PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

OPEN ACCESS Pakistan Journal of Nutrition

ISSN 1680-5194
DOI: 10.3923/pjn.2017.797.804

Research Article
Meat-bone Paste as an Ingredient for Meat Batter, Effect on Physicochemical Properties and Amino Acid Composition

[1]Aitbek Kakimov, [1]Anuarbek Suychinov, [2]Aleksandr Mayorov, [1]Zhanibek Yessimbekov, [1]Eleonora Okuskhanova, [1]Nazira Kuderinova and [1]Anar Bakiyeva

[1]Shakarim State University of Semey, Kazakhstan
[2]Siberian Research Institute of Cheese-making, Barnaul, Russia

Abstract
Background and Objective: Effective use of meat by-products such as entrails and internal organs is of considerable interest to the meat industry, since meat by-product processing can improve the overall productivity and economic output of the meat industry. To determine the effect of meat-bone paste (MBP) on the physical-chemical properties and amino acid composition of meat batters. **Materials and Methods:** Five formulations were developed, control and four meat batters with different amounts of MBP, 10% (MBP-10), 20% (MBP-20), 30% (MBP-30) and 40% (MBP-40), respectively. The active acidity (pH) of the formulations was determined by potentiometry. Samples were analyzed for water binding capacity (WBC) by exudation of moisture onto filter paper following the application of pressure. The amino acid composition was determined by liquid chromatography. **Results:** Proximate analysis of meat batters showed significant differences in ash content in formulations with MBP, which increased from 0.81% (control) to 5.24% (MBP-40), whereas the protein and fat content steadily decreased with increasing MBP. The fat content decreased relative to the amount of MPB from 16.5% seen for control samples to 10.71% for MBP-40. The protein content also decreased relative to the amount of MBP, wherein MBP-40, MPB-10 and control samples had 16.26, 17.67 and 17.49% protein, respectively. Meanwhile, meat batters with higher amounts of MBP had higher pH and WBC values as well as significant ($p<0.05$) increases in the content of glycine, proline and oxyproline, although the total essential amino acid content was reduced with MBP addition relative to control samples. **Conclusion:** Replacing first grade beef with MBP in meat batter formulations does not significantly change the overall nutritive and biological value of meat batters and thus could represent an economical use for meat by-products.

Key words: Bone paste, meat batter, essential amino acids, chemical composition, by-products

Received: May 25, 2017 Accepted: September 01, 2017 Published: September 15, 2017

Citation: Aitbek Kakimov, Anuarbek Suychinov, Aleksandr Mayorov, Zhanibek Yessimbekov, Eleonora Okuskhanova, Nazira Kuderinova and Anar Bakiyeva, 2017. Meat-bone paste as an ingredient for meat batter, effect on physicochemical properties and amino acid composition. Pak. J. Nutr., 16: 797-804.

Corresponding Author: Zhanibek Yessimbekov, Shakarim State University of Semey, 20 A Glinki Street, 071412 Semey, Kazakhstan
Tel: +7 747 520 52 67

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

During slaughter, meat and by-products (including livers, brains, hearts, blood, sweetbreads (thymus and pancreas), fries (testicles), kidneys, oxtails, tripe, tongue, bones and skin) are collected. These by-products are rich in collagen (pork skin, beef and pork head meat, rumen), minerals (bone), vitamins, fat and carbohydrates[1,2]. The inefficient use of these by-products represents a potential economic loss by meat processing plants, whereas improper disposal of by-products may cause disease and impact public health[3].

