Micro structural characteristics of minced meat products from use of protein-mineral additive

**Mykola Golovko, Maksym Serik,
Tetiana Golovko, Valentyn Polupan**

Kharkiv State University of Food Technology and Trade, Ukraine

Keywords:

Meat
Calcium
Additive
Water-holding
Microstructure

Article history:

Received 29.01.2014
Received in revised form
7.04.2014
Accepted 16.04.2014

Corresponding author:

Valentyn Polupan
E-mail:
val-mer@mail.ru

Abstract

Introduction. Infringement of balance mineral substances is widely manifested in the meat products which is much wealthier in phosphorus than calcium. List of additives that containing calcium and technology meat products with their using are limited. Purpose of the work is studying and scientific substantiation of influence protein-mineral additive (PMA) on the technological micro-structural properties of minced meat products.

Matherials and methods. Studies water- and fat-holding ability (WHA, FHA) of samples carried out by gravimetric and refract metric methods. Histological sections were produced at microtome, followed by coloring with hematoxylin and eosin and by the method of Mallory.

Results and discussion. Created a technology of the minced meat products for health improvement using the PMA which is a carrier of Bioorganic calcium. Rational is the addition of PMA in powder form in amount of 7,5 % of the meat systems. Technological parameters of minced meat increase when making additions in particular WHA and FHA approx about 5 and 10 % respectively. Histological studies have shown that PMA promotes the preservation of meat juice and sarcoplasmic proteins in the meat systems during thermal processing.

Conclusions. PMA has a positive impact on the properties of water-holding properties of minced meat and output the finished product.

Introduction

The structure and quality of the nutrition the of modern person can described as those that do not provide to fully all physiological needs of the body of irreplaceable nutritional factors. Today expansion of assortment food products in particular meat, is mainly through by replacing the components of the product at more cheap, economically most advantageous raw materials. Among the essential elements of nutrition the most scarce are mineral compounds, in particular calcium in digestible by the human body form. An

imbalance of minerals commonly seen in meat products naturally much wealthier in phosphorus than calcium. The priority direction of the science of nutrition is the creation balanced chemical composition of food with health-improving properties.

The majority of well-known technology of meat enriched with calcium, a mineral component is represented as water-soluble inorganic salts of calcium or low organic forms, which does not provide this element deposition in body tissues [1-2].

Modern research has proved the importance of food bones as a source of bio-organic calcium compounds. However, for calcium-based food additives on bone and meat technology with their use is limited [3].

Therefore, additional food sources of digestible calcium compounds and their use in the meat processing of mass consumption is actually.

Matherials and methods

In order to study water- and fat-holding ability (WHA and FHA) the developed minced meat samples of natural mince and cutlet mass were researched made by traditional technology using protein-mineral supplements in powder form (PMA) in an amount of 2.5 ... 10 % by weight of raw meat, control samples - made without the use of PMA. WHA and FHA samples was determined by gravimetric and refractometric method.

For micro structural researches were chosen 4 samples

1. Control. Raw minced meat produced without the use of PMA.

2. Experimental model. Raw ground beef, made using 7.5% dry PMA relative to the mass of raw meat.

3. Control. Heat treated minced meat produced without the use of PMA.

4. Prototype. Heat treated ground beef, made using 7.5% dry PMA relative to the mass of raw meat.

In order to study histological characteristics samples of minced meat were fixed in 10% neutral formalin aqueous solution, followed by preparation and pouring in paraffinic blocks. Histological sections thickness of 5-7 microns produced at microtome, followed by coloring with hematoxylin and eosin and by the method of Mallory (differential coloring on the muscular and connective tissue).

For unbiased estimation of the obtained results was carried morphometric studies using the microscope "biolam" and eyepiece micrometer MOV - 1 - 15×. We determined the thickness of the muscular fibers in the control and experimental samples respectively raw and heat-treated. Calculated compacting factor of muscular fibers after samples minced meat heat treatment.

Obtained digital indicators treated variation-statistical methods [4].

Photographing was carried out using a microscope MBI-3 and photo tips MFN-10.

Results and discussion

For enrichment the diet with essential nutrients such as calcium bioorganic, and to correct the chemical composition of meat products we scientifically substantiated and the technology of minced meat products that are rich in digestible calcium by using of protein-mineral additive (PMA). PMA is a stable complex pig skin collagen and minerals (calcium, magnesium), which ensures their metabolic activity.

