysed by lipoxygenase a lipid peroxidation enzyme that oxidize fatty acids giving rise to the hydroperoxides [2,7,59]. Lipoxygenase is widespread in food of animal origin and in common edible plants, particularly in the potato tubers and beans.

Linoleic and linolenic acids are the main polyunsaturated fatty acids, which have oxidized in the presence of oxygen with C9 and C13 hydroperoxides formation, respectively [2,59]. Certain isoformes of lipoxygenase are able to produce hydroperoxides, which are necessary for the jasmonic acid synthesis (fig. 16). The latter is playing an important role in the plants [58].

Lipoxygenases are responsible for quality loss of the juices, particularly melon juice, but the mechanism of lipoxygenase action is still not clear [60]. As it was mentioned above,

lipoxygenase causes oxidation of unsaturated fatty acids, 1,4-*cis-cis*-pentadienic system. This enzyme catalyzes the cooxidation of carotenoids, resulted in the color loss of food products. Furthermore, lipoxygenase causes formation of volatile aldehydes, and consequently the sensory properties of juices.



**Figure. 16. Scheme of linolenic acid oxidation by lipoxygenases in plants.**  
Printed from [60]

Wheat grains have different oxidases, particularly lipoxygenases, which affected on the metabolism of the antioxidants and may cause changes of antioxidant potential of the end products [59,61]. Lipoxygenases action on the unsaturated fatty acids leads to quality loss of food products as well as to changes of color and sensory characteristics. For example, color loss, that taking place in the processes of the pasta manufacturing, mainly accounted for by the lipoxygenase action on linolenic acid, that caused and oxidative decomposition of carotenoid pigments [2,59,62]. Frozen tomato cubes have been covered by layer of the modified starch, in order to prevent color loss, caused by lipoxygenases activity [59].

Lipoxygenase is a catalytic oxidative enzyme, which lost activity by heating at the temperatures more than 60 °C [7]. This procedure improves shelf life of the food products. Furthermore, heating leads to increase of non-enzymatic oxidation degree as well. Lipoxygenases can be deactivated by steam treatment of the soy beans at the temperature 100 °C during 2 min resulted in the substantial drop of concentration of peroxides and finally improved quality of soy oil. Lipoxygenases activity rises during ripening of fruits. This enzyme affected on the strawberry ripening, it causes the color development.

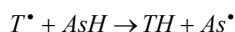
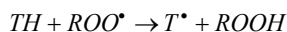
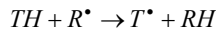
Generally, oxidative stability of lipid containing food products would be achieved in case of low exposure to the light radiation, high temperatures and air oxygen.

### Antioxidants interactions. Synergism and antagonism

Interactions between different antioxidants would be synergistic, antagonistic or additive. Synergism is a phenomenon which occurs if the total antioxidant effect is higher than the sum

of effect of each antioxidant. An example of synergistic antioxidant effect is the action of mixture of  $\alpha$ -tocopherol and ascorbic acid in the processes of lipids autooxidation and photooxidation [7,62]. Antagonism is an opposite effect that would be observed when the summary antioxidant effect lower than that of each antioxidant. An example of antagonism of the antioxidants is the action of mixture catechine and caffeic acid. The additive effect has observed when the summary effect is equal to the effect of antioxidant in mixture. Polyphenolic compounds, such as epigallocatechin gallate, quercetin, epicatechin gallate, epicatechin and cyanidine have an additive effect with  $\alpha$ -tocopherol, which play a role of free radical scavenger [7,63].

The synergism can be explained by different mechanisms of action of the antioxidants: combination of two or more free radical scavengers and thus primary protection of the certain antioxidant; combination of the two antioxidants with different antioxidant mechanism [7]. Regeneration of the most effective free radical scavenger (primary antioxidant) by less effective (coantioxidant, synergist) occurs at the large differences in reduction potentials of these two compounds. The free radical scavenger with bigger reduction potential serves as a primary antioxidant. The total antioxidant effect can be enhanced by regeneration of the primary antioxidant. The example of a such system is a mixture of tocopherol ( $E^\circ = 0,5$  V), which being acted as a primary antioxidant and ascorbic acid ( $E^\circ = 0,33$  V), playing a role of synergist [7]. The direct interaction of a tocopherol molecules (TH) with alkyl or alkylperoxyl radicals of food products would lead to the formation of tocopherol radicals, which does not have antioxidant properties [7]. Ascorbic acid (AsH) donates hydrogen atom to tocopherol radical, which favors tocopherol regeneration and giving rise to the semihydroascorbic acid radical (As $\cdot$ ), which can be further oxidized to give dehydroascorbic acid (DHAs) [65]:



Interaction between tocopherols and carotenoids and their regeneration is another, more complicated example of synergism. In this case carotenoids can be regenerated by tocopherols and vice versa. Though, carotenoids are regenerated predominantly due to larger value of the standard reducing potential of carotenoid cation radical (0,7-1,0 V) compared with that of tocopherol radical (0,5 V) [7,66,67]. It is well known that  $\beta$ -carotene disappeared soon after oxidation of oleic acid. However, duration of antioxidant activity of carotenoids have been increased from 100 to 1500 hours by  $\alpha$ -tocopherol addition [67]. Carotenoids can be regenerated from corresponding cation radicals by  $\alpha$ -tocopherol action. It is interesting, that in certain systems the interaction between carotenoids and  $\alpha$ -tocopherol may not to be occurred, for example at safflower oil oxidation [68].

Two antioxidants, which significantly differ by energy dissociation of O-H bond are considered to be synergists [7]. The bigger energy dissociation of O-H bond of synergist in compare with primary antioxidant the faster the regeneration rate [7,70]. The primary antioxidant can be regenerated as well in case of reaction rate constant at least  $10^3$  l/mol-s, whereas constant of reaction with peroxyl radical approximately equal to that of with antioxidant radicals [7,71]. Regeneration would be terminated by electron transfer from molecule of synergist to the antioxidant [72].

Synergistic antioxidant effect would observed when one antioxidant quickly oxidized and thus protected another [7]. The less active antioxidant scavengers alkyl and alkylperoxyl food

radicals, that resulted in the protection of the more effective antioxidant. In the other case antioxidant radical, that has been formed during oxidation of the less efficient antioxidant, being competed with more effective in reactions with alkylperoxyl radical, which reduce oxidation level of the more efficient antioxidant [7]. Interactions between tocopherols and carotenoids can partly proceed via the above mentioned mechanism [7,72].

The synergists may act as the hydrogen donors to the phenoxyl radical, thereby regenerating the primary antioxidants. The synergistic effect would be observed in case of two antioxidants with different mechanism of action [7]. It has been well established that the combination of metal chelators and free radical scavengers have synergistic antioxidant effect. Metal chelators, including phospholipids, citric acid, ethylenediamine tetraacetic acid are not truly antioxidants, but they are effective as the synergists. They inhibit metal catalyzed oxidation, and decrease total quantity of free radicals, which have captured by scavengers [43]. Metal chelators acted on the initiation stage of oxidation, while scavengers on the propagation stages [7]. Phosphatidylinositol act as a synergist in mixture with the tocopherols, reducing level of lipids oxidation due to inactive metal complexes formation [74]. Quercetin and  $\alpha$ -tocopherol are synergists, which inhibited oxidation of lard due to  $\alpha$ -tocopherol serves as free radical scavenger, while a quercetin acts as metal chelator [7]. Many synergists also provide an acidic media that improves the stability of primary antioxidants.

Antagonism has been observed between  $\alpha$ -tocopherol and both rosmarinic and caffeic acid, between caffeic acid and catechine or quercetin [75,76]. Plant extracts, rich in polyphenols have the antagonistic effect to the  $\alpha$ -tocopherol functionality in lard and safflower oil.

Antagonism between two antioxidants action would occur in case of: competition between formation of antioxidant radical adducts and regeneration of antioxidants; the less efficient antioxidant is regenerated by more efficient; predominant oxidation of the most efficient antioxidant by radicals formed from less efficient; interactions of two antioxidant in certain systems [75,76]. Antagonism of antioxidants occurring in oxidized food systems is still not clear [7].

The antioxidant properties depend on the environment in which they act [77]. As it has been shown by Becker and coauthors,  $\alpha$ -tocopherol and quercetin in emulsion are strong synergists, in liposomes synergistic antioxidant effect weaker, whereas in a dry sunflower oil these compounds have antagonistic effect. The mechanism of action of antioxidant in multiphase systems distinguishes from that of in oils, which can be explained by solvation effects. The authors suggested that antioxidant antagonism occurring in dry can arise through the formation of intermediates at elevated temperatures besides those formed from quercetin, which are susceptible to oxidation [76].

## **Conclusions**

Thus the mechanisms of action of natural and synthetic antioxidants has been analyzed. Understanding of mechanisms of action allows to select the most efficient antioxidant in a certain food system. Even a negligible (0,01-0,001 %) quantity of an antioxidant significantly inhibit processes of oxidation either in food systems and living organisms, in which strong intracellular antioxidant protection is complemented by extracellular. The main role in this system is playing vitamins A, C and E, antioxidant ferments: glutathione, glutathionperoxidase, superoxiddismutase, catalase e.t.c.

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## Some aspects of the formation of emulsions and foams in food industry

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**ABSTRACT**

Emulsions and foams are dispersed systems which are often presented in foodstuffs. A good knowledge of the structure and the mechanical properties of the external and internal phases as well as the interfacial films are essential for controlling the behaviour of such systems. Foods' macromolecules, such as proteins and polysaccharides, are widely used as functional ingredients of the formation and stabilisation of these systems. These molecules contain simultaneously polar and non-polar regions, which give them surface-active properties. During the emulsification or foaming processes, they rapidly adsorb and form the film at the surface of the oil droplets or gas bubbles. The objective of this article is a substantiation of the functionalities of surface-active agents and their usage in food industry.

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Recent experimental investigations of the stability of foam and emulsion have shown that milk proteins have excellent surface-active properties such as emulsification, gelling, foaming, water binding. However, milk proteins do not show the same behaviour: whey proteins are less surface-active than caseins, mainly because of their globular structure. Application of enzymatic hydrolysis is found to improve surface properties of whey proteins. Moreover, the surface-active properties of milk proteins increase when protein-polysaccharide complexes form in the interfacial region of emulsion and foam. The conditions and treatments of formation of multicomponent dispersed systems, which are stabilized by these protein-polysaccharide complexes, should be more investigated.

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### Introduction

Emulsions and foams form the basis of a wide variety of natural and manufactured materials used in the food [1-7]. One of the major concerns for dispersions is keeping the internal phase uniformly distributed during storage and consumption [6, 8-16]. This has led the food industry and many researchers to investigate the ability of hydrocolloids and proteins to stabilize emulsion and foam against creaming, flocculation, coalescence, drainage and coarsening, depending on their intended application [13-15, 17-19]. New ingredients are regularly incorporated into food systems to improve their rheological and physicochemical

properties. Therefore, understanding and monitoring the factors that influence the stability and shelf-life of prepared dispersion is critical for their continued success in the market place.

## **Material and methods**

The material of this research was articles of the international scientific journals published during 2000 and 2012 years, thesis and monographs of scientists of dispersion science. Methodology of the investigation is based upon the use of the methods of analysis, comparison and synthesis.

## **Results and discussions**

An emulsion may be defined as an intimate dispersion of at least one immiscible liquid in another in the form of discrete droplets (diameter in general ranges from 0.1 to 100  $\mu\text{m}$ ). A foam is a fine dispersion of gas bubbles in a liquid [20]. An interfacial layer between the two phases is occupied by some surface-active agents, such as proteins, polysaccharides, phospholipids, monoacyl glycerol esters etc. [6, 14, 17, 19]. The behaviour of foam and emulsion in foods is defined by these three parts of the system: the continuous phase, the internal phase and the interfacial layer [6, 16, 21].

Basically, there are three types of emulsions: oil-in-water (O/W), water-in-oil (W/O) and multiple emulsions i.e. oil-in-water-in-oil (O/W/O) emulsion or water-in-oil-in-water (W/O/W) [6, 20, 21]. O/W emulsion refers to the type of dispersion in which oil is dispersed as droplets in the continuous aqueous phase. Milk and cream are best-known oil-in-water emulsions, in which the milk fat globules are dispersed in aqueous phase containing milk proteins, lactose, salts and minerals. The fat globules are stabilized by natural surfactants i.e. lipoprotein membrane, phospholipids and adsorbed casein. Another food O/W emulsions are coffee whiteners, mayonnaise and salad dressing. In case of W/O emulsion, oil forms the continuous phase and water exists as the dispersed phase. Butter and margarine are common water-in-oil emulsions, in which aqueous phase, which consists of milk proteins, phospholipids, sugar and salts, is dispersed in fat cream or oils.

Milkshakes, beer, bread, cakes, meringue, marshmallow, aerated chocolate bars, vegetable paste foams, sorbet are examples of food foams. Moreover, food industry produces aerated emulsions (ice cream, whipped cream, toppings, etc.), in which air cells are covered with clusters of partially coalesced fat globules and adsorbed fat crystals together with proteins, stabilizing the foam. [6, 22].

Methods of the formation of emulsion and foam. Generally, food emulsions are prepared by using high shear equipment items, such as colloid mills, high speed blenders, high pressure valve homogenizers that emulsify an oil phase and an aqueous phase together in the presence of a surface active agent [6, 17, 19, 21].

The basic procedure is to force a coarse mixture of oil and aqueous phases through a narrow slit under the action of high pressure, resulting in cavitation, intense laminar shear flow and turbulence. Input of mechanical energy subdivides the droplets of internal phase until they reach the final average droplet diameter, in the range 1-100  $\mu\text{m}$  [6, 19, 20]. Mechanical stirring of an oil-water mixture forms drops of liquid that are distorted into cylinders (along the lines of flow) and that break up into smaller droplets. The process is repeated until the droplets are so small they cannot be further distorted and subdivided ceases. A suspended liquid drop forms a sphere, because this shape has minimum surface area (hence minimum interfacial free energy)

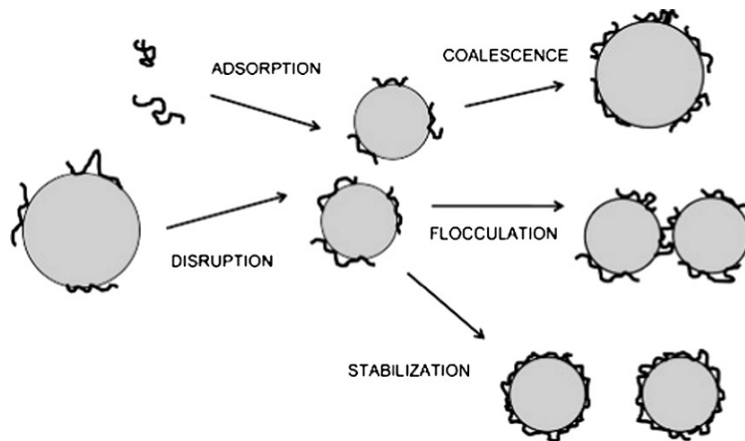
for a given volume. At the same time, the surface active agents, such as emulsifiers being structurally amphiphilic molecules (having both hydrophobic and hydrophilic moieties), are adsorbed at the oil-water interface, creating a stabilizing interfacial layer [6-8, 14,17].

Concerning the energetics involved, foam is nearly identical to an o/w emulsion. The mechanism of air incorporation and subdivision in a foam is the same as for an emulsion: large bubbles are elongated, and the unstable cylinders spontaneously divide [20].

Bubbling and stirring are the two main categories of mechanical methods for foam formation [1, 16, 20]. In the bubbling methods the foam is generated by bubbling gas through the foaming solution. Bubbling can be realized through a single capillary, a set of capillaries, or a porous plate placed in the lower part of the foam generator.

In the stirring methods foam is generated by mechanical mixing of the gas and liquid phases, e.g. by whipping or by mixing with a stirrer, by shaking a vessel partially filled with solution, by simultaneous flow of gas and liquid in a tube, by pouring liquid on the surface of the same solution, etc [1, 20].

Interaction between surfaces. An emulsion having been formed, the oil droplets tend to flocculate and coalesce due to attractive forces. Flocculation has been described as the reversible aggregation mechanism, which arises when droplets associate, due to unbalanced inter-atomic attractive and repulsive forces [6, 18, 20]. On the other hand, coalescence refers to a completely irreversible increase in droplet size gradually leading to the separation of the oil and the aqueous phase (fig. 1).



**Fig. 1. Illustration of main physicochemical processes involved in making of emulsions [18]**

One of the keys in preparing a stable emulsion is to form small oil droplets in a continuous aqueous phase with sufficiently high viscosity to prevent coalescence of the oil droplets [6, 12, 14, 19]. A thermodynamical balance between the emulsion phases is assured by an emulsifier (proteins, polysaccharides, phospholipids), which decreases the interfacial tension and keeps the emulsion stable. An emulsifier should have sufficient hydrophobic groups to strongly adsorb onto the oil-surface and hydrophilic groups to spread out in the aqueous continuous phase, and thus reduce the interfacial tension [19, 17]. The ability of an emulsion to resist any alteration in its properties over the time scale is named the term «emulsion stability» [6, 8, 21].

Foam stability is governed by similar factors as emulsion stability. After a foam formation several processes occur each of them leading to foam destruction [16, 23, 24]:

liquid drainage;  
bubble coalescence;  
bubble disproportionation.

The incorporated bubbles are usually stabilized by proteins and other food macromolecules which, being surface active, adsorb onto the bubble surface and prevent coarsening or drainage due to coalescence by modifying the interparticle forces as well as by providing interfacial rheological properties [16, 23, 24].

Thus, the protein molecules unfold with the hydrophobic side chains entering the air phase and the hydrophilic chains remaining in the water phase. The portion of the proteins located in the aqueous phase hold water, preventing it from draining away from this region and hence preventing the air bubbles from coalescing and destabilizing the foam.

Many polysaccharides being hydrophilic, they do not adsorb at the interface. However, they can enhance the stability of foam by a thickening or a gelling effect of the aqueous solution [24]. Some studies have evidenced an additional role of polysaccharides at the interfacial film [25]. Polysaccharides can interact with adsorbed proteins to form protein-polysaccharide complexes which can increase both the rigidity of the interface and the surface activity of the protein [25, 27]. Aqueous mixtures of proteins and polysaccharides can exhibit various phenomena including complex coacervation, miscibility and segregation [25, 27]. Complex coacervation mainly occurs below the protein isoelectric point as a result of net electrostatic interactions between the biopolymers carrying opposite charges and implies the separation of two phases, one rich in complexes biopolymers and the other phase depleted in both [26].

The stability of aerated emulsions e.g. ice cream, whipped cream is related both to the amount of fat globules adsorbed around the air cells and to the formation of clusters of fat globules between air cells, linking them together in a structural matrix [22].

Emulsifiers and stabilizers for the food industry. Milk proteins and particularly whey proteins are widely used as emulsifying and foaming agents in diverse food products thanks to their unique interfacial properties. Milk proteins in soluble and dispersed forms have excellent surface-active and emulsion-stabilizing properties (film forming, water binding and whipping abilities) [3, 13, 18, 23, 28].

Proteins form different interfacial films and do not show the same behaviour. Differences in the abilities of milk proteins arise largely from the differences in structure, flexibility, state of aggregation, and composition of the proteins. The sequence of surface activity for milk proteins is  $\beta$ -casein > monodispersed casein micelle > serum albumin >  $\alpha$ -lactalbumin >  $\alpha$ s casein =  $\kappa$ -casein >  $\beta$ -lactoglobulin > euglobulins [28]. The  $\beta$ -casein is the most important milk protein fraction because of its high surface activity and flexible nature, due to numerous proline residues, little ordered structure and negligible intermolecular cross-links [13, 28].

Protein molecules change their charging and surface activity with pH and accordingly their foamability and emulsifying properties are also altered.

Thus, whey proteins enable the formation of very small air bubbles (average diameter of 15  $\mu\text{m}$ ) which do not evolve significantly during the first day following the foam formation: no coalescence, no ripening, and no drainage during the first 24 h. On the contrary, the evolution of sodium caseinate stabilised foams is quite different: the average bubble size grows very quickly, and after only a few hours, the foams do not exist anymore. All the liquid drained and the bubbles disappeared. A clear relationship between surface elasticity and foam stability has been found. At least in the case of whey protein aerated systems a high surface elasticity improves foam stability, interfacial films being more resistant and the protein network constituting a mechanical barrier towards rupture of the bubbles and coalescence [29].

It has been studied that there is little differentiation between the products containing the aggregated and non-aggregated casein (i.e. milk protein concentrate and skim milk powder) for emulsifying ability, creaming stability, surface coverage and composition of the interfacial layer. The non-aggregated sodium caseinate and whey proteins have similar emulsifying abilities, which are greater than the aggregated casein. The surface coverages for emulsions made with sodium caseinate and whey protein are approximately 10 times lower than the aggregated casein samples. The casein composition of the interfacial layer in emulsions made with milk protein concentrate and skim milk powder is independent of protein concentration. For sodium caseinate,  $\alpha$ -casein replaces  $\beta$ -casein at the interface as the total protein concentration is increased. The creaming stability of the emulsions shows large differences between the aggregated caseins, the non-aggregated caseins and the whey proteins. The behaviour of sodium caseinate, in particular, is anomalous [13, 18, 31]. It has been proved that the surface tension behavior of sodium and calcium caseinates is similar but the foaming properties are differed. Sodium caseinate presents better foaming properties than calcium caseinate [12, 30, 31].

The addition of monoglycerides reduces the amount of adsorbed protein, except for emulsions produced from heated protein solutions containing high proportion of whey protein, for which an increasing has been observed. Monoglycerides are also effective in reducing coalescence of emulsions containing casein. Pure whey protein emulsions have no coalescence but considerable creaming upon storage. However, emulsions containing casein show extensive creaming and coalescence upon storage. [32] It was found that the interfacial layer forming surfactants such as the sodium stearyl lactylate or the mono-, diglyceride induced a better foam stability and a lower gas permeability coefficient through a gas/liquid interface than a whey protein isolate [33].

It has been documented that heating has an impact on the particle size of emulsions stabilized with milk proteins [28]. Thus, the particle size distribution (pH 6.8) shifted from below 1  $\mu\text{m}$  prior to heating to 1-10  $\mu\text{m}$ , when heated at 140  $^{\circ}\text{C}$  for 80 s. This increase in particle size distribution is attributed to fat globules aggregation, which resulted from interactions between non-adsorbed protein molecules in the serum phase and proteins adsorbed at the interface of fat globules [34].

The impact of thermal processing on the milk protein structure concerns mainly the whey proteins, whereas caseins seem to have a protective effect against denaturation of the serum proteins. Heat treatment of milk proteins prior to emulsion formation is proved to reduce the protein ability to form stable coarse particles, when whey proteins are involved in the process. However, the addition of small amounts of sodium caseinate can substantially improve the heat stability of a protein-based emulsion system [9, 12].

Whey proteins are less surface-active than caseins, mainly because of their globular structure. Although their solubility characteristics are good, their ability to stabilize emulsions and foams are poor, and this limits their use as food ingredients. Application of enzymatic hydrolysis improves surface properties of whey proteins. However, if the degree of protein hydrolysis is not controlled, foam and emulsion stability is decreased drastically. The literature indicates that large molecular size and hydrophobicity of peptides produced by enzymatic proteolysis are important factors to consider for the improvement of the surface activities of proteins [10,11]. As estimated by the particle sizes, the maximum emulsifying capacity has been obtained from hydrolyzates with a 10 or 20% degree of hydrolysis. Higher hydrolysis results in peptides that were too short to act as effective emulsifiers, and, at lower proteolysis, the somewhat reduces solubility of the hydrolyzates slightly decreases their emulsifying power. All of the emulsions are unstable when they are subjected to heat treatment at high

temperatures (122°C), but emulsions prepared from the less hydrolyzed peptide mixtures are stable to heat treatment at 90°C for 30 min [35].

Non-ionic food-grade emulsifiers as well as proteins are commonly used in food industry e.g. in soft baked products. However, the presence of emulsifiers leads to different foam behaviour. Both foams stabilised by sucrose stearate and by monodiglyceride contain small bubbles, shortly after their formation, with quite a certain polydispersity of the bubble size. After 1 day however, the samples are not any more similar. Whereas the average bubble size of foams stabilised by monodiglyceride doubled in 24 h, the one of foams stabilised by sucrose stearate remained quite the same [29].

Compared to the other emulsifiers and proteins, monodiglyceride in  $\alpha$ -gel is the most effective in terms of foamability (Table 1).

**Table 1. Gas volume fraction of foam stabilised by different kinds of surfactants [29]**

<i>Surface active agents (concentration is 0,5 wt %)</i>	<i>Micellar caseins</i>	<i>Sucrose stearate</i>	<i>Sodium caseinate</i>	<i>Whey proteins</i>	<i>Monodiglyceride in <math>\alpha</math>-gel</i>
Gas volume fraction (%)	10	50	50	60-65	80

When both proteins and non-ionic emulsifier molecules coexist in the bulk, the two kinds of molecules compete at interfaces. The effects of low-molecular-weight surfactants on the interfacial rheology of protein films depend on their nature and their concentration relative to protein concentration. The sucrose ester, which is water-soluble, appears to be more effective in adsorbing at the interface and displacing proteins than those which are oil-soluble e.g. lactylated monodiglyceride [12, 29].

Recently, the structure of complexes an aqueous mixture of pectin and a protein, lysozyme, was described in detail. The globular complexes were characterized and showed a strong similarity with aqueous mixtures of lysozyme with a synthetic polymer, sodium polystyrene sulfonate [26].

A protein-polysaccharide coacervation at the air/water interface is an efficient process to increase foam stability. Carrageenans, gum arabic, tragacanth gum have been reported as effective thickeners, stabilizing and gelling agents in food and beverages [14, 15, 36]. It has been noted that egg-albumin/ $\kappa$ -carrageenan at pH below the protein isoelectric point are the most efficient systems to stabilize air/water interfaces in food foams such as marshmallow, Chantilly and mousses [37]. However, the relatively high cost, large quantity required, and problems associated with obtaining a reliable source of consistently high-quality gums and carrageenans have led many food scientists to investigate alternative sources of biopolymer emulsifiers. Hydrophobically modified starches have been identified as one of the most promising replacements. It consists primarily of amylopectin that has been chemically modified to contain nonpolar side groups. These side groups anchor the molecule to the bubble surface, while the hydrophilic starch chains protrude into the aqueous phase and protect air bubbles against aggregation through steric repulsion [36].

The presence of polysaccharides in protein stabilized emulsions can have variable effect on stability and rheological properties. Hydrocolloids are added to increase the stability of the interfacial film separating the droplets that prevent coalescence. Moreover, there is no effect of pH, calcium chloride concentration, or temperature on emulsions stabilized by gum arabic or modified starch. In contrast, droplet aggregation of whey protein-stabilized emulsions is strongly dependent on pH, calcium chloride concentration, and temperature [36, 38].

The carbohydrate addition (glucose, sucrose, starch and inulin) in whey protein suspensions significantly enhances foam stability. Similarly, the emulsion stability increases in suspensions prepared with whey protein isolate and  $\beta$ -lactoglobulin in combination with mono and disaccharides, while significant decrease is remarked in model suspensions prepared with inulin and starch addition. [39].

## Conclusions

Being the most desirable feature for the consumer the emulsion and foam stability significantly influences on the product quality. Up to now, both proteins and polysaccharides are in a scope of interest of the dispersion science. Proteins being an indispensable component of all processed foods have proved to be effective functionally, providing the necessary stability and rheological properties to the final food products, because of their naturally amphiphilic nature and surface active. The combined presence of proteins and polysaccharides strongly increases the emulsion and foam stability. The conditions and treatments of formation of multicomponent foam and emulsion which are stabilized by protein-polysaccharide complexes, should be more investigated.

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## Assessment of prospects using the latest technology stabilization of beverage

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<b>Keywords:</b> Stabilization Microbial cells Bacteria Pasteurization Concentration	<b>ABSTRACT</b> The article presents information related to microbiological stabilization of carbonated and non-carbonated beverages, including high energy value from raw materials of plant origin due to the choice of parameters and modes of heat treatment. An analysis of the possible varieties of microflora in beverages and provides information on the selection of pasteryzatsiynyh units for its inactivation. Analyzed the relationship between osmotic pressure, pH environment and the content of carbon dioxide in beverages and their impact on the stabilization of beverages. These schemes the terms sustainability carbonated and non-carbonated drinks in the absence of these chemical preservatives.
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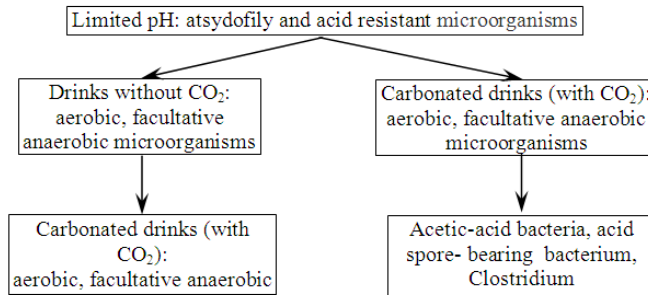
Ensuring the quality of Ukraine's population drinks, berry, fruit and vegetable juices require further development as a source of raw materials and processing technologies incoming material flows. An important part of production processes is to ensure microbiological purity products, or at least create a bacteriostatic environment [1-3]. Obviously, the requirement of 100 percent level guarantees aseptic condition significantly narrows the choice of methods of the latter. In this choice recently in Ukraine palm belonged thermal processing methods of products at pasteurization and sterilization. However, in the last decade rapidly growing use of chemical preservatives, including uncontrolled, creating another environmental problem.

Assessment of prospects for technologies that have a different basis to ensure stabilization of quality indicators drinks and juices is the purpose of this study.

Beverage industry higher energy value from raw materials of plant origin continues to grow, requiring revision for these microbiological requirements. Usually in these drinks no pathogenic microflora and bacteria resistant. Experience points to the possibility of the emergence and development of these acidophilic or acid-fast bacteria (Fig. 1).

In this regard, drinks, saturated with carbon dioxide may produce no heat treatment provided microbiological purity blending and packaging equipment. However, the desire to "nationalize" products based on cherries, grapes, red berries and so leads to the fact that pH 3,7 and carbon dioxide content of 6 g / l did not provide microbial protection, as is the case in orange drinks. There have been indications that this is a consequence of the ingestion of drinks lactic bacteria (*Lactobacillus perolens*) for packaging [3]. High level of risk associated with

high malic acid under the influence of lactic acid bacteria is converted into lactic. The result of these changes is to increase the pH or at least stabilization of the latter.



