

EXPLORING THE POTENTIALS OF AGRICULTURAL BY-PRODUCTS AND CROP RESIDUES IN THE DEVELOPMENT OF LOW-COST NUTRITIVE LIVESTOCK FEEDS IN SOUTH-WEST NIGERIA- A REVIEW.

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ABSTRACT

The competition between humans and livestock for conventional grains has increased the challenges imposed on livestock production as a result of the demands for quality feed resources. This review therefore seeks to explore the potentials of crop residues and other agricultural by-products in the production of nutritive and affordable feeds for livestock in south-west Nigeria as well as the reduction of feed scarcity while enhancing sustainability. By products and crop residues such as brewers dried grains, palm kernel cake, maize stover, rice straws, groundnut haulms etc. when incorporated effectively could enhance the nutritive values of livestock diet. Ruminant livestock has been known to have unique digestive systems and are therefore, able to utilize these alternative feed ingredients, consequently, this helps to minimize the competition for conventional resources with humans. Furthermore, this review also studies the impact of these by-products' inclusion in ruminant diets on the health status, growth parameters of the animals and environmental sustainability.

Keywords: Crop residue, By-products, Alternative feed, Diet, Sustainability

INTRODUCTION

Historically, livestock has relied primarily on maize and soybean meal as key sources of energy and protein respectively, providing essential products like meat, eggs, and milk, which contribute to approximately 20% of the global protein intake for humans (FAOSTAT, 2016). Consequently, projections indicate that livestock production is set to increase by 21% between 2010 and 2025 (Motet et al., 2017). If current feed efficiency remains unchanged, this growth will necessitate an increase in global feed supply from 6.0 to 7.3 billion tons of dry matter (Kim et al., 2019). The competition for traditional grains, such as maize, wheat, and beans, is rising between human and animal populations. As a result, global food security is threatened due to the mounting pressures on natural resources, impacting the sustainability of food systems. It is therefore essential to explore new ingredients, particularly non-conventional feedstuffs, suitable for the animal feed sector.

Initial assessments by the FAO regarding the Food Loss Index suggest that approximately 14% of the world's food is lost from post-harvest to the retail phase (FAO, 2011). Furthermore, halophytes (Abd El-Hack et al., 2018), straw (Zhang et al., 2020), and various residues (Villanueva et al., 2013) are emerging as viable feed options. The ongoing challenge in livestock production is the scarcity of feed, and a promising solution to address this challenge while benefiting the entire circular economy lies in utilizing agricultural byproducts and crop residues to create low-cost, nutritious livestock feeds (Haile et al., 2017). These agricultural byproducts and crop residues are primarily sourced from plants but also partially from animals, serving as essential feed inputs for both humans and livestock. It is uncommon for a crop to be fully utilized by humans; most yield residual and by-product materials that, when processed appropriately, can be fed to livestock (Haile et al., 2017).

Experimental location

The experiment was conducted in South-West Nigeria at Osun State, which is situated within the tropical rain forest zone of an approximate area of 14,875 sq km and can be found between latitude 7° 30' 0" N and longitude 4° 30' 0" E.

Potentials of Agricultural by-products

Investigations such as those conducted by (Koenig et al., 2018) showed that in the diets of ruminants and pigs, the inclusion of agro-industrial residues could alter the meat quality and feeding patterns of the animals. Also,

