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Quality of Spent Hen Surimi as Affected by Surimi Type and Storage Time

Nesrin S Mohammed[1], Amal A Hassan[2], Esam H Mansour[2*], Atef S Osheba[1] and Abo El-Fath A El-Bedawey[2]

[1]*Department of Meat and Fish Technology Research, Food Technology Research Institute, Agricultural Research Center, Giza, Egypt*

[2]*Department of Food Science and Technology, Faculty of Agriculture, Menoufia University, Shibin El-Kom, Egypt*

[*]**Corresponding Author:** Esam H Mansour, Department of Food Science and Technology, Faculty of Agriculture, Menoufia University, Shibin El-Kom, Egypt, Tel: (+02) 01222328188, Fax: (+02) 048-2228187, E-mail: esam_mansour@yahoo.com

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Abstract

Breast and leg spent hen meat were used in the preparation of surimi. Proximate composition, total volatile basic nitrogen (TVBN), thiobarbituric acid (TBA), pH and microbiological analysis of breast and leg meat during preparation of surimi and their storage at -18°C for 3 months were evaluated. Chicken breast meat had higher protein (21.97%), carbohydrates (0.27%) and TVBN (10.44 mg N/100g) and lower moisture (76.22%), fat (0.88%), total ash (0.70%), TBA (0.23 mg malonaldehyd/kg), pH (6.52) values, total bacterial (6.12×10^4 cfu/g), proteolytic bacteria (4.70×10^2 cfu/g) and psychrophilic bacteria (4.65×10^3 cfu/g) counts than chicken leg meat. Moisture content and pH value were increased by increasing the washing steps of chicken meat. However, crude protein, crude fat, total ash, carbohydrates, TVBN, TBA values, total bacterial, proteolytic bacteria and psychrophilic bacteria were decreased by increasing washing steps. Breast type surimi had higher protein (19.37%) and TVBN (10.18 mg N/100g) and lower moisture content (72.69%), fat (0.43%), total ash (0.54%), TBA (0.22 mg malonaldehyd/kg), pH (6.95) values, total bacterial (2.28×10^4 cfu/g), proteolytic bacteria (1.21×10^2 cfu/g) and psychrophilic bacteria (1.38×10^3 cfu/g) counts than leg type surimi. Moisture and protein contents of surimi were not affected by storage time. Crude fat, total ash and carbohydrates contents did not change until two month of storage followed by an increase up to the end of storage time. The TVBN, TBA, pH values were increased as storage time increased. However, total bacterial, proteolytic bacteria and psychrophilic bacteria counts of surimi were decreased as storage time increased.

Keywords: *Spent hen meat; Washing steps; Surimi; Storage time; Microbiological quality*

Introduction

At the end of egg lying cycle, chicken meat (spent laying hen meat) had tough muscle, due to formation of a high amount of heat stable collagen. Therefore these meats need adequate processing to improve their acceptability [1-3]. Surimi defines a concentrate of myofibrillar proteins obtained after mincing and water washing of meat or fish. Surimi technique includes washing, leaching, additive addition and freezing. The main purpose of leaching is to retain myofibrillar proteins by removing sarcoplasmic proteins, lipids, pigments and enzymes. Lipid and enzyme removal can prolong the storage time and enhance the stability of surimi, while pigment removal increases its whiteness [4,5]. Many advantages of surimi production were (1) long shelf life (2) highly functional protein ingredient of good nutritional quality (3) the availability and simplicity of its technology, which permits mass production with consistent product quality (4) prepare from abundant sources of underutilized fish species (5) high content of protein and low fat (6) have slight odor, color, and good gelling ability [1,6-10].

Little information is available on the preparation of surimi from spent hen meat. Therefore the objective of this study was to prepare surimi from breast and leg spent hen meat. Proximate composition, total volatile bass nitrogen, thiobarbituric acid, pH and microbiological analysis of breast and leg meat during preparation of surimi and their storage at -18°C for 3 months were evaluated.

Materials and Methods

Two years old chicken females (spent laying hens) weighing 5-6 kg were purchased from the local market, Cairo, Egypt. Chicken was slaughtered, allowed to bleed for 5 minutes, scalded for 2 min at 60ºC, plucked by hand, eviscerated, rinsed with tap water, skinned, deboned and finally trimmed of fat, as required for the processing. Sorbitol and sodium tripolyphosphate were obtained from El-Gomhoria Company, Cairo, Egypt. Sucrose was purchased from local market, Cairo, Egypt.

