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Utilization of chicken bones (Gallus gallus domesticus) into gelatin using extraction methods

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A B S T R A C T

This study aimed to produce gelatin from chicken bones using various acid solvents and soaking times, and to evaluate the quality of the resulting gelatin in accordance with SNI standards. Chicken bones were soaked in 6% HCl, 4% CH_3COOH, 7% H_3PO_4, 0.3 M citric acid, and lime extract for 24 and 48 hours, and then extracted using a water bath at 75°C for 6 hours. The resulting gelatin was analysed for yield, moisture content, ash content, pH, protein content, organoleptic tests (colour and aroma), and FTIR spectrum. The results showed that all types of solvents could produce gelatin that met several quality parameters as specified in SNI 06-3735-1995. FTIR results for the H_3PO_4 sample showed the presence of characteristic gelatin functional groups, namely 3184.32 cm⁻¹ (Amide A), 1646.58 cm⁻¹ (Amide I), 1456.74 cm⁻¹ (Amide II), 1173.34 cm⁻¹ (Amide III), indicating the successful conversion of collagen into gelatin. The optimal condition was obtained at In the treatment using lime extract with a soaking time of 48 hours, it produced a yield of 3.31%, moisture content of 2.49%, ash content of 1.12%, pH of 4.00, protein content of 79.94%, and the best organoleptic values with scores of 3.20 for color, 1.9 for aroma, and 1.23 for texture. This study indicates that lime can be an effective, environmentally friendly alternative solvent for the production of gelatin from chicken bone waste.

Contribution to Sustainable Development Goals (SDGs):
SDG 12: Responsible Consumption and Production
SDG 9: Industry, Innovation, and Infrastructure
SDG 3: Good Health and Well-being
SDG 13: Climate Action

1. INTRODUCTION

1.1. Research Background

Chicken (Gallus gallus domesticus) is one of the main food sources in Indonesia, both as meat and eggs, and is widely consumed across all levels of society. Data from the Ministry of Agriculture show that in 2024, broiler meat production reached 3.84 million tons, while domestic demand was only 3.72 million tons, resulting in a monthly surplus of approximately 116.19 thousand tons. This excess production indirectly increases waste from poultry slaughter, including bones that are not optimally utilised and are mostly used only as animal feed. Chicken bone waste has potential to be processed into high-value products such as gelatin, given its relatively high collagen content.

Gelatin is a protein produced by the partial hydrolysis of collagen and is widely used across various industries, from food and pharmaceuticals to cosmetics and biomedical applications. Currently, Indonesia's gelatin demand is largely met through imports, typically sourced from bovine and porcine raw materials. This raises concerns about the halal status of such products among the Muslim population. Therefore, the search for alternative gelatin sources that are halal, sustainable, and economical is urgently needed. Chicken bones, as slaughterhouse byproducts, could serve as a potential raw material to help meet domestic gelatin needs.

1.2. Literature Review

Several previous studies have explored methods for extracting gelatin from animal bones, varying the solvent type and soaking time. [1] reported that the use of acetic acid affects the yield and quality of the resulting gelatin. Other studies have shown that different solvents, such as citric acid and hydrochloric acid, can produce varying gelatin characteristics, particularly in pH, clarity, and gel strength [2]. Soaking duration is also an important factor, as periods that are too short or too long can affect the effectiveness of demineralisation and the final gelatin quality [3]. However, to date, there has been no comprehensive study comparing the effects of several types of acidic solvents, including natural solvents such as lime (Citrus aurantiifolia), with varied soaking times on the quality of gelatin produced according to SNI standards

1.3. Objective

This study was conducted to evaluate the gelatin production process from chicken bones using five types of acidic solvents: 6% HCl, 4% CH_3COOH (acetic acid), 7% H_3PO_4 (phosphoric acid), 0.3 M $C_6H_8O_7$ (citric acid), and lime (Citrus aurantiifolia), with variations in soaking time. Analyses performed included yield, pH, moisture content, ash content, protein content, organoleptic tests, and structural characterization using FTIR. The results of this study are expected to provide an alternative use for chicken bone waste as a halal and sustainable source of gelatin and to serve as a reference for developing industrial gelatin processes based on poultry raw materials

