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PHYSICOCHEMICAL AND FUNCTIONAL PROPERTIES OF SURIMI-LIKE PRODUCTS MADE FROM CHICKEN

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ABSTRACT

Chicken surimi was prepared from fresh hand – debonded breast and thigh meat using sodium bicarbonate washing process. The resultant surimi was mixed with cryoprotectants then stored at 4 and – 18°C and analyzed periodically up to 4 weeks. The effect of washing water temperature ranged from 5- 30°C on the quality of surimi was also studied. Results showed that fresh surimi was lighter in color, higher in protein content, lower in fat, total pigments and myoglobin contents compared with debonded meat. On the other hand, it has a good functional characteristics such as emulsion capacity and stability, water holding capacity and viscosity. A gradual losses in protein and viscosity was noticed as the temperature of washing water increase. On the contrary, fat content increased gradually and the yield of surimi did not changed as affected by washing water temperature. Water holding capacity of surimi decreased significantly as affected by cold and frozen storage. Frozen storage caused an increases in viscosity and emulsion capacity compared with cold storage. Hence, frozen storage not only prevent the shelf – life but also improved functional properties of the product.

INTRODUCTION

Consumer demand for processed poultry meat products has increased and large quantities of residual meat, such as, backs, necks and breast frames have become available to processors (Yang and Froning, 1992). Meat adhering to carcasses has been recovered using mechanical separators. Mechanically separated chicken meat (MSCM) has a high content of heme pigments, connective tissue, calcium and fat (Froning, 1981) Yang and Froning, 1992). It has a dark color, undesired textural properties and is susceptible to lipid oxidation. Aqueous washing and sieving have been used to remove fat, heme pigments, connective tissue and other soluble components from MSCM. The resulting preparation was a wet concentrate of chicken myofibrillar proteins, which may be described as chicken surimi (Ball, 1988, Novakofski *et al*, 1993). The resultant material is not only more functional but also more stable, owing to lower concentrations of enzymes, of heme iron, and also of the sugars that are major substrates for microbial growth (Knight, 1992). The quality of the surimi made from MDCM is affected by various processing factors, such as kinds of wash solution, ion strength, washing cycle, pH changes, temperature type of muscle, particle size and rigor state etc. (Lee, 1999). Frozen storage is an essential step in surimi manufacture. Frozen storage brings about detrimental changes in the functional properties of surimi protein, such as gel forming ability, water retention properties and protein solubility (Lee, 1986). The loss of functionality is due to the denaturation of protein, because freezing increases solute concentration and favors dehydration, both of *contribute* to protein denaturation (Mac Donald and Lanier, 1991). To protect the functionality of surimi protein during frozen storage various cryoprotectants, such as sucrose, sorbitol and polyphosphates, have been blended with surimi (Okada, 1985). Spent hen meat is another potential underutilized raw material ordinarily used in low priced minced products in Egypt. Spent hens are old (80 – to 100 wk –old) birds that are characterized by an objectionable toughness of meat because of high amounts of heat–stable collagen (Nakamura *et al*,1975). The toughness has precluded its use in whole meat foods and has reduced its market value (Nurmahmudi and Sams, 1997). However, there is little information on the preparation of surimi – like products from hand debonded chicken meat (HDCM). This investigation was carried out to study the physicochemical and functional properties of surimi made from spent hen meat and to investigate the effect of cold and frozen storage on the quality characteristics of resultant surimi.

MATERIALS AND METHODS

Materials

White spent hens (16 months old) were purchased from Kerdassa Farm, Giza. The birds were slaughtered, allowed to bleed for 2 min before it were placed in the scalding tank where they were subscaleded at 60°C for 30 sec. Birds were defeathered, eviscerated, washed and hand deboned after 3 hr. from slaughter.

