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ATTEMPS AT OBTAINING THE WET CONCERTRATE OF MYOFIBRILS FROM CHICKEN BREAST AND MECHANICALLY DEBONED POULTRY AND ITS FUNCTIONAL PROPERTIES

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Key words: chicken breast, mechanically deboned poultry, wet myofibril concentrate, „chicken surimi" functional, rheological, thermal properties

The paper presents an attempt at obtaining wet myofibril concentrate (poultry-based surimi) from chicken breast muscles and from mechanically deboned spent layers. Water rinsing (4°C or 10°C) of the raw material, straining to separate connective tissue and centrifugation is an effective method of producing functional myofibril concentrate. Myofibril concentrate functionality, thermal properties of myofibrils and rheology of heat induced myofibril gel were studied.

INTRODUCTION

Production of mechanically deboned poultry (MDP) is a well establised common practice. MDP is a source of high quality protein. It is widely used in a variety of meat products but primarily in emulsion type products. It is produced from chicken necks, backs, frames and spent layers. Depending on the starting material MDP may contain 9.3-16.6% protein and 7.9-27.2% fat [3]. According to our experience MDP incorporated into poultry and meat products specially on higher amount levels may cause deterioration of final product quality. Several constraints have limited further use of MDP. It has short storage life, high fat content with high amount of unsaturated fatty acids which makes MDP very sensitive and susceptible to rancidity. Additionally, MDP has dark color and small particle size which results in poor textural properties [1].

Application of water rinsing, extraction — the fish surimi process — to refine poultry meat proteins does have potential. Surimi is actually a frozen concentrate of wet fish flesh myofibrils produced from water washed mechanically deboned fish muscle [10, 11]. Rinising process of minced flesh removes sarcoplasmic proteins, enzymes, the other water soluble compounds, blood, pigment and fat, which are responsible for deterioration of the frozen mince [6]. Then mince is squeezed to reduce the moisture, strained, mixed with salt, phosphates, cryo-protectants and finaly frozen. Salt nad phosphate addition into surimi optimize solubility of proteins in the mince paste. It is a concentrated from of muscle

actomyosin, and therefore the functional „essence" of fish muscle. Actomyosin is known to be the most active in performing the functions of texture formation, particle cohesion, water and fat binding. Fish surimi is the only functional protein concentrate produced from animal muscle tissue. With respect to those functional properties which are important to muscle-based foods, surimi offers singnificantly greater functionaly over competing proteins in terms of its gelling properties [10]. Kamaboko-related food products — popular in Japanese diet — have elastic, gelled, rubbery texture, and are manufactured from heat pasteurized surimi. Surimi is already the base for a new category of restructured and analog shelfish products such as crab legs, which have been enjoying phenomenal sales success in the past years in the U. S. [9, 10].

It is probably possible that high functional protein can be recovered from low quality source, mechanically deboned poultry and from growing amount of bone by-products of the breast filet operation [2]. A protein refining process would be useful for reducing fat and pigment contents simultaneously yielding a highly functional ingredient with bland flavour.

The aim of the investigations was to work out a method of obtaining wet myofibril concentrate, known also as poultry-based surimi, form chicken breast muscle and mechanically deboned poultry meat (MDP). An additional goal of the work was to determine:

— functionality of myofibril concentrates and rheological properties of myofibril gels,

— thermal properties of water washed myofibrils with NaCl and pyrophosphate, the indispensible components influenced myofibrils concentrate functionality.

MATERIAL AND METHODS

Myofibrils were refined from chicken breast and mechanically deboned meat.

Breast muscles were removed from 7-week old broiler carcasses 24 hrs post slaughter. Water washed myofibrils from chicken breast were obtained according to the Wang procedure [16] in which distilled water (4°C) was used instead od a buffer. Recovering of wet myofibrilar concentrate from mechanically deboned poultry (MDP) (Fig.):

