


# Improvement of quality characteristics of turkey pâté through optimization of a protein rich ingredient: physicochemical analysis and sensory evaluation

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## Abstract

The consumer preference for ready-to-eat foods is growing rapidly, it provides many benefits to health care because it is very rich source of dietary fiber, minerals, and amino acids. The present study was to prepare and evaluate the quality of turkey meat pâté made with a high nutritional value protein-herbal supplement containing cereal flours (oat, rice, corn, and buckwheat). The physicochemical characteristics (pH, aw, color, texture, chemical composition), amino acid profile, sensory and quality analysis for turkey meat pâté were investigated. The use of the protein-herbal supplement decreased lightness ( $L^*$ ) and redness ( $a^*$ ) values but intensified the yellowness ( $b^*$ ) of cooked pâtés. The amount of essential amino acids significantly increased compared to the control sample. The protein-herbal supplement which was developed was proved to be very rich source of unsaturated fatty acids: the content of monounsaturated fatty acids increased by 27.8% and polyunsaturated acids by 0.7% in the final pâté.

**Keywords:** pâté; turkey meat; protein supplement; physicochemical properties; amino acid profile.

**Practical Application:** A significant opportunity for food industries to expand and develop new food technologies for plant-based protein foods with greater consumer acceptability.

## 1 Introduction

Given the current problems of the economy, new approaches in the field of meat technology and healthy human nutrition, it is extremely urgent to develop new technologies for high-quality meat and vegetable products, where rationally use regional meat and vegetable raw materials. The introduction of such technologies to produce a product with desired properties is beneficial for manufacturers and meets modern consumer requirements.

The incorporation of vegetables and grains into meat products would change the nutritional and biofunctional value of the product positively (Carvalho et al., 2019). Poultry meat gained enormous popularity as a valuable food with highly digestible proteins of good nutritional quality. Apart from being essential sources of vitamins, proteins, and minerals, it also provides saturated and unsaturated fatty acids, phospholipids and cholesterol. Nowadays however, consumers are more interested in health-oriented meat products due to a negative campaign about meat causing some diseases. In this way, the development of functional foods or food ingredients not only with a good taste, but which are also healthy, safe, and attractive is one of the most active areas of research in the nutrition sciences. Various cereal flours as binders or extenders and different vegetables have been used in ground meat products to explore their therapeutic and medical roles (Para & Ganguly, 2015; Park & Kim, 2016).

Modern scientific and theoretical foundations of the science of nutrition impose increased requirements on the quality and safety of food products, taking into account not only the calorie content, but also the presence of nutrients necessary for human health (biologically active substances, dietary fiber, pectin substances, organic acids, mineral substances), which give food products immunostimulatory, radioprotective, prophylactic, therapeutic and dietary properties.

Currently, scientists in many countries are developing poultry meat pâtés to meet consumer requirements and tastes. The technology of pâté with the addition of beans (10%) into turkey meat has been suggested by Martem'yanova et al. (2017) and Serikova et al. (2015) have promoted that rice grain or rice flour, used in foods, advanced their flavour and structure-forming properties. Using grains as additives in pâté preparation is the most advantageous way of formulating the preferred quality of formulations due to the impact of different nutrients making the end product more nutritious (Souza et al., 2019; Kim et al., 2016). Such additives can modify and most importantly improve various parameters such as texture, water-holding capacity, color and acceptability. The consumption of whole-grain cereals has now increased due to the prophylactic benefits they deliver and cereal enriched meat will be valuable in developing healthy products.

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Thus, the objective of this study was to investigate the effect of the protein-herbal supplement which contains cereal flours (oat, rice, corn, and buckwheat) on the functional characteristics of the turkey meat pâté. The combination of additives to advance the nutritional value of the product may be another way to create a healthy meat product.

## 2 Materials and methods

Selection of grains as additive components was chosen due to their high content of protein, balanced essential amino acid composition, and rich vitamin-mineral complex. Turkey meat and turkey liver as ingredients of the pâtés were selected on the basis of the analysis of their nutritional and biological value. The formulations with the highest

nutritional value and food satisfactoriness were selected from many recipe options.

