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Making duck bone meal as a source of calcium using the sidrap protein hydrolysis technology from poultry-based conventional food processing waste

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ABSTRACT

This study aims to determine the best conditions of modification processing of duck bone meal based on the chemical characteristics and the highest calcium content. The research method was modified by Putranto et al., including washing, bone boiling, damage, presto process, boiling process, extraction of NaOH base, washing, drying, and flouring. The research uses a completely randomized experimental design (CRD), consisting of 3 treatments and three replications, namely P1 (NaOH immersion for 2 hours), P2 (NaOH immersion for 3 hours), and P3 (NaOH immersion for 4 hours). The data analysis technique was quantitative and analytic using ANOVA with a significance level of 5% using the SPSS application to determine the effect of immersing NaOH various treatments on the chemical characteristics of duck bone meal. The analysis includes yield, proximate composition, and calcium. In addition, physical, organoleptic, and microbiological analyses were carried out. The best of manufacture of duck bone meal which produces the best characteristics, was found in the 3 hours immersion treatment (P2) with an average ash content of 56.88%, the water content of 4.08%, fat content of 14.45%, protein content of 23.08%, crude fiber content of 0.29%, phosphorus content of 12.03% and calcium content of 9.86%.

ABSTRAK

Penelitian ini bertujuan untuk menentukan kondisi terbaik pada modifikasi proses pembuatan tepung tulang itik berdasarkan karakteristik kimia dan kandungan kalsium tertinggi. Metode penelitian merupakan modifikasi dari metode yang dilakukan oleh [1], diantaranya pencucian, perebusan tulang, pembersihan, proses presto, proses perebusan, ekstraksi basa NaOH, pencucian, pengeringan dan penepungan. Rancangan percobaan yang dilakukan adalah Rancangan Percobaan Acak Lengkap (RAL), yang terdiri dari 3 perlakuan dan 3 ulangan yakni P1 (Perendaman NaOH selama 2 jam), P2 (Perendaman NaOH selama 3 jam) dan P3 (Perendaman NaOH 4 jam). Teknik analisis data yang digunakan adalah analisis kuantitatif dan analitik menggunakan ANOVA dengan taraf nyata 5% menggunakan aplikasi SPSS untuk mengetahui pengaruh perendaman NaOH berbagai perlakuan terhadap karakteristik kimia tepung tulang itik. Analisis yang dilakukan meliputi rendemen, komposisi proksimat dan kalsium. Selain itu dilakukan analisa fisik, organoleptik dan mikrobiologi. Proses produksi tepung tulang itik yang menghasilkan karakteristik terbaik terdapat pada perlakuan perendaman selama 3 jam (P2) dengan rata-rata kadar abu 56.88%, kadar air 4.08%, kadar lemak 14.45%, kadar protein 23.08%, kadar serat kasar 0.29%, kadar fosfor sebesar 12.03% dan kadar kalsium 9.86%.

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1. Introduction

Duck is a type of poultry commonly found in Sidrap Regency because the typical food in the area is made from duck. The typical food of Sidrap Regency is known as palekko' duck. The number of stalls that have been established has also increased the supply of waste in this district. Meanwhile, no waste treatment has been carried out to reduce environmental pollution. One of the pollutions that are feared for this duck bone waste is the pollution of water bodies. Solid waste will harm certain concentrations and quantities to the environment, especially human health, so it needs to be handled [2]. Bone waste, such as chicken bones, is currently underutilized. However, the consumption of meat is increasing, as can be seen from the number of public restaurants or fast food stalls operating.

Bones contain phosphorus and calcium, which are very beneficial for the body. The utilization of bone waste will positively impact waste management [3]. As we know, duck bones contain organic and inorganic substances that, if they hit a body of water, will cause odor and contamination. In comparison, we know that bones contain high calcium and can manufacture animal foods or food products. One of the uses of duck bone waste is its use as additional material in producing feed after being processed into bone meal. The calcium content in bones is quite high. Therefore it can also be used as supplements and drugs to prevent osteoporosis [4]. In addition, it can also be used as a food product, for example, in the manufacture of dry noodles [5].

The manufacture of duck bone flour rich in calcium has the most important process, namely the immersion of the NaOH solution. This process aims to hydrolyze the protein in the flour so that the resulting bone meal contains high calcium levels. The immersion process in this study was carried out to produce duck bone flour with the best calcium content [4]. Bone flour has a rough texture, is brown, and has a distinctive aroma according to the ingredients used. Bone meal is often used as an additive in the manufacture of feed, namely as a source of additional minerals. As an ingredient rich in protein, bone meal is usually used as complementary material to fish meal in the processing of feed products [6]. Bone flour produced by [7] obtained a fairly high calcium content, namely 31.31%, by boiling three times, while based on research [3], it was 30.93%. Immersion in NaOH solution is one of the most important processes in the manufacture of duck bone meal rich in calcium. NaOH immersion aims to hydrolyze protein so that the resulting bone meal contains high calcium levels [7]. NaOH immersion can also produce duck bone meal that has the best calcium content.

