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A.Zh. Aitbayeva¹ – main author, | ©
R.S. Alibekov², Z.T. Nurseitova³, B.M. Satayev⁴, A.A. Ablash⁵



¹PhD student, ²Candidate of Chemical Sciences, Professor,
³Candidate Of Technical Sciences, Associate Professor, ^{4,5}MSc

ORCID

¹<https://orcid.org/0000-0001-5896-5241> ²<https://orcid.org/0000-0002-0723-3101>
³<https://orcid.org/0000-0002-1057-533X> ⁴<https://orcid.org/0009-0007-1682-2964>
⁵<https://orcid.org/0000-0002-6939-5384>



^{1,2,3,4,5}M. Auezov South Kazakhstan research university,



Shymkent, Kazakhstan



¹aiger_4ik@mail.ru

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CORN GERM BASED MEAT-PLANT CANNED PRODUCT WITH A HIGH NUTRITIONAL VALUE

Abstract. The fortification of canned products by using of the essential supplements allows for the improving of functional properties and nutritional value. The purpose of the study is the rational use of secondary raw materials from corn processing to create canned meat-plant product with high nutritional and energy value. Recipes for natural canned based on corn raw materials were developed. The studied samples of canned products had a balanced macro- and microelement composition. The optimal sample was a sample of canned meat-plant product in the form of meatballs, which contains the highest amount of macroelements: Mg (1.51 mg/kg), Ca (2.30 mg/kg), P (8.09 mg/kg) and K (12.72 mg/kg). Organoleptic analysis showed that all types of canned meet-plant product meet the requirements of regulatory documents. Also, due to the introduction of corn germ and other ingredients into the composition of canned meat-plant product, the nutritional value indicators have improved.

Keywords: canned food, corn, corn germ, beef, beef tongue, meatballs, canned meat and vegetable products.



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Introduction. Canned food is a food product that is packaged in a sealed container and then sterilized to extend the shelf life of the finished product without spoilage [1,2]. The most common types of canned food include meat and vegetable canned food. Meat and vegetable or meat and vegetable canned food is a type of canned food that contains both meat and vegetable components [3,4].

Currently, the canned food industry faces the problem of providing the population with natural canned food products of domestic production that have functional properties [5,6].

The development of such food products can have a positive effect on human health, since the population of the country, especially in large cities, due to lack of time does not have the opportunity to cook food on their own and resorts to

unhealthy eating. Of interest as the main plant material are processed corn products of domestic production.

Corn is the most common crop among grains. During the study of domestic varieties and hybrids of corn, it was found that one of the most common hybrids of corn is Altai 250 MV. This variety is common not only because of its productivity, but also because of its beneficial properties. This hybrid is drought-resistant and cold-resistant, and does not lodge. This hybrid can also be grown in the Almaty region, which accounts for 52.6% of the corn-sown area. In the southern regions of Kazakhstan, one of the most productive varieties is the Turan 680 SV corn hybrid, whose indicators reach 145.6 c/ha. This variety is also resistant to lodging [7].

During the production of sweet corn in canned form, enterprises give preference to whole corn grains. But also, grinding corn grains in the process of producing canned food with the optional addition of plant materials is relevant [8].

In addition, corn germ is used to enrich canned foods in the manufacturing process. Corn germ was used as a concentrate to make meatballs, enriching the meatballs with proteins, carbohydrates, and minerals. This ingredient is also very important for the production of corn oil [9-11].

The process of obtaining corn germ is shown in Figure 1.

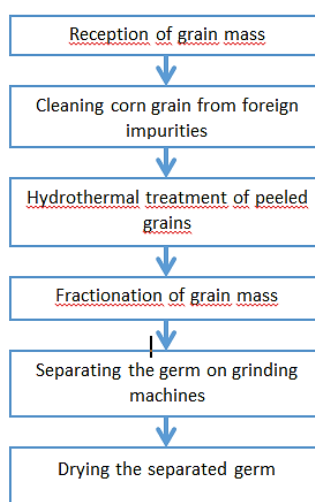


Fig. 1. The process of obtaining corn germ

Materials and methods. The objects of the study are samples of canned food made from meat mixtures in accordance with the requirements and standards of GOST R 55333-2012 and GOST R 55366-2012 [12,13]. They include canned meat and vegetable products with the addition of corn germ and beef tongue, as well as canned meat and vegetable products in the form of meatballs.

