PHYSICAL AND CHEMICAL PROPERTIES OF GELATIN FROM MECHANICALLY DEBONED CHICKEN MEAT RESIDUE (MDCMR)

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Abstract – Mechanically Deboned Chicken Meat Residue (MDCMR) is waste product from chicken processing. Gelatin is water soluble protein mostly present in animal bones, hides, skins and tendons. Gelatin was extracted from MDCMR by combination of alkaline-acid extraction process. This study was done to determine the effect of extraction temperature (60°C, 70°C and 80°C) on the yield of gelatin at pH 4 for 2 hours. Highest yield of gelatin extracted (%w/w) at temperature 80°C (16.03%) compared with gelatin extracted at 70°C (14.19%) 60°C and (5.96%). Proximate analysis of MDCMR showed the protein, moisture, lipid and ash content were 17.77±0.10%, 62.26±0.74%, 9.06±1.99% and 10.10±0.17% respectively. Protein content for the gelatin extracted at temperature of 60°C, 70°C and 80°C were26.61±0.82%, 28.04±1.07% and 33.00±0.35% respectively. Moisture, lipid and ash content for gelatin extracted at temperature 60°C, 70°C and 80°C were significantly different ($p<0.05$). Color determination of gelatin powder and gel showed the significant differences ($p<0.05$) between each other. Gel strength of gelatin were showed significant differences ($p<0.05$) where the gel strength of gelatin extracted inversely proportional to the extraction temperature.

Key Word – Gelatin, Gel strength, Proximate analysis & physical & chemical analysis, Mechanically deboned chicken meat residue (MDCMR)

- INTRODUCTION

Mechanically deboned chicken meat (MDCM) was produced by forcing chicken and some edible chicken meat under a high pressure through a device such as sieve. This process would produce mechanically deboned chicken meat and carcass [1]. These mechanically deboned chicken meats were widely used in many industries especially in food industry, pharmaceutical and cosmetics while the carcass is not utilizing at all until present. This study is to extract gelatin from MDCM residue and analyze the physicochemical properties of the extracted gelatin. Gelatin is one of the popular skin care product. The increased awareness among the people around the world towards health and beauty had given an opportunity to explore a new raw material to extract gelatin. Global demand for gelatin is kept on increasing. Currently, most of the commercial gelatin was extracted from the mammalian source such as skin and bones of cow, yak's bone and fish scale. Bae, (2008) [2] uses fish skin such as *Siganus fuscescens*, *Kyphosus bigibbus*, *Myliobatis tobijei*, *Dasyatis akajei* and *Dasyatis laevigata* to extract gelatin. Partial hydrolysis of collagen will produce gelatin while collagen is a protein mainly found in connective tissues of mammalians such as in cornea, tendon, ligament and skin [3]. Gelatin is a main derivative of collagen [4]. Besides that, gelatins derived from acid-treated and alkali-treated precursors are known as type A and type B, respectively [5]. Tropocollagen is the basic structural unit of collagen [6] which has three polypeptide chains [7]. These three chains coiled to form superhelical structure [7]. However, the industrial extraction process of collagen involves its denaturation to produce gelatin with low molecular weight and high water absorption capacity [8]. In this study, extraction of gelatin will be performed following Alfaro et. al.(2010) [9]'s method with proper modifications. Physiochemical properties such as gel strength determination, colour

determination and percentage of extracted gelatin will be calculated. Proximate analysis will be carried out to determine protein content, moisture content, fat content and ash content.

- MATERIALS AND METHODS

Extraction of Gelatin from MDCMR

The frozen MDCMR were defrozed and cleaned at before extraction. The MDCMR were defatted in water at 35 ^{0}C under constant shaking, and afterwards washed with running water at room temperature (approximately 25 ^{0}C). After that, the MDCMR were demineralized in a solution of 3% HCl for 24 h at 10 ^{0}C, and washed with running water at room temperature to remove the acid in excess, until the pH reaches above 4. Alkaline pre-treatment was carried out in 4 g/100 g NaOH solutions (1:5 w/v) for a period of 72 h at room temperature. The MDCMR was then washed with running water to remove alkali in excess. The extractions were carried out in distilled water at pH 4 that was maintained under constant shaking for 120 min at room temperatures. The pH was adjusted by adding of H3PO4, maintaining a proportion (2.5:1) for the solution and MDCMR, respectively. After the extraction, the material was centrifuged (20,000g, 30 min), and the supernatant obtained was filtered in a Buchner funnel with filter paper Whatman NO. 4. Afterwards, the filtrate was concentrated using rotary evaporator and freeze dried in freeze dryer. Finally, the freeze dried gelatin pieces were packed and stored at 4°C of 60 ^{0}C, 70 ^{0}C and 80 ^{0}C, respectively.