Use of less desirable meat by-products (e.g., entrails and internal organs) is of considerable interest to the meat industry since meat by-product processing can improve productivity and economic output of the meat industry[4,5]. Livestock carcasses or carcass parts consist of muscle, fat, connective and bone tissues, typically between 50-70, 3-20, 9-14 and 15-22%, respectively, depending on the type of livestock. During the boning process, complete separation of muscle and from bones is difficult and on average 8.5% of connective tissues remains on the bones[6]. Among meat by-products, bones are rich in mineral elements (in particular, calcium, phosphorus, magnesium and iron), protein (collagen) and fatty substances[7]. Bone consists of 13.8-44.4% water, 32-32.8% protein (collagen), 28.0-53.0% mineral elements and 1.3-26.9% fat[8]. The most characteristic components of bone are mineral elements, represented by calcium carbonate and phosphoric acid, followed by various oxides (%) (CaO 52, MgO 1.2, P_2O_5 40.3, Na_2O 1.1, K_2O 0.2, Cl 0.1, F 0.1 and CO_2 5.0)[9]. Cattle bones, which contain between 9 and 14 mg kg^{-1} calcium are a major source for calcium and phosphorous salts. According to Drake *et al.*[10], bone is a useful calcium source for nutrition because bone particles are readily dissolved by gastric juices. Moreover, the use of mineral salts in the production of meat-based products enables enrichment of food with mineral supplements, particularly calcium, phosphorous, magnesium and other elements that can be helpful in preventing diseases associated with mineral deficiencies, such as osteoporosis[11].

Ossein is the major component (93%) of bone collagen, with the remainder composed of glycoproteins, lipids and glucosaminoglycans (e.g., chondroitin sulfate, keratin sulfate and other glucosamines and galactosamines)[12]. Collagen is a structural protein that is found in connective tissues such as tendons, bones and cartilage[13].

The basic product processed from livestock bones is meat-bone meal used for animal feed. Such meat-bone meal can provide a rich source of whole protein and is an especially rich source of the essential amino acid lysine, as well as mineral supplements. For human consumption, bone is typically used to prepare protein hydrolysates and mineral supplements, bone broth and bone fat. Bone processing usually involves grinding and hydrolysis of the bones, followed by treatment with various chemical reagents. Studies by Berdutina[14] and Antipova *et al.*[15] described the preparation of protein hydrolysates from bone that included fermentation and acid hydrolysis. For a study on the production of protein supplements, Kutcsakov *et al.*[16] described hydrolysis of meat-bone raw material by hydrochloric acid followed by sodium hydroxide neutralization, defatting and drying[16].

Superfine bone grinding processes that begin by crushing the bone to 1-3 mm particles followed by ultra fine grinding to yield 50-100 mm particles can be used to make paste-like products that have a soft texture and are fully digestible by humans[17-26]. However, such pastes can be used for the production of food supplements and different meat products such as sausages, pates and semi-finished meat products. Moreover, since the meat-bone grinding process does not involve thermal treatments, the vitamin, mineral and protein content is preserved[27].

Overall, meat-bone by-products used in processed meat products can lower production costs and make use of meat by-products. In this study, it is determined the effect of meat-bone paste on the physicochemical and amino acid properties of meat batters.

MATERIALS AND METHODS

Samples: Beef tissue and bones (rib and vertebrae) were donated by the Tyumenbayev Meat Company in Semey city, Republic of Kazakhstan. Meat and rib bones from cattle were obtained after carcass boning and were packed in clean polyethylene bags that were rapidly transported to the laboratory and stored at -18°C for 2 h. The total weight of bone and meat was 50 kg (25 kg each).

Meat-bone paste (MBP) preparation: Bones with attached meat tissue were washed with cold water and then crushed into 50-70 mm long fragments. The bone fragments were stored at 18-20°C before loading into the hopper of a crushing machine V2-FDB (Russia) equipped with an 8 mm diameter meat grinder plate. The bone was ground and crushed again using a 3 mm meat grinder plate, water was then added to a 1:1 ratio (w/w). The mixture was frozen at -3-5°C for 1 h and then ground using a Supermasscolloider MKZA-10-15

(MASUKO SANGYO CO.,LTD, Kawaguchi, Japan) micromilling machine having rotational knives spaced at 0.5 mm. The resulting meat-bone paste (MBP) was used to prepare meat batters.

