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Cashew Nut Meal as a Feed Ingredient for Livestock – A Review

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ABSTRACT

Traditional protein sources, such as soybean meal and groundnut cake, have seen rising costs, prompting the exploration of alternative, cost-effective feed ingredients for cattle feed. Cashew Nut Meal (CNM), a byproduct of cashew nut processing, presents a promising alternative due to its favorable nutritional profile and potential economic benefits. This review aims to explore the feasibility of utilizing CNM as a protein source in livestock diets, focusing on its nutritional value, economic viability, and challenges associated with its use. The paper discusses the role of agricultural by-products in enhancing livestock nutrition and promoting sustainable farming practices. Future research is recommended to focus on comprehensive nutritional profiling of CNM, the mitigation of anti nutritional factors, and the development of innovative processing methods to improve its bioavailability. Additionally, establishing quality control standards and conducting life cycle assessments can ensure the sustainability of CNM as a feed ingredient. The support of CNM effectively, livestock producers, especially in cashew-growing regions, can reduce feed costs, improve feed efficiency, and contribute to more sustainable and profitable livestock farming practices.

KEYWORDS: Cashew nut meal, Novel Feed Resource, Protein Supplement.

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INTRODUCTION

Traditionally, protein sources like soybean meal and groundnut cake have been the cornerstone of cattle feed in India. However, the rising costs of these conventional feed ingredients have driven the need to explore; alternative, more cost-effective protein sources (Ojediran et al., 2024). Agricultural by-products utilization as animal feeds is the need of the hour to meet the demand of livestock nutrition and indirectly, of the food requirements of a rapidly increasing human population (Shamsi et al., 2012). The objective of this review is to provide an in-depth analysis of CNM as a source of feed ingredient in livestock, exploring its nutritional benefits, economic viability, potential challenges while considering the broader implications for sustainable livestock farming in developing countries.

Source of Cashew Nut Meal

Cashew nut meal (CNM), a byproduct of cashew kernel processing (*Anacardium occidentale*), has gained recognition as a valuable feed ingredient and functional food component due to its rich nutrient profile. Comprising protein, fats, fiber, vitamins, and minerals, it serves as a nutritionally beneficial option. Discarded cashew nuts deemed unfit for human consumption have a protein content ranging from 18–27% of dry matter and an oil content of 36–51% of dry matter (Lebas et al., 2012). The cashew processing industry, particularly prominent in regions such as Kerala, Goa, Karnataka, and Andhra Pradesh, has emerged as a promising source of protein for dairy cattle (Ojediran et al., 2024). India, being one of the world's leading cashew producers, offers an opportunity to utilize CNM as an underexplored resource, potentially transforming it into an economically viable and locally available feed alternative for dairy farmers. Research indicates that CNM can effectively replace soybean meal (SBM) in compounded ruminant feed formulations, with inclusion levels of up to 30% (w/w) showing no negative impact on rumen fermentation or digestibility (Rashmi et al., 2024).

COMPOSITION NUTRITIONAL PROFILE OF CNM

The nutritional composition of CNM typically includes: Crude protein: 25 –30%, Ether extract (Crude fat): 10–15%, Crude fiber: 5–10%, Ash content: 3–5% metabolizable energy approximately 3000–3500 kcal/kg (Rico et al., 2016). Many authors reported that the cashew oil meal had (Akande et al., 2015, Aletor et al., 2007 and Lima et al., 2004) dry matter content of 93.7 per cent, 36.6 per cent crude protein, 0.9 per cent crude fibre, 16.9 per cent crude fat, 5.1 per cent total ash, 2240 kcal/kg of gross energy. Calcium (1.5 %), Phosphorous (12 %), Potassium (2.0 %), Sodium (1.1%), Magnesium (3.2 %), Manganese (11mg/kg), Zinc (25 mg/kg) and Iron (139 mg/kg) per kg of dry matter content. Blomhoff et al., (2006) reported in his study that, CNM contained high protein (21%), carbohydrate (22%), fat (47 %), vitamins (thiamine) and also rich in manganese, potassium, copper, iron, magnesium, zinc and selenium.