Preparation of surimi

Surimi was prepared as described by Jin., *et al*. [10]. The lean chicken meat of breast and leg were separately ground in a meat grinder (MISANO, Italy). The ground lean chicken meat of breast and leg were separately washed three times with cold water (pH 7, 4°C) for 1 min each cycle at a ratio of ground chicken meat:water 1:3 (w/v). The last washed contained 0.3% NaCl. After each washing cycle, the ground lean chicken meat of breast and leg were separately filtered through a 1-mm mesh metal screen to remove connective tissues. The filtrates were centrifuged at 5000 rpm for 25 min and the supernatants containing fat and water-soluble proteins were discarded. The resulting sediments were separately mixed with cryoprotectants (4% sucrose, 4% sorbitol and 0.2% sodium tripolyphosphate). Surimi of chicken breast and leg were separately packaged in polyethylene bags and stored at -18°C for 3 months. Samples were taken at specific time intervals for analysis.

Proximate composition

AOAC methods were used to determine moisture (method 985.14), crude fat (method 960.39), crude protein (method 992.15) and total ash (method 900.02 A) contents [11]. Total carbohydrates content was calculated by difference.

Chemical quality characteristics and pH values

Total volatile basic nitrogen (TVBN) was determined by the method described by Winton and Winton [12]. Thiobarbituric acid value (TBA) was determined according to the procedure described by Kirk and Sawyer [13]. The TBA values were expressed as mg malonaldehyd/kg of dry sample. The pH value was determined using 10% dispersion of surimi sample in distilled water using a Jenway Digital pH meter (Model 3510).

Bacteriological Methods

Total bacterial count and psychrophilic bacteria

The procedure of APHA [14] was followed for total bacterial count and psychrophilic bacteria count using the standard plate count agar and enumerated after incubation at 30°C for 3 days and 8°C for 5 days, respectively.

Lipolytic bacteria count

Lipolytic bacteria were counted according to the methods mentioned by Difco manual [15] using 10% olive oil. The Plates were incubated at 37 ºC for 5 days.

Coliform bacteria count

The coliform bacteria were determined using MacConkey agar medium according to the method described by APHA [14]. The plates were incubated at 37ºC for 24-48 hrs.

Salmonella spp: The *Salmonella spp* was determined according to the method described by FAO [16]. The plates were incubated at 35ºC for 24h.

***Staphylococcus aureus* count:** The *S. aureu*s bacteria was determined according to the method described by APHA and Difco Manual using Baird-Parker medium plus 5 ml egg yolk telluride emulsion to each 100 ml of sterilize media which mixed well before pouring in the plates [14,15]. The plates were incubated at 37ºC for 24 hr.

Yeast and mold counts

The procedures of Difco manual were followed for the determination of yeast and mold counts using potato-dextrose agar medium. The plates were incubated at 20-25ºC for 5 days [15].

Statistical analysis

Data were presented as mean of three replicates ± standard deviations. Two way randomized blocks design was used for surimi type data. Comparisons among means were performed using LSD test. The differences were considered

significant at the 5% level ($p \leq 0.05$) using a Statistical Analysis System (SAS Institute, Inc., Cary, NC, 2008).

Results and Discussions

Proximate composition of chicken used in preparation of surimi

Proximate composition of chicken was affected ($p \leq 0.05$) by chicken part and washing steps (Table 1). Chicken breast had higher ($p \leq 0.05$) crude protein and carbohydrates contents than chicken leg. However, chicken leg had higher ($p \leq 0.05$) moisture, crude fat and total ash contents than chicken breast. Vecerek., *et al*. reported that light-red breast muscles contain more protein and less fat as compared with dark-red leg muscles [17].