### 2.1 Preparation of the plant based protein supplement

Rice (*Oryza sativa*), oat (*Avena sativa*), corn (*Zea mays*), buckwheat (*Fagopyrum esculentum*), skimmed milk powder, dried egg mélange and water for hydration were used to develop a plant based protein supplement, and were obtained from a local market. All samples were stored at 2-3 °C separately prior to preparation of the protein enriched pâté. The flow sheet of manufacturing the plant based protein supplement is shown in Figure 1. The technology features include cleaning all grains of impurities, washing and drying in a hot air dryer (HK-350AS+, China) at  $50 \pm 1$  °C for 24 h, and then cooling at

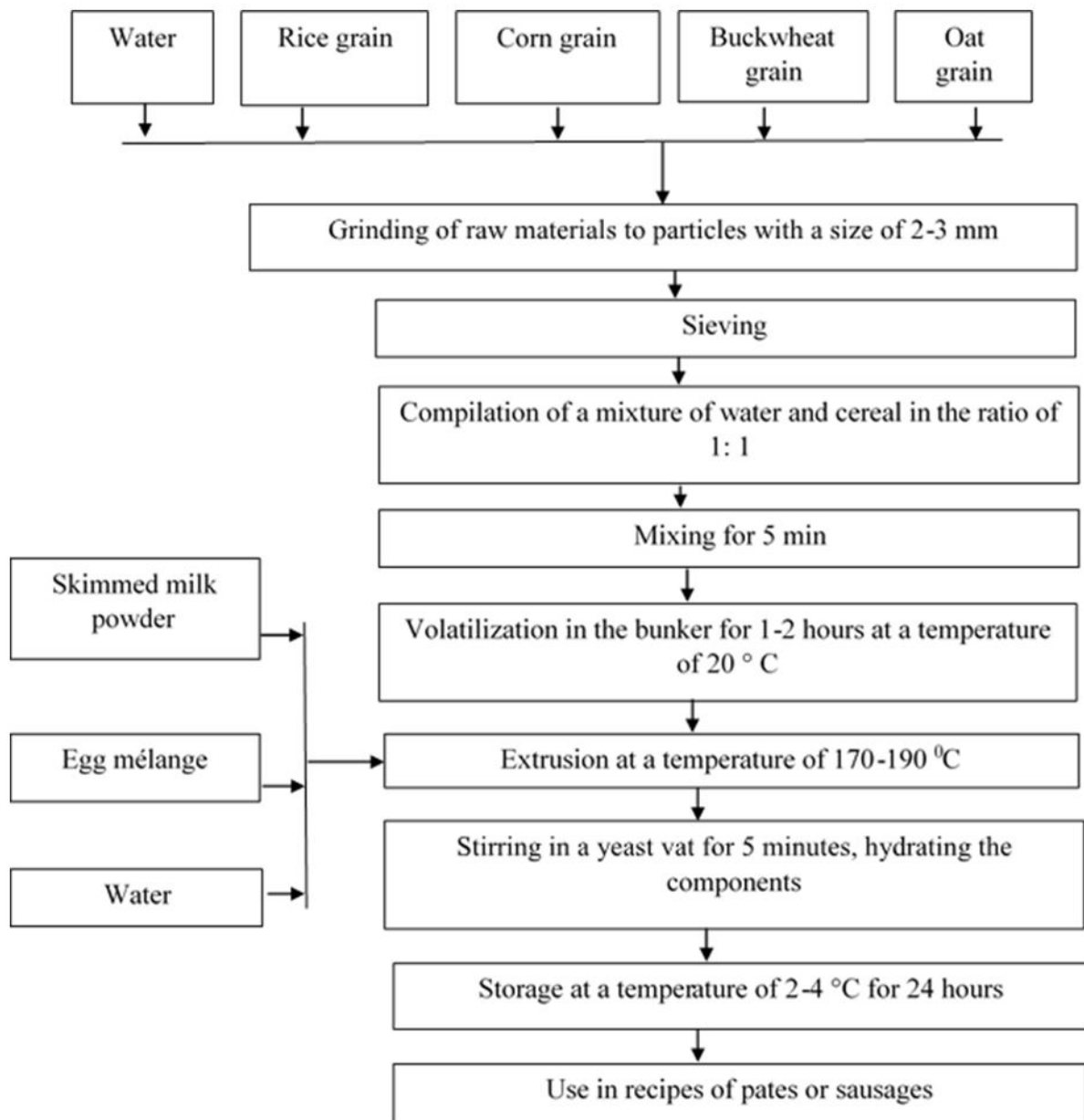


Figure 1. Flow chart of the technology of herbal supplement.