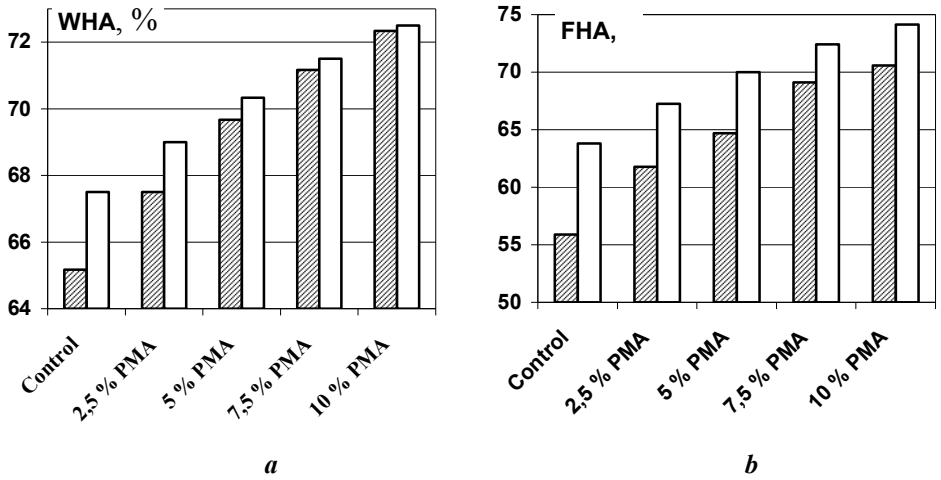
Investigations have established that the most appropriate is addition of PMA (in powder form) in the mince meat products in the quantities about 7.5% by weight of raw meat on stage of mixing prescription ingredients. It leads to an improvement of

technological, organoleptic characteristics, that fundamentally changes the traditional production process of the product, and provides about 50% of the daily physiological need for usable calcium [5].

Scientific interest and practical value is to study the effect of PMA in water- and fat-holding ability (WHA, FHA) developed samples of minced meat. From the data characteristics of the microstructure is strongly dependent samples technological properties minced meat systems, changes of protein components, yield and organoleptic properties of the finished product (texture) economic production efficiency.

On fig. 1 is shown the change in WHA (a) and FHA (b) minced meat by using PMA. The diagram shows that the WHA of ground meat at entering PMA in an amount of 2.5 ... 10% increases: for natural ground meat − on 2,33 ... 7,33% for cutlet mass − 1.5 ... 5%.

Results of the research of FHA minced meat show increasing the value of this parameter with increasing content of PMA. When used PMA in an amount of 2.5 ... 10% FHA value compared with control increased to 5.88 ... 14.71% for natural forcemeat and at 3.45 ... 10.35% for cutlet mass. Probably, this effect is achieved by the presence in PMA water soluble polypeptides that act as emulsifiers to form direct emulsion.



a *b*

Fig. 1. Changing WHA (a) and FHA (b) minced meat by using PMA

▨ - *natural mince* □ - *kotlet mince*

It can be assumed that the increase in WHA minced meat by using PMA predefined the following:

− Through the use of PMA ensure absence of connective tissue basis and reducing the number of raw meat that can "squeeze" moisture during denaturation while heat treatment;

− A high degree of crushing PMA increases the active surface macromolecular substances - collagen for moisture absorption, increasing the number of proteins (of collagen) in the aqueous phase mince. Collagenic proteins composed of PMA able to swell, show hydration properties;

− It is possible interaction of calcium compounds PMA with myofibrils proteins of meat, in consequence is formation of complexes with high functional- technological properties;

− As a result of capillary-porous structure of PMA particles can to refrain moist by the surface tension in the pores of PMA.

In order to confirm the obtained highly functional and technological indicators, including WHA and FHA, minced of meat with PMA was researched micro structural characteristics of semi-finished and finished minced meat products using the PMA.

Minced meat semis without using PMA. On the histological sections of control samples raw minced meat are determined shredded muscle fibers plump and dense connective and adipose tissue. From Fig. 2 shows that the grinding mince uneven, a sign of what is the presence on the area of section fragments structurally framed muscular tissue with saved entries endomysium and peremizium and milled muscle fibers with loss of the beam and the violation of the integrity of the sarcolemma.

