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Physicochemical Characteristics of the New Polyphyto-component Composition for Food Industry

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The physicochemical properties of the new polyphyto-component composition have been studied. It was established that the optimum content of hawthorn fruit, flowers of sage, oregano, thyme, basil leaves and clove buds in the new polyphyto-component at the following proportion 8 : 2 : 2 : 2 : 2 : 1. The highest yield of complex nutrients has been determined in the optimum condition of polyphyto-component preparation in 40% aqueous-alcoholic solution is the infusion duration of 4,5-5,0 hours. The experimental data have processed by the method of mathematical statistics. The investigated polyphyto-component consists of essential minerals that improve the nutritional value and enrich the functional properties, such as macro-elements: Ca - 1552,44 mg, K - 588,83 mg, Na – 387,88 mg, P – 372,63 mg, Mg – 241,94 mg; as well as micro-elements: Fe – 1134,66 mcg, B – 1459,31 mcg, Zn – 110,62 mcg, Cu – 3,065 mcg, Cr – 3,521 mcg. By chromatographic analysis a new polyphyto-component composition has been identified that contains of 6,0 mg/l of important ascorbic acid.

Key words: antioxidants, ascorbic acid, food, macro- and micro-elements, organoleptic assessment, polyphyto-component, vacuum extraction.

Introduce the problem of the improving of the meat products quality

The meat processing industry of Kazakhstan is one of the most important sectors of food industry that to meet the growing of the consumers requirement in a high-quality foodstuff. In the human diet the meat is a main source of native essential amino acids, lipids, vitamins, macro- and micro-elements et al. In the XXI century meat processing industry should to solve the problem of increasing a volume and improving a quality of meat and sausage products, including the smoked products that have a great consumers demand[1] (Mezenova, 2001).

Since ancient times, all kinds of meat and fish products: sausages, boiled and smoked meat have been considered as delicates (Mezenova, 2001). Currently, the smoking is one of the most common processing methods in the production of the meat products (Klyuchko, 2009). For the smoking technology apply various methods of treatment (Rogov, 2000). The traditional technology provides for process during at the thermal conditions of smoke-air blend in three stages: pre-drying, smoking (roasting) and boiling. Contemporary trends in the technology of smoked cured products are aimed to the improvement of smokeless fuming and the diversification of the final products. Nowadays in the fuming of meat

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products mainly the liquid smoking preparations (LSP) on the base of aqueous solutions of the wood pyrolysis are used that have minimal toxicity with the maximum adequacy to the smoked fume (Rogov, 2000). For example, the newest liquid smoking preparations are "VNIRO", "Alder smoke", "Liquid smoke" et al. (Slapoguzova, 2004), as well as fumitory compositions of companies of "O.A.Broste", "Red Arrow", "Raucharoma" (Slapoguzova et al, 2006). All above mentioned LSP, as liquid analogues of smoke fume, solve the environmental problems of fumitory production. However, the actual matter is the improving of technology and increasing a biological value of the final products. The problems solutions on the intensification of processes and improving the quality of food products, particularly meat products are possible by improving the traditional methods (Singh et al, 2012). One of the priorities of Kazakhstan State policy in the field of healthy nutrition is the development a food safety by maximum enrichment of biologically active substances (BAS). All parts of the plant are considered to be good source of a large number of bioactive substances (Saggu et al, 2007).

Developing of new plant origin functional food additives

A special value has the medicinal ingredients of plant origin or phyto-components (Peter, 2004), for those long centuries-old experiences of folk medicine have formed a high level of the confidence (Singh et al, 2012). The diversity and complexity of the phyto-components composition of plant raw materials may explain their polyvalent pharmacological activity (Jurikova et al, 2012). Phenols and flavonoids of medicinal plants origin have antioxidant and antimicrobial activities (Alghazeer et al, 2012).

