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Justification The Technology Of Obtaining Protein-Vitamin Functional Products.

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ABSTRACT

The methodological approaches to the substantiation of the technology of protein-vitamin products of functional orientation using soy, root and fruit raw materials growing in the Far Eastern region of Russia are developed. Data were obtained enabling the design of nutritional systems of functional orientation in the extended assortment.

Keywords: functional products, assortment, soybean, root and berry raw materials, parameters, technology, scheme, composition, design.

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INTRODUCTION

One of the main areas of food technology at present is the development of the technology of the functional products of the extended assortment [1].

At the same time, the expansion of the range of such products is due to the need for food with the prescribed physiological effects, regulated by national standards GOST R 52349-2005 and GOST R 54059-2010 [2, 3].

In this regard, the purpose of the research is to develop the technology of the functional products of the extended assortment using vegetative raw materials of the Far Eastern region containing physiologically functional food ingredients (PFFI).

Research objectives:

- to characterize the biochemical composition of protein-vitamin systems obtained on the basis of soybean and root-crop raw materials, as well as berry-acid complexes (BAC) in the form of berry juices;
- to obtain mathematical models in the form of adequate regression equations characterizing the coagulation process when using BAC as a coagulant;
- to give a comparative characteristic to the obtained food systems within the limits of their biochemical composition;
- to develop technological schemes for the production of functional products of the extended assortment using soy, root and berry raw materials.

MATERIALS AND METHODS

The process of obtaining this type of product involves the preparation of a protein-vitamin-carbohydrate suspension by co-disintegrating pre-soaked soybean seeds with a grounded component in the form of carrots, or pumpkins, or beets at a ratio of 1: 1 and a hydromodule of 1: 6. The obtained protein-vitamin dispersion system (BVDS) is separated from the insoluble fraction. An aqueous solution of the berry-acid complex (BAC) is introduced to the PVDS preheated to a temperature of 50-60 ° C in order to carry out the coagulation process. The obtained protein-vitamin coagulum is separated from the serum, granulated and dried to obtain protein-vitamin concentrate. Wet coagulates are used for making sauces and mayonnaise. The separated insoluble fraction (ocara) is directed to granulation and drying to produce protein carbohydrate granulate. The remaining whey is used to prepare fermentation beverages - kvass.

RESULTS AND DISCUSSION

Table 1 presents data describing the biochemical composition of soy protein-vitamin disperse systems, berry-acid complexes, as well as their energy value.

Based on the developed approach, by a priori ranking, the most significant factors of the process are identified, which influence the process of coagulation of protein substances in the protein carbohydrate dispersion system, as well as the process of obtaining protein-vitamin concentrate (PVC) and protein carbohydrate granulate (PCG).

Three factors for the production of protein-vitamin coagulates are identified as the main ones: the mass fraction of the solution of the berry-acid complex M_g,%; concentration of ascorbic acid K in BAC,%; duration (exposure) of coagulation T, min. (table 2). By the optimization criterion, the coagulation temperature is adopted - t_i ° C.

Table 1: Biochemical composition of soy protein-vitamin disperse systems, berry-acid complexes and their energy value $(\overline{X} \pm m; \quad p \leq 0,05)$ **[4]**

Product	Mass fraction, %						Vitamins, mg / 100 g			Energy value, kcal / 100 g
	water	proteins	lipids	carbohydrates	cellulose	minerals	C	E	β-carotene	
Soy Protein-Vitamin Disperse Systems (SPVDS):										
- soy-carrot	86,4	3,5	1,5	4,1	2,0	2,5	5,0	1,7	4,5	52,3
- soy-pumpkin	86,4	3,5	1,4	4,2	2,5	2,0	4,5	1,5	10,0	53,4
- soy-beetroot	86,4	3,4	1,2	3,9	2,4	2,7	4,0	1,6	-	49,9
Berry-acid complex based on cowberry juice	86,0	0,7	0,5	8,0	1,6	0,2	150	-	-	43,0
Berry-acid complex based on blueberry juice	88,2	1,0	-	7,0	1,2	0,3	145	-	-	36,8
Berry-acid complex based on blackberry juice	86,5	1,1	0,6	8,0	2,2	0,9	133	-	-	49,8
Berry-acid complex based on honeysuckle juice	89,0	0,8	0,11	7,2	2,3	0,5	175	-	-	40,3
Berry-acid complex based on bramble juice	88,0	2,0	-	4,4	2,0	0,7	144	-	-	25,6
Berry acid complex is based on the juice of the Amur grapes	80,2	0,6	0,2	15,0	0,6	0,5	138	-	-	66,6

Table 2 presents the factors of the process and the levels of their variation.