Content of macro- and microelements. The composition and amount of mineral substances in the samples of canned corn were determined using the method of mass spectrometry with inductively coupled plasma (ICP-MS) and using a scanning electron microscope (SEM). Using these methods, it is possible to determine a number of non-metals and metals. Unlike other methods, such as atomic absorption spectroscopy, where only one element can be determined, the method used allows determining all elements, significantly accelerating the measurement process [14].

Sensorometric indicators. In order to obtain an expanded idea of the sensory parameters of finished samples with additives, sensorometric analysis is used to assess the quality of canned corn in points. Based on a set of numerical values, a point scale is created. The latter are used in combination with the evaluation of the properties of the analyzed food products in a given quality area. The use of multipoint ranges and their modifications in this method allows obtaining various information data. Parameters such as color, aroma, taste, texture or appearance are determined. The universal system of sensorometric indicators offers four quality levels, which are positive and satisfactory, while the fifth level is unsatisfactory. These requirements correspond to a five-point scale, in which these assessments are given: excellent quality – 5 (from 80 to 100%), above average – 4 (from 60 to 80%), average quality – 3 (from 40 to 60%), below average – 2 (from 20 to 40%), unacceptable quality – 1 (from 0 to 20%) [15].

Organoleptic evaluation. The assessment of organoleptic indicators was carried out by scoring and rating in accordance with the standard – GOST ISO 6658:2016. At the moment, the analysis of organoleptic indicators is most often used not only in the quality control of food products, but also during the production of innovative food products with functional properties.

Analysis of energy and nutritional value. The assessment of these parameters of canned products was carried out in accordance with the following regulatory standards: GOST 25011-2017, GOST 26183-84, GOST 9793-2016, GOST 31727-2012 [16-19].

Developing a recipe for canned meat and vegetables with the addition of corn germ and beef tongue. Before starting to prepare canned meat and vegetables, it is necessary to prepare glass tares and recipe components.

Glass containers for canned food are sterilized in a steam autoclave at 121°C for 15 minutes. After sterilization, the marinade for beef and tongue is prepared. To make the marinade, onions are peeled and grated to form a homogeneous paste using a blender. Black pepper is then added to the onion mixture.

Next, the beef and tongue are cut into pieces measuring 3 cm and 5 cm. The meat and tongue are then pre-marinated and left to marinate for 4-5 hours. Before packaging, the onion paste must be removed, and the marinated meat should be salted to prevent moisture loss.

Next, the plant components are prepared through a process of washing, peeling, and cutting.

Before adding the corn germ to the mixture, it must be softened by processing in a water bath for 30 minutes.

Next, the ingredients proceed to the packaging stage. Marinated beef and tongue, processed corn germ, chopped vegetables, bay leaf, coriander, salt, sugar, and citric acid are placed into pre-sterilized containers.

After the sealing process, the prepared canned products must be sterilized. Sterilization is carried out in a steam autoclave at a temperature of 121°C for 1.5-2 hours [20].

Table 1 presents the recipe for canned meat and vegetables with corn germ and beef tongue.

Table 1
Recipe for canned meat and vegetables with corn germ and beef tongue

Components	Mass fraction, grams (glass container 700 ml)
Canned food	
Beef meat	140
Beef tongue	70
Carrots	46,1
Green beans	45
Corn germ	44
Onions	48
Cauliflower	54
Coriander	3
Sugar	2
White sugar	2,5
Citric acid	0,7
Leafy greens	4
Water	240
Marinade, r	
Onions	89
Black pepper	0,7
Salt	1,7

Development of a recipe for canned meat and vegetable products in the form of meatballs. The ingredients used for the production of canned meat and vegetable products in the form of meatballs are shown in Table 2.

Table 2
Recipe for canned meat and vegetable products (meatballs) with the addition of corn germ

Components	Mass fraction, grams (glass container 350 ml)
Beef meat	66
Beef tongue	35,7
Chicken eggs	10
Cauliflower	20
Corn germ powder	5
Salt	3 (1 for meatballs, 2 for brine)
Green beans	20
Cherry tomatoes	20
Onions	15
Leafy greens	4
Coriander	0,2
Dried garlic	0,2
Black pepper	0,1
Citric acid	0,8
Bone broth	150

Before preparing canned meat and vegetables, it is necessary to prepare the container and the necessary raw materials. Glass containers for canned food are subjected to steam sterilization in a steam autoclave at a temperature of 121°C for 15 minutes.