The 200 g samples of MDP were placed in a glass container with 800 ml of distilled water and rinsed. The mixture was hand stirred for 10 min. followed by centrifuging at 2300 g for 20 min in Janetzki K26 centrifuge at 4°C. The supernatant with fat was decanted and the pellet was again resuspended in distilled water and the procedure was repeated 4 times. The ratio of MDP to water was 1 : 4 (w/v) each time. After the last washing procedure the rinsed slurry was resuspended in a minimum volume of water and poured through a 30-mesh strainer (Newark, Wire Cloth, Co., U. S.) into a container, then increasing the total volume of water to four times the MDP weight. Mainly the connective tissue was left on the surface of the strainer. After that final centrifugation was done. The

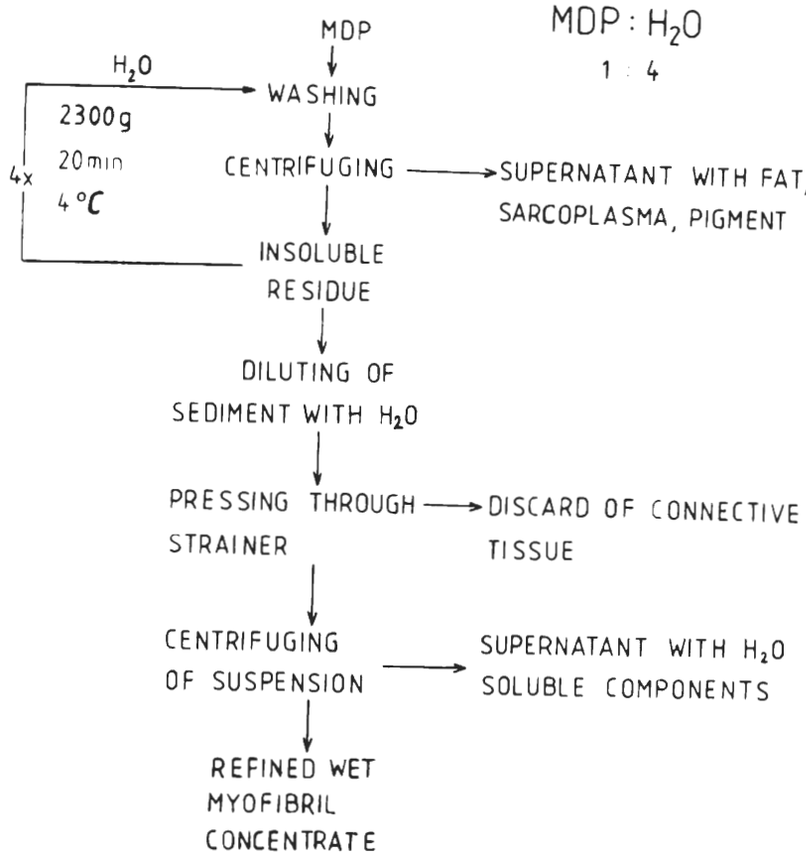

Fig. Flow diagram of wet myofibril concentrate preparation from mechanically deboned poultry (MDP).

pellet of wet myofibrils was used for chicken-based surimi production. The following temperatures of washing water were applied: 4, 10, 20, 30°C.

Proximate analysis included: moisture content determined by drying the samples at 105°C, protein calculated from Kjeldahl nitrogen determination using a conversion factor of 6.25, and Soxhlet's method was used for fat estimation. The values of pH assay were based on Japanese grading system of fish surimi [13].

Expressible drip estimation was based on free water test in meat [5]. Colour measurements were made with Gardner colormeter, USA, calibrated to pink tile having the following values $y = 32.3$, $x = 41.6$, $z = 26.7$. The calculation of x, y, z, values into Hunter color parameters was accomplished according to the instruction described by Karasinski and Bielinski [7]. Lightness (L) and chromaticity dimensions „a" (redness) and „b" (yellowness) were recorded.

MYOFIBRILL GEL PREPARATION

Myofibrill gels obtained from chicken breast meat and MDP were prepared after Nippon Suisan Kaisha Ltd [13] with slight modifications. Gels from chicken breast and MDP were prepared in a similar way, but dilution with 3% of NaCl solution was done to achieve the $9 + 0.5\%$ protein concentration.