room temperature. The dried grains were blended finely using laboratory mill and passed through a <2 mm (10 mesh) in sieve. The grain powders were vacuum-sealed with PE/nylon film using a model DZ-260PD vacuum packaging system (Russia) and stored in a refrigerator until used to manufacture plant based protein supplement. Next, drinking water in a ratio of 1:1 was added to a mix of grain powders (rice 25%, corn 20%, buckwheat 15% and oat 20%) and mixed for 5 minutes. The mixture of grain was kept in the bunker for 1-2 h for uniform distribution of moisture, and extrusion is carried out at a temperature of 170-190 °C. The extruded mixture of grain components is placed in a container, in a yeast tank, and skimmed milk powder (11%), dried egg mélange (5%), and water (4%) for hydration were added and mixed for further 5-6 minutes. The plant based protein supplement was vacuum sealed in polyethylene bags and stored at 2-4 °C for 24 hours until use. The technique was reiterated twice for the formulation.

## 2.2 Manufacture of pâtés

Two types of pâtés were manufactured: the control product, which did not contain protein supplement and the pâté “Damdi” containing protein supplement. Fresh turkey breast (moisture 72.7%, protein 23.1%, fat 3.1%, ash 1.17%), turkey liver (moisture 72.3%, protein 21.1%, fat 2.7%, ash 1.3%) were collected from a local market. The samples were cleaned, washed and packed separately in polyethylene bags and stored at 4 °C in a refrigerator before use. For pâté elaboration, turkey meat was cut into small cubes and scalded in boiling water into plastic bags for 5 min. Raw turkey liver was loaded into a blancher or boiler, hot water at 4 -6% of the mass of the liver was added and blanched for 30-40 min. The blanched turkey liver (8%), turkey meat (52%), onion (6%) and garlic (0.9%) are first ground in a grinder (Moulinex HV6 - ME511H27, France) with a 2-3 mm diameter lattice holes.

The ingredients were blended using a cutter (GL-TQ5A, China) for 5-8 min with the protein supplement (18%), sodium chloride (2%), and black pepper (0.1%) until a homogeneous paste was obtained. A hot broth (13%) was slowly added during homogenization to keep the mixture at a constant temperature of 58–60 °C to reach a final temperature 45 °C. All were carefully mixed and to give the meat a more delicate texture, the resulting mass was passed through a colloid mill. The prepared paste is immediately transferred for the vacuum packaging. The pâté was stuffed loosely in synthetic cellulose casings (Russia) with a diameter of 6 cm and a length of 35 cm (600g/piece), clipped at both ends and cooked in hot water at  $87.5 \pm 2.5$  °C for 45 min until the temperature at the center reached 72 °C. Then, the pâtés cooled and stored at 4 °C for further analysis on the day of after manufacture. A total of two bathes (1000 g each one) of each formulation were manufactured.

## 2.3 Pâté proximate composition

The chemical composition of each treatment was analyzed in triplicate according to the standard methods. Moisture, protein, ash and fat content were determined respectively according to the requirements of GOST (State Standard) R 51479-99 (oven-drying method), GOST 25011-81 using the Kjeldahl method,

GOST 31727-2012 (muffle furnace), and GOST 23042-86 using the Soxhlet method. Fatty acid content were determined according to GOST R 55483-2013 by gas chromatography, and according to GOST R 34132-2017. All determinations were performed in triplicate.

