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IMPACT OF WASHING SOLUTIONS ON CHEMICAL COMPOSITION AND PHYSICO-CHEMICAL PROPERTIES OF SURIMI-LIKE MECHANICALLY DEBONED TURKEY MEAT

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Abstract: *The impact of washing solutions on mechanically deboned turkey meat (MDM) was evaluated with the aim to produce surimi-like material using solutions of succinic (pH 5.9) and lactic acid (pH 5.8). Inorganic phosphoric acid was found to be the strongest ionization constants, with tartaric, then citric, malic, lactic and succinic acids. In washed samples found that moisture content at the end of the study was 87.6%–92.7%, fat 1.04%–3.2%, protein 17.4–18.2%, ash 0.079–0.086%. The number of washing significantly influenced the increase in moisture content and the reduction of fat content. The moisture content increased from 65.0% (P <0.05) for unwashed masses to 69.3–74.1% after the second washing and to 76.2–79.7% after the third washing. Obtained surimi-like material may have a moisture content in the range of 73 to 80%, but 78% moisture content is technologically the best. During the experimental studies of turkey MDM it was found that the best indicators were achieved for minced meat washed with 0.3% succinic acid at ambient temperature of 15°C, 1:4 ratio of turkey MDM to acid solution, 20 min mixing time and 20 min centrifugation. Surimi-like material washed with succinic acid had higher pH and moisture retention capacity, and showed better colour changes than unwashed turkey MDM and other surimi-like materials. This study demonstrates that succinic acid solution provides the achievement of desired surimi-like material with the best technological quality and low fat content.*

Keywords: *mechanically deboned turkey meat, washing liquids, surimi-like material.*

1. Introduction

Shortage of domestic fresh meat (mainly beef and pork), fast growth, high reproducibility, productivity and viability of farm poultry makes it necessary to develop and apply innovative scientific-based processing [1].
Resource-saving technologies of poultry processing industry provide for complex processing of poultry [5]. Conservation and rational use of poultry meat in food technologies through introduction of deep industrial processing in order to obtain a wide range of products for various purposes is an urgent nationwide problem [3].
One of the raw materials for meat processing industry,which is widely used due to its high adaptability, high protein content, low cost, is mechanically deboned turkey meat (MDM) [1].
Mechanically deboned poultry meat is poultry meat obtained by mechanically separating soft tissues from the bones of poultry carcasses or parts thereof, in which calcium content is higher than that in chopped meat [2].
MDM, in compliance with standards, should have a paste-like viscous consistency, be pink or red, and have fresh smell. MDM should not contain bones over 0.75 mm in size, salt, sodium nitrite, animal and vegetable materials, except

poultry, foreign impurities and other additives [6]. In many countries production of mechanically deboned meat should meet very stringent requirements. One of them, for example, is to limit the shelf life of bones used to produce MDM - no more than 24 hours at 0°C or 8 days frozen [7].

MDM are made from chicken or turkey carcasses. They are treated with circular saws and pneumatic tools. Quite often, separators are used to break bones and divide them into components (soft and hard) [2]. As a result, there is a half-dry bone mass and a mass of muscle tissue which looks like pasty stuffing. It also includes fat, tendons, skin and connective tissues. Such product is used immediately after boning [8].

The use of MDM both as minced meat and as a recipe component has a number of negative aspects. Among them are the reduction of oxidative and microbiological stability, specific fat shine and red color (from pink to dark red), which is due to technological factors of production and biochemical properties of this raw material due to the transition of bone marrow lipids and hemoproteins [9]. On this basis, the urgent task is to improve the technology of MDM through the use of stabilizing, antioxidant additives and other technological operations, which will increase functional, technological and consumption properties of such meat systems [3].

Not well-researched there are regulations for washing cycles, temperature for washing liquids, setting the modes of centrifugation, optimal introduction of surimi-like material in the formulation to create a product with a prolonged shelf life [2, 10].

The purpose of the research is to theoretically substantiate and experimentally confirm the effectiveness of washing of MDM with various washing liquids (organic acids - lactic and succinic, deionized water, sodium chloride, sodium bicarbonate solution, potassium phosphate buffer solution) adhesive ability (surimi-like material).

Poultry deboning and further processing of poultry meat lead to accumulation of a large number of by-products from the less noble parts (neck, wing tips, skeleton and back bones, skin), the commercial cost of which is low. The process of mechanical deboning is associated with problems such as darkening and odor, and thus is not suitable for long-term storage [6, 7, 8]. To overcome this problem, there is a need to re-use mechanically deboned meat in a process that reduces darkening, bitter taste and odor. Thus, surimi processing was proposed [8, 9].

Surimi is the original Japanese term referring to white, tasteless and odorless myofibril preparation obtained from mechanically deboned fish meat, washed separately with water and mixed with cryoprotectants [11]. When protein concentration is obtained by washing meat other than fish, the product is known as surimi-like material [12].