Meat batter preparation: Five meat batter formulations were prepared using varying amounts of MBP and prime and grade one beef from which all visible connective tissue was removed. The mixtures were then ground by passage through a meat grinder fitted first with an 8 mm plate and then a 5 mm plate. The basic composition of the meat batter was 50% prime beef, 35% grade one beef (together a total of 85% beef), 10% ground boiled beans and 5% egg mélange. Then, MBP was substituted for the prime and grade one beef mixture at four amounts 10, 20, 30 and 40%, respectively (Table 1). Meat batters were prepared in a mixer-cutter to which the minced meat, MBP, boiled beans, 2.5% sodium nitrite, egg mélange and water were added individually. All the ingredients were mixed and ground together for 5-10 min at 2-4°C. Salt was added to extract myofibrillar proteins[28], whereas egg mélange was included as an emulsifier to bind the meat batter components, as well as a source of unsaturated fatty acids and lecithin[29]. For seasoning, peeled and minced garlic, granulated sugar, black or white pepper and coriander were added. Sodium nitrite was included as a preservative (Table 1). After mixing, the meat batters were packed in polyethylene bags and stored at (-8°C).

pH measurement: Active acidity (pH) was determined using the potentiometer method and a 340 pH-tester (Infraspak-Analit, Russia). Before the analysis the pH-tester was calibrated using special standard solution mixed with distilled water with pH 4.0 and 6.68. This was done simply by dipping the 2 electrodes into a solution and taking a reading. Then, the meat samples were minced and mixed with distilled-deionized water in the ratio, 1 part of meat:10 parts of water. The pH reading was obtained after 30 min of infusion at 20°C.

Water-binding capacity: The method used to determine water-binding capacity (WBC) of the samples involved applying pressure to the sample to push the moisture onto filter paper. The amount of moisture absorbed by the filter paper was based on the area of the spot made by the sample on the filter paper. Specifically, for each sample, 0.3 g minced meat was placed on a 15-20 mm diameter disk plate on a Mettler Toledo electronic balance (Mettler Toledo, Switzerland). The meat was then transferred onto an ash-free filter (Munktell Filter AB, Sweden) and placed on a glass or Plexiglass plate. The sample was covered with the same filter before a 1 kg load was placed on top of the meat. The weight was left in place for 10 min. Upon removing the weight, the top filter was removed and the amount of bound water was calculated as described below (in Eq. 1 and 2). The filter was scanned using an Xpress M2070 scanner (SAMSUNG, Japan) after the contour of the wet spot was traced on the filter paper. The area of the spot was calculated using Compas-3D V-10 software[30]:

$$X_1 = (A\text{-}8{,}4B)\cdot 100/m_0 \quad (1)$$

$$X_2 = (A\text{-}8{,}4B)\cdot 100/A \quad (2)$$

where, X_1 is the bound water content expressed as percentage of meat, X_2 is the bound water content expressed as percentage of total water, B is the wet spot area (cm^2), m_0 is the sample weight (mg), A is the total moisture content in the sample (mg).

Table 1: Meat batter composition

	Meat batter formula (kg/100 kg)				
Ingredients	Control	MBP-10	MBP-20	MBP-30	MBP-40
Prime beef	50	50	50	50	45
First grade beef	35	25	15	5	-
Meat-bone paste (MBP)	0	10	20	30	40
Boiled ground beans	10	10	10	10	10
Egg mélange	5	5	5	5	5
Salt	2.5	2.5	2.5	2.5	2.5
Sodium nitrite	7.5×10^{-3}	7.5×10^{-3}	7.5×10^{-3}	7.5×10^{-3}	75×10^{-3}
Sugar granulated	0.1	0.1	0.1	0.1	0.1
Black or white pepper	0.13	0.13	0.13	0.13	0.13
Coriander	0.065	0.065	0.065	0.065	0.065
Garlic	0.24	0.24	0.24	0.24	0.24

Amino acid determination: To quantify amino acids in the samples, a Shimadzu LC-20 Prominence liquid chromatography system (Shimadzu, Japan) equipped with fluorometric and spectrophotometric detectors (Shimadzu, Japan) and a Supelco C18 column (5 µm, 200 $m^2 g^{-1}$, Sigma-Aldrich, USA) was used. A linear gradient with an eluent flow rate of 1.2 mL min^{-1} was used and the column was heated in an oven at 400°C prior to use. Samples were subjected to acidic hydrolysis and treatment with a phenyl isothiocyanate solution in isopropyl alcohol to yield phenylthiohydantoins. Amino acids were detected using fluorometric and spectrophotometric detectors at set to 246 and 260 nm wavelengths.

