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Utilization of Biscuit Waste in Poultry Diet- A Review

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ABSTRACT

Nowadays achieving sustainability and cost-effectiveness while providing sufficient nourishment for birds is a challenge faced by the poultry sector. Food waste is a global issue, involving fruits, vegetables, stale bread, pastries, biscuits, canned and baked foods, and expired dairy products. The surge in fast food and bakery consumption increases waste due to limited shelf life. These contributes to food wastage as well as pose disposal challenges and environmental concerns, which is a significant problem in a country like India where millions still lack access to adequate nutrition. Proper processing and management of bakery waste can reduce its burden by repurposing it as feed for monogastric animals like poultry. Among the bakery wastes, the biscuit waste typically incorporates carbohydrates, fats, and some protein making it a valuable ingredient for poultry feed. Biscuit waste can be utilized in feed formulations to supplement conventional ingredients through proper processing techniques like grinding, drying, pelletizing, and nutritional analysis. According to studies on poultry diets biscuit waste can save production costs, increase feed efficiency, and maintain or improve bird performance indicators including feed conversion ratio and weight gain. Utilizing biscuit waste for poultry feed helps to advance the circular economy principles by keeping waste out of landfills and lowering the environmental impact of the food and poultry industries. Overall, using biscuit waste into chicken feed can improve sustainability, resource efficiency, and economic viability by lowering food waste, preserving resources, minimizing the impact on the environment, and cutting production costs.

KEYWORDS: Biscuit waste, feed intake, performance, poultry, waste reduction

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1. INTRODUCTION

India is currently the third-largest egg producer in the world (122 billion eggs in 2020–2021), behind China and the USA, and the fifth-largest broiler producer (4.4 mmt in 2020–2021, behind China, the USA, Brazil, and the Russian Federation) as a result of the rapid increase in poultry production (Gulati and Juneja, 2023). Backyard poultry farming (BYPF) contributes 17.8% (18.41 billion) of India's egg output (103.32 billion) reducing poverty, ending hunger, empowering women, and providing part-time income in tribal and rural communities (Rajkumar et al., 2021). India's Ministry of Agriculture and Farmers' Welfare estimates that the country consumes only 69 eggs and 3.35 kg of chicken person^{-1} year (Scudiero et al., 2023).

Large-scale poultry production increases the demand for feed, which contributes 60–70% of input costs in commercial poultry industries where maize is the main energy source (Thirumalaisamy et al., 2016). Poultry feeds made from agricultural leftovers rather than corn will therefore result in much lower production costs (Adejumo et al., 2005). This has spurred researchers' efforts to use less expensive energy feed and alternative feed resources, in particular the wastes and byproducts from the agricultural industry, to substitute maize for feeding of livestock (Ajaja, 2005). Atteh and Ologbenla, (1993) stated that such alternatives should have comparative nutritive value and cheaper than the conventional sources. A portion of the alternative feed materials come from the food sector. This industry produces a significant amount of garbage, which has regulatory bodies very concerned about where it will end up after being tossed into the environment, where it will likely cause a wide range of environmental issues (de Barros Júnior et al., 2018; Volpato et al., 2014).

The bakery sector, a major global food industry, employs diverse production methods and sizes, resulting in variable waste composition due to the combination of many waste types (Macgregor, 2000). It can be fed to animals as a high-energy diet (Westendorf et al., 1999). There are two categories for bakery goods: moist bakery goods and dry bakery goods (Onwumere et al., 2012). Dried bakery products have a greater fat level (11%), it is comparable to corn in terms of protein and amino acid composition (10.8% crude protein, 0.27% lysine, and 0.10% tryptophan). Wheat flour is the primary component of all bakery goods, bakery meal is high in starch. This starch is very digestible and has a high nutritional value since it has previously undergone thermal processing, or cooking (Mavromichalis, 2013).

In terms of biscuit production, India comes in second place globally, behind the United States (Singh et al., 2023). The biscuit industry generates significant waste which can be repurposed for animal feeding. This waste also includes un-marketed or expired goods that have not been approved by manufacturers' quality control departments (Gonzaga et al., 2020).

Biscuit dough (BD), a byproduct of the biscuit industry, is as high in energy as maize when it comes to broiler performance. It belongs to the group of soft, moist baked goods that, when incorporated in the diets have a great potential to lower the price of poultry production (Shittu et al., 2016). Biscuit waste, a waste product not only benefits animals but also reduces feed costs, ultimately reducing the overall production cost compared to maize and is environment friendly (Adeyemo et al., 2013). The aim of this paper is to review the recent studies done on utilization of biscuit waste as an alternative energy resource to maize in poultry diet and to see its impact on production, health and overall economics.

