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Research Article

Broilers Litter Management: A Review of Environmental Impacts, Nutritional Value and Sustainable Utilization

Ayanniyi, N. N[1], Eze, J. N[1]., Bassey M. S[1]., Aliyu, J. E[1]., Agboola, B. T[2]., Oduaro, A. O[1]. and Olawuyi T. O[1]

[1]National Cereals Research Institute, Badeggi, Bida, Niger State. Nigeria
[2]Department of Animal Science, University of Ibadan, Oyo State
Correspondence e-mail: *newrain36@yahoo.com*

Abstract

The increasing global demand for animal protein has pressured researchers to explore innovative ways to boost animal productivity. However, efforts to meet this demand are hindered by insecurity, unregulated policies, natural disasters, community conflicts, and land grabbing issues, particularly in developing nations. This has necessitated the search for alternative feed resources to enhance animal productivity. Broiler litter, comprising poultry droppings, feed waste, and bedding materials, has emerged as a potential feed resource technology for ruminant animal production. Rich in nutrients, broiler litter can be manipulated to improve animal yield. Despite concerns about the safety of meat and milk products from animals fed on broiler litter, its use in ruminant agriculture has gained popularity. This review examines the composition of poultry litter, its environmental impacts, and alternative uses as animal feed. Poultry litter poses significant environmental implications if not managed properly, including water pollution, soil degradation, and air pollution. Sustainable management practices, such as proper storage, processing, and application of poultry litter, are crucial to mitigate environmental concerns and promote sustainability. By adopting these practices, we can harness the benefits of poultry litter while protecting the environment and promoting agricultural productivity

Keywords: *Feed shortage, non-conventional feeds, poultry litter, environment*

Introduction

Meat is a highly valued commodity, essential for its nutritional composition and protein source. The World Bank has identified protein availability as a critical factor in human development, particularly at early stages of life (World Bank, 2006). However, the increasing demand for protein due to population growth has led to meat becoming a luxury only the affluent can afford (Lee et al., 2008). To address this issue, governments worldwide are seeking ways to increase animal productivity and make meat more accessible. Unfortunately, livestock enterprises face significant challenges, including feed shortages, which hinder the success of even high-yielding indigenous ruminant breeds (Ayanniyi, 2018). To overcome this challenge, non-conventional feed resources, such as broiler litter, have been introduced as alternative feed sources for ruminant animal production (Takkar, 2018; Kumar, 2019). The use of litter in livestock feed has become increasingly popular, but it also raises concerns about safety and environmental impact. The livestock sector is a significant contributor to global warming, partly due to methane production in ruminant animals (Gerber et al., 2013). Additionally, the accumulation of large-scale waste litters from the broiler industry poses environmental concerns and health risks to humans and animals.

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To maximize the potential of broiler litter, environmentally and economically sustainable technologies must be developed to utilize this waste without harming the ecosystem (Makkar, 2018). While some broiler litter is used as fertilizer and soil improvement, its improper application can lead to environmental degradation and physiological imbalances in crops (Singh et al., 2017). This review examines the composition of poultry litter, its environmental impacts, and alternative uses as animal feed. It also explores the best management technologies for processing poultry litter and its optimal utilization in ruminant animal production, aiming to improve productivity, sustainability, and profitability while minimizing environmental harm.

Broiler litters

The broiler litter refers the bedding materials used primarily to dry and to absorb the dropping of the bird such that comfortability is guaranteed for the birds. These materials which may include wood shavings saw dust, pine apple straw and also rice straw are essential in ensuring proper hygiene and sanitation (Yilmaz, 2015). Good quality broilers litters must provide dryness, absorbency, comfort and sanitation. In Nigeria, poultry business has recorded tremendous growth in the recent past. Figures from available data have revealed that poultry business has astronomically increased from 2011 to 2020. This has accordingly led to rising of poultry waste with attendant effect in the environment. This therefore calls for comprehensive waste management approach to reduce the impact on the environment. Past studies have shown that the estimated litters from commercial farm have doubled recently and if left unchecked, its effect could be devastating on the masses, (Dongare *et al*., 2023). The quality and quantity of litter depend on bedding materials, its management, feed intake and the digestibility. Coincidentally, poultry litters contain quite significant amount of nutrients which could be beneficial to the other categories of livestock especially the ruminant animals and fish. Perfectly dried broiler litters contain energy, CP, Crude fat and crude fiber. Others minerals contained in the litter are iodine, cobalt and iron and are very important in the nutrition of ruminant animals. Broiler litters whether mixed with other feeds like grain or on its own has been found to be invaluable feed for cattle and fish. This is facilitated because ruminants can utilize the uric acid as building blocks for most of metabolic processes taking place in the rumen and also for the adaptation of the physiology of their GIT to handle such. (Bolan *et al*., 2010). In spite of this foregoing however, the presence of foreign materials like plastic, feather and others like glass could the hinder the digestibility of the litter besides predisposing the animals to unwanted situation such as diseases, poor growth and death. Hence it is important to remove such items before they are fed to animals. Similarly the presence of potentially high ash contents inherent in broiler litters could pose a serious danger to sheep. Little thanks to the recommendation of less than 28% ash content fed to sheep (Williams 1999). From hygienic point of view however, untreated poultry waste may contain deleterious micro-organisms such as clostridium, salmonella and enterobacter species. They may trigger pathogenesis (Kwata *et al*., 2006). In addition various feeds additives like the antibiotics, arsenicals and coccidiostat added to the feeds may have residual effects in the animals and the human beings who may unknowing consume products from them (Kwata *et al*.,2006). Again some fungi that naturally live in the litter can result in the mycotoxin production. Although there has not been report of disease situation occasioned by feeding broiler litters to farm animals, yet certain elements like copper has been implicated as responsible for poor productivity in sheep. When excess copper is added as growth promoters in broilers, they are excreted because copper are poorly absorbed by birds gastro intestinal tract (GIT), this may trigger certain ailment in animals especially sheep (Sharma *et al*., 2005)