	Washing steps	Chicken part		Means[1]
		Breast	Leg	
Moisture %	Unwashed	73.71 ± 0.68	74.94 ± 0.69	74.33[d]
	First washing	76.03 ± 0.75	78.59 ± 0.77	77.31[c]
	Second washing	76.97 ± 0.67	79.62 ± 0.68	78.30[b]
	Third washing	78.16 ± 0.81	80.51 ± 0.82	79.34[a]
Means[2]		76.22[b]	78.42[a]	
Crude protein %	Unwashed	22.97 ±0.72	20.06 ± 0.68	21.52[a]
	First washing	22.13 ± 0.49	19.16 ± 0.71	20.75[b]
	Second washing	21.87 ± 0.60	18.62 ± 0.66	20.15[c]
	Third washing	20.89 ± 0.55	17.95 ± 0.57	19.42[d]
Means[2]		21.97[a]	18.95[b]	
Crude fat %	Unwashed	1.63 ±0.06	3.17 ± 0.07	2.40[a]
	First washing	0.97 ± 0.05	1.26 ± 0.06	1.12[b]
	Second washing	0.54 ± 0.04	0.92 ± 0.04	0.73[c]
	Third washing	0.39 ± 0.03	0.79 ± 0.04	0.59[d]
Means[2]		0.88[b]	1.54[a]	
Total ash %	Unwashed	1.40 ± 0.05	1.48 ± 0.06	1.44[a]
	First washing	0.62 ± 0.04	0.75 ± 0.03	0.69[b]
	Second washing	0.41 ± 0.03	0.57 ± 0.04	0.59[c]
	Third washing	0.36 ± 0.02	0.54 ± 0.02	0.45[d]
Means[2]		0.70[b]	0.84[a]	
Carbohydrates %	Unwashed	0.29 ± 0.02	0.35 ± 0.03	0.32[a]
	First washing	0.25 ± 0.03	0.24 ± 0.02	0.27[b]
	Second washing	0.21 ± 0.02	0.27 ± 0.02	0.24[c]
	Third washing	0.20 ± 0.01	0.21 ± 0.01	0.20
Means[2]		0.27[a]	0.24[b]	

Each value in the table is the mean of three replicates ± standard deviation
[1]Means in the same column with different letters are significantly different at $p \leq 0.05$
[2]Means in the same row with different letters are significantly different at $p \leq 0.05$
Table 1: Proximate composition of chicken as affected by chicken part and washing steps

Moisture content was significantly ($p \leq 0.05$) increased by increasing the washing steps. However, crude protein, crude fat, total ash and carbohydrates contents were significantly ($p \leq 0.05$) decreased by increasing washing steps. The increase in moisture content was mainly due to the absorption of water by hydrophilic residues of myofibrillar proteins [18]. However, the decrease in crude protein, crude fat, total ash and carbohydrates contents was attributed to the increment in moisture content after washing process. Ismail., *et al*. reported that the main functions of washing process during preparation of surimi were to remove fat, blood, enzyme and sarcoplasmic proteins [19]. These results are in agreement with those reported by Nowsad., *et al.* for unwashed and washed spent hen [1].

Total volatile basic nitrogen, thiobarbituric acid and pH value of chicken used in preparation of surimi

The TVBN, TBA and pH value of chicken were affected ($p \leq 0.05$) by chicken part and washing steps (Tables 2). Chicken breast had a higher ($p \leq 0.05$) TVBN value and lower ($p \leq 0.05$) TBA and pH values than chicken leg. These could be attributed to high protein and low fat contents of chicken breast as compared with chicken leg (Table 1). Bhattacharyya., *et al*. found that lipid oxidation is close related to fat levels and the higher the amount of fat, the

greater the TBA value [20]. Rasha reported that fresh spent hen meat had 12.16 mg N/100 g total volatile nitrogen and 0.21 mg malonaldehyd/kg thiobarbituric acid [21].