After this, the vegetable components are prepared: cauliflower, leafy greens, cherry tomatoes and green beans are washed, peeled and cut (cherry tomatoes are not cut). The stage of preparing meatballs comes next.

The meat with beef tongue is cut into pieces of 3 cm and 5 cm. Then the beef meat and tongue are mixed with chicken egg, onion, corn germ powder, sugar, salt, coriander, black pepper to obtain minced meat from a meat grinder. Then the process of forming meatballs with a diameter of 2 cm takes place, and then they are fried in sunflower oil until browned.

The packaging process comes next where the fried meatballs are mixed with plant components, coriander, and citric acid. Then, together with the bone broth, the recipe components are placed in a sterilized glass container.

Next, after the packaging process, it is necessary to sterilize the prepared canned goods. Sterilization is carried out in a steam autoclave for 1 to 2 hours at a temperature of 121°C.

Research results and discussion. *Organoleptic characteristics.* The organoleptic characteristics of canned meat and vegetable products, including corn germ and beef tongue, were assessed in accordance with the requirements of the current standard GOST R 55333-2012 [9].

Table 3 shows the organoleptic properties of canned meat and vegetable products made from corn germ and beef tongue.

Table 3

Organoleptic properties of canned meat and vegetable products made from corn germ and beef tongue

Evaluated parameters	Requirements for regulatory standards	Indicators of the studied sample
Appearance and consistency	Beef pieces with vegetable additives	Beef pieces with vegetable additives in the form of carrots, cauliflower, onions and green beans
Taste	Characteristic taste for this type of canned food, foreign tastes are unacceptable	Taste is characteristic of this type of canned goods, without foreign tastes
Aroma	Characteristic aroma for this type of canned food, foreign aromas are unacceptable	Aroma is characteristic of this type of canned goods, without foreign aromas
Foreign impurities	None	Absent

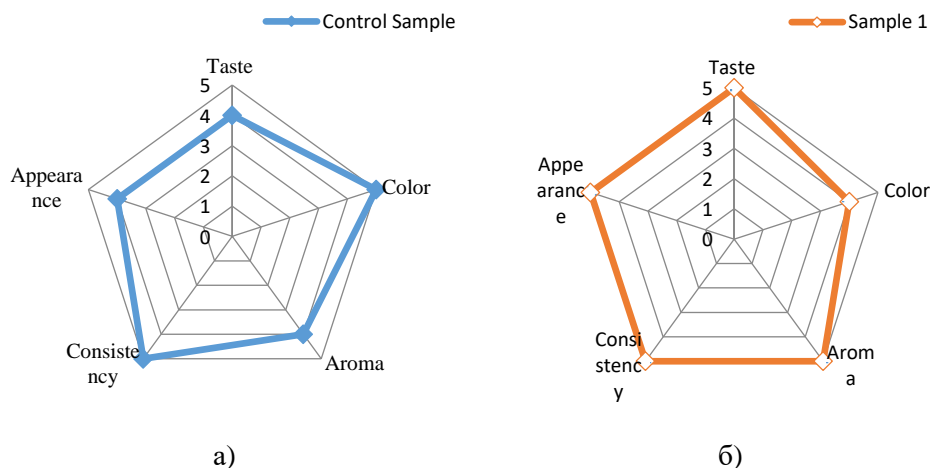
The organoleptic characteristics of canned meat and vegetable products in the form of meatballs with the addition of corn germ were analyzed in accordance with the current standards GOST R 55333-2012, as well as GOST R 55366-2012.

Table 4 presents the organoleptic properties of a sample of canned meat and vegetable products in the form of meatballs with the addition of corn germ.

Sensory parameters. During the evaluation of the sensory properties of canned meat and vegetables with the addition of corn germ and beef tongue, it was found that the aroma and taste of this canned product are similar to canned food of this type. The appearance of this sample is also characteristic of canned meat and vegetables, the assessment of which is 4.8 points. The sensory characteristics of this sample of canned product are presented in Figure 2.