Proximate Analysis

Ash, moisture, lipid and protein content were determined according to AOAC, 1990 method respectively AOAC 923.03 , AOAC 984.25, AOAC 960.39 and AOAC 991.20.

Determination of gelatin yield

The yield of extracted gelatin were calculated using the formula below :

$$\text{Yield} = \frac{\text{Dry weight of gelatin (g)}}{\text{Wet weight of MDCMR (g)}}$$

Determination of Gel Strength

Gelatin solution was prepared following the *British Standard (BS 757:1975)* method The samples were refrigerated at 7 ^{0}C for 18 h. After cool maturation, the gel strength, expressed in Bloom value, was determined with a *Texture Analyzer* (TA.XT2, Stable Microsystems LTD, UK) The plunger was forced to penetrate 4mm into the sample at 8-10 ^{0}C to determine the maximum force (in g).

Determination of colour

Color was evaluated with a colorimeter (CR 300, Minolta Co., Japan) by using 6.67% (w/v) gelatin gels.

Experimental Design and Statistical Analyses

An experimental design of CRD *(Complete Randomized Design)* was used. The analyses were done in duplicates and all the data were analysed using *one-way ANOVA. Duncan Multiple Range* test was used to determine the significance interval at confidence level of 95% (p= 0.05).

III. RESULTS AND DISCUSSION

Proximate composition of raw material

In this study, the average moisture, lipid, protein and ash content of raw material (shown in Table 1) were analysed using AOAC 1990. The ash content of MDCM residue is very high compare to MDCM and FCBM due to the composition of bones such as marrow, cartilage, sodium ions and calcium phosphate [10]. The moisture content of MDCM residue is higher than MDCM also due to bone marrow which is high in moisture [10].

Table 1 Proximate Analysis of MDCMR Compare to MDCM and FCBM

Proximate Content (% w/w ± Standard Deviation)

	Moisture	Lipid	Protein	Ash	Reference
MDCM Residue	62.26± 0.74	9.06± 1.99	17.77± 0.10	10.10± 0.17	
MDCM	61.66± 0.59	24.37± 0.47	11.0± 0.90	0.70± 0.07	Negrao et al. (2005)
FCBM	72.34± 0.37	2.04± 0.29	24.0± 0.27	1.12± 0.02	Negrao et al. (2005)

MDCM = Mechanically Deboned Chicken Meat ; FCBM = Fresh Chicken Breast Meat

Determination of yield

The yield of gelatin at different extraction temperature was clearly shown in Table 2. The yield of gelatin from MDCMR is approximately 12 % with combination of acid and alkaline extraction. This study indicates that yield of gelatin is directly proportional to extraction temperature as it was reported by Alfaro et al. (2010). The main component of organic fraction of bones is collagen Approximately 30% of bone is organic fraction, over 90% of that organic fraction is collagen. Thus, bones can be treated as an alternative to skin in extracting gelatin.

Table 2 Summary of Extracted Gelatin from MDCM Residue

	Extraction Temperature (^{0}C)		
	60°C	70°C	80°C
A=Dry weight of gelatin after freeze dryer (g)	59.62	70.95	80.15
B=Dry weight of gelatin/wet weight of MDCM residue (%w/w)	5.96	14.19	16.03
Average of B (%)		12.08	
C= Dry weight of gelatin/wet weight of Extracted protein (%w/w)	5.96	5.46	7.63
Average of C (%)		6.35	
D= Yield of gelatin at different temperature per total dry weight of gelatin (%)	28.29	33.67	38.04