Hawthorn consists of: triterpene acids, procyanidins, lignans, phenolic acids (Liu et al, 2010), sugars and flavonoids (Lui et al, 2011). Currently innovative way of fuming with the use of the newest liquid smoking preparations (LSP) is becoming increasingly widespread (Shingisov et al, 2014). Recent studies have shown that parapharmaceutics well balanced present in the composition of liquid smoking preparations (LSP) enriched by plant supplements (Klyuchko et al, 2009). The developed LSP has a high nutritional value due to the presence of natural biologically active substances: vitamins, polysaccharides, minerals (Smirnov, 2004). In particularly, minerals execute a role of the functional ingredients: colors, flavors, antiseptics, antioxidants (Edwards et al, 2012). Mineral elements work hand in hand with other food micronutrient classes like vitamins as co-factors and also promote the functioning of the macronutrients like carbohydrate, fats and protein (Salau, 2014). Development of new phyto components with various functionalities in the form of an integrated liquid concentrate in the smoking preparations will increase a quality of the final product.

Currently, in the food industry, for the extraction of complex nutrients from the plant raw materials are various extraction methods apply that differ in the nature of the extractant (water, water-alcohol mixture, buttermilk) the method of physical (Satayev et al, 2012) impact on the extractable substance (microwave processing, electric discharge, ultrasound, etc.) (Peter, 2004). Most of these methods are used in varied versions, extraction times, methods of distribution of raw materials in the extractors (Jurikova et al, 2012). Comparative analysis of the extraction methods shows that one of the main problems in the extraction of plant raw materials is the duration of the extraction process and the completeness of the extraction complex of nutrients with minimal costs.

Theoretical and practical implications of the study.

Thus, by analyzing advantages and disadvantages from the vision of the shortening a duration of the extraction process, and the maximum output of the complex nutrients of the above mentioned methods, the most promising approach is the extraction of raw materials at low temperatures by using ultrasound technology. The additional application of ultrasound technology in a vacuum creates a cavitation and turbulence in the liquid extractant that resulting in rapid swelling and dissolution of the raw contents of the cells increases the rate of flow of the feed particles in the diffusion boundary layer turbulence arises and eddies. Molecular diffusion in the feed particles in the boundary diffusion layer is practically replaced with convection that leads to an intensification of mass transfer. As a result of cavitation is the destruction of cellular structures that accelerates the process of moving nutrients into the extractant through their washout. Strong turbulent flow, hydrodynamic flows promote to transfer mass, solubility of compounds, an intense mixing of the cell inside takes place that impossible to achieve by other extraction methods. Furthermore, the variation in pressure upon compression and decompression of the ultrasound wave distribution may a cause sponge effect whereby improved penetration of extractant in the feed. The proposed technology of extraction of plant raw materials is easily implemented by using universal ultrasound tanks for food processing with applying of a vacuum created apparatus in the system.

The work purpose was a creating of a polyphyto-component of hawthorn fruit, flowers, sage, oregano, thyme, basil leaves, clove bud are cultivated in the South-Kazakhstan region by the low-frequency vacuum ultrasound extraction.

METHOD.

Raw materials and laboratory equipment

The study raw materials were the hawthorn fruits, sage flowers, thyme, oregano, basil leaves and clove buds. All raw materials were purchased in "Zerde" LLP. For the powdering of the plant raw materials the laboratory mill brand LM 202 (Russia) has been used. The raw material was grinded till granulometry sizes of 1,5 - 2,0 mm. For preparation of 40% aqueous-alcoholic extractant have been applied ethanol and distilled water. Studies of ascorbic acid content in the extracts were performed on the liquid chromatograph ProStar Varian. The mineral content of the extracts was studied by mass spectrometry VARIAN - 820MS with inductively coupled plasma.

