EFFECT OF MECHANICALLY DEBONED CHICKEN MEAT HYDROLYSATES ON THE GEL PROPERTIES, WATER-HOLDING CAPACITY AND DPPH RADICAL SCAVENGING ACTIVITY OF FRIED FISH PASTE

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Abstract – The aim of this study is to investigate the effect of addition of mechanically deboned chicken meat (MDCM) hydrolysates on the physicochemical properties of fried fish paste. Addition of 0.8% MDCM hydrolysates (T2) was more effective in decreasing cholesterol content of fish paste compared to the addition of 0.4% MDCM hydrolysates. All the treatment with MDCM hydrolysates had higher breaking force values than the control at 4 and 6 weeks. Also, deformation, gel strength, and jelly strength were higher for the added MDCM treatments compared to the control at 4 or 6 weeks (P<0.05). However, the WHC was lower in the MDCM hydrolysates treatments compared to the control during storage (P<0.05). The addition of MDCM hydrolysates increased DPPH radical scavenging activity (P<0.05).

Key Words – Myosin heavy chain, Mass spectrometry, Porcine muscle.

I. INTRODUCTION

Surimi is the stabilized myofibrillar protein which is prepared from fish muscle by mincing and water washing of mechanically deboned fish to remove blood, lipids, enzymes, and sarcoplasmic proteins [1]. Also, surimi is light in color, bland in odor, low in fat, and extremely functional due to the unique gelling properties of the myofibrillar proteins, their qualities make surimi an ideal functional ingredient for fabricating new food products [2]. Usually, surimi-based foods are the primary ingredient used to fish paste or crab stick. Numerous studies have been conducted on surimi using fish meat. Also, the application of surimi technology in the production of surimi-based products from other species could provide a new approach toward increasing its utilization. As for studies on animal meats, to evaluate the development of surimi-based products made from beef, pork, chicken, animal heart, mechanically deboned meats and spent laying hen meat [3].

One of the raw materials used in the production of processed poultry products is mechanically deboned chicken meat (MDCM), which is produced by numerous processing plants. The hydrolysis of MDCM protein could be an alternative solution to obtain value-added products. Hydrolysates rich in low molecular weight peptides (di- and tri-peptides with as little as possible free amino acids) have been shown to have more dietary uses due to their high nutritional and therapeutic values [4].

Therefore, the aim of this study is to investigate the effect of MDCM hydrolysates addition on the physicochemical properties of fried fish paste.

II. MATERIALS AND METHODS

Sample preparation: The Alaska Pollack and mechanically deboned chicken meat (MDCM) were purchased from a commercial market. MDCM was enzymatic hydrolyzed using commercial proteases such as Alcalase 2.4 L (2.4 AU/g), Flavourzyme 500 mg (500 LAPU/g), Netrase 0.8 L (0.8 AU/g), Protames 1.5 mg (1.5 AU/g) (Novonordisk, Bioindystrials, Inc., Denmark), Pepsin 570 mg and Trypsin 12,800 mg (Sigma corp., Missouri, USA). A 250 g sample of MDCM was minced and then homogenized in 250 mL distilled water using a Polytron homogenizer (T25-B, IKA Sdn. Bhd., Malaysia) at 8,000 rpm for 1 min. The mixture was heated and adjusted pH of Protarnox [Alcalase (55°C, pH 7.0), Flavourzyme (50°C, pH 7.0), Netrase (50°C, pH 6.0), Protames (40°C, pH 7.0), Pepsin (37°C, pH 3.0), and Trypsin (37°C, pH 8.0)]. The enzyme was added (1 g enzyme/100 protein) to the mixture and hydrolyzed for 0.5, 1, 1.5, 2, 4 and 6 h. After 6 h the hydrolytic process was terminated by heating the mixture up to 100°C and maintaining this temperature 10 min, assuring inactivation to the enzyme. The resulting slurry was centrifuged at 3,000×g (Union 5KR, Hanil, Korea) for 20 min. The protein hydrolysate was stored in a cold chamber at 4°C. The manufacturing process of boiled fish paste and the basic formulation of fish paste were presented in Figure 1 and Table 1. The manufactured fish pastes were vacuum packed in polyethylene film bags, allowed to equilibrate 6 weeks at 10±1°C and then evaluated their physicochemical qualities.