Table 4
Organoleptic properties of a sample of canned meat and vegetable products in the form of meatballs with the addition of corn germ

Characteristic	GOST R 55333-2012 and GOST R 55366-2012	Sample
Appearance	For meatballs: shape – round-flattened. The surface of the meatballs should be sprinkled with breadcrumbs. Cooking meatballs without breadcrumbs is allowed. Meatballs with vegetable additives are allowed.	Meatballs: round shape. The surface is sprinkled with breadcrumbs in the form of corn germ. Meatballs with green beans, cauliflower, and tomato (cherry).
Taste	Characteristic taste for this type of canned food, foreign flavors are unacceptable	The taste is characteristic of this type of canned goods, without foreign tastes
Foreign impurities	None	None
Consistency	Juicy, soft and not crumbly (for meatballs)	Juicy, soft and not crumbly
Aroma	Characteristic aroma for this type of canned food, foreign flavors are unacceptable	Aroma is characteristic of this type of canned goods, without foreign aromas



a) control sample; b) canned meat and vegetable products with added corn germ and beef tongue

Fig. 2. Sensorimetric evaluation of canned meat and vegetable products with added corn germ and beef tongue

The assessment of the sensorimetric properties of canned meat and vegetable products revealed that the sample of these canned products containing corn germ and beef tongue has a taste and aroma that is typical for this type of canned products.

The appearance of this sample of canned meat and vegetable products is similar to its analogue. The assessment for these canned products is 4.8 points.

Figure 3 shows the sensorimetric indicators of canned meat and vegetable products in the form of meatballs with the addition of crushed corn germ.

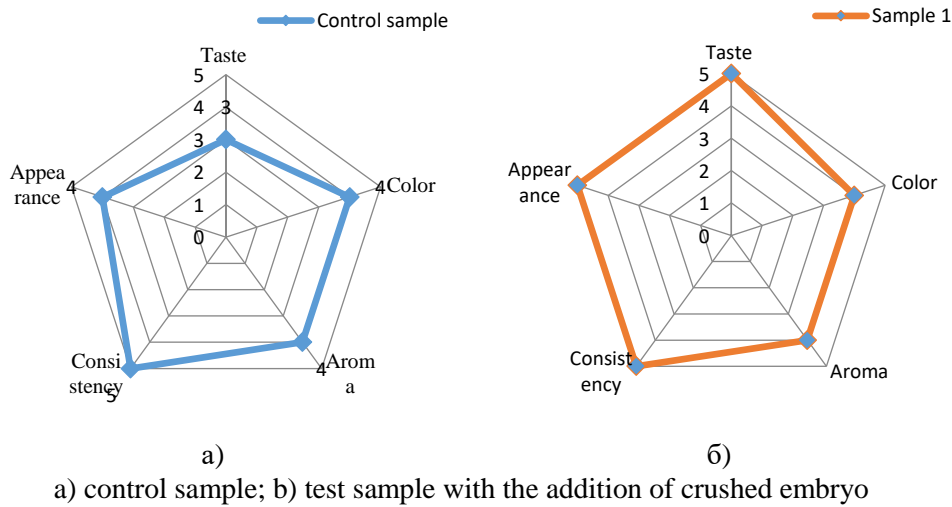


Fig. 3. Evaluation of sensorimetric characteristics of canned meat and vegetable meatballs

During the analysis of sensorimetric characteristics of meat and vegetable preserves in the form of meatballs with the addition of crushed corn germ, it was found that this sample has a rich and pleasant taste with vegetable and meat notes. These preserves have an excellent appearance and consistency, as well as a pleasant, but slightly less intense aroma. This type of preserves was rated at 4.6 points.

Macro- and microelement composition. Inductively coupled plasma mass spectrometry was used to determine the mineral composition of the obtained preserve samples.

Table 5 shows the macro- and microelement composition of samples of canned meat and vegetable products (meatballs breaded with corn germ powder) and canned meat and vegetable products with the addition of beef tongue.

Table 5

Macro- and microelement composition of the samples of the obtained canned goods

Elements	Samples, mass, mg/kg	
	Sample 1 (Meat and vegetable canned food (meatballs))	Sample 2 (Meat and vegetable canned food)
O	32.16	23.16
Na	18.93	24.41
Mg	1.51	0.77
P	8.09	3.64
S	0.41	0.64
Cl	23.87	37.02
K	12.72	8.60
Ca	2.30	1.75

The mineral composition of the resulting canned food is shown in Figure 4.