Hygroscopic characteristics of extracts of plant materials were studied by the following standard equipment: for the determination of the pH – ion meter brand «SCHOTT Instrument» Lab 850 (Germany); viscosity was determined by a capillary viscosimeter; the density of the extract was investigated by aerometer. Solids in the extract were determined by using a refractometer IRF-454 B2M. The experimental low-frequency ultrasound device has been developed for the study of regularities of the process of the raw materials extraction (Shingisov et al, 2015),

The experiment methodology

For the obtaing of new polyphyto-component, the extract plant material was powdered until particles sizes of 1,5 - 2,0 mm. Place in a glass bowl (2) the test raw materials poured 40% aqueous-alcoholic solution and infuse for 4 hours(Figure 1). Then, a glass bowl with the researched raw material introduced into the preheated at the temperature 38-40°C the isothermal bath (1) then the water chiller (4) was used.

At the closing vacuum pass valve (6), the vacuum pump was joined (7). After measuring of residual pressure in the system (5) and setting the duration of ultrasound treatment of raw materials the low-frequency ultrasound device was switched on (3). Further after reaching the predetermined time of sonication investigated materials the pump vacuum was switched off (7), and then the vacuum valve was opened (6) the extract in the glass container was collected (2). Then the extract was filtered through a sieve and the remaining raw materials are squeezed. The obtained extract was directed to the further study.

RESULTS AND DISCUSSION

Creating of the composition proportion

For the obtaing of polyphyto-component, each kind of the plant raw materials has been a pre-extracted. Then, based on the sensory analysis and physicochemical characteristics of the extract, in the different proportions of polyphyto compositions have been combined.

The main criterion for the selecting of the best combinations of polyphyto-component specimen was an organoleptic factor or sensory evaluation. The most interesting proportions in the terms of combinations of sensory characteristics are shown in Table 1.

Table 1. Proportions for combinations of plant raw materials

Combination number	Polyphyto-component correlation hawthorn fruit: sage flowers: marjoram flowers: thyme flowers: basil leaves: clove buds
1	20 : 2 : 2 : 2 : 2 : 1
2	10 : 2 : 2 : 2 : 2 : 1
3	7 : 2 : 2 : 2 : 2 : 1
4	5 : 2 : 2 : 2 : 2 : 1
5	8 : 2 : 2 : 2 : 2 : 1

The next step of the study was sensory evaluation of combinations by following factors: colour, odor and flavor. The results are shown in Table 2.

According to the obtained data in Table 2 it is seen that by the organoleptic quality among considered options combinations of extracts the best combination is option number 5, with the following ratios 8 : 2 : 2 : 2 : 2 : 1. The yield of the complex of healthy compounds depends on the infusion duration in the extract.

The analysis of Table 2 shows that according to the organoleptic quality of the options considered combinations hawthorn extracts, flowers sage, oregano, thyme, basil leaves and clove bud with the best option is the option number 5, with the following proportions of the above mentioned raw materials 8 : 2 : 2 : 2 : 2 : 1.

Processing by the mathematical statistic method

In order to avoid errors during the study of basic physical and chemical properties of plant materials extracts, the experimental data were processed by the method of mathematical statistics. For this homogeneity variance estimates determined by Cochran's criterion in accordance with the following equation:

$$G_p = \frac{\left[S^2(y_{ik})\right]_{max}}{\sum_{i}^{n} S(y_{ik})}$$

where ($\left[S^2(y_{ik})\right]$) - the maximum variance of the k-th yield;

$\sum_{u}^{n} S(y_{uk})$ a sum of the variance of all k-th yields.

The hypothesis of the homogeneity of variance is accepted if the calculated value of Cochran's criterion G_p (Eq.1) less than the tabulated value of G_T, i.e.

$$G_p < G_T \qquad ...(2)$$

The checking of hypotheses about the significance of the coefficient *b* was carried out by dispersion evaluation:

$$\varepsilon(b_i) = t(p, f) \cdot S(b_i) \qquad ...(3)$$

$$S^2(b_i) = \frac{S^2\left(\bar{y}_i\right)}{N} = \frac{\sum_{u}^{N}\sum_{K}^{M}(y_{ik} - y_i)}{N \cdot (m-1)n \cdot N} \qquad ...(4)$$