Processing of poultry litter

With recent advancement in poultry industry, large percentages of litters are produced. Iommelli (*et al*., 2022) had earlier reported that a thousand of broilers in a deep litter will on weekly basis produce more than 30 tonnes of litter materials with different proportions of nutrient respectively ranging 45-67%, 12-19% and 18-30% for true protein, ammonia and uric acid respectively, in addition to proportional percentages of energy, fiber and moisture. (Belewu, 1997). Broiler litter has very significant quantity of micro and macro

nutrients, vitamins A, E and also Selenium. Together with these nutrients, they also contain high protein, good energy, balanced contents of micro and macro nutrients and very cost effective in comparison with other feed resources. If well processed, broiler litter has the components 60-80% dry matter, 15% CP, 10-20% CF, and 2.5% EE. Even though the likes of calcium, phosphorous, nitrogen, potassium and sodium are proportionally small compared with certain formulated diet for specific physiological demands yet, these inherent nutrients make it ideal for ruminant animals. Processing of broiler litters require very critical precautions. They must be dry with less than 15% moisture to prevent mold growth, risk of contamination and nutrient availability. The processing skills besides improving the environment also convert waste to very quality products. The following are some methods by which broiler litters are processed to improve its quality, safety, nutritional value and to make it ideal substrates for the ruminant animals.

Physical processing methods

The Physical processing involves drying, grinding and pelleting. Drying ensures that broiler litters are sufficiently dried to reduce the moisture content in order to facilitate storage, reduce contamination and transport. The act of grinding enhance better texture, ensures palatability and digestibility. Pelleting helps to reduce waste, improve smart handling and nutrients are aggregated and concentrated for easy availability for the animals.

Chemical processing

The addition of lime has proven to be effective in reducing population of pathogens, improve pH and increase calcium contents. The use of chemicals such as urea and enzyme treatments has been very efficient. While urea increase nitrogen availability, reduce ammonia emissions and protein proportions, the addition of enzyme helps to breakdown the complex nutrients, and thereby facilitate digestibility and reduction in anti-nutritional factors. Spraying with recommended dose of propionic or acetic acid has also been suggested.

Biological processing

The applications of compositing, anaerobic digestion and vermin-compositing have been used over the years to effectively process the litters. The compositing eliminate pathogens; reduce nutrients availability and provide good acidic medium. The anaerobic digestion help to produce biogas, reduce greenhouse gas emissions and help in the recovery of nutrients. Vermi-compositing involves the use of earthworms to degrade the litters as reported by FAO 1980 to a level that the nutrients are readily available, reduce deleterious pathogens population and enhance acidic atmosphere, (Takkar, 2018; Kumar, 2019).

Thermal processing

Heating the litter to temperature that will ensure the death of any opportunistic microbes especially if the temperature is between 140 -160 Fahrenheit and within a specific time range has been recommended. The duration here will depend on the percentage of the components as earlier mentioned. The litter should have at least 20 percent moisture by weight for it to be optimally stacked. The caveat here is that extremely high temperature must be avoided because there is possibility of spontaneous chemical reaction which may render protein in the litter less digestible to the animals. This chemical process, also called Maillard reaction could take place. The Maillard reaction is a chemical reaction between amino acids and reducing sugars to create melanoidins, compounds that give browned food its distinctive flavor. Seared steaks, fried dumplings, cookies and other kinds of biscuits, breads, toasted marshmallows, and many other foods undergo this reaction. It usually occurs at high but moderate temperature between 140-160°C. Otherwise, if it occurs without the heat being monitored and regulated accordingly, the quality nutrient inside the deep stacking may not be accessible by the animal as the reaction is usually irreversible. The natural thing that follows is that the protein becomes impervious to attack by digestive enzymes. Again, limiting the percentage proportion of oxygen in the deep stack by packing the litter with a machine and by covering the litter with thick plastic sheeting will prevent the poultry litter from getting too hot during fermentation. If well processed, broiler litter can stay for up to five years with less loss of

quality. Another skill involving the use of heat is torrefaction and is essentially to conserve energy density, reduce moisture and prolong the shelf life. For better result however, all these methods can be used either individually or in combined ways to improve the quality of the litters and also for its safety.