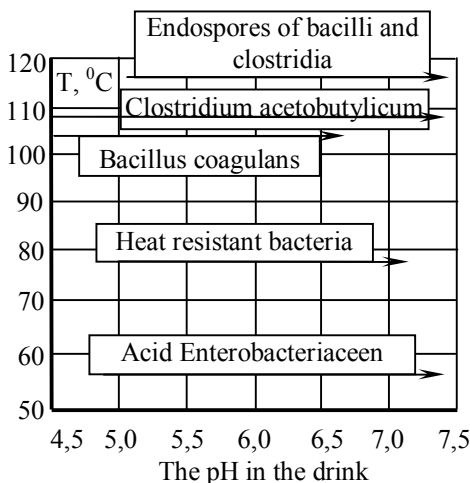
**Fig. 1. Scheme on varieties of microorganisms in beverages**

The desire to increase the biological value of drinks leads to the use of insoluble additives as ballast substances, flour from grain or fruit cells. Around these substances can be created "alkaline island" in the micro environment of germinating endospores of bacilli and kostrydiy, which will result in total damage output even with accurate exposure modes of heat pasteurization.

In these "alkali islands" also can develop pathogens (*Bacillus cereus*, *Clostridium perfringens*, *Staphylokokken*, *Enterokokken*) and thus offset the effects of such selective factor, which is the pH.

The only solution in such cases is still increasing number sterilized units, the determination of which is necessary to take into account the types of microorganisms (Fig. 2).

Among the influential factors to yield beyond regulated mikrobiological standards are upgraded to 0.1 - 0.2 mg per liter of zinc content. In lemonade and mixed drinks over time has



**Fig. 2. Dependencies temperature pasteurization at cutting beverages within 1 minute**

marked the rapid growth of yeast cells. However, the drinks limited presence of zinc content of yeast cells is not shown.

Named standart should be considered when designing new mixed drinks, and fortified with nutrients and growth substances "multi beverages" or other special drinks.

It is known that an important factor in staying microorganisms in bacteriostatic state is osmotic pressure environments. If concentrates (base) subject to pasteurization or drinks of various temperatures, the result of condensation on the surface of water vapor formed local area with low concentration of solids and limited osmotic pressure. This creates the conditions for a rapid exponential multiplication of microorganisms and increase their concentration to levels at

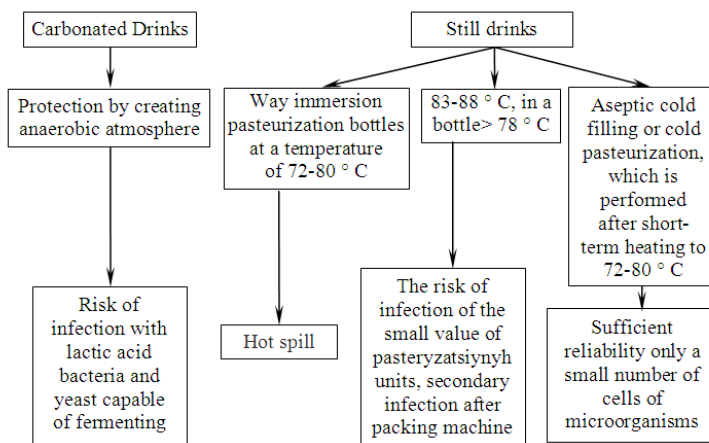
which products become unfit for further use.

In this regard, regulated microbiological standards not canned bases (Table 1).

**Table 1. Microbiological standards for non-canned bases**

Total cell	max	100	in	1 g
Yeast	max	5	in	10g
Disputes filamentous fungi	max	5	in	10g
Lactic acid bacteria	max	5	in	1 g
Acetic bacteria	max	5	in	1 g
E. Owl and bacteria Escherichia stick	absent		in	10g
Disputes bacteria	max	10	in	1 g

Effect of dissolved carbon dioxide in beverages has a dual character. Firstly it affects the pH, and secondly its effect is caused by increasing the osmotic pressure of solutions. For non-carbonated beverages without preservatives are necessary sterilized processing, the parameters of which are shown in Fig. 3.



**Fig. 3. Scheme to the terms of the sustainability of carbonated and non-carbonated beverages**

High demands from the standpoint of Microbiology take place for reasons that are used in the manufacture of yoghurt. A sample of the parameters of some of them:

- Banana-apple basis - 19o Brix, 2.6% acid, pH 3.4;
- multifruit carrot basis - 36o Brix, 2.6% acid, pH 3.4;
- orange-apple-strawberry basis - 33o Brix, 1.7% acid, pH 3.7.

Basics due to the high possibility of infection should packing aseptically and 100 g must be neither yeast or lactic acid and acetic acid bacteria. At 10 g should not be present disputes filamentous fungi. The total number of cells should not exceed 1 in 20 h, and the contents of spores of bacteria should be 10 / h. Under such conditions the resistance is 2-3 months at a temperature of 5-10 °C or 4-6 weeks at a temperature of 10-20 oC. Combining a mixture of

fruit and dairy products difficult situation microbiological and temperature pasteurization bases and finished beverages should exceed 85 °C. Although pH <4.0 should ensure microbiological stability, but significant presence in beverages particles of fruit is accompanied by the formation of "alkaline island" with all their consequences. Thanks to the latter, included with dairy products clostridia spores and spore-forming bacteria survive in parameters pasteurization.

## **Conclusions**

The information and analysis of the literature can note the following.

1. Refusal to use chemical preservatives in conjunction with the development of new fruit and berry foundations meet contemporary needs of society. The latter is particularly relevant with regard to baby food.

2. Select the number of units sterilized by heat treatment should be carried out with the minimum possible while maintaining aseptic packaging equipment.

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## Refinement of the physical and chemical methods for the determination of sugars

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**Keywords:**

Sugars  
Fermentable sugars  
Determination  
Express-analysis

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**ABSTRACT**

The purpose of the work is the comparison of the main existing methods for the determination of sugars to identify the most accurate and easy-to-use in the brewing industry. Experimentally there are optimal methods for determination of sugars for the use in laboratory and industrial conditions of the brewing industry. The correlated coefficients were determined between the results obtained by different methods for the adequate reflection of the main components of sugar share of wort and beer. The essential practical conclusion of the research is the methods for determination of sugars have a sufficiently high accuracy in the determination of the maltose concentration in wort. These methods are the most suitable for the control of kinetics and regulation of production processes.

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### Introduction

Beer brewing is a complex biochemical process flow of which depends on many factors. To achieve consistently high quality of the product it is necessary to monitor the main parameters of raw materials and intermediate product at all stages of production. Quantitative and qualitative determination of carbohydrates in the wort is one of the main parameters of cooking wort and beer.

Methods for determination of sugars are divided into physical and chemical. The first one are based on the change in the physical properties of solutions depending on the concentration of the test substances in them (the value of the refraction of light, the rotation of the plane of polarization of light, conductivity, density, optical density, etc.). The second one on the specific properties of these substances to enter into certain chemical reactions. Both the first and the second have some inaccuracies in the study of multicomponent systems, one of which is wort.

The aim of this work is the comparison of some existing methods for the determination of sugars to identify the most accurate and convenient one for use in the brewing industry. As the normative documents are regulated only the content of the extract [SSTU 3888-99].

## Material and methods

Model solutions were used as solutions of glucose and maltose in the wort and distilled water. Many methods for the determination of sugars require specialized and expensive equipment. Therefore, the choice we stopped at the most simple methods. For comparison were chosen next methods: refractometric, polarimetric, Bertrand method and iodometric (based on the oxidation of iodine aldoz).

## Results and discussions

As a result of the first series of experiments with aqueous solutions of glucose from 1 to 10% in 1% increments have the following results:

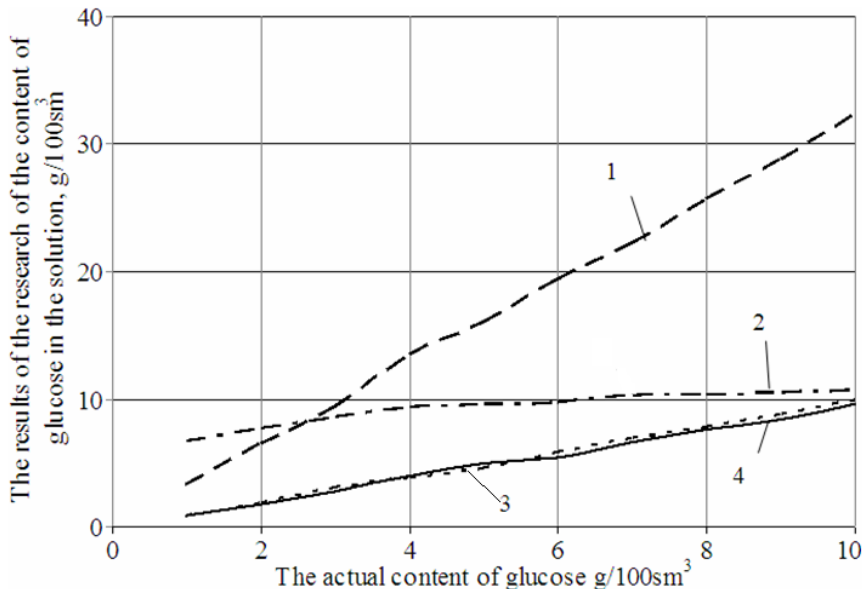
- physical methods for determining sugars (refractometric and polarimetric) were the most accurate;
- method of Bertrand had stable error, and showed an average of 3.23 times inflated results concerning index of refractometer;
- the ratio of the results by the method of Bertrand to sample is described by the formula (1):

$$y = 0,312x - 0,021, \quad (1)$$

where  $x$  – sugar content by the method of Bertrand,  $g/100sm^3$ ;

$y$  – the actual content of glucose  $g/100sm^3$ ;

the value of the reliability of approximation of this equation  $R^2 = 0,999$ ;



**Fig. 1. Comparison of methods for determination of glucose in aqueous solutions: 1 – Bertrand method; 2 – iodometric; 3 – polarimetric; 4 – refractometric**

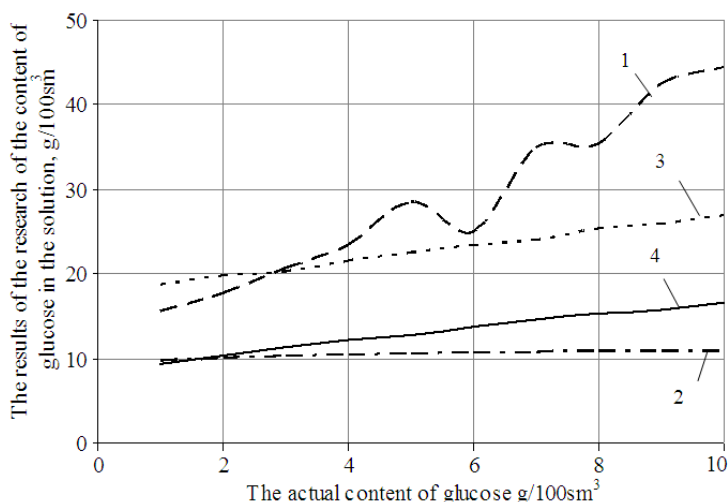
- the least accurate results had iodometric method which although showed a relative increase in the concentration of glucose, but did not have a dependency. This can be explained by the narrow range of working concentrations of this method.

In the second series of experiments the similar samples of glucose were diluted by wort 8.4% of dry substances and the measurement were repeated (Fig. 2). As a result the most linear results were again obtained by physical methods of analysis, however, indexes of polarimeter were larger than indexes of refractometer an average on 9.68. The dependence between these indexes is described by formula (2):

$$y = 0,870x - 6,708, \quad (2)$$

where x – indexes of polarimeter, %;

y – indexes of refractometer, %.



**Fig. 2. Comparison of methods for determination of glucose in wort:**  
1 – Bertrand method; 2 – iodometric; 3 – polarimetric; 4 – refractometric

The value of the reliability of approximation of this equation  $R^2 = 0,992$ .

By the method of Bertrand we have got jumping on indexes with every change of dilution which can be explained by the influence of substance of wort on the chemistry of this method. Iodometric method had no reliable results again and showed changes in the concentration of 1-st to the last sample only 1.22 g/100sm<sup>3</sup>.

The third series of experiments was conducted on aqueous solutions of maltose with the same concentrations (Fig. 3). As a result, we are seeing a high accuracy of all methods except method Bertrand, whose results are higher than the actual average of 1.18 times. The dependence of the data obtained by the method of Bertrand to the actual sample maltose expressed by (3):

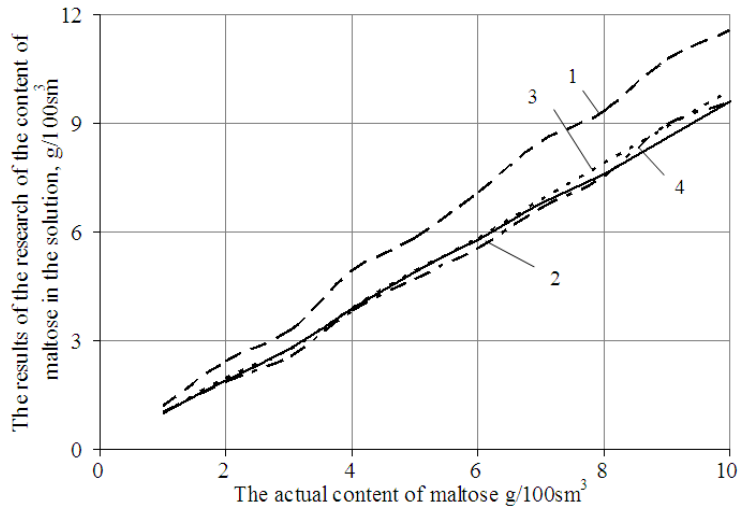
$$y = 0,847x, \quad (3)$$

where x – amount of sugars by Bertrand, g/100sm<sup>3</sup>;

y – actual content of maltose, g/100sm<sup>3</sup>.

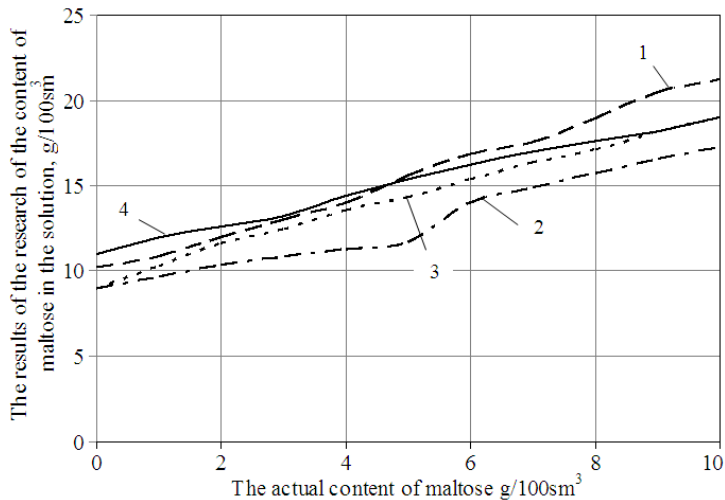
The value of the reliability of approximation  $R^2 = 0,997$ .





**Fig. 3. Comparison of methods for determination of maltose in aqueous solutions:**  
 1 – Bertrand method; 2 – iodometric; 3 – polarimetric; 4 – refractometric

The fourth series of experiments was carried out with solutions of maltose in wort 11% of dry substances (Fig. 4). These results have high correlation. Deviations from the average values  $f \pm 1,35-1,6$ . Modified breeding slightly impacted on the results of iodometric method. Physical methods had some inaccuracy because of insufficient transparency wort that was complicating removal of indexes.



**Fig. 4. Comparison of methods for determination of maltose in wort:**  
 1 – Bertrand method; 2 – iodometric; 3 – polarimetric; 4 – refractometric

### Conclusions

As a result of these studies physical methods (refractometric and polarimetric) have high accuracy in measuring the concentration of aqueous solutions of glucose, also method of

Bertrand which resulted in actual concentration is calculated by the formula  $y = 0,312x - 0,021$ .

Determination of glucose in the wort showed high accuracy only physical methods. On chemical methods greatly affect substances that make up the wort.

As a result of studies of aqueous solutions of maltose observed high accuracy of all methods except the method of Bertrand. Actual concentration dependence of the results obtained by the method of Bertrand described by the formula  $y = 0,847x$ .

All methods for determining sugars showed sufficient accuracy in determining the concentration of maltose in the wort and are allowed to control the dynamics of the processes.

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## Rye-wheat bread production at the restaurants

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<b>Keywords:</b>	<b>ABSTRACT</b>
Rye flour Bread Enzymatic additives	The technological process of dough-making of rye flour on accelerated technology with using of "Ibis" integrated (complex) bakery improvers is investigated. The Influence of "Ibis" improvers on the process of accumulation of acids, structural and mechanical properties of dough and quality of bread is analysed.
<b>Article history:</b>	It is set that using of "Ibis" integrated bakery improvers allows to reduce the duration of products maturation, provides high porosity and specific volume of bread. The results of our research showed that with using more improvers the porosity of the bread increases. It also increases the specific volume of bread; makes crumb more elastic, good taste and bread flavor.
Received 14.01.2013 Received in revised form 05.03.2013 Accepted 22.03.2013	Detailed laboratory baking and researching of viscosity, plasticity structural and mechanical properties of rye-wheat dough prove the effectiveness of using the integrated (complex) bakery "Ibis" improver for accelerated technologies of rye-wheat bread production. Using this improver will reduce the duration of technological process of bread producing while maintaining the quality of finished products.
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### Introduction

Producing and serving different dishes, restaurant institutions often use their own bakery and industrial products. However, it is their own production which gives them the opportunity to expand the assortment and produce products that can not be produced by mass baking.

Rye-wheat bread is very popular among the population. Also it is fact that they are much better for our health than wheat sorts. Rye bread contains a big amount of essential amino acids (such as lysine and arginine), as well as essential B vitamins, and PP. Comparing with wheat flour rye flour contains 30% more iron and twice more magnesium and potassium, which are necessary for our health. Moreover rye bread has less calories, as it contains less starch and more dietary fiber. Consuming this kind of bread has a positive effect on metabolism. For this reason, this bread is recommended for special diet at diabetes and obesity.

Rye-flour dough making technology is based on creating high acidity of the dough to reduce enzyme activity and increase swelling of proteins, pentosans and flour shell particles [1]. Based on the specifics of carbohydrate-amylase and protein complexes of rye flour, rye-wheat bread technology provides dough making with the use of leaven to produce high quality

bread. Thus the traditional technology of rye-wheat bread producing with liquid or dense leavens is quite difficult and labor-intensive.

Nowadays rye-wheat bread accelerated technologies are really actual, they are based on the using of acidulants, and integrated baking improvers. As this supplement we considered the possibility of using "Ibis" improvers for rye-wheat bread baking (LTD "Lesaffr Ukraine", Kyiv). "Ibis" - is an integrated Baking improver which is used for a speed-up rye-wheat bread production method that provides the necessary quality, acidity of bread and homogeneous structure of crumb porosity. The advantages of using IBIS are:

- Significant time savings of rye-wheat bread production;
- Simplification of acidity regulating procedure;
- Dark color of the crumb and pleasant taste and flavor of rye bread. The integrated baking improver "Ibis" contains barley malt flour, wheat flour and citric acid.

### **Material and methods**

During our research we used wheat flour of the first quality and rye flour with medium baking properties. We used an integrated Baking improver "Ibis", which is a brown powder with rye bread flavor.

In the laboratory environment a series of experiments on the use of integrated bakery improvers "Ibis" for rye-wheat bread production was conducted. Dough was prepared in speed-up way with adding 0.6%, 0.8% and 1.0% "Ibis" to flour in the dough.

Dough kneading process took place in a laboratory dough machine. Products were formed manually, maturation was led to completion at  $t = 30-32$  ° C and bread was baked at  $t = 200 - 220$  ° C. Titratable dough acidity was defined by mash. The changing of visco-plastic dough properties were investigated by the degree of its spreading during the fermentation process, the specific volume of the dough was defined by the changing of dough volume during the fermentation process in the graduated cylinder. Finished products were analyzed by the terms of acidity, porosity and specific volume of bread. [2]

The content of aromatics in bread was investigated by the content of carbonyl compounds, which are the main substances that form the bread aroma. Their concentration in bread was defined by the content of bisulphate connective compounds in bread crumb and crust. This method is based on the ability of carbonyl compounds to form compound products (adducts) with sodium bisulphate. This property of carbonyl compounds is taken as a basis for the method of bread aroma estimating, developed by PP. Tokarev and VL Kretovich.

### **Results and discussions**

Analysis of research results (Table 1) shows a positive effect of complex baking improvers "Ibis" on bread making process and its quality. Adding "ibis" contribute more intensity of acids accumulation in dough, which reduced the duration of products maturation and also had a positive affect on the taste qualities of bread.

Porosity index describes the structure of bread crumb, its volume and digestibility. Low level of porosity shows that bread is made of bad fermented dough. Analyzing the structure of bread crumb it was indicated that the porosity increases with adding more "Ibis" improvers. Increasing this parameter correlated with an increase in specific volume of bread, friability and elasticity of bread crumb and perfect look of products.

**Table 1. "Ibis" improvers Effect on bread making process and its quality**

INDEX	ADDING «Ibis», % to the main part of the flour in the dough		
	0,6 %	0,8 %	1,0 %
<b>Dough</b>			
Kneading duration, min.	5	5	5
Initial acidity, grad.	5,0	5,6	6,0
Duration of fermentation, min.	30	30	30
Duration of maturation, min.	50	45	40
Final acidity, grad.	6,8	8,0	8,2
Mass concentration of moist, %	47	47	47
<b>Bread</b>			
specific volume, cm <sup>3</sup> /g	2,13	2,17	2,37
Shape stability	0,36	0,38	0,39
Porosity, %	64	67	68
Acidity, grad.	6,2	7,4	7,8
Look	Right shape, smooth		
Crumb quality	Non-rigid		
Porosity	Equable		
Taste and flavor	Natural for rye-wheat bread		

The acidity of bread has real influence on its taste. The acidity also demonstrates the main features of bread making process. The acidity is caused by primary products acidity and products that are formed during the dough ripening.

One of the advantages of "Ibis" is a simplification of acidity control, so we investigated the changes of dough titrated acidity after its mixing and during its fermentation. The results of our research shows (Fig. 1), that adding "Ibis" improvers to dough increases the initial dough acidity to 0.4 - 1.2 deg, due to own high acidity of the improvers. During the fermentation dough acidity increases due to the intensification of the dough fermentation process. Adding "ibis" brought more intensive acid accumulation, which reduced the duration of products maturation and had a positive influence on bread taste.

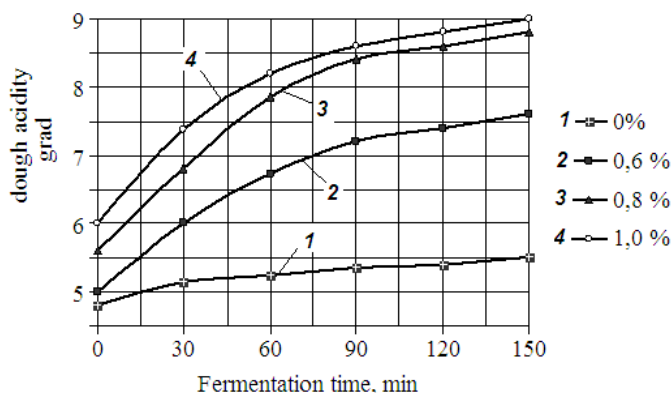
The Research of dough abilities to save its shape, which was conducted on spreading of the dough balls showed (Table 2), that increase amount of improver slightly affects the viscoplastic properties of the dough, which allows to get products with high shape stability and high quality.

**Tab.2. "Ibis" improvers effect on dough balls spreading, mm**

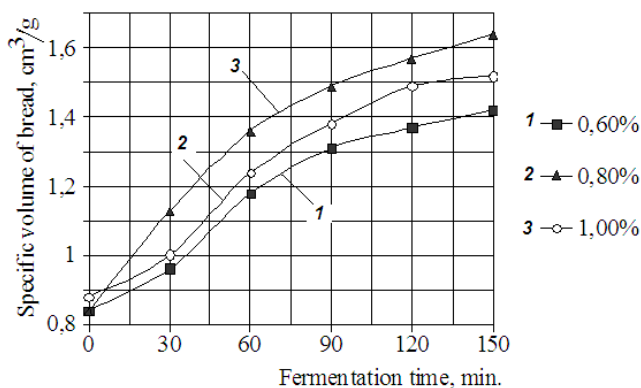
Duration of fermentation, min	Adding «Ibis», % to the main part of the flour in the dough			
	0	0,6	0,8	1,0
0	45	45	45	45
60	65	65	70	75
120	75	75	75	80
180	80	80	80	85

Structural and mechanical properties of the dough were studied at the changes of dough specific volume in a graduated cylinder at t = 30 ° C for 2 hours fermentation. Analysis of the

data showed (Fig. 2), that the largest specific volume of dough was in samples with 0.8% of "Ibis". These data correlate with the analysis of the finished products quality. So, adding 0.8% of "Ibis" baking improvers to the dough during the accelerated way of rye-wheat bread production is enough for high bread quality.



**Fig. 1** Dough acidity change during fermentation



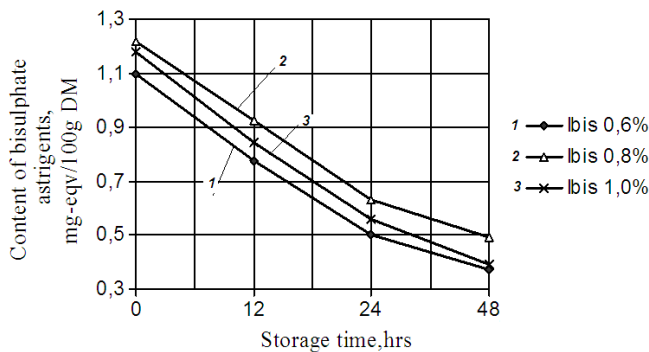
**Fig.2.** dough specific volume change with the adding of "Ibis" improvers

Assimilation of bread by the human body is mostly depend on its contain of the aromatics. Pleasant taste and flavor of bread cause the increased secretion of enzymes in the digestive system and this provides a fast and good assimilation of nutrients. Also we have studied the effect of "Ibis" baking improvers on of accumulation aroma making compounds during bread baking and their loss during the storage. We determined the number of carbonyl compounds, which mainly form the bread aroma. The evaluation of aroma was providing through the content of bread bisulphate astringent compounds in bread crumb and crust (Fig. 3, Fig. 4).

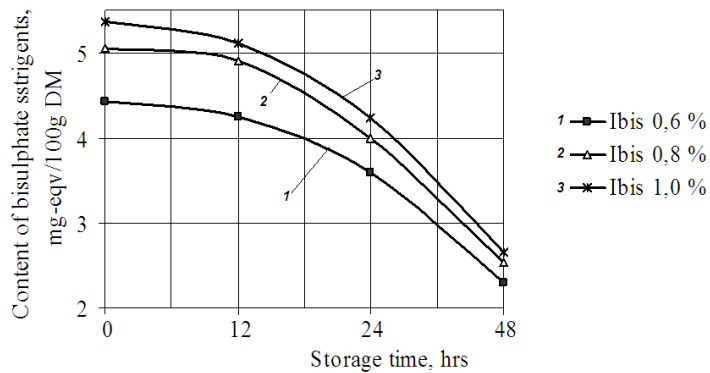
The amount of these compounds in bread increased with increasing adding of improvers to dough. During the storage bread lost its taste and flavor which is associated with biochemical and other processes that occur during bread firming. Bread crust lost its aromatics in the

environment, some of them goes from the crust into the crumb. Flavor impairment during the storage of bread can also occur due to oxidation of aldehydes by the air.

Results of our research showed (Fig. 3) that the content of bisulphate astringent compounds in bread crumb decreased, due to the redistribution of these substances into the bread crust. After 24 hours of bread storage aromatics content in all samples of bread decreased almost in half. The content of these substances in bread crust (Fig. 4) just after baking was 4-5 times higher than in crumb as it was caused by the formation of aromatics under high temperature during baking and as a result of melanoidin formation reaction. After 12 hours of storage bisulphate astringent compounds does not change, but during the subsequent storage their content in bread crust is significantly reduced, which requires more detail study of the bread firming process with adding "Ibis" bread improvers.



**Fig.3** Content of bread bisulphate astringent compounds in bread crumb with "Ibis" improvers.



**Fig.4.** Content of bread bisulphate astringent compounds in bread crisp with "Ibis" improvers

Conclusion. Conducting laboratory baking test and research of visco-plastic, structural and mechanical properties of rye-wheat dough confirm the effectiveness of the "Ibis" bakery improvers for the speed-up production of rye-wheat bread. Using this improver will shorten the process of bread production while maintaining high quality of finished products. Our studies have shown that the use of "Ibis" integrated bakery improvers is effective for accelerating

technologies of rye-wheat bread production. Using it provides high specific volume of bread, porosity, and as a result bread has good flavor and taste. Basing on our research, we recommend to produce rye-wheat bread with 0.8% of "Ibis" integrated bakery improvers to the most part of the flour. It won't only expand the range, but it will also improve the quality of finished products. During advanced research we are planning to do more detailed analyze of complex improvers impact on visco-plastic properties of the dough, to study the process of bread staling with the addition of "Ibis" integrated bakery improvers, to work out the recommendations for the speed-up technology of rye-wheat bread production in the restaurant institutions.

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## The regulation doses of sulfur dioxide with the aid of preparations, based on glutathione of yeasts in the production of pink table wine

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<b>Keywords:</b>	<b>ABSTRACT</b>
Rose wine Cabernet sauvignon Induced oxidation Glutathione Yeast Tannin Sulphitation Redox state Phenol	This research article presents study the influence of partial sulfur dioxide replacement by preparations based on yeast glutathione and tannin on the quality of rose table wine. The objects of research were rose table dry wine, made of Cabernet Sauvignon. The samples were prepared in conditions of micro winemaking by the scheme that included processing without maceration using preparations, based on glutathione of yeasts, tannin and sulfur dioxide. The preparations were added to the must before clarification at doses of 2 g/dal tannin, 2 g/dal preparation of glutathione and 50-75 mg/l sulfur dioxide. The influence of preparations and their doses in oxidation induced on change of the redox state of this type of wine was analyzed. The model system consisted of rose table wine, in which were added sulfur dioxide, glutathione of yeast and tannin. The influence of preparations on the organoleptic and physico-chemical quality and on the color change of rose wine was set. The use of preparations based on glutathione of yeast can increase the level of free sulfur dioxide, which will lead to better protection from oxidation, or the possibility of reduction the dose of sulphitation for equal level of protection
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### **Introduction**

Industrial production of wine involves the use of sulfur dioxide as a powerful antioxidant and antiseptic. However, scientists are looking for alternatives of its using. This is especially relevant in the fast-growing world of organic winemaking.

