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Chemical Quality of Chicken Bone Waste Gelatin Extracted using Chloride Acid

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ABSTRACT

This study aims to isolate and extract the chicken bone gelatin through hydrolysis process and was analyzed chemically the extracted gelatin product. Research activities included several stages: (1) chicken bone waste preparation (2) ossein extraction (3) gelatin production (4) gelatin chemical analysis. The extraction time was 60 minutes with 5 treatment levels of HCl concentration ie K1 = 2%, K2 = 3%, K3 = 4%, K4 = 5% and K5 = 6%. Each treatment was repeated three times. Gelatin analysis consists of water content, ash content, protein content, pH value, viscosity, and gel strength. The highest water content was 15,76% at 2% HCl concentration, the highest ash content was 44,40% at 2% HCl concentration, and the highest protein content was 23,23% at 3% HCl concentration. The highest pH value was 4.14 produced by gelatin at 2% HCl concentration, viscosity was 5,13 cP and gel strength of 252,43, the best bloom was produced by gelatin at 6% concentration level. The conclusion of this research is the best quality of gelatin is obtained by using chicken bones and the use of chloride acid for 24 hours and 6% HCl concentration level.

Keywords: Extraction, Gelatin, Chicken bone waste

Introduction

Broiler chicken bone has a low economic value. In fact, its production keeps increasing as the increase of processed chicken products that is feared will pollute the environment. This is an opportunity to develop processed chicken bone to be a product with higher economic value, one of them is through the gelatin production.

The high demand of gelatin in Indonesia requires a large quantity of gelatin availability. However, Indonesia still needs to import gelatin to meet the demand. The raw materials to produce gelatin are pigskin (42,4%), cowhide (29,3%), cow bone or pig bone (27,6%), and other materials are from fish skin and sheepskin (0,7%) (GMIA, 2012). This is show that gelatin production is largely from pig, which is prohibited from being consumed by Muslim, so that chicken bone waste gelatin can be one of the alternatives to meet the demand of healthy and halal food in Indonesia. Gelatin is produced by the process of collagen partial hydrolysis. Collagen is a fibrous protein found in the bones, cartilage and skin which are difficult to digest Barbooti *et al*., 2008; Guillen *et al*., 2011; Jayathikalan *et al*., 2011).

Gelatin is generally made of livestock by-product resulting from livestock slaughter and processing, such as skin and bones. The highest component of chicken bone is collagen, which is 5,64-31,39% (Liu *et al*., 2001). Collagen (found in the bones, cartilage and skin) will produce gelatin when it is hydrolyzed partially (Barbooti *et al.*, 2008; Guillen *et al*., 2011). So far, chicken bones just become a by-product, in fact, in the chicken bone it can be found hydroxyproline of 3,26% in the femur and it can be processed to be gelatin.

Chicken bone is a special ligament. In bone, each cell is stored in each lacuna (there is only one cell in lacuna), and one lacuna is connected to another through a number of small canaliculi resembling fibers, with the task to transfer signals. These fibers are called as collagen. This collagen will be converted into gelatin when it is hydrolyzed (Hardikawati, 2016).

A research on gelatin extracted from chicken bone has been conducted on research (Puspitasari and Setiani, 2013) that shows the use different concentration, the length of immersionn, and its interaction affects color quality, level of clarity and level of thickness of chicken bone gelatin. As the HCl concentration and the length of immersion increases, the color quality, level of clarity and level of thickness of gelatin increases. This is supposed to be influenced by pH value.

Materials and Methods

The main material used is chicken bone which is taken from restaurant waste in Sukoharjo. Chemical and supporting materials are: NaOH, HCl, aquadest, pure commercial gelatin from SIGMA. Tools for this research are (1) kitchen equipment such as knife, cutting board, basin, sieve, blender and stove, as well as (2) laboratory equipment such as analytical scales (Sartorius), oven (IK Oven Carbolite), desiccator, water bath, centrifuge and glassware that supports including measuring cups, erlenmeyer, weigh bottles, and glass beaker.

