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Chemical Characteristics and Macrostructure of Hair Concentrates of Bali Cattle Produced from Waste of Skin Crackers Industry

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ABSTRACT

The potential use of waste of livestock as animal feed showed a very significant development. The research objective was to evaluate the chemical composition and macrostructure of hair concentrate produced from waste of skin crackers industry in various production processes. The research material using 1 kg of hair waste of Bali cattle, male aged 2.5-3 years. Skin of Bali cattle was cooking at temperature of 90°C for 1 hour to process hair closing. Waste hair washed and dried by oven at 60°C for 24 hours. Soaking material was using 0.5M NaOH at concentration of 10% and 20% (v/v). Total of 5 g samples of hair waste of Bali Cattle respectively inserted into NaOH 0.5M as soaked solution. The samples were stored for 2 days and 6 days. Samples were drying in an oven on temperature of 100°C for 8 hours and then ground using a blender. The study conducted using experimentally design with a Completely Randomized Design (CRD) and then analyzed by ANOVA. The treatment shows real effect then tested by Duncan'S Multiple Range Test (DMRT) at 5% level. The result showed that different concentrations of NaOH 0.5M in soaking of hair waste significant effect on the protein content and ash, but no effect on the water, fat and crude fiber content. The time difference has significant effect on the protein content. There is no interaction between the using of the concentration of NaOH 0.5M at the time of soaking in chemical characteristics of hair concentrate. Based on the macrostructure analysis was show that the tissue structure in the hair concentrates shorter than hair waste (without treatment/control). Based on the results and discussion can be concluded that, soaking process was using combination of 20% (v/v) of NaOH 0.5M for 6 days (C20;T6) shows the chemical characteristics better than other treatments and control. By microstructure, hair concentrate produced has a soft texture with a tissue structure of hair shorter than control.

KEY WORDS
Bali cattle, hair, skin crackers, NaOH concentration, time soaking

INTRODUCTION

Bali Cattle is one of the local cattle in Indonesia, which has great potential to be developed. Bali cattle have also found in other countries such as Malaysia [1]. Each slaughter of Bali cattle produced waste that could potentially generate hair waste. In Indonesia, skin of Bali Cattle partly processed into industrial products by the

skin crackers. Crackers processing industry of Bali cattle skin is one of the small industrial business units in Indonesia. In the production process, this industry resulted in waste of hair are mostly still containing tissue of the skin (epidermis layer) and meat tissues. The waste is so far untapped and largely still disposed around industrial areas. In terms of chemical composition, this waste were dominated by protein, fat and water so it is potentially experiencing a process of decay and damage the environment, if the handling does not support [2].

The initial of proposing team result showed that the potential hair waste from skin cracker industry is quite significant. The percentage of waste hair of Bali Cattle can reach 3% of body weight. If 10 pieces/day was to process of Cali catlle, average body weight of 250 kg, the potential for hair produced up to 10 x 250 kg x 3% = 75 kg/day or 2.250 kg /month ≈ 2.3 tons /month [3]. Production process of hair concentrate from waste of skin crackers industrial has not been widely studied. Hair of Bali cattle has major structural keratin that different from keratin in wool, hooves and horns. Hair can be an alternative source of protein, especially for monogastric animals [4], as well as a source of nutrients for plants [5]. Utilization of by-products of cattle has been widely studied by previous researchers. In addition to hair waste, utilization of by-products of animal bones developed as a material for producing a food supplement for humans [6]. Collagen products that the result of the extraction process chicken bones has been test in experimental animals. The results show that, the collagen from the bone broiler can consume by humans safely at certain dose [7]. Utilization of by-products such as poultry manure also has potential as raw material for organic fertilizer on the soil. Manure of poultry is very effective to improve the condition of agricultural land, especially rice plants [8].

Production process of hair concentrate usually uses heating methods, chemical and microbiological fermentation [9]. Some researchers have previously mentioned that, the use of NaOH chemical compound can be improved product quality feather meal, especially for ruminants [10]. Application of chemicals in the production process of animal feed has been much study by some previous researchers. For example, the use of a compound of formaldehyde as an ingredient to reduce microorganism contamination in feed post-production [11]. Hair concentrate are a waste processed products, which are manufactured through several processes to their improved as feed for ruminant and non-ruminant [12] [13]. The study aims to evaluate the characteristics of the chemical composition and physical macrostructur of hair waste from Bali cattle using 0.5M NaOH as a soaking solution and different processing time.