1. Crude Protein

CNM is rich in protein, typically ranging from 20 to 25% of its dry weight. The amino acid profile includes essential amino acids, particularly lysine, tryptophan which are often limited in plant-based diets (Diarra et al., 2014). Hence it is particularly suited for dairy cattle, where protein quality is directly related to milk production efficiency (Rashmi et al., 2024). The protein content in CNM typically ranges from 20% to 25%, depending on the processing method and the specific variety of cashew (Diarra and Usman, 2014). The meal has a good quality protein containing 4.6 per cent lysine, 1.3 per cent tryptophan about 2 per cent cystine and 1.6 per cent methionine, further it contains well-balanced essential amino acids such as lysine, leucine and tryptophan (Piva et al., 1971). This is particularly beneficial as lysine and tryptophan are often limited in plant-based diets (Abdulrahman et al., 2011). The bioavailability of proteins in CNM has been shown to be high, making it a valuable protein source in food processing as well (Pinto et al., 2020). The protein and energetic characteristics of CNM shows that it can be used as an alternative supplementation to low-quality forages for lambs (Costa et al., 2021).

2. Crude Fat

Cashew nut meal (CNM) contains a fat content ranging from 20–30% (Ojediran et al., 2024), with values reported at 21.98 ± 0.01% (Silu et al., 2017), 36.70% (Aremu et al., 2006), and 34.95% (Omusuli et al., 2009). This variability in fat content may stem from differences in processing techniques and durations. The fat is primarily composed of unsaturated fatty acids, serving as an excellent energy source, particularly beneficial for lactating cows in high-production phases (Ojediran et al., 2024). Oleic acid (omega-9) and linoleic acid (omega-6) are the dominant fatty acids in CNM, contributing significantly to its nutritional and functional properties. Oleic acid, a monounsaturated fatty acid (MUFA), is known for its cholesterol-modulating effects, particularly in lowering LDL cholesterol levels, thereby supporting cardiovascular health. Linoleic acid, an essential polyunsaturated fatty acid (PUFA), enhances immune function and promotes inflammatory balance (Adeyeye, 2004). The synergistic combination of omega-9 and omega-6 fatty acids further optimizes lipid metabolism and overall health (Pinto et al., 2020).With a fat profile comparable to olive oil, CNM is particularly heart-healthy and offers antioxidant benefits. Its digestibility and palatability make it suitable for diverse applications, including use as a protein fortifier in food products. Additionally, CNM's energetic properties have been demonstrated as an effective alternative supplementation for low-quality forages, particularly in lamb diets (Costa et al., 2021). This versatile profile highlights CNM's potential as both a feed and functional food component.

3. Crude Fiber and Carbohydrates

Cashew nut meal (CNM) contains moderate levels of dietary fiber, which play a significant role in enhancing gastrointestinal health and supporting a balanced gut microbiota. Its carbohydrate content, primarily comprising starch and sugars, ranges between 20–30%, providing an essential energy source for animal feed applications (Okafor and Aniche, 2013). The fiber content contributes to improved digestive health, while the carbohydrate profile ensures sufficient energy supply (Okafor and Aniche, 2013). Furthermore, CNM's fiber composition offers potential as a prebiotic, promoting the growth of beneficial gut bacteria and supporting gut health in food products (Pinto et al., 2020). The fiber content of cashew nut cake has been reported as 3.44 ± 0.35% (Silue et al., 2017), while fat-free cashew samples exhibit lower fiber levels of 1.42 ± 0.2% (Omosuli et al., 2009). The carbohydrate content, calculated by difference, is 38.30 ± 0.12%, with reducing sugars at 2.66% and total sugars at 9.94%, as noted by Silue et al. (2017), while Omosuli et al. (2009) reported a carbohydrate content of 25.39%. These nutrient values underscore CNM's versatility as a source of both energy and dietary fiber, making it a valuable ingredient in animal nutrition and functional food formulations.

4. Minerals and Vitamins

Silue et al. (2017) reported that potassium (799.27 ± 0.44) was the most abundant mineral, followed by phosphorus (672.38 ± 0.54), magnesium (266.42 ± 0.32), and chromium (262.75 ± 0.88). The least abundant minerals were sodium (8.96 ± 0.01), zinc (16.32 ± 0.04), iron (33.05 ± 0.13), and calcium (55.48 ± 0.03). Olaofe and Sanni (1988) and Aremu et al. (2005) similarly observed lower levels of iron and zinc. Notably, minerals such as chlorine, manganese, and copper were undetected. Despite this, the mineral values are higher than those reported by Pamplona-Roger (2008) for cashew nut flour, who recorded calcium (45.0 mg), phosphorus (490 mg), magnesium (260 mg), iron (6 mg), potassium (565 mg), and zinc (5.6 mg). Rico et al. (2016) also found slightly different values for cashew kernels, reporting calcium (52.0 mg), sodium (6.6 mg), phosphorus (570.0 mg), potassium (670.0 mg), magnesium (265.0 mg), iron (7.1 mg), and zinc (5.9 mg). The significant levels of magnesium, phosphorus, and potassium in CNM are essential for bone health and cellular function (Abdulrahman et al., 2011). Moreover, B-complex vitamins such as B6, niacin, and thiamine contribute to energy metabolism (Pinto et al., 2020). Phosphorus, being highly abundant, supports bone density and cellular functionality (Diarra and Usman, 2014). Potassium helps regulate blood pressure and maintain fluid balance, while iron facilitates oxygen transport and helps prevent anemia (Okafor and Aniche, 2013). The zinc content in CNM is particularly valuable for immune function and skin health, as zinc is involved in DNA synthesis, wound healing, and immune response. Regular consumption of zinc-rich foods like CNM can significantly enhance these processes (Adeyeye, 2004).