2. Research Methodology

2.1. Materials and Tools

The materials used in this study were duck bone waste (sample) obtained from a palekko duck restaurant in Sidrap and chemicals such as aquades, a mixture of selenium catalysts, HCl, NaOH, boric acid, bromocresol green indicator, methyl red indicator, hexane, HNO_3, methyl petaline, phosphates 1 and 2. In addition, equipment for preparing duck bone meal. Other equipment for product analysis is glass, oven, aluminum crucible, desiccator, scale, furnace, hot plate, analytical balance, Kjeldahl distillation apparatus, magnetic stirrer, conical flask, soxhlet, filter paper, boiling flask, aluminum foil, basin, grinder, knife, spectrometer, and pressure cooker.

2.2. Research Design

1.5 N NaOH immersion was carried out with three treatments and three repetitions. The NaOH immersion treatments were P1 (Immersion for 2 hours), P2 (Immersion for 3 hours), and P3 (Soaking for 4 hours). The results obtained were analyzed proximate (ash content, protein content, water content, fat content, and crude fiber content) and phosphorus and calcium levels. In addition, the quality of duck bone meal produced is better than the standard quality bone meal (SNI 01-3158-1992) seen from [8].

2.3. The Process of Making Duckbone Flour

The stages carried out in this study were washing, bone boiling, cleaning, pressurizing process, boiling process, extraction of NaOH base, washing, drying, flouring, and testing stages at the Integrated Biotechnology Laboratory, Faculty of Animal Science Unhas. Duck bone waste samples were obtained from one of the palekko' duck food stalls in Sidrap. Making bone meal refers to methods [3] and [7]. The process of making duck bone flour can be seen in the flow chart below. Making duck flour goes through 10 stages: washing, boiling at 80 degrees Celsius for 30 minutes, cleaning and weighing 200g for each treatment, stem using a press cooker for three hours, boiling three times at 100 degrees Celsius for 30 minutes, extracting using NaOH base with 1.5N NaOH immersion at a temperature of 60 degrees Celsius, washing, drying, refining, and sifting.

2.4. Product Characteristics

The product characterized is duck bone meal. Product characterization was conducted by testing water content using the oven method, fat content using Soxhlet, protein content using the Kjeldahl method, crude fiber content, and ash content [9]. In addition, the products were analyzed by calcium content [10] and phosphorus content [11]. Product characterization was carried out at the Integrated Biotechnology Laboratory, Faculty of Animal Husbandry, Universitas Hasanuddin.

2.5. Data Analysis

The data analysis technique used was quantitative and analytical analysis using ANOVA with a significance level of 5% using the SPSS application to determine the effect of immersing NaOH various treatments on the chemical characteristics of duck bone meal.

3. Result and Discussion

3.1. Yield

The average results of immersion can be seen in Table 1. Judging from the results of the ANOVA test below, it shows that there is a significant difference ($P < 5\%$). The highest yield of duck bone meal was 35.82% in the P1 treatment, namely by immersing in NaOH for 2 hours. This decrease in yield occurs because the longer the time used during the processing process, the more non-mineral components in the material will dissolve [12]. The yield of duck bone produced was still higher than the bone meal produced by [13], which was only 8.85%.

Table 1. Average yield of each treatment of duck bone meal.

Treatment	Yield (5)
P1 (soaking for 2 hours)	35.82[a]
P2 (soaking for 3 hours)	29.81[b]
P3 (soaking for 4 hours)	27.81[c]
Average	31.15

Note: a, b, c = similar letter notation shows no significant difference based on Duncan's test with a level of 5%.

3.2. Water Content

The results of the ANOVA test showed P < 5%. There was a significant difference between each treatment of the water content test on duck bone meal. Based on Duncan's further test, treatment P2 was significantly different from treatment P1 and P3. Meanwhile, treatment P1 and treatment P3 were not significantly different. Based on observations, the water content of duck bone meal produced ranged from 4.08%-5.01% (Table 2). The water content of the produced duck bone meal meets the quality standard of bone meal set by SNI 01-3158 1992, which is a maximum of 8%. The water content of duck bone meal produced was still lower than that of tuna bone meal by [14], which was 5.60%, but higher than that of belida bone meal by [3] which was 3.12%.

Table 2. Average chemical characteristics of duck bone meal in various treatments.