Preparation of chicken surimi :

Chicken surimi was prepared according to the method described by Dawson *et al* (1988) with simple modification summarized as follow : Breast and thigh meat was separated after removing the skin and held at 5°C overnight before mincing. The debonded breast and thigh meat was minced separately twic in a cutter robot coupe, R 301 ultra, (France). Hand debonded chicken meat (HDCM) was mixed with 3 volumes of 0.5 % $NaHCO_3$ at pH 8.5. The suspension was stirred for 20 min at 130 xg, allowed to stand 10 min, and the fat was skimmed off. The suspension was sieved (1.4 mm, 12 mesh), resulting in a solid meat portion and a slurry(slurry 1). The solid meat portion which contained mainly connective tissue proteins, was resuspended in 3 volumes 0.5 % $NaHCO_3$ at pH 7.5 (pH was adjused using 60 % (v / v) lactic acid solution). The stirring, skimming and sieving procedures were repeated. The resulting solid meat was discarded and the slurry (slurry 2) was combined with slurry 1 and centrifuged again at 5000 xg for 20 min. The supernatant was discarded and the pellet was washed twice with 2 volumes of deionized water and centrifuged at 11000 xg for 20 min. The pellet was then washed in a 0.2 % NaCl solution and centrifuged at 11000 xg for 20 min. The final pellet which constituted a refined preparation of myofibrillar proteins was referred as chicken surimi. Since the surimi was to be stored at 4 °C and – 18°C, 4 % sucrose, 4% sorbitol, 8 % maltodextrin, 0.3% sodium tripolyphosphate and 0.3% tetrasodium pyrophosphate were mixed into mince as cryoprotectants. The resultant surimi was then packed in polyethylene plastic bags and stored at 4°C and – 18°C.

Analytical Methods:

Moisture, protein, fat and ash contents were performed according to the methods described in the A.O.A.C. (1995).

Collagen was determined by the method described by Lowry, Gilligan and Katersky (1941).

Total pigments and myoglobin were determined according to (Hornsey ,1956).

Color measurements of different samples were carried out using a spectro – colorimeter (tristimulus color machine) with CIE Lab color scale (Hunter, Lab Scan XE, Reston VA.) calibrated with a white standard tile of Hunter Lab color standard (LXNo. 16379) : X = 77.26, Y = 81.94 and Z = 88.14 (L^* = 92.47, a^* = - 0.87, b^* = - 0.18). Color difference (ΔE) was calculated from a,b and L parameters, using Hunter – Scotfield 's equation (Hunter, 1975).

$$(\Delta E) = (\Delta a^2 + \Delta b^2 + \Delta L^2)^{1/2}$$

where $a = ? a - a_o$, $b = b - b_o$ and $L = L - L_o$.

subscript "O" indicates color of control. Hue angle (tg^{-1} b / a) and saturation index [$a^2 + b^2$] were also calculated.

The pH of the homogenized samples were measured using glass electrode of Hi 9021 Micro Processor pH meter (HNNA instruments).

Emulsifying capacity (EC) was determined according to the method of Swift *et al*, (1961). The result was calculated as ml oil / g sample.

Emulsion stability (ES) was evaluated using the method of Inklaar and Fortuin (1969). The separated oil was calculated as a percentage of the total amount of the oil added.

Water holding capacity (WHC) was determined by the method of Jauregui *et al*, (1981). Water holding capacity was expressed as grams of water held per gram of protein within chicken surimi samples.

Viscosity of myofibril suspensions (20 mg / ml protein) was determined according to Xiong and Brekke (1989) using Brookfield Synchro - Lectric viscometer at 4°C (Brookfield Engineering Laboratories, Inc., Stoughton, MA) equipped with a # 3 disc spindle at 50 rpm. Viscosity readings were taken after the spindle had spun for exactly 20 sec.

Protein solubility was determined according to the method described by Hwang *et al*, (1977). The results were calculated as percentage of soluble protein in the total protein.

The Statistical Analysis System (SAS, 1987) was used to carry out an over all analysis of variance (ANOVA), regression and correlation analysis among the studied variables.