The gel was produced using 100-300 g of wet myofibril concentrate of MDP or breast muscle and 3% NaCl by blending intensely for 10 min. The temperature during process must be kept below 10°C. The resulting paste was stuffed into 21 mm diameter collagen casing linked in 120 mm length segments (50 g of sample)

and immediatelly heated in a water bath at 70 or 90°C for 40 min. Then the samples were cooled in tap water and left at 4°C for 18 hrs. Casing was removed and cylindrical specimens (21 mm in diameter and 10 mm thick) were sliced and then exposed to the texture profile analysis.

Gel texture profile analysis. Cores of gel samples from wet myofibrilar concentrate, MDP, or breast muscle were subjected to texture analysis according to Lyon et al. procedure [12]. An Instron food testing instrument model 1140 with 500 kG compression load cell was used to double compression of each gel core with a pin of 35 mm in diameter. From the two bite compression curves the traits of hardness in Newtons (maximum height of the first compression curve), springiness (the distance sample recovers between first and second comperssion), cohesiveness (ratio of the two total areas under the curve) were determined.

Differential scanning calorimetry (DSC) of water washed myofibrils from chicken breast with additives was performed on a Perkin-Elmer DSC-4 according to the procedure described by Kijowski and Mast [8]. Temperatures of maximum transitions ($T_{max\ 1,2}$) and enthalpy of transition (ΔH) were determined. The following additives were incorporated into myofibril concentrare: NaCl — 1, 2, 3%; pyrophosphate (PP) — 0.25, 0.5, 0.75, 1.0%. The additives were initially dissolved in 40 °C water; these solutions were mixed with the samples in an amount equal to 10% of specimen weight and allowed to equilibrate for 12 hr at 4°C.

RESULTS AND DISCUSSION

After four washing operations and straining of minced and homogenized chicken breast meat three fractions were obtained: wet myofibril preparation, residue of connective tissue fragments, and water soluble constituents. Table 1 shows recovery of water washed myofibrils from comminuted chicken meat. The losses of raw material mass resulting from washing out the fat, blood, sarcoplasmic proteins and other muscle components were 18.1% but it was 36.9% of the raw material protein. The rest was the fraction of connective tissue which did not pass through the strainer during cleaning the myofibrils and amounted to 6.6% of muscle protein. Table 2 shows the yield of myofibril weight in percent of mechanically deboned poultry meat. On avarage it was 26.7% of

Table 1. Recovery of water washed myofibrils from chicken breast (n = 6)

	% of meat weight	% of meat protein
Chicken breast	100	100
Wet myofibril concentrate	71.4 (5.4)*	56.4 (1.4)
Residue of connective tissue	8.4 (0.57)	6.6 (0.2)
Loss of weight (water soluble constituents)	18.1 (5.8)	36.9 (1.5)

*) Mean value, standard deviation in brackets

Table 2. Bulk balance in the processing of wet myofibril concentrate from mechanically deboned poultry (MDP), (per cent of MDP weight)

	Temperatures of rinsing water			
	4°C	10°C	20°C	30°C
MDP	100	100	100	100
Wet myofibrils concentrate	27.7 (2.3)*)	26.5 (0.1)	23.9 (0.4)	28.9 (0.8)
Residue of connective tissue	29.0 (3-4)	29.2 (0.1)	24.6 (2.7)	23.9 (1.2)
Water soluble constituents + fat	43.2 (5.7)	44.4 (0.3)	51.6 (3.2)	47.1 (0.9)

*) Mean value, standard deviation in brackets

Table 3. Protein recovery in water washing process of mechanically deboned poultry (MDP)

n = 4	Temperatures of rinsing water			
	4°C	10°C	20°C	30°C
MDP	100	100	100	100
Wet myofibril concentrate	20.7 (1.0)*)	17.1 (0.42)	19.5 (0.1)	19.2 (1.1)
Residue of connecive tissue	32.5 (2.1)	31.1 (0.38)	43.2 (0.3)	36.1 (0.9)
Loss of water soluble proteins	64.7 (2.0)	51.7 (0.42)	46.3 (0.2)	44.7 (2.1)

