Original article
UDK 664.952
https://doi.org/10.24143/2073-5529-2022-3-92-97
EDN CHAUSM

Evaluating quality of gerodietic fish molded products enriched with seafood cryoconcentrates

Valery D. Bogdanov*✉, *Anna V. Pankina

Far Eastern State Technical Fisheries University,
Vladivostok, Russia, bogdanovvd@dgtru.ru✉

Abstract. At present, innovations in the field of food production are associated with the development and implementation of technologies for functional products, including those exhibiting the gerodietic properties. Under the production of such products, the dry powdered seafood cryoconcentrates developed by us, which have a unique chemical composition, can successfully act as a physiologically functional ingredient or enriching additive. The goal of research was to study the physicochemical, organoleptic characteristics and safety indicators of new species enriched molded fish products. The objects of research were molded fish products (sausages) obtained by technology in accordance with the current regulatory documentation. As enrichers for fish sausages, the mixtures of cryoconcentrates from seafood were used: cucumaria, squid, Pacific herring milt, octopus skin, scallop mantle, and seaweed. The mixtures according to their characteristics met the requirements of STO 00471515-071-2019 "Dry seafood concentrates". Structural-mechanical, biochemical properties, and sensory characteristics of molded fish products (sausages) enriched with cryoconcentrates developed by us were studied. The study of the biological activity of enriched fish sausages indicates that they contain biologically complete proteins, hexosamines, nucleatides, glycosides, carotenoids, and iodine in amounts that provide the physiological daily requirement of the human body by more than 22.3%, which allows attributing them to the functional foods. The calculation of the content of essential lipid components in a 100 g serving of sausages shows that it significantly exceeds the established daily intake of these essential micronutrients (by more than 15%), which confirms the functionality of the product in this indicator. The enriched molded fish products have high organoleptic characteristics and water-holding capacity, which determines the yield of finished products, their juiciness and consistency. The physico-chemical and microbiological safety of a new range of enriched fish sausages has been experimentally confirmed. The high functionality of the molded fish products enriched with seafood cryoconcentrates justifies the recommendations for using them as gerodietetic food products.

Keywords: minced fish, chemical composition, biological activity, organoleptic properties, functional ingredient

For citation: Bogdanov V. D., Pankina A. V. Evaluating quality of gerodietic fish molded products enriched with seafood cryoconcentrates. *Vestnik of Astrakhan State Technical University. Series: Fishing Industry*. 2022;3:92-97. (In Russ.). https://doi.org/10.24143/2073-5529-2022-3-92-97. EDN CHAUSM.

Научная статья

Оценка качества обогащенных криоконцентратами морепродуктов рыбных формованных изделий геродиетической направленности

Валерий Дмитриевич Богданов*✉, *Анна Валерьевна Панкина

Дальневосточный государственный технический рыбохозяйственный университет,
Владивосток, Россия, bogdanovvd@dgtru.ru✉

Аннотация. В настоящее время инновации в области производства продуктов питания связывают с разработкой и внедрением в промышленность технологий функциональных продуктов, в том числе проявляющих геродиетические свойства. При производстве таких продуктов в качестве физиологически функционального ингредиента или обогащающей добавки могут успешно выступать разработанные нами сухие порошкообразные криоконцентраты морепродуктов, которые имеют уникальный химический состав. Целью работы являлось исследование физико-химических, органолептических характеристик и показателей безопасности новых видов обогащенных рыбных формованных продуктов. Объектом исследований являлись рыбные формованные изделия (сосиски), полученные по технологии в соответствии с действующей нормативной документацией. В качестве обогатителей рыбных сосисок использовали смеси криоконцентратов из морепродуктов: кукумарии, кальмара,