2. MATERIALS AND METHODS

2.1. Materials

The main material used was 3 kg of fresh chicken bones (Gallus gallus domesticus) obtained from a local poultry slaughterhouse waste. Chemicals and reagents included 6% hydrochloric acid (HCl), 4% acetic acid (CH_3COOH), 7% phosphoric acid (H_3PO_4), 0.3 M citric acid ($C_6H_8O_7$), and lime (Citrus aurantifolia) extract as a natural solvent. Deionized water (aquadest), 50% sodium hydroxide (NaOH) solution, 0.1 N sulfuric acid (H_2SO_4), copper sulfate ($CuSO_4$), and potassium sulfate (K_2SO_4) were also used for protein analysis.

2.2 Methods

The study employed a factorial experimental design with two independent variables:

1. **Acid** solvent type: 6% HCl, 4% CH_3COOH (acetic acid), 7% H_3PO_4 (phosphoric acid), 0.3 M $C_6H_8O_7$ (citric acid), and lime (Citrus aurantifolia) extract.
2. Soaking time: 24 hours and 48 hours.

Controlled (fixed) parameters included: **raw material mass:** 250 g; **soaking solution volume:** 500 mL; **extraction volume:** 500 mL; **extraction temperature:** 75°C.

Observed response variables were: yield, pH, moisture content, ash content, protein content, organoleptic properties (color, aroma, texture), and functional group profile by FTIR.

3. RESULT AND DISCUSSION

3.1 Result

3.1.1. Effect of Soaking Time and Solvent Type on Gelatin Protein Content

Figure 1 shows the effect of acid solvent type and soaking time on the protein content of the extracted gelatin. Soaking for 48 hours produced higher protein content than 24 hours for all solvent types. The highest value was observed for lime extract at 48 hours (79.94%), while the lowest was for acetic acid at 24 hours (74.13%). The increase in protein content with longer soaking time indicates that demineralization proceeded more effectively, breaking collagen cross-links and facilitating protein extraction [4]. The natural lime solvent performed best, likely because it contains citric acid and ascorbic acid, which can dissolve bone minerals while also assisting collagen hydrolysis. Nevertheless, the protein content obtained remains below the SNI standard (≥85%), which may be attributed to suboptimal solvent concentrations or incomplete filtration and drying.

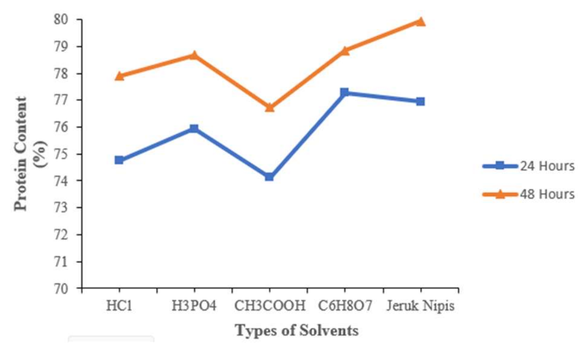

Figure 1. Gelatin protein content results from chicken bones

3.1.2 Effect of Soaking Time and Solvent Type on Gelatin Yield

Figure 2 shows that gelatin yield increased with longer soaking time. At 24 hours, the highest yield was obtained with HCl (2.88%) and the lowest with citric acid (2.17%). At 48 hours, the highest yield was obtained with lime extract (3.31%). Longer soaking allows the solvent to penetrate bone tissue more effectively, dissolve minerals, and break collagen bonds, releasing more gelatin. The natural lime solvent performed well because its organic acids accelerate demineralization without excessively damaging the collagen structure.