MATERIALS AND METHODS

Materials:

The main material used in the study is hair waste of Bali Cattle, male, aged 2.5-3 years from skin crackers processing industry, NaOH 0.5 M, plastic clips, paper labels, distilled water, water, H_2SO_4 (p.a), H_3BO_3 (p.a), selenium (p.a) and indicators. The equipment used is iron plate, oven (*Memmert*), microscope camera binocular (*type Zeiss P95-C Primo Star*), camera for microscope (*type Zeiss AxioCam ERC 5s*), an analytical balance (*Sartorius TE 214S*) and equipment for proximate analysis [14].

Methods:

Preparation of solution for soaking process:

One sheet of skin of Bali cattle cleaned of dirt and blood. Skin of Bali cattle cooked at temperature of 90°C for 1 hour. Hairs of the skin were removing by using an iron plate. Hair waste washed and then dried in an oven at 60°C for 24 hours. Five liters of NaOH 0.5M made as a parent media solution for the needs of the soaking process. It was dilute to reach a concentration of 10% and 20% (v/v) as a media soaking process.

The process of making of hair concentrate:

Total of 100 g of hair waste of Bali Cattle samples prepared for treatment soaking process. Number of 0.5M NaOH with a concentration of 10% and 20% prepared in bekerglass each 200 ml. Total of 5 g samples of hair waste of Bali Cattle respectively inserted into bekerglass soaking solution containing 0.5M NaOH 10% and 20% (v/v). Soaking process of hair conducted for 2-6 days. Samples feather waste dried in oven 100°C for 8 hours and then finely ground using a blender.

Parameter research:

The parameter of chemical characteristics includes water, protein, fat, ash and crude fiber content. Parameter of macrostructur of hair concentrate carried out using a dissecting microscope with a magnification of 100µm.

The study design and data analysis:

The study conducted experimentally by Completely Randomized Design (CRD) 2 x 2 factorial patterns with repeat 3 times. Treatment applied was the first factor consists of two levels soaking solution with concentration (10% and 20%) (v/v) and the second factor consisted of two levels of time process (2 days and 6 days). Data analyzed by analysis of variance (ANOVA) with the help of statistical program SPSS version 15.0.

The treatment, which shows the real effect, then performed the real difference test with Duncan'S Multiple Range Test (DMRT) at the level of 5% [15]. The macrostructure data were analyze by descriptively.

RESULTS AND DISCUSSION

Water content:

The water content is the percentage of water of a material based on the weight of the wet (wet basis) or based on the dry weight (dry basis). Comparison graph of water content of hair concentrate from Bali Cattle on a combination to different processes presented on Figure 1.

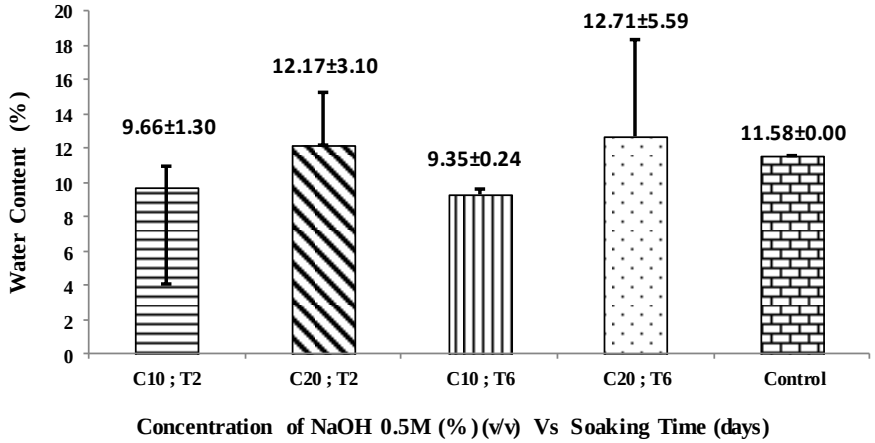


Fig. 1: Comparison graph of water content (%) of hair concentrate from Bali cattle at the different NaOH concentration with soaking time