Statistical analysis: Statistical analysis was performed using Statistica 12.0 software (STATISTICA, StatSoft Inc., Tulsa, OK, USA). Differences between samples were evaluated using ANOVA and were considered to be statistically significant at $p \leq 0.05$.

RESULTS AND DISCUSSION

Proximate composition of meat batter: Proximate composition of the meat-bone paste (MBP) was determined. Relative to the base formulation (control), MBP had a higher ash level (15.99±0.18%) but a lower fat (4.35±0.06%) and protein (14.70±0.17%) content and a moisture level of 64.97±0.79%. The effect of increasing amounts of MBP on the proximate composition of meat batters (Table 2) was analyzed. At 40% MBP (MBP-40), the ash content significantly increased relative to the control (5.24 vs. 0.81%), whereas the protein and fat content steadily decreased with increasing amounts of MBP. In particular, the fat content of the control sample fat content was 16.50% but the MBP-40 batter had only 10.71% fat. Meanwhile, MBP-40 had a lower protein content than the control, which was slightly but not significantly, lower than that of MBP-10 (16.26, 17.49 and 17.67%, respectively). The moisture content of the samples ranged from 65.20-67.79% and there were no significant differences among the formulations. The energy value of meat batters steadily decreased with the addition of MBP, with MBP-40 having the fewest calories per 100 g.

The ash content of the MBP-30 and MBP-40 formulations was markedly higher (4.18 and 5.24%, respectively) than the recommended amount for meat batters (approximately 3.5%). Similar trends in moisture, fat and protein (64.17, 17.83, 16.68%, respectively) content were observed in a study by Kahramanov[31] for meat batters made from grade two beef, fermented meat trimmings and blood. Except for the ash content, the proximate composition of these meat batters was also similar to that observed by Kakimov[32], who developed a protein supplement (protein 15.39%, fat 12.94% and ash 1.41%) for meat batters consisting of bone fat, blood, egg mélange and ultrafine ground bone. In another study, Pershina[33] showed that bone powder added to a sausage formulation that included beef, pork, milk and eggs resulted in sausages that had a lower protein content (12.0-14.0%) and higher fat content (18-22%), which both differed from those seen for this study. Krishnan and Sharma[34] used offal meat (rumen and heart meat) to process cooked sausages that had a protein content similar to the MBP-40 formulation (16.39% vs. 16.26%), whereas meat patties composed of ground beef and 10% spleen tissue in a study by Bittel and Graham[35] had significantly higher protein content (26%) than it was seen with our formulations. Overall, however, the proximate composition of the meat batter was consistent with that observed for previous studies.

pH and WBC determination: The pH is an important parameter that can significantly impact sensory, microbiological, physicochemical and rheological characteristics of meat and meat products[36]. The addition of MBP raised the pH of the meat batter, with more neutral pH values seen for MBP-40 vs. the control (6.20 vs. 7.26) (Table 3, Fig. 1). This effect is likely because the MBP itself has a high pH (7.28). The WBC also changed with the addition of increasing amounts of MBP as evidenced by the sharp and significant increase in WBC of more than 15% between MBP-10 and MBP-20 (Table 3, Fig. 1). The increase can be attributed to the high water binding capacity of MBP.

Amino acid determination: The MBP also changed the total amino acid content of the meat batter formulation (Table 4). Amino acid composition of MBP showed the large amount of

Table 2: Chemical composition of meat batters

Index (%)	Control (n =15)	MBP-10 (n =15)	MBP-20 (n =15)	MBP-30 (n =15)	MBP-40 (n =15)
Moisture	65.20±0.60	66.23±0.96	66.75±1.35	67.28±0.77	67.79±0.72
Protein	17.49±0.28	17.67±0.16	17.17±0.15	16.68±0.21	16.26±0.20
Fat	16.50±0.20[c]	14.02±0.22	12.94±0.12[b]	11.86±0.13	10.71±0.12[a]
Ash	0.81±0.01[a]	2.08±0.04[b]	3.14±0.03[c]	4.18±0.06[d]	5.24±0.06[e]
Energy value, kcal/100 g	218.5	196.8	185.1	173.4	161.4