Table 2. Sensory evaluation of combinations

Sensory characteristics		
Colour	Odor	Flavor
Option number 1		
Thick red as tea	Faint odor	The bitterness of wormwood, tart
Option number 2		
Russet	Pleasant as a balm	The bitterness of wormwood, astringency
Option number 3		
Deep-brown	Pleasant	Very bitter, no astringency, tip of tongue
Option number 4		
Deep-brown	Pleasant	Very bitter
Option number 5		
Deep-brown	Mint-flavored, clear taste , pleasant	Initially bitter, at the end of a pleasant

Table 3. Values of A, B and C constants for the polyphyto-component

Name of measurement	Coefficient value			Approximation validity
	A	B	C	
Solids yield, %	-0,1125	1,395	12,3	1
Density, ρ kg/m^3	-0,25	4,0	945,0	1
Viscosity, μ centistokes	-0,0138	0,1625	2,12	1
pH value, pH	-0,017	0,1855	4,7	1

where $t(p, f)$ - the tabulated value of Student's criterion for a given probability $(\zeta = 0{,}95)$ and degrees of freedom f_j;

Fig. 1. The low-frequency ultrasound device

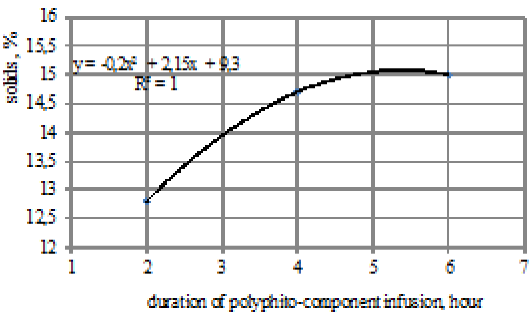

Fig. 2. Dependence of the solids from the duration of the infusion polyphyto-component in extract

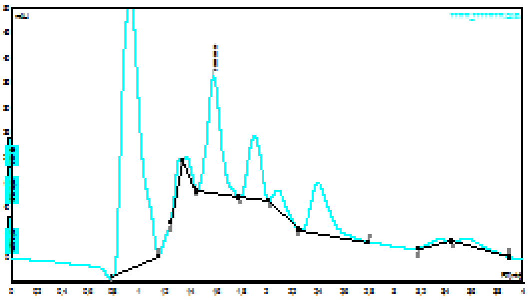

Fig. 3. The determination of ascorbic acid in the polyphyto-component by the HLC Pro Star Varian

$S^2(\bar{y}_i)$ - mean variance for the experiment reproducibility of average output in each row;
N - number of dispersion
N - number of dispersion.
The coefficient b_i is considered significant if

$$|b_i| > \varepsilon(b_i) \qquad ...(5)$$

t_{cr} is determined from the table for the number of freedom *f*

$$f = N(m-1) \qquad ...(6)$$

where N - number of experiments;
m - number of cycles (in this case, m = 3).
All equations are approximated by using the software "Excel 2003".

Polyphyto-component extracts study

As it is known that at the extraction of plant materials, one of the main parameters characterizing the complete extraction of complex nutrients is solids yield. Analysis of experimental data shows that the completeness of nutrients extraction complex depends on the duration of infusion of raw materials in the extractant. Therefore were conducted a study on the influence of the duration infusion on the solids yield from the optimal variant combinations of extracts, i.e. polyphyto-component 40% aqueous-alcoholic solution for 2, 4 and 6 hours. The study results are shown in Figure 2.