This research is designed in some stages including: First, chicken bone gelatin isolation and extraction through hydrolysis process. Second, production and characterization. At an early stage of preparation, chicken bones are washed and cleaned from remaining meat and fat that is still attached to the bone. Chicken bones are cut into 2-4 cm pieces so that it can speed up the process of chemical reactions that will be carried out. The next stage is bone submersion by adding 2%, 3%, 4%, 5% & 6% HCl solution for 24 hours then neutralized by using 0.1% NaOH and rinsing with running water to get bone meal (ossein). A total of 10 grams of bone meal is then hydrolyzed using 0.15 N HCl at 70^{o}C temperature for 3 hours.

The bone meal solution is then filtered using filter paper, the solid part left on the filter paper is dried in an oven at 55^{o}C. Laboratory analysis including chemical analysis of gelatin, namely: analysis of water content, ash content, protein content, pH value, viscosity and gel strength.

The experimental design used in this study is a Completely Randomized Design (CRD) with one treatment parameter called as gelatin extraction using 2%, 3%, 4%, 5% & 6% HCl solution, with a duration of 24 hours using 3 experimental replication units. Data obtained from physical analysis were calculated statistically using SPSS 17 software using ANOVA method then followed by Duncan's Multiple Range Test (DMRT) if there were significant differences between treatments. Presentation of charts and tables is using Microsoft Excel 2007 software.

Result and Discussion

From the series of experiments that have been conducted, it is resulted data on moisture content, ash content and gelatin protein content of chicken bone gelatin. The data can be seen in Table 1.

Water content

Water is an important ingredient in food. Water can be either an intracellular or extracellular component of a product (Mostafa, 2015). Water in food ingredients determines the acceptability, freshness, and durability of the ingredients. Water can also affect the appearance, texture, taste, and quality of food (Winarno, 2008). Tests on gelatin water content were carried out to determine whether the gelatin produced met the gelatin quality standards according to the Indonesian National Standard (SNI 06-3735-1995).

Table 1 shows that the concentration of chloride acid solution as a soaking solution does not affect the water content of the chicken bone gelatin with values range between 12.97% - 15.76%. The increasing concentration in acid solution causes a decrease in gelatin water content. This is in line with the research conducted by Yuliani (2014), that the concentration of acidic solution as a soaking solution and the length of the submersion affect the moisture content of the mackerel fish skin gelatin, with a value range between 6.55% - 12.35%. All treatment interactions have water content that still meets the gelatin quality standard which is a maximum of 16% (SNI, 1995). The decrease in water content with an increase in the concentration of chloride acid as a soaking solution can be seen in Figure 1.

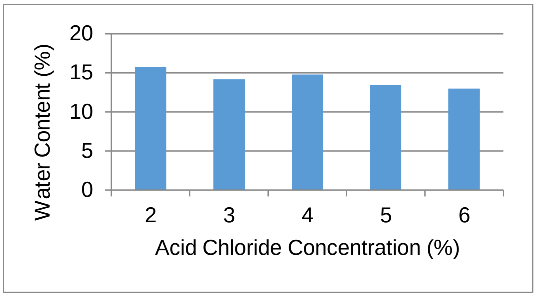

Figure 1. Water content of chicken bone gelatin.

Protein content

Gelatin as one of conversion protein types produced by the process of collagen hydrolysis, basically has a high protein content. Collagen molecules are composed of approximately twenty amino acids that have a slightly different shape depending on the source of the raw material. The amino acids glycine, proline and hydroxy proline

Table 1. Average results of chemical analysis of moisture content, ash content and protein content of gelatin from chicken bone extracted using hydrochloric acid for 24 hours

Variable	Water content (%)	Protein content (%)	Ash content (%)	pH value	Viskosity (cP)	Gel Strength (bloom)
HCl 2%	15.76^a	20.80^{bc}	44.40^e	4.14^a	1.32^a	63.87^a
HCl 3%	14.16^a	23.23^a	37.09^d	4.07^a	2.46^b	118.20^b
HCl 4%	14.79^a	21.80^{bc}	24.06^c	3.87^{ab}	3.30^{bc}	142.79^{bc}
HCl 5%	13.48^a	22.70^b	22.97^b	3.68^b	4.69^c	213.72^c
HCl 6%	12.97^a	18.60^c	23.01^a	3.42^c	5.13^d	252.43^d
HCl 2%	15.76^a	20.80^{bc}	44.40^e	4.14^a	1.32^a	63.87^a

are the main amino acids of collagen. Aromatic and sulfur amino acids are found in small amounts (Yuliani, 2014).