[a,b,c]Mean values in the same column with different letters differ significantly (p<0.05), Results are Mean± SD, n: Number of samples

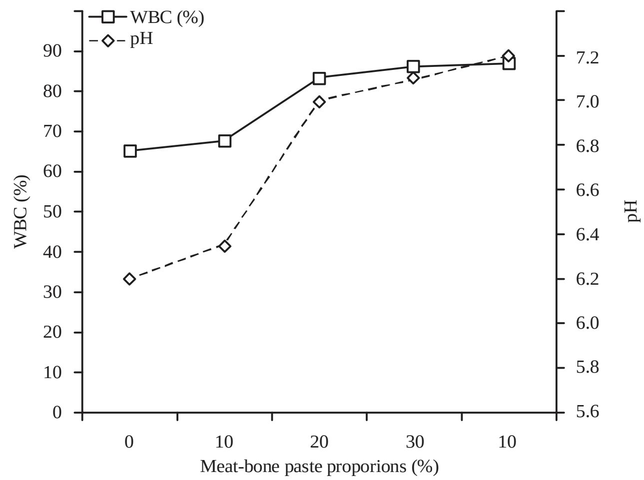

Fig. 1: pH and WBC levels in meat batters with different proportions of meat-bone paste

Table 3: Effect of MBP on pH and water binding capacity (WBC) of meat batters

		Meat batters with different quantities of MBP			
Index	Control	MBP-10	MBP-20	MBP-30	MBP-40
pH	6.20±0.08	6.35±0.11	7.00±0.09	7.10±0.07	7.26±0.08
WBC (%)	65.28±0.61	67.72±0.89	83.52±1.24*	86.29±1.12*	87.19±1.38**

*Indicates that the values are statistically different from control (*p<0.05, **p<0.02). Results are Mean±SD

Table 4: Amino acid composition of meat batters, mg/100 g of product

	Meat batters with different amounts of MBP				
Amino acids	Control	MBP-10	MBP-20	MBP-30	MBP-40
Non-essential	13322.23	13054.39	12786.56	12518.72	12156.36
Alanine	1325.41	1294.80	1264.19	1233.58	1190.84
Arginine	1396.98	1359.69	1322.39	1285.10	1233.07
Aspartic	2124.30	2028.15	1931.99	1835.84	1720.64
Histidine	757.00	695.56	634.11	572.67	504.32
Glycine	1214.89	1347.90	1480.92	1613.94	1740.01
Glutamic	3435.00	3223.95	3012.91	2801.86	2568.41
Proline	1050.39	1106.78	1163.17	1219.57	1274.98
Serine	934.20	884.41	834.62	784.82	731.28
Tyrosine	751.73	693.82	635.92	578.02	513.06
Cystine	282.30	256.18	230.06	203.94	176.88
Oxyproline	50.05	163.17	276.28	389.40	502.86
Essential	7758.08	7961.07	7380.97	6779.72	6116.38
Valine	1040.25	1075.34	1000.43	925.51	844.75
Isoleucine	922.50	935.21	872.30	788.24	701.60
Leucine	1633.25	1678.76	1558.58	1438.39	1302.21
Lysine	1661.65	1709.99	1591.12	1472.26	1332.94
Methionine	495.90	506.32	465.23	424.15	376.81
Threonine	915.99	940.69	862.88	785.07	703.86
Tryptophan	244.41	244.41	216.27	188.13	160.06
Phenylalanine	844.13	870.35	814.16	757.98	694.15
Total	21080.31	21015.46	20167.53	19298.45	18272.74

glycine (2556.28 mg/100 g), proline (1649.32 mg/100 g) and oxyproline (1360.75 mg/100 g). These amino acids constitute the major portion of collagen and play an important role in human body. With increasing amounts of MBP, the amino acid content of the meat batters decreased, whereas the formulation with the lowest amount of MBP, MBP-10, was statistically similar to that of the control (21.0 g/100 g vs. 21.1 g/100 g).

