Feeding Value of Unfermented and Fermented Corncob

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Abstract— *Corncob is a readily available agricultural byproduct, is often underutilized despite its abundance and potential in animal nutrition. This study evaluates the effect of solid-state fermentation on the nutritional composition of corncob to enhance its value as a feed ingredient, particularly for monogastric animals such as poultry and swine. Results indicated that fermentation markedly reduced crude fiber and anti-nutritional factors like phytates, improving digestibility and phosphorus bioavailability. These enhancements indicates that fermented corncob could be an alternative feed resource to conventional feed stuffs, contributing to sustainable livestock production, reduced feed costs, and better utilization of agro-industrial waste. Its incorporation into animal diets aligns with circular agriculture practices and supports resource-efficient feed development. However, the analysis also resulted in reductions in crude protein, fat, and ash content, while calcium levels remained low before and after fermentation, indicating the need for either improved fermentation methods or dietary supplementation to ensure balanced nutrition.*

Keywords— Agricultural byproducts, Digestibility, Fermentation, Nutrient composition, Sustainability.

I. INTRODUCTION

Corn (*Zea mays*) is one of the major crops in the Philippines, second only to rice in terms of area harvested and volume produced. Corn is harvested year-round; the resulting byproducts faces the ultimate challenge of managing agricultural waste. The corncobs often overlooked and discarded as one of byproducts of corn that is usually disposed improperly. Corncob has a potential feed ingredient used for animal feeding due to its ample supply and 20% corn content in waste products. (Eniolorunda, et al., 2023).

Ochetim (1993) states that when corncobs are accessible, high-energy feed components such as maize can be partially substituted with corncobs; however, the inclusion rate for optimal use and bird performance must be determined. The primary factors hindering the use of corncobs in poultry nutrition are its fibrous composition, elevated fiber levels, low protein as along with lipid and mineral content. The corncob is made up of cellulose, hemicellulose, and lignin. Cellulose is a polymer made of glucose units connected through beta 1,4 bonds. Cellulose is not easily hydrolyzed because of two primary factors. One factor is that cellulose is insoluble in water and forms crystals. Another factor is that cellulose of practical interest is rarely pure but coexists with lignin and hemicellulose in well-defined anatomical structures. In addition, lignin creates a physical barrier around cellulose, rendering it highly resistant to effective breakdown through acid hydrolysis. Lignin likewise decreases the availability of cellulose to cellulase enzymes. Poultry animals are unable to utilize cellulose for energy due to the absence of cellulase: the enzyme that breaks down the beta 1,4 bonds. (Llanes et al., 2022). Recent research also highlighted fermentation as an effective method for improving nutritional value of fibrous feed materials Fermentation not only reduces fiber content and anti-nutritional factors but also enhances palatability and nutrient availability (Sugiharto, 2019). This approach offers a promising strategy to convert waste materials like corncobs into valuable feed resources. Fermentation can transform waste materials into useful ingredients for animal feed by increasing the microbial protein content and lowering anti-nutritional factors.

In light of recent reports indicating that fermentation can improve nutrient values and reduce the fiber content of feed ingredients while also decreasing its anti- nutritional factors (Sugiharto, 2019), it is timely to look into different fermentation methods that would improve the nutrient composition of corncob.

This study aims to determine the chemical composition of corncob and compare the values between unfermented and fermented corncobs.

II. MATERIALS AND METHODS

2.1 Preparation of Unfermented Corncob:

Corncobs were collected from farms in Barangay Sto. Domingo, San Manuel, Pangasinan. The collected corncobs were sun-dried and subsequently ground using a hammer mill equipped with a 4.0 mm mesh screen. A 1 kg sample of the ground corncobs was then subjected to proximate analysis.

2.2 Fermentation Procedure of Corncob:

Corncobs were first weighed and thoroughly mixed with molasses at a rate of 15% based on the total weight of the final mixture. Afterward, 0.4% of a commercial odor-erasing composting microbial powder (OEMC) was added, also calculated relative to the total weight. This microbial powder contained a blend of beneficial microorganisms, including nitrogen-fixing bacteria, which promote decomposition and enhance fermentation efficiency. The prepared mixture was then packed into clean, high-density polyethylene plastic jars, compacted tightly to minimize air pockets, and the jars were sealed securely to create an anaerobic environment. Finally, the sealed jars were stored in a cool, dark location for a fermentation period of 14 days. Following the fermentation process, a 1 kg sample of the fermented corncob was collected and subjected to proximate analysis.