## 2.4 pH, water activity ( $a_w$ ), and colour measurements

The pH values of the cooked meat pâtés with and without protein supplement were determined with a pH meter (Model 340, Mettler-Toledo GmbH, Switzerland). The pH values of the samples were measured by blending a 5 g sample with 20 ml distilled water for 60 s in a homogenizer at 8000 rpm (X – 1000, USA). Water activity was measured for high-moisture materials by the cryoscopy method, for objects of intermediate humidity – with a Hygropalm – AW1 (Rotronic) device. All determinations were conducted in triplicate. The instrumental colour (L\*: lightness; a\*: redness; b\*: yellowness) of the pâté emulsion was determined using a Konica Minolta CM – 2600 (Japan) spectrophotometer with illuminant D65, 100 observer and 8 mm for measurement; with a pure glass plate between the samples (n = 7) and the equipment.

## 2.5 Emulsion stability and texture analysis

The emulsion stability was measured using the method of Baliga & Madaiah (1970). Texture profile analysis (TPA) was performed with a Texture Analyser TA – XT Plus (Stable Micro Systems, England). Samples were determined in triplicate.

## 2.6 Determination of amino acid profile and fatty acids composition

The amino acid composition of the product was determined by ion exchange chromatography on a Biochrom 30+ automated analyzer after preliminary hydrolysis of the weighed portions in a solution of 6 N hydrochloric acid. The fatty acid composition of the product was determined by isolating lipids from paste samples through extraction with chloroform/methanol according to the method of Folch. The purity of the isolated lipids was checked by thin layer chromatography. Fatty acid composition was determined using a Hewlett Packard HP 6890 gas chromatograph with a flame ionization detector and an HP-Innowax 30 m x 0.25 mm x 0.25 µm column manufactured by Agilent Technologies, USA.

## 2.7 Sensory evaluation

The sensory profiling of the pâtés was carried out using a scale of 5-point system, ranging from 1 (extremely disliked) to 5 (extremely liked) according to GOST R 9959-2015. Twenty non-trained potential consumers (students and staff of the Shakarim State University of Semey) evaluated the indicators of taste, color, flavor, texture and overall acceptance. The pâtés were manufactured according to the same procedure described earlier. Each sample was coded with random numbers of three digits. The protocol for sensory analysis was approved by the local Ethics Committee (Shakarim State University of Semey, Semey, Kazakhstan – protocol #87).

### 3 Results and discussion

The results (Table 1) show that the addition of the protein-herbal supplement increased the protein, ash and carbohydrates content, and reduced the moisture and fat content. The decrease in the fat content in the new types of pâté compared with the control sample can be explained with addition of the protein-herbal supplement, which has low caloric value. Analysis showed that the Damdi pâté exceeded the control sample in protein content by 8.8%, had a 25.3% lower fat content compared to the control sample, and a 7.4% higher content of carbohydrates. The ash content exceeded the control sample by 1.9%. Similar results of the fat reduction were found by authors (Carvalho et al., 2019; Souza et al., 2019) with addition of hydrated wheat fiber (decreased by 32.6%) and oat fiber (a fat reduction around 60%). And all these findings are also in good agreement with the results of Serdaroglu (2006), Choi et al. (2009), and Yang et al. (2009). This analysis shows that protein vegetable supplement increased the amount of protein and decreased the level of fat in the final product, and had a tangible effect on its nutritional value. This expected to enhance its consumer acceptance.

The effect of the protein-herbal supplement on the pH, water activity and color characteristics of the pâté is shown in Table 1. The pH value of the control sample was 5.86 and increased to 6.17 when the protein herbal supplement was added. The change in pH of a final product largely depends upon the fiber source added. This pH increase was probably due to a lower proportion of soluble fiber in cereals (7%) (Fernández-López et al., 2004). An increase in pH with the addition of dietary fiber has been reported by Kim et al. (2016) in chicken sausages with germinated barley and in meatballs incorporated with oat bran and wheat bran (Yilmaz, 2005). A comparative evaluation of the test samples showed that, in comparison with the control, in the pâté incorporating the protein-herbal supplement, the water activity indicator was lower by 0.01-0.012 units, which is explained by the ability of cereal flour in protein-herbal supplement to bind moisture firmly. As a result, increased pH may effect on the consistency and water-holding capacity of the pâté.