In these fibers occurs bundle of myofibrils formation micro-slit spaces resulting from loss of fiber sarcoplasm liquid fraction (Fig. 3). Liquid protein fraction of meat juice between fibers is not detected, indicating a free leaking it from the control sample of raw minced meat until the last fixation formalin.

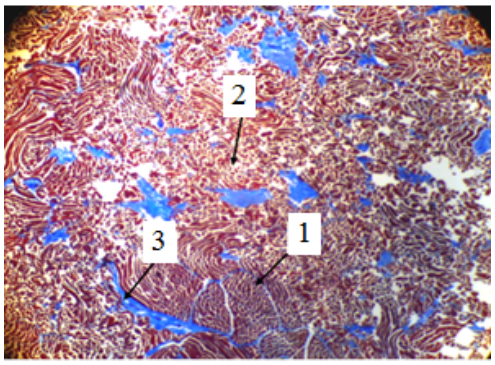


Fig. 2. A sample of raw minced meat with PMA (Mallori, × 3,2)
1 – fragments of muscular tissue structure decorated with saved entries endomysium and peremizium;
2 – finely milled muscular fibers with loss beam organization; 3 – fragments of connective tissue

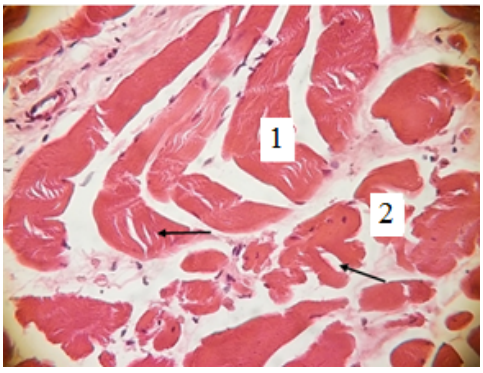


Fig. 3. A sample of raw minced meat with PMA (hematoxylin and eosin, × 40)
Micro cracks in musclar fibers shown by the arrows:
1 - longitudinal sections of muscle fibers;
2 – transverse sections of muscle fibers with violation the integrity of sarcolemma

Meat chopped semi-finished products using the PMA. In histological sections of test samples of raw minced meat (Fig. 4), as in control, defines all its components, as well as dispersed particles PMA. Latest at preparations colored with hematoxylin and eosin, have the form of basophilic particles that are show adhesive properties on structured components minced (Fig. 5).

Adding impurities to the minced meat had positively affect on the preservation of meat juice in semifinished from chopped meat (Fig. 5). Protein components of impurities, revealing hydrophilic properties, linking liquid component of meat juice. A characteristic feature of the test samples of raw minced meat is to keep the internal structure of the muscle fibers without stratification of myofibrils, indicating a lower degree of loss by them liquid components of sarcoplasm.

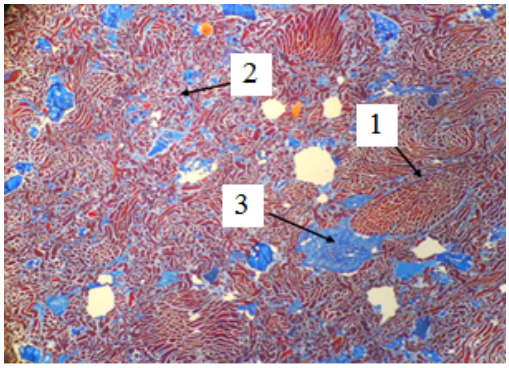


Fig. 4. Example of raw minced of PMA (Mallory, × 3,2)
1 – samples of muscle tissue structure executed with saved entries endomysium and peremizium;
2 – finely milled muscle fibers with loss beam organization;
3 – fragments of connective tissue

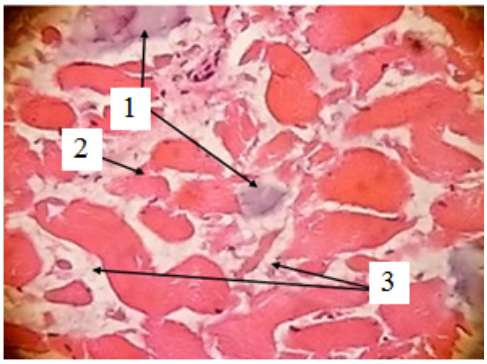


Fig. 5. Example of raw minced PMA (hematoxylin and eosin, × 40)
Micro cracks in the muscle fibers are almost absent.
1 – dispersed particles of impurities;
2 – transverse sections of muscle fibers in violation of the integrity of sarcolemma;
3 – meat juice between milled muscle fibers

Heat-treated minced meat products made by traditional technology without PMA. Heat treated control samples of mince characterized by irregular structuring (Fig. 6). On the histological preparations are defined areas of adhesion muscle fibers in large-sized conglomerates, which are formed between the large cavity.