As seen (Figure 2) with the increasing of duration of polyphyto-component infusion in the extract, a yield of solids is not unique. For example, if the infusion duration increases from 2 till 4 hours then solids yield is increased by 8,96% as compared with the output value of solids on insisting sample polyphyto-component for 2 hours in a 40% aqueous-alcoholic solution. By increasing the infusion time till 6 hours yield solids is increased by 2,53% compared with the value of the output solids on insisting for 4 hours and was 16,2% by the sample weight polyphyto-component was studied. Further extension of infusion time over 6 hours leads to the increasing of solids yield of the sample only of 1,2%. It is known that one of the important quality indicators of polyphyto-component is ascorbic acid content or vitamin C. In this regard there were performed experiments for the determination of ascorbic acid in the polyphyto-component. The obtained results are presented in Figure 3.

Apparently from figure 3, in the investigated polyphyto-component sample an ascorbic acid content is 6,0 mg / l. Variation in the percentage of solids and ascorbic acid on insisting leads to the changing of the physicochemical parameters of the polyphyto-component sample. The study results of physicochemical characteristics are shown in Figures 4, 5 and 6.

Analysis of the patterns of the density changing from the duration of the infusion shows that with increasing the insisting duration a polyphyto-component density monotonically increases. For example, if for 2 hours, a density is 952kg / m^3, while at the increasing the infusion until - 4 hours polyphyto-component density increases 957 kg / m^3, or 0,53%. Further increase in the duration of the infusion till 6 hours leads to a slight change in the density polyphyto-component only 0,31% and 960 kg / m^3.

The extension of the infusion time a polyphyto-component viscosity changes that seen in Figure 5.

The data (Figure 5) show that with the prolonging of the infusion duration, polyphyto-component viscosity increases. For example, for the interval from 2 to 4 hours a viscosity increases by 7,14%, and between 4 and 6 hours, a viscosity increases till 1,96%. At the analyzing of the changes in viscosity in the range from 2 to 6 hours, it can be seen a grow by 9,7%.

The presented data (Figure 6) show that with increasing the duration of the polyphyto-component infusion a pH increases. For example, when polyphyto-component insisting from 2 till 4 hours active acidity increases of 3,4%, a further the infusion duration till 6 hours leads pH value of 0,6%.

Thus, in the physicochemical parameters have been found that the optimal condition for polyphyto-component insisting in 40% aqueous-

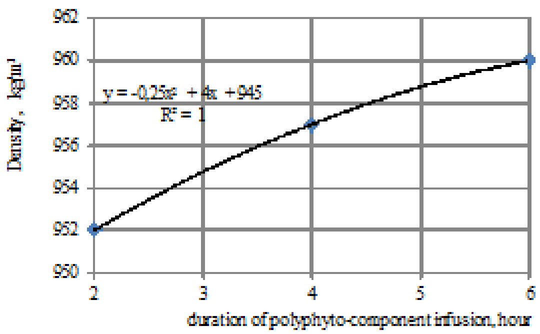

Fig. 4. The duration impact of the polyphyto-component infusion and sample density

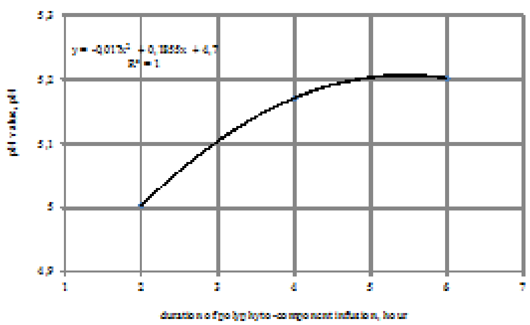

Fig. 5. The dependence of the viscosity and the duration of polyphyto-component infusion

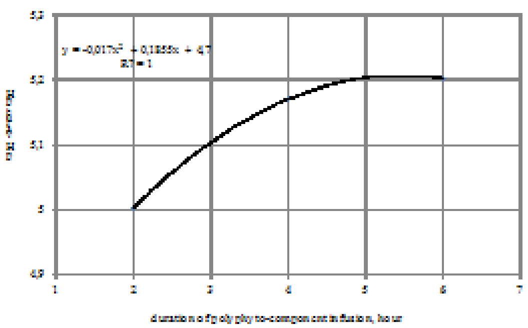

Fig. 6. The dependence of the pH value and the duration of polyphyto-component infusion