One of the essential and important quality characteristics in meat products is color. The color characteristics of cooked meat products mainly derive from the additives used in the formulation and the pigmentation of meat source. The effect of the protein-herbal supplement on color values of pâtés is shown in Table 2. It was found that the addition of the protein-herbal supplement

decreased the lightness ( $L^*$ ) but intensified the yellowness ( $b^*$ ) of cooked pâtés. Also, the redness ( $a^*$ ) value of pâtés has been reduced. Similar results were reported by Yang et al. (2009), where the incorporation of cereal flours reduced the redness of duck sausages. Barros et al. (2018) found that the increase of chia flour addition in chicken nuggets showed a trend of decreasing lightness. Choi et al. (2011) reported that the yellowness of meat products increased mainly due to carotenoid pigments in cereal bran and color of cereal bran or flour.

The emulsion stability of pâté formulated with the protein-herbal supplement is shown in Table 2. Emulsion stability increased significantly after the incorporation of the protein-herbal supplement. The increase in emulsion stability is probably due to a gel-forming property of the starch component of the cereal flours, as well as by protein fractions. Ali et al. (2011) reported that emulsion stability improved after adding rice flour, and Park & Kim (2016) have described similar results where the content of black rice powder increased emulsion stability. Furthermore, not only non-meat ingredients but many other factors such as types of cereal flours, salt, fat content, and manufacturing processes could effect on emulsion stability. Thus, authors reported that emulsion stability increased in chicken patties during the incorporation of wheat and oat bran (Talukder & Sharma, 2010). Therefore, our results of emulsion stability in this study are due to the addition of the protein-herbal supplement.

**Table 2.** Effect of protein-herbal supplement on color, emulsion stability, and sensory evaluation of turkey pâtés.

Parameters	Control	Pâté "Damdi"
$L^*$ (lightness)	82.34	78.42
$a^*$ (redness)	6.75	5.42
$b^*$ (yellowness)	18.80	19.78
Emulsion stability (%)	90.53	93.13
Hardness (kg)	0.321	0.346
Springiness (mm)	1.305	1.407
Cohesiveness (%)	54.65	54.06
Gumminess (kg)	0.201	0.254
Chewiness (kg)	0.15	0.28
Taste	4.4	5.0
Color	5.0	4.8
Flavor	4.6	5.0
Overall acceptance	4.8	5.0
Texture	4.6	4.8

**Table 1.** Proximate composition of the turkey meat pâté with protein-herbal supplement (Mean  $\pm$  Standard Error (SE)).

Indicator name	Control sample from turkey meat pâté (g/kg)	Protein-herbal supplement (g/kg)	Pâté "Damdi" (g/kg)
Moisture	80.32 $\pm$ 1.5	10.07 $\pm$ 1.8	64.56 $\pm$ 1.2
Proteins	9.3 $\pm$ 0.15	14.43 $\pm$ 0.12	17.85 $\pm$ 0.12
Lipids	30.0 $\pm$ 0.3	4.48 $\pm$ 0.28	4.63 $\pm$ 0.3
Ash	0.58 $\pm$ 0.19	11.10 $\pm$ 0.15	2.50 $\pm$ 0.15
Carbohydrates	3.2 $\pm$ 0.13	59.92 $\pm$ 0.11	10.46 $\pm$ 0.12
Sodium chloride, %	2.5	12.05	2.5
pH	5.86	6.21	6.17
$a_w$	0.936 $\pm$ 0.005	0.910 $\pm$ 0.005	0.923 $\pm$ 0.005

Probably, some carbohydrates or phenolic compounds of cereal flours may be able to bind with the proteins of the meat and stabilize the emulsion. High emulsion stability is considered to be a desirable attribute for customer acceptance from the quality point of view.

The texture profile of control and protein-herbal supplement added pâtés are presented in Table 2. Non-meat proteins such as cereal flours, whey protein, and soy protein are mostly used to improve the texture of meat products. The hardness, springiness, and chewiness of pâté incorporated with the protein-herbal supplement increased moderately. On the other hand, there were no differences in gumminess and cohesiveness as compared to the control sample. Similar improvements in texture profiles have been reported for barley-incorporated chicken sausages (Kim et al., 2016), for frankfurters due to addition of different types of dietary fiber (Colmenero et al., 2005). The report by Feng & Xiong (2002) concludes that the product texture profile changes when interactions between meat and nonmeat additives take place which affects the emulsion. Therefore, the protein-herbal supplement has functional properties in improving the quality of meat pâtés.