молок сельди тихоокеанской, кожи осьминога, мантии гребешка, морской капусты. Смеси по своим характеристикам соответствовали требованиям СТО 00471515-071-2019 «Сухие концентраты из морепродуктов». Исследованы структурно-механические, биохимические свойства, сенсорные характеристики формованных рыбных изделий (сосисок), обогащенных разработанными нами криоконцентратами. Исследование биологической активности обогащенных рыбных сосисок свидетельствует о том, что в их составе содержатся билогически полноценные белки, гексозамины, нуклеатиды, гликозиды, каротиноиды и йод в количествах, обеспечивающих физиологическую суточную потребность организма человека более чем на 22,3 %, что позволяет отнести их к функциональным продуктам питания. Из расчета содержания эссенциальных липидных компонентов в 100-граммовой порции сосисок следует, что оно существенно (более чем на 15 %) превышает установленную суточную норму потребления этих незаменимых микронутриентов, что подтверждает функциональность продукта и по этому показателю. Обогащенные рыбные формованные изделия имеют высокие органолептические характеристики и показатели водоудерживающей способности, определяющей выход готовых изделий, их сочность и консистенцию. Экспериментально подтверждена физико-химическая и микробиологическая безопасность нового ассортимента обогащенных рыбных сосисок. Установленная высокая функциональность формованных рыбных изделий, обогащенных криоконцентратами морепродуктов, позволяет рекомендовать их в качестве продуктов питания геродиетической направленности.

Ключевые слова: рыбный фарш, химический состав, биологическая активность, органолептические свойства, функциональный ингредиент

Для цитирования: *Богданов В. Д., Панкина А. В.* Оценка качества обогащенных криоконцентратами морепродуктов рыбных формованных изделий геродиетической направленности // Вестник Астраханского государственного технического университета. Серия: Рыбное хозяйство. 2022. № 3. С. 92–97. https://doi.org/10.24143/2073-5529-2022-3-92-97. EDN CHAUSM.

Introduction

Saturation of the consumer market with food with regulated nutritional value is one of the leading trends in the development of the food industry both in our country and abroad. Food products of a gerodietic orientation should be balanced in terms of chemical composition, energy value, easily digestible and well-absorbed by the body of an elderly person. Often, for targeted regulation of the nutritional and biological value of food products, a well-established technology for enriching the food dispersed systems with special ingredients: minerals, vitamins, phospholipids, carotenoids, and other biologically active components is used. It is proposed to use hydrolysates and enzymes from echinoderms, Holothuroidea, the Far East trepang and cucumaria japonica that contain a set of biologically active substances in their composition as food fortifiers and biocorrectors [1, 2].

Far Eastern State Technical Fisheries University developed in recent years the cryotechnologies for dry concentrates of seafood (cryoconcentrates) exhibiting the properties of food biocorrectors due to the content of carotenoids, nucleoproteins, amino acids, collagen, hexosamines, glycosides, mineral and ballast substances, and polyunsaturated fatty acids, including ω3 and ω6. Getting into the human body with food, they have a positive effect on many physiological processes, which generally improves the physical and mental state of a person, his (or her) mental abilities and cognitive functions. This is especially important for the elderly, as in general the quality of their life improves and its duration increases.

Recipes have been developed and technological parameters have been substantiated for the production of fish sausages enriched with dry concentrates of seafood intended for the nutrition of the elderly. The goal of the research was to study the physico-chemical, organoleptic characteristics and safety indicators of new types of enriched molded fish products.

Objects and methods of study

To achieve the goal, we studied the fish molded products (sausages) made on technology in accordance with STO 00471515-087-2021 “Fish sausages enriched with dry concentrates from seafood. Quality and safety requirements. Requirements for production, storage, sale”.

Enrichers of fish sausages for gerodietetic nutrition were mixtures of dry concentrates from seafood: cucumaria, squid, Pacific herring milt, octopus skin, scallop mantle, and seaweed. The mixtures according to their characteristics met the requirements of STO 00471515-071-2019 “Dry seafood concentrates”.

The raw material was thawed, cut, washed, crushed, mixed with enrichers and auxiliary components, stuffed into a casing, subjected to heat treatment and cooled.

The study of the general chemical composition of the developed fish products was carried out according to GOST 7636 - 85. Besides, there was used the express method to find the amount of water in dispersed systems by using an ML - 50 moisture meter; drying was carried out at a temperature of 200 °C.

Determination of the content of hexosamines, carotenoids, triterpene glycosides, and deoxyribonucleic acid (DNA) was carried out by spectrophotometric method on a UV-2100 spectrophotometer (Shimadzu, Japan) using standard methods for preparing the materials for research.

The fatty acid composition of the lipid fraction was determined by a gas-liquid chromatograph GC – 2010 (Shimadzu).

The organoleptic evaluation of gerodietic fish sausages was carried out by the tasting commission of experts, who used the scoring scales developed by us [3].

The water-holding capacity was determined by pressing method.