RESULTS AND DISCUSSION

Proximate analysis :

Proximate composition and collagen contents of hand debonded chicken meat (HDCM) and chicken *surimi are presented* in Table (1).Lipid *content* was very low in breast (0.85 %) while in thight was (4.03 %) in minced meat, because the external fats were removed by hand from the meat before mincing. These results agree with that *obtained* by Lan *et al*, (1995) *and* Nowsad *et al*, (2000) who found an average of less than 4 % lipid in chicken breast and thigh muscles. Amato *et al*, (1989) found a lipid content of about 3 % in broiler breast and 8 % in thigh muscles. In the whole muscle, bone marrow *and skin are responsible* for a large increase of fat (Froning, 1970). On the other hand, fat content was greatly reduced by 38.82 % and 59.06 % in surimi made from breast and thigh meat, respectively. These results confirmed with *those of previous* studies which have *shown* that aqueous washing followed by skimming and sieving removed fat, from minced meat (Dawson *et al*, 1988, Yang and Froning, 1992 and Mc Cormick *et al*, 1993, Nowsad *et al*, 2000). *Mc* Keith *et al*, (1988) *reported a similar decrease in* fat content after production of a surimi-like product from pork, beef and beef by- products. Moisture and protein content were slightly increased in surimi made from breast and thigh as shown in Table (1). These *results confirmed* well with the results reported by Nowsad *et al*, (2000). The ash content of both surimi made from breast and thigh meat was reduced by 74.29 % and 14.7 % respectively. Mc Cormick *et al*, (1993) *reported* that, *processing mechanically* or *hand* debonded chicken meat into surimi reduced the ash content of the resultant surimi and the reduction in ash content was higher in surimi made from hand bonded meat compared with that *made from* mechanically *debonded meat*. They added also, the reduction in ash content may be due to the association of bone particles with connective tissues removed during washing. In surimi – like product made from mechanically separated meat, no bone *particles larger than* 0.71 *mm* were recovered and 97 % of the bone particles recovered were < 0.3 man. Bone particles of 0.85 mm are the largest allowed in mechanically separated meat (USDA, 1982).

Table (1) : Proximate composition (wt / wt) and collagen content of hand deboneded chicken meat (HDCM) and chicken surimi.

Chemical composition (%)	Breast		Thigh	
	HDCM	Chicken surimi	HDCM	Chicken surimi
Moisture	75.14 ± 0.45	76.98 ± 1.03	75.02 ± 0.28	76.43 ± 1.27
Protein	19.12 ± 0.33	19.69 ± 0.55	16.54 ± 0.42	17.81 ± 0.42
Fat	0.85 ± 0.02	0.52 ± 0.003	4.03 ± 0.28	1.65 ± 0.41
Ash	1.05 ± 0.10	0.27 ± 0.004	0.75 ± 0.06	0.64 ± 0.07
Collagen	1.01 ± 0.20	1.24 ± 0.15	1.42 ± 0.14	2.56 ± 0.28

Hand debonded breast and thigh minced meat had a collagen content of 1.01 and 1.42 % respectively. Heavy connective tissues were mostly removed from the mince during mincing. However, the collagen in spent hen was higher than that of broiler breast and thigh muscles as found by Amato *et al*, (1989) and Lan *et al*, (1995). Processing of hand debonded chicken meat into surimi – like material increased percentage of collagen in the products from 1.01 to 1.24 % and from 1.42 to 2.56 % for surimi made from breast and thigh meat, respectively as shown in Table (1). This may have resulted from reduction of connective tissues particle size during deboning which allowed collagen to remain with the product (Mc Corimick *et al*, 1993).They added also, the maintenance of collagen and a reduction in fat and sarcoplasmic proteins were responsible for the increased collagen percentage.