The main difference between biowine and industrial wine is the reduction of doses of sulfur dioxide. Its complete absence could lead to oxidation of fine table wines as white and pink [1].

The world-wide practice is to protect such wines from oxidation with help of sulfur dioxide and other organic-original antioxidants [1,2]. These include glutathione of yeast and tannin. Glutathione – is the tripeptide that formed by the remains of the glutamic acid, cysteine

and glycine - three amino acids. The presence of  $\gamma$ -peptide linkage protects tripeptide from decay by intracellular peptidases. Glutathione reduces disulfide bonds formed within cytoplasmic proteins to cysteines by serving as an electron donor. Its providing reductant properties to glutathione and the ability to inhibit the process of free radical oxidation of phenolic compounds. [1,3]. The tannins, in turn, remove natural oxidase of grape - tyrosinase and laccase. Since these enzymes in their chemical nature are the proteins, the tannins react with them at the classic reaction of tannin-protein. Due to its ability to capture oxygen tannins also have strong antioxidant properties and protects the wine from oxidation of its components [2,4].

Therefore, the aim of this work was to study the influence of partial sulfur dioxide replacement by preparations based on yeast glutathione and tannin on the quality of rose table wine.

### **Material and methods**

Objectives of the work included:

- To analyze the influence of preparations and their doses in oxidation induced, on change of the redox state of this type of wine;
- To set the influence of preparations on the organoleptic and physico-chemical quality of rose wine;
- To set the influence of preparations on the color change of rose table wine.

The objects of research were rose table dry wine, made of Cabernet Sauvignon. The samples were prepared in conditions of micro winemaking by the scheme that included processing without maceration using preparations, based on glutathione of yeasts, tannin and sulfur dioxide. The preparations were added to the must before clarification at doses of 2 g/dal tannin, 2 g/dal preparation of glutathione and 50-75 mg/l sulfur dioxide.

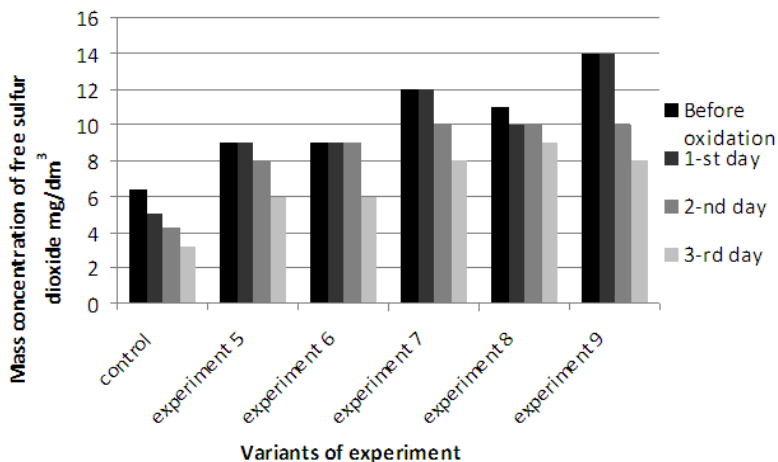
Induced oxidation of model systems was carried out in furnaces at  $t = 45 \pm 5^\circ \text{C}$  for 6 days with free air flow. The model system consisted of rose table wine, in which were added sulfur dioxide, glutathione of yeast and tannin. The scheme of induced oxidation presented in Table 1.

**Table 1. Diagram of experiments**

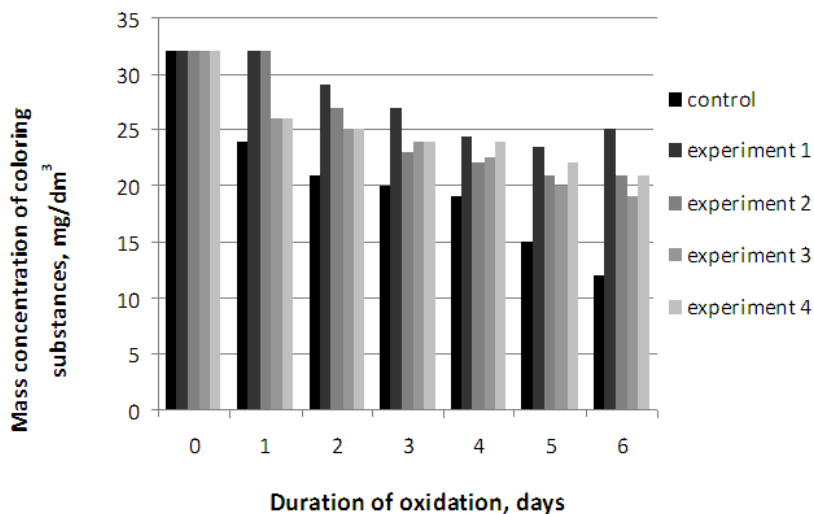
Series №1			Series №2		
The mass concentration			The mass concentration		
	Glutathione, g/dm <sup>3</sup>	Sulfur dioxide, mg/dm <sup>3</sup>		Glutathione, g/dm <sup>3</sup>	Sulfur dioxide, mg/dm <sup>3</sup>
control	-	150	control	-	150
experiment 1	0,1	150	experiment 5	0,2	50
experiment 2	0,2	150	experiment 6	0,2	75
experiment 3	0,3	150	experiment 7	0,2	100
experiment 4	0,4	150	experiment 8	0,2	125
			experiment 9	0,2	150

## Results and discussions

Figure 1 shows that the mass concentration of free sulfur dioxide was higher and remained at the initial level of 2 days in samples where preparation of glutathione was added. The mass concentration of coloring substances (Fig. 2) was reduced by 20-42% in the case of the addition of glutathione and by 3 times, where in addition to sulfur dioxide, antioxidants were not used.

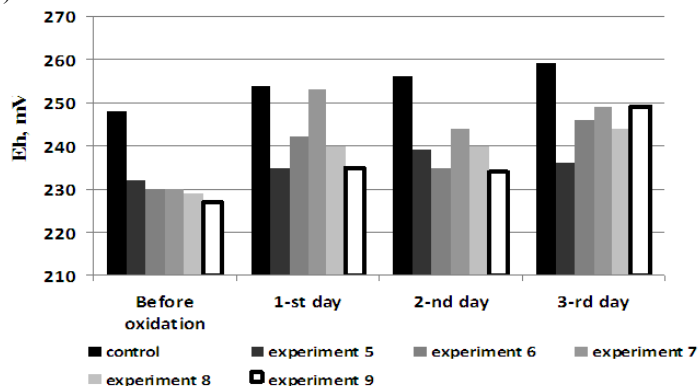


**Fig.1. Effect of adding glutathione of yeast on the content of free sulfur dioxide and it changing in the process of induced oxidation**



**Fig.2. Effect of adding glutathione of yeast on the mass concentration of coloring substances in the process of induced oxidation**

The redox potential of wine was lower than the control while adding glutathione, even after oxidation did not rise to the level of the original wine in which was added only sulfur dioxide (Fig. 3).



**Fig.3. Effect of adding glutathione of yeast on the changing of redox potential in the process of induced oxidation**

Also should be noticed the positive effect of the addition of glutathione to the optical performance of wine. As can be seen from Table 2 the optical characteristics of the samples with glutathione after oxidation are significantly lower than in controls. The values of  $\Delta G$  are especially indicative, which means the protective effect of glutathione on the phenol system of rose wine.

**Table 2. Optical characteristics of rose wine before and after induced oxidation**

Variants of experiment	Before oxidation			$\Delta G$
	I	T	G	
control	0,1	0,57	6,1	-
After oxidation				
control	0,62	1,2	24,1	18,0
experiment 1	0,37	1,0	16,3	10,1
experiment 2	0,50	1,0	20,6	14,5
experiment 3	0,40	1,1	19,8	13,7
experiment 4	0,34	1,1	19,7	13,6

Based on these facts, rose table wines were prepared with using researched antioxidants. Analysis of physical and chemical quality indicators (Table 3) allowed to establish a positive impact on the quality of wine, which was shown in the concentration of anthocyanins, the free sulfur dioxide and reducing redox potential Eh. Experimental samples were marked by tasters higher than controls.

Likewise be mentioned that the use of preparations based on glutathione of yeast and tannin make it possible to get rose wine with different shades of pink, which is especially appreciated in their production (Fig. 6).

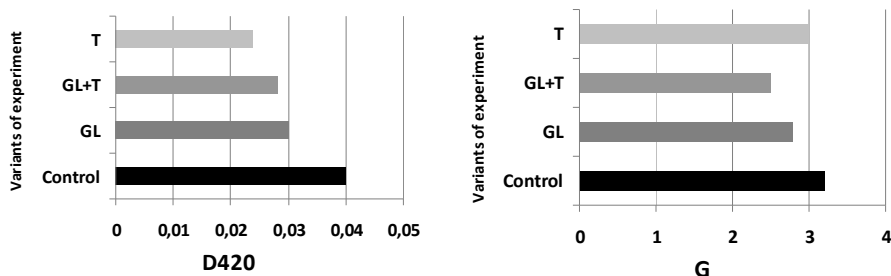
Thus, the use of preparations based on glutathione of yeast can increase the level of free sulfur dioxide, which will lead to better protection from oxidation, or the possibility of reduction the dose sulphitation for equal level of protection. Therefore this method is effective

in preservation anthocyanins, reduction the appearance level of yellow colors - shades of oxidation; promotion tasting characteristic and variation for different shades of rose table wines.

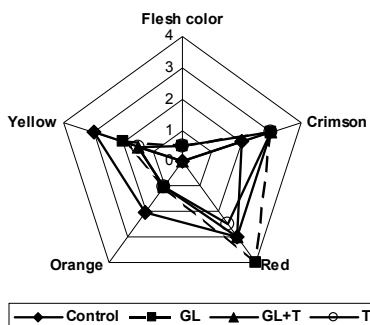
**Table 3. Quality indicators of rose table wine which are made by adding reduction actions preparations**

Research variants	Physico-chemical quality of wine								Eh, mV	Tasting scores	
	The volume fraction, %	The mass concentration of						sulfur dioxide, mg/dm <sup>3</sup>			
		alcohol	titratable acids, g/dm <sup>3</sup>	volatile acids, g/dm <sup>3</sup>	phenolics, mg/dm <sup>3</sup>	coloring substances mg/dm <sup>3</sup>	sulfur dioxide, mg/dm <sup>3</sup>				
							free				total
Control	13,0	8,9	0,6	380	23	11	50	210	7,6		
GL	12,9	9,0	0,5	280	35	14	50	198	7,8		
GL+T	13,2	8,8	0,5	586	33	12	52	205	7,75		
T	13,2	9,2	0,4	618	29	14	47	201	7,75		

Also noted lower rates of yellow shades and yellow in the test specimens, which are indicate about oxidation of rose wines (Fig. 4, 5).



**Fig. 4, 5. Effect of antioxidants on the formation of yellow shades of rose table wine**



**Fig. 6. Diagram of color shades of rose table wine, made with the usage of antioxidants**

## Conclusions

The use of preparations based on glutathione of yeast can increase the level of free sulfur dioxide, which will lead to better protection from oxidation, or the possibility of reduction the dose of sulphitation for equal level of protection

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## Using of infrared reflectance spectra of sunflower meal for determination its moisture content

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### ABSTRACT

**Keywords:**  
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In this work we have studied the near-infrared reflectance spectra of sunflower meal to develop of calibration equation for moisture content determination. Sunflower meal samples with different humidity that varied from 5 to 19 % were investigated. Investigations were carried out on the spectrometer „Infracad - 61” in the range of wavelength 1330-2370 nm through 10 nm. It was detected that 1460 and 1930 nm wavelengths are characteristic for moisture content determination of sunflower meal using reflectance coefficient. Analysis of first and second derivatives from the optical density spectra gave possibility to detect their characteristic wavelengths, which were moved to low wavelengths region and were located at 1400 and 1890 nm for the first derivative of the optical density spectra and at 1370 and 1860 nm – for the second derivative of the optical density spectra. Calibration equations are developed and value of probable approximation are obtained. It is possible to determine moisture content of sunflower meal using wavelength mentioned above.

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### Introduction

Oil seed cake and meal are the products of their processing with recovering of oil by pressing or solvent extraction respectively. These products contain proteins, fibers, vitamins, minerals and are the important source of feed and edible proteins and are used also directly as feedstuff [1, 2]. Moisture of meal and cake is an important parameter that determined their quality during storage.

Near-infrared reflectance spectroscopy is widespread used now for determination of moisture content in pharmaceutical pellets [3], foliage [4] and other agricultural and food foods [5]. This technique is an informative, rapid and gives possibility to analyze chemical composition of different objects [6 – 10].

Low absorption in near-infrared region and using of diffusion reflectance of samples gives possibility for direct analysis of product and determination in a wide concentration range. This technique does not require complex and continuous sample preparing. The principle of this method is a comparison of spectral properties of investigated sample with a such spectral properties of samples with known chemical composition (standards). That is why using of this

methods requires calibration and development of calibration equation on the base of near-infrared reflectance spectra measurement of standards samples.

In this work we have studied the near-infrared reflectance spectra of sunflower meal to develop of calibration equation for moisture content determination.

### **Material and methods**

Sunflower meal near-infrared reflectance spectra at the range of  $\lambda = 1330\text{--}2370$  nm were measured on the infrared spectrometer „Infrapid-61”. The spectra were measured through every 10 nm.

The samples were grinded on the lab mill and sifted through the 1 mm hole diameter sieve. Samples with the moisture content from 5 to 19 % were preparing by drying and moistening of industrial sunflower meal. Humidity of series of samples for calibration were determined by drying of samples to the constant mass [SStU ISO 771].

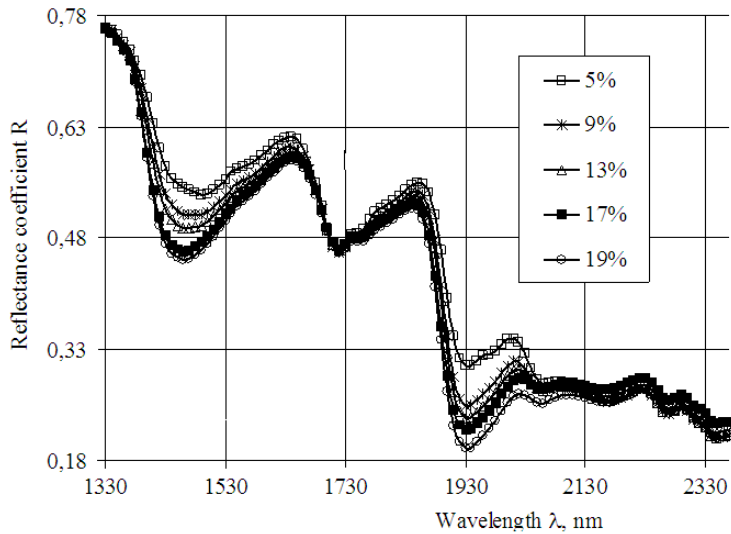
### **Results and discussions**

Near-infrared reflectance spectra of sunflower meal samples with different humidity are given on the Fig.1. It is known that near-infrared spectrum of water has number of characteristic absorbance band and their intensity is used for moisture determination [A.A. Avramenko, M.P. Esel'son, A.A. Zaika. *Infrakrasnye spektry pishhevyyh produktov*. M., 1974]. The main absorbance band of water corresponds to main molecule vibration and is located in the 6000 nm region. Combinational vibration of –OH group is at the  $\lambda = 1930$  nm and the valence vibration (the first overtone) is at  $\lambda = 1450$  nm. That is why these wave lengths are used for moisture determination.

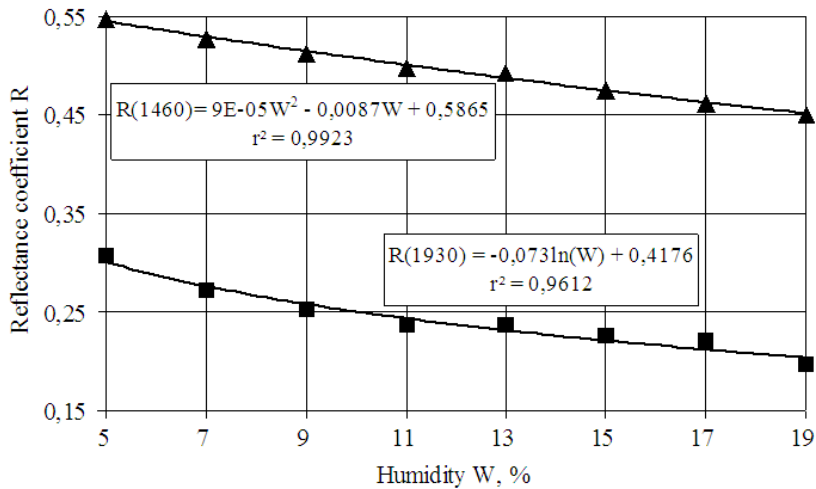
According to this characteristic minima of reflectance spectra intensity are in the range  $\lambda = 1460\text{--}1490$  nm and at 1930 nm (Fig. 1). Analysis of reflectance spectra of sunflower meal samples with different humidity have shown that reflectance coefficient increases with decrease of moisture content. Besides that minimum of reflectance intensity in the range  $\lambda = 1460\text{--}1490$  nm is moving to low wave region. Reflectance spectra namely at the  $\lambda = 1930$  nm are usually using for moisture determination in different dry products (milk powder, seed, flour, hops etc.) [Patent 62607 Ukraine]

After determination of characteristic wave lengths the next stage was development of calibration equation and determination of correlation coefficient (Fig. 2).





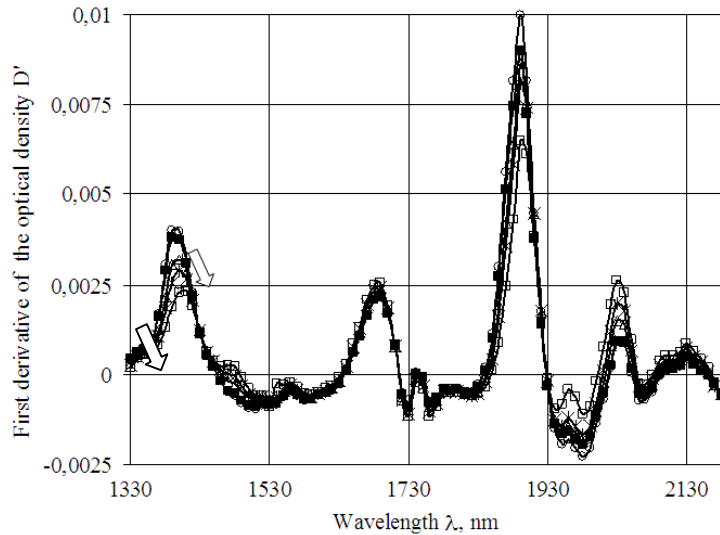
**Fig. 1.** Dependence of near-infrared reflectance spectra of sunflower meal samples from their humidity



**Fig.2.** Dependence of the reflectance coefficient from moisture content in sunflower meal

The one calibration equation is calculated for dependence of the reflectance coefficient at 1460 nm from moisture content. This is the polynomic dependence with the assured probability of 99 %. Another one is logarithmic curve and is a dependence of the reflectance coefficient from moisture content at 1930 nm with an assured probability of 96 %.

NIR spectrometer that was used calculates also first (D') and second (D'') derivatives from the optical density spectra. Obtained function are shown on the Fig. 3 and 5. Extremum position on these curve are moved to low wave region in comparion to reflectance spectra. The main extrema of first derivative are at 1400 and 1890 nm.

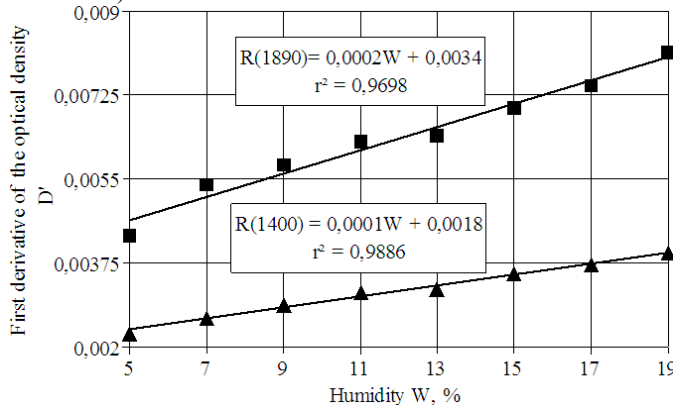


**Fig. 3. First derivative of the optical density spectra of sunflower meal samples with different humidity**

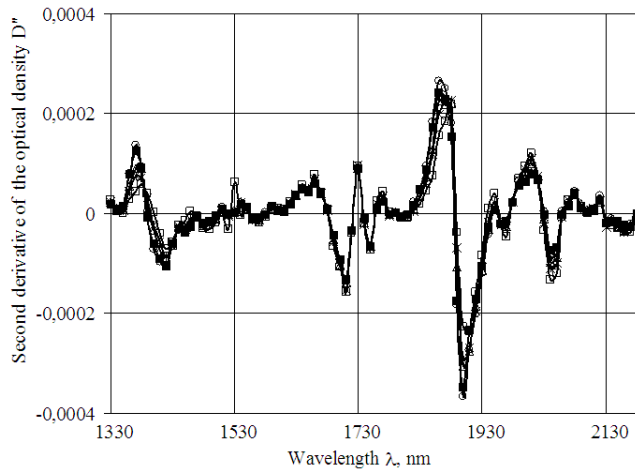
Calibration equation calculated on the base of first derivative spectra are shown on the Fig. 4. These are almost linear dependence and have highest assured probability that is 99 % at 1400 nm and 97 % at 1890 nm.

It is known that the second derivative ( $D''$ ) of the optical density are used more often for determination of chemical composition [5]. We have calculated the second derivative of the optical density of our samples and have detected that extremum position on these curve are moved to low wave region in comparison with reflectance spectra too. They were located at 1370 and 1860 nm (Fig.5).

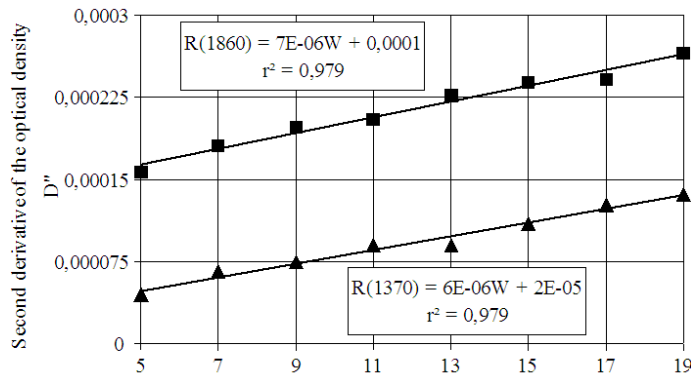
Calibration equations calculated on the base of second derivative spectra are shown on the Fig. 6. They reflect a linear dependence of second derivative of the optical density from humidity of sunflower meal. The assured probability of this equation is very high (98 % at 1370 and 98 % at 1860 nm).



**Fig. 4. Dependence of first derivative of the optical density from humidity of sunflower meal**



**Fig. 5.** Second derivative of the optical density spectra of sunflower meal samples with different humidity



**Fig. 6.** Dependence of second derivative of the optical density from humidity of sunflower meal

## Conclusions

In this study we have analyzed the reflectance spectra in near-infrared region of sunflower meal and detected characteristic reflectance band for humidity determination. They are located at 1460 and 1930 nm for reflectance coefficient spectra, at 1400 and 1890 nm for the first derivative of the optical density spectra and at 1370 and 1860 nm – for the second derivative of the optical density spectra. But the highest precision of analyses with linear dependence was observed under measuring of first and second derivatives of the optical density. It is possible to determine moisture content of sunflower meal using wavelength mentioned above.

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## **Substantiation of using wine-making secondary products as alternative raw material for confectionery industry**

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**Keywords:**

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Husks of grapes  
Confectionery  
Phenol  
Pectin

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**ABSTRACT**

The article is aimed at studying the concentration of pectin and phenol substances in grapes and in processed grapes products as well as at assessing the expediency of making them part of recipe as a valuable raw material for new kinds of confectionery.

The husks of industrial grapes obtained from wine materials production were taken as the object of research.

The results of the research conducted in respect of the quantitative composition of pectin and phenol substances in husks of industrial grapes have been performed. The applicability of processed grapes products in confectionery manufacture has been determined.

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### **Introduction**

Food status of the population is surely to be one of the most significant factors which influence people's health. Because of extreme environmental pollution the issue of functional nourishment stands first among the rest of the world's problems.

Confectionary is labeled as the high-caloric foodstuffs with high content of carbohydrates, fat and low content of biologically active components.

The analysis of chemical composition of confectionery manufacture raw materials proves the expediency of using phytogetic substances. Recently much more attention is focused upon the scientific research and the development of ways of processing plant raw materials with high content of biologically active substances.

Fruits, berries and vegetables are of considerable benefit to one's nourishment. They contain necessary mineral substances, vitamins, organic acids, pectin substances, dietary fibers. They are the main and practically the only source of biologically active substances such as phenol compounds.

The aim of the article is to examine the content of biologically important substances in grapes and its products and determining the appropriateness of including them in recipes as a valuable raw material for new types of confectionery.

## **Material and methods**

The object of study Grape squeeze was obtained as a result of industrial wine.

When formulating the confectionery articles the nontraditional types of raw materials are not only to provide the unique biochemical properties. They are intended for bearing certain function-technological properties in order to provide the confectionery articles with original organoleptic properties (flavour, smell, structure) and with the proper quality in the course of storage.

Taking in consideration these requirements the fundamental research aimed at formulation of new nontraditional foodstuffs of plant raw materials and new kinds of confectionery articles using the first-mentioned foodstuffs is pursued at the National food technologies university.

From among the plant raw materials enriched by valuable nutritive and biologically active substances the grapes and processed grapes products can be noted.

After the grapes have been industrially processed into wine and juice plenty of secondary products are left. They constitute from 10 to 20% of the total amount of grapes being processed [1, 2].

Considerable areas intended for grapes cultivation in the south of Ukraine, large number of primary wine-making enterprises and the problem of utilization of wastes which should be treated as secondary material resources are regarded as factors defining a choice of grapes processing products as the source of raw materials.

For the confectionery manufacture the husks of grapes and the grapes seeds are of primary interest since they serve as sources of biologically active substances: vitamins, macro- and microelements, phenol compounds, cellular tissue, organic acids, essential amino acids, polyunsaturated fatty acids. Besides, the most important components of grapes which are of major interest for the confectionery manufacture are pectin and polyphenol [3].

Developing innovation techniques was the reason for the research of the physicochemical and rheological properties of vegetable products and semi-finished products, of the changes in moisture bond forms in the products, the sorption characteristics and water activity.

The traditional source of obtaining the pectin is, undoubtedly, beet marc as well as apple and tangerine residue. The husks of grapes in respect of their potential pectin-bearing function are much less perspective. Thus, the content of pectin substances, mainly protopectin, in ripe industrial grapes does not exceed 1,4%. Whereas, these are the husks of grapes which can be regarded as a rich and diverse source of microelements and biologically active compounds [4].

Pectin from the grapes belongs to biologically active substances since it is favourable to creation of complexes with heavy and radioactive substances and their further externalization from human organism. Owing to its antibacterial and anti-inflammatory properties pectin lowers cholesterol levels and blood sugar and improves digestion. This property of theirs can be applied for creating functional foodstuff [5, 6].

## **Results and discussions**

In order to corroborate the industrial significance of the husks of grapes as a valuable pectin-bearing raw material we have pursued a research to determine the pectin substances content in the husks of industrial grapes which are cultivated in the Southern Coast of Crimea. The research samples were selected in the state of biological ripeness of grapes at the wine-making plant State-run enterprise “Alushta” of SC NPAM “Massandra”. As the research

samples we have picked out the husks of main industrial grapes left after the grapes have been processed into wine materials, they are Cabernet-Sauvignon, Merleau, black Muscatel, white Muscatel, Isabella.

As a result of the research conducted it has been established that the content of water-soluble pectin in puree produced from the husks of grapes under test made up 0,225% from Cabernet-Sauvignon, 0,810% from Merleau, 0,893 % from Isabella, 0,897 % from black Muscatel, 0,585% from white Muscatel to the mass of dry matter. The principal pectin quality factor is the degree of etherification, which indicates the quantity of methoxylation carboxyl groups of polygalacturonic acid. It has been established that the quantity of etherified groups of grapes pectin constitutes 61,0 – 62,5%. It is indicative of the fact that the grapes pectin belongs to the pectins which found a wide application in confectionery manufacture.

It has been found experimentally that when the husks of grapes puree with 60 % of sugar is boiled it is converted into solid jellies, which means that the grapes pectin possess good jelly-forming properties. Therefore, with regard to these criteria the husks of grapes prove to be the perspective source of pectin substances, whereas the semi-products made of ones are to find proper application in confectionery manufacture.

The concentration of phenol substances in the grapes under test makes up 475 mg/100 g. That is, the samples of grapes under test are characterized by the high content of phenol substances making it possible to use the processed grapes products for enrichment of confectionery products with the biologically active substances.

We have initiated certain research as for the application of the processed grapes products for saccharine confections. There was developed a technology for processing the husks of grapes which results in obtaining puree with high content of pectin, owing to partial destruction of protopectin contained in the cell membranes and in the intercellular walls of a grape.

The puree and the jam obtained from the husks of grapes can be used as the boilings filler and the filling for biscuit dough, for fondant confectionery production in order to improve its organoleptic properties and to extend the confectionery consumption expiration date, for foam type confectionery mass (such as soufflé and nougatines), for fruit and jelly candy centers, marshmallow and marmalade.

Powder made of grapes seeds is recommended to be used when preparing icing, candy substance and waffle filling.

Newly developed kinds of confectionary were displayed at the international professional contests “Sweet triumph” carried out in the frames of international exhibition “Lasoschi – 2012” and received awards under the following nominations: “Grand-prix” and Triumph of innovations”.

## **Conclusions**

Thus, according to the research results, the application of processed grapes products enables creation of a new expanded range of confectionery production by means of use of natural colors, antioxidants, with higher nutritive and biological value and with unique organoleptic properties.