The study of the sanitary-indicative characteristics of the developed fish sausages, the content of toxic elements, nitrosamines, pesticides, polychlorinated biphenyls, and radionuclides in them was determined in accordance with the current standards and guidelines.

Results of study

We position the developed new range of enriched fish sausages, first of all, as products containing biologically complete proteins, carotenoids, hexosamines, triterpene glycosides, nucleic acids, and minerals. Seafood cryoconcentrates include organically bound iodine in the mineral composition, which normalizes the functioning of the thyroid gland, the production of thyroxine and triiodothyronine hormones that are important for the body [4]. One of the defining characteristics of the quality of a developed functional product is the content of key functional food ingredients. These food ingredients should be present in the product in an amount of at least 15% of the daily norm per one daily serving of the product [5]. Estimated data on the content of physiologically functional ingredients in one consumer package of a molded product weighing 100 g are given in Table 1, the results of determining the chemical parameters of new types of molded fish products (sausages) are shown in Table 2.

Table 1

Content of nutritional components in enriched fish sausages

Indicators	Daily rate*	In 100 g of product, not less than
Protein, g	68	10.2
Iodine, mg	0.150	0.0225
Glycosides, mg	2	0.3
DNA, mg	325	48.8
Carotenoids, mg	2	0.3
Hexosamines, mg	700	105

*From [2].

Table 2

Chemical characteristics of enriched fish sausages

Indicators	Sausage recipe name			
	“General-strengthening”	“Mineral-correcting”	“Restorative”	“Immunomodulatory”
Protein, %	15.6	15.4	17.7	17.3
Water, %	72.9	73.3	68.5	67.9
Lipids, %	8.9	9.7	10.1	10.6
Minerals, %	2.57	3.61	2.80	2.77
Iodine, mg/100g	0.016	0.126	0.065	0.061
Glycosides, mg/100g	0.75	0.80	0.60	2.40
DNA, mg/100g	165	0.00	255	680
Carotenoids, mg/100g	0.45	0.60	0.567	0.917
Hexosamines, mg/100g	110	108	280	245
Calorie content, kcal/100g	142.5	148.9	161.7	164.6

Protein content in 100 g of fish sausages ranges from 15.4 to 17.7 g, depending on the recipe. This means that using one portion of sausages weighing 100 g will provide an elderly person’s daily need in valuable protein (68 g) by more than 22.6%. It should be borne in mind that the proteins in sausages are mainly represented by proteins of pollock, pink salmon, and seafood, which exhibit a high biological value.

Recipes of fish sausages “Restorative” and “Immunomodulatory” provide the physiological daily needs of a human body by 22.3% or more for all studied biologically active substances: triterpene glycosides, carotenoids, nucleic acids, hexosamines, and iodine. Functionality of the molded product recipes (“General-strengthening”, “Mineral-correcting”) is also high and differs from the first two recipes in only one indicator: a reduced iodine content of – 13.45% of the daily norm (“General-strengthening”) and the absence of DNA (“Mineral-correcting”).

The developed molded fish products contain an increased content of mineral substances (2.57-3.61%), which is a consequence of their enrichment with seafood cryoconcentrates. This is especially noticeable in “Mineral-correcting” sausages, which contain the maximum amount of minerals, including organically bound iodine due to Japanese kelp, which is part of the enriching additive.

The lipid content in enriched fish sausages is in the range of 8.9-10.6%. Depending on the recipe, they are represented by fatty components of fish muscle tissue of pollock and pink salmon, as well as by lipids that make up butter and vegetable (sunflower) oil. The high

nutritional value of pollock and pink salmon lipids is known due to their rather high content of polyunsaturated fatty acids (PUFA) [6, 7]. The group fatty acid (FA) composition of lipids in enriched fish sausages is shown in Table 3.