	Washing steps	Chicken part		Means[1]
		Breast	Leg	
TVBN mg N/100g	Unwashed	12.57 ± 0.17	12.23 ± 0.15	12.40[a]
	First washing	10.76 ± 0.19	10.36 ± 0.17	10.56[b]
	Second washing	9.57 ± 0.18	9.17 ± 0.19	9.37[c]
	Third washing	8.86 ± 0.21	8.29 ± 0.18	8.58[d]
Means[2]		10.44[a]	10.01[b]	
TBA mg malonaldehyd/ kg	Unwashed	0.339 ± 0.03	0.461 ± 0.02	0.40[a]
	First washing	0.261 ± 0.04	0.257 ± 0.04	0.26[b]
	Second washing	0.187 ± 0.02	0.215 ± 0.01	0.20[c]
	Third washing	0.116 ± 0.01	0.192 ± 0.03	0.15[d]
Means[2]		0.23[b]	0.28[a]	
pH	Unwashed	6.13 ± 0.02	6.21 ± 0.03	6.17[d]
	First washing	6.52 ± 0.04	6.60 ± 0.04	6.56[c]
	Second washing	6.64 ± 0.03	6.88 ± 0.02	6.76[b]
	Third washing	6.78 ± 0.02	6.95 ± 0.03	6.87[a]
Means[2]		6.52[b]	6.66[a]	

Each value in the table is the mean of three replicates ± standard deviation
[1]Means in the same column with different letters are significantly different at $p \leq 0.05$
[2]Means in the same row with different letters are significantly different at $p \leq 0.05$
Table 2: Total volatile basic nitrogen, thiobarbituric acid and pH value of chicken as affected by chicken part and washing steps

The TVBN and TBA values of chicken meat were significantly ($p \leq 0.05$) decreased by increasing the washing steps. However, pH value of chicken meat was significantly ($p \leq 0.05$) increased by increasing the washing steps. The decrease in TVBN and increase in pH were attributed to the removal of soluble proteins, free nitrogen, free fatty acids, free amino acids or other water soluble compounds during the washing process [18]. The decrease in TBA might be explained by the removal of some part of fat and blood which encouraging the lipid oxidation [22]. Mean TVBN (8.58- 12.40 mg N/100g) and TBA (0.15-0.40 mg malonaldehyd/kg) values of chicken breast and leg were below the maximum permissible limit (20 mg N/100g and 0.9 mg malonaldehyd/kg) reported by Egyptian standard specifications [23].

Microorganisms	Chicken breast				Chicken leg			
(cfu/g)	Washing steps				Washing steps			
	Unwashed	1	2	3	Unwashed	1	2	3
Total bacterial	6.12×10^4	4.21×10^4	3.65×10^4	2.32×10^4	8.83×10^4	6.71×10^4	4.96×10^4	3.51×10^4
Proteolytic bacteria	4.70×10^2	1.88×10^2	1.49×10^2	1.35×10^2	6.40×10^2	3.12×10^2	2.31×10^2	2.16×10^2
Psychrophilic bacteria	4.65×10^3	2.96×10^3	1.78×10^3	1.47×10^3	5.60×10^3	3.81×10^3	2.62×10^3	2.18×10^3

Lipolytic bacteria, Coliform bacteria, *Staphylococcus aureus*, *Salmonella spp* and Yeast and mold = Not detected
Table 3: Effect of washing steps on microorganism counts of unwashed and washed chicken breast and le

Microbiological analysis of unwashed and washed chicken breast and leg

Chicken breast had lower total bacterial, proteolytic bacteria and psychrophilic bacteria counts than chicken leg (Table 3). Lipolytic bacteria, coliform bacteria, *Staphylococcus aureus, Salmonella spp* and yeast and mold are not detected in chicken breast and leg indicating the sanitary conditions of raw chicken meat. Total bacterial counts of chicken breast and leg in the present study were 2.32-8.83×10^4 cfu/g. Comparable total bacterial counts of chicken breast and leg were reported by Kamil., *et al*. and El-Safy, (4.9×10^3 to 2.8×10^5 cfu/g) [24,25]. Marwa found that fresh chicken breast meat were completely free from coliform bacteria, lipolytic bacteria, *Salmonella spp* and yeast and mold [26]. Total bacterial, proteolytic bacteria and psychrophilic bacteria counts were decreased by increasing washing steps. Mello., *et al*. reported that the washing process may have a beneficial effect on the reduction of microorganisms [27].