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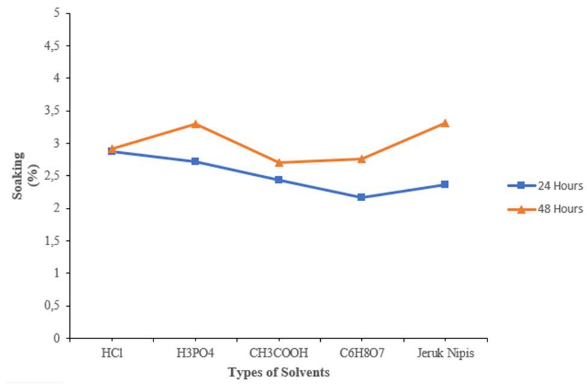

Figure 2. Gelatin yield results from chicken bones

3.1.3 The Effect of Soaking Time and Type of Solvent on pH Value

Figure 3 shows that the pH value of gelatin ranges from 4.0 to 4.55. A longer soaking time slightly decreases the pH in all solvents, with the lowest value in lime (4.0) and the highest in H_3PO_4 (4.55). The decrease in pH occurs because acid residues are trapped in the bone matrix, increasing the acidity of the extraction solution. Low pH helps break down collagen cross-links, but if it is too acidic, it can reduce gel quality [5]. All treatments are still within GMIA standards (3.8–5.5), making them safe for food applications.

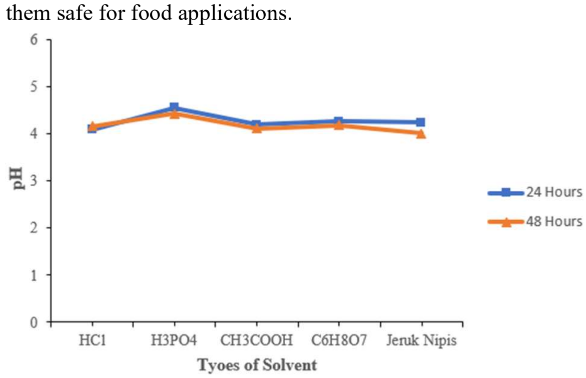

Figure 3. The pH value of chicken bone gelatin

3.1.4 *The Effect of Soaking Time and Type of Solvent on Gelatin Water Content*

Figure 4 shows that the water content is higher after 24 hours of soaking (9–15%) and decreases significantly after 48 hours (2.49–6.91%). The lowest value was obtained with lime solvent for 48 hours (2.49%). The decrease in water content is influenced by the soaking time and longer drying, providing a greater opportunity for water to exit the tissue [6]. Gelatin with a low water content has a longer shelf life and meets SNI standards (≤16%).

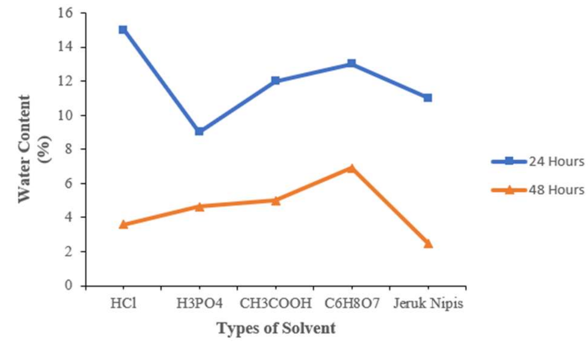

Figure 4. Moisture Content Results of Gelatin from Chicken Bones

3.1.5 *The Effect of Soaking Time and Type of Solvent on Gelatin Ash Content*

Figure 5 shows that ash content decreases with increasing soaking time. The highest value is found in lime soaked for 24 hours (5.96%), and the lowest in lime soaked for 48 hours (1.12%). High ash content indicates the presence of inorganic mineral residues that were not entirely removed during demineralisation. Longer soaking increases mineral solubility, resulting in purer gelatin [7]. The ash content value at 48 hours mostly meets the SNI standard (≤3.25%).