5. Antioxidant Compounds

CNM is a rich source of polyphenolic compounds (479.39 ± 0.00 mg/100 g DM) and contains smaller quantities of flavonoids, such as quercetin and catechins (55.48 ± 0.06 mg/100 g DM), as well as tannins (134.19 ± 0.37 mg/100 g DM). It also demonstrates a notable antioxidant activity (AOA) of 75.11 ± 0.00%. Among the phenolics, gallic acid is a key compound, recognized for its anti-inflammatory and antimicrobial properties (Diarra and Usman, 2014). The flavonoids in CNM, including quercetin and catechins, are powerful antioxidants. Quercetin, in particular, is known for its ability to modulate allergic reactions and support respiratory health, making CNM an appealing ingredient in food formulations designed to combat oxidative stress (Okafor and Aniche, 2013; Goufo and Trindade, 2014). The presence of these flavonoids suggests that CNM can play a role in the management of cardiovascular diseases and oxidative stress, as flavonoids act as biological antioxidants (Mbatchou and Kosoono, 2011). These bioactive compounds offer significant nutritional and therapeutic benefits. As potent antioxidants, they protect cells from damage caused by reactive oxygen species, including singlet oxygen, superoxide, peroxyl radicals, hydroxyl radicals, and peroxynitrite. Furthermore, their anti-inflammatory, antifungal, and antibiotic properties enhance their value in promoting overall health and well-being (Meddleton et al., 1993; Abalokoka et al., 2014).

6. Anti nutritional components of CNM

CNM, like other nut-based byproducts, contains some antinutritional components that can impact nutrient availability digestibility if not properly managed. The primary antinutritional factors in CNM include phytates, oxalates, tannins and Cyanidic acid, which can limit the bioavailability of certain nutrients, particularly minerals. However, processing techniques such as roasting or soaking can help to reduce the levels of these compounds, making CNM more suitable for use in food / animal feed.

a. Phytates

These compounds can bind to essential minerals such as calcium, iron, magnesium, and zinc, forming insoluble complexes that hinder their absorption in the digestive tract (Diarra and Usman, 2014; Erdman, 1979). Although phytates exhibit antioxidant properties, their high concentrations can significantly reduce the bioavailability of critical minerals, posing a concern, particularly for populations whose diets are deficient in mineral-rich foods (Adeyeye, 2004). Research has shown that processing techniques such as soaking and fermenting CNM can effectively reduce phytate levels, thereby enhancing mineral absorption (Okafor and Aniche, 2013). According to Silue et al. (2017), CNM contains 87.27 ± 0.00

mg/100 g DM of phytates, while Mbatchou et al. (2011) reported a lower concentration of 6.78 mg/ 100 g DM in cashew meal. These findings underscore the variability of phytate content and the potential benefits of processing methods to improve the nutritional quality of CNM.

b. Oxalates

CNM also contains oxalates, which can interfere with calcium absorption by forming calcium oxalate, an insoluble compound that reduces calcium availability. In large amounts, oxalates can contribute to the formation of kidney stones, especially in individuals predisposed to oxalate accumulation (Pinto et al., 2020). While the oxalate content in CNM is generally moderate, and the processing methods such as roasting can to help reduce these levels, making the meal safer for consumption in both human and animal diets (Goufo and Trindade, 2014). As per Salimata et al., (2017) the oxalate content of CNM can range from 73.99 mg to 140 mg per 100g.

c. Tannins

Tannins are phenolic compounds present in CNM that can interfere with protein iron absorption by binding to them forming complexes that are less digestible (Reddy Kumar, 2017). Defatted cashew reject meal contains 1.51 percent tannins. Cashew nut testa, also known as the cashew nut husk, contains around 19.9–22.1 percent tannins (Akande et al., 2015). Tannins also have astringent properties, which can reduce palatability, particularly in animal feed. However, tannins possess antioxidant properties that provide some health benefits, such as reduced oxidative stress (Abdulrahman et al., 2011). Processing methods like boiling or soaking can reduce tannin levels, improving the digestibility / palatability of CNM.