2.3 Experimental Design:

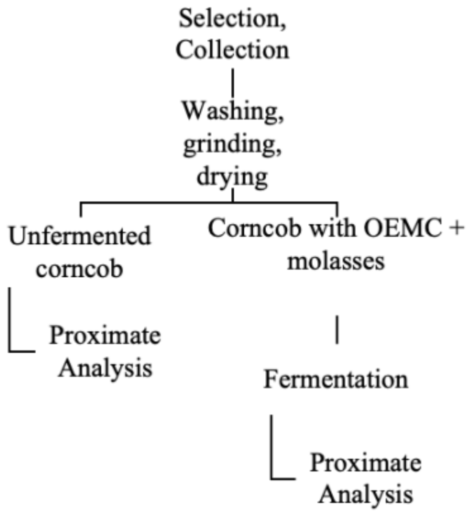

FIGURE 1: Experimental Layout for Proximate Analysis

This flowchart illustrates the experimental procedure used to prepare and analyze fermented and unfermented corncob samples.

2.4 Proximate analysis:

Proximate analysis is a standard method used to determine the basic nutritional composition of feed and food samples. It includes the measurement of moisture, crude protein, crude fat, crude fiber, ash, and essential minerals such as phosphorus and calcium. Several official methods established by the Association of Official Analytical Chemists (AOAC) were used to perform these measurements. The feed analyses were carried out at the Regional Animal Disease Diagnostic Laboratory (RADDL) Region I, located in Sta. Barbara, Pangasinan. Proximate analyses were conducted on oven-dried samples of both unfermented and fermented corncob.

Moisture content was determined using (AOAC Official Method 934.01), where the sample is dried in an oven at 105°C until a constant weight is achieved. Crude protein was analyzed using the Kjeldahl method (AOAC Official Method 2001.11). Ash content was analyzed using furnace-ignition method (AOAC Official Method 942.05). Crude fat was assessed using AnkomXT10 Filter Bag Technique (AOCS Official Procedure Am 5-04). Crude fiber was measured using Ankom^{200} Filter Bag Technique (AOCS Approved Procedure Ba 6a-05).

For mineral analysis, phosphorus content was measured using vanadomolybdate method (ISO 6491. 1998). Lastly, calcium content was analyzed using Titrimetry using $KMnO_4$ (AOAC Official Method 927.02).

III. RESULTS AND DISCUSSION

3.1 Proximate Analysis Content of Unfermented and Fermented Corncob:

Table 1 presents the results on the proximate analysis content of unfermented and fermented corncob. Result indicates that the moisture content increased from 7.7% in unfermented corncob to 9.3% after fermentation of corncob. This is likely due to the introduction of water during fermentation because of the dryness of the corncobs. Other studies typically reported that moisture increases of 5-15% during solid state fermentation, depending on water addition. The crude protein content decreased from 3.6% in unfermented corncob to 1.3% in fermented corncob. This reduction contrasts with most fermentation studies that show protein increases due to microbial biomass production. However, similar protein reductions were observed in cassava peel fermentation (Zhang et al., 2024), likely due to proteolytic activity or nitrogen loss ammonia. A study by Kaur et al. (2023) reported that during solid-state fermentation, crude protein content in a cereal-based substrate decreased significantly from 16.7% to 13.1%, while crude fat content also declined from 4.2% to 2.5%. These reductions were attributed to microbial utilization of nutrients during fermentation. The ash content decreased from 2.7% in unfermented corncob to 0.5 % in fermented corncob. Restuti Fitria et al. (2020), investigated ammonization fermentation of corn husk using a commercial starter (M21 Decomposer) and reported that ash content decreased notably during treatment. Specifically, the ash level reduced from that of untreated corn husk to 1.89 % in the fermented product. The crude fat decreased from 0.6% in unfermented corncob to 0.1% in fermented corncob. Similar findings in the study of Zhang et al., (2022) states that solid state fermentation with *Rhizopus oligosporus* decreased crude fat from 18.5% to 2.3% due to fungal lipases breakdown fats, while some fatty acids are incorporated into microbial biomass. A sudden decrease in crude fiber is observed, dropping from 27.0% in unfermented corncob to 9.3% in fermented corncob. This substantial change indicates that fermentation effectively broke down lignocellulosic components, such as cellulose and hemicellulose, into simpler compounds. Lower crude fiber content improves the digestibility of corncob, making it more suitable for broiler diet, as high fiber levels can limit nutrient absorption. This finding highlights the potential of fermentation to transform corncob into a more nutritionally accessible byproduct, enhancing its value in animal nutrition.