Proximate composition of surimi

There are differences ($p \leq 0.05$) in moisture, crude protein, crude fat and total ash contents between breast and leg

type surimi (Tables 4). However non-significant ($p > 0.05$) difference in carbohydrates content was observed between breast and leg type surimi. Breast type surimi had a higher ($p \leq 0.05$) crude protein content than leg type surimi. This could be attributed to a high protein content of raw chicken breast compared with chicken leg (Table 1). However, breast type surimi had lower ($p \leq 0.05$) moisture, crude fat and total ash contents than leg type surimi. These results are in agreement with those obtained by Menezes., *et al*. for surimi from mechanically deboned chicken meat, Hur., *et al*. for alaska pollack with spent laying hen surimi, Nowsad., *et al*. for unwashed and washed spent hen surimi [1,28,29]. Moisture and protein contents of surimi were not significantly ($p > 0.05$) affected by storage time. However, crude fat, total ash and carbohydrates contents did not significantly ($p > 0.05$) change until two month of storage followed by an increase up to the end of storage time. Jin., *et al*. reported that moisture, crude fat and carbohydrate contents of imitation crab stick prepared from chicken surimi were not significantly different during storage at 10°C for 4 weeks [10].

	Storage time (months)	Surimi type		Means[1]
		Breast	Leg	
Moisture %	0	72.96 ± 0.71	74.94 ± 0.73	73.95[a]
	1	72.84 ± 0.68	74.88 ± 0.69	73.86[a]
	2	72.63 ± 0.70	74.68 ± 0.72	73.66[a]
	3	72.34 ± 0.66	74.39 ± 0.66	73.37[a]
Means[2]		72.69[b]	74.72[a]	
Crude protein %	0	19.32 ± 0.49	16.55 ± 0.41	17.94[a]
	1	19.35 ± 0.39	16.56 ± 0.38	17.96[a]
	2	19.37 ± 0.42	16.58 ± 0.49	17.98[a]
	3	19.42 ± 0.38	16.59 ± 0.39	18.01[a]
Means[2]		19.37[a]	16.57[b]	
Crude fat %	0	0.40 ± 0.017	0.89 ± 0.015	0.65[b]
	1	0.42 ± 0.018	0.91 ± 0.018	0.67[ab]
	2	0.44 ± 0.016	0.93 ± 0.019	0.69[ab]
	3	0.45 ± 0.019	0.94 ± 0.017	0.70[a]
Means[2]		0.43[b]	0.92[a]	
Total ash %	0	0.51 ± 0.012	0.74 ± 0.015	0.63[b]
	1	0.53 ± 0.017	0.75 ± 0.014	0.64[b]
	2	0.55 ± 0.014	0.77 ± 0.013	0.66[ab]
	3	0.57 ± 0.013	0.79 ± 0.012	0.68[a]
Means[2]		0.54[b]	0.76[a]	
Carbohydrates %	0	6.81 ± 0.15	6.88 ±0.18	6.85[b]
	1	6.86 ± 0.17	6.90 ±0.19	6.88[b]
	2	7.01 ± 0.18	7.04 ±0.16	7.03[b]
	3	7.22 ±0.16	7.29 ±0.17	7.26[a]
Means[2]		6.98[a]	7.03[a]	

Each value in the table is the mean of three replicates ± standard deviation
[1]Means in the same column with different letters are significantly different at $p \leq 0.05$
[2]Means in the same row with different letters are significantly different at $p \leq 0.05$
Table 4: Proximate composition of surimi as affected by surimi type and storage at -18°C for 3 months

Total volatile basic nitrogen, thiobarbituric acid and pH values of surimi

There are differences ($p \leq 0.05$) in TVBN, TBA and pH values between breast and leg type surimi (Table 5). Breast type surimi had a higher ($p \leq 0.05$) TVBN and lower TBA and pH values than leg type surimi. Similar observation was reported for chicken breast and leg meat (Table 2).

The TVBN, TBA and pH values of surimi were significantly ($p \leq 0.05$) increased as storage time increased. Kaba reported that positive relationship was found between TVBN and TBA values and time of storage [22]. Jin., *et al*. found that the pH values increased with storage time in all sausage containing spent hen surimi samples [9]. The increment of pH values might be attributed to the production of volatile basic components such as ammonia and total volatile nitrogen by meat spoilage bacteria reported by Lawrie and Ledward and Osheba [30,31]. Mean total volatile nitrogen (11.55 mg N/100g) and TBA (0.33 mg malonaldehyd/kg) values of surimi after 3 months of storage were

below the maximum permissible limit (20 mg N/100g and 0.9 mg malonaldehyd/kg) reported by Egyptian standard specifications [23].