*) Mean value standard deviation in brackets

MDP mass and about 19% of protein present in MDP. This yield is much lower than that obtained for chicken muscles. Explanation of such a great difference in yield of myofibrils from MDP and chicken muscles should be provided by various chemical and protein composition of the raw materials (Table 4 and 5). MDP contained about 10 times more fat and singnificantly less protein than chicken breast meat. Moreover, the relative proportion of myofibril proteins in MDP is considerably lower and connective tissue is higher than in chicken breast. Recent studies with slightly changed technology of additional cleaning of MDP washed with water and application of a special rubbing device made it possible to increase myofibril yield to the range of 30-38% of the material protein. Table 2 shows that MDP weight losses due to washing amounted from 43.2 to 51.5% i.e. from 44.7 to 51.7% of the raw material protein (Table 3). The connective tissue residue separated in refinement process of myofibrils constituted 31.1-36.1% of MDP protein which is about 5 times more than in the process of cleaning myofibrils from breast meat of chicken.

However, one of the main goals altering the technology of obtaining surimi from fish is possibly the most effective removal of fat, sarcoplasmic proteins, enzymes and water soluble components, as well as stability and functional quality of myofibrill isolate. The highest yield of myofibrils from MDP was obtained using washing water at 4°C. Table 4 gives basic composition of wet myofibril

Table 4. Proximate analysis of chicken breast and water washed myofibrils, % n = 4

Constituent	Chicken breast	Water washed myofibrils
Water	72.9 (1.6)*)	80.4 (1.7)
Dry matter	27.1 (1.7)	19.6 (1.7)
Protein	22.4 (2.1)	17.0 (0.7)
Fat	2.1 (0.2)	0.67 (0.67)

*) Meat value, standard deviation in brackets

isolate from chicken breast muscles. The final product contained 80.4% water, 17% protein and 0.67% fat. Protein content on dry weight basis was increased from 82.6% in the breast meat to 86.7% in the washed product. Fat on the dry matter basis dropped from 7.7% in the meat to 3.4% in the myofibril wet concentrate. Considerable changes in the basic composition of MDP followed its washing with water (Table 5). On avarage the final product of MDP washing contained 87% of moisture, 9.7% of protein and 1.5% of fat while the basic composition of unwashed MDP was 64.2% of moisture, 13.3% of protein and 21.4% of fat for all applied temperatures. Protein content of myofibrill concentrate increased to 68.3% while in unwashed raw material it was 37.2% (on dry matter basis). Aqueous extraction procedure resulted in a singnificant reduction in fat content from 59.9% in the MDP source to 11.9% in the wet myofibril concentrate. It was proved that the method applied for washing of MDP is a successful method to obtain the desired reduction of fat in the final product. The lowest fat content of the concentrate was obtained when the samples were washed with 4°C water. Similary as in case of effectivenes of washing up fat from the MDP, the temperature of water did not exert a strong influence on protein content of the myofibril preparation which was maintained within the range of 9-10.5%.

Table 5. Proximate analysis of MDP and wet myofibrils concentrate from MDP washed with water of different temperatures (%)

	MDP	4°C	10°C	20°C	30°C
Water	64.2 (1.07)*)	88.2 (0.19)	86.4 (1.69)	87.7 (1.69)	85.7 (0.77)
Dry matter	35.7 (1.07)	11.8 (0.19)	13.5 (1.69)	12.3 (1.69)	14.2 (0.77)
Protein	13.3 (1.13)	9.0 (0.37)	9.7 (0.79)	10.5 (0.10)	9.7 (1.00)
Fat	21.4 (0.08)	1.3 (0.18)	1.7 (0.37)	1.4 (0.32)	1.7 (0.21)

*) Mean value, standard deviation in brackets

The results of expressible drip test of myofibril concentrate measured on the basis of the volume of water released from sample by pressing it with 1 kG load for 1 hr according to Hamm's method [5] are given in Table 6. The expressible drip was significantly higher in surimi obtained from the MDP than that from

Table 6. Expressible drip and pH value of wet myofibril concentrate rinsed with water of 4 and 10°C (n = 6)

Myofibrils	Expressible drip		
	4°C	10°C	pH
From chicken breast	15.4 (1.7)*)	16.1 (1.4)	6.17 (0.31)
From MDP	35.7 (3.1)	42.7 (2.1)	6.57 (0.02)

*) Mean value, standard deviation in brackets

breast muscles, despite the fact that the pH value of the latter was 0.4 unit lower than that of the former. The difference in the amount of released water was probably due to higher moisture content of the wet myofibril concentrate of the MDP amounting, on avarage, to 87% for four temperatures of rinsing water, while in the breast muscle concentrate it was 80.4%. The application of water washing procedure to chicken breast muscle lightened the colour of raw meat singnificantly from L = 49.1, to L = 80.4 (Table 7).