Change in total pigments and color :

The changes in total pigments, myoglobin and color of surimi – like products prepared from breast and thigh chicken meat are shown in Table (2). It could be noticed that total pigments and myoglobin were decreased in resultant surimi either made from breast or thigh meat, compared with hand debonded chicken meat (HDCM). Data presented in the same table revealed that, surimi – like products was lightest in color (higher Hunter "L" values) and lowest in redness (lower Hunter "a" values), compared with HDCM. On the other hand, surimi made from breast meat had a lower value of yellowness (" b " value) compared with that made from thigh meat. Moreover, a / b ratio decreased in resultant surimi, indicating that $NaHCO_3$ - washing during processing successfully removed the pigments responsible for color, such as myoglobin and hemoglobin. The a / b ratio is an index of apparent change in redness (Hunter, 1972 and Francis, 1975). Yang and Froning (1992) obtained a marked increment of lightness and decrement of redness in mechanically debonded poultry meat washed with 0.1 M Nacl. They added also, sodium bicarbonate more effectively removed heme pigments from washed meat than either water or dilute saline solution alone. These results agree with the results obtained by Dawson *et al*, (1988) and Nowsad *et al*, (2000).

Table (2) : Change of total pigment, myoglobin and color (L . a . b scale.) content of hand debonded chicken meat (HDCM) and chicken surimi

Properties		Breast		Thigh	
		HDCM	Chicken surimi	HDCM	Chicken surimi
Total pigment (mg / g wet tissue)		0.49 ± 0.02	0.21 ± 0.06	1.19 ± 0.07	0.46 ± 0.07
Myoglobin (mg / g wet tissue)		0.18 ± 0.04	0.11± 0.02	0.29 ± 0.07	0.23 ± 0.06
Color	L	49.73 ± 0.57	59.73 ± 0.55	34.94 ± 0.53	44.93 ± 0.54
	a	7.13 ± 0.27	4.05 ± 0.70	13.75 ± 0.55	10.16 ± 0.29
	b	12.53 ± 0.16	11.59 ± 0.35	9.96 ± 0.54	11.68 ± 0.62
	a / b	0.57 ± 0.01	0.35 ± 0.04	1.39 ± 0.13	0.87 ± 0.07

L = Lighter a = Redness b = Yellowness

Functional properties :

Emulsifying capacity and emulsion stability of chicken surimi are shown in Table (3). Data revealed that surimi made from breast or thigh chicken meat had a higher emulsifying capacity and emulsion stability compared with hand debonded chicken meat. These results are in agreement with those reported by Acton and Saffle (1970) and Elkhalifa *et al*, (1988). The higher emulsifying capacity of surimi made from breast meat compared with that made from thigh meat may be due to the type of protein present in the emulsion which affects the emulsifying capacity (Satterlee *et al*, 1971). On the contrary, Hudspeth and May (1967) observed that the emulsifying capacity of salt – soluble proteins from dark meat was higher than that from white meat. Maurer *et al*, (1966) noted that collagen, the major protein component of skin, bone and connective tissue, was a deteriment to the emulsifying capacity of meat.

Table (3): Functional properties of hand debonded chicken meat (HDCM) and chicken surimi.

Properties	Breast		Thigh	
	HDCM	Chicken surimi	HDCM	Chicken surimi
PH Value	6.25 ± 0.07	6.9 ± 0.14	6.45 ± 0.07	7.25 ± 0.07
Emulsifing capacity (ml oil/g protein)	369.72 ± 0.84	407.69 ± 2.18	373.29 ± 1.17	388.23 ± 1.27
Emulsion stability %	64.27 ± 0.51	94.84 ± 1.26	61.82 ± 1.26	93.82 ± 0.98
Water holding Capacity %	51.98 ± 0.21	63.23 ± 0.57	46.91 ± 1.61	57.08 ± C.20
Viscosity	59.57 ± 1.19	155.34 ± 2.55	55.13 ± 2.24	88.01 ± 0.030