from the surveys conducted by Francesch et al. (2016), grape by-products for instance, could improve the intestinal microbiome, gut health, as well as the levels of unsaturated fatty acids when used as feed ingredients for poultry. Similarly, there has been a drastic increase in the interest governing the inclusion of plant-derived antioxidants in livestock diets (Abd El-Hack et al., 2018). Other recent studies such as (Chen et al., 2021) and poultry (Cayan and Erener, 2015) demonstrated that the feed conversion efficiency, immunity built-up, gut microbiome and body weight in monogastric animals (pigs and poultry) and ruminants (cattle, sheep and goats) could be enhanced with the inclusion of some agro-industrial products. Moringa stem meal when provided in a reasonable quantity (not exceeding 60 g/kg) serves as a nutritive alternative feed material for geese especially in the finisher phase (Zhai et al. 2020). To enhance the feed conversion ratios of laying hens as well as the butyrate contents in the cecal compartment while reducing the cholesterol levels, by-products from the ancient wheat varieties (containing 50% *Triticum aestivum* variety and *Triticum durum*) could be given as feed resources (Lombardi et al. 2020). This ancient grain diet can bolster production performance, positively impacting both animal health and environmental sustainability. Numerous studies have also suggested that agricultural by-products could play a role in lowering cholesterol levels in eggs (Omri et al., 2019). Cayan et al. (2015) reported that olive leaf powder not only improved the final weight of laying hens but also enhanced yolk colour, reducing yolk cholesterol levels. In the investigation of Gurbuz and Salth (2017), it was proven that powder obtained from both ginger (*Zingiber officinale*) roots and sumac (*Rhus coriaria* L.) seeds could reduce the cholesterol levels in the yolk and blood thereby influencing acid composition positively. Dehydrated bo-caiuva pulp has shown potential antioxidant properties, decreasing lipid oxidation in egg yolk (Gurbuz and Salth, 2017). Including by-product feeds in the diets of laying hens under heat stress may yield beneficial effects for hen health, enhancing performance and egg quality (Zhao et al., 2019). Additionally, tomato pomace has mitigated the adverse effects of heat stress on serum enzyme activities, oxidative status, immune responses, and bone composition (Hussini-Yashan et al., 2015).

In tropical regions, agro-industrial by-products are both abundant and diverse, representing a considerable resource for enhancing livestock production. The incorporation of these by-products into livestock diets is warranted during times of forage supply shortages or when competition arises for traditional feed ingredients, whether regarding quantity or quality. In Nigeria, particularly in the Southwestern region, the types of agro-industrial by-products vary from initial processing wastes of farm produce to by-products from agro-allied industries.

Many of these residues remain underutilized, resulting in environmental pollution and hazards. Those that are used often do not reach their full potential. Useful agro-industrial by-products in the livestock realm include brewers dried grains (BDG), palm kernel cake (PKC), maize offal (MO), wheat offal (WO), and cassava peels (CP). As grain production inadequately meets the needs of both humans and livestock, the focus shifts to feed ingredients with minimal direct value to humans. These residues (BDG, MO, and WO), which are by-products of sorghum, maize, and wheat processing, tend to have low protein and high crude fibre levels, limiting their applicability in monogastric animals (such as poultry and pigs) (Table 1). However, ruminants, with their capacity to digest low-quality feeds and roughages, make better use of these products, thereby not competing with human food resources. While there is a significant supply of agro-industrial by-products, their utilization is influenced by their chemical composition and the specific livestock species being fed. Wheat bran and offal are among the most commonly encountered, followed by fresh or wet brewers' grains.

Table 1: Common Agricultural By-products and Crop Residues for Livestock Feed in South-West Nigeria

By-product/Crop Residue	Source	Crude Protein (%)	Fiber Content (%)	Potential Use in Livestock Feed
Brewers Dried Grains	Brewery waste	25	18	Used as a protein source for ruminants and pigs
Wet Brewer Grain	Brewery waste (wet form)	24	15	High moisture content, good for dairy and beef cattle feed
Palm Kernel Cake	Palm oil processing	17	20	Suitable for ruminants and pigs, rich in energy and fibre
Maize Stover	Maize harvest residues	6	32	Roughage source for ruminants, improves digestion
Rice Straws	Rice farming residues	4	38	Used as roughage for ruminants but requires supplementation
Groundnut Haulms	Groundnut farming residues	14	25	Good protein source for ruminants, especially during dry seasons
Wheat Bran	Wheat milling	16	10	Energy and fibre sources, commonly used in poultry and livestock feeds