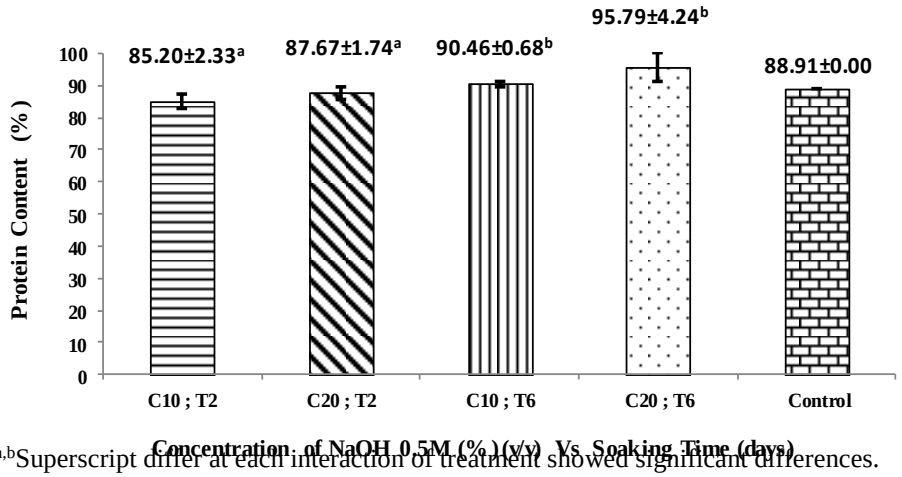
Based on statistical test of the data in Figure 1 shows, that the difference in concentrations of NaOH and the time of soaking and interaction not significant effect on the water content. This shows that the treatment given was not able to raise the content of water-soluble properties that although hair waste soaked is not a significant impact on the content of water of product hair concentrate. NaOH is very soluble and has a high solubility in water, but has a lower solubility in solvents derived alcohol (ethanol or methanol). At the time of melting or dissolving process NaOH into the water, the exothermic reaction occur which released/freed heat to the air.

The water content affect the quality of products, especially related to the appearance and texture. High water levels encourage the growth of microorganisms, especially bacteria, molds, and yeasts so that there will be changes in the product. Water particles contained in the free form and some bound both in the matrix material and in its network. Water is a free form highly volatile because it usually found on the surface of the foodstuffs. The water content needs to be measure to determine the shelf life of a food. Thus, a manufacturer can directly determine the shelf life of their products without having to wait until the product is damage.

The content average of the moisture of hair concentrate is at a value from 9.35 to 12.71%. This value does not vary much with the controls (11.58%). The water content of the product is still relatively low when compared with the tolerance limit of microbial growth in the water content of human food that is 14-15% [16]. The amount of water in the materials will affect the durability of materials against damage caused by microbes and insects [17].

Protein content:

Hairs were a by-product of livestock that have potential as source of protein in cattle [10]. Comparison of protein content of hair concentrate on concentrations of NaOH and time soaking different presented in Figure 2.



Note : [a,b]Superscript differ at each interaction of treatment showed significant differences.

Fig. 2: Comparison graph of protein content (%) of hair concentrate from Bali cattle at the different NaOH concentration with soaking time

Based on statistical test of the data in Figure 2 shows that the difference in concentrations of NaOH 0.5M. Interaction did not show any real effect, but the soaking time showed a significant influence on the protein content of hair concentrate. Increase of NaOH concentration and soaking time increasing the protein content of hair concentrate. This suggests that the building blocks of protein molecules have undergone structural changes caused by the improvements made by NaOH particles so that the protein content is also increased.

NaOH solution was an alkaline chemical compound that capable of changing the composition of proteins in hair waste. Acids and bases can disrupt the salt bridges contained in the proteins. Positive and negative ions in the salt can change partners with positive and negative ions of an acid or a base, so that the salt bridge in a protein that is one type of interaction on the protein disrupted and it can be said denatured protein.

Content of crude protein of hair concentrate in the range of 85.20%-95.79%, on average, higher than control (88.915%). Crude protein content of hair concentrate of Bali Cattle treatment was average higher than chicken feather meal (91.80%) [18]. It is suggests that the potential utilization of hair waste into livestock feed cows protein source is quite large.

Fat content:

Comparison of fat content of hair concentrates from Bali Cattle at treatment concentrations of NaOH and different soaking time presented in Figure 3.

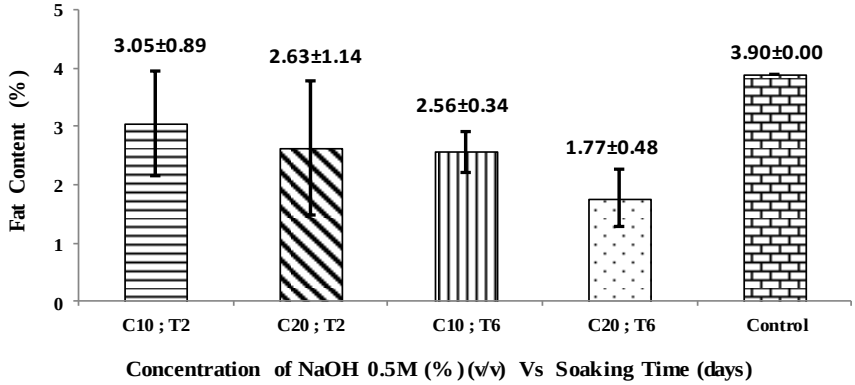


Fig. 3: Comparison graph of fat content (%) of hair concentrate from Bali cattle at the different NaOH concentration with soaking time