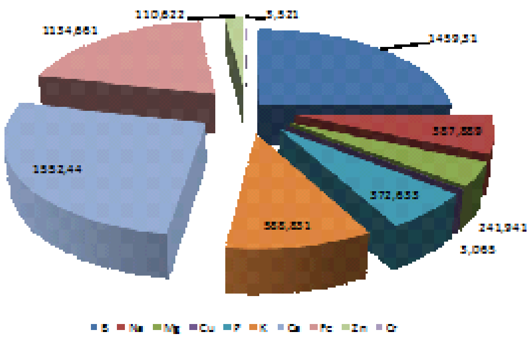

Fig. 7. Macro-and micro-elements content in the polyphyto-component

alcohol solution is the infusion duration of 5,0-5,3 hours.

For the practical application of the research results in the food industry, of the solids yield and physicochemical parameters of the duration of the polyphyto-component infusion in 40% aqueous alcohol solution of the experimental data with a high accuracy there were approximated by a polynomial Trend's equation form of the second order that has a following form:

$$Y = A x^2 + B x + C \quad ...(7)$$

The constants A, B and C are shown in Table 3.

Micro- and macro-elements content

Minerals are essential for food components. They, like ascorbic acid or vitamin C, have not energy value is nonetheless necessary in the specified amounts. In this regard, studies were conducted for the determining the mineral composition of polyphyto-component. Results are presented in Figure 5.

The quantitative analysis of macro-and microelements is shown a high content of the important macroelement calcium in polyphyto-component, as Ca-1552,44 g.

Studies have found that polyphyto constituent concludes such microelements as potassium macronutrients – K-588,83 mcg, sodium Na-387,88 mg phosphorus P -372,63 mg , magnesium Mg-241,94 g , and trace elements of iron Fe-1134,66 mcg , boron B-1459,31 g , zinc Zn-110,62 mcg, copper Cu-3,065 mcg, chromium Cr-3,521 mcg.

From the above mentioned data are seen that the composition of polyphyto component consists of macro-and microelements in sufficient quantity for the improving a nutritive value and functionality properties of the finished products.

CONCLUSION

Based on the described studies it has been concluded that the polyphyto-component composition, obtained by the developed technology under a low-frequency ultrasound vacuum extraction, has the optimum content of extracts of hawthorn fruit, sage flowers, oregano, thyme, basil leaves and clove buds of polyphyto-component is in the following correlation 8 : 2 : 2 : 2 : 2 : 1. It has been established that polyphyto-component contain 6,0 mg /l of ascorbic acid or vitamin C that plays an important role in human life. On the basis of study changes in the physicochemical characteristics have been found that the optimal condition for the insisting of polyphyto-component in 40% aqueous-alcohol solution is the duration of the infusion of 4,5-5,0 hours. Results of the mineral composition of polyphyto-component show a sufficient content of macro- and micro-elements. By chromatographic analysis a new polyphyto-component composition has been identified that contains of 6,0 mg/l of important ascorbic acid.