Treatment	Water content (%)	Ash content (%)	Fat content (%)	Protein content (%)	Fiber content (%)	Calsium content (%)	Phosphorus content (%)
P1 (soaking for 2 hours)	5.01 ± 0.06[b]	54.88 ±0.19[a]	16.35 ± 0.13[b]	22.56 ± 0.34[a]	0.28 ± 0.09[a]	10.31 ± 0.16[a]	11.54 ± 0.30[a]
P2 (soaking for 3 hours)	4.08 ± 0.01[a]	56.88±0.46[c]	14.45 ± 0.14[a]	23.08 ± 0.07[b]	0.29 ± 0.02[a]	9.86 ± 0.36[a]	12.03 ± 0.52[a]
P3 (soaking for 4 hours)	4.98 ± 0.06[b]	56.12±0.20[b]	14.55 ± 0.20[a]	22.54 ± 0.98[a]	0.32 ± 0.04[a]	9.66 ± 0.39[a]	12.17 ± 0.35[a]

Note: a, b = similar letter notation shows no significant difference based on Duncan's test with a level of 5%

3.3. Ash Content

The results of the ANOVA test showed P < 5%. There was a significant difference between each treatment of the ash content test on duck bone meal. Based on Duncan's further test, treatment P1 was significantly different from treatment P2 and P3. Meanwhile, treatment P2 was significantly different from treatment P1 and P3, and P3 was significantly different from P1 and P2. The ash content produced in this study ranged from 54.88%-56.88% (Table 2). The highest ash content was produced at P2, namely soaking for 3 hours, which indicates that the duration of immersion in NaOH affects the ash content of the duck bone meal produced. Phosphorus and calcium were higher due to the hydrolysis process of non-ash components, especially protein, during NaOH immersion, increasing ash content [14].

3.4. Protein Content

The results of the ANOVA test showed P < 5%. There was a significant difference between each treatment of the protein test on duck bone meal. Based on Duncan's further test, treatment P1 was not significantly different from treatment P3 but significantly different from P2. The resulting protein content ranged from 22.54%-23.08% (Table 1). The protein content produced is still below the tuna bone meal produced by [13], which is 33.50% which is not produced using the protein hydrolysis method in the manufacture of bone meal. The protein content produced is still high enough so that it will impact low yields for phosphorus and calcium levels. According to [14], the separation and utilization of calcium and phosphate are carried out using a solvent and heating through a protein hydrolysis process. There is a change to water-soluble gelatin from when heated collagen, which is insoluble in water in protein. There is still much-undissolved gelatin content, so the protein content produced is still high.

3.5. Fat Content

The results of the ANOVA test showed P < 5% indicating that there was a significant difference between each treatment of the fat test on duck bone meal. Based on Duncan's further test, treatment P2 was significantly different from treatment P1 but not significantly different from treatment P3. The fat content produced ranged from 14.45%-16.35% (Table 1). The fat content of the duck bone meal produced shows a fairly high-fat content and is above the standard set by SNI. Bone flour has a maximum fat content of 6% (SNI 01-3158 1992). The fat attached to the bone cannot be removed easily and is

difficult to remove even if the bone is immersed in an alkali solution [15] because the fat in the bone is composed of complex bonds [15]. The aroma and taste of bone meal will be influenced by the high-fat content of bone meal produced and will cause fat oxidation reactions to occur easily [13].

3.6. Fiber Content

The results of the ANOVA test showed P < 5%, no significant difference between each treatment of the crude fiber test on duck bone meal. The fiber content of duck bone meal produced ranged from 0.28%-0.32% (Table 1). The longer the duck bone soaking, the higher the fiber content. The higher the fiber content of a food product, the slower the rate of digestion and absorption of nutrients [16].

3.7. Calsium Content

The results of the ANOVA test showed P < 5%, no significant difference between each treatment of the calcium test on duck bone meal. The calcium content of duck bone meal produced ranged from 9.66%-10.31% (Table 1). The calcium content of duck bone meal using the protein hydrolysis method is still low and below the quality standard of the bone meal according to SNI 01-3158 1992. However, duck bone meal produced by the protein hydrolysis method has increased calcium levels compared to the drying method. Duck bone flour from the drying method was 1.90% [17]. Bone flour has a maximum calcium content of 20%-30% (SNI 01-3158 1992) because the high protein content affects the low calcium levels produced. After all, the protein hydrolysis process is not optimal.

3.8. Phosphorus Content

The results of the ANOVA test showed P < 5%, no significant difference between each treatment of phosphorus test on duck bone meal. The phosphorus content of duck bone meal produced ranged from 11.54%-12.17% (Table 1). Phosphorus levels produced in this study were still relatively high compared to phosphorus levels in belida fish bone meal, which ranged from 3.98%-4.06% [18]. According to [19], in an alkaline environment, calcium and phosphorus in bones will form calcium-phosphate. According to [20], this calcium-phosphate is a crystalline mineral that is insoluble in alkaline conditions (alkaline pH).

4. Conclusion

The results showed that the protein content was higher than the level of calcium and other nutrients so that duck bone meal could be used as an alternative source of animal protein.

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