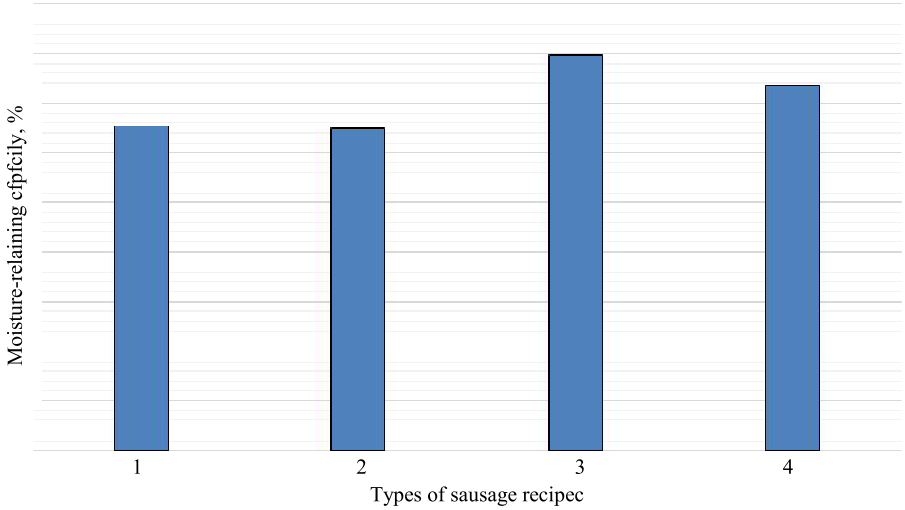
Table 3

Lipid composition of enriched fish sausages

FA group	Recipes							
	"General-strengthening"		"Mineral-correcting"		"Restorative"		"Immunomodulatory"	
	% of FA sum	g in 100 g of product	% of FA sum	g in 100 g of product	% of FA sum	g in 100 g of product	% of FA sum	g in 100 g of product
UFA	33.12	2.45	41.65	3.09	30.46	2.62	38.15	2.89
MUFA	30.66	2.69	32.15	2.39	32.14	2.44	31.04	2.57
PUFA	36.12	2.71	26.20	2.17	37.40	2.85	30.81	2.11
ω3	2.11	0.049	2.07	0.042	3.32	0.048	2.27	0.031
ω6	19.32	0.51	18.15	0.46	25.38	0.75	17.92	0.55

From the data in Table 3 it follows that the qualitative composition of the lipids of enriched fish sausages depends on their prescription composition. If vegetable oil (sunflower) is included in the recipes of sausages of "General-strengthening" and "Restorative", then the content of PUFA in these sausages is much higher compared to sausages of "Mineral-correcting" and "Immunomodulatory", where the added oil is butter. In general, it should be noted that enriched fish sausages in terms of the lipid component meet the requirements for gerodietetic products [4]. The calculation of the content of essential lipid components in a 100 g portion of sausages shows that the developed molded fish products can be classified as functional products (more than 15% of the daily intake).

The water-retaining capacity of the developed fish sausages was studied (Fig.).



Water-retaining capacity of the developed fish sausages:
1 – "General-strengthening"; 2 – "Mineral-correcting"; 3 – "Restorative"; 4 – "Immunomodulatory"

The data of the figure show that fish sausages enriched with seafood cryoconcentrates have rather high water-holding capacity, which determines the yield of finished products, their juiciness and consistency.

An equally important indicator, in addition to functionality, is the organoleptic characteristic of the product, which shows that the developed enriched fish sausages exhibit high organoleptic properties. Sausages "Restorative" and "Immunomodulatory", according to tasters, are more attractive in appearance, color, and consistency in comparison with sausages "General-strengthening" and "Mineral-correcting". It is also noted that sausages made from minced pink salmon have higher WHC values than sausages made from minced pollock.

Thus, samples of enriched molded fish products obtained according to the developed recipes show high functionality, as they contain biologically active substances: proteins, triterpene glycosides, carotenoids, nucleic acids, hexosamines, and iodine. The content of these macro- and micronutrients corresponds to the recommended daily norms of the physiological needs of the human body, established for functional foods.

Data on the safety assessment of the consumption of molded fish products enriched with seafood cryoconcentrates are presented in Table 4.

Table 4

Physico-chemical safety indicators of developed fish sausages

Indicators	Permissible level: less, mg/kg	Content in products	
		"General-strengthening"	"Immunomodulatory"
Toxic elements			
Lead	1.0	0.3	0.1
Arsenic	5.0	1.0	0.8
Cadmium	0.2	0.05	0.06
Mercury	0.5	0.1	0.1
Histamine	100.0	21	31
Nitrosamines: sum of NDMA and NDEA	0.003	Not found	Not found
Pesticides			
Hexachlorocyclohexane (a, b, g-isomers)	0.2	0.03	0.02
DDT and its metabolites	2.0	1.0	1.0
2, 4 - D acid, its salts and esters	Not allowed	Not found	Not found
Polychlorinated biphenyls	2.0	0.6	0.8
Radionuclides			
Cesium-137	130	60	55
Strontium-90	100	48	40

The data in Table 4 show that the developed enriched fish sausages correspond to the current regulatory documents in terms of the content of toxic elements, pesticides and radionuclides [6].