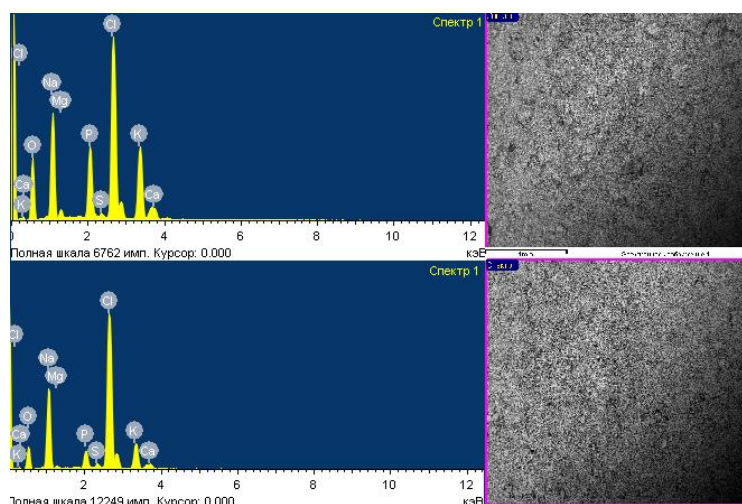


Fig. 4. Macro- and microelement composition of samples of the obtained canned goods: meat and vegetable canned goods in the form of meatballs breaded with corn germ powder (sample 1); meat and vegetable canned goods containing beef tongue and corn germ (sample 2)

According to the results of the assessment of the macro- and microelement composition of the canned food samples, the highest content of Mg (1.51 mg/kg) and K (12.72) was observed in sample 1, which can have a positive effect on the functioning of the nervous system and heart. The next sample (sample 2) contains the highest content of Na 24.41 mg/kg and Cl 37.02 mg/kg, which has a positive effect on the functioning of the nervous system and the gastrointestinal tract. Sample 1 was chosen as the optimal sample due to its high content of Ca and P, the amount of which is 2.30 mg/kg and 8.09 mg/kg, the content of which is very important for the functioning of the human skeletal system and its growth.

Determination of energy value. To determine the energy value, studies were conducted on a sample of canned meat and vegetable products containing beef meat and tongue, corn germ meatballs, and a sample of canned meat and vegetable products (meatballs). The tests were conducted at a temperature of 20.5-24.5°C with room humidity of 68-73%.

The results of the studies of the nutritional energy value of the samples of canned meat and vegetable products are shown in Table 6.

Table 6

Results of studies of the nutritional energy value of canned meat and vegetable samples

№	Name of indicators, units of measurement	Sample 1 Canned meat and vegetable products containing corn germ, beef and tongue	Sample 2 Canned meat and vegetable products (meatballs)
1	Nutritional value, g/100g		
2	Proteins	5,91±0,89	8,5±1,28
3	Fats	1,52±0,09	2,32±0,14
4	Carbohydrates	3,38±0,17	2,95±0,15
5	Moisture	88,24±0,09	84,96±4,25
6	Ash	0,95±0,05	1,27±0,06
7	Energy value, kcal/kJ/100g	50,84/212,71	66,67/279,0

The analysis of the results of the study of the nutritional and energy value of the samples of canned meat and vegetable products shows that canned meat and vegetable products in the form of meatballs (8.5+1.28g/100g) contain more proteins than canned meat and vegetable products containing corn germ, beef meat and tongue (5.91+0.89g/100g). All samples have an increased content of proteins due to the addition of corn germ, which is rich in essential amino acids. This indicates a higher nutritional value of this product in terms of the protein component. In terms of fat content, canned meat and vegetable products containing corn germ and beef tongue (1.52+0.09g/100g) are inferior to canned meat and vegetable products in the form of meatballs (2.32+0.14g/100g) by 35%. As an optimal sample, we can single out meat and vegetable preserves in the form of meatballs due to the high protein content, as well as the low carbohydrate content, which is typical for corn germ. Also, the ash content is higher in this sample (1.27 + 0.06 g / 100 g), which indicates a greater amount of minerals.

Conclusion. The following recipes for natural corn-based canned foods were developed: meat and vegetable canned foods containing corn germ, beef and tongue, and meat and vegetable canned foods in the form of meatballs. Organoleptic and sensory analysis of these canned food samples was conducted.

The organoleptic evaluation was conducted in accordance with the requirements of the current regulatory documents. The organoleptic evaluation showed that the canned food samples meet the requirements of the regulatory documents. The sensory evaluation of the canned food samples showed an improvement in the studied parameters compared to the control samples.