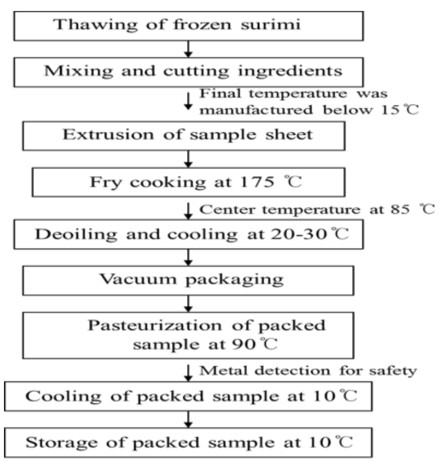

Figure 1. Manufacturing process of boiled fish paste

Table 1. The basic formulation of fish paste

Ingredients (%)	Control	T1	T2
Alaska Pollack	59.70	59.70	59.70
Spent laying hen surimi	14.93	14.93	14.93
Fresh egg white	4.72	4.72	4.72
Soy protein	0.94	0.94	0.94
Sugar	1.51	1.51	1.51
Salt	1.51	1.51	1.51
Monosodium glutamate	1.26	1.26	1.26
Seasoning mix	0.31	0.31	0.31
Wheat starch	6.30	6.30	6.30
Distilled water	8.82	8.42	8.02
MDCM[2)] hydrolysates	-	0.4	0.8
Total	100	100	100

[1)]Mechanically deboned chicken meat

Analytical methods: The proximate composition and cholesterol analysis were performed according to AOAC [5] and Russo et al. [6] methods, respectively. The gel characteristics such as breaking force, deformation, and gel strength were measured using a texture analyzer (EZ-test, Shimadzu, Tokyo, Japan) equipped with a cylindrical plunger (diameter 5 mm, depression speed 80 mm/min). The water-holding capacity and 2,2-diphenyl-1-picryhydrazla hydrate (DPPH) radical scavenging activity were determined by the methods described by Hughes et al. [7] and Brand-Williams et al. [8], respectively. The statistical analysis was performed by general linear model and Duncan's multiple range test of SAS program[9].

III. RESULTS AND DISCUSSION

Proximate composition and cholesterol content: Proximate composition and cholesterol content of fish paste added MDCM hydrolysates are shown in Table 2. The fish paste showed no significant difference in crude protein and ash content compared to the control. However, all the treatment with MDCM hydrolysates lowered moisture contents compared to control ($P<0.05$). Crude fat content in MDCM added groups was significantly higher than that in control ($P<0.05$). The cholesterol content of fish paste added MDCM hydrolysates was lower than that of the control ($P<0.05$). Addition of 0.8% MDCM hydrolysates (T2) was more effective in decreasing cholesterol content of fish paste compared to the addition of 0.4% MDCM hydrolysates. High concentrations of total cholesterol, LDL-cholesterol, and low levels of HDL-cholesterol are a major risk factor for the development and progression of atherosclerosis and coronary artery disease. In addition, cholesterol oxidation products (COPs) may occur favorable with LDL particles, especially in hypercholesterolemic subjects [10]. Some animal protein hydrolysates have been found to have an antioxidant activity [11]. Therefore, we suggest that the addition of MDCM hydrolysates is effective for reducing total cholesterol content; and its oxidative derivatives, which enhances quality and the marketability of fried fish paste.

Table 2. Proximate composition (g/100g) and cholesterol content (mg/100g) of fish paste batter in added MDCM hydrolysates

Measurements	C[1)]	T1	T2
Moisture	69.74±0.10^{A}	68.87±0.12^{B}	69.00±0.10^{B}
Crude protein	18.16±0.17	18.39±0.52	17.28±0.18
Crude fat	0.80±0.02^{B}	1.02±0.06^{A}	1.07±0.09^{A}
Ash	0.76±0.13	0.87±0.17	0.75±0.12
Cholesterol	21.19±0.01^{A}	17.59±0.08^{B}	11.51±0.38^{C}

Data are means ± standard deviation. *n* = 3.
[A-D]Means with different superscript in the same column significantly differ at $p < 0.05$.
[1)]Treatments are the same as in Table 1.

Gel characteristics: Gel characteristics of fried fish paste in added MDCM hydrolysates are shown in Table 3. The breaking force values increased during storage in the T1 and T2. The breaking force was lower in T2 as compared to the other treatment until 2 weeks (P<0.05). The gel strength and jelly strength were consistent trends in these characteristics observed among the fish paste samples. However, all the treatment with MDCM hydrolysates higher breaking force values than the control at 4 and 6 weeks. Also, deformation, gel strength, and jelly strength were higher for the added MDCM treatments compared to the control at 4 or 6 weeks (P<0.05). Protein concentration had a major positive effect on the breaking force [12]. Also, Sylvia et al. [13] reported that the gel-forming ability of surimi increased with a decrease in water content due to higher myofibril protein concentrations and increases of cross-link density. In this study, T1 and T2 showed significantly lower moisture content than the control. Therefore, our results indicate gel characteristics may be influenced by the changes of proximate compositions and addition of MDCM in fish paste.