The results of microbiological studies of enriched fish sausages are shown in Table 5.

Table 5

Microbiological safety indicators of developed fish sausages

QMAFAnM, CFU/g		Bacteria of *Escherichia coli* group (coli-forms)		*S. aureus*		Pathogenic bacteria, incl. *Salmonella* and *L. monocytogenes*	
Permissible levels	Content in products	Standard product weight, g	Result	Standard product weight, g	Result	Standard product weight, g	Result
Sausages "General-strengthening"							
$1 \cdot 10^4$	$0.025 \cdot 10^4$	0.1	Not found	0.1	Not found	25	Not found
Sausages "Immunomodulatory"							
$1 \cdot 10^4$	$0.042 \cdot 10^4$	0.1	Not found	0.1	Not found	25	Not found

The data in Table 5 indicate that by microbiological indicators new types of enriched molded fish products comply with the requirements of the current regulatory documents [8, 9].

Conclusion

Thus, based on the conducted research, it can be concluded that the developed recipes of enriched fish sausages belong to the category of functional types of products, have a high nutritional value, high consumer properties, and also meet the food safety requirements in terms of physico-chemical and microbiological indicators.

References

1. Kovalev N. N., Pozdniakova Iu. M., Pertseva A. D., Tun Ch. Sostav i antioksidantnye svoistva fermentativnogo gidrolizata myshechnoi tkani trepanga [Composition and antioxidant properties of enzymatic hydrolyzate of trepang muscle tissue]. *Pishchevaia promyshlennost'*, 2016, no. 1, pp. 52-55.

2. Pozdniakova Iu. M., Pivnenko T. N. Pertseva A. D., Kovalev N. N. Funktsional'nye produkty pitaniia iz dal'nevostochnykh goloturii [Functional food products from Far Eastern sea cucumbers]. *Pishchevaia promyshlennost'*, 2017, no. 12, pp. 17-21.

3. Safronova T. M. *Spravochnik degustatora ryby i rybnoi produktsii* [Handbook of taster of fish and fish products]. Moscow, Izd-vo VNIRO, 1998. 244 p.

4. MR 2.3.1.2432-08. 2.3.1. *Ratsional'noe pitanie. Normy fiziologicheskikh potrebnostei v energii i pishchevykh veshchestvakh dlia razlichnykh grupp naseleniia Rossiiskoi Federatsii. Metodicheskie rekomendatsii* (*utv. Rospotrebnadzorom 18.12.2008*) [MP 2.3.1.2432-08. 2.3.1. Balanced diet. Norms of physiological needs for energy and nutrients for various groups of the population of the Russian Federation. Guidelines (approved by Rospotrebnadzor on December 18, 2008)]. Moscow, Rospotrebnadzor Publ., 2009. 41 p.

5. Kodentsova V. M., Vrzhesinskaia O. A. Analiz otechestvennogo i mezhdunarodnogo opyta ispol'zovaniia obogashchennymi vitaminami pishchevykh produktov [Analysis of domestic and international experience in using food products enriched with vitamins]. *Voprosy pitaniia*, 2016, vol. 82, no. 2, pp. 31-48.

6. Bogdanov V. D., Blagonravova M. V., Saltanova N. S. *Sovremennye tekhnologii proizvodstva solenoi produktsii iz sel'di tikhookeanskoi i lososevykh* [Modern technologies for production of salted products from Pacific herring and salmon]. Dary prirody Kamchatki. Petropavlovsk-Kamchatskii, Novaia kniga Publ., 2007. 235 p.

7. Kupina N. M., Bashtovoi A. N., Pavel' K. G. Issledovanie khimicheskogo sostava, biologicheskoi tsennosti i bezopasnosti mintaia *Theragra chflcogramma* zaliva Petra Velikogo [Studying chemical composition, biological value and safety of pollock Theragra chflcogramma from Peter the Great Bay]. *Izvestiia TINRO*, 2015, vol. 180, pp. 310-319.