The analysis result of protein content test showed that the HCl concentration treatment with 24 hours of immersion significantly affected the protein content of chicken bone gelatin, with a range of 18.60% - 23.23% and the highest value of 23.23% obtained from gelatin waste bone chicken with 3% HCl concentration.

According to Jannah (2013), the higher the concentration of the solvent given, the greater amount of protein will be produced. This is because the more solvent concentration is given, the stronger the interaction between the bone and the solvent. This interaction causes calcium in the bones to be released from the chicken bones. It also causes the reaction of hydrogen bond breaking and the opening of the collagen coil structure, so that more collagen (protein) is converted into gelatin.

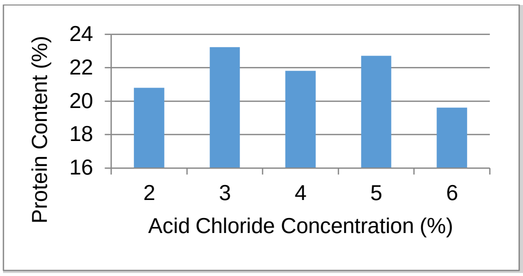

Figure 2. Protein level of chicken bone gelatin.

Ash content

The measurement of ash content aims to determine the amount of mineral content found in gelatin and is one of the important parameters to assess the quality of gelatin, especially in terms of its purity. Ash is an inorganic substance, a residue of the combustion of an organic material.

The result of the ash content analysis showed that the HCl concentration treatment with 24 hours of immersion significantly affected the ash content in chicken bone gelatin, with a range of 22.97% - 44.40% and the highest value of 44.40% obtained from gelatin chicken bone waste with HCl 2% concentration.

Based on the analysis of ash content, it is obtained a quite large result (above the value of the SNI standard), indicates that the content of minerals, especially metals, is also quite high. Based on the results of AAS analysis, it was found that Cu metal was 0.6% (from native chicken bones, 0.5% acetic acid concentration) and 1.1% Cu metal content (Broiler chicken bone type, 1% acetic acid concentration). Based on the standard of SNI, Cu metal in gelatin is a maximum of 30 mg/kg or 0.3%, so in this study there is still a large amount of metal content especially Cu. The amount of Cu or ash content is especially because of both native chickens and Broilers have very fragile bones which are easily crushed during curing treatment in the form of Ossein. Ossein in powder form can easily pass through the filtering process with ordinary filter paper so that during the extraction process the Ossein powder gelatin will merge with gelatin (Jannah, 2013).

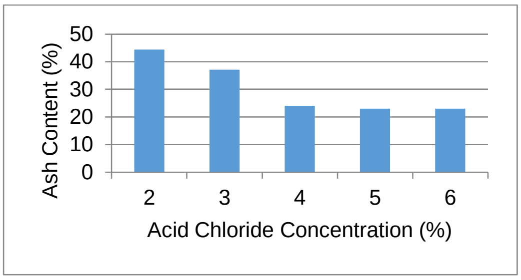

Figure 3. Ash content of chicken bone gelatin.

pH value

The pH (acidity) value of gelatin is one of the important parameters in the gelatin quality standard. The results of data analysis showed the interaction, HCL concentration was found a very significant difference ($P<0.05$) to the pH value of chicken bone gelatin. The pH value obtained in this study ranged from 3.42 to 4.14. The results of this study are in the standard range of gelatin resulted from the acid process determined by GMIA (2012) which is 3.3-5.5, whereas according to Ward and Courts (1977) the pH value of commercial gelatin ranges from 4-7.

The concentration of HCL with 2% level at 24 hours of immersion produces gelatin with the highest pH value of 4.14, this is because the chloride acid used during the immersion is not absorbed too much into the collagen fibril tissue so that during bone washing, chloride acid gets rid of the bone easily, thus producing a good pH value (close to neutral pH) (Rapika *et al*., 2016).

HCL concentration with a level of 6% at 24 hours of immersion produces gelatin with the lowest pH value of 3.42, this is influenced by the use of higher concentration of chloride acid, so that more chloride acid enters the collagen fibril tissue and is extracted to produce low pH value of chicken bone gelatin (Rapika *et al*., 2016).