Washing meat with low marketing value is thought to contribute to increased raw material value [8]. The surimi-like product was made by using different types of meat, such as [15], beef [14], pork [13], lamb [12], heep [11], laying hens [10], ducks [9, 8], chicken meat [7, 8, 9].

Surimi-like material has been found to have very good technological properties, above all high moisture retention capacity and good thermal gelation [8]. It is not associated with intense sensory taste or odors. However, the final quality of surimi - like material obtained from washed meat is not always identical, depending on raw material and recovery parameters such as the number of washing cycles, type of washing solutions and meat / water ratio [11].

In addition to water, sodium chloride (NaCl), sodium bicarbonate and sodium phosphate buffer [9] have been proposed as useful washing solutions for treatment of surimi-like material.

Thus, information on the use of surimi-like meat material can be found in several literature sources. Such studies include pork hot dogs with mechanically separated surimi-like material [8], beef heart with surimi-like material [14], pork sausage with surimi-like material [13], crab sticks with surimi – like poultry material [6], pork pies with surimi-like pork material [11], burgers with surimi-like duck material [9] and mechanically deboned chicken meat with surimi-like material [8].

Processing of turkey meat to surimi condition will facilitate the use of by-products from less noble parts of turkey for production of high-quality industrial products, as well as will prevent odors and darkening during long-term storage.

2. Materials and methods

Frozen and cooled turkey MDM was taken as raw material for research. Turkey MDM was washed with organic acid solutions at a concentration of 0.3%. The experiment was conducted three times with 1: 2 and 1: 4 ratio of turkey MDM / acid, in solutions of organic acids with stirring the solutions in the range from 10 to 20 minutes [8]. Centrifugation from 10 to 20 min was performed to separate soluble proteins, connective tissue, bone tissue, cell membranes and storage of neutral lipids, as well as to reduce liquid content.

Physico-chemical methods were used during the study. Determination of amino acid composition was conducted in accordance with the method of ion exchange chromatography. Quality and quantitative determination of components consisted in dividing of them into separate components after the hydrolysis of proteins and determination of their quantitative estimation with the help of automatic analyzer of amino acids as T- 339, on polystyrene sulfonate ion exchange resins of "Ostion LJ ANB" in Li- citrate buffer one column mode. The elutions of amino acids from a column conduct in turn by Li-by citrate buffers from pH 2,75±0,01; pH 2,95±0,01; pH 3,2±0,02; pH 3,8±0,02; pH 5,0±0,2. Amino acids rectifying with the help of solution of ninhydrin on a running photometer at a length of waves by 560 nm. The results of detection was registered oneself by a variplotter on a paper in form the peaks of absorption of light of ninhydrin-positive substances in an eluate, that in number in direct ratio concentrations of this substance in solution. Correlation of solution of ninhydrin reagent and eluents is 1 to 2; temperature of thermostatic T1=38,5 °C ; T= 65 °C. The prototype was diluted in Li-citrate buffer by pH 2,2±0,02 and inflicted on a ion exchange column with the help of metering device. The quantitative estimation of хроматограм of pre-production model settles accounts in relation to standard mixture of amino acids of firm BioRaD [10].

Amino acid SCORE expected according to the certificate scale of FAO/WHO [4, 6].

The choice of acid for studies was focused on ionization constants.

Ionization constant is a specific equilibrium constant in chemistry that shows the degree of dissociation of hydrogen ions (H^+) with acids in solution. Strong acids dissociate almost completely and, accordingly, have large values of acidity constant ($Ka > 1$). Weak acids dissociate incompletely and have the value of $Ka << 1$ [11].

Since the difference in Ka value between the weakest and the strongest acids is several orders of magnitude, the ionization constant is usually denoted by the inverse of its decimal logarithm (pKa).
Thus, the purpose of this research was to develop surimi - like material from turkey MDM by studying the effect of washing solutions on its composition, technological and functional properties [4].

3. Results and discussion

3.1. Study of raw materials and ionization constants of acids.

Data in Table 1 show that inorganic phosphoric acid is the strongest in terms of ionization constants, tartaric, then citric, malic, lactic, succinic acids are the strongest organic acids [2]. Acetic is the weakest acid. Lactic acid is monobasic, malic and succinic - two-basic, citric - three-basic acids. Succinic, tartaric and malic are related acids. Malic acid is derivative of succinic acid. All these acids are good preservatives. They can wash out various substances from the product and can enter into complexing reactions [5].