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## The influence of technological treatments on physical and chemical structure of wine

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**Keywords:**

Wine  
Stabilizing  
Winemaking

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**ABSTRACT**

A necessary condition for the competitiveness of domestic wine in the international consumer market is to further increase the wine quality with extension of terms of the guaranteed stability up to 1.5 years.

Gelatin and bentonite are ones of the most common purifying and stabilizing preparations, which are widely used in the practice of winemaking. In this context, it is an important task of testing imported auxiliary products of new generation and their adaptation to the domestic winemaking.

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### Introduction

The problem of long-term stability of wine remains actual even now. To a great extent it is predetermined by quality of technological processes carried out in order to remove the reasons of prepared wine turbidity.

One of the most common types of turbidity is colloidal turbidity that is detected at low temperatures. The main reason of colloidal turbidity appearance is a presence of substances with colloidal nature or those that express significant colloidal properties. Nowadays there are a lot of means for wine stability, which are recommended to the wine manufactory for deleting colloids and prediction from colloidal turbidity. However they can provide the long-term wine stability not always.

Gelatin and bentonite are ones of the most widespread preparations in wine making which posses purifying and stabilizing properties.

Gelatin is used in the wine making for purification of wine materials and stabilizing of prepared wines mainly for reversible colloidal turbidity. In addition, gelatin gives good results in correction process of rough wine materials with large content of phenolic compositions.

The aim of research was to determine the influence of means for wine materials treatment with preparations of liquid gelatin in combination with bentonite.

## Material and methods

The objects of research were white table wine materials and red ones. The scheme of experiment provided determination of physical and chemical characteristics of wine materials and processing them in different technological ways with the purpose to stabilize wine materials for colloidal turbidity.

First test was carried out on white table wine materials with phenolic substances in the sum of 260 mg/dm<sup>3</sup>.

## Results and discussions

According to the table data the overfining doses are: for gelisola – 100 mg/dm<sup>3</sup>, for aquacola – 10 mg/dm<sup>3</sup>, for albumicola – 100 mg/dm<sup>3</sup>, for liquid gelatin – 10 mg/dm<sup>3</sup>. For air-dry preparations of gelatin the overfining doses are 100 mg/dm<sup>3</sup> (gelatin Extra) and 300 mg/dm<sup>3</sup> (domestic gelatin P- II) correspondly.

Next test was carried out on a red table wine materials Alushta in order to clarify a overfining dose of gelatin only.

**Table 1. Influence of dose of gelatin for treatment of white wine materials**

Dose of gelatin, mg/dm <sup>3</sup>	Initial turbidity, ph.n.	Test results, ph.n.	
		TA	E
<b>Gelisol</b>			
unprocessed wine	4,26	6,01	5,14
10	0	0,63	0,73
20	0	0,53	1,16
50	0	0,63	1,70
<b>100</b>	0	3,15	4,84
<b>Aquacol</b>			
5	0,2	1,11	0,24
<b>10</b>	0	7,09	0,44
20	0	1,99	2,52
<b>Extrsa</b>			
10	0,1	5,57	4,31
20	0	1,49	0,53
50	0	0,58	0,05
<b>100</b>	0	over swing	over swing
<b>P-II</b>			
100	0	0,68	0,73
250	0	0,92	1,6
<b>300</b>	0	over swing	over swing
<b>Albumicol</b>			
20	0	0,48	0
50	0	0,44	0
<b>100</b>	0	1,45	0,1
250	0	13,40	5,09
<b>Liquid gelatin</b>			
5	0	0,58	1,16
<b>10</b>	0	over swing	over swing

According to the table data the overfining doses are: for gelisol – 100 mg/dm<sup>3</sup>, aquacol – 1000 mg/dm<sup>3</sup>, albuminokol – 500 mg/dm<sup>3</sup>, liquid gelatin – 1000 mg/dm<sup>3</sup>. For air-dry preparations of gelatin the dose of overfining is 2000 mg/dm<sup>3</sup> (both gelatin Extra and domestic gelatin P-II).

**Table 2. Influence of dose of gelatin for treatment of red wine materials**

Dose of gelatin, mg/dm <sup>3</sup>	Initial turbidity, ph.n.	Tannin test results, ph.n.	OKP test after processing, ph.n.
<b>Gelisol</b>			
unprocessed wine			
<b>100</b>	0	7,11	0,96
250	0	2,6	0,48
500	0	0,72	0,72
<b>Aquacol</b>			
250	0	0	115,4
500	0	0	81,1
750	0	0	-
<b>1000</b>	0	6,0	-
<b>Extra</b>			
<b>100</b>	1,07	11,0	53,18
250	0,97	1,92	69,72
500	0,78	0	-
<b>P-II</b>			
<b>100</b>	0	105,2	52,16
250	0	6,7	103,01
500	0	5,4	80,03
<b>Albumicol</b>			
100	0	0	1,92
250	0	2,2	78,63
<b>500</b>	0	6,9	94,02
750	0	10,3	75,83
<b>Liquid gelatin</b>			
500	0	0	97,96
750	0	0	72,26
<b>1000</b>	0	3,3	-

From the test results it is possible to conclude that the doses of overfining for liquid gelatin are 500-1000 mg/dm<sup>3</sup>, and for air-dry preparations of gelatin - 2000 mg/dm<sup>3</sup>.

For achievement of maximum effect of fining process it is necessary to observe a number of rules, including the reasonable choice of gelatin and optimal scheme of processing, determination of fining substances dose through the tests and gradual infusion them into wine.

To speed up the purification process, and for the removal of biopolymers involved in the formation of wine turbidity, quite often debourbage is accompanied by infusion of supplemental materials into mash. Among these materials can be distinguished sorbents, flocculants and enzymes. Bentonite is the most common sorbent used for mash purification. Bentonite is entered into mash in the amount from 2 mg/dm<sup>3</sup> to 10 mg/dm<sup>3</sup>, depending on content of protein in it. According to the opinion of many specialists this process helps to delete from 50% to 90 % proteins and up to 30 % polysaccharides from mash. At the same

time oxidative enzymes are deleted almost in full, that reduces tendency of wine to oxidative turbidity substantially.

Treatment of wine materials has been conducted both with liquid gelatin only and in combination with bentonite in order to stabilize wine for reversible colloidal turbidity.

The dose of gelatin for treatment of wine materials has been set as a result of realization of same tests. The results of these tests are given in the table 3.

**Table 3. Treatment of white wine materials with gelatin in combination with bentonite**

Dose of gelatin, mg/dm <sup>3</sup> bentonit, g/dm <sup>3</sup>	Initial turbidity, ph.n.	Test results, ph.n.	
		TA	E
<b>Gelisol</b>			
unprocessed wine	4,3	6,0	5,1
2,5/0,5	0	1,8	0,9
5/0,5	0	0,8	1,7
5/1	0	1,6	2,8
<b>Aquacol</b>			
2,5/0,5	0,1	2,0	0,5
5/0,5	0,1	2,2	2,1
5/1	0,1	0,9	0,2
<b>Albumicol</b>			
5/0,5	0,9	2,1	1,9
5/1	0,1	1,1	1,2
5/2	0,1	0,5	0,9
<b>Liquid gelatin</b>			
5/0,5	0,2	1,3	1,4
5/1	0	0,8	1,2
5/2	0,1	0,9	1,2
<b>Extra</b>			
5/1	0,5	2,1	0,4
5/2	0,2	1,1	0,1
10/1	0	1,1	0,1
<b>P-II</b>			
5/1	0,3	2,1	0,8
5/2	0	0,6	0,7
10/1	0	0,2	0,1

As can be seen from the table of results, the optimal fining dose in combination gelatin - bentonite for treatment of white wine materials with phenolic substances in sum of 260 mgs/dm<sup>3</sup> with liquid gelatin preparations is from 5/1 to 5/2, with domestic gelatin is 5/2.

The results of treatment of red table wine materials with gelatin jointly with bentonite are given in the table 4.

An analysis of results testifies that the dose of liquid gelatin preparations for red wine processing has been reduced in 2,5-3 times, that proves the economy of liquid gelatin preparations in comparison with domestic gelatin.

The liquid forms of gelatin have a rather low gelling temperature, well dissolve in cold water, do not require heating that makes them easy to use in production. They are received as a result of hydrolysis of high molecular gelatin. Dry substances content is 10-25 %.

But for more effective application of liquid gelatin for treatment of red wine materials the process was conducted in cold.

**Table 4. Treatment of red wine materials with gelatin in combination with bentonite**

<b>Dose of gelatin, mg/dm<sup>3</sup> and bentonite, g/dm<sup>3</sup></b>	<b>Initial turbidity, ph.n.</b>	<b>OKP test after processing, ph.n.</b>
<b>Gelisol</b>		
unprocessed wine	7,5	70,4
10/1	0,5	2,9
20/1	0,2	0,5
<b>Akvakol</b>		
10/1	0,2	8,2
20/1	0	6,6
25/1	0	1,44
<b>Albumikol</b>		
10/1	0,5	10,8
20/1	0,5	3,4
40/1	0	over scale
<b>Liquid gelatin</b>		
10/1	0,2	3,9
20/1	0,2	1,7
<b>Extra</b>		
50/1	0	over swing
50/2	0	over swing
75/1	0,2	2,4
<b>P-II</b>		
50/1	1,2	over swing
50/2	1,4	over swing
75/1	1,7	3,8

Processing of red wine with liquid gelatin jointly with bentonite was performed at temperature +4... +5 ° C. As can be seen from the table of results, domestic gelatin has been gelled and has not been work at low temperature.

In order to conduct wine processing along with cold treatment, tests were carried out at temperature of 0... -4 ° C. It was set the following optimal doses of gelatin (mg/dm<sup>3</sup>) and bentonite (g/dm<sup>3</sup>) for wine stability: liquid gelatin – 5/1, albuminokol – 5/1, gelisol – 5/1, aquacol – 10/1, Extra – 40/1. But as it was mentioned above, domestic gelatin P-II does not work at cold temperature.

Finally the choice of an appropriate gelatin needs to be a compromise between its ability to flocculate and to interact with wine tannins, it must work in the assumed conditions, and in particular in cold. At the same time a great importance plays the type of wine and the goal of processing. For example, for pink and faintly red wine a lot of attention should be paid to preserve colour intensity. For white wine it is important to prevent overfining.

Among reasons of wine destabilization one is excess of heavy metals, which catalyze the oxidative processes and participate in formation of turbidities.

As a result of the researches of many authors (Rodopulo, Tyurin, Ogorodnik, Panasyuk, Ribero-Gayon) it is proved that iron in wine is in bivalent or trivalent cation forms which capable to form the relevant complexes with organic acids, phenolic substances, proteins, and polysaccharides. Over time some complexes lose their solubility that leads to wine turbidity.

According to the some scientific works (Spiess, Yatsyna, Balkuli, Naumova) there is a direct dependence between forms of iron and pH of solution. If pH increases, Fe (II) transforms in Fe (III) completely, and if pH decreases, the ratio between ionic and complex forms changes in favor of the last.

**Table 5. Treatment of red table wine materials with gelatin in combination with bentonite in cold**

Dose of gelatin, mg/dm <sup>3</sup> and bentonite, g/dm <sup>3</sup>	Initial turbidity, ph.n.	OKP test after processing, ph.n.
<b>Gelisol</b>		
unprocessed wine	7,5	70,4
20/1	0	over swing
10/1	0	over swing
5/1	3,85	3,85
<b>Aquacol</b>		
20/1	5,77	11,42
10/1	14,0	17,06
5/1	3,85	1,68
<b>Albumicol</b>		
20/1	0	3,61
10/1	0	over s swing
5/1	0	over swing
<b>Liquid gelatin</b>		
20/1	0,48	0,48
10/1	0	0,48
5/1	0	1,44
<b>Extra</b>		
75/1	1,20	0,48
50/1	0,96	6,96
40/1	0,72	29,83
<b>P-II</b>		
75/1	5,77	over swing
50/1	6,47	over swing
40/1	6,68	over swing

The processes of oxidation and rehabilitation of iron in wine play a major role in the occurrence of turbidities. The composition of wine as a rehabilitating liquid assists to maintain iron in the less oxidized form. However bivalent iron Fe (II) is stable in wine, does not form insoluble compositions, and therefore does not affect on limpidity of wine.

In contrary trivalent iron Fe (III) forms insoluble composition, causes turbidity of wine and fall out in sediment when its concentration reaches a certain level. Fe II does not cause turbidity of wine even at very high doses.

Complex compositions of iron particularly with organic acids have been already become a subject of a large number of researches for a long time. Experiments were performed on a model solution. Firstly a certain dose of iron was entered into model solution, then gelatin was added and after that it has been observed more efficient wine purification and formation of a flaky sediment in it. Tanigal was used as tannin.

### Conclusions

In accordance with results of experiments it is possible to conclude that it is necessary to conduct a demetallization before wine processing. When influence of iron concentration on the interaction of gelatin with tannins was researched, we have found out that the mass fraction of pyrogalllic hydroxyls increases with increasing concentration of iron, that testifies a decline in the efficiency of tannin interaction with gelatin in the presence of iron.

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## The development of the restaurants' chain in the capital region of Ukraine

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<b>Keywords:</b> Restaurant Society development Capital	<b>ABSTRACT</b> The main task of the present stage of our society development is aimed at overcoming the decline of social production, the construction of a socially oriented economy, based on market relations. In recent years the development of the restaurant business has increased. Only during the last year the total number of RI has increased by 7.2%, and the number of seats - 10.2%, due to the opening of new restaurants and bars in the capital region of Ukraine. In the medium-term dynamics of the network of all restaurants will be characterized by an increasing number of quick-service organization that are focused on the use of semi high degree of readiness. The using underground spaces will also increase the investment flows for the restaurants development.
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### Introduction

The main task of the present stage of our society development is aimed at overcoming the decline of social production, the construction of a socially oriented economy, based on market relations.

There is a need to develop new approaches to the organization and management of economic activities. The restaurant business does not remain aside from the penetration of the "new economy" elements, that has a particular relevance.

The basis of structure and functioning of restaurant institutions (RI) is their scientifically based classification, that allows you to determine the location of each part of it in the whole system and distributes them according to standard criteria.

Nowadays, the implementation of information services is an important factor for the restaurant business and it represents a restaurant business sector, which has the highest rate of development, particularly in tourism. The virtual market of restaurant services is a market where the restaurants are represented in Internet advertising information about its own institution.



## Material and methods

In recent years the development of the restaurant business has increased. Only during the last year the total number of RI has increased by 7.2%, and the number of seats - 10.2%, due to the opening of new restaurants and bars in the capital region of Ukraine.

These figures are not accidental, as the capital region of Ukraine is an attractive tourist center, and its tourist infrastructure makes a significant share in the city's economy.

## Results and discussions

*The main advantages of tourism industry in the capital are:*

- the convenient geographical location of Kyiv between Europe, Russia and other CIS states;
- visa-free; attractive for tourism landscape of the city, the Dniper river and its embankments, hills, parks;
- cultural and historical monuments of world level.

*Disadvantages:*

- insufficient Kyiv promotion abroad as a tourist destination;
- high prices for lower quality services than in other Eastern European cities.

Currently there are possible strategies of the capital of Ukraine development:

*a) short-term:* launch of the travel portal, improving traffic, establishing information terminals, the introduction of the guest card, simplifying hiking trails; categorization of hotels according to international standards, to attract low-cost airlines.

*b) medium-term prospects (up to 2015):* the creation and promotion of city tourism brand; Kyiv listing in the registry of the leading tour operators and sites selling tours; reconstruction of tourism system, reconstruction of historical and architectural monuments; renovation of hotels, infrastructure construction for cultural, sporting and business events, international events [1].

*c) long-term prospects (up to 2025 p.):* creating new objects of tourism, the transformation of the Dneper in tourist and recreational area, construction of accommodation facilities and services [2].

It is very important to create seats (for 10 thousand people) in restaurants objects (restaurants, cafes, snack bars, bars, bars, canteens, etc.) for the development of restaurants in the capital region. This figure should meet the needs of the population and tourists. Now, Kyiv is on the second place among the regions - 528 seats, there are 348 seats on average in Ukraine. Statistical data on the presence of RI objects and the number of seats in various districts of Kyiv shown in Table 1 [3].

The dominant feature is found in the central regions (Shevchenko and Pecherskiy), it is characterized by the largest number of seats. Analysis of RI and seats are given in Tables 2, 3.

The largest share among restaurant business objects took cafes, snacks - 43.6% (the peak of development was observed at the end of 2010 - 46.6%), dining - 30.5%, restaurants - 17,1% and bars - 8.3%.

Along with the increasing number of IR seats and it is also observed the increase of cash flow. Thus, if in 2009 the rate of turnover of restaurants totaled 1200.7 million., then in 2012 this figure reached 3069.5 million - the increase in almost three times [3].

**Table 1. Availability of network restaurants in Kyiv ( September 2012) [3]**

District name	Quantity	Seats (thousand)
Kyiv	1424	147,7
<i>districts:</i>		
Goloseevskiy	104	8,7
Darnitskiy	109	14,7
Desnyanskiy	107	15,1
Dniprovskiy	150	13,4
Obolonsky	138	16,2
Pecherskiy	186	19,0
Podolsky	104	11,9
Svyatoshinsky	94	14,4
Solomensky	160	11,9
Shevchenko	272	22,4

**Table 2. RI number 2009–2012 in Kyiv**

Type	2009	2010	2011	2012
Restaurant	147	169	176	244
Cafes, snack bars, etc.	696	653	619	621
Bars	95	106	94	118
Canteens	466	443	436	435

**Table 3. Number of seats in Kyiv (thousand seats)**

Type	2009	2010	2011	2012
Restaurant	20,3	22,2	25,2	30,5
Cafes, snack bars, etc.	33,9	37,2	34,0	40,8
Bars	3,7	6,4	4,2	5,4
Canteens	68,7	71,5	70,7	71,0

Thus, the analysis of RI performance shows positive trends in their development.

Restaurant industry is one of the economic activities that is created to provide direct services to the public. Sustainable development of restaurant business determines the social climate in society, providing food security for the city, helps create new jobs, increases revenue.

Due to the preparations and holding of the European Championship finals in 2012, the network of restaurants has grown significantly, as a result the number of seats in some restaurants was 100 persons per 1,000 population. Progressive growth of RI made a great contributions to the development of restaurants in Kyiv and for the future [4].

The development of restaurants in the capital region is not static, it constantly renovates. This is done not only by increasing the number of places, but thanks to the latest technology, which simplifies the process of delivering services, thereby reducing the duration of service. For example, some restaurants popularize their services on the Internet by creating branded websites, placing them in the search, commercial business, tourist accommodation and other information systems to expand marketing, promotional and managerial capabilities.

But restaurants should not be limited only by the activities of information and advertising

character, they have to attract customers to participate in virtual-technological process.

Virtual services market is a market in which the represented restaurants provide On-line booking tables for customers via the Internet.

Internet-project "All About Restaurants Kyiv" conducts management work in the formation of such market [5], it is an electronic catalog of capital RI, which provides complete information about the institution, menus, prices, address and other services.

According to the study of virtual market restaurant services in Interenet project, European cuisine can be offered in 57.1% of all represented in the database restaurants, Ukrainian - 27.9%, French - 5.6%, American - 4.3%, Japanese - 3.9%, Chinese, Mexican, Italian - 3.0%, Georgia - 2.6% India - 2.1%, Arabic and German about 1.7%.

So, there is a wide variety of ethnic cuisines in the restaurant business of the capital region. There are typical national dishes, management style of ruling the process, traditions in cooking technology, design solutions and serving tables, providing musical and services for each type of cuisine.

The results of RI grouping in terms of cost of services per person are: 10 USD - 18.9%, from 10 to 20 USD - 41.6%, from 20 to 30 USD - 22.8% from 30 to 50 USD - 15.0%, from 50 USD and above - 1.7%. The cost of raw materials, business category, daily turnover, solvency of customers, the atmosphere of stay and rest, including a list of entertainment services directly influence at the price level of restaurant services.

Recently, one of the common ways of customer's payment is using bank cards. For example, consumers with credit cards "MasterCard / eurocard" serves 71.2% RI, "Visa" - 70.8%, "Maestro Cirrus" - 41.6%, "American Express", "Visa Electron" - to 28, 3%, "Prestige card" - 4.3%, "Diners Club" - 2.1%, "Discovery" - 0.9%, "JCB" - 0.4% of the total number of establishments.

So, to reserve a table via the Internet, a potential customer chooses a restaurant represented by the menu and prices. The total cost automatically calculates after ordering the list of dishes. Then the system has to specify the following data: month, day, time, and number of people and type of reservation (breakfast, lunch, dinner, birthday). To confirm the order must it is necessary to specify the feedback (email, fax, telephone). Some restaurants also offer virtual electronic map of all available tables in the hall, allowing potential customers confidently determine the choice of location. On-line reservation is free of charge, the customer pays only for the cost of the order in a restaurant, and sometimes even gets a discount about 5... 10%.

This system extends the corporate group service for business people, tourists, delegations and others.

A feature of this project is to update materials database timely, to use active marketing and advertising support and relationships with the media, and to conduct periodic surveys to identify the demand of restaurant services, drawing a portrait client, identifying sources of information about restaurants, that allows you to build a strategy for marketing activities, focusing on potential consumers [6].

The main obstacles of restaurants development are:

- the change of objects activity, especially in the downtown. Under current law, in case of the privatization of the facility, purchase or sale, a new owner can use an object inappropriately. Moreover, most restaurants are working on rented areas, areas that do not meet standards. Owners of some areas overstate the rent payments and transfer the authorization to competitor tenants;
- there is a lack of effectiveness in the system of control in sanitary rules and regulations in the workplace, which is associated with the risk for health (poisoning);
- low availability of RI service for the people with the low income;

## — *Food Technology* —

- insufficient quantity of buildings in new areas of the city, as the construction of residential areas was carried out without allocation of for social facilities;
- increase in food prices;
- the negative trend of the financial crisis, credit limitation, reduced payment capacity of the population [4].

### **Conclusions**

The purpose of the further development of the restaurant business in Ukraine is to meet demand for the services of assured quality at affordable prices.

Priorities for further RI development can be:

- legal, economic (including tax) and administrative stimulation of entrepreneurial activity in the restaurant industry;:
- to promot the further development of the network of public institutions, especially in new residential areas;
- strict enforcement of sanitation control by the state in enterprises of restaurant business.

The main objective, aimed at improving the quality and range of services in RI, is to improve their competitiveness:

- the net expansion and protection of the existing enterprises;
- assistance in attracting investment in new construction of restaurant establishments and introduction of new technologies;
- providing benefits to renting places that are owned by the local community;
- to increase services to the European level;
- providing professional training for the staff, including language learning for specialists such as waiters, bartenders, etc..
- strengthening of informational and promotional activities (eg, production listings of the restaurants with the characteristics of their service address location, contact information);
- development of equipment for the fan zones servicing.

In the medium-term dynamics of the network of all restaurants will be characterized by an increasing number of quick-service organization that are focused on the use of semi high degree of readiness.

The using underground spaces will also increase the investment flows for the restaurants development.

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## Analysis of near infrared reflectance spectrum of rape seed with different content of erucic acid

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Spectroscopy  
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Rape seed,  
Erucic acid

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### ABSTRACT

The objective of this study was to analyze of reflectance spectrum in near-infrared region of rapeseed with different erucic acid content and to choose the most informative wavelength for development of calibration equation. Near-infrared reflectance spectra at 1330-2370 nm were measured for rape seed with high and low erucic acid content. The fatty acid composition of seed oil were determined by gas-liquid chromatography. We have detected difference in absorbance level between low and high erucic acid seed in the range of 1700-1860 and 1930-2370 nm. The first derivative of reflectance spectra were analyzed and wavelength set are proposing for development of calibration equation of erucic acid content in rape seed. Our data could be used for determination of erucic acid content in rape seed by near-infrared reflectance spectroscopy.

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## Introduction

Near-infrared reflectance spectroscopy (NIRS) is a widespread technique for chemical composition analysis of different agricultural seed [1,2]. The advantage of this method is nondestructive analysis without using of chemicals. It is possible to estimate moisture, protein, oil, glucosinolate content in seed by NIRS. Moreover, recently this technique was proposed to determine the fatty acid composition of seed oil, free fatty acid content and peroxide value in oil [2-5].

In order to use this technique for the measurement of some composition parameters of seed or oil development of calibration equation is necessary. For this purpose the reflectance spectra of samples with different chemical composition are measured. To receive an adequate calibration equation analysis of at least 30 samples are necessary. The more samples are using for calibration the higher reliability of equation. The even distribution of the samples within the range of calibration number of samples for the investigated parameter is important too. Reflectance data on the some wavelength range are using to calculate of calibration equation.

Additionally, development of calibration equation is necessary for the every species or at least plant family [1] and for every instrument that is being used.

On the other hand nowadays rape is a very important oil crop because of its high seed oil content and special fatty acid composition. Rape breeding was directed on the creation of rape seed with low content or without erucic acid in oil as it was shown a negative influence of this fatty acid on human and animal health. Thus now there are two groups of cultivated rape with high and low erucic acid content. The first is using for technical oil production and other one for edible oil. That is why detection of erucic acid content in rape seed is an important task for seed processing.

Although gas-liquid chromatography of fatty acid methyl esters is using for fatty acid composition determination NIRS technique is optimal for express analysis.

The objective of this study was to analyze of reflectance spectra in near-infrared region of rapeseed with different erucic acid content and to choose the most informative wavelength for development of calibration equation.

## **Materials and methods**

Two different kind of rape seed (*Brassica napus*) were used, with high and low erucic acid content.

“Dry” seeds were preparing in the air oven at 105 °C bringing up their mass to the constant value.

For the reflectance spectrum measuring seed samples were grinded on the laboratory grinder.

The seed oil content was determined in milled samples by Soxhlet oil extraction with petrol ether.

For the determination of fatty acid composition seed oil was extracted on the laboratory screw press. Fatty acid composition was determined by gas-liquid chromatography of fatty acid methyl esters. They were analyzed on Hewlett Packard gas chromatograph model HP 6890 with capillary column HP-88 (88%-cyanopropyl aryl-polysiloxane, 100m x 0.25 mm x 0.25  $\mu$ m film thickness (Agilent Technologies). The temperature of injector was 280 °C, detector — 290 °C. The column temperature was from 60 to 230 °C. The rate of carrier gas was 1.2 ml/min. Identification of the fatty acids was performed by comparison of the retention times with standards mixture of fatty acid methyl esters (37 Component FAME Mix, Supelco).

The reflectance spectra of samples were measured on monochromator near-infrared reflectance spectrometer Infrapid-61 model QA-262 (Hungary). For each sample the reflectance spectrum ( $\lg 1/R$ ) from 1330 to 2370 nm was recorded at 10-nm intervals. The first derivative from  $\lg 1/R$  spectra was calculated.

## **Results and discussion**

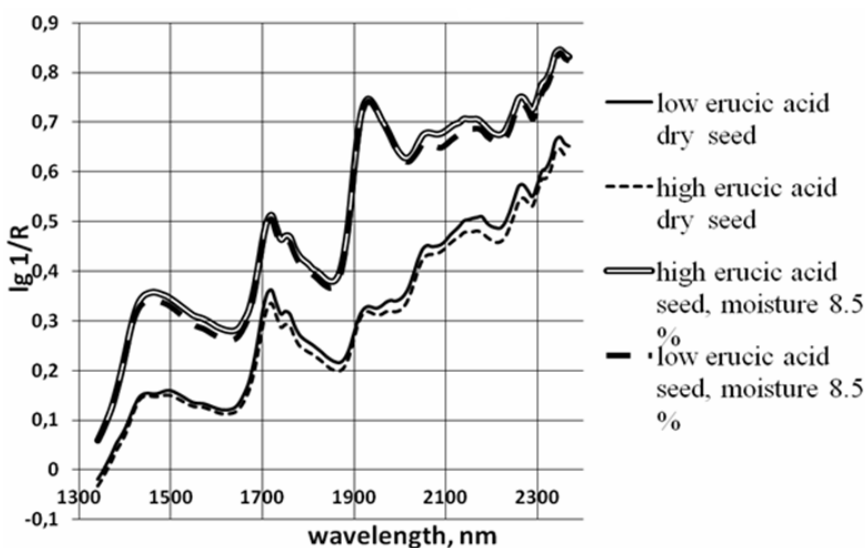
We have analyzed the fatty acid composition of different rape seed samples from local market. Seed moisture have shown was ranged from 8 to 10 % and fat content from 45 to 49 %. Determination of fatty acid composition detected that there were samples with low (< 5 %) and high content of erucic acid (Table 1).

We have used the samples with different content of erucic acid for the near-infrared reflectance spectra measuring. For each sample reflectance spectrum ( $\lg 1/R$ ) was recorded at 10 nm intervals. Obtained spectra are given on the Fig.1.

The reflectance spectra were transformed as  $\lg 1/R$  (optical density) and they indicate the big difference of optical density between seed dry substances and seed with 8.5 % of moisture. The spectra of seed with actual moisture have demonstrated almost total superposition, there was only some difference in the range 1430-1630 nm and 2000-2200 nm between samples with low and high erucic acid content. Evident peaks of absorbance on the 1450 and 1930 nm wavelength are belonging to the absorbance bands of water and caused by stretching vibrations of water molecule as it is known.

**Table 1. Major Fatty acids (% of total fatty acids) in rape seed oil.**

Fatty acid	Mean	
	low erucic acid	high erucic acid
C 16:0	4,6	3.5
C 18:0	2,0	1.0
C18:1	50,5	13.0
C 18:2	16,9	14.0
C 18:3	7,7	9.0
C20:1	2,3	7.5
C 22:1	1,3	47.5



**Fig.1. The reflectance spectra of low and high erucic acid rape seed.**

Comparison of two spectra belonging to the “dry” seed (seed dry substances) have shown that appearance of these two spectra are very similar, but there is a difference in absorbance level between low and high erucic acid seed in range of 1700-1860 and 1930-2370 nm.



NIR spectra correspond to the highest overtones and combinations of fundamental vibrations of —CH group: the first overtone is at 1500-1800 nm and the combination bands of —CH stretching motions and deformations are at 2200-2400 nm [6]. Revealed differences in absorbance level between low and high erucic acid seed are probably explaining by these vibrations.