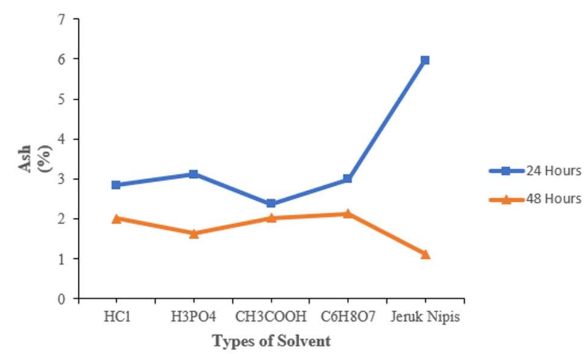

Figure 5. Ash content results of gelatin from chicken bones

3.1.6 Organoleptic Test Scores of Gelatin on Color, Aroma, and Texture

- Colour: Treatment with H_3PO_4 for 24 hours produced the highest score (5.73), indicating a darker colour and lower preference. The lowest score was obtained with $C_6H_8O_7$ (1.33) at 48 hours, indicating a lighter colour preferred by the panellists.
- Aroma: Lime treatment for 48 hours yielded the lowest score (1.90), indicating a lighter, more neutral smell, compared with HCl (2.60) at 24 hours, which had the strongest odour.
- Texture: Lime treatment for 48 hours produced the best texture (1.23), followed by HCl treatment for 48 hours (1.33). A high score for HCl at 24 hours (5.00) indicates a less smooth texture.

A longer soaking time (48 hours) generally produces gelatin with a lighter color, a more neutral aroma, and a smoother texture. This is due to a more thorough demineralisation and washing process, which allows pigments, denatured protein residues, and odorous compounds to dissolve and be removed [8]. The use of natural solvents, such as lime, provides better sensory results because their organic acid composition does not leave a sharp residual odour, unlike inorganic solvents (HCl and H_3PO_4). These results are consistent with the study by [9], which reported that gelatin extracted with natural solvents has better organoleptic quality than that extracted with synthetic solvents.

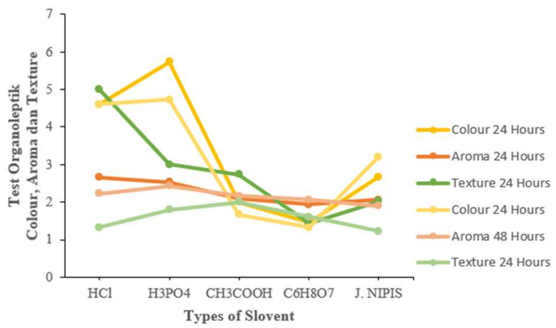

Figure 6. Organoleptic score of gelatin from chicken bones

3.1.7 Result FTIR

Table 1. FTIR Analysis Results

Functional Group	IR Corelation (cm^{-1})	Wave Number (cm^{-1})	
		Research Gelatin	Commercial Gelatin
Amida A	3700-2900	3184.32	3283.40
Amida I	1636-1661	1640.58	1628.02
Amida II	1560-1335	1456.74	1520.61
Amida III	1300-1200	1173.34	1235.78

*Source ; Robert C, Ph, D, Infrared Spectal Corelation (1972)

Fourier Transform Infrared (FTIR) analysis results showed that gelatin extracted from chicken bones has characteristic absorption bands of hydrolyzed collagen protein. Under H_3PO_4 treatment, the FTIR spectrum exhibited main peaks at 3184.32 cm^{-1} (Amide A, N-H and O-H stretch), 1646.58 cm^{-1} (Amide I, C=O stretch), 1456.74 cm^{-1} (Amide II, N-H bending and C-N stretch), and 1173.34 cm^{-1} (Amide III, C-N and C=O vibrations). These absorption bands match the characteristics of commercial gelatin, indicating that the extraction process successfully converted collagen into gelatin. The Amide A band around 3184 cm^{-1} indicates the presence of hydrogen bonding in N-H and O-H groups, typical of gelatin proteins. Amides I and II are associated with peptide bonds formed from the amino acids that make up collagen. The presence of the Amide III peak confirms the single-helix structure of hydrolyzed gelatin. These results are consistent with the studies by [10] and [11], which reported that gelatin has The FTIR spectrum is similar to that of hydrolyzed collagen protein. This indicates that the extraction method used has been effective in breaking the collagen cross-links into a soluble gelatin structure.