The amount of non-essential amino acids such as glycine and proline was significantly increased by approximately 43

Table 5: Calculated essential amino acid content in 100 g of protein in meat batter formulations

Index	Isoleucine	Leucine	Lysine	Methionine+ cystine	Phenylalanine+ tyrosine	Threonine	Tryptophan	Valine	Total
Control	5.27	9.34	9.50	4.45	9.12	5.24	1.40	5.95	50.27
MBP-10	5.32	9.50	9.68	4.32	8.85	5.32	1.38	6.09	50.46
MBP-20	5.08	9.08	9.27	4.05	8.44	5.02	1.26	5.83	48.02
MBP-30	4.82	8.63	8.83	3.77	8.01	4.71	1.13	5.55	45.44
MBP-40	4.44	8.01	8.20	3.41	7.42	4.33	0.98	5.19	41.99
FAO Ideal protein	4.00	7.00	5.50	3.50	6.00	4.00	1.00	5.00	36.00
AS* Control	131.86	133.40	172.74	127.12	152.07	130.93	139.74	118.95	-
AS MBP-10	133.07	135.73	175.96	123.30	147.54	133.10	138.33	121.72	-
AS MBP-20	126.99	129.65	168.46	115.68	140.73	125.62	125.94	116.51	-
AS MBP-30	120.54	123.21	160.51	107.60	133.52	117.69	112.81	110.99	-
AS MBP-40	111.12	114.40	149.04	97.29	123.73	108.21	98.43	103.90	-

A S: Amino acid score, FAO: Food and agriculture organization of the united nations

and 21%, respectively, in meat batters with 40% MBP. Notably, these two amino acids, along with the proline derivative oxyproline are the major constituents of collagen and have an important physiological role in that glycine participates in nitrogen metabolism and protein synthesis and also has a vital role in brain function. Meanwhile, proline is essential for muscle stamina, as proline deficiencies are associated with fatigue[37].

Consumption of foods with high amino acid contents that can be used for collagen production will contribute to muscle development and regeneration. Overall, the essential amino acid content of meat batters prepared here conformed to the Food and Agriculture Organization of the United Nations (FAO) scale for ideal protein content (Table 5). However, in MBP-40 meat batters, the limiting amino acids were methionine and cysteine (amino acid score 97.3%) and tryptophan (AS 98.4%). Methionine is a major building block for proteins and is associated with vitamin B_{12} deficiency. Tryptophan boosts synthesis of the vitamin PP and deficiencies in this amino acid can lead to serious illnesses such as tuberculosis, cancer and diabetes.

The highest amino acid score was seen for meat batters with 10% MBP. Increases in the amount of MBP were associated with decreasing amino acid scores (Table 5). The highest amino acid score was calculated for lysine (175.96) in MBP-10 and this value decreased to 149.04 for MBP-40. Lysine is essential for bone formation and childhood development and also promotes calcium digestion and nitrogen metabolism in humans. Moreover, adequate lysine is critical for synthesis of antibodies and hormones as well as for collagen formation and tissue regeneration[38]. The sum of the phenylalanine and tyrosine content for the control was around 50% higher than the FAO recommendation and the addition of MBP upto 40% decreased the value to a level that was closer to that of the FAO (Table 5).

The approximate level of leucine and threonine in both the formation and the controls was higher than that of the FAO, although MBP-40 had the lowest amount. The MBP-40 also had the lowest amount of isoleucine relative to the control and was closest to the value set by the FAO (4.44 vs. 4.0). Isoleucine is essential for hemoglobin production and provides an energy source for muscle while also preventing early muscle fatigue. Threonine improves cardiovascular and immune system function and that of the liver. This amino acid is also involved in glycine and serine synthesis. Each of these amino acids is important for strengthening ligaments and all muscles, including the heart.

Overall, these results indicate that the optimum quantity of MBP in meat batters ranges between 10 and 20% of total mass. Partial replacement of beef with a MBP can reduce production costs by as much as 15% while enriching meat batters with amino acids such as glycine, proline and oxyproline. However, excess amounts of MBP in meat batter formulations reduces their nutritive value and is inconsistent with regulations for meat products.