2. NUTRITIVE VALUES

Biscuit waste is made with wheat flour, skim milk powder, vegetable fat, sugar, salt, and flavorings which is edible (Adeyemo et al., 2013). The composition of waste from the biscuit industry might vary depending on the components and formula used (Table 1). With similar proportions of carbohydrate, sugar, fat, protein, and lysine to maize, but

Table 1: Chemical composition of biscuit waste

Components	Biscuit waste	Biscuit dough	Wafer-type biscuit waste
Dry matter (%)	89.27-92.40	92.94	87.45-92
Metabolizable energy (kcal kg^{-1})	-	3899.16	3300-3833.14
Starch (%)	49.46	-	-
Ether extract (%)	10.16-11.01	13.86	4.05-17.00
Crude protein (%)	5.25-7.87	11.33	9.37-12.6
Moisture (%)	-	-	8
Ash (%)	1.00-1.62	1.07	1.12-2.2
Crude fibre (%)	1.05	0.59	2.55
Nitrogen free extract (%)	81.69	66.09	-
Calcium (%)	-	-	0.5
Phosphorus (%)	-	-	0.2
Linoleic acid (%)	-	-	0.7
Methionine (%)	-	-	0.41
Lysine (%)	-	-	0.91
Arginine (%)	-	-	0.99

Biscuit Waste-Adeyemo et al. (2013), Omoikhoje et al. (2017); Biscuit Dough Waste-Olajide and Oyegunle, (2019); Wafer-based Biscuit Waste-Shahryar et al. (2012), Gonzaga et al. (2020)

with higher sodium content, biscuit waste is regarded as a high-energy source (Corassa et al., 2014). Because of its equal energy value to maize, a primary energy ingredient in poultry production, it helps to lessen the high cost of maize. When it comes to feeding broilers, biscuit waste could be an excellent substitute for maize and other cereal grains because it has no anti-nutritional factors (Adeyemo et al., 2013). According to Longe, (1986), the energy and crude protein (CP) contents of biscuit waste were 4.70 mj kg^{-1} and 10.80%, respectively.

3. FEASIBILITY AND BENEFITS OF USING BISCUIT WASTE IN POULTRY FEED

Using biscuit waste in poultry feed is a feasible and beneficial practice that can provide several advantages

3.1. Cost reduction

Biscuit waste can be a cost-effective feed material, as it can be obtained for free or at a reduced cost. It can be used instead of expensive grains or protein sources, and its high fat and carb content can increase the feed's calorie level. Biscuit waste can provide essential nutrients to poultry, reducing the need for expensive supplements. Producers can also save on waste disposal by using biscuit waste in poultry feed. They can use it as a valuable resource for animal nourishment rather than having to pay for its removal (Ajasin et al., 2010; Shahryar et al., 2012).

3.2. Increased palatability and improved performance

Biscuit waste, a common feed ingredient, provides energy, flavor, and protein to poultry, supporting their metabolic processes and performance. Its attractive texture and flavor enhance the palatability of feed, leading to better nutrient intake. Biscuit waste also contains fiber, essential for gut health and digestive function. It's an economical option for poultry producers, reducing feed costs without compromising nutritional quality. It also promotes environmental sustainability by repurposing waste. Comparing broiler chickens and meat quails fed diets containing up to 20% biscuit waste to those fed normal diets, studies have revealed comparable performance, carcass yield, and feed conversion efficiency (Shahryar et al., 2012; Narayanan et al., 2009).

3.3. Reduced waste

Biscuit waste, containing carbohydrates, fats, and protein, can provide nutritional value to poultry. It can be processed to ensure safety and mixed with other feed ingredients for a balanced diet, reducing reliance on resource-intensive feed sources and reducing human food consumption (Shahryar et al., 2012).

3.4. Nutritional value

Poultry can get energy from biscuit waste, which is a good source of carbohydrates. But it can be lacking in other nutrients, like protein, thus the diet is needed to be balanced by adding more feed ingredients. To ensure a balanced diet, it should be used judiciously and thoroughly tested for nutritional content and potential contaminants before incorporating it into poultry feed (Narayanan et al., 2009; Ajasin et al., 2010). Numerous studies have been conducted to study the impact of biscuit waste on poultry (Table 2).

4. CHALLENGES AND REGULATORY RISKS

Using biscuit waste in poultry feed is of great benefit but it also brings certain challenges and regulatory risks along with it. These can be associated with the nutritional variability, pathogenic risks, toxicity risks, etc.