Table 2: Factors and levels of variation for the process

Levels	Factors		
	X_1 / M_g, %	X_2 / K, %	X_3 / T, min.
Upper level (+)	15,0	7,0	6,0
Basic level (o)	12,5	5,0	5,0
Lower level (-)	10,0	3,0	4,0
Variable Range (E)	2,5	2,0	1,0

As a result of exploratory experiments, the levels of variation by the indicated factors are determined.

After the implementation of the experiment on the planning matrix and data acquisition, they were processed, Tables 3–4.

Table 3: Regression dependence analysis $Y_{5\text{-}7} = f(X_1, X_2, X_3)$

Criterion	Standard deviation	R- correlations	Coefficient of determination R^2	F- criterion	Significance of F-criterion (p)
$Y_5 \rightarrow opt$	3,99	0,947	0,90	4,88	0,04
$Y_6 \rightarrow opt$	2,21	0,981	0,963	14,47	0,004
$Y_7 \rightarrow opt$	3,35	0,950	0,902	5,15	0,04

Table 4: Regression analysis results

Criterion	a_0	a_1	a_2	a_3	a_{12}	a_{13}	a_{23}	a_{11}	a_{22}	a_{33}	Conclusion on adequacy	
											F_R	F_T
Y_5	55,55	-4,06	-3,07	-2,81	-	-2,37	-	7,54	2,35	-	4,88	3,59
Y_6	52,51	-2,88	-4,11	-2,72	1,37	-1,87	1,62	5,88	2,56	3,09	14,47	3,59
Y_7	53,19	-3,13	-3,07	-2,5	1,87	-	1,62	5,88	-	3,04	5,15	3,59

On the basis of the mathematical processing of the experimental data, mathematical models were obtained that characterize the process of thermo-acid coagulation in BVDS, which, after screening out insignificant coefficients, obtained the following form:

– in coded form:

$$Y_5 = 55{,}55 - 4{,}06 \cdot X_1 - 3{,}07 \cdot X_2 - 2{,}81 \cdot X_3 - 2{,}37 \cdot X_1 \cdot X_3 + 7{,}54 \cdot X_1^2 + 2{,}35 \cdot X_2^2 \rightarrow opt$$

$$Y_6 = 52{,}51 - 2{,}88 \cdot X_1 - 4{,}11 \cdot X_2 - 2{,}72 \cdot X_3 + 1{,}37 \cdot X_1 \cdot X_2 - 1{,}87 \cdot X_1 \cdot X_3 +$$
$$+ 1{,}62 \cdot X_2 \cdot X_3 + 5{,}88 \cdot X_1^2 + 2{,}56 \cdot X_2^2 + 3{,}09 \cdot X_3^2 \rightarrow opt$$

$$Y_7 = 59{,}19 - 3{,}13 \cdot X_1 - 3{,}07 \cdot X_2 - 2{,}5 \cdot X_3 + 1{,}87 \cdot X_1 \cdot X_2 + 1{,}62 \cdot X_2 \cdot X_3 +$$
$$+ 5{,}88 \cdot X_1^2 + 3{,}04 \cdot X_3^2 \rightarrow opt$$

– in decoded form:

$$t_5 = 287{,}27 - 27{,}93 \cdot M_g - 11{,}78 \cdot K - 0{,}95 \cdot M_g \cdot T + 1{,}21 \cdot M_g^{\,2} + 0{,}59 \cdot K^2 \rightarrow opt$$

$$t_6 = 321{,}76 - 22{,}3 \cdot M_g - 15{,}96 \cdot K - 28{,}34 \cdot T + 0{,}27 \cdot M_g \cdot K - 0{,}75 \cdot M_g \cdot T +$$
$$+ 0{,}81 \cdot K \cdot T + 0{,}94 \cdot M_g^{\,2} + 0{,}64 \cdot K^2 + 3{,}1 \cdot T^2 \rightarrow opt$$

$$t_7 = 359{,}12 - 26{,}27 \cdot M_g - 13{,}21 \cdot K - 36{,}34 \cdot T + 0{,}37 \cdot M_g \cdot K + 0{,}81 \cdot K \cdot T +$$
$$+ 93 \cdot M_g^{\,2} + 3{,}04 \cdot T^2 \rightarrow opt$$