REFERENCES

1. Alghazeer, R., El-Saltani, H., Saleh, N.A., Al-Najjar, A., Naili, M.B., Hebail, F., & El-Deeb, H., Antioxidant and Antimicrobial Activities of Cynara scolymus L. Rhizomes. *Modern Applied Science*, 2012; **6**(7): 54-63.
2. Edwards, J.E., Brown, P.N., Talent, N., Dickinson, T.A., & Shipley P.R., A review of the chemistry of the genus Crataegus. *Phytochemistry*, 2012; **79**: 5-26.
3. Jurikova, T., Sochor, J., Rop, O., Mlcek, J., Balla, S., Szekeres, L. Adam, V., & Kizek, R., Polyphenolic Profile and Biological Activity of Chinese Hawthorn (Crataegus pinnatifida BUNGE) Fruits. *Molecules*, 2012; **17**: 14490-14509.
4. Klyuchko, N.Y., Mezenova, O.Y., & Baidalinova, L.S., Parapharmaceutics in food products based on aquatic organisms. (pp. 346), *Kaliningrad: KSTU*, 2009.
5. Liu, P., Yang, B., & Kallio, H., Characterization of phenolic compounds in Chinese hawthorn (Crataegus pinnatifida Bge. var. major) fruit by high performance liquid chromatography-electrospray ionization mass spectrometry. *Food Chemistry*, 2010; **121**(4): 1188-1197.
6. Liu, P., Yang, B. & H.Kallio, Phenolic Compounds in hawthorn (Crataegus grayana) fruits and leaves and changes during fruit ripening. *Journal of Agricultural and Food Chemistry*, 2011; **59** (20): 11141-11149
7. Mezenova, O.Y., Modern problems and methods of research in technology smoked products: study book, *Kaliningrad: KSTU*, 2001; 149.
8. Peter, K. V., Handbook of herbs and spices. V.1-3 / Edited by K.V.Peter, *CRC Press Boca Raton Boston New York Washington, DC Cambridge England, Woodhead Publishing Ltd*, 2004.

9. Rogov, I.A., Zabashta, G.P., & Kazyulin G.P., General technology of meat and meat products. *Moscow: Colossus*, 2000; 367.
10. Saggu, S., Divekar, H.M., Gupta, V., Sawhney, R.C., Banerjee, P.K., & Kumar, R., Adaptogenic and safety evaluation of seabuckthorn (Hippophae rhamnoides) leaf extract: a dose dependent study, *Food and Chemical Toxicology*, 2007; **45**(4): 609-617.
11. Salau, R.B., & Hasan, M.N., Evaluation and Analysis of Dietary Essential Mineral Micronutrients in Selected Malaysian Foods Using FAAS and ICP-MS. *Modern Applied Science*, 2014; **8**(6): 103-111.
12. Satayev M., Shakirov B., Mutaliyeva B., Satayeva L., Altynbekov R., Baiysbay O. & Alibekov R. Mathematical modeling of methoxyanabasine Ñ11Í16N2O polymer solution ultrafiltration. Heat Mass Transfer. 2012; **48**(6), 979-987. http://dx.doi.org/10.1007/s00231-011-0948-8
13. Shingisov, A.U., Alibekov, R.S., Mailybaeva, E.U., Erkebaeva, S.U., & Nurseitova, Z.T., Physicochemical Properties Study of the Rosehip Drying. *International Conference on Chemical, Food and Environmental Engineering (ICCE 15) Dubai (UAE) proceedings*, 2015; 56-57.
14. Shingisov, A.U., Urazbayeva, K.A., Kobzhasarova, Z.I., & Mussayeva, S.A., Research of half smoked sausage contained the smokeless liquid preparation (additive) enriched by polyphytocomponent. *International Journal of Applied and Fundamental Research*, 2014; **8**: 50-54.
15. Singh, A.K., Nagpal, D., & Attrey, D.P., Characterization of a prepared poly-herbal formulation and comparison of its DPPH scavenging activity with other marketed formulations. *European Journal of Biological Sciences*, 2012; **4**(3): 68-72.
16. Slapoguzova, Z.V., Substantiation and development of barrier technology of fish products by using the smoking preparation «VNIRO». Thesis of Candidate of Technical Sciences, VNIRO, Moscow, 2004.
17. Slapoguzova, Z.V., Mezenova, O.Y., & Klyuchko,N.Y., Smokers liquid medium of the new generation. The proceedings of the scientific practical conf. «Food and marine biotechnology: the problems and prospects, *Moscow: Max Press*, 2006; 144.
18. Smirnov E.V., Natural flavoring substances from plant materials in the production of flavorings. *Journal Food ingredients: raw materials and additives*, 2004; **1**: 35-38.