STATEMENT OF SIGNIFICANCES

This study characterized how the addition of an ultrafine ground MBP to base formulations affects the physical properties and amino acid composition of meat batters. Replacement of beef with 20% MPB had a positive effect on the overall properties and amino acid composition relative to the control. This study will help define how ultrafine grinding of bone to produce MBP can be used to develop a novel meat product to increase economic output and reduce waste during meat processing.

ACKNOWLEDGMENT

The authors thank the staff of the engineering laboratory at the Shakarim State University Scientific Center of Radioecological Research in Semey (Republic of Kazakhstan) for conducting the analyses.

REFERENCES

1. Kakimov, A.K., B.B. Kabulov, Z.S. Yessimbekov and N.A. Kuderinova, 2016. Use of meat-bone paste as a protein source in meat product production. Theory Pract. Meat Process., 1: 42-50.
2. Choi, Y.S., K.E. Hwang, H.W. Kim, D.H. Song and K.H. Jeon *et al*., 2016. Replacement of pork meat with pork head meat for frankfurters. Korean J. Food Sci. Anim. Resour., 36: 445-451.
3. Silva, F.A.P., D.S. Amaral, I.C.D. Guerra, P.S. Dalmas and N.M.O. Arcanjo *et al*., 2013. The chemical and sensory qualities of smoked blood sausage made with the edible by-products of goat slaughter. Meat Sci., 94: 34-38.
4. Toldra, F., M.C. Aristoy, L. Mora and M. Reig, 2012. Innovations in value-addition of edible meat by-products. Meat Sci., 92: 290-296.
5. Okuskhanova, E., B. Assenova, M. Rebezov, Z. Yessimbekov, B. Kulushtayeva, O. Zinina and M. Stuart, 2016. Mineral composition of deer meat pate. Pak. J. Nutr., 15: 217-222.
6. Lawrie, R.A. and D.A. Ledward, 2006. Lawrie's Meat Science. 7th Edn., Woodhead Publishing Limited, Cambridge, UK.
7. Okuskhanova, E., F. Smolnikova, S. Kassymov O. Zinina and A. Mustafayeva *et al*., 2017. Development of minced meatball composition for the population from unfavorable ecological regions. Ann. Res. Rev. Biol., 13: 1-9.
8. Kakimov, A., Z. Yessimbekov, B. Kabulov, A. Bepeyeva, N. Kuderinova and N. Ibragimov, 2016. Studying chemical composition and yield stress of micronized grinded cattle bone paste. Res. J. Pharm. Biol. Chem. Sci., 7: 805-812.
9. Fayvishevskiy, M.L. and S.G. Liberman, 1974. Bone Complex Processing in Meat Plants. Pishevaya Promyshlennost, Moscow.
10. Drake, T.G.H., S.H. Jackson, F.F. Tisdall, W.M. Johnstone and L.M. Hurst, 1949. The biological availability of the calcium in bone. J. Nutr., 37: 369-376.
11. Niewoehner, C., 1988. Calcium and osteoporosis. Cereal Foods World, 33: 784-787.
12. Fratzl, P., 2008. Collagen: Structure and Mechanics. Springer Science and Business Media, USA.
13. Gomez-Gullen, M.C., B. Gimenez, M.E. Lopez-Caballero and M.P. Montero, 2011. Functional and bioactive properties of collagen and gelatin from alternative sources: A review. Food Hydrocolloids, 25: 1813-1827.
14. Berdutina, A.V., 2000. Development of protein hydrolysate from offal meat products. Ph.D. Thesis, Moscow University, Moscow.
15. Antipova, L.V., O.S. Osminin, C.Y. Shamkhanov and T.I. Strukova, 2004. Method for the production of protein food supplement. Patent No 2226841, Russia, April 20, 2004.
16. Kutcsakov, V.Y., S.V. Frolov, S.P. Udachin, S.N. Goryainov and V.I. Marchenko, 2006. Method for the production of hydrolysate from bone of poultry, fish. Patent No. 2272418, Russia, March 3, 2006.
17. Kakimov, A.K., B.B. Kabulov, Z.S. Yessimbekov, N.K. Ibragimov and A.K. Suychinov, 2016. Effect of technological factors on meat-bone paste quality. Agro-Ind. Complex Russia, 23: 466-472.
18. Cardila, F., 2012. Method for producing bone-mixed meat paste. Patent No. 2012210197, Japan, November 1, 2012.
19. Saburo, S., 1992. Food raw material and food prepared by using livestock bone as raw material. Patent No. 04-293472, Japan, October 19, 1992.
20. Kinichi, E. and M. Tatsu, 1992. Production of fish bone paste and utilization of fish bone paste. Patent No. 04-190768, Japan, July 09, 1992.
21. Kyoichi, I., 1992. Calcium-rich health food. Patent No. 03-078463, Japan, October 13, 1992.
22. Shinjuro, N., 1983. Meat-like composition and its preparation. Patent No. 58-205472, Japan, November 30, 1983.
23. Shuji, F., 1983. Frozen food containing kneaded bean curd and chicken paste. Patent No. 58-158149, Japan, September 29, 1983.
24. Tsuneo, M., 1989. Production of marrow paste. Patent No. 01-296955, Japan, November 30, 1989.
25. Yoshiyuki, C., H. Takao and Y. Katsumi, 1979. Preparation of cow bone paste. Patent No. 55-118378, Japan, March 7, 1979.
26. Kakimov, A.K., E.T. Tuleuov and N.A. Kuderinova, 2006. Processing of Meat Bone for Food Consumption. Tengri, Semipalatinsk, Kazakhstan.
27. Kuderinova, N.A., 2004. Development the technology of production and using of food component from bone. Ph.D. Thesis, Shakarim State University of Semey, Semipalatinsk, Kazakhstan.
28. Gordon, A., S. Barbut and G. Schmidt, 1992. Mechanisms of meat batter stabilization: A review. Crit. Rev. Food Sci. Nutr., 32: 299-332.
29. Nys, Y., M. Bain and F. van Immerseel, 2011. Improving the Safety and Quality of Eggs and Egg Products: Egg Chemistry, Production and Consumption. Vol. 1, Woodhead Publishing Limited, India, ISBN: 9781845697549, Pages: 632.
30. Kabulov, B.B., A.K. Kakimov, N.K. Ibragimov and Z.S. Yessimbekov, 2014. Method of determining the water binding capacity of food products. Patent No. 28152, February 17, 2014. (In Russian).
31. Kahramanov, A.M., 1994. Development of technology of cooked sausage using fermented meat trimmings. Ph.D. Thesis, Moscow University, Moscow.