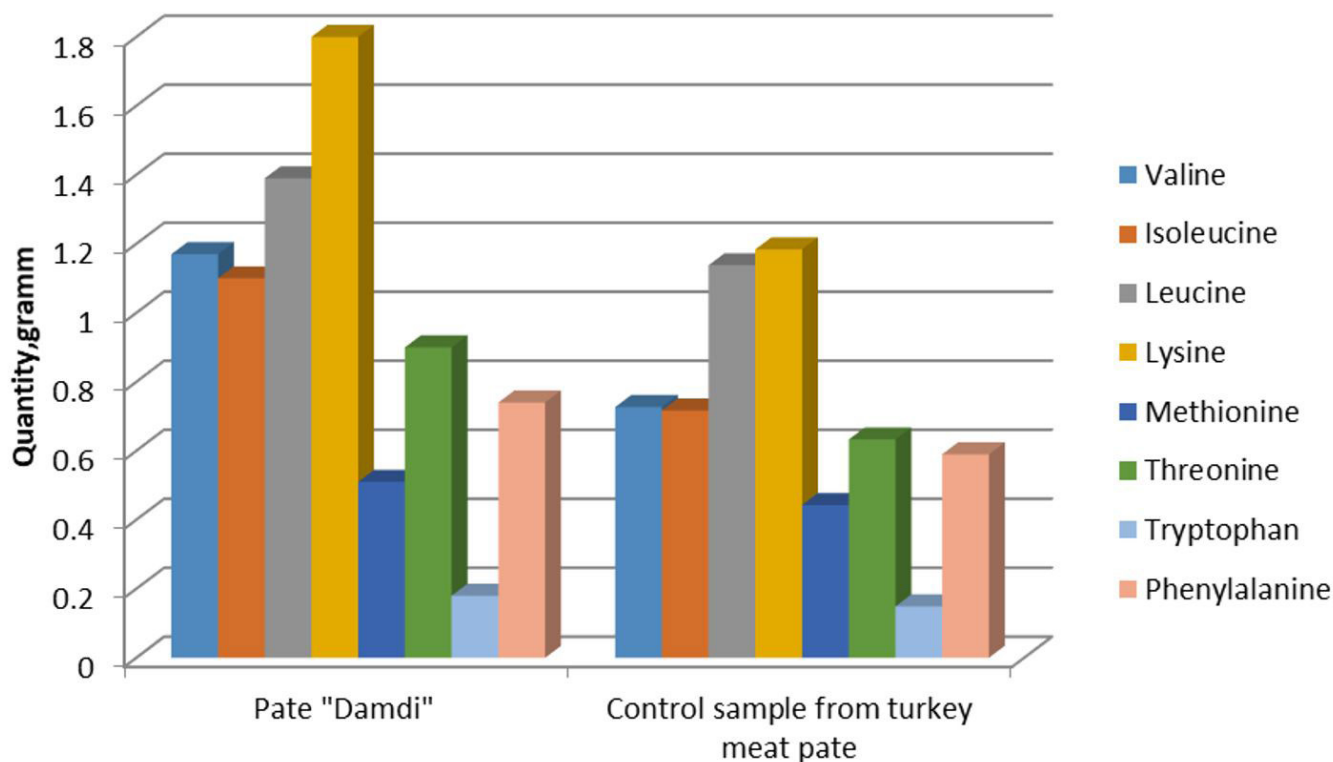
An essential factor determining the quality of any animal products is the amino acid profile. The introduction of protein-herbal supplement into the formulation significantly improved the biological value of the finished product: it contributed to the enrichment of the product with soluble and insoluble dietary fiber, essential amino acids, and unsaturated fatty acids. Figure 2 summarizes the effect of the incorporation of the protein supplement on the amino acid profile of fresh pâté.

It can be noted that Damdi pâté content of 8 essential amino acids exceeded the control sample of turkey pâté.

Examination of the experimental data shows that the amount of essential amino acids in the “Damdi” pâté was increased compared to the control sample: the amount of valine by 0.4 g, isoleucine by 0.3 g, leucine by 0.2 g, lysine by 0.6 g, methionine by 0.067 g, threonine by 0.267 g, tryptophan by 0.031 g, and phenylalanine by 0.15 g. The data obtained shows that the pâté has a higher biological value than the control sample of turkey pâté.