The adequacy of the models obtained, according to the results of the regression analysis, with a probability of P = 0.95, with correlation coefficients R_5 = 0.947, R_6 = 0.981 and R_7 = 0.950 is confirmed by the inequality $F_R > F_T$ (table 5). The reliability of the models is estimated by the level of significance of the Fisher criterion, which should be less than 0.05, that is, p_5 = 0.04, p_6 = 0.004 and p_7 = 0.04, which means that the models obtained are significant. The degree of accuracy of the description of the process model characterizes the coefficient of determination (R^2), since R^2_{5-7} is in the range of greater than 0.8 - 0.95 (table 5), then we can talk about high accuracy of approximation (the model describes the phenomenon well).

Table 5 shows the areas of extreme values of the factors X_1, X_2 and X_3, at which Y_{5-7} tends to the optimal value.

Table 5: Extreme value areas

Criterion	X_1 / M_g	X_2 / K	X_3 / T	Y_{5-7} / t_{5-7}
$Y_5 \rightarrow opt$	1,27/13,2	1,1/6,06	0,84/1,81	57,1/57,0
$Y_6 \rightarrow opt$	0,96/11,07	0,98/6,21	0,98/5,76	55,0/55,0
$Y_7 \rightarrow opt$	0,93/10,3	1,0/5,27	0,96/6,26	56,0/56,0

Based on these data, a graphical interpretation of the dependencies obtained in the form of response surfaces and their cross sections has been carried out.

The obtained protein-vitamin coagulates, concentrates and granules are characterized by high organoleptic characteristics, have a characteristic, pronounced taste, color and aroma, corresponding to the raw materials used.

Taking into account the parameters obtained, a waste-free technology has been developed for the production of the specified food products containing a set of sequentially performed operations with the corresponding recipes.

Technological schemes of the process of obtaining protein-vitamin concentrate and protein-carbon granules are presented in Figures 1 and 2, and the comparative biochemical composition of the finished concentrate and granules are presented in Tables 6 and 7.

Table 6: Comparative biochemical composition (%) and energy value of soybean-carrot-berry protein-vitamin paste, protein-vitamin concentrate and protein-carbohydrate granulate $(\overline{X} \pm m;\ \ p \leq 0,05)$

Product	Mass fraction, %						Bio-flavonoids in terms of rutin	Vitamin E, mg / 100 g	β- carotene, mg / 100 g	Vitamin C, mg / 100 g	Energy value, kcal / 100 g
	water	proteins	lipids	carbohydrates	cellulose	minerals					
Protein-Vitamin Paste (Soybean-Carrot)	54,2	15,9	5,1	20,1	1,1	2,7	19,4	4,5	3,0	300,0	197,9
Protein-vitamin concentrate (soy-carrot-berry)	10,0	27,1	7,2	47,2	2,3	8,5	54,9	9,4	14,0	150,0	362,0
Protein-carbohydrate granules (soybean-carrot)	9,3	15,2	6,5	64,4	18,5	4,6	5,5	4,3	7,8	-	367,9
Carrot concentrate (powder, chips) *	14,0	7,8	0,6	56,4	-	3,0	-	-	3,5	10,0	257,0

* data from the source [5].