Based on the statistical analysis (Figure 3) was shows that the application of the treatment different shows no effect on the fat content Bali Cattle hair concentrate. The results of research showed that the fat content of chicken feather meal product reached 1.2% [19]. Based on this, it appears that on average, the fat content of hair concentrate of Bali cattle (1.77-3.05%) and controls (3.90%) higher than the chicken feather meal. This is likely influence by the presence of fat glands. It is more dominant in Bali Beef cattle compared to chicken. One of the benefits of fat in the diet is as an energy source [20].

Crude fiber content:

The results data of crude fiber content of hair concentrate produced from Bali cattle treatment NaOH concentration and immersion time differently summarized in Figure 4.

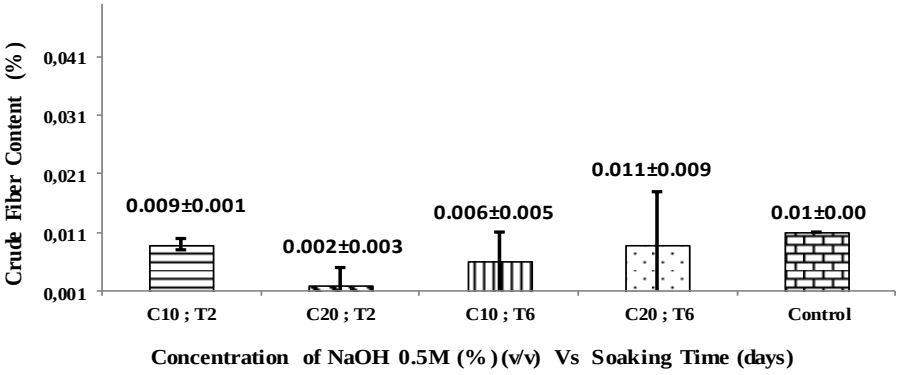
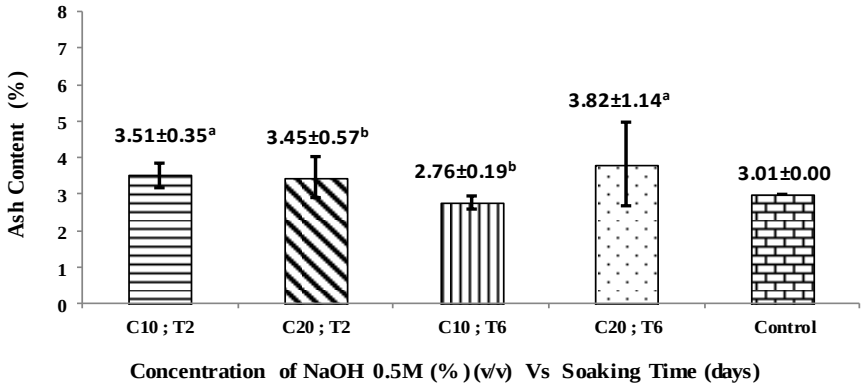


Fig. 4: Comparison graph of crude fiber content (%) of hair concentrate from Bali cattle at the different NaOH concentration with soaking time

Statistical results of the data in Figure 4 was shows that different concentrations and soaking time and their interaction in the process of production of feather meal Bali cattle do not show significat effect on crude fiber content. Crude fiber content of hair consentrate and control can be say to be very low (0.002-0.01%) compared to chicken feather meal hydrolyzate (0.5%) [18]. Fiber in the form of NDF and ADF were directly involved in nutrient digestion process [20].

Ash content:

Differences of NaOH concentration treatment and time process on ash content of hair concentrate presented in Figure 5.



Note : [a,b]Superscript differ at each interaction of treatment showed significant differences.

Fig. 5: Comparison graph of ash content (%) of hair concentrate from Bali cattle at the different NaOH concentration with soaking time

Based on the statistical test of data in Figure 5 was shows that the difference in concentrations of NaOH highly significant effect on the ash content of hair concentrate of Bali cattle, while soaking time different treatments and their interaction showed no significant effect.