Regulations on feeding poultry litter

Broiler litter can be used as a feedstuff, but safety regulation and strict precaution must be adhered to. (Al-Khalifah, 2012). There are currently no federal or State regulations governing the use of broilers litter as a feedstuff; however, certain common-sense guidelines must apply. They should not be over fed to either dairy or meat animals. They must not be offered in nothing less than 21 days before slaughter. The reason for this prohibition is that the residues of certain pharmaceuticals used in the production may present residual effect.

Comparison between other Feedstuff with Broilers Litters

There is needless to recognize the variations between different feedstuff available for livestock but this will make the review hanging if it fails to bring forth probable criterion for its justification as for animal feeds. Therefore, the review briefly discussed these components relative to their percentage proportions.

From literatures, broiler litters have comparatively similar crude protein content with feedstuffs like alfalfa hay, wheat bran and soybean meal but higher than that from corn silage (table 1). Even though the review does not consider the analytical variation yet very findings were somewhat similar (Kumar, 2019). For instance Singh, 2017 reported 40-50% fiber digestibility for wheat straw, Reddy, (2003) submitted 50-60% digestibility for Alfalfa and 30-40% for broiler litters by Yilmaz, (2015). These submissions were also corroborated by other workers Al-Kkalifah 2012, Pain (1994) and also by findings from National Research Council (NRC) 2012.

The Importance of Poultry Litter on the Environment for Sustainability

Broiler litter, a by-product of the poultry industry, has significant environmental implications. The increasing demand for protein has led to a surge in poultry production, resulting in substantial amounts of litter (Lee et al., 2008). If not managed properly, poultry litter can pollute the environment, contaminate water sources, and harm human health (Kwata et al., 2006). But if well treated, they can improve soil fertility and soil structure (Yilmaz, 2015), support plant growth and crop yields (Reddy, 2003), reduce the need for synthetic fertilizers (Pain, 1994), and promote sustainable agriculture practices (National Research Council, 2012).

In spite of these foregoing, broiler poses environmental concerns, including: water pollution - excess nutrients from poultry litter can contaminate water sources, leading to eutrophication and harm the aquatic life (Al-Khalifah, 2012). Again improper application of the litter can lead to soil acidification; nutrient imbalances also soil fertility impairment (Singh, 2017). The air pollution is another significant aspect; they can emit ammonia, particulate matter, and other pollutants, contributing to air quality issues (Bolan et al., 2010)

Sustainable Management Practices

To mitigate these concerns, sustainable management practices are essential. These include proper storage and handling of poultry litter, processing and treatment to reduce pathogens and nutrients (Iommelli et al., 2022), application of poultry litter as a fertilizer, following recommended rates and guidelines, integration with other sustainable agriculture practices, such as crop rotation and conservation tillage. Broilers litter is a valuable resource that can support sustainable agriculture practices and reduce environmental pollution. However, proper management and processing are crucial to mitigating potential environmental concerns (Belewu, 1997). By adopting sustainable management practices, we can harness the benefits of poultry litter while protecting the environment and promoting sustainability.

Conclusion

Broilers litter is a valuable resource that can sustainably support agriculture practices and reduce environmental pollution. However, proper management and processing are crucial to

mitigate potential environmental concerns. By adopting sustainable management practices, such as proper storage, processing, and application of poultry litter, we can harness the benefits of poultry litter while protecting the environment and promoting sustainability. Additionally, the use of poultry litter as animal feed, particularly for ruminant animals, can provide a cost-effective and nutrient-rich alternative to traditional feed sources. Overall, a comprehensive approach to poultry litter management is necessary to ensure environmental sustainability and promote agricultural practice and productivity.

Future Thrust

The findings of this review highlight the potential of broiler litter as a valuable resource for sustainable agriculture practices and animal feed. However, further research is needed to:

1. Develop and optimize processing technologies to improve the nutritional value and safety of broiler litter for animal feed.
2. Investigate the long-term environmental impacts of using broiler litter as fertilizer and animal feed.
3. Explore the economic viability of using broiler litter as a substitute for traditional feed sources in ruminant animal production.
4. Develop and implement sustainable management practices for broiler litter production, processing, and application.
5. Investigate the potential of other non-conventional feed resources, such as agricultural by-products and food waste, to support sustainable animal production.

By addressing these knowledge gaps, we can unlock the full potential of broiler litter and other non-conventional feed resources to promote sustainable agriculture practices, reduce environmental pollution, and support food security.

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Table 1: Comparison between other Feedstuff with Broilers Litters

Feedstuff	**DM (%)**	**CP(%)**	**CF(%)**	**Energy(kcal/kgDM**
Broiler litters	60-80	15-25	10-20	2000-2500
Corn silage	30-40	8-12	25-35	1800-2200
Alfalfa hay	90-95	15-20	25- 30	2200-2500
Oats grain	90-95	10-12	10-12	2500-2800
Wheat bran	90-95	15-18	10-12	2200-2500
Cotton seed meal	90-95	40-45	10-12	2800-3000
Soybean meal	90-95	45-50	10-12	3000-3200

Sources; (Singh, (2017), Takkar, (2018) and Kumar, (2019)