	Storage time (months)	Surimi type		Means[1]
		Breast	Leg	
TVBN mg N/100g	0	8.75 ± 0.12	8.40 ± 0.14	8.58[d]
	1	8.97 ± 0.13	8.72 ± 0.11	8.85[c]
	2	11.29 ± 0.15	10.61 ± 0.13	10.95[b]
	3	11.72 ± 0.11	11.37 ± 0.15	11.55[a]
Means[2]		10.18[a]	9.78[b]	
TBA mg malonaldehyd/ kg	0	0.118 ± 0.01	0.198 ± 0.02	0.16[d]
	1	0.191 ± 0.03	0.262 ± 0.04	0.23[c]
	2	0.248 ± 0.02	0.296 ± 0.03	0.27[b]
	3	0.307 ± 0.04	0.352 ± 0.04	0.33[a]
Means[2]		0.22[b]	0.28[a]	
pH	0	6.78 ± 0.02	6.96 ± 0.03	6.87[d]
	1	6.82 ± 0.04	7.18 ± 0.02	7.00[c]
	2	6.97 ± 0.03	7.25 ± 0.04	7.11[b]
	3	7.21 ± 0.02	7.47 ± 0.03	7.34[a]
Means[2]		6.95[b]	7.22[a]	

Each value in the table is the mean of three replicates ± standard deviation
[1]Means in the same column with different letters are significantly different at $p \leq 0.05$
[2]Means in the same row with different letters are significantly different at $p \leq 0.05$
Table 5: Total volatile basic nitrogen, thiobarbituric acid and pH value of surimi as affected by surimi type and storage at -18°C for 3 months

Microbiological analysis of surimi

Data in (Table 6) showed that total bacterial counts of surimi ($1.79\text{-}2.28\times10^4$ cfu/g) did not exceed the maximum levels (10^5 cfu/g) of microbiological criteria for fresh and frozen poultry given by Egyptian standard specifications [23]. Breast type surimi had lower total bacterial, proteolytic bacteria and psychrophilic bacteria counts than leg type surimi. Lipolytic bacteria, coliform bacteria, *Staphylococcus aureus, Salmonella spp* and yeast and mold were not detected in breast and leg type surimi. Similar observation was for chicken breast and leg meat (Table 3). Mohammed., *et al*. reported that lipolytic bacteria, *Staphylococcus aureus, Salmonella Spp* and coliform bacteria were not detected in kobeba prepared from spent hen meat [3].

Microorganisms (cfu/g)	Surimi type	Storage time (months)			
		0	1	2	3
Total bacterial count	Breast	2.28×10^4	2.07×10^4	1.96×10^4	1.79×10^4
	Leg	3.45×10^4	3.21×10^4	3.17×10^4	3.09×10^4
Proteolytic bacteria	Breast	1.21×10^2	1.07×10^2	1.0×10^2	9.00×10
	Leg	1.85×10^2	1.31×10^2	1.18×10^2	1.02×10^2
Psychrophilic bacteria	Breast	1.38×10^3	1.29×10^3	1.16×10^3	1.15×10^3
	Leg	2.11×10^3	1.98×10^3	1.64×10^3	1.48×10^3

Lipolytic bacteria, Coliform bacteria, *Staphylococcus aureus, Salmonella Spp* and Yeast and mold = Not detected
Table 6: Effect of storage at -18°C for 3 months on microorganism counts of breast and leg type surimi

Total bacterial, proteolytic bacteria and psychrophilic bacteria counts of breast and leg type surimi were decreased as storage time increased. This decrease might be due to the addition of sodium tripolyphosphate during the preparation of surimi which has antimicrobial activity. The reduction of microorganism counts during 2-3 months of storage might be due to the breakdown of microorganisms cell wall by ice-crystals formed during freezing process [3].

Conclusion

From the above results, it could be concluded that breast type surimi had higher crude protein and carbohydrates contents and lower moisture, crude fat and total ash contents than leg type surimi. The TVBN, TBA and pH values of surimi were increased during storage time. However, total bacterial, proteolytic bacteria and psychrophilic bacteria counts of surimi were decreased as storage time increased. Lipolytic bacteria, coliform bacteria, *Staphylococcus aureus, Salmonella spp* and yeast and mold were not detected in surimi.

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