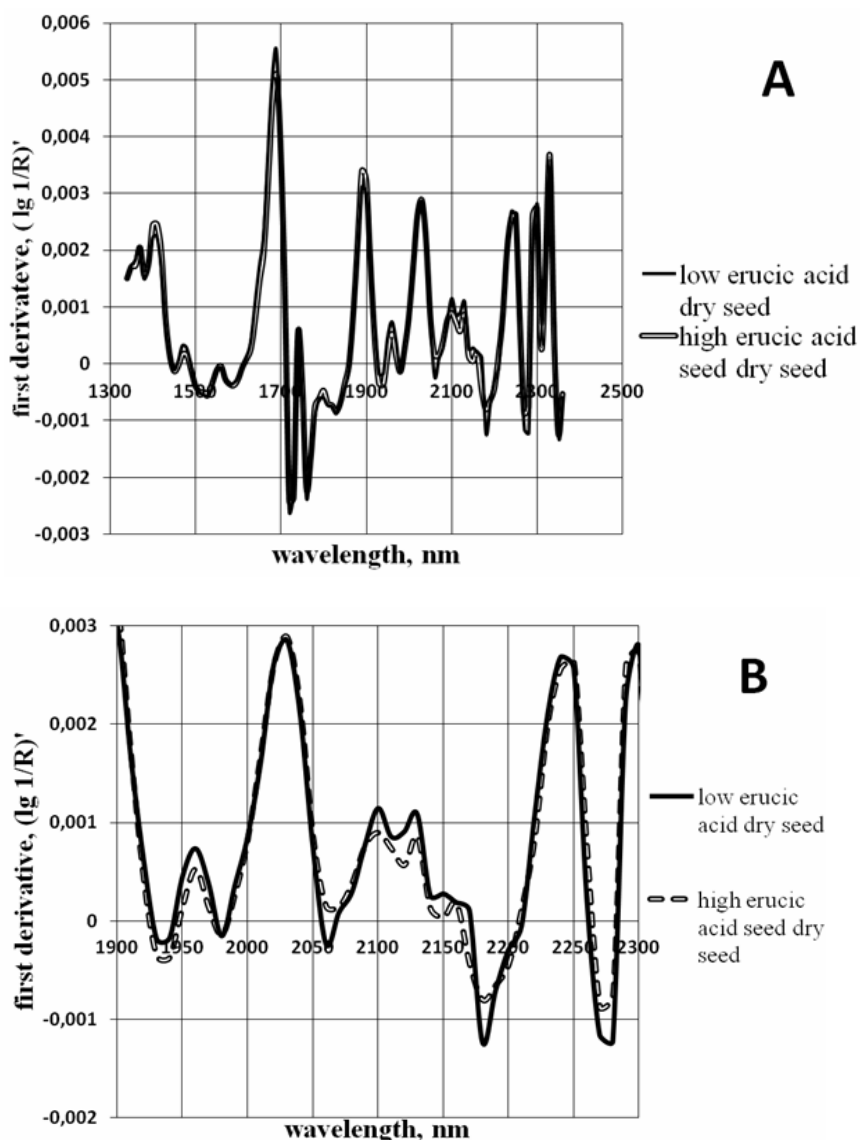


Fig.2. The first derivative of near infrared reflectance spectra of low and high erucic acid rape seed. A – at 1330-2370 nm, B – at 1920-2280 nm.

In order to get more information from absorbance spectra we have analyzed the first derivatives of these spectra (Fig.2). The most evident difference between first derivatives was detected in the range 1930-2270 nm. We suppose that they can be caused by different fatty acid composition of low and high erucic acid rape seed. We can suppose that this range is an informative for the development of fatty acid composition calibration equation.

Since at least six point of wavelength are needed for calculation programme of spectrometer Infracid-61 we have proposed the next wavelength for the development of fatty acid composition calibration equation: 1960, 2060, 2100, 2150, 2190, 2270 nm.

## **Conclusions**

In this study we have analyzed the reflectance spectra in near-infrared region of rapeseed with different erucic acid content which was obtained on the near-infrared reflectance spectrometer Infracid-61. We have detected the different level of absorbance between low and high erucic acid seed at 1700-1860 and 1930-2370 nm. We have proposed some wavelength for development of calibration equation for estimation of erucic acid content in rape seed using Infracid-61.

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## Investigation of organic impurities movement by accelerating column of alcohol which is under pressure lower than atmospheric

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<b>Keywords:</b>	<b>ABSTRACT</b>
Spirit Rectification Quality Concentration Column	Nowadays in a highly competitive market alcohol in Ukraine actual task for distillation factories is a significant reduction in the cost of finished products in the production of ethanol - rectified the highest quality. The aim of this study was: «to determine the optimal process parameters of energy-saving operation in the columns of ethanol rectification units that works under pressure lower than atmospheric with a stability production of high-quality alcohol». The movement of organic impurity in the columns of ethanol rectification units (ERU), working in energy-saving mode under pressure lower than atmospheric with aim to improve the quality of rectified spirit and increase specific output of marketable products is investigated. The most optimal technological parameters of the rectification work installation with additional columns and modes of control and regulation of this ERU were identified. The series of experiments was conducted to determine the degree of concentration and removal of organic impurity by performance booster column, which operates in vacuum. Experiments were carried out in a production condition on the gas chromatograph "Kristall 2000M".
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### Introduction

Nowadays in condition of fierce competition on the market of alcohol production in Ukraine and abroad the topical task before distilleries is to reduce production cost in the production of rectified spirit of the highest quality.

The first way to increase the specific output of rectified alcohol is removal it from alcohol-containing waste by incorporating distillation column (DC) in the scheme of ethanol rectification unit (ERU) according to the technology, developed at the National University of Food Technologies [1].

Recently for reduction of energy costs ethanol rectification units have been transferred to work under pressure lower than atmospheric [2,3].

Reducing the operating pressure lower than atmospheric causes a change in the coefficients of organic impurity and the coefficients of evaporation rate of ethanol, which requires adjustment of technological modes of process distilling.

The purpose of this study is to determine the optimal process parameters of distillation column operation which operates in energy-saving mode under pressure lower than atmospheric.

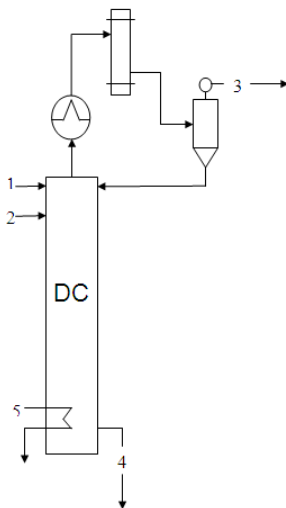
## Research Methods

Test samples were carried out by chromatographic method on a gas chromatograph "Kristall 2000M" with a relative error of 1.2%. Studies were conducted on ethanol rectification unit Kozlivsky distillery, which operates under vacuum capacity of 4200 dal / day.

## Results and discussion

Experience of its operation showed that for stable production of high-quality of commercial rectified spirit, is necessary to provide removal of it with alcohol-containing waste 1 from areas of maximum concentration as a percentage of absolute alcohol (a.a. brew), namely:

- Capacitor separator brew 2,5 – 3,0 %;
- Capacitor distillation column 1 5,0% ;
- The main fraction (MF) epuration column 6%;
- Fusel fraction 4,0%;
- Fusel spirit 1,0-1,5%;



**Fig. 1. The scheme of work DC**  
1-water; 2-supply; 3-concentrate ester-fusel (CEF); 4-cubic liquid; 5-the heating steam.

The total number of selected fractions in the production of high-quality alcohol is 18.5 - 19.5%. Outlet of these amount of alcohol-containing fractions with technological process is economically unfeasible, so we additionally introduced distillation column to the scheme BRU for concentrating and removing organic impurities of alcohol. Distillation column of Kozlivsky distillery was used as a research subject, which operates under a residual pressure at the top of the column (-4.6) m.v.st. and cubed (-2.3) m.v.st.. Technical characteristics of distillation column : Column has a 40 valve plates, diameter of columns – 1200 mm, height – 8100 mm, specific steam consumption - 2.7 kg / l. a.a. brew. To optimize the DC it is necessary to investigated the behavior of alcohol impurities at their high concentration when DC is working under vacuum. Fig. 1 shows a diagram of the DC.

Concentrating and removal of related alcohol impurities in DC that are introduced in ERU with brew.

"The degree of extraction ( $\beta$ )» and "the degree of concentration ( $\alpha$ )» of related alcohol impurities depending on the efficiency hydroselection were the defied. Efficiency hydroselection was determined by the concentration of alcohol in the cubic liquid of DC at a concentration of 3.7, 3.9, 4.2, and 4.3, 4.6, 4.9, 6,0% vol. The table shows the concentration of volatile organic impurities in alcohol performance booster column at a concentration of alcohol in the cubic liquid at 3.7%, and qualitative indicators of commercial alcohol.

**The concentration of volatile organic alcohol impurities by distillation column at a concentration of alcohol in a cubic liquid 3.7% vol.**

Name of impurities	Zone sampling (apparent concentration of alcohol% vol.)				The degree of concentration of impurities, $\lambda$	The degree of removal of impurities, $\beta$
	Spirit (96,3%)	CEF, mg/dm <sup>3</sup> (71,5%)	Cube DC, mg/dm <sup>3</sup> (3,7%)	Supple column, mg/dm <sup>3</sup> (73%)		
	1	2	3	4		
Acetaldehyde	0,36	365,26	3,37	144,84	2,52	42,98
Methyl acetate	traces	141,2	traces	24,55	5,75	complete
Ethyl acetate	traces	7103	traces	643,1	11,04	complete
Methanol	0,0022	0,031	0,07	0,069	0,45	0,99
Isopropanol	1,9	56,58	traces	3,67	15,42	complete
Isobutyl acetate	traces	117,7	traces	4,01	29,35	complete
N-propanol	traces	36770	2717	5116	7,19	1,88
Crotonic aldehyde	traces	33,05	traces	traces	Complete	complete
Isobutanol	traces	74900	traces	3601	20,80	complete
Izoamilatsetat	traces	505,1	traces	30,58	16,52	complete
N-butanol	traces	1015	traces	69,13	14,68	complete
Isoamyl spirit	traces	258000	7,73	12710	20,30	1644,24
N-pentanol	traces	115,5	53,04	54,16	2,13	1,02
N-hexanol	traces	578,9	traces	31,28	18,51	complete
Furfural	traces	-	traces	5,94	Complete	complete
Benzaldehyde	traces	22,71	traces	4,8	4,73	complete

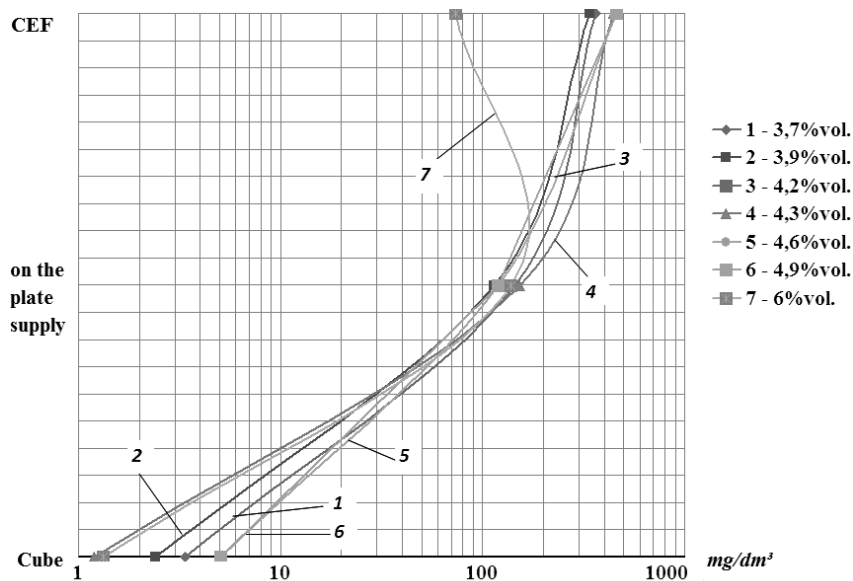
The degree of concentrating and removal of organic impurities of alcohol in DC was identified on the basis of obtained data.

Analyzing the process of separation of impurities in the performance booster column that runs under pressure lower than atmospheric, we can divide them into 2 groups varying degrees hydroselection.

The first group includes: acetaldehyde, methanol, izoamilatsetat, n-propanol, n-butanol, isopropanol, isobutyl acetate, isoamyl spirit. For their effective concentration it is necessary to maintain the concentration of alcohol in the cube DC between 3.7 ... 4.9% vol.

Group 2 includes: methyl acetate, ethyl acetate, n - pentanol, n-hexanol. For their effective concentration it is necessary to maintain the concentration of alcohol 6.0% vol.

Fig. 2 -7 shows graphs of the distribution of organic alcohol impurities depending on the degree hydroselection (concentration of alcohol in the cube DC). The next graphs are presented in the master's work.



**Fig.2. The concentration of acetaldehyde**

The most effective concentration of acetaldehyde occurs when the concentration of alcohol in the cube PBC between 3.9 ... 4.3% vol. By increasing the concentration to 6% vol. - efficiency acetaldehyde concentration decreases times at average.

The best concentration of methanol occurs when the concentration of alcohol in the cube DC to 3.9% vol. With increasing concentration of the cube liquid to 6.0% vol. the degree of extraction and concentration of methanol decreases by almost 1.8 times.

Isopropanol is effectively removed at a concentration of cube liquid between 3.7 ... 4.9% vol.

When the concentration of alcohol from 3.7 to 3.9% vol. at concentration of n - propanol is the most effective.

When the concentration of alcohol in the cube LCD is 6% vol. removal and concentration of isoamyl alcohol is the worst. The best its removal occurs at the concentration of alcohol in the cube 3.7 ... 4.9% vol.

Ethyl acetate and methyl acetate are the most efficiently removed when the concentration of alcohol in the cube of distillation column about 6% vol.

## Conclusions

Organic impurities of alcohol, which form its analytical and organoleptic properties for their degree of removal and concentration in the distillation column, with its work under vacuum (up to - 4.6 m.vod.st.) we can divide into two groups.

The first group includes, principally, intermediate impurities (n-propanol, n-butanol, isopropanol, isobutanol, isoamilatsetat), acetaldehyde and methanol, which are more effectively removed and concentrated under hydroselection that provides the concentration of alcohol in the cube of distillation column within 3, 7 ... 4.9% vol.

The second group includes: ethyl acetate, methyl acetate, n-pentanol and n-hexanol, which are the most effectively remove and concentrated at a concentration of alcohol in the cube of distillation column at 6.0% vol., to be considered when modeling the quality parameters of commercial alcohol.

The obtained results allowed to optimize the disposal technology of rectified spirit waste of ethanol rectification units that works in energy-saving mode under pressure lower than atmospheric and to reduce their number at average from 18% to 0.3 ... 0.5% of absolute alcohol brew during stable production of high quality rectified spirit and this, in turn, increases the competitiveness of alcohol production both in domestic and foreign markets.

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## Features and benefits analysis of transient processes in food technology

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**ABSTRACT**

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The analysis of physical background features and benefits of the transition process in food technology from the point of view of the interests they intensify heat and mass transfer. A structural analysis of discrete-pulse, extruder technology and technology sudden changes of pressure transients and their application to the assessment of energy potential and concluded that common ground in the form of primary energy savings potential in these technologies.

It was concluded that for most processes in food technology it is possible to reduce the fast thermodynamic parameters such as pressure. Thus there is a change in pulse energy potential with capacities that can exceed conventional technology even several orders of magnitude. That is what defines significant prospects spread discrete pulse, extruder technologies and technologies sharp decrease pressure for gas-saturated environments.

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Transients are the parts most dynamic phenomena associated with the change of electromagnetic, mechanical, acoustic, thermodynamic, mass transfer, hydrodynamic and other parameters. They correspond to variable speed motion, acceleration or deceleration until conditions stabilize and achieve static or dynamic equilibrium in which the coming steady.

Physical basis of transition is well illustrated by the dynamics of mechanical systems. For example, the phases of acceleration, steady motion and freewheel in moving mass  $m$  under the influence of the driving forces  $P_d$  and the presence of the resistance  $P_r$ . In accordance with the principle of D'Alembert believed that such a mass movement is characterized by a set of inertial forces (where  $\ddot{x}$  - the second derivative of the displacement coordinates) and the driving force and resistance.

It is important that during acceleration driving force performs work related to overcoming the resistance to a move and work simultaneously driving force is the source of growth of the kinetic energy of moving masses. Over a period of steady movement equality holds work forces and driving forces of resistance, and the accumulated kinetic energy expended in freewheel mode, often in the form of dissipative phenomena.

It follows that the greatest burden on the source of the driving force is identical to the acceleration, which also synchronizes with major mechanical components of the system load. The above feature a similar structure inherent course the vast majority of heat and mass transfer characteristic of Food Technology. However, under certain conditions and run-down modes can be characterized by significant driving differences.

## — *Processes and Equipment of Food Productions* —

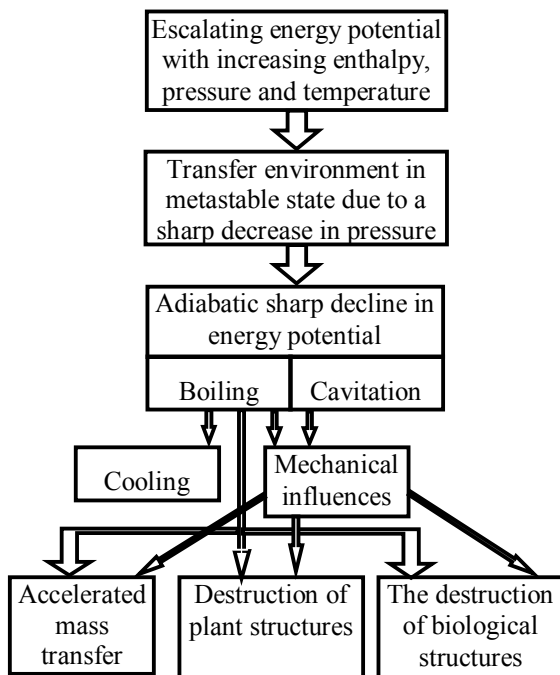
Importantly, driving factor (as a driving force in the mechanical model) can not act, but the accumulated kinetic energy works as inertial power factor, or the role of energy source with the following transformation can play accumulated potential energy.

Every avalanche in stock cars and special moving mass as flywheels act as reservoirs of kinetic energy. It is important that such accumulation may be arbitrarily extended in time and reach significant levels with limited capacities driving forces.

It is logical to say that for kinetic energy storage system crucial moving mass and the speed of their movement. Thus the importance of prevailing is linear or angular velocity of the moving mass as kinetic energy of the body or of material bodies is proportional to their square.

If the ultimate goal of the process is to achieve the maximum possible power of the body or the environment, it will meet the requirement of expeditious transfer them to a state of minimized kinetic or potential energy. This transition corresponds to the principle of Le Shatel'ye, but this time it does not look like gravity as well organized process. We emphasize that the maximum effects of this energy jump corresponds to the minimum time of its course. Classic examples of this situation is the phenomenon of water hammer, cavitation vapor bubbles collapse, sudden depressurization of the reactor liquid fraction having a temperature higher than its boiling temperature at atmospheric pressure, etc. [1-4].

From this perspective, the above mechanical, hydrodynamic, hydraulic, gas-liquid system and the thermal energy potential can be seen as a kind of hub of kinetic and potential energies. It is obvious that a sharp decline in the energy potential of any system is a germ of both negative and positive impacts on the environment and their structural components. It is important that in the aggregate effects could determine the suitability of the use of certain technologies.



**Fig. 1. Block diagram of discrete-pulse technology**

It is in this way obtained the development of discrete-pulse, extruder, electrohydraulic, ion technology, technology sudden change of pressure in relation to gas-liquid environments and more. They are increasingly using relatively Food Technology at targeted organizations transients in order to intensify mass transfer and heat transfer, directly from their course, and to speed up subsequent processing steps environments.

In this perspective among the tasks of this study include the following:

- perform a structural analysis of discrete-pulse technology and transients on their application to the assessment of the energy potential;
- perform structural analysis technology sudden pressure change and their energy basis.

## — *Processes and Equipment of Food Productions* —

Let more detail on the structure of these transient effects.

Discrete switching technology. Certainly under this name means a series of technologies that have implemented fast decrease of the energy (heat) capacity. Picture 1 shows a block diagram of the components of such technologies on the example of liquid systems. In accordance with the latter because of adiabatic boiling and cavitation achieved mechanical impacts on the environment, with all their consequences in the form of rapid mass transfer, destruction of biological structures of animal and vegetable origin, etc.

It is important to note that the latter can be achieved at the macro level and intercellular and even cellular structures, which can significantly speed up these processes of extraction, desorption, etc. homogenization.

Metastable state actually corresponds to the transfer medium in a superheated state, which usually stays short and thus it is important to enter deep into it.

Pressure from among these thermodynamic parameters for the system is the only one for which the possible implementation of the fast drop. The lower limit is determined by atmospheric or vacuum pressure volume, which connects (or created) the processed medium.

Of course, that technologically easier to organize processes with limited lower atmospheric pressure value. But that means the ultimate limit of ambient temperature  $t(f) \approx 100^\circ \text{C}$ , which corresponds to the end of adiabatic boiling. Hence it is clear that the range of temperatures in which the entire flow process, greater than  $100^\circ \text{C}$ .

If the initial temperature of the environment corresponded to the temperature  $t(i)$ , the temperature range is adiabatic boiling

$$\Delta t = t_{(i)} - t_{(f)} \quad (1)$$

Hence, the energy potential of the transition process is

$$\Delta E = mc\Delta t, \quad (2)$$

where  $m$  and  $c$  - respectively, the mass and heat capacity environment.

Assessment of external impacts on the environment carried out on the basis of specific energy injected into it, and in our case we have the opportunity to perform relevant calculations, taking the value  $m = 1 \text{ kg}$ ,  $c = 4.19 \text{ kJ} / (\text{kg} \cdot \text{K})$ .

Their results are shown in the table.

**Table 1. The results of calculations to determine the energy potential liquid system**

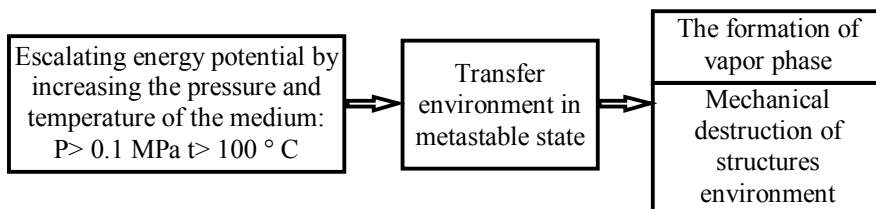
<b>Difference temperatures <math>\Delta t</math>, <math>^\circ \text{C}</math></b>	2	4	6	8	10	12	14	20	30
<b>Energy potential <math>\Delta E</math>, kJ</b>	8,38	16,7	25,14	33,52	41,9	50,2	58,66	83,8	125,7

The concentration of energy impacts is important, not only in space or volume, but in the time course of the process. That last transience largely determines the outcome. For example, concerning the extruder technology, which formed a vapor phase expansion is virtually unlimited volume, final pressure for the system clearly fits the atmosphere. Also there is no influence of hydrostatic pressure, which is somewhat limiting for liquid phase in a closed volume. As a result, the output material flow from the extruder to be destructive of the generated steam is released with its full volume over time, approaching the instant action.

Extruder technology. Although the total production of extruder technology similar to discrete-pulse (they are based, the same rapid change in potential energy), but their

— **Processes and Equipment of Food Productions** —

organization is different. It is important that their progress all the components of processes occurring in a continuous mode and cover a relatively limited part of the treated environment. Block diagram of a generalized extruder technology is shown on Picture 2.



**Fig. 2. Block diagram of transients extruder technology**

High efficiency on the level of mechanical stress due to the brevity of the process of formation of a vapor phase. The value of the energy potential in this case is determined by the difference of the initial and final temperatures, that is depth entering the environment in a metastable state.

Although the process of generating a vapor phase is estimated as fleeting or momentary, but phenomenological considerations lead to the conclusion that the rate of vaporization  $dG / d\tau$  depends on the driving force of this process, that is, the temperature difference between the fluid and the final.

$$\frac{dG}{d\tau} = \frac{dG}{d\tau} \left( t - t_{(f)} \right) \quad (3)$$

Obviously, the maximum  $dG / d\tau$  corresponds to the temperature difference, when  $t = t(i)$ , while evaporation does not stop when you reach  $t = t(f)$ . However, the last character if steaming is different, since the processes at a boil stop.

The value of the energy difference that wears extrusion mode is determined by the formula (2), but the value of the specific heats of grain or other product will be less because of their moisture is limited. The most heat capacity is known, the known matter in the physical world is water. Therefore, to improve extrusion process cereals moistened.

Thus, the comparison of discrete-pulse technology in their classical sense and extruder technology leads to the conclusion that the presence of similar and different patterns in them. Obviously, this indicates the possibility of combining in one complex of elements. For example, the preparation of beet chips to the diffusion process requires the greatest possible level of plasmolysis of cellular structures. The existing technologies it is achieved through temperature effects at 70 °C as a result of appropriate treatment in hot processing. However, this heat treatment has negative consequences associated with denaturation protoplasm beetroot tissue and subsequent extraction. Reducing costs and increasing the yield of the target product may seek introduction to the use of the area between **hot processing** and diffusers vacuum chamber through which a continuous flow mode adiabatic boiling transported beet chips.

Technology sudden change of pressure (TSCP). Take these technologies to the gas-liquid processes under aerobic cultivation of microorganisms, fermentation process of beer, alcohol, wine industries carbonated drinks champagne carbonation apparatus sugar industry and others. Gas phase for microbiological processes is air, and called on other industries such gas phase is

— **Processes and Equipment of Food Productions** —

carbon dioxide, which is directly synthesized in fermentation processes or forcibly dissolved in the liquid phase.

An important feature of the interaction of liquid media with carbon dioxide is relatively high solubility of the latter and one that depends on the partial pressure according to Henry's law. The latter provision leads to the conclusion that the use of potential energy of dissolved CO<sub>2</sub> for intensification, absorption, absorption, desorption in gas-liquid systems, "gas - liquid - solid" and so on.

Perform initial assessment on the possible accumulation of power potential in the "gas - water."

The solubility of gases in water is known to depend on the magnitude of their partial pressures and temperature, for example, at  $t = 20\text{ }^{\circ}\text{C}$  and  $P = 0.75\text{ MPa}$  CO<sub>2</sub> solubility is 14 g / l. Suppose that in intensive mode desorption pressure of 0.1 MPa carbon dioxide content reduced to 4 g / l.

Volume of gas phase, which is released at the same time will

$$V_g = \frac{MRT}{P} = \frac{0,01 \cdot 188,9 \cdot 293}{10^5} = 0,554 \cdot 10^{-2} \text{ m}^3 \quad (4)$$

where  $M = 0.01\text{ kg}$  - weight of desorbed gas;  $R = 188,9\text{ J} / (\text{kg} \cdot \text{K})$  - gas constant,  $T = 293\text{ K}$  - ambient temperature,  $P = 10^5\text{ Pa}$  - pressure under normal conditions.

Thus, the reverse process of absorption due to the partial pressure of 0.75 MPa we achieve dissolution of gas volume in terms of normal conditions  $0,554 \cdot 10^{-2}\text{ m}^3$ . Maintaining such a large amount of CO<sub>2</sub> in the dissolved state is possible with stabilized temperature of  $20\text{ }^{\circ}\text{C}$  only for maintaining the pressure 0.75 MPa. The sharp drop in the last means transition gas-saturated environment to a new state of equilibrium. For values of these parameters the energy potential is lost by desorption, is

$$\Delta E = P_{0,75} V_g = 0,75 \cdot 10^6 \cdot 0,554 \cdot 10^{-2} = 4155 \text{ J.}$$

Comparison of the obtained results with the data table shows that they are of the same order. It is possible to substantially increase the parameter  $\Delta E$  as by increasing solubility at low temperature environments, and by increasing the partial pressure of the gas phase.

In accordance with this design formula for determining potential energy difference is reduced to the form

$$\Delta E = P_{(i)} \frac{\left( M(P_{(i)}; t_{(i)}) - M(P_{(f)}; t_{(f)}) \right) RT}{P_{(f)}} \quad (5)$$

where  $M(P_{(i)}; t_{(i)})$  - mass dependence of the solubility of carbon dioxide from the pressure  $P(i)$  and temperature  $t(i)$  absorption;  $M(P_{(f)}; t_{(f)})$  - mass solubility of CO<sub>2</sub> at the end of desorption,  $P(f)$  and  $t(f)$  - respectively the final pressure and temperature at the end of desorption.

As in the first two cases a critical factor influencing the shifting environment in the metastable state is pressure, although the temperature is also responsible for entering deep into it. Therefore, expanding the limits of potential energy should reach by increasing pressure and decreasing temperature environment escalating mode and, conversely, the pressure drop in a pre-heated in a sealed environmental conditions in a "triggering" potential.

## Conclusions

1. Discrete pulse, extruder technology and technology drastic reduction pressures have common ground in the form of initial accumulation of energy potentials. The management function of the energy potential while serving pressure liquid, gas-liquid systems or systems with the addition of these solid phase.

2. For most processes in food technology it is possible to reduce the fast thermodynamic parameters such as pressure. According to the dynamic changes of the last impulse is a change of power potential with capacities in excess of traditional technologies on the order of or even several orders of magnitude. That is what defines significant prospects spread discrete pulse, extruder technologies and technologies sharp decrease pressure for gas-saturated environments.

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## Entropy analysis of heat exchanging appliances

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<b>Keywords:</b> Thermodynamics Heat exchange Process Entropy Exergy of warmth	<b>ABSTRACT</b> The article describes thermodynamic methods as well as optimization methods of heating and heat exchanging engineering system of sugar industry. The authors suggest noncyclic approach to the analysis of efficiency of heat exchanging apparatus, the basis of which is irrefutable fact that irreversibility as physical reason of inefficiency of technical heat engineering systems really exists. Thermodynamic analysis, which was mentioned in the article, assumes determination of measure of irreversibility of processes in the apparatus and energetic efficiency of apparatus in the whole with the help of exceptionally entropy. The measures taken to improve energetic efficiency of apparatus of saccharine factory on the example of the first group of juice heating in front of evaporator system using the given methodology, were fully analyzed.
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### Introduction

It is obvious that nowadays such major characteristics as “area of thermoexchange surface” and “coefficient of efficiency” are traditionally used in saccharine industry. That is not enough, as while comparing constructionally different HEAs it makes no sense to compare relation between area of thermoexchanging surface and its characteristics. The usage of exergy method of thermodynamic analysis [3] (which is widely used while analyzing technical systems – work generators) contradicts the fundamental principles of methodology of optimization of thermoexchanging processes and systems.