Table 1

Acid ionization constants that are widely used in food industry

Acids	Ionization constant	
	Ka	pKa = –log
Citric	$7.4 \cdot 10^{-4}$	3.13—4.55
	$2.2 \cdot 10^{-5}$	
	$4.0 \cdot 10^{-7}$	
Apple	$3.5 \cdot 10^{-4}$	3.46—5.05
	$8.9 \cdot 10^{-6}$	
Succinic	$1.6 \cdot 10^{-5}$	4.21—5.63
	$2.3 \cdot 10^{-6}$	
Lactic	$1.5 \cdot 10^{-4}$	3.83
Acetic	$1.74 \cdot 10^{-5}$	4.76
Phosphoric	$7.1 \cdot 10^{-3}$	2.15
Tartaric	$1.3 \cdot 10^{-3}$	2.89

3.2. Effect of selected wash solutions on surimi-like material.

Washing solutions with different pH media were used: succinic acid (5.9); lactic acid (5.8) [4]. During preparation of surimi - like material the pH and buffering agents nature of the washing solution play an important role not only in product stability but also from a technological point of view [8].
Number of washings significantly influenced the increase of moisture content and the reduction of fat content. The moisture content increased from 65.0% ($P < 0.05$) for unwashed product to 69.3–74.1% after the second washing and to 76.2–79.7% after the third washing. The number of washings increases moisture content [6]. It has been found that surimi-like material can have a moisture content in the range of 73 to 80%, but 78% moisture content is technologically the best.
Centrifugation on a centrifuge CLMN – 24 helped to reduce water content, to separate soluble proteins, bones tissues, skin, connective tissues, cell membranes and to preserve neutral lipids [12]. This process

reduces pigment content to the acceptable for turkey MDM level.

In the process of washing we obtained surimi-like material and studied its physico-chemical parameters (Table 2).

Table 2
Influence of solutions on physico - chemical indicators of surimi-like material obtained from mechanically deboned turkey meat

Washing solution/meat	t°C	τ (min)	Ratio (turkey MDM/ acid)	Moisture content, %	Fat content, %	Protein content, %	Ash, %
Turkey MDM	-	-	-	63.0	19.8	12.4	0.096
Lactic acid 0.3%	15	10	1:2	87.6	3.2	17.6	0.086
Lactic acid 0.3%	15	20	1:4	92.7	2.1	17.4	0.091
Succinic acid 0.3%	15	10	1:2	89.6	2.93	18.2	0.079
Succinic acid 0.3%	15	20	1:4	91.8	1.04	18.0	0.083

Table 2 shows chemical composition of washed turkey MDM. No significant interaction effect was found between the detergent solution and the number of washings for any of the estimated parameters [12]. However, the number of washings had significant effect on increase of moisture content and reduction of fat and protein content.

Obviously, washing increased humidity (from 60.0% to 87.6% -92.7%) and reduced fat content (from 19.8% to 1.04% -3.2 %). Moisture content in the washed samples increases due to the concentration of protein and reduction of its interaction with other components, such as fat, thus increasing its hydration [11].

Fat removal is crucial in preparation of surimi-like material since fat is likely to be oxidized and protein denaturation will increase during frozen storage [9, 13]. In addition, lipids tend to oxidise in surimi-like material with high fat content, which worsens aroma due to rancidity. Thus, fat removal improves the quality of surimi-like material and demonstrates inhibition of lipid oxidation [2].

As reported in previous studies [1, 8, 2], fat content in surimi-like products can reach 3% due to the fat content of the raw materials used.

According to fatty and sarcoplasmic proteins are removed in the process of efficient washing. However, sequential washing decreases the amount of crude protein in the end surimi-like product. Protein content increased compared to the reference (turkey MDM) sample.

Ash content (mean value 0.084) had no effect ($p > 0.05$) on washing and did not differ ($p > 0.05$) from unwashed turkey MDM. This is not consistent with other studies [3, 6] that reported significant decrease of this component after successive washings.

During experimental studies of turkey MDM we found that the best quality indicators are obtained in MDM washed with 0.3% succinic acid at a temperature of 15^{o}, 1: 4 ratio of turkey MDM to acid solution, 20 minutes duration of stirring and 20 minutes duration of centrifugation.

As a result of washing the product looks very similar to white poultry meat, which is due to the fact that washing significantly tones up light and discolors red colours.

4. Conclusion

Turkey MDM is a potentially available raw material for production of surimi-like product obtained in the course of washing.

Functional properties of turkey MDM can be improved by processing it into surimi-like material. Three times washing of meat was sufficient to effectively remove fat, maintain stable protein content and achieve high functional and textural properties.
Washing allowed us to get surimi-like material with high technological properties. Thus, based on our research, succinic acid is the best washing solution since it allows to get surimi-like material with the highest technological quality for further use in production of low-fat meat products.
The influence of washing liquids and cycles on the yield and recovery of protein from the gray-like material of MDM turkey is established. The best results are obtained when washing with sodium bicarbonate after the second wash (protein yield - 37.3% recovery - 38.6%).

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