32. Kakimov, A.K., 2007. Scientific basis of technological processing of combined meat products with bone raw material. Ph.D. Thesis, Almaty Technological University, Kazakhstan.
33. Pershina, Y.I., 2000. Studying and developing technology of meat products enriched with vitamin supplement and food bone powder. Ph.D. Thesis, Kemerovo State University, Kemerovo.
34. Krishnan, K.R. and N. Sharma, 1990. Studies on emulsion-type buffalo meat sausages incorporating skeletal and offal meat with different levels of pork fat. Meat Sci., 28: 51-60.
35. Bittel, R.J. and P.P. Graham, 1981. The use of mechanically separated spleen in meat patties. J. Food Sci., 46: 1272-1273.
36. Feiner, G., 2006. Meat Products Handbook: Practical Science and Technology. CRC Press, Boca Raton, FL., ISBN-13: 9781845690502, Pages: 648.
37. Kakimov, A., Z. Yessimbekov, A. Suychinov, T. Japanov and A. Zolotov, 2017. Mineral and amino acid composition of meat-bone paste. Proceedings of the 3rd International Scientific and Practical Conference, Scientific Issues of the Modernity, Volume 5, April 27, 2017, Dubai, UAE., pp: 5-7.
38. Okuskhanova, E., B. Assenova, M. Rebezov, K. Amirkhanov and Z. Yessimbekov *et al*., 2017. Study of morphology, chemical and amino acid composition of red deer meat. Vet. World, 10: 623-629.