The issue of choice of analysis of effectiveness of HEA was reviewed by the authors in [1,2], where the expediency of usage of non-cyclic entropy method for thermodynamical analysis and HEA optimization, as well as energetic balance method for composing energy model of HEA performance is substantiated.

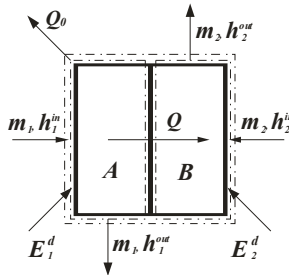
### Results and discussions

Adhering to producers’ terminology, HEA of “condensate-juice” type is called as “heat exchangers”, and HEA of “steam-liquid” type – as “heaters”.

According to non-cycle entropy method technique [1, 2], integrated thermodynamic analysis assumes the determination of measure of irreversibility of processes, that occurs in HEA, the sources of which are heat exchanging at the finite variance of temperatures, the

dissipation of mechanic energy of heat transfer medium currents and heat exchanging with the environment.

The quantitative characteristics of irreversibility is increasing of entropy of isolated system, which determines from the entropy balance of ABC system (fig. 1), which consists of 3 subsystems: A, B, and C (A is heating heat transfer medium subsystem, B - heat transfer medium subsystem, C – environment subsystem).

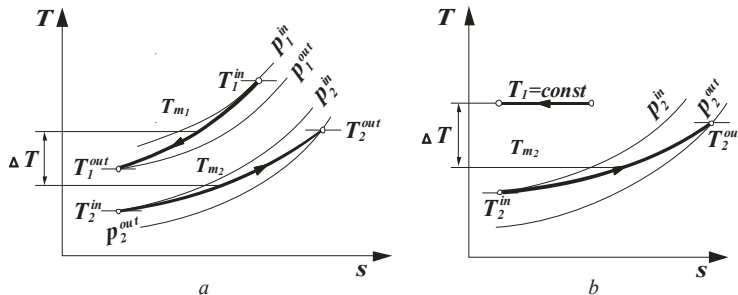


**Fig. 1.** before the folding of entropy balance of HEA

In general, entropy balance of HEA is agglomerated with the help of following simplifications:

- change of kinetic and potential energy is neglected;
- for heat transfer mediums, in which transition between preset thermodynamic states is followed by temperature changes (fig. 2 a, 2 b), change of thermal qualities is not considerable, which allows to introduce medium thermodynamic temperature:

$$T_m = \frac{T^{in} - T^{out}}{\ln \frac{T^{in}}{T^{out}}} \quad (1)$$



**Fig. 2.** Change of thermodynamical states of hot and cold heat transfer media:  
a – in heat transfer medium, b – in heater

Written form of entropy is grounded on its qualities and assumes that all its parts are absolute values; entropy can be either brought in or taken out together with the streams of substance and heat, and increase because of the irreversibility of the processes.

Entropy balance of every subsystem (fig. 1) looks like this:

Entropy balance of subsystem A:



— **Processes and Equipment of Food Productions** —

$$m_1 s_1^{in} + \frac{E_1^d}{T_{m_1}} = m_1 s_1^{out} + \frac{Q}{T_{m_1}} + \frac{Q_0}{T_{m_1}} \quad (2)$$

Entropy balance of subsystem B:

$$m_2 s_2^{in} + \frac{Q}{T_{m_2}} + \frac{E_2^d}{T_{m_2}} = m_2 s_2^{out} \quad (3)$$

Entropy balance of subsystem C:

$$\Delta S_c = \frac{Q_0}{T_0} \quad (4)$$

Estimating entropy additivity, in another words,  $DS_{ABC} = DS_A + DS_B + DS_C$ , and the fact that AB subsystem together with C subsystem create generally isolated adiabatic system ABC (concluded from the boundary line quantities of the system), for which entropy change equals general entropy increase fom irreversibility of the processes:  $\Delta S_{ABC} = \Delta S_{irrev}^{tot}$ . It can be written in the following way:

$$\Delta S_{irrev}^{tot} = m_1 s_1^{out} + m_2 s_2^{out} - (m_1 s_1^{in} + m_2 s_2^{in}) + \frac{Q_0}{T_0} \quad (5)$$

or

$$\Delta S_{irrev}^{tot} = \left( \frac{Q}{T_{m_2}} - \frac{Q}{T_{m_1}} \right) + \left( \frac{Q_0}{T_0} - \frac{Q_0}{T_{m_1}} \right) + \frac{E_1^d}{T_{m_1}} + \frac{E_2^d}{T_{m_2}} \quad (6)$$

We rewrite the equation (6) in general view:

$$\Delta S_{irrev}^{tot} = \Delta S_{irrev}^T + \Delta S_{irrev}^0 + \sum \Delta S_{irrev}^p \quad (7)$$

in which  $\Delta S_{irrev}^T = \frac{Q}{T_{m_2}} - \frac{Q}{T_{m_1}}$  - is increasing of system entropy, conditioned by irreverence of

heat exchange between subsystems A and B; W/K;  $\Delta S_{irrev}^0 = \frac{Q_0}{T_0} - \frac{Q_0}{T_{m_1}}$  - increasing of entropy at dissipation of mechanical energy of streams of heat transfer medium (in case of the heaters  $E_1^d / T_{m_1} = 0$ ) W/K.

Thermodynamical efficiency of HEA, considering the irreverence of the processes, is defined by non-dimensional coefficients: entropy coefficient of thermodynamical efficiency:

$$\eta_s^p = 1 - \frac{\Delta S_{irrev}^{tot}}{\Delta S_{irrev}^{max}} \quad (8)$$

Or entropy coefficient of thermodynamical non-efficiency:

$$\eta_s^{imp} = \frac{\Delta S_{irrev}^{tot}}{\Delta S_{irrev}^{max}} \quad (9)$$

While

$$\eta_s^{imp} + \eta_s^p = 1 \quad (10)$$

in which  $\Delta S_{irrev}^{tot}$  - is increasing of entropy of isolated system, that goes across to two given states, W/K;  $\Delta S_{irrev}^{max}$  - maximal possible increasing of entropy of adiabatic system - system passes from given state to the state of thermodynamic balance with the environment, W/K.

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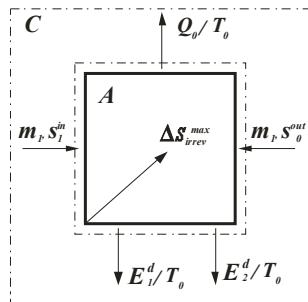
Coefficients (8) and (9) do not have known (discovered) drawbacks of performance factor (energetic, exergy), as they characterize the degree of diversion of real system from reverent in structure borders of the second thermodynamic law. Let us explain this.

Including the fact that the state of balance of isolated system is defined by the maximum of its entropy (consequence of the second thermodynamic law) and restrictions, imposed by the nature on the operation of technical systems (energy has technical meaning till it has the potential different from the one of the environment), denominator of equations 8 and 9 is used as the standard of comparison.

It means that  $\Delta S_{irrev}^{max}$ , being the result of heat exchanging of hypothetical TS (system A) with the environment (system C) (fig. 3), which quantitatively characterizes maximal irreversibility at given characteristics of environment and is calculated with the help of the following equation (fig. 3):

$$\Delta S_{irrev}^{max} = m_1(s_0 - s_1) + \frac{Q_0}{T_0} + \frac{E_1^d}{T_0} + \frac{E_2^d}{T_0} \quad (11)$$

in which  $s_0$  - is specific entropy of heating heat transfer medium at the temperature of environment, J/(kg·K).



**Fig. 3. Hypothetic TS**

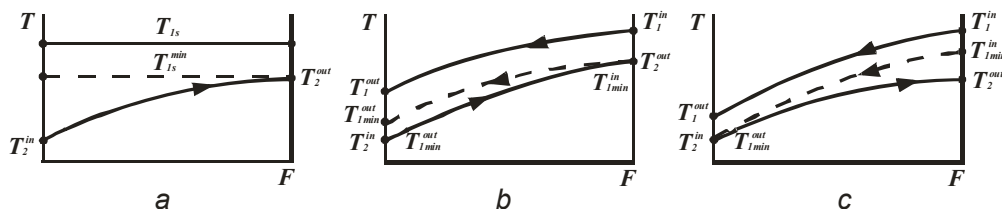
While analyzing the heaters in equation (6)  $T_{m1} = T_{1s}$  - the temperature of saturation of dry saturated steam, and  $E_1^d / T_0 = 0$ .

The efficiency of functioning of HEA – local effectiveness of potential usage of heat transfer medium (temperature), including dissipation processes in given temperature interval – defined entropy coefficient of HEA effectiveness:

$$\eta_s = \frac{\Delta S_{irrev}^{min}}{\Delta S_{irrev}^{tot}} \quad (12)$$

in which  $\Delta S_{irrev}^{min}$  - is a minimal entropy increasing because of heat exchanging irreverence in HEA,  $\Delta S_{irrev}^{min} = Q(T_{m_1}^{min} - T_{m_2}) / (T_{m_1}^{min} T_{m_2})$ , W/K,  $Q$  – true heat effectiveness of HEA, W;  $T_{m_2}$  - medium thermodynamic temperature of the heating up heat transfer medium, K;  $T_{m_1}^{min}$  - minimal possible medium thermodynamic temperature of heating heat transfer medium, K. For heaters  $T_{m_1}^{min} = T_{1s}^{min}$  (fig. 4 a); for heat transfer media with large mass account thermal capacity of heating heat transfer medium according to equation 6 and fig. 4 b  $T_{m_1}^{min} = (T_{1min}^{in} - T_{1min}^{out}) / (\ln T_{1min}^{in} / T_{1min}^{out})$ , thus  $T_{1min}^{in} = T_{2}^{out}$ ; for heat exchangers with larger mass

account thermal capacity of heating up heat transfer medium  $T_{m_1}^{\min}$  is calculated analogically, including  $T_{1\min}^{\text{out}} = T_2^{\text{in}}$  (fig. 4 c).



**Fig. 4.** Before defining  $\Delta S_{\text{irrev}}^{\min}$

a - in the heater; b - in the heater with bigger mass consumptive thermal capacity of heat transfer medium; c - in heater with bigger mass consumptive thermal capacity of heating heat transfer medium

## Conclusions

Suggested technique of thermodynamic analysis assumes scientifically proved systematic approach to comparative analysis and different construction, that, obviously, is suitable to do with the help of entropy coefficient of efficiency, as well as for defining their thermodynamic efficiency in margins of sugar plant. The last can be achieved with the help of using entropy coefficient of thermodynamic efficiency and allows to analyze different heat exchanging systems for defining the level of their influence on general energetic efficiency of sugar plant.

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## Research of the features of reactive power compensation in the combined system of food industry

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### ABSTRACT

**Keywords:**  
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The ways of increasing operation efficiency of reactive power compensation on the plants are considered. Small capacitor units may be connected at the individual loads. Greater power – factor corrective effect for a given total capacitor kilovolt – ampere will result with the capacitors located directly at each individual load, since the current is thereby reduced all the way from the load to the source. The first cost of an installation of individual capacitors will be greater, however, than that for one unit of the same total kilovolt – amperes located at a central point. The greater saving in operating expense due to individual capacitors must be weighed against their increased first cost. The locking circuit against high voltage is presented. The problems of its engineering implementation are considered. The expediency of the use of each synchronous motor for reactive power compensation. If the load factor of a synchronous motor is less than unity, economically expedient to use fully expected reactive power output. The need to apply the power of higher harmonics filters with a distortion factor is more than 8%, which is typical for plants with thyristor converters. Recent calculated from the calculated values of the distortion factor is based on the composition and level of harmonics.

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### Introduction

Almost all factories of food industry in Ukraine have a combined system of electricity supply and receive electricity from their own thermal power stations and are connected to the supply system. In the repair period thermal power station is not working and electricity is received from the general electrical networks.

### Material and methods

Power-stations have limited possibilities to generate reactive power. At thermal power station generators with power factor of 0.8 are installed. Much of the generated reactive power has consumed by transformers and power lines. Distribution of reactive power consumption is: induction engines - 70%, transformers - 20%, lighting and other electrical consumers - 10% [1].

## — *Automatization of Technological Processes* —

It is not enough to use the generators reactive power of the own thermal power station for the normal plant operation, and many factories are equipped with high condensing apparatus. But it is not reasonable because during the transmission of reactive power to consumers there are significant losses of active power due to resistance of conductors  $r$

$$\Delta P = \frac{Q^2}{U^2} \cdot r \quad \text{or} \quad \Delta P = P^2 \cdot (1 + tg^2 \varphi)$$

The crosscut of conductors is increased, because crosscut is selected according to the load current, and the current depends on the reactive power

$$I = \frac{P}{\sqrt{3} \cdot U \cdot \cos \varphi}$$

Thus, there is the overrun of conductor material.

The power of transformers ST is used irrationally

$$S_T = P \cdot \sqrt{(1 + tg^2 \varphi)}$$

There are additional losses of voltage [1]

$$\Delta U = \frac{Q_x}{10 \cdot U_{\text{НОМ}}^2},$$

$x$  – the reactance of the power supply system's elements.

Thus, the reactive power which is transmitted to electrical consumers is to be reduced (to compensate) to economic levels.

### **Results and discussions**

During the process of compensation it is necessary to consider the following general requirements [2,3]:

- 1) the reactive power can be generated at any point of the network (unlike the active power);
- 2) the network unloading depends on the distance between sources of reactive power and consumers facilitates;
- 3) the balance of reactive power must be the same for all power supply system components.

A small weight, no rotating parts, slight loss of energy, ease of maintenance, safety and reliability allow the using of the capacitors for reactive power compensation at all levels of electricity supply.

The synchronous engines are widely used by enterprises to drive devices that do not require the speed control (compressors, pumps, ventilators, etc.). The engines can work with outstripping power-factor and reactive power to compensate other electrical consumers. The compensating engine capacity is determined by the load on its shaft, voltage and current excitation.

When placing capacitors in the enterprise network be aware that there are individual and centralized reactive power compensation [1].

In case of individual compensation the capacitor unit is connected to the clamp of electrical consumer without commutation apparatuses. This type of compensation should only be used only in relatively large electrical consumers by the quantity of annual working hours. Individual compensation allows relieving of all production network from the reactive currents. However, this method demands significant investments. In addition, time of compensating

## — Automatism of Technological Processes —

devices work depends on the time of turning on of electro-transceiver because when you turn off the electric network you turn off the capacitor battery, too.

With centralized compensation the capacitor unit is to be connected to the tire of 0.4 kV transformer substations or to the tire of 6... 10 kV distribution units [4].

In the first case the all high-voltage network, transformer of transformer substation and thermal power station generators are relieved because of reactive power; in the second - only part of the high-voltage network and generators thermal power station.

The criterion of rational decision of a reactive power compensation problem is the reducing of losses. They consist of the costs for compensating, regulatory and related devices, the costs for reactive-power control and its transmission to the elements of network. These costs include the components that do not depend on the value of reactive power. That's why the methods of the compensating devices power determination were developed. They does not require taking into account the absolute value costs of the electrical system elements [2,3,4].

According to this methodology for an acting factory during the reconstruction of the electricity supply system:

$$Q_{KV} = Q_M - Q_{TEH},$$

where:  $Q_M$  - the maximum consumption of reactive power on the daily chart speed plant,  $Q_{TEH}$  - reactive power of the thermal power station generators.

As a rule:

$$Q_{KV} = Q_{HK} - Q_{BK},$$

$Q_{HK}$  - power of compensating devices (voltage up to 1000 V),

$Q_{BK}$  - the same but for voltage of 6... 10 kV.

In turn:

$$Q_{HK} = Q_{HK1} + Q_{HK2},$$

where:  $Q_{HK1}$  - the total power of CD based on the optimal number of transformers TS and acceptable their downloading  $\beta$  ;

$Q_{HK2}$  - the power of compensating devices based on the optimal value of losses in transformers and network with voltage of 6... 10 kV that nourishes of these transformers.

The maximum reactive power is determined. It is reasonable to pass it through the transformers in transformer substation network voltage up to 1000 V

$$Q_T = \sqrt{(N_{TE} \cdot \beta_T \cdot S_T)^2 - P_P^2},$$

where:  $N_{TE}$  - the number of transformers in the group (workshop, corps),

$\beta_T$  - the expected load factor of transformers,

$S_T$  - the nominal power of transformer in a group, kV · A,

$P_P$  - the calculation of the active power of electrical consumer with voltages up to 1000 V.

The total capacity of compensating devices for this group of transformers is

$$Q_{HK1} = Q_P - Q_T,$$

where:  $Q_T$  - the calculation of the reactive power of electrical consumer with voltages up to 1000 V.

If you find that  $Q_{HK1} < Q_T$ , then it should be accepted  $Q_{HK1} = 0$ .

At the second stage an additional total capacity of compensating devices for this group of transformers of transformer substation is determined:

— **Automatization of Technological Processes** —

$$Q_{HK2} = Q_p - Q_{HK1} - \gamma \cdot N_{TE} \cdot S_T ;$$

where  $\gamma$  - the calculation coefficient which depends on the power scheme and is determined by the formula.

For one substation:

$$\gamma = \frac{49,5}{100 + \frac{r \cdot l \cdot S_T}{F}} ;$$

here:  $l$  - the length of the supply line (with radial circuit) or the distance to the first transformer (in the main circuit), km,  $F$  - crosscut of power lines conductors, mm<sup>2</sup>,  $r$  - coefficient which depends on the supply voltage:  $r = 8(27)$  in radial circuits for 6 and 10 kV,  $r = 15(5)$  according to the backbone networks.

Each synchronous engine can be a source of reactive power, the nominal value of which is [1,2,3]:

$$Q_{CD} = P_{CD\text{HOM}} \cdot \text{tg}\varphi_{\text{HOM}} ,$$

where:  $P_{CD\text{HOM}}$  - the nominal active power of SM,

$\text{tg}\varphi_{\text{HOM}}$  - the nominal power factor.

If the load factor of synchronous engine is less than 1 (one), economically reasonable to use fully expected reactive power of synchronous engine

$$Q_{CD} = \alpha_M \cdot S_{CD\text{HOM}} ,$$

where:  $\alpha_M$  - the factor of the synchronous engine's allowable overload, which depends on its loading with active power.

$$\alpha_M = \sin \varphi_{\text{HOM}} + (1 - K_3) \cdot \left( \frac{\sin \varphi_{\text{HOM}}}{48 \cdot \sin \varphi_{\text{HOM}} - 32} + 0,4 \right) ,$$

where  $K_3$  - the load factor active power synchronous engine.

If the distortion factor is  $k_{HC}$  to 5-8% (it is typical for plants with thyristor converters), it is recommended to use the capacitor batteries together with protective reactor or filter for compensation [2, 3]. The power of capacitor battery is determined by the balance of reactive power.

Voltage of the power capacitor is

$$U_{BK} = \frac{v_{\text{MIH}}^2 \cdot U_{\text{HOM}}}{(v_{\text{MIH}}^2 - 1)}$$

where  $U_{\text{HOM}}$  - the nominal network voltage, where the protected by reactor condenser is set;

$v_{\text{min}}$  - the minimum number of harmonic.

It is necessary to provide an inductive character of the circle for the harmonic with the lowest frequency of the harmonics which are generated by nonlinear loading total. The inductive resistance of protective reactor at 50 Hz is

$$x_p \geq \frac{1,1 \cdot U_{BK.HOM}}{(v^2 Q_{BK.HOM})}$$

where  $Q_{BK.HOM}$  - reactive total power of power capacitor according to the data of a manufacturer.

If the distortion factor is more than 8% (it is typical for plants with thyristor converters) it is recommended to use the power filters of higher harmonics (hereinafter - just filters). They are calculated from the computed value  $k_{HC}$  which is based on the composition and level of harmonics. The calculation of filters should be started from the smallest harmonic filter. It is necessary to check the admissibility of filters loading with the current of proper harmonics. The total reactive power generating filters should be chosen from the condition of reactive power balance.

Let's considered the calculation of the filter which is tuned to the same frequency [2,3,4]. The voltage at the filter elements is

$$U_c = U_L + U_{\text{ж}},$$

where  $U_c, U_L$  - the voltage on the capacitor and the coil inductance,

$U_{\text{ж}}$  - supply voltage.

The power of the filter is

$$S = \frac{U_{\text{ж}}^2}{x_c - x_L},$$

where  $x_c, x_L$  - the reactance of capacitor and inductor at the basic frequency.

The characteristics of the filter which is tuned to harmonic  $v$  are

$$x_o = vL = \frac{x_c}{v}; \quad x_L = \frac{x_c}{v^2}; \quad U_L = \frac{U_c}{v^2}$$

Then

$$S = \frac{U_{\text{ж}}^2}{x_c \left(1 - \frac{1}{v^2}\right)}; \quad U_c - U_L = U_c \left(1 - \frac{1}{v^2}\right) = U_{\text{ж}}; \quad U_c = U_{\text{ж}} \frac{v^2}{v^2 - 1}.$$

The capacitors for the filters should have a low temperature coefficient of capacitance. It is needed to avoid the filter damaging due to changes in ambient temperature or capacitors self-heating. That's why we are to avoid the prolonged work with overvoltage, because it can cause a dielectric thermal destruction or its destructive ionization.

The load of the first harmonic capacitor is

$$\frac{U_c}{x_c} = \left(\frac{U_{\text{ж}}}{x_c}\right) \cdot \left[\frac{v^2}{v^2 - 1}\right]^2 = S \cdot \left[\frac{v^2}{v^2 - 1}\right]$$

Load from the higher harmonics is

$$I^2 \cdot \left(\frac{x_c}{v}\right) = \left[\left(\frac{I_v^2 \cdot U_{\text{ж}}^2}{S_v}\right) \cdot \left(\frac{v^2}{v^2 - 1}\right)\right]$$

The power losses in the capacitor are



$$S \cdot \kappa_c = \kappa_c \cdot \left[ S + \frac{I_h^2 \cdot U_{\mathcal{K}}^2}{S_h} \right] \cdot \left[ \frac{H^2}{H^2 - 1} \right],$$

where  $S$  - total load kvar;

$\kappa_c$  - factor of loss, kW / kvar.

The inductance of the filter is calculated as follows.

Load from the first harmonic is

$$\frac{U_L}{x_L} = \left( \frac{U_C}{v^2} \right) \cdot \left( \frac{v^2}{x_C} \right) = \frac{U_C}{v^2 \cdot x_C} = \frac{S}{v^2} \cdot \left( \frac{v^2}{v^2 - 1} \right)$$

Load from the higher harmonics is equal to load on the condenser.

The energy losses in inductance grow due to the surface effects or hysteresis. Besides, the magnetic nonlinearity can derange the filter. You are to keep the low magnetic flux density in the presence of magnetic core. It is better to use reactors without a magnetic core. The significant switching overvoltage can appear in the reactor coil.

It is convenient to found the power losses in the joint equivalent resistance

$$r = \frac{x_O}{Q} = \frac{x_C}{H Q}$$

The current of the first harmonic is

$$I_1 = \frac{S}{U_{\mathcal{K}}}$$

The total power losses are

$$\begin{aligned} (I_1^2 + I_v^2) \cdot r &= \frac{S^2}{U_{\mathcal{K}}^2} \cdot \frac{x_C}{v \cdot Q} + \frac{I_v^2 \cdot x_C}{v \cdot Q} = \\ &= \left( \frac{S^2}{v \cdot Q} \right) \cdot \frac{1}{S} \cdot \frac{v^2}{v^2 - 1} + \frac{I_v^2 \cdot U_{\mathcal{K}}^2}{v \cdot S \cdot Q} \cdot \frac{v^2}{v^2 - 1} = \\ &= \left[ \frac{S}{v \cdot Q} + \frac{I_v^2 \cdot U_{\mathcal{K}}^2}{v \cdot S \cdot Q} \right] \cdot \frac{v^2}{v^2 - 1}. \end{aligned}$$

## Conclusions

The cost of electric energy losses increases much faster than the cost of capacitors. It allows supplying of all induction engines with the capacitors of individual compensation. It will help to reduce the losses in electric networks of voltage up to  $Q_I$ .

The use of individual compensation capacitor allows refusing from complicated and expensive devices for power capacitors control which are used as the necessary parts of a centralized compensation on the transformer substations.

Each synchronous engine of the sugar refinery can be a source of reactive power. If the load factor of a synchronous engine is less than 1 (one), it is more reasonable to use fully expected reactive power output.

It is shown that if the distortion factor is KHC to 5-8% (it is typical for plants with thyristor converters), it is recommended to use the capacitor batteries together with protective

reactor or filter for compensation. The power of capacitor battery is determined by the balance of reactive power.

When your distortion factor is more than 8% (which is typical for plants with thyristor converters) there is the necessity to apply the power higher harmonics filters. They are calculated from the computed value of the distortion factor which is based on the composition and level of harmonics. The calculation of filters should be started from the smallest harmonic filter. It is necessary to check the admissibility of filters loading with the current of proper harmonics. The total reactive power generating filters should be chosen from the condition of reactive power balance.

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## Exploration of occupational injuries in food industry of Ukraine

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**Keywords:**

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Frequency of injury  
Artial loss  
Capacity  
Injury heaviness  
Sort of events

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**ABSTRACT**

The aim of this work is carrying out of statistical analysis of occupational injuries among Food Industry employees. The object of research is occupational injury in Food Industry for 2003-2011 period.

Status of occupational injury in Ukraine was analyzed for 2003-2011 period.

We show a results of occupational injury dynamic research in Food Industry of Ukraine from 2003 to 2011 years. Distribution for male and female injured employees on enterprises of Food Industry was performed. Indexes of injury rate and heaviness were calculated. And finally, distribution of accidents for main reasons, sorts of events, profession group, age, work experience was performed.

Exploration of labor safety conditions and also of occupational injury reasons and circumstances is useful for developing of sound and effective ways for prevent and reduce the occupational injury, illnesses and worker's traumatism.

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### Introduction

The main problem of labor safety is occupational injuries and professional illness. This problem is caused by differences between human desire to total safety and facilities of science, technology and manufacture resources. That's why for reduce the occupational injury and illness there's one thing important now and will be always – a choice. The choice between efficiency and manufacture safety, between cheap and more expensive prevention measures, between full attention to labor safety needs what is necessary and resource limits.

Exploration of labor safety conditions and also of occupational injury reasons and circumstances is useful for developing of sound and effective ways for prevent and reduce the occupational injury, illnesses and worker's traumatism.

In case of topic actual is solving of scientific problem that consist in exploration of reasons and accident sorts that leads to injuries of food industry workers. Reasoned measures for occupational injury prevention are also important and can provide effective prophylactic in general and accompanies social and economic positive effect through the reducing of occupational injury level.

The aim of this work is to make a statistical analysis of occupational injury among employees of Food Industry.

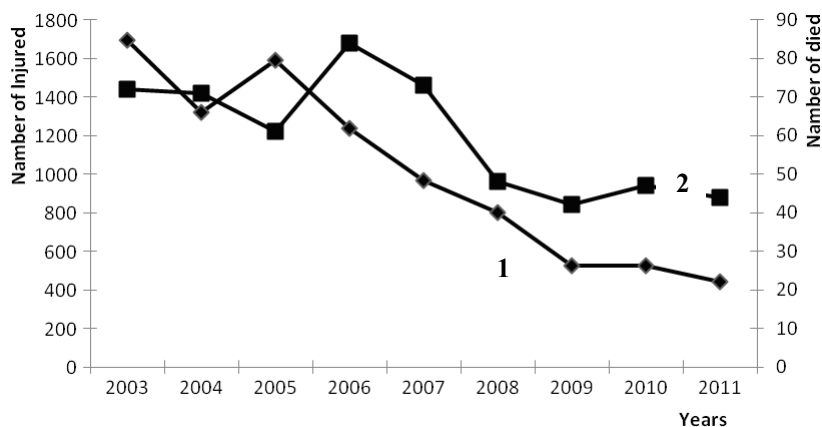
The object of research is occupational traumatism in Food Industry for 2003-2011 years.

## Material and methods

One of the methods of occupational injury research is the statistical method. It gives the opportunity to find out quantitative side of traumatism and also explore his basic reasons and patterns of action by large number of factors. Data for analysis was taken from the H-1 form. This is a standard act investigating accidents that occurred with great-employees during labor (official) duties, including assignments in accordance with the Regulations on the investigation and management accounting cases accidents, occupational diseases and accidents at work [Procedure of investigation and accounting of accidents, professional diseases and work accidents. -K. : Osнова, 2004. – 104 p. Podobed I.M. Prediction of occupational injuries in agricultural economic sector of Ukraine: Dissertation abstract of technical sciences candidate: 05.26.01/ State Committee of industry safety, labor protection and mining observation. - K., 2008. – 20 p.].

## Results and discussions

The analyses of occupational injury level in Ukraine, shows that the food industry is one of five most dangerous economic branches [Evtushenko O.V. Analysis of occupational injury statistic in Food Industry of Ukraine. Food Industry].

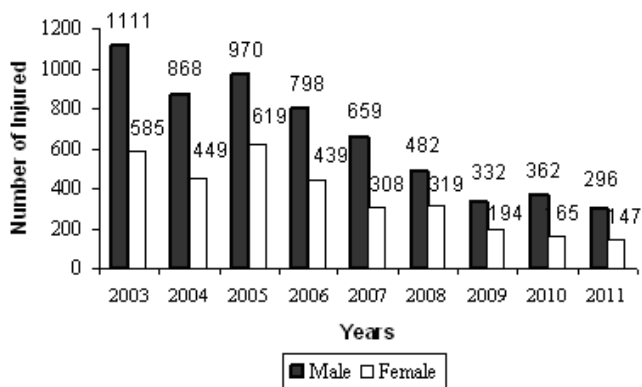


**Fig. 1. Dynamic of occupational injury in food industry of Ukraine, 2003-2011 period**  
*1-injured; 2-injured lethally*

The analysis of literary sources, shows that 9,1 thousands of person were injured in food industry only for 2003-2011 years. Since 2003, in the food industry more than 541 employees had died (fig. 1). [Koshil O.G. Statistical bulletin. Accidents at workplace in 2002 – 2011 / Koshil O.G., Kostrovenko L.N. -K. : State Statistic Committee of Ukraine, 2003 - 2011].