Water – holding capacities of HDCM and surimi – like products were compared (Table 3). Water holding capacity of breast minced meat was higher (51.98 %) than that of thigh meat (46.91 %). On the other hand, the water holding capacity of surimi made from breast or thigh meat was higher (63.23 and 57.08 %, respectively) than minced meat as shown in the same table. The increase of water holding capacity resulting from addition of salt and / or polyphosphate as reviewed by Paterson *et al*, 1988, Tsai and Ockerman, 1981. Addition of salt increases the hydration of proteins or increases solubility of proteins such as actine and myosin. Water holding capacity of meat samples is mainly a function of protein – protein interactions in myofibrillar proteins. A weak protein – protein interaction results in an open matrix allowing a higher proportion of total water to be immobilized than in meat proteins with strong protein interactions. The effects of salt and phosphate are to dissociate actomyosin, reducing interactions of these proteins and opening the protein matrix (Park *et al*, 1996).

The viscosity of surimi prepared from breast or thigh meat was higher than the HDCM. Viscosity of surimi made from breast meat was higher

(155.34) than that made from thigh meat (88.01) as shown in Table (3). These results are consistent with the observations reported by Xiong and Brekke (1989) who stated that the breast myofibril suspension was more viscous than the leg myofibril suspension, while they both contained a small quantity of solublized proteins. This may be due to the structural / morphological differences between the two types of myofibrils (Cassens and Cooper, 1971). .

Effect of washing water temperature on fat content, water soluble protein, viscosity and yield of chicken surimi :

The washing process is usually carried out to produce white, odorless and bland flavors surimi products. It removes substances that promote protein denaturation during frozen storage and enhances the functional properties of protein (Yoon *et al*, 1991). Also this process causes loss in soluble matter, lower the solid yield and requires large amount of water (Hastings, 1989, Pacheco *et al*, 1989). In this study, the washing system was carried out by water at different temperature ranged from 5 to 30°C, and ratio of meat to water was 1 : 4. Data presented in Table (4) revealed that the fat content of the resultant surimi made from breast or thigh meat increased gradually as the washing temperature increased.The incremental rate of fat ranged from 1.92 to 19.23 % and from 18.79 to 46.67 % for surimi made from breast and thigh meat, respectively, compared with unwashed surimi. The increase in fat content was mainly attributed to removal of soluble protein in washed water (Lin and Park, 1996).

A gradual losses of water soluble proteins was found when the surimi washed with water at different temperature ranged from 5 to 30°C as shown in Table (4). Lin and Park (1996) reported that sarchoplasmic proteins are the most solublized protein in the washing water. Microscopically, the water – washed muscle had intact muscle fiber fragments with visible striations and amorphous protein particles. The amorphous particles appeared to be disrupted myofiberillar proteins since, in many cases, they were continuous with intact fiber fragments. Small particles of connective tissues were also present. Intact fragments were not obviously pigmented so they were presumably small enough for soluble protein to wash out (Park *et al*, 1996).

With respect to the effect of water temperature during washing on viscosity of chicken surimi, data indicated that viscosity of surimi made from breast or thigh chicken meat decreased gradually as the temperature of washing increases (Table 4). The reduction rate of viscosity was lower in surimi made from breast meat (ranged from 2.61 to 9.36 %) than that made from thigh meat. This may be due to the breast myofibral suspension was more viscous than the thigh myofibrial suspension as reported by Xiong and Brekke,1989 .

The yield of chicken surimi was slightly decreased as a function of washing temperature as shown in Table (4).

Table (4) : Effect of washing water temperature on fat content, water soluble protein, viscosity and yield of chicken surimi.