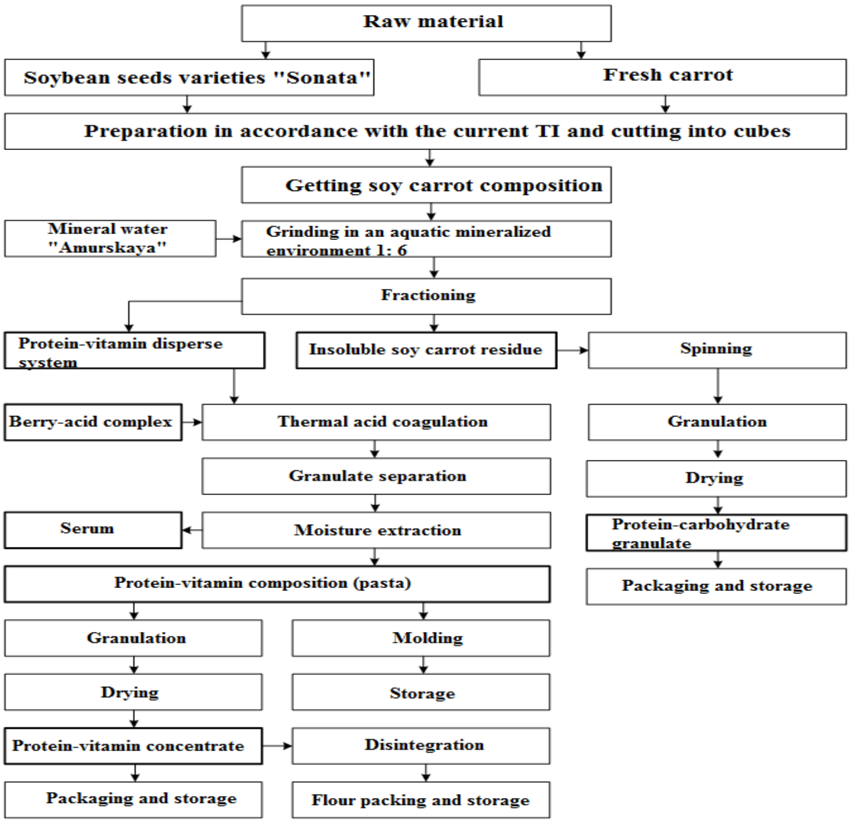

Figure 1: Technological scheme of obtaining protein-vitamin concentrate and protein-carbohydrate granules

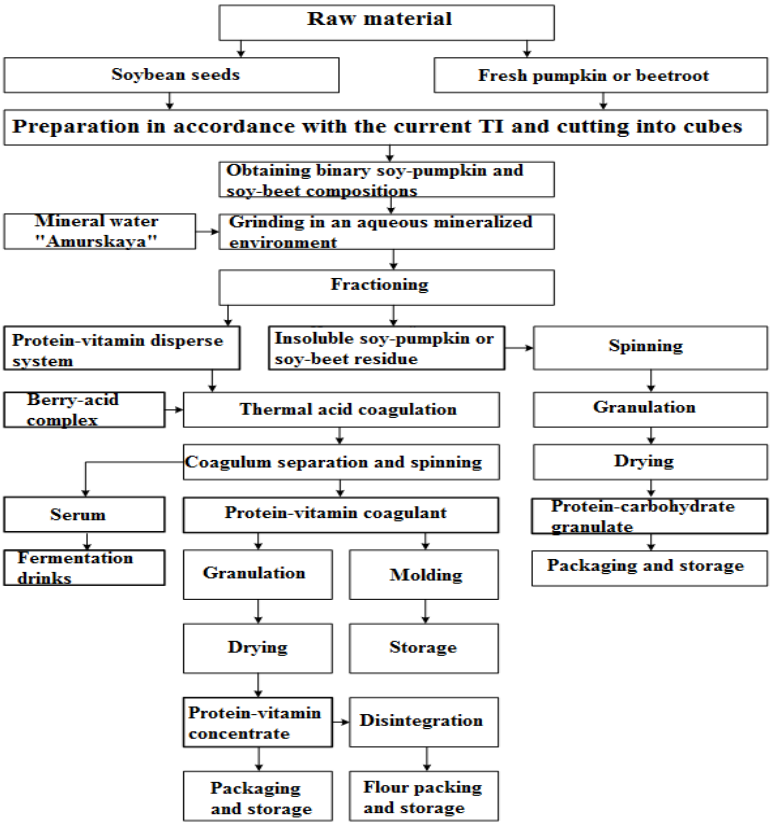

Figure 2: Technological scheme of obtaining protein-vitamin concentrate and protein-carbohydrate granules

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Analysis of the data presented in Table 6 shows that the soy carrot product in the form of protein and vitamin concentrate compared to carrot concentrate in the form of dry powder or chips contains 70% more proteins, more than 2 times more minerals, and 15 times more vitamin C.

On the basis of the conducted research, regulatory documentation for the industrial production of the above products was developed.