Table 7. Colour characteristics of wet myofibril concentrate from chicken breast and mechanically deboned meat MDP (n = 6)

	Chicken breast	Myofibril concentrate	MDP	Myofibril concentrate	
				4°C*)	10°C*)
L (lightness)	49.1 (1.5)**)	80.4 (3.3)	50.1 (3.3)	54.6 (3.5)	52.1 (4.5)
a (redness)	17.1 (2.4)	1.4 (0.9)	12.8 (1.7)	2.6 (0.4)	2.4 (0.7)
b (yellowness)	12.1 (1.6)	10.3 (1.5)	14.6 (2.0)	18.8 (1.6)	16.4 (1.2)

*) Temperature of rinsing water
**) Mean value, standard deviation in brackets

The most dramatic effect of water washing was in redness; the "a" value decreased from 17.1 to 1.4. There was some decrease in yellowness (b value). Washing mechanically deboned poultry (spent layer) lightened the colour marginally, but reduced the redness of samples from 12.8 to 2.5. There was simultanously a small increase in yellowness. The mechanically deboned hen meat and water washed product from this source has more greyish or brownish colour than reddish. This colour could be attributed to blood and muscle pigment present in the interspace of cell systems. The ideal surimi from light muscles of fish species is white or light in colour, odorless and tasteless. Surimi derived from fatty material such as MDP and dark fiber muscle system can exhibit in poorer colour, stronger flavour and must be more carefully processed to yield a satisfying quality product. The most important criterion of myofibril concetrate (surimi) quality is its heat gelling and its mechanical and rheological properties. Tables 8 and 9 give the results of investigations on myofibril

Table 8. Texture profile analysis of gels from wet myofibril concentrate of 9.0 ± 0.5% protein content from chicken breast (n = 12)

Heating temperature	Chicken breast	Myofibrils	
	70°C	70°C	90°C
Hardness (Newtons)	8.1 (0.9)*)	26.1 (22.2)	29.1 (2.2)
Cohesiveness	0.40 (0.002)	0.56 (0.05)	0.65 (0.08)
Springiness	0.70 (0.08)	0.81 (0.10)	0.77 (0.02)

*) Mean velue, standard deviation in brackets

Table 9. Texture profile analysis of gels from wet myofibril concentrate of 9.0 ± 0.5% protein content from mechanically deboned poultry (MDP), (n = 12)

Rinsing water temperature gel heating temperature	MDP — 70°C	Myofibrils			
		4°C	10°C	4°C	10°C
		70°C		90°C	
Hardness (Newtons)	9.5 (2.4)*)	33.00 (3.8)	40.50 (1.8)	34.50 (3.7)	48.40 (2.5)
Cohesiveness	0.50 (0.08)	0.65 (0.11)	0.50 (0.04)	0.60 (0.07)	0.56 (0.06)
Springiness	0.75 (0.07)	0.82 (0.06)	0.80 (0.03)	0.81 (0.03)	0.80 (0.03)

*) Mean value, standard deviation in brackets

concentrate texture with 9% protein content and heated at 70 and 90°C. Comparing heating temperatures it can be concluded that the gels obtained at higher temperature are harder. This possibly results from more dense network of bounds in the gel network. Hardness of a myofibril concentrate gel is over three times higher than that of breast muscles gel, of the same protein concentration (Table 8). Also the cohesiveness and springiness of the gel was higher in case of myofibril concentrate than meat tissue gel. Actomyosin present mainly in myofibril preparation enhances hardness and elasticity of gel. The presence of water-soluble protein retards gel setting by interfering with myosin cross-linking process [14], or sarcoplasmic proteins bind actomyosin making it less available for the cross-linking process [15]. Similar results were obtained for characteristics of the gel from mechanically deboned meat and from myofibril concentrate obtained from this raw material of lower usefulness. The hardness of myofibril concentrate gels was over 3 to 5 times higher than that of the MDP ones. The gel hardness depended both on washing temperature of the water used and on heating temperature of the concentrate during gel setting. Higher temperature of washing water, i.e. 10°C, made the gel harder and more chewy in comparision with that washed at 4°C. The mechanism of this phenomenon is unclear. The water at 10°C cannot produce changes of denaturation character. Perhaps the water at 10°C washes out some components of the raw material which can not be removed by the water at 4°C. Heating the gels at 90°C as in case of myofibril