Washing water temperature(°C)	Fat content %		Water soluble protein		Viscosity		Yield	
	Breast	Thigh	Breast	Thigh	Breast	Thigh	Breast	Thigh
Control (unwashed)	0.52±0.003	1.65±0.41	-	-	155.34±2.55	88.01±0.30	-	-
5	0.53±0.005	2.05±0.10	2.23±0.12	1.37±0.22	148.83±0.41	58.38±0.24	57 2±0.14	68.9±0.42
10	0.56±0.01	2.19±0.05	2.27±0.37	1.72±0.26	151.28±0.09	61.33±0.28	56 4±0 14	68 2±0.14
15	0.59±0 01	1.96±0.08	2.54±0.10	2.67±0.22	150.34±0.31	62.39±0.04	55 2±0 56	65.1±0.84
20	0.56±0.01	2.21±0.13	2.59±0.19	3.19±0.07	145.74±0.54	56.43±0.16	54.95±0 35	64 2±0.14
25	0 62±0.01	2.42±0.15	2 74±0.13	3.17±0.38	140.80±0 60	52.49±0 20	54 8±0 63	63 8±0 35
30	0.61±0.02	2.27±0.19	3 12±0.18	3.53±0.62	142.28±0.04	50 37±0 22	52 3±0 07	62 8±0.28

Effect of storage on the functional properties of surimi :

Table (5) shows the changes in pH, water holding capacity and viscosity of chicken surimi during cold and frozen storage. The pH of surimi made from breast meat and thigh meat ranged from 5.95 to 6.9, and from 6.3 to 7.25, respectively during storage at 4°C. Data indicated that the pH of surimi made from breast meat did not change significantly ($p < 0.05$) during the first two weeks, then decreased gradually up to the end of storage period. On the other hand, the pH of surimi made from thigh meat decreased gradually after the first week of storage up to the end of storage period (Table 5). Results revealed also that the pH of surimi did not change significantly as affected by frozen storage as shown in the same table.

The reduction in the pH value during cold storage may be due to the breakdown of glycogen which lead to the accumulation of lactic acid and a decrease in pH (Benjakul *et al*, 2002). On the other hand, Sikorski *et al*, (1990) reported that the changes in pH depends also on the liberation of *inorganic phosphate and ammonia* due to the enzymatic degradation of ATP.Nowsad *et al*, (2000) reported that the pH of chicken surimi declined at 1 to 2 months of frozen storage and then stabilized at a more or less constant value. They added also, the decrement of pH significantly correlated with the loss of textural qualities during storage. Various authors have found a positive correlation with tripolyphosphate and pH increment of surimi (Hamm, 1970 and Okada,1985). Chang and Regenstein (1967a), however, reported that sodium hexametaphosphate with sucrose and sorbitol partially inhibited the pH increase in frozen codfish mince.

Water holding capacity of surimi made from breast and thigh meat decreased *significantly* ($p < 0.05$) *as affected by cold and frozen storage* (Table 5). Water holding capacity of surimi made from breast and thigh reduced by 12.0 and 17.01 % at the end of cold storage (4°C), respectively, while, it was 9.47 and 8.94 %, respectively for that stored under frozen storage (- 18°C). The reduction in water holding capacity may be due to the reduction in protein solubility during storage (Xiong and Brekke, 1989).It is clear that soluble protein interact with water more favorably than if they are associated (myofibrils). In particular, the increasing WHC can be mainly attributed to the total amount of myosin solubilized, because myosin is largely responsible for water holding capacity in meat systems (Nakayama and Sato, 1971).

The viscosity changes of surimi during cold and frozen storage are shown in Table (5). Surimi made from breast meat was more viscous than that made from thigh meat. This is may be due to the structural / morphological differences between the two types of myofibrils (Cassens and Cooper, 1971). These results confirmed with that obtained by Lee (1998) who reported that breast protein of chicken meat had higher viscosity than thigh protein. Data showed that, cold storage caused a gradual significant decreases in viscosity started from the second week up to the end of storage

Table (5) : Changes of pH value, water – holding capacity and viscosity of chicken surimi during storage at 4°C and – 18 °C.