8. TR EAES 040/2016. *Tekhnicheskii reglament Evraziiskogo ekonomicheskogo soiuza «O bezopasnosti ryby i rybnoi produktsii»* [TR EAEU 040/2016. Technical Regulations of the Eurasian Economic Union "On the safety of fish and fish products"]. Available at: https://mosrst.ru/wp-content/uploads/2020/02/tr-eaes-040-2016.pdf (accessed: 12.04.2022).

9. TR 021/2011. T*ekhnicheskii reglament tamozhennogo soiuza «O bezopasnosti pishchevoi produktsii». Prilozhenie № 11* [TR 021/2011. Technical Regulations of the Customs Union "On food safety". Application No. 11]. Available at: https://mskstandart.ru/upload/file/021_2011_o_bezopasnosti_pishevoy_produkcii.pdf (accessed: 12.04.2022).

Список источников

1. *Ковалев Н. Н., Позднякова Ю. М., Перцева А. Д., Тун Ч.* Состав и антиоксидантные свойства ферментативного гидролизата мышечной ткани трепанга // Пищ. пром-сть. 2016. № 1. С. 52–55.

2. *Позднякова Ю. М., Пивненко Т. Н. Перцева А. Д., Ковалев Н. Н.* Функциональные продукты питания из дальневосточных голотурий // Пищ. пром-сть. 2017. № 12. С. 17–21.

3. *Сафронова Т. М*. Справочник дегустатора рыбы и рыбной продукции. М.: Изд-во ВНИРО, 1998. 244 с.

4. *МР 2.3.1.2432-08. 2.3.1*. Рациональное питание. Нормы физиологических потребностей в энергии и пищевых веществах для различных групп населения Российской Федерации. Методические рекомендации (утв. Роспотребнадзором 18.12.2008). М.: Роспотребнадзор, 2009. 41 с.

5. *Коденцова В. М., Вржесинская О. А*. Анализ отечественного и международного опыта использования обогащенными витаминами пищевых продуктов // Вопр. питания. 2016. Т. 82. № 2. С. 31–48.

6. *Богданов В. Д., Благонравова М. В., Салтанова Н. С.* Современные технологии производства соленой продукции из сельди тихоокеанской и лососевых // Дары природы Камчатки. Петропавловск-Камчатский: Новая книга, 2007. 235 с.

7. *Купина Н. М., Баштовой А. Н., Павель К. Г.* Исследование химического состава, биологической ценности и безопасности минтая *Theragra chflcogramma* залива Петра Великого // Изв. ТИНРО. 2015. Т. 180. С. 310–319.

8. *ТР ЕАЭС 040/2016.* Технический регламент Евразийского экономического союза «О безопасности рыбы и рыбной продукции». URL: https://mosrst.ru/wp-content/uploads/2020/02/tr-eaes-040-2016.pdf (дата обращения: 12.04.2022).

9. *ТР 021/2011*. Технический регламент таможенного союза «О безопасности пищевой продукции». Приложение № 11. URL: https://mskstandart.ru/upload/file/021_2011_o_bezopasnosti_pishevoy_produkcii.pdf (дата обращения: 12.04.2022).

The article is submitted 18.05.2022; approved after reviewing 22.08.2022; accepted for publication 09.09.2022
Статья поступила в редакцию 18.05.2022; одобрена после рецензирования 22.08.2022; принята к публикации 09.09.2022

Information about the authors / Информация об авторах

Valery D. Bogdanov – Doctor of Technical Sciences, Professor; Professor of the Department of Food Technology; Far Eastern State Technical Fisheries University; bogdanovvd@dgtru.ru

Валерий Дмитриевич Богданов – доктор технических наук, профессор; профессор кафедры технологии продуктов питания; Дальневосточный государственный технический рыбохозяйственный университет; bogdanovvd@dgtru.ru

Anna V. Pankina – Candidate of Technical Sciences, Assistant Professor; Assistant Professor of the Department of Food Technology; Far Eastern State Technical Fisheries University; bogdanovvd@dgtru.ru

Анна Валерьевна Панкина – кандидат технических наук, доцент; доцент кафедры технологии продуктов питания; Дальневосточный государственный технический рыбохозяйственный университет; bogdanovvd@dgtru.ru