4.1. Nutritional variability

Depending on the source and processing techniques, biscuit waste might have different nutritional contents, which can impact the feed's overall quality. This fluctuation can cause health problems and uneven performance in poultry, especially in high-achieving birds (Olajide and Oyegunle, 2019). According to research, biscuit waste may be abundant in fats and carbohydrates but low in the vital vitamins, minerals, and amino acids needed for diet that is balanced (Narayanan et al., 2009). This may result in dietary imbalances that have an impact on the birds' development, well-being, and output.

4.2. Pathogenic risks

If improperly handled or stored, biscuit waste can turn into a haven for many types of bacteria, fungus, and other microbes. Pathogens such as *Salmonella*, *Escherichia coli* (*E. coli*), *Listeria monocytogenes*, and molds like *Aspergillus* and *Penicillium* species can be among them (Saranraj and Geetha, 2012). Foodborne diseases can result from eating biscuit waste tainted with toxins or pathogenic microbes. Depending on the kind and degree of contamination, symptoms might vary from minor gastrointestinal distress to more serious illnesses (Neil et al., 2012). There are microbes in biscuit waste that can cause poisons. For instance, nivalenol (NIV), deoxynivalenol (DON), fusarenon-X (FX) are the type of *Fusarium* mycotoxins which are dangerous substances that, if ingested, can result in a number of health problems (Tanaka et al., 2010). These contaminants can then be passed on to poultry through the feed.

4.3. Toxicity risks

Biscuits have the potential to contain elevated concentrations of hazardous heavy metals such as lead and cadmium, consumers' health (Dada et al., 2017). Mycotoxins are poisonous byproducts of fungus that can contaminate biscuit ingredients such as wheat and corn (Pasqualone

Table 2: Impact on poultry health and performance

Waste	Species	Inclusion level (%)	Results	References
Biscuit waste (BW)	Broiler	0, 25, 50, 75, 100	• Highest feed intake for control diet with no difference in AWG among treatments. • Lowest FCR at 100% inclusion level. • No difference in carcass weight. Lowest breast weight at 75% and 100% inclusion levels and highest for 25% inclusion. • No difference in organs weight except gizzard weight highest for control diet. • 50% inclusion of BW recommended for broiler diet.	Adeyemo et al. (2013)
Biscuit waste meal (BWM)	Broiler	0, 25, 50, 75	• No difference in haematological indices among treatments. • Highest values for serum total protein, albumin, and globulin at 75% inclusion. • Highest SAT at 25% while SAP was highest for control diet. • Improvement of blood quality at 50% inclusion of BWM in broilers.	Omoikhoje et al. (2018)
Biscuit dough waste (BDW)	Broiler	0, 25, 50, 75, 100	• AFBW and ADWG highest for control diet. • Recommended level for CFPKWG at 25% inclusion. • Haematological and biochemical indices varied among the treatments. • Inclusion of BDW up to 100% level has no health risk.	Olajide and Oyegunle (2019)
Biscuit and wafer waste (BWW)	Broiler	0, 8, 16, 24	• More feed intake for 8, 16, 24% inclusion. No variation in weight gain, FCR and carcass trait among treatments. • Increase in blood glucose at 16, 24% inclusion. • In case of BWW diets more amount of total cholesterol and triglyceride. • Recommended level of 24% has no negative impact on performance or carcass trait.	Shahryar et al. (2012)
Biscuit waste	Broiler	0, 25, 50, 75	• ALW, DFI, DW, PER, FCR higher for 50% dietary inclusion. • Variability in carcass traits and organ weights among the dietary treatments. • Inclusion of 50% recommended for excellent performance.	Omoikhoje et al. (2017)
Biscuit dough waste (BDW)	Broiler	0, 5, 10, 15	• Percentage of eosinophils and monocytes highest at 15% inclusion. No variation in serum constituents among dietary treatments. • Gut parameters- Highest villus height at 15% inclusion whereas large intestine weight and length increased with in inclusion levels. • 15% inclusion of BDW has no anti-effect on broilers.	Shittu et al. (2016)
Wafer-type biscuit waste	Quail	0, 20	• No distinctness in weight gain, FCR and carcass quality. • Inclusion up to 20% level recommended in diets of meat-quails.	Gonzaga et al. (2020)

AWG: Average weight gain; FCR: Feed conversion ratio; SAT: Serum aspartate transaminase; SAP: Serum alkaline phosphate; AFBW: Average final body weight; ADWG: Average daily weight gain; CFPKWG: Cost of feed kg^{-1} weight gain; ALW: Average live weight; DFI: Daily feed intake; DW: Daily weight; PER: Protein efficiency ratio

et al., 2021). Poultry products may include these poisons. 1-Methyl Naphthalene and certain different polycyclic aromatic hydrocarbons (PAHs), are possible carcinogen created during baking, is present in high concentrations in biscuits (Oyekunle et al., 2021). Poultry can become infected with PAHs by eating biscuit waste.