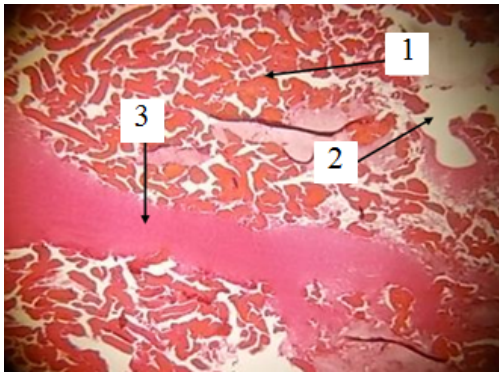


Fig. 6. sample of heat-treated mince without PMA (hematoxylin and eosin, × 10)
1 – adhesion of muscle fibers in large conglomerates;
2 – large cavity;
3 – coagulant of meat juice

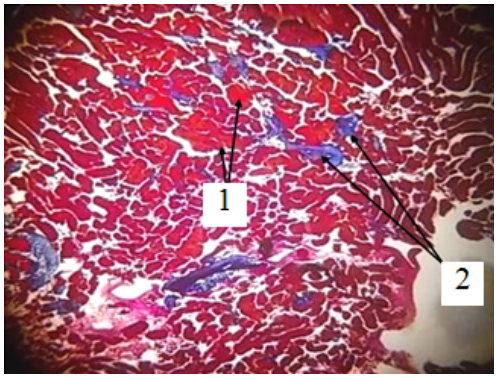


Fig. 7. A sample of heat-treated minced without PMA (Mallory, × 10)
1 – conglomerates of finely milled muscle fibers, colored in bright red;
2 – connective tissue

Empty slotted gaps formed between the individual muscle fibers. This structure leads to fragility of the finished mince meat product.

From Fig. 6 clearly shows that the voids between the compacted muscle fibers is determined by thermally coagulated juice of the meat in the form of large areas of oxyphilic granular mass.

In preparations painted by Mallory (Fig. 7) muscle fibers often become a mosaic view due to the prevalence of some of them bright red color, which results from excessive loss of protein fractions sarcoplasm when leak in meat juice.

Heat-treated minced meat products made of PMA. In heat-treated experimental samples of minced dense arrangement of muscle fibers occurs only in not chopped fragments where no impurity (Fig. 8). These fragments of minced when stained preparations revealed partially it turns coloring mosaic muscle fibers (Fig. 9).

On Fig. 8 shows that thermally coagulated meat juice mostly evenly distributed between the muscle fibers, which are also defining and dispersed particles of impurities.

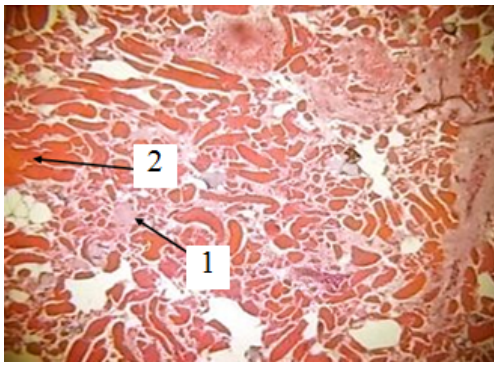


Fig. 8. A sample of heat-treated minced PMA (hematoxylin and eosin, × 10)
1 – meat juice between chopped muscle fibers;
2 – partial adhesion of muscle fiber Samples of mince in which was not included PMA

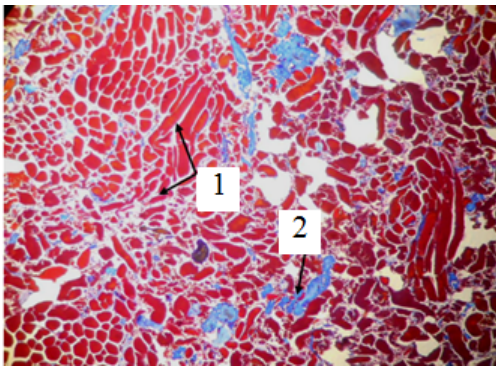


Fig. 9. A sample of heat-treated minced PMA (Mallory, × 10)
1 – muscle fibers and their fragments placed evenly;
2 – connective tissue

Thus, we can conclude that the control samples of minced because of mechanical integrity violations of sarcolemma muscle fibers lose in composition of meat juice soluble fraction of sarcoplasmic proteins. An introduction experimental impurity in PMA mince not only prevents the loss of meat juice that is evenly distributed between the fragments and of minced is kept in the finished product, but also significantly reduces the loss of muscle fibers sarcoplasmic proteins after heat treatment.