Storage time (weeks)	pH value (4°C)		pH value (−18°C)		Water holding capacity% (4°C)		Water holding capacity% (−18°C)		Viscosity (4°C)		Viscosity (−18°C)	
	Breast	Thigh	Breast	Thigh	Breast	Thigh	Breast	Thigh	Breast	Thigh	Breast	Thigh
Control	6.9 ± 0.14 A	7.25 ± 0.07 A	6.9 ± 0.14 A	7.25 ± 0.07 A	63.23 ± 0.57 A	57.08 ± 0.20 A	63.23 ± 0.57 A	57.08 ± 0.20 A	155.34±2.55 A	88.01 ± 0.29 A	155.34±2.55 D	88.01 ± 0.29 D
1	6.9 ± 0.00 A	7.2 ± 0.00 A	6.85± 0.07 A	7.25 ± 0.07 A	61.98 ± 0.48 AB	55.72 ± 0.55 B	61.82 ± 0.71 A	55.71 ± 1.87 AB	151.78±0.60 AB	82.38 ± 1.64 A	249.27±1.33 A	101.45±1.25 A
2	6.75 ± 0.07 A	7.05 ± 0.07 B	7.05 ±0.07 A	7.4 ± 0.00 A	60.39 ± 0.03 B	53.27 ± 0.05 C	57.87 ± 0.62 B	52.69 ± 0.78 BC	147.37±2.90 B	73.58 ± 2.62 B	246.87±0.76 B	97.17 ± 2.19 B
3	6.3 ± 0.00 B	6.85 ± 0.07 C	7.0±0.00 A	7.3 ± 0.00 A	58.37 ± 1.47 C	50.39 ± 0.09 D	55.52 ± 1.16 B	49.89 ± 1.06 C	61.94±1.82 C	57.94 ± 3.83 C	243.74±3.40 C	93.83 ± 2.10 C
4	5.95 ± 0.07 C	6.3 ± 0.00 D	6.75± 0.07 A	7.14 ± 0.07 A	55.64 ± 0.04 D	47.37 ± 0.36 E	57.24 ± 1.56 B	51.98 ± 0.49 BC	50.48±0.19 D	40.68 ± 2.21 D	241.67±2.05 C	91.22 ± 0.64 C

* Means followed by the same letter(s) in the same colum are not significantly ($P \leq 0.05$) different from each other according to Duncan's multiple range test

(4 weeks). On the contrary, frozen storage caused an increase in viscosity after one week then decreased and still higher than the fresh samples. This is due to swelling of myofibrils and more of the myofibrillar proteins were solubilized and dispersed causing an increase in viscosity (Offer and Trinick, 1983). On the other hand, as the degree of myofibril dissociation increased, the size of the swollen myofibrils became smaller, resulting in a decrease in viscosity. These results confirmed well with that obtained by Scott *et al*, (1988) and Xiong and Brekke (1989). Who reported that , a higher proportion of myofibrillar protein would explain the unexpectedly high values of viscosity. Furthermore these data support the results reported by other researchers concerned with remarkable differences between white (breast) and red (leg) muscle myofibrillar proteins in their physicochemical and functional properties.

Emulsifying capacity and stability of surimi stored at 4 and – 18°C are shown in Table (6). It could be noticed that emulsifying capacity of surimi made from breast meat decreased significantly after two weeks up to the end of storage at 4°C or – 18°C. While the emulsifying capacity of the surimi made from thigh meat increased significantly during storage at 4 or – 18°C, except the sample stored at 4°C after 4 weeks as shown in the same table. Storage of surimi at 4 or – 18°C caused a significant decreases in emulsifying stability with different levels as shown in Table (6). The changes in emulsion properties of surimi during cold and frozen storage may by due to the changes in protein matrix which available for emulsion formation. Froning (1976) reported that the histological examination of mechanically debonded poultry meat has less of a protein matrix than hand debonded poultry meat. He also added mechanically debonded turkey meat produced emulsions with somewhat larger fat globule size than the hand debonded counterparts. The lack of a protein matrix in the MDCM emulsions was postulated to be caused by protein loss due to heat denaturation during the deboning cycle. Schnell *et al*, (1973) revealed that, as skin content of the meat prior to deboning was increased, the emulsion capacity and stability were significantly decreased.