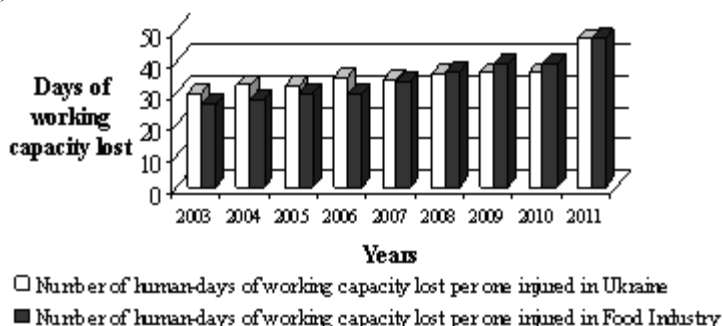
According to the State Statistic Committee of Ukraine, from 2003 to 2011 in food industry was injured nearly 9,1 thousands of employee. Where 64,6% of injured are male and 35,4% are female workers, that in two times less than male injured level (fig. 2).

— *Life Safety* —



**Fig. 2. Dynamic of injured male and female workers in food industry of Ukraine, 2003-2011 period**

While 2003-2011 years, in food industry number of injured with loss of work capacity on 1 and more working days and with lethal consequences has been decreased from 3,7 to 1,2 per 1000 employees [Koshil O.G. Statistical bulletin. Accidents at workplace in 2002 – 2011 / Koshil O.G., Kostrovenko L.N. - K. : State Statistic Committee of Ukraine, 2003 - 2011]. In the same time, the number of inoperability man-days in whole Ukraine increased from 29,7 to 47,0 per one injured. In food industry, this index increased from 26,3 to 47,2 according to same period (fig. 3).



**Fig. 3. Comparative growth dynamic of inoperability man-days per one injured at work in food industry of Ukraine, 2003-2011 period**

As we see, on a table 1, the frequency of injury coefficient and the partial loss of working capacity coefficient are repeating the tendency of total accidents number decreasing in food industry of Ukraine. In 2011, the frequency of injury coefficient was in 3 times less, than in 2003 and was amounted 1,2 against to 3,7. While, the partial loss of working capacity coefficient in 2011 decreased in 5 times as compared with 2003, that made 47,2 against 26,3.

The main accounting figures of injury now are values combinations of rate and heaviness, they showed in table 1.

**Table 1. Estimates of occupational injuries in Food Industry of Ukraine, 2003–2011**

Occupational injuries indexes	Years								
	2003	2004	2005	2006	2007	2008	2009	2010	2011
<b>Frequency of injury coefficient <math>C_f</math></b>	3,7	2,8	3,4	2,7	2,1	1,9	1,4	1,4	1,2
<b>Partial loss of working capacity coefficient <math>C_{plwc}</math></b>	0,191	0,069	0,159	0,052	0,057	0,038	0,037	0,044	0,036
<b>Injury heaviness coefficient <math>C_{ih}</math></b>	26,3	28,1	29,7	29,4	33,6	36,8	38,8	39,1	47,2
<b>Relative coefficient of mortality <math>C_{rm}</math></b>	1,3	1,6	1,2	2	2,3	1,8	2,4	2,7	2,6

The analysis of statistical data shows that the lethal accidents with dead of employee are: transport accident (34,6%), falling of injured (17,5%), in that number falling from the height (10,2%), influence of outfit and details that move, fly and spinning (11,6%) and falling, collapse of materials, rocks, soils etc. (9,5%) (table 2).

Analysis of injury reasons allows us to make the conclusion that the main reasons of injury among Food Industry workers are: breach of labor and production discipline (16,2%), traffic infraction (16,2%), drawbacks in study of labor rules (12,9%).

Technical reasons of injury also have a big importance. They appears in cause of construction drawbacks, limitation of capital goods quality (5,4%), discrepancy of technological process safety requirements (4,2%), unsatisfactory technical status of industrial objects, buildings, constructions, territory, capital goods and transport (9,6%).

Above 66% of deadly injured employees in Food Industry belong to the next groups of professions: drivers (26,3%), low-skilled employees (17%), operators (11,6%) and locksmiths (11,3%).

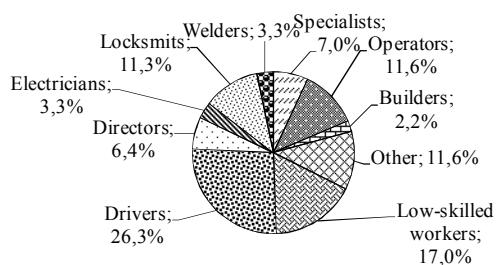
Dividing of deadly injured employees of Food Industry by the age in 2003-2011 years showed on picture 3 and dividing by the professional experience is showed in. We can see that above 30% of deadly injured employees are 40-50 years old. And above 25% of injured was 30-40 years old. Thus, dead of age 30-50 years old are 57% from all deadly injured in this branch. It means that most of Food Industry employees are from this age category. Big number of injured workers with service record over the 20 years (51,3%) had injured cause of “accustom to danger”. This is the psychophysical reason of safety rules violation. Big number among dead employees with low professional experience: less than year 30% and less than 3 years above 23%. It can indicates that professional training of employees is failed and inexperienced workers have a low control in Food Industry enterprises.

Analysis shows us that 30% of dead workers in Food Industry are not educated by the profession or kind of work, that causes accident. Besides, 11-13% of injured wasn't instructed with entrance or second instructions.

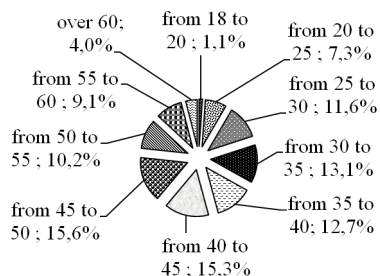
Analysis data shows that from all deadly injured workers those who educated by profession of type of work above 37% got injury during six month after training. From all injured who pass the workplace training over 80% had died during 3 month after training. This facts suggests about drawbacks in professional training of branch workers and defective implementation of instructing in Food Industry enterprises.

**Table 2. Dividing of dead by the accidents of occupational injury in Food Industry in 2000-2011**

Types of accidents	Percent
Transport accidents	34,6
Falling of injured	17,5
<i>Including the:</i>	
Falling from height	10,2
Falling during the move	3,6
Falling, collapse, ruing of objects, materials and other	9,5
Influence of outfit and details that move	11,6
<i>Including the:</i>	
influence of outfit and details that move, fly and spinning	7,3
Electric Shock	5,5
<i>Including the:</i>	
Touch to the power line and broken wires	1,8
Extreme temperature effects (except fire)	2,9
Effect of hazardous and toxic substances	4,4
Drowning	0,4
Asphyxia	1,8
Murder or injury caused by another person	1,8
Natural disaster	0,4
Fire	2,5
Explosion	3,6
Other types	3,5



**Fig. 4. Dividing of deadly injured employees of Food Industry by the profession groups in 2003-2011**



**Fig. 5. Dividing of deadly injured workers of Food Industry by the age in 2003-2011**

21% of deadly injured workers in Food Industry during the accident was in alcohol intoxication condition what means the low discipline on branch enterprises. Analysis shows that in 48% of cases the injured has violated the labor protection law and another person violated law at 77% of cases. Above a half of accidents was caused by a different level directors who violated the labor protection law. Meanwhile, the part of injured directors amounts slightly more than 6%.

— *Life Safety* —

**Table 3. Dividing of dead by the reasons of occupational injury in Food Industry for 2000-2011**

Accident reason	Percent
<i>Technical</i>	
Constructive drawbacks, imperfection, low reliability of capital goods	5,4
Constructive drawbacks, Imperfection, low reliability of transport	0,3
Low quality of development or absence of the project documentation for construction, reconstruction of production objects, buildings, etc.	2,7
Imperfection, mismatch between the security requirements of technological process	4,2
Poor technical condition of production facilities, buildings, structures, territory	3,9
Poor condition of the capital goods	3,3
Poor condition of the transport	2,4
Poor condition of the working environment	0,3
<i>Organizational</i>	
Unsatisfactory functioning or absence of labor protection system	5,4
Drawbacks during study of working safety methods	12,9
Unsatisfactory of creating, imperfection or absence of labor protection instructions	0,6
Absence of labor protection duties in job instructions	0,6
Violation of work and rest regime	0,9
Absence or poorly medical survey (professional selection)	0,9
Unused personal protection in fact of its' absence	1,2
Work with switched off, broken collective protection devices, alarm systems, ventilation	1,2
Using of workers with another profession	0,3
Violation of technological process	1,2
Safety violation during the operation of machines, mechanisms etc.	4,5
Violation of safety rules during the transport using	3,6
Traffic infraction	16,2
Disuse of personal protection (if you have it)	3,6
Disuse of collective protection	0,3
Violation of labor and production discipline	16,8
<i>Psychophysical</i>	
Alcohol, drug, toxic intoxication	3
Poor physical and health	0,3
Injury as a result of wrongful act of another person	1,2
Other reasons	2,8

**Table 4. Splitting of specific weight of dead workers by the experience in Food Industry for 2000-2011 period**

Years range	Work experience, years	
	Total	By profession
Less than 1 year	4,4	29,8
From 1 to 3	3,6	23,6
From 3 to 5	3,6	7,6
From 5 to 10	10,2	12
From 10 до 15	12,7	10,2
From 15 to 20	14,2	6,2
Over 20	51,3	10,5

### Conclusions

The results of research shows, that in food industry of Ukraine during 2003-2011 the number of work accidents was decreased almost in 4 times.



Big part of injuries accounted for experience workers who have service record over than 20 years and for workers with professional experience less than one year. We should to pay special attention during the primary and second instructing on the workplace. Besides, it is necessary to improve quality of instructing, intensify the control for low-skilled workers. It is necessary to enlarge the responsibility of all level directors on branch enterprises with aim to prevent the labor safety law violation which leads to work accidents.

The frequency of injuries decreased, but the severity of injuries is still high. That means, the accidents became more dangerous. Average frequency of injuries Cf amounts 2.3 and severity of injuries index Cih amounts 34.3 – both of them for period from 2003 to 2011. It indicates that, despite decline of total number of accidents in food industry, the severity of injuries is increasing and it's necessary to take crucial and complex measures for reduce these rates.

Lately modern manufacture work in course international law of labor safety, where for rationale of prevention measures usually using a results of injury risk analysis. Choosing and reasoning of occupational injury prevention ways and measures is provided with consideration of risk factor.

That's why the next important step of exploration is developing of effective prophylactic measures for occupational injury prevention by definition of influence pattern on accidents which caused by technical, organizational, social, economic and manufacture reasons.

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## Attraction of foreign investment to Ukraine: problems and solutions

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### ABSTRACT

**Keywords:**  
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The study focuses on the problems involved in attracting foreign investment to Ukraine and some suggestions to their solution, based on the country's economic potential. The role of foreign investments is investigated in the system of financial provision of the Ukrainian economy. The purpose of the research is the determination of the solutions to the problem of attracting foreign investment to Ukraine, forming further strategy of investment allocation between the priority sectors. Research object is foreign investments in the economy of Ukraine.

If the government adopts economic, legislative and administrative reforms, that have been proposed in the paper, the investment climate of our country will improve, which will increase the image of our country in the global market and will lead to the inflow of foreign capital into Ukraine. It is advisable to maintain investment projects aimed at developing the private sector, organizing exhibitions on investment projects.

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### Introduction

This topic is especially pertinent today because it is impossible to strengthen Ukraine's economy without investment boom, including foreign investment, without finding reliable and stable sources of capital and, ultimately, without establishing a favorable investment climate.

Problems of attracting foreign investment, creating a favorable environment for its development, mechanisms to stimulate investment activity is reflected in the works of foreign and Ukrainian scientists such as R. Alibera, B.Gubskiy, D.Dunning, J.Keynes, V. Kozik, V.Novitsky, O. Rogach, F. Ruhman, I.Fisher. Strategic priorities for investment development in terms of adaptation to the globalization of the economy were highlighted in the works by O. Bilorus, A.Gal'chyns'kiy, V. Geyets, D. Lukyanenko, Y. Saveliev, A. Filippenko.

E. Avdokushyna, J.Bell, A.Hawryluk, J.Galbraith, K.Clark, A.Miller, S. Pisarenko, M. Porter, A. Rumyantsev, V. Tsygankov, M Chumachenko devoted their writing theoretical, methodological and organizational aspects of the formation and functioning of services market.

## — *Economics and Management* —

### *Availability of Competitive Sectors*

*Agrarian sector.* Agrarian sector is one of the most prospective sectors in Ukraine, generating more than 20% of country's GDP. Ukraine is in the top five of the largest grain exporters and is №1 sunflower oil exporter.

*Complex machine building.* Ukraine is a traditional leader in production of machinery, cars, and airplanes, and is also one of the six space equipment manufacturing countries in the world.

*Energy.* Ukraine produces about 20 billion m<sup>3</sup> of the natural gas per year, and has about 1 000 billion m<sup>3</sup> of discovered natural gas reserves. Ukraine has a huge potential for producing energy from renewable sources and implementing energy-saving technologies. Ukraine's "green" energy tariffs are more attractive than in many other countries.

*IT sector.* Ukraine is the 5-th biggest market of the IT outsource services, which is growing at a fastest pace.

*Tourism.* Ukraine has huge unrealized tourism potential due to the variety of tourist attractions: ski resorts in the Carpathian Mountains, Crimea, Black Sea beaches, medieval cities and castles, ethnic, music and movie festivals and many others, which attract 20 million tourists annually.

In broad terms, investment is the foundation of a modern economy: it brings together the interests and resources of private individuals, legal entities and the state to generate real socio-economic development. Global experience shows that transition economies are not capable of developing their economies properly without attracting and effectively using investment, including foreign investment. By accumulating business, public and mixed capital and providing access to modern technologies and management, investments not only help form national investment markets, but also bring new life to markets for goods and services. In addition, investments generally support efforts at macroeconomic stabilization and make it possible to ease social pressures during the transformation period.

The investment potential of any country - frequently, the term "investment appeal" is used - is characterized by a combination of macroeconomic indicators, such as: economic growth, the ratio between consumption and savings, lending rates, profit rates, inflation levels and dynamics, consumer demand, the presence and proportion of production factors, infrastructure development, and so on.

Ukraine could potentially become one of the leading countries in terms of direct and portfolio foreign investment. This is supported by Ukraine's large domestic market, comparatively skilled yet inexpensive labor, major scientific and technological potential, abundant natural resources, and its available, if underdeveloped, infrastructure.

Certain reform-based transformations and positive practical improvements can be seen in Ukraine's economy currently. These positive results include the growth of GDP in recent years, rising average wages and pensions, a well-provided consumer market, diversified exports, a relatively stable national currency, and steadily growing annual investment.

Indeed, effective investment activity by any and all business entities will foster the growth of the country's economy because, no matter what, it generates material resources for the society and makes it possible for the overall well-being of the population to improve.

Today, the quality of investment policy affects many things: industrial output, the condition and technical level of fixed assets at Ukrainian enterprises, the options for restructuring the economy, and the solutions to social and environmental problems.

Investment is the basis for developing individual businesses, specific sectors and the economy as a whole. The modern economic environment demands an active policy for attracting foreign direct investment. In Ukraine, investment activity is regulated by legislation

that is in the process of being updated and improved, in order to draw greater inflows of FDI and to improve their effectiveness.

### **Material and methods**

For the purpose of this study, the works of domestic and foreign scientists and community organizations on investment management and effectiveness were used as a theoretical and methodological base, as well as Ukrainian investment legislation and regulations. This paper is based on materials used by the State Agency for Investment and Innovation, materials of state statistics and tutorials, as well as materials that reflect the investing and financing activities of the research object.

### **Results and discussions**

The risk of investing in any country is essentially the level of uncertainty in forecasting return on investment (ROI) and it includes political, economic and social components.

It is possible to invest foreign capital in Ukraine by:

- setting up companies with the share-based participation of foreign capital - joint ventures;
- setting up companies that fully belong to foreign investors and their branches;
- purchasing rights to use land and other natural resources, as well as other property rights;
- buying ownership of enterprises, property clusters, buildings, structures, shares in companies, stocks, bonds, and other securities;
- providing loans, credits, property and rights to property, and so on.

The state regulates investment activity in order to support its economic, scientific, technological, and social policies. This regulation is determined by socio-economic indicators, national and regional economic development programs, and the State and local Budgets, which allocate public funding for investment activity.

At the same time, favorable conditions need to be established for investors who put their money into those areas Ukrainian society needs the most. First of all, this is the social sphere, upgrading production, creating new jobs for citizens who need social security, implementing innovation and hi-tech projects, applying discoveries and inventions, developing the agro-industrial complex, implementing programs to eliminate the after-effects of the Chornobyl disaster, manufacturing building materials, and investing in education, culture, environmental protection, and healthcare.

Foreign investors can bring in scientific and technological know-how and cutting-edge management practice. In addition, attracting foreign capital to actual production is much more useful than borrowing to purchase the same goods, which only increases the country's debt burden.

At the moment, the flow of foreign capital is already vitally important to achieve medium-term goals, such finding a way out of the current crisis and reviving economic growth. At the same time, Ukraine's national interests do not always coincide with interests of foreign investors. This makes it important to attract foreign capital in such a way that investors can satisfy their own needs while simultaneously helping the country reach its social goals.

*How to stimulate investment to Ukraine*

## — *Economics and Management* —

The Government's immediate objective must be to stimulate investment and to spur significant growth in investment volumes. Increasing investment flows was and continues to be a priority for executive bodies.

To spur investment, including foreign investment, a number of measures need to be taken at the national level:

- reduce the level of state regulation of commercial activity and ensure the stability of relevant legislation;
- eliminate ambiguities in legislation and regulations and finish judicial reform;
- improve regulations regarding the exercise of property rights;
- complete administrative reform, make the policy-making process both public and transparent, and, hence, eliminate red tape and corruption;
- institute effective corporate governance;
- foster the development of capital markets, first of all the banking sector and the stock and insurance markets;
- reduce tax pressure;
- ensure a stable political environment;
- increase efforts to establish a positive image for Ukraine.

### *The role of the government in stimulating investment*

The key policy objective regarding investment is to establish equal conditions for doing business and investing in Ukraine's economy for business entities of various forms of ownership, to ensure that investment happens in a transparent and civilized manner, and to improve the distribution of investment sources. Government policy should concentrate on:

- accelerating economic growth on its own renewable investment base and a suitably market basis;
- instituting open consultations between executive bodies and business, and disseminating information about the real economic situation, domestic and foreign markets, market prices, and regulations;
- significantly reducing the share of the shadow economy;
- establishing equal conditions for the activities of business regardless of their form of ownership or the origin of their capital;
- forming a working competitive environment;
- strengthening the stock market, developing vehicles for joint investment, insurance and pension funds, establishing a market for corporate securities and integrating it into international capital markets;
- providing additional economic incentives to attract investment to priority sectors;
- setting up an effective system for protecting intellectual property;
- establishing conditions for the development of high technologies and the infrastructure for innovation;
- developing and utilizing the country's investment potential;
- establishing cooperation with key non-government and community organizations and institutions that are prepared to participate in formulating and implementing investment and innovation policy in Ukraine.

These elements of the new "investment and innovation system" aim at improving the business and innovation climate in the country and should be instituted by the State Investment and Innovation Agency as soon as possible. They reflect the ideas of domestic and international businesses and community organizations as presented during roundtables, sessions of the World Economic Forum in Kyiv, and numerous investment forums held in

## — *Economics and Management* —

Ukraine, and propositions that were presented during debates on the working drafts of Green and White Papers on problems with attracting foreign investment to Ukraine.

### *Key solutions to investment problems*

#### Forming a legal base

One of the most important factors for improving Ukraine's investment climate is to establish a legal environment suitable to a market economy. This requires the state to take two key steps:

- conclude interstate agreements providing incentives, protecting investments and avoiding double taxation, exchange information about regulations and legislation governing investment activity, and establish stable legislation and other conditions;
- expand cooperation with the International Monetary Fund, the World Bank and the EBRD regarding financial assistance to Ukraine and carry out the necessary measures to complete accession to the World Trade Organization.

To gradually adjust national legislation to EU legislation and WTO requirements, regulations and legislation need to be adopted governing:

- further tax reforms;
- a legal base to facilitate a working stock market;
- the protection of individual contributions to life and health insurance programs, and to non-state pensions.

### *Establishing transparent executive decision-making*

The institution of transparent government procedures for making decisions related to investment projects financed by State and local Budgets and those investment projects that have vital significance for the general population must include:

- making decisions to hold public debate on draft regulations regarding developing business activity, setting up community councils and business councils under executive bodies, consulting with businesses, community organizations, academics, and other specialists to evaluate the effectiveness of existing regulations;
- participating in international events to promote Ukraine's investment potential, showcasing priority investment projects through the international media and the internet, holding exhibitions and similar events more frequently.

### *Improving the privatization investment climate*

Privatization policy should aim at:

- replacing the fiscal model of privatization with an investment and innovation model and privatizing large companies and monopolies based on individual plans by selling controlling stakes to industrial investors;
- re-equipping enterprises technically and technologically using part of the proceeds from privatization.

### *Providing incentives for long-term lending*

Improving the investment climate in Ukraine depends considerably on resolving problems with the way the banking system operates: increasing the concentration of banking capital, expanding long-term lending to the real sector of the economy, and attracting personal deposits.

The main factors that restrain long-term commercial lending to businesses are high lending risks, the insolvency of most borrowers, lack of real guarantees that they will repay their loans and liquid collateral, and an ineffective tax system. To stimulate investment activity through long-term lending, the state needs to take steps to:

- institute a mechanism for effectively protecting lenders and a transparent procedure for selling off collateral;

## — *Economics and Management* —

- ensure that banking capital is concentrated more by increasing capitalization and solvency among banks and instituting procedures for reorganizing and eliminating the unstable ones;

- provide incentives for banks to attract more personal deposits;
- set up a specialized financial institution to provide long- and medium-term financing and loans for priority investment projects;
- institute mortgage lending;
- provide incentives for foreign capital flows to the banking sector.

### *Developing the stock market*

The main objectives in developing the domestic stock market include:

- implementing a tax policy that will foster the stock market;
- establishing conditions for increasing stock market capitalization and liquidity;
- expanding cooperation with the OECD, the International Organization of Securities Commissions and other international organizations in order to institute international disclosure standards;

- simplifying the procedure for settling for securities contracted with non-residents;
- improving the system of accounting, settling and reporting for stock market participants;
- making the activity of joint investment vehicles transparent;
- concentrating trade on organized markets whose operations meet international standards;
- raising the effectiveness of the National Depository System in protecting the rights of holders of securities and in regulating settlements for operations involving securities by setting up a central depository based on the National Depository of Ukraine;
- developing a mechanism for insuring stock market participants.

### *Renewing territories with special investment regimes*

The purpose of introducing a special investment regime in territories with unfavorable socio-economic and environmental conditions is to attract investment into priority industries in order to preserve existing jobs and create new ones, to introduce new technologies, to develop foreign trade, to increase the output of high quality goods and services, and to set up modern industrial, transportation and market infrastructure.

Another important investment policy goal is fostering industrial parks for hi-tech production. To renew investment processes in territories with special investment regimes, the government needs to take two key steps:

- develop and implement strategic and short-term development programs for each zone and territory where a special investment regime will be introduced;
- provide incentives for investing in priority sectors, facilitate the introduction of cutting-edge technologies and the manufacture of products that are competitive on external market by optimizing priority commercial activities.

### *Attracting investment to science, technology and innovation*

To provide incentives for attracting domestic and foreign investors to science, technology and innovation, the government should ensure:

- a system of discounted refinancing for commercial banks, if they provide loans at discounted interest rates to implement investment projects related to developing and installing hi-tech equipment and other innovative products;
- an expansion of the practice of providing commercial loans secured by commercial property at discounted interest rates;
- the establishment of share-based investment funds to implement large-scale investment projects;
- lending to innovation enterprises through leasing, factoring and other operations;

- the necessary infrastructure to develop innovation processes and a full innovation cycle, from concept to manufacturing and selling hi-tech products and technologies;
- the organization of a single center in Ukraine where the efforts of the Government, science and business can be consolidated to develop high technologies.

## **Conclusions**

The investment potential of Ukraine is characterized by high heterogeneity, because the investment policy should be conducted based on the capabilities and needs of each region. Thus, the western region can be effective with the use of local natural resources (sulfur, potassium salt, oil, gas), developing a network of health resort and tourist complexes. The Eastern region needs reconstruction and technical equipment of mines, metallurgical and engineering industries on the basis of waste, low-waste and clean technologies. The South is the most profitable as to the reconstruction and technical reports, development of production equipment for the food and canning industry, expansion of health resort and tourist complexes. The Northern region should use the newest technology and implement measures to their ecological, economic and social regeneration.

The introduction of joint investment vehicles should provide suitable conditions for investing. By improving the system of corporate governance, a transparent system for protecting the rights of all investors will develop.

Investment resources should grow with the effective use of public investment and increased long-term lending volumes for the real economy, at the same time as the possibilities of foreign investment are used in more traditional ways.

Government support for high technologies and the development of an innovation infrastructure in the country should help attract investment into innovations and bring the Treasury revenues from the use of this know-how.

By implementing the strategy for long-term economic development, Ukraine should see State Budget and local budgets investments on industrial and social projects grow, while the specific volumes are determined at the appropriate level of government.

Foreign investors are awaiting for the possibility to start exploring Ukraine's rich resources, and creating a favourable climate for that would give a rise to Ukraine's future prosperity.

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— ***Economics and Management*** —

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### АНОТАЦІЇ

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#### **Вивчення фазового складу морозива методом низькотемпературної <sup>1</sup>H ЯМР- спектроскопії**

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Методом низькотемпературної <sup>1</sup>H ЯМР-спектроскопії досліджено стан водної фази морозива в процесі підвищення його температури від -60 °С до 0 °С. Доведено, що у морозиві з низьким вмістом жиру стандартного хімічного складу вільна вода практично відсутня, а зв'язана знаходиться у вигляді двох фракцій - слабозв'язаної та сильнов'язаної. Перша фракція утворюється переважно водою, яка входить до складу гідратованих цукрів, а друга – за рахунок адсорбційної взаємодії з біополімерною складовою сумішшю.

У наближенні кристалізації води і цукрів у вигляді індивідуальних речовин розраховано розподіл за радіусами кристалів льоду у сумішах. Встановлено, що розміри сформованих кристалів знаходяться у діапазоні 1-16,6 нм і для них характерні два максимуми, що обумовлені різною енергією зв'язку води. Встановлено незначну відмінність фазового складу сумішей для виробництва морозива, які містять пшеничне борошно та сучасну стабілізаційну систему. З'ясовано, що клейстеризоване пшеничне борошно, якого більше у 5 разів, порівняно із стабілізаційною системою, практично не поступається останній у зв'язуванні води.

Результати досліджень можуть бути застосовані для розрахунку фактичних концентрацій цукрози і лактози у сумішах та морозиві. Подібні розрахунки дозволять знизити вірогідність появи у морозиві вад консистенції, які викликані надлишковою кристалізацією дисахаридів та води.

**Ключові слова:** морозиво, фазовий склад, зв'язана вода

УДК 664.8

#### **Антиоксиданти в харчових системах. Механізм дії**

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Описані механізми дії антиоксидантів природного і синтетичного походження в харчових системах (окиснення ліпідів, білків, вуглеводів), які дозволяють передбачати ефективність їх застосування для тривалого зберігання харчових продуктів. Головними з розглянутих механізмів захисної дії антиоксидантів, які детально проаналізовані і обговорені, є: деактивація вільних радикалів, перенос атома Гідрогена, утворення хелатів, одноелектронний перенос, гасіння синглетного кисню і фотосенсибілізаторів,

## — Abstracts —

деактивація ліпоксигеназ. Особлива увага приділена розгляду дії сумішей антиоксидантів і найбільш ефективним синергістам.

**Ключові слова:** окиснення, вільні радикали, активація кисню, фотосенсибілізатори, синергізм, антагонізм.

УДК 664

### Особливості формування харчових емульсій і пін

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Емульсії і піни - це дисперсні системи, які найчастіше присутні у харчових продуктах. У прогнозуванні й управлінні поведінкою таких систем важливу роль відіграють знання про їх структуру та властивості дисперсійного середовища, дисперсної фази й міжфазних взаємодій. У якості стабілізаторів харчових дисперсних систем широко використовують полісахариди і білки, у складі яких одночасно містяться полярні і неполярні групи, що надають цим харчовим макромолекулам властивостей поверхнево-активних речовин. Під час утворення емульсії або піни дані речовини здатні швидко адсорбуватися на поверхні краплини чи повітряної бульбашки у вигляді тонкої захисної плівки. Метою даної статті є вивчення функціональних властивостей поверхнево-активних речовин та їх застосування у харчовій промисловості.

Білки молока володіють хорошими властивостями поверхнево-активних речовин, зокрема, емульгуючою, загущуючою, піноутворюючою, вологозв'язуючою. При цьому не усі молочні білки проявляють однакові властивості: сироваткові білки є менш активними ніж казеїни, що спричинено їх глобулярною будовою. Встановлено, що застосування ферментативного гідролізу сприяє посиленню властивостей сироваткових білків як поверхнево-активних речовин. Покращення властивостей білків молока також відбувається при утворенні білково-полісахаридних комплексів на поверхні розділу фаз емульсій та пін. Умови й технологічні режими формування багатоконпонентних дисперсних систем, стабілізованих такими білково-полісахаридними комплексами потребують більш глибокого дослідження.

**Ключові слова:** емульсії, піни, поверхнево-активні речовини, поверхня розділу фаз, стабільність.

УДК 664.8

### Оцінка перспектив використання новітніх технологій стабілізації напоїв

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Наведено інформацію, що стосується мікробіологічної стабілізації газованих та негазованих напоїв, в тому числі і підвищеної енергетичної цінності на основі сировини рослинного походження за рахунок вибору їх параметрів та режимів теплової обробки.

Проведено аналіз щодо можливих різновидів мікрофлори в напоях та наведено інформацію стосовно вибору кількості пастеризаційних одиниць для її інактивації.

## — Abstracts —

Проаналізовано взаємозв'язок між осмотичним тиском, показником рН середовища і вмістом діоксиду вуглецю в напоях та їх впливу на стабілізацію напоїв.

Наведено схему до умов забезпечення стійкості газованих і негазованих напоїв за відсутності в них хімічних консервантів.

**Ключові слова:** стабілізація, мікробні клітини, бактерії, пастеризація, концентрація.

УДК 663.4

### Уточнення фізичних і хімічних методів визначення цукрів

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Метою проведеної роботи є порівняння основних існуючих методів визначення цукрів для виявлення найбільш точних та зручних при використанні у пивоварній промисловості. Експериментально встановлено оптимальні методи визначення цукрів для використання в лабораторних та виробничих умовах пивоварної промисловості. Встановлені корелюючі коефіцієнти між результатами, отриманими різними методами для адекватного відображення основних компонентів цукрової частки суслу і пива. Суттєвим практичним висновком досліджень є те, що фізичні методи визначення цукрів мають достатньо високу точність при визначенні концентрації мальтози в суслі і найбільш придатні для контролювання кінетики і регулювання виробничих процесів.