Table 7: Comparative biochemical composition (%) and energy value of soy-pumpkin-berry, soy-beet-berry protein-vitamin pastes, protein-vitamin concentrates and protein-carbohydrate granules

$(\overline{X} \pm m;\ \ p \leq 0,05)$

Product	Mass fraction, %						Bio-flavonoids in terms of rutin	Vitamin E, mg / 100 g	β- carotene, mg / 100 g	Vitamin C, mg / 100 g	Energy value, kcal / 100 g
	water	proteins	lipids	carbohydrates	cellulose	minerals					
Soya-pumpkin-berry protein-vitamin paste	54,0	14,0	5,2	23,0	3,5	3,5	18,3	4,2	3,3	300,0	194,8
Soy beet-berry protein-vitamin paste	50,0	16,0	5,2	24,0	4,5	4,5	18,2	4,0	-	300,0	206,8
Protein-vitamin concentrate (based on soybean-pumpkin composition)	10,0	25,2	6,5	49,6	8,6	8,6	50,2	9,1	18,5	15,0	357,7
Protein-vitamin concentrate (based on soy beet-berry composition)	10,0	26,4	7,0	48,2	8,3	8,3	51,3	9,0	-	150,0	361,4
Protein-carbohydrate granulate (based on soy-pumpkin composition)	9,0	12,3	5,7	68,2	4,8	4,8	5,4	4,2	8,1	-	373,3
Protein-carbohydrate granulate (based on soy-beet composition)	9,0	13,6	6,0	66,9	4,5	4,5	5,0	4,1	-	-	376,0
Pumpkin concentrate (powder, flakes) *	14,0	7,5	0,6	72,3	5,6	5,6	-	-	-	8,0	324,6
Beet concentrate (powder, chips) *	14,0	9,0	0,6	61,3	5,1	5,1	-	-	-	10,0	286,6

* data from the source [5].

The studies were carried out on the basis of soybean ginger and soybean citrus suspensions obtained by grinding the presoaked soybean seeds and particles of fresh ginger or citrus peel in a ratio of 1: 1 in saline water. Under the same regimes and ratios, soya citrus suspension was prepared.

The biochemical composition and the energy value of the raw materials, ready-made suspensions are presented in table 8.

Table 8: Biochemical composition and energy value of raw materials, ready-made suspensions and coagulant

Product	Mass fraction, %							Vitamins, mg / 100 g			Bio-flavonoids in terms of rutin	Energy value, kcal / 100 g r
	water	proteins	lipids	carbohydrates	cellulose	minerals	organic acid	C	E	β- carotene		
Soybean seeds varieties "Lazurnaya"	12,3	39,0	17,5	20,0	5,0	6,1	-	-	8,3	1,2	450	414,4
Ginger*	78,9	8,9	0,7	10,8	2,0	0,7	0,5	5,0	0,26	-	25,0	80,0
Mandarin peel *	42,0	0,1	1,2	52,5	4,2	2,2	0,1	130	-	12,5	0,28	226,8
Orange peel *	43,0	0,1	2,4	49,9	4,4	2,0	0,2	170	-	0,3	0,2	217,2
Soybean ginger suspension *	85,2	5,5	1,5	6,7	1,1	2,5	-	65	1,6	-	25,0	66,7
Soya-citrus suspension *	85,1	5,4	1,4	7,2	1,9	2,6	-	80	1,7	-	25,0	70,6
Berry-acid complex on lingonberry pulp	86,9	-	0,8	9,0	3,3	2,2	1,5	150	-	-	27,0	56,4
Berry-acid complex on blueberry pulp	87,5	-	0,7	9,5	3,2	2,3	1,4	150	-	-	29,0	58,7

* data from the source [3].

Analysis of the data presented in table 7 shows that soy beet product in the form of protein-vitamin concentrate compared with beet concentrate in the form of dry powder or shavings contains 66% more proteins, almost 2 times more minerals, as well as 15 times more vitamin C. At the same time, soy-pumpkin protein-vitamin concentrate compared to pumpkin concentrate in the form of a dry powder or flakes, contains 3.33 times more protein and almost 19 times of vitamin C.

CONCLUSION

The possibility and expediency of creating functional food products of an extended range based on soybean root-berry compositions containing significant concentrations of PFFI has been established.

Using the obtained mathematical models, the parameters of the coagulation process are justified when using BAC as a coagulant.

A comparative analysis has shown that innovative food products contain significant concentrations of PFFI, which allows them to achieve a given effect of maintaining the activity of the cardiovascular system when used regularly.

Technological schemes for obtaining products of a functional orientation of an expanded range have been developed.

The totality of the data obtained allows us to design food systems for this purpose using vegetable raw materials of domestic production.

REFERENCES

[1] Basics of the state policy of the Russian Federation in the field of healthy nutrition of the population for the period up to 2020: order of the government of the Russian Federation of October 25, 2010. № 1873-p. // http://www.rg.ru/2010/11/03/pravila-dok.html.