On average, the value of ash content of hair concentrate of 2.76%-3.82% higher than the control (3.01%). Soaking with NaOH can change the order of mineral waste of Bali cattle hair, which consists of a carbon-carbon in the form of cysteine amino acids that make up keratin. Keratins were protein fibers that make up hair, feathers, and nails, as well as rich in amino acids of cystine and cyctein [21]. The ash content of materials related to the mineral content of these materials [22]. Values of ash content higher treatment of the ash content of chicken feather meal (3.00%) [23] and 1.90% [18].

Physical appearance and macrostructure of hair tissue:

Comparison of physical appearance and microstructural tissue of hair waste (before soaking) with products hair concentrate (after soaking) from Bali cattle presented in Figure 6. Physical appearance and macrostructure on hair waste of Bali cattle each presented in Figure 6a and 6b. Physically, waste hair of Bali cattle has a stiff and rough texture with the cell size is longer. Compared with hair concentrate product in Figure 6c and 6d, this product has a texture more elastic and soft. The size of the cell becomes shorter after soaking in a solution of NaOH 0.5M. Based on the color, hair concentrate product has a brighter color than the feather waste. Based on the odor, hair concentrate product has a fishy odor better than the hair waste.

Fishy odor in the hair concentrate product caused by the influence of the production process. In the production process, the reaction between the protein in the form of keratin bristles with molecules of NaOH. The molecular structure of the protein keratin has N ions that may be able to experience the process of decomposition resulting in a process of degradation or denaturation produces a fishy odor. The process of protein degradation can produce amino acid polypeptide, peptone, N elements, and components that can cause a foul odor such as NH_3 [24]. Hydrolysis process affect an increasing levels of NH_3 (ammonia) on a product [18].

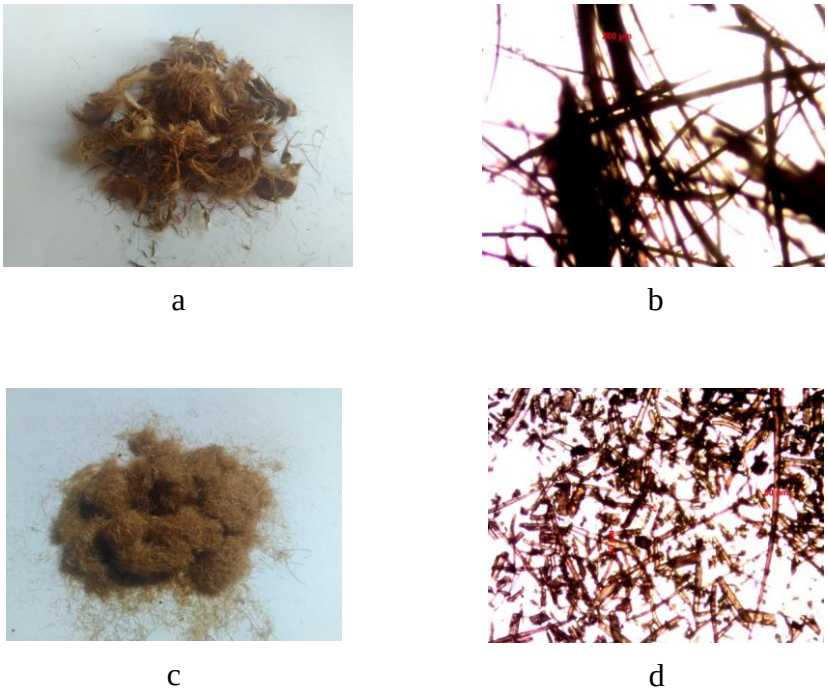


Fig. 6: An overview of physical appearance and cell macrostructure of hair waste (before soaking process in NaOH 0.5 M) and hair concentrate (after soaking process in NaOH 0.5 M) from Bali cattle *(a =physical of hair waste; b = macrostructure tissue of hair waste ; c = physical of hair concentrate; d = macrostructure tissue of hair concentrate ; (Magnification 40X)*

Conclusion:

Application of NaOH 0.5M at different concentrations in the production process of hair concentrate of Bali Cattle significant effect on the protein and ash content, but has no significant effect on the water, fat and crude fiber content of hair concentrate. The differences of soaking time in NaOH 0.5M solution on the production process of hair concentrate of Bali Cattle has significant effect on the protein content. There is no significant effect interaction NaOH 0.5M with soaking time on the chemical characteristics of hair concentrate. Application NaOH 0.5M at concentration of 20% (v/v) for 6 days (C20;T6) shows the chemical characteristics better than other treatments and control. This study can continued to evaluate the level of digestibility of hair concentrate in the feed of ruminant or non-ruminant.

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