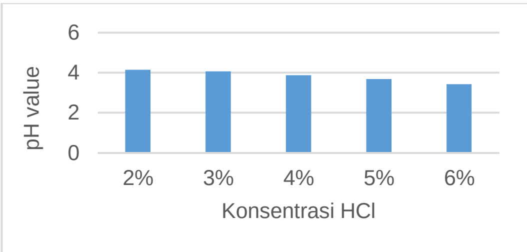

Figure 4. pH value of chicken bone gelatin.

Viscosity

Gelatin viscosity is one of the important physical properties of gelatin. Viscosity test is conducted to determine the level of gelatin viscosity as a solution at a certain temperature (Rusli, 2004). Based on statistical tests, it is shown that the gelatin viscosity was significantly different ($P<0.05$) in the treatment of HCL concentration addition. 2% HCL concentration for

24 hours of immersion has the lowest viscosity value of 1.32 cP. Avena (2006) stated that the smaller the molecular weight of gelatin, the faster the distribution of gelatin molecules in solution, resulting in a low viscosity value.

HCL 6% concentration for 24 hours of immersion has a high viscosity value of 5.13 cP. The high viscosity value is influenced by the molecular weight and the length of the amino acid gelatin chain and the complete breakdown of the collagen chain. The higher HCL concentration will affect the viscosity value of chicken bone gelatin. The viscosity values obtained from this study ranged between 1.32-5.13 cP. This value meets the standards set by GMIA (2012) which is 1.3-7.5 cP.

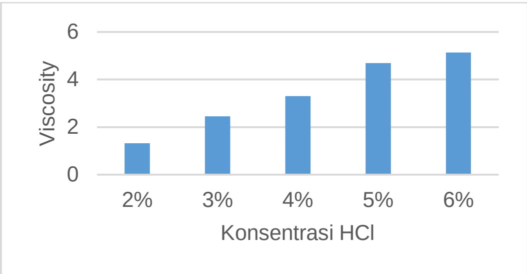

Figure 5. Viscosity of chicken bone gelatin.

Gel strength

Chicken bone gelatin strenght gel produced from 2-6% HCl with 24 hours of immersion can be seen briefly in Table 1. Based on statistical calculations, the use of various HCl concentrations significantly affects ($P<0.05$) the gel strenght. It shows that immersion using 2-6% HCl for 24 hours affects the gel strength of chicken bone gelatin with values ranging from 63.87-252.43 bloom. By considering pH standard (3.8-5.5), viscosity (1.3-7.5 cP) and gel strength (50-300 bloom) from GMIA (2012), the best gel strength of chicken bone gelatin is obtained from the immersion of 6% HCl for 24 hours with a gel strength of 252.43 bloom. Based on the bloom value, gelatin chicken bone strength gel is included in the medium-high bloom type (Schrieber and Gareis, 2007). Based on the GMIA (2012), 50-300 blooms are suitable for edible films, food ingredients, soft and hard capsules. The value of gel strength produced is thought to be influenced by pH and viscosity resulting from the interaction between HCl concentration and the length of immersion.

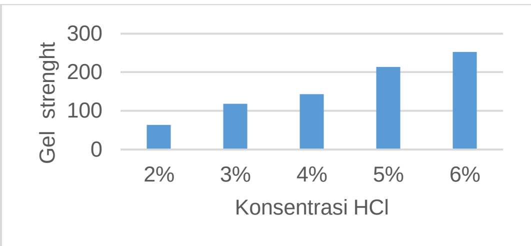

Figure 6. Gel strengh of chicken bone gelatin.

Conclusions

Based on the research that we have conducted, the chemical quality of gelatin obtained by using chicken bones and the use of different chloride acid immersion solutions for 24 hours is obtained the highest water content of 15.76% at 2% HCl concentration, the highest protein content of 23, 23% at 3% HCl concentration, the highest ash content was 44.40% at 2% HCl concentration, the highest pH value was 4.14 at 6% HCl concentration, the highest viscosity was 5.13 cP at 6% concentration and the highest gel strength of 252, 43 at 6% HCl concentration.

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