Proximate Composition and Functional Properties of Broiler Chicken Bone Flour

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Abstract

Chicken bone flour is an underutilized by-product of the poultry industry with significant potential for use in food fortification, particularly as a natural source of calcium and other essential minerals. This study evaluated the proximate composition and functional properties of chicken bone flour to assess its suitability for food formulation. Slaughtered, dressed and cut broiler chicken meat was washed and boiled. The flesh was separated from the bones for use in production of a novel snack. The bones were sun-dried and milled into fine flour and packaged in a Ziploc bag. The flour was analysed for functional properties and proximate composition using standard methods. Proximate analysis revealed high ash (26.2%) and protein (33%) contents. The flour exhibited moderate water and oil absorption as well as emulsion capacities with values of 0.876 g/g, 0.687 g/g and 53.8% respectively. Conversely, the solubility of the flour was low with a solubility value of only 4%. The results of this study indicate that broiler chicken bone can serve as a mineral and protein enriching ingredient in food formulations. Further studies on consumer acceptability and sensory characteristics are recommended.

Keywords: Broiler, Chicken, Bone, Flour, Food, Formulations.

Introduction

Chicken bone flour, also known as bone meal or poultry bone meal, is a nutrient-rich ingredient made from ground chicken bones. Chicken bone flour presents a promising ingredient for enhancing the nutritional and functional properties of various food products, addressing the growing demand for sustainable and health-promoting food innovations. This increasing interest stems from its potential to provide a sustainable source of macro and micronutrients, thereby improving the nutritional profile of staple foods and novel food formulations (Kadir *et al.*, 2024). Leveraging chicken bone flour not only contributes to circular economy principles by valorizing a co-product of the poultry industry but also offers a rich matrix of calcium, phosphorus, and high-quality proteins (Karuppannan *et al.*, 2020). This valorization aligns with global efforts to reduce food waste and enhance food security through innovative ingredient development (Karuppannan *et al.*, 2020). It has the potential to fortify a range of food items, from baked goods to meat analogues, thereby increasing their nutritional density without significantly altering their sensory attributes (Zhang *et al.*, 2025). The exploration of chicken bone flour as a food additive seeks to overcome common nutritional deficiencies, particularly in products traditionally low in essential amino acids and minerals (Kadir *et al.*, 2024). Its incorporation could particularly benefit products requiring improved texture, emulsification, and nutritional enhancement, similar to how other flours are utilized to modify product characteristics (Yessimbekov *et al.*, 2023). The aim of this study is to determine the proximate composition and some functional properties of 8-weeks broiler chicken bone.

Materials and methods

Materials

Broiler chickens (8-week-old) were purchased from the Teaching and research farm of the Department of Animal Production, Federal University of Technology Minna and all analysis were carried out at the Department of Food Science and Technology laboratory, Federal University of Technology Minna.

Sample Preparation

The broiler chickens were slaughtered, dressed, cut into pieces and boiled for 5 min. The flesh was separated from the bones. The bones were sundried for 24h spanning over 3 days. The dried bones were crushed and milled using a hammer mill. The flour was sieved through a 2mm mesh sieve and stored in Ziploc bags at room temperature.

Determination of Proximate Composition of Broiler Chicken Bone Flour

The proximate components of broiler chicken bone flour were quantified using the AOAC methods (2012). Moisture assessment was conducted using oven-drying at 105 °C, crude protein was determined using the micro-Kjeldahl procedure, crude fat was determined using Soxhlet extraction, crude ash was determined using incineration in a muffle furnace at 550 °C and crude fibre was the organic residue after digestion using H_2SO_4 or NaOH. Carbohydrate was obtained by difference, that is, by subtracting the amount of moisture, protein, fat, and ash from 100 %.