Table 10. Effect of freezing of gel from wet myofibril concentrate on texture profile analysis (8.4% protein in gel, n = 9)

Heating temperature	Fresh concentrate		Frozen concentrate	
	70°C	90°C	70°C	90°C
Hardness (Newtons)	26.1 (2.2)*)	29.1 (2.2)	15.1 (1.4)	20.9 (0.94)
Cohesivness	0.56 (0.05)	0.65 (0.08)	0.59 (0.03)	0.50 (0.06)
Springiness	0.81 (0.09)	0.84 (0.01)	0.76 (0.10)	0.82 (0.05)

*) Mean value, standard deviation in brackets

concentrate gels obtained from breast muscles, resulted in higher hardness than heating at 70°C. The cohesiveness and springiness of the myofibril gels was higher than that of the gels obtained from mechanically deboned meat. Table 10 gives the results of the effect of freezing wet myofibril concentrate at-18°C on mechanical parameters of the gel obtained from them. All rheological parameters of the gels, hardness, cohesiveness, springiness turned out to be lower for the gels of frozen concentrate. Despite the fact that susceptibility to denaturation, agglomeration of protein in poultry meat is lower than that of fish muscle [10], the obtained results suggest the nesessity of cryoprotectants application in manufacture of myofibril concentrates.

Salt and phosphate addition to the myofibril paste may optimize solubility and functionality of actomyosin, as it is well documented in meat science literature [4]. Some research on fish surimi indicates that 2.5-3% NaCl produces an optimum gelling effect in terms of gel strength and compliancy [10]. Myofibrils are presumably an excelent model to study meat functionality and should be useful for better understanding of the thermal changes in the main proteins. Our previous studies with DSC have yielded valuable information that during programmed heating water washed myofibrils produce two main thermal transitions: myosin at 57°C and actin at 78°C [8]. In this study the myosin transition occured at 58.4°C and actin at 80.7°C (Table 11). Increase in NaCl concentration from 1 to 4% produced a significant decrease in myosin denaturation temperature from 56.6 to 53.6°C. The denaturation temperature of actin was 16.8°C lower in the samples treated with 3% NaCl addition than in sample with no salt. At the same time an increases in NaCl concentration caused significant reduction in total enthalpy (ΔH) of denaturation. The influence of phosphate concentration (0.25-1.0%) on the thermal transition parameters is presented in Table 11. The addition of phosphate stabilized myosin, i.e., thermal denaturation occured at significantly higher temperature than in the control samples. The addition of 0.25% pyrophosphate caused the greatest stability. However, pyrophosphate destabilized actin. Summarizing the DSC study of water washed chicken myofibrils it should be pointed, that NaCl addition reduces heat stability of the main proteins, allowing them to initiate gelation at much lower temperature.

Table 11. Major thermal transition temperatures (T_1, T_2) and total enthalpy (ΔH) of water washed myofibril treated with NaCl and phosphates (n = 4)

Salt	%	T_1(°C) myosin	T_2(°C) actin	ΔH(Joul/g)
NaCl	0	58.4 a	80.7 a	11.7 a
	1	56.6 b	71.8 b	10.9 a
	2	55.4 c	67.7 c	9.0 b
	3	53.6 d	63.9 c	7.1 c
	4	53.6 d	64.0 c	6.3 c
Pyrophosphate	0	58.4 d	80.7 a	11.7 b
	0.25	62.9 a	78.4 b	13.9 a
	0.50	60.8 b	74.5 c	13.4 a
	0.75	59.8 c	70.9 d	13.4 a
	1.00	59.3 c	70.6 d	13.6 a

a-d) Figures marked with various letters demonstrate statistically significat differences at p = 0.05 (in columnes separately for NaCl and pyrophosphate treatment)

Summing up, the investigations on myofibril conecentrates one can conclude that the myofibril concentrates have high gel-forming ability. The myofibril concentrate could be an ingredient of high nutritive value, useful muscle food industry. The concentrate could be possibly a base-texture form ingredient for producing new kinds of meat dishes. Myofibril concentrates with gelling properties and high mechanical resistance can also be used in the production of other food systems, e.g. pastes, chunks, dry products with addition of other animal or plant proteins, carbohydrates — the food with excellent nutritive characteristics. However further study require increase the myofibrils recovery efficiency as well as the purity and the colour of chicken-surimi preparation.