Table 3. Changes in gel characteristics in added MDCM hydrolysates of fried fish paste during cold storage

Treatments[1)]		Storage periods (weeks)			
		0	2	4	6
Breaking force (g)	C	379.67±7.51^{A}	408.00±20.07^{A}	382.33±20.53^{B}	357.00±26.46^{B}
	T1	374.67±6.43^{Ac}	394.74±10.74^{Abc}	435.33±24.66^{Aa}	417.00±10.00^{Aab}
	T2	341.33±16.77^{Bc}	355.00±8.66^{Bc}	433.33±12.58^{Aa}	398.0±03.61^{Ab}
Deformation (mm)	C	6.91±0.21^{a}	6.71±0.06^{a}	5.81±0.32^{Cb}	5.71±0.21^{Bb}
	T1	6.67±0.25	6.47±0.35	6.31±0.12^{B}	6.61±0.35^{A}
	T2	6.71±0.21	6.51±0.15	6.91±0.23^{A}	6.77±0.15^{A}
Gel strength (g/cm^2)	C	1933.62±38.22^{A}	2077.92±102.20^{A}	2023.60±234.30	1818.18±134.70^{B}
	T1	1908.16±32.74^{Ab}	2064.34±89.43^{Aa}	2217.13±125.60^{a}	2123.76±50.93^{Aa}
	T2	1738.39±85.42^{Bc}	1808.00±44.11^{Bc}	2206.94±64.08^{a}	2026.99±18.36^{Ab}
Jelly strength (g*mm)	C	262.32±12.96^{Aa}	273.70±15.58^{a}	231.43±37.19^{Bab}	203.36±7.96^{Bb}
	T1	249.93±5.95^{AB}	262.79±25.52	274.63±18.13^{AB}	275.63±18.99^{A}
	T2	228.97±14.58^{Bc}	231.00±8.49^{c}	299.27±12.61^{Aa}	269.56±5.40^{Ab}

Data are means ± standard deviation. *n* = 3.
[A-B]Means with different superscript capital letters in a column within each treatment differ significantly (P < 0.05).
[a-c]Means with different superscript small letters in a row within at storage time differ significantly (P < 0.05).
[1)]Treatments are the same as in Table 1.

Water holding capacity and DPPH radical scavenging activity: Water holding capacity (WHC) and DPPH radical scavenging activity of fried fish paste in added MDCM hydrolysates are shown in Table 4. The WHC was lower for the added MDCM hydrolysates treatments compared to the control during storage (P<0.05). During cooking, the various meat proteins denature and cause structural changes, shrinkage of meat fibers, and gel formation of myofibrillar proteins. Therefore, our results indicate WHC may not be affected by addition of MDCM in fried fish paste with extensive degradation of muscle fibers. In the results of DPPH radical scavenging activity, all treatments had increased DPPH radical scavenging activity values, but fish paste maintained significantly decreased DPPH radical scavenging activity after 2 weeks (P<0.05). DPPH radical scavenging activity was higher for the added MDCM hydrolysates treatments compared to the control until 4 weeks. Also, the addition of MDCM hydrolysates increased DPPH radical scavenging activity significantly increased (P<0.05). Wu et al. [14] reported that for mackerel protein hydrolysate, its DPPH activity improved. Wu et al. [14] found that porcine hemoglobin hydrolysates which prepared through hydrolysis by Alcalase followed by Flavourzyme exhibited high ferrous ion chelating abilities and DPPH radical scavenging activity. In our research, the DPPH radical scavenging activities of the Alcalase hydrolysates were similar to whom of the reported Wu et al. [14].

Table 4. Changes in water-holding capacity (WHC) and DPPH radical scavenging activity in added MDCM hydrolysates of fried fish paste during cold storage

Treatments[1)]		Storage periods (weeks)			
		0	2	4	6
WHC (%)	C	69.74 ± 0.10^{Aa}	69.40 ± 0.10^{Ab}	69.71 ± 0.02^{Aa}	69.22 ± 0.11^{Ac}
	T1	68.82 ± 0.12^{B}	69.05 ± 0.09^{B}	68.97 ± 0.12^{B}	68.67 ± 0.30^{B}
	T2	69.00 ± 0.10^{B}	68.61 ± 0.14^{C}	68.58 ± 0.25^{C}	68.73 ± 0.17^{B}
DPPH (%)	C	19.70 ± 1.00^{Cb}	21.76 ± 1.66^{Ca}	17.63 ± 1.21^{Bc}	13.91 ± 1.16^{d}
	T1	21.20 ± 0.46^{Bb}	23.69 ± 1.69^{Ba}	19.00 ± 1.29^{Ac}	14.15 ± 1.11^{d}
	T2	23.98 ± 0.91^{Ab}	25.44 ± 1.42^{Aa}	20.65 ± 0.84^{Ac}	14.44 ± 0.74^{d}

Data are means ± standard deviation. n = 3.
[A-B]Means with different superscript capital letters in a column within each treatment differ significantly (P < 0.05).
[a-c]Means with different superscript small letters in a row within at storage time differ significantly (P < 0.05).
[1)]Treatments are the same as in Table 1.

IV. CONCLUSIONS

The addition of MDCM hydrolysates affected the increases in DPPH radical scavenging activity and improved the gel properties and cholesterol content of fried fish paste. However, WHC was decreased by addition of MDCM hydrolysates.

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