Use of crop residues in livestock production

Crop residues refer to the leftover materials after harvesting, while crop by-products are the outputs resulting from the processing of crops. Due to feed scarcity especially during prolonged dry seasons in Southwest Nigeria, crop residues and agro-industrial byproducts have become increasingly significant for livestock feeding. The practicality of these byproducts often depends on their production proximity to farms and seasonal availability. Agro-industrial by-products are derived from the processing of plant or animal materials, typically generated by agricultural enterprises. These products are often regarded as waste, having little or no nutritional value for humans, but they can serve as potential sources of non-conventional feed ingredients.

In ruminants, the advantages of using agro-industrial by-products and crop residues have been more thoroughly researched due to the inherent capacity of ruminants to utilize high-fibre feed resources, although the required quantities are much greater than those needed for monogastric animals. The inherent strengths of ruminant animals in the food production chain could be further enhanced by more diversified and efficient use of side streams and increased reliance on fibrous feeds that are unsuitable for human and monogastric nutrition. Over the past few decades, animal production systems have experienced substantial changes, resulting in the consolidation of larger herds on less specialized intensive farms, where ruminants, in particular, are often housed indoors (Yang et al., 2021). Commonly fed high-fibre materials like maize stover, rice straw, and wheat straw are essential to ruminant diets (Nayan et al., 2019). Nonetheless, energy content remains crucial for ruminant dietary needs. The energy utilization data for unconventional feedstuffs is often not well documented. Notwithstanding, on a dry matter basis, the net energy and metabolizable energy for rice straw are 3.42 and 6.76 MJ/kg respectively. In contrast, the ME and NE for wheat straw are 6.43 and 3.28 MJ/kg (Wei et al., 2018). In addition, other recent studies have shown that the nutritional qualities of these straws and other agro-industrial resources could be improved prior to their inclusion in livestock diets by enzymatic treatment and fermentation (Zhang et al., 2017). Data from several other studies on the use of cassava peels and leaves further demonstrated their potential to improve the performance of lambs, cows and dairy ewes (Amaral et al., 2019; Chikwanha et al., 2019; Gao et al., 2019). Also, according to Moate et al., (2014), grape by-products could be used to minimize the emission of methane (CH₄) as well as the yields could be reduced by approximately 20% by using grape-by products for dairy cows.

Development of low-cost nutritive livestock feeds

Over the years in the livestock industry, there has been a significant development in the potential of these cheap unconventional feeds. In addition, agricultural by-products, crop residues, and agro-industrial by-products fall under the category of alternative feed resources, characterized as cost-effective, non-competitive, and readily available materials of plant and animal origin that can help mitigate feed shortages and reduce production costs. Their use has historically involved partial or complete substitution of conventional feed resources in livestock production. Many of these feed options are rich in protein, fibre, and other essential nutrients crucial for the feed industry.

Recent studies have shown the impact of agro-industrial residues or by-products on the quality of livestock as well as the effects on growth performance indices. However, it is quite difficult to quantify the significance of each of these agro-industrial by-products as well as the intricate chemical additives in the rate of feed intake and livestock performance.

CONCLUSION

This review has shown that the utilization of agricultural by-products as nutritive and affordable livestock feeds generally serves as a potential strategy to reduce feed scarcity in a sustainable manner. These agricultural by-products do not just improve the feed quality of livestock but also significantly solve the global challenge of feed competition. Evidently, ruminant livestock could process fibrous feed materials very effectively thereby proving the possibility of including several agricultural residues or by-products in livestock diets. Consequently, there is improved livestock productivity, gut health, and sustainable environmental systems. Further research and development should be conducted on the optimization and fortification of several agricultural residues so as to increase their potential as feed resources in livestock diets while increasing environmental sustainability.

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