Conclusions

1. Created technology of the mince meat products using PMA. Exactly PMA is the carrier of bioorganic calcium metabolic activity which caused by the binding of calcium and collagen pigskin.
2. Established improve the organoleptic and technological parameters of mince meat products using PMA, by raising the value of WHA, FHA mincemeat. Probably, this indicates a positive effect PMA on output the finished product against the background

of conservation of other functional-technological characteristics of the finished product, along with the fact that the use of recycled cheaper raw materials will reduce the cost of production.

3. Putting PMA in mince not only prevents the loss of meat juice that evenly placed between fragments of minced meat and preserving in the finished product, but also significantly reduces the loss of muscle fibers sarcoplasmic proteins. The obtained results of histological investigations meat products and ready-made products from PMA bring a positive impact of PMA on the water-holding properties of minced meat and output the finished product.

References

1. Marta Alino et al. (2010), Physicochemical properties and microbiology of dry-cured loins obtained by partial sodium replacement with potassium, calcium and magnesium, *Meat Sci*., 85(3), pp. 580–588.
2. Zharinov A. I. et al. (2008), Razrabotka myasnogo gerodieticheskogo produkta, obogashchennogo kal'tsiem, *Vse o myase*, 3, pp. 17–22.
3. Cherevko O.I., Mykhailov V.M., Holovko M.P., Polevych V.V., Chuiko L.O., Serik M.L., Holovko T.M. (2013), *Naukovi osnovy tekhnolohii mineralizovanykh produktiv kharchuvannia: monohrafiia v 3 ch. Ch. 1. Vykorystannia produktiv pererobky kharchovoi kistky u tekhnolohii produktiv spetsialnoho pryznachennia: monohrafii*a, Kharkiv.
4. Avtandilov G. G. (1990), *Meditsinskaya morfometriya*, Meditsina, Moskow.
5. Holovko M.P., Serik M.L., Holovko T.M., Polupan V.V. (2013), Tekhnolohiia miasnykh posichenykh vyrobiv iz vykorystanniam napivfabrykatu bilkovo-mineralnoho, *Naukovi pratsi Odeskoi natsionalnoi akademii kharchovykh tekhnolohii*, 44(2), pp. 189-193.
6. E. Tornberg (2013), Engineering processes in meat products and how they influence their biophysical properties, *Meat Science*, 95(4), pp. 871-878.
7. Shai Barbut (2013), Frying - Effect of coating on crust microstructure, color, and texture of lean meat portions, *Meat Science*, 93(2), pp. 269-274.
8. Frisullo P., Laverse J., Marino R., Del Nobile M.A. (2009), X-ray computed tomography to study processed meat microstructure, *Journal of Food Engineering*, 94(3–4), pp. 283-289.
9. Farouk M.M., Frost D.A., Krsinic G., Wu G. (2013), Phase behaviour, rheology and microstructure of mixture of meat proteins and kappa and iota carrageenans, *Food Hydrocolloids*, 25(6), pp. 1627-1636.
10. Soto A.M., Morales P., Haza A.I., García M.L., Selgas M.D. (2014), Bioavailability of calcium from enriched meat products using Caco-2 cells, *Food Research International*, 55, pp. 263-270.
11. Cáceres E., García M.L., Selgas M.D. (2006), Design of a new cooked meat sausage enriched with calcium, *Meat Science*, 73(2), pp. 368-377.
12. Fletcher N. (2014), Food Additives: Preservatives, *Encyclopedia of Food Safety*, 2, pp. 471-473.
13. Olmedilla-Alonso Begoña, Jiménez-Colmenero Francisco, Sánchez-Muniz Francisco J. (2013), Development and assessment of healthy properties of meat and meat products designed as functional foods, *Meat Science*, 95(4), pp. 919-930.