5. FOOD SAFETY AND REGULATORY CONSIDERATIONS

The possibility that many allergies could find their way into human food through the use of food waste as animal protein feeds presents a serious risk to food security. The bulk of the 14 major allergens, including traces of

nuts, groundnuts, and peanuts, as well as gluten, dairy, fish, and egg proteins, are commonly found in garbage from cafeterias, restaurants, homes, shops, and bakeries (Testa et al., 2017). Food waste such as biscuit waste, etc. can include a variety of additives and processed components in addition to allergens. These include artificial sweeteners (like aspartame), flavor enhancers (like monosodium glutamate), artificial color additives, and others that can bioaccumulate in animal tissues and be transferred to humans. Human health risks linked to these chemicals include allergic responses on the skin and in the respiratory system, as well as stomach and intestinal cancer (Gultekin et al., 2020; Rinninella et al., 2020).

The safe integration of food wastes and waste streams into animal and poultry feeds is a major concern for the international livestock and poultry industry's regulatory frameworks. It is crucial that safety assessment processes make use of cutting-edge biotechnologies to precisely and early identify biological and chemical pollutants in food waste, much like in the case of cellular agriculture. Sensitive methods of detection and treatment are necessary to guarantee the safe application of these alternatives, since studies have shown that food waste contains amounts of pesticides and heavy metals higher than those permitted in traditional protein sources (Dou et al., 2018). To prevent pertinent risks to food safety, standards and programs for the certification of treatment methods and procedures, as well as waste kinds suitable for conversion to animal and poultry feed, may need to be established (Westendorf et al., 2000). Occurrences of certain outbreaks of diseases exacerbate customers' mistrust and undermine their faith in regulatory bodies to ensure the safety of innovative feeds and, by extension, poultry products.

6. ENVIRONMENTAL IMPACTS

Repurposing biscuit waste as poultry feed provides a sustainable option by keeping food waste out of landfills and lessening the impact on the environment. By incorporating it, greenhouse gas emissions are reduced and resource depletion is minimized. It encourages the circular economy concepts of ecological balance, sustainable poultry nutrition enhancement, and inventive recycling.

6.1. Waste reduction

One effective way to keep a large amount of organic waste out of landfills and incinerators is to use biscuit waste into chicken feed. This lessens the amount of waste that ends up in landfills, which can help with problems like methane emissions from organic stuff that is decomposing. The quantity of food waste produced in the food sector is decreased by using biscuit waste as a feed element. This strategy backs the idea of "food for feed," which reduces the environmental effects of disposing of food waste by turning it into animal feed (Shahryar et al., 2012).

6.2. Energy saving

Energy inputs are usually needed for processing and transportation when biscuit waste is produced. The energy used in its manufacturing is not squandered when this waste is used to make poultry feed, which improves energy efficiency overall. Because biscuit waste has an energy content that is comparable to maize, it can be a good substitute for poultry feed. This energy efficiency can contribute to a decrease in the greenhouse gas emissions and total energy consumption linked to the production of poultry (Adeyemo et al., 2013; Ajasin et al., 2010).

6.3. Resource conservation

The need for traditional feed sources like grains or soybeans may decline if biscuit waste is used as a component. Natural resources like water and arable land, which are frequently overused in agricultural production, may be less stressed as a result (Adeyemo et al., 2013; Ajasin et al., 2010).

6.4. Lower carbon footprint

Biscuit waste can be used as a feed ingredient, reducing carbon footprints compared to conventional ingredients. Locally sourced waste can be processed through anaerobic digestion, producing renewable gas and nutrient-rich digesta. Repurposing biscuit waste as poultry feed contributes to a circular economy and reduces poultry production's carbon footprint, with a 10% mix reducing emissions (Pinotti et al., 2021).

7. CONCLUSION

Biscuit waste, made from wheat flour, skim milk powder, and other ingredients, is a high-energy feed alternative for poultry, offering cost savings and improved feed palatability. It has the potential to lessen the dependence on expensive maize grains while improving waste management. However, challenges include nutritional variability, pathogenic risks, and potential toxicity from contaminants that necessitate safety and regulatory compliance. Environmentally, repurposing biscuit waste reduces landfill use and greenhouse gas emissions, promoting a more sustainable poultry feed solution.

8. FUTURE RESEARCH

Further research is crucial to assess biscuit waste for poultry feed, including its nutritional value, health effects, and economic viability. Evaluating impacts on poultry health, meat quality, egg production and overall welfare along with economic feasibility and environmental impacts is essential.

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