Determination of Functional Properties of Broiler Chicken Bone Flour

Water absorption capacity and oil absorption capacity were determined by the method reported by Falade and Okafor (2015). One g of the sample was mixed with 10ml of distilled water or refined soybean oil, kept at ambient temperature for 30min and centrifuged for 10min at 2000Xg. The bulk density was determined according to method reported by Falade and Okafor (2015). The flour sample (50 g) was placed into 100 ml graduated cylinder and tapped 20 to 30 times, until no noticeable change in volume. The bulk density was determined as weight per unit volume of the sample. Solubility was determined by the method reported by Falade and Okafor (2015). One gram of sample in 50 ml of distilled water was heated at the specified temperatures for 1 h while gently stirring and then centrifuged at 4,500 rpm for 30 min. The supernatant was decanted into a weighed evaporating dish and dried at 100 °C for 20 min. The difference in weight of the evaporating dish was used to calculate flour solubility. The emulsion capacity was determined by the method reported by Falade and Okafor (2015). One g sample, 10 ml vegetable oil and 10 ml distilled water were prepared in calibrated centrifuged tube. Emulsion was centrifuged for 5 minutes at 2000g. The ratio of the height of emulsion layer to the total height of the mixture was calculated as emulsion capacity in percentage. For gelatinization temperature, 1 g flour sample was weighed accurately in triplicate and transferred to 20 ml screw capped tubes. 10 ml of water was added to each sample. The samples were heated slowly in a water bath until they formed a solid gel. At complete gel formation, the respective temperature was measured and taken as gelatinization temperature (Falade and Okafor, 2015).

Results and Discussion

Proximate Composition of Broiler Chicken Bone Flour

The proximate composition of the chicken bone flour sample is presented in Table 1. The protein content was notably high (**33.00 %**), comparable to values reported for cereal-legume mixtures (Oyegoke *et al.*, 2021). This indicates its potential as a protein-enriching ingredient in food formulations. The moderate fat content (**21.06 %**) will contributes to flavour enhancement but may negatively affect keeping quality due to lipid oxidation. The elevated ash content (**26.20 %**) suggests significant mineral presence. This observation corroborates the findings of Kadir *et al.* (2024), who emphasized the usefulness of animal bone flours as mineral fortifiers in food systems. The low moisture level (**6.20 %**) is desirable for extended shelf life and microbial safety, making the flour suitable for incorporation into dry food mixes or extruded snacks. Additionally, the carbohydrate content (**13.55 %**) adds to the energy contribution and complements the overall macronutrient balance of the flour.

Table 1: Proximate Composition of Broiler Chicken Bone Flour

Component	Value (%) ± SD
Moisture	6.20 ± 0.00
Fat	21.06 ± 0.01
Ash	26.20 ± 0.01
Protein	33.00 ±0.71
Carbohydrate	13.55 ±0.71

Functional Properties of Chicken Bone Flour

The results of the functional properties of broiler chicken bone flour are presented in Table 2. The water absorption capacity (WAC) of the flour was **0.876 g/g**. This moderate WAC indicates a good ability of the flour to absorb and retain water, which may be attributed to the presence of hydrophilic components such as collagen and residual protein in the bone matrix (Awuchi *et al.*, 2019). The oil absorption capacity was **0.697±0.001 g/g**, reflects a moderate capacity to retain oil. This property is important in food applications where flavour retention and mouthfeel are critical, such as in meat products, sauces, and dressings. The ability of chicken bone flour to bind oil may be due to the presence of nonpolar amino acid side chains in proteins or a porous structure that traps lipids. The bulk density of the flour was **0.851±0.008 g/cm³**, indicating a relatively dense flour. High bulk density is advantageous for packaging and transportation, as it allows for reduced volume. Emulsion capacity was recorded at **53.846±0.001%**, indicating a significant potential for chicken bone flour to stabilize oil-in-water mixtures. This is likely due to the presence of amphiphilic proteins capable of reducing interfacial tension between immiscible phases. High emulsion capacity supports the use of chicken bone flour in emulsified products such as processed meats, meat analogues, and condiments.

Table 2: Functional Properties of Chicken Bone Flour

Property	Mean ± SD	Unit
Water Absorption Capacity	0.876 ± 0.000	g/g
Oil Absorption Capacity	0.697 ± 0.001	g/g
Bulk Density	0.851 ± 0.008	g/cm³
Solubility	4.00 ± 0.000	%
Emulsion Capacity	53.846 ± 0.001	%
Gelation Temperature	80	°C

Conclusion

This study has demonstrated the potential of chicken bone flour as a valuable ingredient for food formulation. The flour exhibited high ash content, making it a promising fortificant for addressing mineral deficiencies in human diets. Its functional properties such as water and oil absorption capacities—also suggest its suitability for incorporation into various food products including bakery items, extruded snacks, and complementary foods. Furthermore, the low moisture content highlights its safety and stability under proper storage conditions. These attributes, combined with its nutrient density and waste-reducing potential, position broiler chicken bone flour as a sustainable and health-promoting ingredient in the food industry. Further studies should focus on sensory evaluation, consumer acceptability, and the effect of chicken bone flour incorporation on the physicochemical and textural properties of finished food products.

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