4. CONCLUSION

Gelatin produced from chicken bones by soaking in various types of acids: 6% HCl, 4% CH_3COOH, 7% H_3PO_4, 0.3 M citric acid, and lime extract for 24 and 48 hours showed protein content of 74.13–79.94%, yield of 2.17–3.31%, pH 4–4.55, moisture content of 2.49–15%, and ash content of 1.12–5.96%. Organoleptic tests showed colour values of 1.33–4.60, aroma values of 1.9–2.6, and texture values of 1.23–5.00. Although most parameters met SNI 3537:1995, the protein content was still below the standard (85%). Some treatments also did not meet the standard for ash content, color, aroma, and texture. The optimum condition was obtained with lime soaking for 48 hours, resulting in a yield of 3.31%, a moisture content of 2.49%, ash content of 1.12%, pH of 4, and protein content of 79.94%. All parameters met SNI, except for aroma and protein content. However, this treatment was still considered the best overall.

REFERENCE

[1] [1] Sari, I., et al. (2017). Pengaruh penggunaan asam asetat terhadap rendemen dan kualitas gelatin tulang ikan. *Jurnal Teknologi Pangan, 8*(2), 45–51.

[2] [2] Putri, D., & Rahmawati, A. (2019). Pengaruh jenis asam terhadap mutu gelatin tulang ikan. *Jurnal Teknologi Hasil Perikanan, 22*(1), 55–62.

[3] [3] Wahyuni, D., et al. (2021). Pengaruh lama perendaman terhadap mutu gelatin tulang ayam. *Jurnal Ilmiah Teknologi Hasil Pertanian, 12*(1), 20–27.

[4] [4] Yusron, A., et al. (2023). Efisiensi hidrolisis kolagen pada pembuatan gelatin tulang ayam dengan variasi waktu perendaman. *Jurnal Teknologi Bioproses, 14*(2), 33–41.

[5] [5] Muyonga, J. H., Cole, C. G. B., & Duodu, K.

[6] G. (2004). Extraction and physicochemical characterization of Nile perch (Lates niloticus) skin and bone gelatin. *Food Hydrocolloids, 18*(4), 581–592.

[7] [6] Islami, A., et al. (2018). Pengaruh metode pengeringan terhadap kadar air gelatin. *Jurnal Teknologi Industri Pertanian, 9*(1), 40–46.

[8] [7] Rachmania, F., et al. (2023). Optimasi proses demineralisasi tulang ikan untuk produksi gelatin berkualitas. *Jurnal Teknologi Hasil Perikanan Indonesia, 26*(1), 25–32.

[9] [8] Setyowati, D., et al. (2022). Pengaruh pelarut alami terhadap aroma dan tekstur gelatin tulang ikan. *Jurnal Teknologi Hasil Perikanan Indonesia, 25*(2), 55–62.

[10] [9] Nopianti, R., et al. (2021). Ekstraksi gelatin dengan pelarut alami sebagai alternatif ramah lingkungan. *Jurnal Teknologi Hasil Perikanan Indonesia, 24*(1), 1–8.

[11] [10] Maryam, S., Effendi, N., & Kasmah. (2015). Produksi dan karakterisasi gelatin dari limbah tulang ayam dengan menggunakan spektrofotometer FTIR (Fourier Transform Infra Red). *Majalah Farmaseutik, 15*(2), 96–104.

[12] [11] Zilhadia, Z., Suryani, S., & Harahap, M. B. (2018). FTIR dan SEM karakterisasi gelatin dari tulang ikan patin. *Jurnal Sains dan Teknologi Kimia, 9*(2), 190–195.

 https://doi.org/10.29165/ajarcde.v9i3.825