CONCLUSIONS

1. Washing ground chicken breast muscles and mechanically deboned meat (MDP) with water of 4°C or 10°C four times and straining to separate connective tissue and centrifuging is an effective method of producing functional myofibril concentrate.

2. With the applied procedure of washing chicken breast muscles and MDP the myofibril yield was 56.4% and 19% of raw material protein, respectively.

3. Protein content in the washed MDP increased on avarage to 68.3% as compared to unwashed MDP, on a dry weight basis. Fat content of the concentrate fell to 11% while in the raw material it was 60% on a dry weight basis.

4. The applied method of obtaining manufacturing myofibril concentrates from MDP causes a significant increase in mechanical resistance of thermally induced gel as compared to raw material properties. Hardness of a myofibril concentrate gel was 3 to 5 times higher than that of the MDP gel.

5. Freezing of myofibril concentrates brings about deterioration of rheological parameters of the gel.

6. The myofibril concentrate form breast muscles was significantly lighter (L = 49.11) and less red (a = 1.4) than the original material (L = 8.04; a = 17.1). Depigmentation of the MDP concentrate was less effective since lightness increased from 50.1 to 54.6 and redness decreased from 12.8 to 2.6.

7. Addition of 3% NaCl to wet myofibril concentrate brings about rise in thermal stability of myosin by 5.4°C with simultaneous reduction in actin thermal stability by 16.8°C.

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PRÓBY OTRZYMYWANIA MOKREGO KONCENTRATU MIOFIBRYLI Z PIERSI KURCZĄT I Z MECHANICZNIE ODKOSTNIONEGO DROBIU ORAZ JEGO WŁAŚCIWOŚCI FUNKCJONALNE

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Streszczenie

Opracowano metodę uzyskiwania mokrego koncentratu miofibryli z mięśni piersiowych kurcząt i z mięsa mechanicznie odkostnionego (MMO) kur niosek. Wykorzystano do tego procedurę zbliżoną do procesu wytwarzania surimi z mięsa ryb. Drobiowe surimi uzyskiwano w wyniku

4-krotnego przemywania surową wodą destylowaną o temp. 4, 10, 20, 30°C, przy stałym stosunku wody do surowca jak 4 : 1 i jednorazowam przeciskaniu próby przez sito w celu oddzielenia tkanki łącznej i odwirowaniu przez 20 min przy 2300 g. Biorąc pod uwagę redukcję zawartości tłuszczu i jakość cieplnych żeli otrzymywanych z koncentratu, właściwą temperaturą wody płuczącej była temp. 4 i 10°C. Koncentrat miofibryli uzyskany z MMO przemywanego wodą o temp. 4°C miał 11,8% suchej masy, w tym 76% białka. Odzysk miofibryli z MMO wynosił 19%, a z mięśni piersiowych 56% w stosunku do białka surowca. W przemywanym MMO zawartość białka wzrosła prawie dwukrotnie, a zawartość tłuszczu zmalała ok. 6 razy (w przeliczeniu na suchą masę). Przemywanie mięśni i MMO wodą powoduje rozjaśnienie barwy produktu i istotną poprawę charakterystyki tekstury żeli. Twardość żeli z koncentratu miofibryli była 3-5-krotnie większa niż żelu z MMO. Zamrażanie koncentratu miofibryli pogarsza właściwości reologiczne żelu z niego otrzymanego. Stosowany dodatek 3% NaCl do mokrego koncentratu miofibryli w celu efektywnego żelowania cieplnego powoduje obniżanie temperatury denaturacji miozyny o 5°C a aktyny o 16,7°C.