**Ключові слова:** зброджувані цукри, методи визначення цукрів, експрес-аналіз.

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### Виробництво житньо-пшеничного хліба в ресторанах

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Досліджено технологічний процес приготування тіста з житньо-пшеничного борошна за прискореною технологією з використанням комплексного хлібопекарського поліпшувача «Ібіс». Проаналізовано вплив поліпшувача «Ібіс» на процес кислотонакопичення, структурно-механічні властивості тіста й на якість хліба.

Внесення комплексного хлібопекарського поліпшувача «Ібіс» дозволяє зменшити час вистоювання виробів, скорочує тривалість технологічного процесу виготовлення хліба. Пористість хліба збільшується зі збільшенням внесення поліпшувача. Зростання цього показника корелює із збільшенням питомого об'єму хліба, добре розпушеною й еластичною мякушкою та гарним товарним виглядом виробів.

Проведення пробного лабораторного випікання і вивчення в'язкопластичних і структурно-механічних властивостей житньо-пшеничного тіста підтверджують ефективність використання комплексного хлібопекарського поліпшувача «Ібіс» для прискорених технологій виробництва житньо-пшеничного хліба. Використання даного поліпшувача дозволить скоротити тривалість технологічного процесу виробництва хліба при збереженні високої якості готових виробів.

**Ключові слова:** житнє борошно, хліб, поліпшувачі

УДК 663.2

**Регулювання дози діоксиду сірки за допомогою препаратів, на основі глутатіону дріжджів у виробництві рожевих столових виноматеріалів**

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Досліджено вплив часткової заміни діоксиду сірки препаратами на основі глутатіону дріжджів і таніну на якість рожевих столових виноматеріалів. Об'єктами дослідження були рожеві столові сухі виноматеріали, виготовлені з сорту винограду Каберне-Совіньйон. Зразки готували в умовах мікровиноробства за схемою, яка включала переробку без настоювання на м'яззі з використанням препаратів, на основі глутатіону дріжджів, танінів і діоксиду сірки. Препарати були додані в сусло перед освітленням у дозі 2 г/дал таніну, 2 г/дал глутатіону і 50-75 мг/дм<sup>3</sup> діоксиду сірки.

Було досліджено вплив препаратів та їх доз в умовах індукованого окиснення на зміну окисно-відновного стану даного типу вина. Модельна система складалася з столового рожевого виноматеріалу, в який були додані діоксид сірки, глутатіон дріжджів і танін.

Було встановлено вплив препаратів на органолептичні і фізико-хімічні показники та на зміну кольору рожевого вина.

Використання препаратів на основі глутатіону дріжджів може збільшити рівень вільного діоксиду сірки, що призведе до більш ефективного захисту від окиснення, або дасть можливість знизити дози сульфітації для рівного рівня захисту.

**Ключові слова:** рожеве вино, Каберне-Совіньйон, індуковане окиснення, модельні системи, глутатіон дріжджів, таніни, доза сульфітації, окисно-відновний стан.

УДК 543.42:664.38

**Використання інфрачервоних спектрів відбивання соняшникового шроту для визначення вмісту вологи**

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Досліджено інфрачервоні спектри відбивання в ближній області соняшникового шроту з метою побудови калібрувального графіку для визначення вмісту вологи. Були використані зразки соняшникового шроту з різною вологістю, яка знаходилась у межах від 5 до 19 %. Вимірювання проводили на аналізаторі „Інфрарід-61” в інтервалі довжин хвиль 1330-2370 нм з кроком 10 нм. За коефіцієнтом відбивання встановлені характеристичні довжини хвиль (1460 та 1930 нм) для експрес-аналізу вмісту вологи в шроті. Проаналізовані перші та другі похідні оптичної густини, для них також визначені характеристичні довжини хвиль, які в цьому випадку зміщуються в короткохвильову область і становлять 1400 та 1890 нм для першої похідної і 1370 та 1860 нм для другої відповідно. Побудовані калібрувальні криві та наведені рівняння, що описують їх, а також для кожного калібрувального графіка встановлена величина достовірності апроксимації. Це дасть можливість визначити вміст вологи в соняшниковому шроті, використовуючи вказані вище довжини хвиль.

## — Abstracts —

**Ключові слова:** інфрачервона спектроскопія, спектр, відбивання, соняшниковий шрот, вологість.

УДК 663.2:664.6

### **Обґрунтування вибору вторинних продуктів виноробства в якості нетрадиційної сировини кондитерської промисловості**

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Метою статті є вивчення вмісту пектинових та фенольних речовин у винограді і продуктах його переробки та визначення доцільності включення їх в рецептури в якості цінної сировини для одержання нових видів кондитерських виробів.

Об'єктом досліджень були вичавки винограду технічних сортів, отримані в результаті промислового виробництва виноматеріалів.

Наведено результати досліджень з визначенням кількісного складу пектинових та фенольних речовин в вичавках винограду технічних сортів. Визначена можливість використання продуктів переробки винограду при виробництві кондитерських виробів.

**Ключові слова:** виноград, продукти переробки, виноградні вичавки, кондитерські вироби, фенольні та пектинові речовини.

УДК 663.2

### **Вплив технологічних обробок виноматеріалів на їх фізико-хімічний склад**

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Необхідною умовою забезпечення конкурентоспроможності вітчизняних вин на міжнародному споживчому ринку є подальше підвищення їх якості із збільшенням термінів гарантованої стабільності до 1,5 років.

Одними з найбільш поширених препаратів освітлюючого і стабілізуючого дії, що знайшли широке застосування в практиці виноробства, є желатин і бентоніт. У цьому зв'язку є актуальною задача апробації імпортованих допоміжних препаратів нового покоління, адаптації їх до вітчизняному виноробству.

УДК 543.42

### **Аналіз спектрів відбивання насіння ріпаку з різним вмістом ерукової кислоти в ближній інфрачервоній області**

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Мета роботи - аналіз спектрів відбивання в ближній інфрачервоній області насіння ріпаку з різним вмістом ерукової кислоти та вибір найбільш інформативних довжин

## — Abstracts —

хвиль для створення градуовального рівняння. Інфрачервоні спектри відбивання вимірювали в діапазоні 1330-2370 нм для насіння ріпаку з високим і низьким вмістом ерукової кислоти. Жирнокислотний склад олії насіння ріпаку визначали газово-рідинною хроматографією. Нами було виявлено різницю рівнів поглинання між низькою та високоеруковим насінням ріпаку в області 1700-1860 та 1930-2370 нм. Проаналізовано перші похідні спектрів відбивання. Запропоновано набір довжин хвиль для створення градуовального рівняння визначення вмісту ерукової кислоти. Одержані нами дані можуть бути використані для визначення її вмісту в насінні ріпаку.

**Ключові слова:** інфрачервона спектроскопія, спектри відбивання, насіння ріпаку, ерукова кислота.

УДК 663.52

### **Дослідження руху органічних домішок спирту по розгінній колоні, яка працює під тиском нижчим за атмосферний**

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В умовах жорсткої конкуренції на ринку спирту в Україні актуальним завданням на сьогоднішній день перед спиртовими заводами стоїть значне зниження собівартості готової продукції при виробництві спирту – ректифікату найвищої якості. Метою даної роботи було: «визначити оптимальні технологічні параметри експлуатації енергозберігаючої брагоректифікаційної установки, яка працює під тиском нижчим за атмосферний при стабільному виробництві високоякісного спирту». В роботі досліджено рух органічних домішок етилового спирту по колонах брагоректифікаційної установки (БРУ), які працюють в енергозберігаючому режимі під тиском нижчим за атмосферний з метою покращення якості ректифікованого спирту та збільшення питомого виходу товарної продукції. В роботі були визначені найбільш оптимальні технологічні параметри роботи брагоректифікаційної установки з додатковими колонами та визначені режими контролю і регулювання роботи даної БРУ. Проведена низка дослідів по визначенню ступеня концентрування та ступеня вилучення органічних домішок по розгінній колоні, яка працює під вакуумом. Досліди проводили у виробничих умовах на газовому хроматографі «Кристал 2000М».

**Ключові слова:** спирт, органічні домішки, брагоректифікаційна установка, якість, ступінь концентрування, ступінь вилучення, розгінна колона.

УДК 664

### **Аналіз особливостей і переваг перехідних процесів в харчових технологіях**

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Виконано аналіз фізичного підґрунтя особливостей і переваг перехідних процесів в харчових технологіях з точки зору інтересів інтенсифікації в них тепло- і масообміну. Проведено структурний аналіз дискретно-імпульсних, екструдерних технологій та технологій різких змін тисків і перехідних процесів за їх застосування з оцінкою

## — Abstracts —

енергетичного потенціалу та зроблено висновок про спільне підґрунтя у формі початкового накопичення енергетичних потенціалів в даних технологіях.

Наведено інформацію, що для більшості процесів у харчових технологіях існує можливість швидкоплинного зниження такого термодинамічного параметру, як тиск. При цьому відбувається імпульсна зміна енергетичного потенціалу з потужностями, які можуть перевищують традиційні технології навіть на кілька порядків. Саме це визначає суттєві перспективи поширення дискретно-імпульсних, екструдерних технологій та технологій різкого зниження тисків для газонасичених середовищ.

**Ключові слова:** дискретно-імпульсні технології, енергія, рівень, потенціал, тиск.

УДК 664

### **Дослідження особливостей компенсації реактивної потужності на підприємствах харчової промисловості**

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Розглянуто шляхи підвищення ефективності компенсації реактивної потужності на харчових підприємствах. Показано, що застосування конденсаторів індивідуальної компенсації дозволяє відмовитися від складних та дорогих пристроїв регулювання потужності конденсаторних установок, якими необхідно комплектувати установки централізованої компенсації на трансформаторних підстанціях, а захист двигуна від режиму самозбудження можна здійснити шляхом підключення конденсаторів до затискачів двигуна через автоматичний вимикач, що обладнаний електромагнітом дистанційного відключення.

**Ключові слова:** реактивна потужність, індукції двигуна, компенсація.

УДК 331

### **Дослідження виробничого травматизму в харчовій промисловості України**

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Метою роботи є проведення статистичного аналізу виробничого травматизму серед працівників харчової промисловості. Об'єктом дослідження є виробничий травматизм в харчовій промисловості за 2003-2011 роки.

Проаналізовано стан виробничого травматизму в Україні за період 2003...2011 рр.. Подано результати дослідження динаміки виробничого травматизму в харчовій промисловості України з 2003 по 2011 роки. Проведено розподіл кількості потерпілих працівників чоловічої і жіночої статі на підприємствах харчової промисловості. Розраховано показники частоти і тяжкості травматизму. Розподілено нещасні випадки за основними причинами, видами подій, групами професій, віком, стажем роботи.

Дослідження умов та стану охорони праці, а також причин та обставин виробничого травматизму в харчовій промисловості дозволить розробити обґрунтовані та ефективні шляхи профілактики та зниження рівня виробничого травматизму та профзахворювань, а також зниження ризику травмування серед працівників галузі.



## — Abstracts —

**Ключові слова:** виробничий травматизм, нещасний випадок, коефіцієнт частоти травматизму, коефіцієнт часткової втрати працездатності, коефіцієнт тяжкості травматизму, вид подій, причина нещасного випадку.

УДК 330

### **Залучення іноземних інвестицій в Україну: проблеми та рішення**

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Дослідження зосереджено на проблемах, пов'язаних з залученням іноземних інвестицій в Україну та деяких пропозиціях щодо їх вирішення на основі економічного потенціалу країни. Роль іноземних інвестицій досліджується в системі фінансового забезпечення економіки України.

Метою дослідження є визначення вирішення проблеми залучення іноземних інвестицій в Україну, формування подальшої стратегії розподілу інвестицій між пріоритетними секторами. Об'єктом дослідження є іноземні інвестиції в економіку України.

Методами дослідження є огляд літератури з загальної теми, аналіз та обробка статистичних даних, аналіз джерел даних та інвестиційних процесів в Україні.

Якщо уряд буде приймати економічні, правові та адміністративні реформи, які були запропоновані в статті, інвестиційний клімат в нашій країні буде поліпшуватися, що дозволить підвищити імідж нашої країни на світовому ринку і призведе до притоку іноземного капіталу в Україну. Бажано підтримувати інвестиційні проекти, спрямовані на розвиток приватного сектора, організувати виставки інвестиційних проектів.

**Ключові слова:** іноземні інвестиції, інвестиційний клімат, інвестиційна діяльність, інвестиційний потенціал.

## Abstracts in Russian

### АННОТАЦИИ

УДК 663.674:664.7

#### **Изучение фазового состава мороженого методом низкотемпературной $^1\text{H}$ ЯМР–спектроскопии**

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Методом низкотемпературной  $^1\text{H}$  ЯМР-спектроскопии изучено состояние водной фазы мороженого в процессе повышения его температуры от  $-60\text{ }^\circ\text{C}$  до  $0\text{ }^\circ\text{C}$ . Доказано, что в мороженом с низким содержанием жира стандартного химического состава свободная вода практически отсутствует, а связанная наблюдается в виде двух фракций – слабосвязанной и сильносвязанной. Первая фракция образуется преимущественно водой, входящей в состав гидратированных сахаров, а вторая – за счет адсорбционных взаимодействий с биополимерной составляющей смесей.

В приближении кристаллизации воды и сахаров в виде индивидуальных веществ рассчитаны распределения по радиусам образующихся в смесях кристаллов льда. Установлено, что размеры формирующихся кристаллов находятся в диапазоне 1-16,6 нм и для них характерны два максимума, обусловленные различной энергией связи воды.

Доказано незначительное отличие фазового состава смесей мороженого, содержащих пшеничную муку и современную стабилизационную систему. Выявлено, что клейстертизованная пшеничная мука, превосходящая количественно стабилизационную систему в 5 раз, практически не уступает последней в связывании воды.

Полученные данные могут быть использованы при расчете фактических концентраций сахарозы и лактозы в смесях и мороженом. Такие расчеты позволят снизить вероятность появления в мороженом пороков консистенции, вызванных появлением крупных кристаллов дисахаридов и льда.

**Ключевые слова:** мороженое, фазовый состав, связанная вода.

УДК 664.8

#### **Антиоксиданты в пищевых системах. Механизм действия**

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Описаны механизмы действия природных и синтетических антиоксидантов в пищевых системах (окисление липидов, белков, углеводов), позволяющие прогнозировать эффективность их применения для продолжительного хранения пищевых продуктов. Детально обсуждены и проанализированы основные механизмы защитного действия антиоксидантов: деактивация свободных радикалов, перенос атома водорода, образование хелатов, одноэлектронный перенос, тушение синглетного

## — Abstracts —

кислорода и фотосенсибилизаторов, инактивация липоксигеназ. Особое внимание уделено рассмотрению действия смесей антиоксидантов и наиболее эффективным синергистам.

**Ключевые слова:** окисление, свободные радикалы, активация кислорода, фотосенсибилизаторы, синергизм, антагонизм.

УДК 664

### **Особенности формирования пищевых эмульсий и пен**

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Эмульсии и пены это дисперсные системы, которые чаще всего присутствуют в пищевых продуктах. При прогнозировании и управлении поведением таких систем важную роль играют знания об их структуру и свойствах дисперсионной среды, дисперсной фазы и межфазных взаимодействий. В качестве стабилизаторов пищевых дисперсных систем широко используют полисахариды и белки, в составе которых одновременно содержатся полярные и неполярные группы, придающие этим пищевым макромолекулам свойства поверхностно-активных веществ. Во время образования эмульсии или пены данные вещества способны быстро адсорбироваться на поверхность капли или воздушного пузырька в виде тонкой защитной пленки. Целью данной статьи является изучение функциональных свойств поверхностно-активных веществ и их применение в пищевой промышленности.

Белки молока обладают хорошими свойствами поверхностно-активных веществ, в частности, эмульгирующим, загущающим, пенообразующим, влагосвязывающим. При этом не все молочные белки проявляют одинаковые свойства: сывороточные белки являются менее активными чем казеины, что вызвано их глобулярной строением. Установлено, что применение ферментативного гидролиза способствует усилению свойств сывороточных белков как поверхностно-активных веществ. Улучшения свойств белков молока также происходит при образовании белково-полисахаридных комплексов на поверхности раздела фаз эмульсий и пен. Условия и технологические режимы формирования многокомпонентных дисперсных систем, стабилизированных этими белково-полисахаридных комплексов, требуют более глубокого исследования.

**Ключевые слова:** эмульсии, пены, поверхностно-активные вещества, поверхность раздела фаз, стабильность.

УДК 664

### **Оценка перспектив использования новейших технологий стабилизации напитков**

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В статье приведена информация, касающаяся микробиологической стабилизации газированных и негазированных напитков, в том числе и повышенной энергетической

## — Abstracts —

ценности на основе растительного сырья за счет выбора их параметров и режимов тепловой обработки.

Проведен анализ относительно возможных разновидностей микрофлоры в напитках и приведена информация по выбору количества пастеризационных единиц для ее инактивации. Проанализирована взаимосвязь между осмотическим давлением, показателем рН среды и содержанием диоксида углерода в напитках и их влияния на стабилизацию напитков.

Приведена схема условий обеспечения устойчивости газированных и негазированных напитков при отсутствии в них химических консервантов.

**Ключевые слова:** стабилизация, микробные клетки, бактерии, пастеризация, концентрация.

УДК 663.4

### Уточнение физических и химических методов определения сахаров

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Целью проведенной работы является сравнение основных существующих методов определения сахаров для выявления наиболее точных и удобных при использовании в пивоваренной промышленности. Экспериментально установлены оптимальные методы определения сахаров для использования в лабораторных и производственных условиях пивоваренной промышленности. Установлены коррелирующие коэффициенты между результатами, полученными разными методами для адекватного отображения основных компонентов сахарной части сусла и пива. Существенным практическим выводом исследований является то, что физические методы определения сахаров имеют достаточно высокую точность при определении концентрации мальтозы в сусле и наиболее пригодны для контролирования кинетики и регулирования производственных процессов.

**Ключевые слова:** сбраживаемые сахара, методы определения сахаров, экспресс-анализ.

УДК 664.6: 664.644.2

### Производство ржано-пшеничного хлеба в ресторанах

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Исследован технологический процесс приготовления теста из ржано-пшеничной муки по ускоренной технологии с использованием комплексного хлебопекарного улучшителя «Ибис». Проанализировано влияние улучшителя «Ибис» на процесс кислотонакопления, структурно-механические свойства теста и на качество хлеба.

Установлено, что внесение комплексного хлебопекарного улучшителя «Ибис» позволяет уменьшить продолжительность расстойки изделий, уменьшает продолжительность технологического процесса приготовления хлеба. Результаты исследований показали, что пористость хлеба тем больше, чем больше внесено

## — Abstracts —

улучшителя. При этом увеличивается удельный объем хлеба, мякиш эластичный, хороший вкус и аромат хлеба.

Проведение пробного лабораторного выпекания и изучение вязкопластических и структурно-механических свойств ржано-пшеничного теста подтверждают эффективность использования комплексного хлебопекарного улучшителя «Ибис» для ускоренных технологий производства ржано-пшеничного хлеба. Применение данного улучшителя позволит сократить продолжительность технологического процесса производства хлеба при сохранении высокого качества готовых изделий.

**Ключевые слова:** ржаная мука, хлеб, комплексные улучшители.

УДК 663.2

### **Регулирование дозы диоксида серы с помощью препаратов, основанных на глутатионе дрожжей в производстве розового столового вина**

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Представлены исследования влияния частичной заменой диоксида серы препаратами на основе глутатиона дрожжей и танина на качество розовых столовых виноматериалов. Объектами исследования были розовые столовые сухие виноматериалы, изготовленные из сорта винограда Каберне-Совиньон. Образцы готовили в условиях микровиноделия по схеме, которая включала переработку без настаивания на мезге с использованием препаратов, основанных на глутатионе дрожжей, танинов и диоксид серы. Препараты были добавлены в сусло перед осветлением в дозе 2 г/дал танина, 2 г/дал глутатиона и 50-75 мг/л диоксида серы.

Было исследовано влияние препаратов и их доз в условиях индуцированного окисления на изменение окислительно-восстановительного состояния данного типа вина. Модельная система состояла из столового розового виноматериала, в который были добавлены диоксид серы, глутатион дрожжей и танин.

Было установлено влияние препаратов на органолептические и физико-химические показатели и на изменение цвета розового вина.

Использование препаратов на основе глутатиона дрожжей может увеличить уровень свободного диоксида серы, что приведет к более эффективной защите от окисления, или дает возможность снижения дозы сульфитации для равного уровня защиты.

**Ключевые слова:** розовое вино, Каберне-Совиньон, индуцированное окисление, глутатион дрожжей, танины, доза сульфитации, фенольный комплекс.

УДК 543.42:664.38

### **Использование инфракрасных спектров отражения подсолнечного шрота для определения содержания влаги**

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В работе исследовали инфракрасные спектры отражения в ближней области подсолнечного шрота с целью построения калибровочного графика для определения содержания влаги. Были использованные образцы подсолнечного шрота с разной

## — Abstracts —

влажностью, которая находилась в пределах от 5 до 19 %. Измерения проводили на анализаторе "Инфрарид-61" в интервале длин волн 1330-2370 нм с шагом 10 нм. По коэффициенту отражения установлены характеристические длины волн (1460 и 1930 нм) для экспресс-анализа содержания влаги в шроте. Проанализированы первые и вторые производные оптической плотности, для них также определены характеристические длины волн, которые в этом случае смещаются в коротковолновую область и составляют 1400 и 1890 нм для первой производной и 1370 и 1860 нм для второй соответственно. Построены калибровочные кривые и приведены уравнения, которые описывают их, а также для каждого калибровочного графика установлена величина достоверности аппроксимации. Это даст возможность определить содержание влаги в подсолнечном шроте, используя указанные выше длины волн.

**Ключевые слова:** инфракрасная спектроскопия, спектры отражения, подсолнечный шрот, влажность.

УДК 663.2

### **Обоснование выбора вторичных продуктов виноделия в качестве нетрадиционного сырья кондитерской промышленности**

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Целью статьи является изучение содержания пектиновых и фенольных веществ в винограде и продуктах его переработки и определение целесообразности включения их в рецептуры в качестве ценного сырья для получения новых видов кондитерских изделий.

Объектом исследований были выжимки винограда технических сортов, полученные в результате промышленного производства виноматериалов.

Приведены результаты исследований по определению количественного состава пектиновых и фенольных веществ в выжимках винограда технических сортов. Определена возможность использования продуктов переработки винограда при производстве кондитерских изделий.

**Ключевые слова:** виноград, продукты переработки, виноградные выжимки, кондитерские изделия, фенольные и пектиновые вещества.

УДК 663.2

### **Влияние технологических обработок виноматериалов на их физико-химический состав**

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Необходимым условием обеспечения конкурентоспособности отечественных вин на международном потребительском рынке является дальнейшее повышение их качества с увеличением сроков гарантированной стабильности до 1,5 лет.

Одними из наиболее распространенных препаратов осветляющего и стабилизирующего действия, нашедших широкое применение в практике виноделия, являются желатин и бентонит. В этой связи является актуальной задача апробации

## — Abstracts —

импортных вспомогательных препаратов нового поколения, адаптации их к отечественному виноделию.

УДК 543.42

### **Анализ спектров отражения семян рапса с различным содержанием эруковой кислоты в ближней инфракрасной области**

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Цель работы - анализ спектров отражения в ближней инфракрасной области семян рапса с разным содержанием эруковой кислоты и выбор наиболее информативных длин волн для создания калибровочного уравнения. Инфракрасные спектры отражения определяли в диапазоне 1330–2370 нм для семян рапса с высоким и низким содержанием эруковой кислоты. Жирнокислотный состав масла семян рапса определяли газожидкостной хроматографией. Обнаружено разные уровни поглощения низко- и высокоэруковых семян рапса в области 1700–1860 и 1930–2370 нм. Проанализированы также первые производные спектров отражения и предложен набор длин волн для создания калибровочного уравнения для определения содержания эруковой кислоты. Полученные нами данные могут быть использованы для определения содержания эруковой кислоты в семенах рапса методом ближней инфракрасной спектроскопии.

**Ключевые слова:** инфракрасная спектроскопия, спектры отражения, семена рапса, эруковая кислота.

УДК 663.52

### **Исследование движения органических примесей спирта по разгонной колонне, работающей под давлением ниже атмосферного**

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В условиях жесткой конкуренции на рынке спирта в Украине актуальной задачей на сегодняшний день перед спиртовыми заводами стоит значительное снижение себестоимости готовой продукции при производстве спирта - ректификата высокого качества. Целью данной работы было: «определить оптимальные технологические параметры эксплуатации энергосберегающей брагоректификационной установки, работающей под давлением ниже атмосферного при стабильном производстве высококачественного спирта». В работе исследовано движение органических примесей этилового спирта по колоннам брагоректификационной установки (БРУ), работающая в энергосберегающем режиме под давлением ниже атмосферного с целью улучшения качества ректифицированного спирта и увеличения удельного выхода товарной продукции. В работе были определены наиболее оптимальные технологические параметры работы брагоректификационной установки с дополнительными колоннами и определены режимы контроля и регулирования работы данной БРУ. Проведен ряд исследований по

## — Abstracts —

определению степени концентрирования и степени извлечения органических примесей по разгонной колонне, которая работает под вакуумом. Опыты проводили в производственных условиях на газовом хроматографе «Кристалл 2000М».

**Ключевые слова:** спирт, органические примеси, брагоректификационная установка, качество, степень концентрирования, степень извлечения, разгонная колонна.

УДК 664

### **Анализ физических основ особенностей и преимуществ переходных процессов**

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Выполнен анализ физических основ особенностей и преимуществ переходных процессов в пищевых технологиях с точки зрения интересов интенсификации в них тепло- и массообмена. Проведен структурный анализ дискретно-импульсных, экструдерных технологий и технологий резкого снижения давления и переходных процессов при их использовании с оценкой энергетического потенциала. Сделан вывод об их общей основе в форме первоначального накопления энергетических потенциалов в данных технологиях.

Представлена информация, что для большинства процессов в пищевых технологиях существует возможность резкого снижения такого термодинамического параметра, как давление. При этом происходит импульсное изменение энергетического потенциала с мощностями, которые могут превышать традиционные технологии даже на несколько порядков. Именно это определяет существенные перспективы распространения дискретно-импульсных, экструдерных технологий и технологий резкого снижения давления для газонасыщенных сред.

**Ключевые слова:** дискретно-импульсные технологии, энергия, уровень, структура, потенциал, давление.

УДК 664

### **Исследование особенностей компенсации реактивной мощности на предприятиях пищевой промышленности**

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Рассмотрены пути повышения эффективности компенсации реактивной мощности на пищевых предприятиях. Показано, что применение конденсаторов индивидуальной компенсации позволяет отказаться от сложных и дорогих устройств регулирования мощности конденсаторных установок, которыми необходимо комплектовать установки централизованной компенсации на трансформаторных подстанциях, а защита двигателя от режима самовозбуждения можно осуществить путем подключения конденсаторов к зажимам двигателя через автоматический выключатель, оборудованный электромагнитом дистанционного отключения.

**Ключевые слова:** реактивная мощность, индукции двигателя, компенсация.



УДК 331

**Исследование производственного травматизма в  
пищевой промышленности Украины**

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Целью работы является проведение статистического анализа производственного травматизма среди работников пищевой промышленности. Объектом исследования является производственный травматизм в пищевой промышленности за 2003-2011 годы.

Проанализировано состояние производственного травматизма в Украине за период 2003...2011 гг. Поданы результаты исследования динамики производственного травматизма в пищевой промышленности Украины с 2003 по 2011 годы. Проведено распределение количества потерпевших работников мужского и женского пола на предприятиях пищевой промышленности. Рассчитаны показатели частоты и тяжести травматизма. Проведено распределение несчастных случаев по основным причинам, видам событий, группам профессий, возрастом, стажем работы.

Исследование условий и состояния охраны труда, а также причин и обстоятельств производственного травматизма в пищевой промышленности позволит разработать обоснованные и эффективные пути профилактики и снижения уровня производственного травматизма и профзаболеваний, а также снижение риска травмирования среди работников отрасли.

**Ключевые слова:** Производственный травматизм, несчастный случай, коэффициент частоты травматизма, частичная потеря работоспособности, коэффициент тяжести травматизма, вид событий, причина несчастного случая.

УДК 330

**Привлечение иностранных инвестиций в Украину:  
проблемы и решения**

Ирина Хамутовская

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Исследование сосредоточено на проблемах, связанных с привлечением иностранных инвестиций в Украину и некоторых предложениях по их решению на основе экономического потенциала страны. Роль иностранных инвестиций исследуется в системе финансового обеспечения экономики Украины.

Целью исследования является определение решения проблемы привлечения иностранных инвестиций в Украину, формирования дальнейшей стратегии распределения инвестиций между приоритетными секторами. Объектом исследования являются иностранные инвестиции в экономику Украины.

Методами исследования являются обзор литературы по общей теме, анализ и обработка статистических данных, анализ источников данных и инвестиционных процессов в Украине.

Если правительство будет принимать экономические, правовые и административные реформы, которые были предложены в статье, инвестиционный климат в нашей стране будет улучшаться, что позволит повысить имидж нашей страны на мировом рынке и

— **Abstracts** —

приведет к притоку иностранного капитала в Украину. Желательно поддерживать инвестиционные проекты, направленные на развитие частного сектора, организовывать выставки инвестиционных проектов.

**Ключевые слова:** иностранные инвестиции, инвестиционный климат, инвестиционная деятельность, инвестиционный потенциал.

— *Instructions for Authors* —

## **Instructions for Authors**

**Dear colleagues!**

The Editorial Board of scientific periodical «**Ukrainian Journal of Food Science**» invites you to publication of your scientific research.

Requirements for article:

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The structure of the article:

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Points from 1 to 5 should be in English, Ukrainian and Russian.

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  - Methods of research
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  - References

If you need you can add another parts and divide them into subparts.

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Photos are not appropriate to use.

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Читачі журналу - науковці, викладачі, інженерно-технічні працівники та керівники підприємств харчової промисловості.

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Всі наукові статті, представлені для публікації в «**Ukrainian Journal of Food Science**» проходять «Подвійне сліпе рецензування» (рецензент не знає, чию статтю рецензує, і, відповідно, автор не знає рецензента) принаймні двома вченими, призначених редакційною колегією: один є членом редколегії і один незалежний учений.

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