TABLE 1
PROXIMATE ANALYSIS CONTENT (%) OF UNFERMENTED AND FERMENTED CORNCOB

Parameter	Unfermented Corncob	Fermented Corncob
Moisture	7.7	9.3
Crude Protein	3.6	1.3
Ash Content	2.7	0.5
Crude Fat	0.6	0.1
Crude Fiber	27.0	9.3

3.2 Calcium (Ca) and Phosphorus (P) Content of Unfermented and Fermented Corncob:

The results from Table 2 shows the calcium and phosphorus content of unfermented and fermented corncob. Results indicate that phosphorus content in unfermented corncob was 0.1% which decreased to below detectable levels <0.05% after fermentation. This reduction suggests that the fermentation process may have broken down phosphorus containing compounds, such as phytates, or led to leaching. In contrast, calcium levels remained low (<0.05%) in both unfermented and fermented corncob, indicating that fermentation did not enhance calcium content. These findings align with existing studies, such as Tsao et al. (2000), who reported that microbial fermentation reduces phosphorus by degrading phytic acid, and Sharma et.al. (2022), who observed similar trends in fermented agro-industrial wastes. Additionally, the persistently low calcium levels are consistent with research by Bumbie, G.Z. (2017), which highlighted corncobs inherently low calcium content due to its fibrous structure. The reduction in phosphorus could be beneficial for animal feed by lowering anti-nutritional factors, but supplemental calcium would be necessary to balance nutritional value. Further research could explore co-fermentation with calcium rich substrates to improve mineral retention. Overall, the study highlights the role of fermentation in modifying phosphorus content, while emphasizing the need for additional strategies to improve calcium levels in corncob-based products.

TABLE 2
CALCIUM AND PHOSPHORUS CONTENT (%) OF UNFERMENTED AND FERMENTED CORNCOB

Parameter	Unfermented Corncob	Fermented Corncob
Phosphorus	0.1	< 0.05
Calcium	< 0.05	< 0.05

IV. CONCLUSION

This study reveals how solid-state fermentation influence the nutritional composition of corncob, a readily available agro-industrial byproduct. Fermentation improved the digestibility of corncob by markedly reducing its crude fiber content, which can enhance its utility in animal nutrition, particularly for monogastric animals such as broilers. The reduction in anti-nutritional factors such as fiber and phytates as indicated by lower phosphorus levels enhances the bioavailability of nutrients in fermented corncob, as a potential feed ingredient. These findings support the inclusion of fermented corncob into livestock diets for sustainable animal production, resource efficiency, and agro-industrial waste reduction.

Despite its benefits, the fermentation process revealed certain limitations. Notably, reductions in crude protein, fat, and ash content suggest nutrient losses under the current fermentation conditions. Additionally, the consistently low calcium levels before and after fermentation, unsuitable as a complete feed on its own. This implies that fermentation method may need to be improved, or extra nutrients may need to be added to make the feed more balanced.

Fermented corncob is considered as a promising alternative feed ingredient, its incorporation into animal diets helps mitigate the rising costs of traditional feedstuffs such as maize and soybean meal and also contributes to sustainable livestock production by promoting the use of agro-industrial by-products. Its improved digestibility and reduced anti-nutritional content make it suitable for inclusion in poultry and possibly swine diets, provided that nutrient balancing is performed.

The outcomes of this study contribute to the growing body of knowledge supporting circular agriculture and sustainable feed development.

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