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To cite this article: M R Gau *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **788** 012153

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Effect of differences in fermentation process methods of cattle hair waste on the properties of hair protein concentrate

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Abstract. Cattle hide cracker processing industry is one of the industries that produces a large amount of hair waste. Cattle hair waste (CHW) contains a fairly complete nutritional composition. The CHW has the potential to be produced into hair protein concentrate (HPC) for the provision of animal feed. The fermentation method of CHW was identified to affect the properties of the HPC. This study aims to evaluate the effect of applying different fermentation methods on the CHW to the properties of HPC. The research was designed experimentally using a completely randomized (CRD) design with a unidirectional pattern of 4 treatments with 3 replications. A total of 4 fermentation methods were applied, namely R₁ = CHW + *Bacillus subtilis*; R₂ = CHW + Cooking pressure + *Bacillus subtilis* bacteria; R₃ = CHW + NaOH 5% + *Bacillus subtilis*; R₄ = CHW + Cooking pressure + 5% NaOH + *Bacillus subtilis*. The results showed that the different fermentation methods of CHW had a significant ($P < 0.05$) effect on the characteristics of the HPC. The test results regarding crude fiber content obtained values ranging from 1.20 to 4.59%. Fat content is in the range of 6.32-8.69%, while the ash content is in the range of 1.41-2.45%. The application of the R₂ fermentation process method shows the best treatment in terms of its ability to reduce the amount of crude fiber in the HPC from CHW.

1. Introduction

Indonesia is a country that has a diversity of livestock such as chickens, goats, cows and buffaloes. Currently, in Indonesia, the need for food for the community has increased along with the increasing population. Thus, the rate of slaughtering livestock also tends to increase.

In the livestock slaughtering industry, especially cattle, besides producing meat, it also produces by-products in the form of leather. The cattle hide is then processed into traditional food products in the form of skin crackers. In Indonesia, the skin cracker processing industry is growing rapidly. This industry produces cattle hair waste (CHW). The production of cattle hair waste from cattle (CHW) is high enough that it has the potential to be used as a protein source of animal feed. The development of livestock by products for processing into products has grown rapidly. Apart from fur by products, the



use of urine by-products from livestock has also been used as raw material for making liquid organic fertilizers [1]. Another by product that has been developed by several scientists is the use of cow skin and bones as raw materials to produce collagen. Collagen has been widely applied in industrial fields [2,3].

Hair is an epidermal structure that forms the outer covering of the body at a ratio of about 6% of the live weight of the animal. In vertebrate animals, hair is a structure that is classified as the most complex. This part is like horns, hooves and scales, hair is an integumentary attachment. Hair is part of the skin that is formed from a controlled breeding process from the activity of biological cells from the epidermal tissue or the outermost layer of the body [4].

Hair in general has a high protein level in the form of keratin protein. Keratin protein has a low digestibility because of the chemical bonds in the form of disulfide bonds. According to Tarmizi (2011), the use of natural hair without processing as a feed ingredient has very low nutritional value because of the presence of keratin protein compounds which make hair difficult to digest [5]. Therefore, efforts are needed to break these chemical bonds. One effort that can be done is processing it into hair protein concentrate (HPC). HPC production is carried out through a series of processes. One of them is the fermentation process. The quality and quantity of HPC is closely related to the type and processing time carried out [6]. This study aims to evaluate the chemical properties of HPC treated with several different process methods.

2. Materials and methods

2.1. Materials

The main research material in the form of cattle hair wastes (CHW) was obtained from the skin cracker processing industry in the Slaughterhouse Complex, Tamangapa, Antang, Makassar, Indonesia. CHW are the residual waste from cattle hide cracker processing. The fermentation process in CHW were carried out using a type of bacteria *Bacillus subtilis* FNCC 0060 obtained from the Center for Food and Nutrition Studies, Gajah Mada University, Yogyakarta, Indonesia. Solution of 5% of NaOH (1.25 M) was obtained from the Animal Feed Chemistry Laboratory, Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia.

2.2. Methods

2.2.1. Research design. The study was designed using a completely randomized design (CRD) with a unidirectional pattern, 4 treatments with 3 replications. There are 4 types of treatment methods applied in this study, namely: (1) $R_1 = \text{CHW} + \textit{Bacillus subtilis}$; (2) $R_2 = \text{CHW} + \text{Cooking Pressure} + \textit{Bacillus subtilis}$; (3) $R_3 = \text{CHW} + 5\% \text{ of NaOH (1.25 M)} + \textit{Bacillus subtilis}$; (4) $R_4 = \text{CHW} + \text{Cooking Pressure} + 5\% \text{ of NaOH (1.25 M)} + \textit{Bacillus subtilis}$.