[2] GOST R 52349-05. Food products. Functional food products. Terms and Definitions. - M .: Standardinform, 2005. - 3 p.

[3] GOST R 54059-2010 Functional food products. Classification and general requirements. M. 2011. - 8 p.

[4] Dotsenko S.M. The scientific basis for the creation of functional foods with the use of biologically active resources of the Far Eastern region: monograph / C.M. Dotsenko, I.V. Bibik. - Blagoveshchensk: DalGAU, 2014. - 293 p.

[5] Reports on the research activities of the All-Union Scientific Research Institute of Soybeans on the instructions of the Russian Academy of Agricultural Sciences No. 10.03.01.01 Develop technologies for the production of functional foods using soybean / Head S.M. Dotsenko. - Blagoveshchensk, 2011 – 2015.

[6] Kenijz, Nadezhda Viktorovna; Koshchaev, Andrey Georgievich; Nesterenko, Anton Alekseevich; and others. Study The Effect Of Cryoprotectants On The Activity Of Yeast Cells And The Moisture State In Dough. Research journal of pharmaceutical biological and chemical sciences. Volume: 9. Issue: 6. P: 1789-1796. Publ: NOV-DEC 2018.

[7] Omarov, Ruslan Saferbegovich; Rastovarov, Evgeny Ivanovich; Alexandrova, Tatiana Sergeevna; and others. Estimation the grass feeding influence on cattle productivity and meat quality. Research journal of pharmaceutical biological and chemical sciences. Volume: 9. Issue: 2. P: 907-912. Publ: MAR-APR 2018.

[8] Sarbatova, Natal'ja Jur'evna; Frolov, Vladimir Jur'evich; Omarov, Ruslan Saferbegovich; and others. Study of Biotechnological Potential of Blood Agricultural Animals and Poultry for The Development of New Balanced Food Products. Research journal of pharmaceutical biological and chemical sciences. Volume: 9. Issue: 2. P: 555-562. Publ: MAR-APR 2018.

[9] Omarov, Ruslan Saferbegovich; Shlykov, Sergei Nikolayevich; Khramchenko, Anna Aleksandrovna. Innovative Approaches To The Development Of New Food Products Based On Secondary Raw Materials Of Animal Origin. Research journal of pharmaceutical biological and chemical sciences. Volume: 9. Issue: 6. P: 1824-+. Publ: NOV-DEC 2018.

[10] Omarov, Ruslan Saferbegovich; Shlykov, Sergei Nikolayevich; Nesterenko, Anton Alekseyevich. Obtaining A Biologically Active Food Additive Based On Formed Elements Blood Of Farm Animals. Research journal of pharmaceutical biological and chemical sciences. Volume: 9. Issue: 6. P: 1832-+. Publ: NOV-DEC 2018.

[11] Omarov, Ruslan Saferbegovich; Shlykov, Sergei Nikolayevich; Nesterenko, Anton Alekseevich; and others. Development Of Technology Dessert Products Based On The Integrated Use Raw Materials Of Animal And Vegetable Origin. Research journal of pharmaceutical biological and chemical sciences. Volume: 10. Issue: 1. P: 1697-1703. Publ: JAN-FEB 2019.

[12] Omarov, Ruslan Saferbegovich; Shlykov, Sergei Nikolayevich; Konieva, Oksana Nikolaevna; and others. New Types Of Protein Products Based On Modified Blood Plasma. Research journal of pharmaceutical biological and chemical sciences. Volume: 9. Issue: 6. P: 1625-+. Publ: NOV-DEC 2018.

[13] Omarov, Ruslan Saferbegovich; Zakotin, Vladislav Evgenievich; Marynich, Aleksandr Pavlovich; and others. Studying the mechanism of formation the beef' fatty acids composition by grass feeding. Research journal of pharmaceutical biological and chemical sciences. Volume: 9. Issue: 2. P: 901-906. Publ: MAR-APR 2018.

[14] Mastepanenko, Maxim Alekseevich; Gabriyelyan, Shaliko Zhorayevich; Vorotnikov, Igor Nikolaevich; and others. Simulation Of Quantization Error By The Rounding Level Of Input Samples. Research journal of pharmaceutical biological and chemical sciences. Volume: 9. Issue: 6. P: 1831-+. Publ: NOV-DEC 2018.