Proximate composition of gelatin

Table 3 Proximate Analysis of Gelatin Extracted from MDCM Residue

	Proximate Composition (% w/w ± Standard Deviation)			
	Moisture	Lipid	Protein	Ash
Gelatin 60° C	10.84^{b}± 0.87	0.01^{b}± 0.02	27.61^{c}± 0.82	48.29^{b}± 2.50
Gelatin 70° C	6.56^{b}± 0.43	0.18^{a}± 0.09	28.04^{b}± 1.07	52.48^{a}± 0.45
Gelatin 80° C	12.70^{a}± 0.94	0.22^{a}± 0.18	33.00^{a}± 0.35	39.82^{c}± 3.75

$^{a–c}$ Different letters in the same column indicate an insignificant difference ($P < 0.05$).

Gel strength Gelatin Extracted from MDCMR

According to Figure 1, gelatin 60°C, 70°C and 80°C indicates significant difference ($p<0.05$). Bone collagen needs extreme extraction conditions such as temperature, time period of extraction and so on to produce gelatin with short molecular chains. The gel strength decreases with increasing extraction temperature. Imino acid (β and γ fractions) needs higher temperature to fully degrade and this functional property of above stated fractions could produce highly stable gelatin gel.

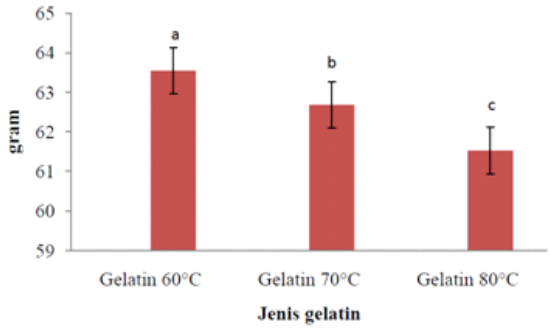

Figure 1. Gel Strength of Extracted Gelatin from MDCM Residue

Colour Gelatin Extracted from MDCMR

Colour of gelatin powder analysed. All the three types of gelatin show significant difference of L*, a* and b* value ($p<0.001$). The three parameters in the model represent the lightness of the color (L*,L*=0 yields black and L*=100 indicates white), its position between magenta and green (a*, negative values indicate green while positive values indicate magenta) and its position between yellow and blue (b*, negative values indicate blue and positive values indicate yellow). The intensity of white colour of gelatin powder decreases with increasing extraction temperature while intensity of yellow colour of gelatin powder increases with increasing extraction temperature.

Table 4 Colour Analysis ofGelatin Extracted from MDCM Residue

	L*	a*	b*
Gelatin 60°C	$81.48^{a}\pm 1.08$	$-5.18^{a}\pm0.15$	$8.27^{a}\pm0.84$
Gelatin 70°C	$71.45^{b}\pm 0.65$	$0.13^{b}\pm0.34$	$9.21^{b}\pm0.43$
Gelatin 80°C	$63.83^{c}\pm 0.83$	$1.32^{c}\pm0.18$	$12.75^{c}\pm0.66$

$^{a-c}$ Different letters in the same column indicate an insignificant difference ($P < 0.05$).

CONCLUSION

The protein content of extracted gelatin 60°C, 70°C and 80°C shows a distinct difference ($p <0.05$). Extracted gelatin at 80°C (33.00%) contains the highest protein content and followed by gelatin gelatin 70°C (28.04%) and 60°C (26.61%). The other proximate values such as moisture, lipid and ash content of extracted gelatin at 60°C, 70°C and 80°C shows distinct difference too($p<0.05$). Colour analysis of gelatin powder and gelatin gels shows significant difference ($p>0.05$). the different extraction temperature gives significant effect in final product($P<0.05$). The final product at 60°C, 70°C and 80°C respectively 28.29%, 33.67% and 38.04%. The percentage of yield is directly proportional to the extraction temperature. The extraction temperature of 80°C resulted in huge amount of yield production compare to other extraction temperature. The increasing extraction temperature resulted in distinct decrease ($p <0.05$) in gel strength of extracted gelatin. The gel strength of gelatin at 60°C, 70°C and 80°C respectively 63.55g. 62.68g and 61.53g.

ACKNOWLEDGEMENTS

This study was financially supported by Ministry of Agriculture, Malaysia, Grant 05-01-02-SF1009.

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