During the analysis of macro- and microelements, the highest content of Mg (1.51 mg/kg) and K (12.72) was observed in the sample of meat and vegetable preserves in the form of meatballs. The next sample of meat and vegetable preserves containing the embryo and beef tongue contained the highest content of Na 24.41 mg/kg and Cl 37.02 mg/kg.

The energy and nutritional value of corn-based canned food samples was determined. The presented samples showed good results in terms of added protein and corn germ content. Compared with another sample, meat and vegetable canned food in the form of meatballs showed the best results, having a high protein content (8.5+1.28 g/100 g) and a low carbohydrate content (2.95+0.15 g/100 g).

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А.Ж. Айтбаева¹, Р.С. Алибеков¹, З.Т. Нурсеитова¹, Б.М. Сатаев¹, Ә.Ә. Әбләш¹

¹М. Әуезов атындағы Оңтүстік Қазақстан зерттеу университеті,
Шымкент, Қазақстан

ТАҒАМДЫҚ ҚҰНДЫЛЫҒЫ ЖОҒАРЫ ЖҮГЕРІ ҰРЫҒЫ НЕГІЗІНДЕГІ ЕТ-ӨСІМДІК КОНСЕРВІЛЕРІ

Аңдатпа. Консервілерді маңызды қоспаларды қолдану арқылы байыту функционалдық қасиеттері мен тағамдық құндылығын жақсартуға мүмкіндік береді. Зерттеудің мақсаты – жоғары тағамдық және энергетикалық құндылығы бар ет-консервілерді жасау үшін жүгері өңдеуден алынған қайталама шикізатты ұтымды пайдалану. Жүгері шикізаты негізінде табиғи консервілердің рецептері әзірленді. Консервіленген өнімдердің зерттелген үлгілері теңдестірілген макро- және микроэлементтік құрамға ие болды. Оңтайлы үлгі ретінде макроэлементтердің ең көп мөлшері: Mg (1,51 мг/кг), Ca (2,30 мг/кг), P (8,09 мг/кг) және K (12,72 мг/кг) болатын, фрикаделькалар түріндегі консервіленген ет комбинаты өнімінің үлгісі болды. Органолептикалық талдау консервіленген өсімдік өнімдерінің барлық түрлері нормативтік құжаттардың талаптарына сәйкес келетінін көрсетті. Сондай-ақ консервіленген ет-өсімдік өнімінің құрамына жүгері ұрықтары мен басқа ингредиенттерді енгізу есебінен тағамдық құндылық көрсеткіштері жақсарды.

Тірек сөздер: консервілер, жүгері, жүгері ұрығы, сиыр еті, сиыр тілі, фрикаделькалар, ет-өсімдік консервілері.

А.Ж. Айтбаева¹, Р.С. Алибеков¹, З.Т. Нурсеитова¹, Б.М. Сатаев¹, Ә.Ә. Әбләш¹

¹Южно-Казахстанский исследовательский университет им. М. Ауэзова,
Шымкент, Казахстан

МЯСОРАСТИТЕЛЬНЫЕ КОНСЕРВЫ НА ОСНОВЕ КУКУРУЗНЫХ ЗАРОДЫШЕЙ С ВЫСОКОЙ ПИЩЕВОЙ ЦЕННОСТЬЮ

Аннотация. Обогащение консервов незаменимыми добавками позволяет улучшить функциональные свойства и пищевую ценность. Целью исследования является рациональное использование вторичного сырья переработки кукурузы для создания консервов мясорастительного происхождения с высокой пищевой и энергетической ценностью. Разработаны рецептуры натуральных консервов на основе кукурузного сырья. Исследуемые образцы консервов имели сбалансированный макро- и микроэлементный состав. Оптимальным образцом признан образец консервов мясорастительного происхождения в виде фрикаделек, в котором содержится наибольшее количество макроэлементов: Mg (1,51 мг/кг), Ca (2,30 мг/кг), P (8,09 мг/кг) и K (12,72 мг/кг). Органолептический анализ показал, что все виды консервов мясорастительного происхождения соответствуют требованиям нормативных документов. Также за счет введения в состав консервов мясорастительного происхождения зародышей кукурузы и других ингредиентов улучшились показатели пищевой ценности.

Ключевые слова: консервы, кукуруза, кукурузный зародыш, говядина, говяжий язык, фрикадельки, мясорастительные консервы.