2.2.2. Preparation of CHW. Cattle hide was cleaned using running water. The cattle hide was put into a pot filled with water at 80°C for 15 minutes while stirring. Cattle hide was separated with CHW using special equipment. The CHW was then washed again with running water. CHW which have been free of grease and dirty was then dried using the sun for 7 days until it dries. The dried CHW was then used as research materials.

2.2.3. Fermentation process of CHW. The dried CHW samples were put into 4 fermentation bottles. Bottles 1, 2, 3 and 4 respectively for the treatment of fermentation methods R_1 , R_2 , R_3 and R_4 . The cooking pressure (R_2) process was carried out in an autoclave at 21 psi for 10 hours. Soaking process CHW in 5% of NaOH 1.25 M solution (R_3) and (R_4) was carried out for 120 minutes. The CHW fermentation process was carried out for 7 days at room temperature.

2.2.4. *Parameters and data analysis.* The parameters in the study were: (1) protein level, (2) fat level and (3) fiber level. The data obtained were then analyzed using ANOVA. The treatment that showed a significant effect was then tested using the Duncan's multiple range test (DMRT) [7].

3. Results and discussion

3.1. Protein level

Cattle hair waste (CHW) is a waste from cattle that contains high protein. Feather can be processed into hair protein concentrate (HPC) through a certain process. However, protein in hair is classified as a protein that is difficult to digest. Comparison of the HPC protein composition in several process methods was presented in full in figure 1.

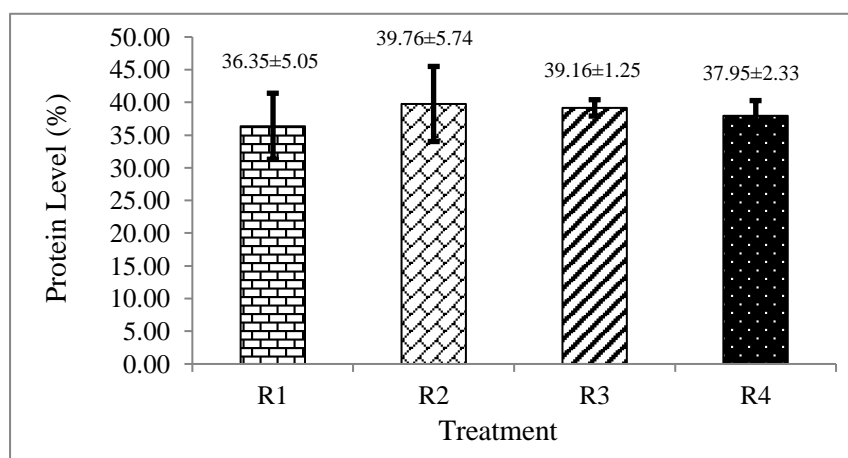


Figure 1. Comparison of protein level (%) in HPC from CHW using four different treatment methods.

Note: HPC=hair protein concentrate; CHW=cattle hair waste; R₁=CHW + *Bacillus subtilis*; R₂=CHW + Cooking Pressure + *Bacillus subtilis*; R₃=CHW + 5% of NaOH 1.25 M + *Bacillus subtilis*; R₄=CHW + Cooking Pressure + 5% of NaOH 1.25M + *Bacillus subtilis*.

Based on the ANOVA research results (Figure 1), it shows that the different treatment methods applied to CHW do not show a significant effect ($P>0.05$) at the HPC protein level. The levels of HPC protein produced were in the range of 36.35-39.76%. The data obtained is different from the results of Sidik (2016) study which analyzed the protein level of beef hair meal reaching a value of 90.79% [8]. Other researchers Puastuti (2007) obtained the value of crude protein level from chicken feather flour (91.80%) [9]. Furthermore, [10] produced chicken feather flour with a protein level of 83-85%. A significant difference has been explained by Said et al., (2017), that the protein level in chicken feather flour is at a value of 60.91-83.07% [11]. The reasons for the differences can be due to different fermentation methods. The fermentation method is thought to degrade the proteins present in the hair. According to Brandelli (2008), the bacterium *Bacillus subtilis* can produce the keratinase enzyme. Keratinase enzymes are among the enzymes that can break bonds in keratin protein [12].

3.2. Fat level

Fat generally functions as a source of energy, a raw material for hormones, to help transport of fat-soluble vitamins, as an insulating material against temperature changes, as well protect the internal organs of the body. In experimental animals that do not get a sufficient amount of fat in their diet will experience growth retardation, some even stop growing and eventually die. Comparison of fat levels in HPC produced using different processing methods was presented in Figure 2.