Saturated fats in small amounts (15 grams per day) are necessary for the body, but meat products are not considered by dietitians as healthy foodstuffs because of their high content of saturated fatty acids. Regular intake of monounsaturated fatty acids (MUFAS) on the other hand decreases the amount of bad cholesterol in the blood, improves vascular tone, and decreases the risk of cardiovascular pathologies (a stroke or heart attack). MUFAS are a group of essential lipid molecules in which there is one double carbon bond. Authors (Martin et al., 2008) have shown that replacing pork fat with olive oil in pâté can provide the highest levels of monounsaturated fatty acids. Also, poultry, rabbit, and fish are major sources of polyunsaturated fatty acids in the right amounts. The fatty acid profile of the meat-vegetable pâté shows a high content of monounsaturated fatty acids (Table 3).

Analysis of the fatty acid composition of the pâtés showed that in the pâté “Damdi”, the content of saturated amino acids slightly decreased. Compared to the control, the test samples of pâté with a cereal flour blend contained more polyunsaturated fatty acids, mainly due to the incorporation of the protein



**Figure 2.** Comparative characteristic of the amount of essential amino acids in the “Damdi” pâté and a control sample of turkey meat pâté.

**Table 3.** The content of unsaturated and saturated fatty acids.

Name	Quantity	
	Control sample from turkey meat pâté, %	Pâté «Damdi», %
Content of saturated fatty acids,%	22.13	18.7
The content of monounsaturated fatty acids,%	12.7	40.56
The content of polyunsaturated acids,%	15.5	16.25
C <sub>18:2</sub> fatty acid content, g	1.04	5.36
Content of C <sub>18:3</sub> fatty acid, g	0.06	6.67
Content C <sub>20:4</sub> fatty acids, g	0.05	3.98

herbal supplement in the formulation. The concentration of monounsaturated fatty acids in the meat and vegetable pâté was almost twice the concentration of saturated fatty acids. The new turkey meat and vegetable pâté exceeded the control sample in the content of unsaturated fatty acids, and the content of polyunsaturated fatty acids is very important for proper and balanced nutrition. These findings are in good agreement with previous observations by other researchers (Morales-Irigoyen et al., 2012; Terrasa et al., 2016), who found that replacing fat with canola oil and sunflower oil increased the content of mono- and polyunsaturated amino acids. Experimental studies show that the addition of a protein-vegetable additive increases the nutritional and biological value of turkey meat pâté.

Table 2 shows the data obtained from the sensory properties of the pâtés. Assessment of the appearance of the pâté samples did not reveal any visible defects. The pâté had a finely divided, moderately uniform structure, and a clean and dry surface. The Damdi pâté was a little darker in color, possibly due to the presence of buckwheat flour in the protein-herbal supplement. As a result of the organoleptic evaluation of samples of the new type of pâté, the positive dynamics of changes in the flavor, juiciness and overall acceptability of the pâté with the introduction of the protein-herbal supplement is outlined. Yang et al. (2007) observed that the addition of oatmeal and tofu showed higher sensory scores in pork sausages. Duck meat sausage with added rice had higher acceptability than sausages with added millet, wheat, corn, and barley flours (Yang et al., 2009). Incorporation of bajra flour enriched the juiciness, texture and overall acceptability of chicken nuggets (Para & Ganguly, 2015). But Barros et al. (2018) found that the partial substitution of fat by chia flour did not demonstrate any effect on sensory properties. In conclusion, the addition of the protein-herbal supplement improved the flavor of the cooked pâté. Thus, the sensory features of pâté with protein-herbal supplement was very encouraging, with great acceptance by consumers.

#### 4 Conclusions

The protein-vegetable additive demonstrated a positive possibility for incorporation into pâté. This additive can help to improve acceptability due to low fat content and a high nutritional value. Ready meat and vegetable pâté has higher nutritional properties, biological value, and high organoleptic characteristics. The meat and vegetable pâté showed a promising method to improve the health benefits of pâté.

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