From the aforementioned results it could be concluded that surimi made from hand – debonded chicken meat had a good quality characteristics. It has low content of pigments and myoglobin as well as lighter in color compared with that prepared from mechanically debonded chicken meat. On the other hand, the resultant surimi has a good functional characteristics during storage. Therefore, based on this study, the manufacture of surimi-like products from hand debonded chicken meat would be recommended as an redient in meat products such as hamburger, frankfurter, sausage .

Table (6) : *Changes of emulsifying capacity* and emulsion stability of chicken surimi during storage at 4°C and – 18 °C.

Storage time (weeks)	Emulsifying capacity (ml oil / g protein) (4°C)		*Emulsifying capacity* (ml oil / g protein) (−18°C)		Emulsion stability % (4°C)		Emulsion stability % (−18°C)	
	Breast	Thigh	Breast	Thigh	Breast	Thigh	Breast	Thigh
Control	407.69±2.18 A	388.23±1.27 CD	407.69±2.18 A	388.23±1.27 C	94.84±1.26 A	93.82±0.98 A	94.84±1.26 A	93.82±0 98 A
1	406.77±2.17 A	402.22±0.14 A	407.77 ±2.19 A	478.78±2.07 A	92.72±0.86 AB	89.16±1.34 B	91.76±0.63 B	90.36±0.66 B
2	397.81±0.62 B	394.83±0.67 B	403.94±1.84 B	475.32±1.40 A	90.52±0.11 B	88.21± 1.54 B	90.23±0.13 B	88.79± 0.62 B
3	392.45±1.12 B	392.58±1.70 BC	400.65±2.84 B	471.98 ±1.87 B	74.53±1.15 C	72.64±1.19 C	90 97±0.48 B	90.85 ±0.71 B
4	384 28±1.46 C	387.28±2.27 CD	400.78±3.44 B	473.78±2.16 A	71.10±0.04 C	71.03±0 44 C	90.57±0.13 B	89.80±0 63 B

- Means followed by the same letter(s) in the same colum are not significantly ($P \leq 0.05$) *different from each other according to* Duncan's multiple range test

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الخواص الطبيعية و الكيماوية والوظيفية للسوريمى المصنع من لحم الدجاج

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تم إعداد سوريمى من صدور و أفخاذ أمهات الدجاج الطازجة المنزوعة العظم يدويا بإستخدام طريقة الغسيل ببيكربونات الصوديوم. ثم تم خلط السوريمى الناتج مع مواد الحماية و التخزين على ٤ ، –١٨م وتم التحليل على فترات منتظمة حتى ٤ أسابيع.كما تم دراسة تأثير درجات حرارة ماء الغسيل من ٥ : ٣٠م علىدرجة جودة السوريمى و أظهرت النتائج المتحصل عليها أن السوريمى الطازج كان أفتح فى اللون و أعلى فى البروتين و أقل فى الدهون و الصبغات الكلية و محتوى الميوجلوبين مقارنة باللحوم المنزوعة العظم. ومن ناحية اخرى لوحظ أنها تتميز بخواص وظيفية جيدة مثل قوة و ثبت الإستحلاب , قوة الإحتفاظ بالماء و اللزوجة .

كما لوحظ أن هناك فقد تدريجى فى البروتين و اللزوجة بزيادة درجة حرارة ماء الغسيل و على العكس يزيد محتوى الدهون تدريجيا ولم يتغير تصافى السوريمى بتأثير درجة حرارة ماء الغسيل .أما التخزين بالتبريد أو التجميد أدى الى إنخفاض معنوى فى قوة الإحتفاظ بالماء للسوريمى كما وجد أن التخزين بالتجميد أدى الى زيادة اللزوجة, قوة الإستحلاب مقارنة بالتخزين بالتبريد. وعلى ذلك فإن التخزين بالتجميد لا يزيد فترة الحفظ فقط و لكنه يحسن من الخواص الوظيفية للمنتج.