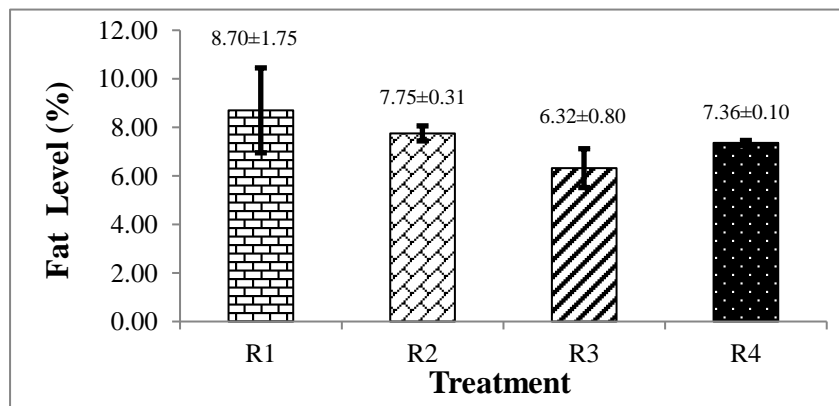


Figure 2. Comparison of fat level (%) in HPC from CHW using four different treatment methods;

Note: HPC=hair protein concentrate; CHW = cattle hair waste; R₁ = CHW + *Bacillus subtilis*; R₂=CHW + Cooking Pressure + *Bacillus subtilis*; R₃=CHW + NaOH 5% + *Bacillus subtilis*; R₄=CHW + Cooking Pressure + NaOH 5% + *Bacillus subtilis*.

The results of analysis using ANOVA on the data in Figure 2 show that the difference in treatment methods on CHW did not have a significant effect ($P>0.05$) on the fat level of HPC. The fat level obtained from the HPC production process was quite varied, namely 6.32-8.70%. The resulting data differ from the opinion National Research Council (1996) that the fat in chicken feather flour is in the range of 3-7.21% [13]. Likewise, the results obtained by Dini et al., (2015) that the fat level in chicken feather flour is 3.37-10.9% [14]. The high fat level in HPC can be affected by the fat level of the CHW source, namely cattle hide. The results of the fat concentrate test results from Said et al., (2018) showed varying values (4.96-6.05%) [15]. This result is lower than the test results on CHW. This result is because the fat level in HPC is much influenced by the fat content in cattle hide.

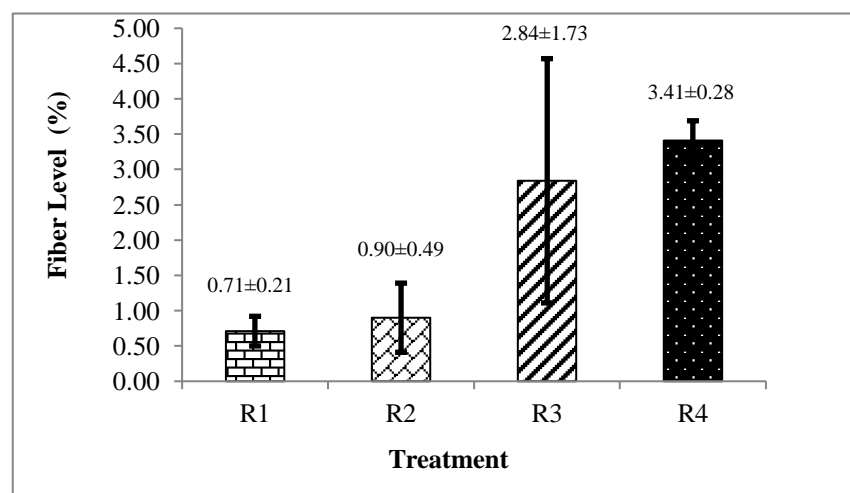


Figure 3. Comparison of fiber level (%) in HPC from CHW using four different treatment methods.

Note: HPC=hair protein concentrate; CHW = cattle hair waste; R₁ = CHW + *Bacillus subtilis*; R₂=CHW + Cooking Pressure + *Bacillus subtilis*; R₃=CHW + NaOH 5% + *Bacillus subtilis*; R₄=CHW + Cooking Pressure + NaOH 5% + *Bacillus subtilis*

3.3. Fiber level

An overview of the comparison of HPC fiber content from CHW raw materials by applying different fermentation process methods is presented in full in Figure 3.

The results of the analysis using ANOVA (Figure 3) in this study indicate that the difference in the fermentation process method which involves the activity of the bacterium *Bacillus subtilis* does not show a significant effect ($P > 0.05$) on the levels of HPC fiber. The value of fiber level in HPC products is in the range of 0.71-3.41%. This amount is different from the results obtained by other researchers [14], where the crude fiber level in feather flour is in the value range of 0.04-0.08%.

4. Conclusion

The application of different fermentation methods to CHW as the main ingredient did not give a different response to the HPC production process. The application of R₁ treatment is the most efficient method compared to other treatments (R₂, R₃ and R₄).

Acknowledgement

The author would like to thank the Rector of Hasanuddin University, the Dean of the Faculty of Animal Science, Hasanuddin University for all the research facilities that have been provided to students and the organizers of The 3rd International Conference of Animal Science and Technology (ICAST-3) for their assistance

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