d. Saponins and Trypsin Inhibitors

Saponins and trypsin inhibitors are also found in CNM in smaller amounts. Saponins can reduce nutrient absorption by forming complexes with proteins in the digestive enzymes, while trypsin inhibitors specifically hinder protein digestion by blocking trypsin, a key enzyme involved in protein breakdown. In CNM the total phenolic content in methanol extract seems to be higher than that in the other extracts and quantified as 18.1 mg/g tannic acid (Pradhan et al., 2020). The trypsin inhibitor and phytate were 1.045 mg/g and 0.87 g/100 of CNM respectively and no saponins were detected (Pradhan et al., 2020). The presence of these compounds can reduce the nutritional quality of CNM, particularly for animals with high protein requirements (Diarra and Usman, 2014). However, heat treatment, such as roasting, has been shown to inactivate trypsin inhibitors, making CNM more nutritionally accessible (Okafor and Aniche, 2013).

e. Cyanidic Acid

Cyanogenic glucoside is an organic compound containing sugar moiety, and is capable of yielding cyanide on hydrolysis. About ten cyanogenic glucosides including amygdalin, prunasin, dhurrin, linamarin, and taxiphyllin have been reported in edible plants. Hydrocyanic or prussic acid (HCN) is toxic and rapidly acts as a common poison Silue et al. (2017), reported that the CNM has a cyanidic acid content of 1.07 ±00 mg /100g DM. This low level may be due to the naturally low cyanide content of cashew nuts (Nkafamiya et al., 2015).

7. Feeding recommendations for livestock

a. Ruminants:

i) Dairy cows

Cashew nut meal (CNM) can be incorporated into ruminant diets at levels of up to 30% without negatively impacting growth or health, provided it is processed to reduce antinutritional factors (Diarra Usman, 2014). When included at 24% in the concentrate portion of dairy cow diets, CNM maintains production while reducing milk fat content and short-chain fatty acids. At the same time, it increases the proportion of long-chain fatty acids, thereby enhancing the nutraceutical properties of milk and its associated health benefits (Pimentel et al., 2007).

In total mixed rations (TMR) based on maize silage, CNM has been successfully included at levels as high as 50% of the dietary dry matter (Pimentel et al., 2012a). In a sugarcane-based diet, incorporating 24% CNM reduced milk fat content from 36.8 g/kg to 26.6 g/kg. While in maize silage-based diets, CNM inclusion did not affect dry matter intake (DMI), which remained at 21.3 kg/day, in sugarcane-based diets, it reduced sugarcane DMI from 7.7 to 7.05 kg/day and overall diet DMI from 14 to 13.22 kg/day (Pimentel et al., 2012a; 2007). These variations may be attributed to differences in how CNM is offered, either separately or as part of a mixed diet.

Importantly, CNM inclusion does not alter rumen fermentation parameters, ensuring that it integrates well into ruminant digestion systems (Pimentel et al., 2012b). In semi-arid regions of Northeast Brazil, diets containing 20% CNM for dairy cows were found to reduce the interval between calving and first ovulation, indicating potential reproductive benefits (Brasil, 2003). These findings highlight CNM's versatility and value as a feed ingredient for ruminants across diverse production systems.

ii) Sheep

Cashew nut meal (CNM) can be safely incorporated into sheep diets, provided that the dietary lipid content is maintained below 6–7%, as exceeding this threshold may reduce fiber digestibility, dry matter intake (DMI), and forage digestibility (Silva et al., 2008). CNM inclusion at levels of 13–18% of dietary dry matter (DM) in a concentrate fed at 1.2% of body weight (BW) as a supplement to hay showed no adverse effects on sperm quality in breeding rams (Medeiros, 2005; Oliveira et al., 2014). In adult ewes, CNM included at 12% or 24% of DM in a concentrate diet supplemented with hay yielded varying outcomes depending on the inclusion rate. At 12%, CNM had no detrimental effects, whereas at 24%, it increased the incidence of degenerated oocytes and reduced the proportion of viable oocytes. Based on these findings, it is recommended to limit CNM inclusion in ewe diets to levels below 24% to avoid reproductive challenges (Fernandes et al., 2014).

b. Monogastrics

For pigs and poultry, cashew nut meal (CNM) is generally recommended at inclusion levels of 5–10% of the total diet. Higher levels may negatively impact growth performance due to the fiber content and the presence of antinutritional factors, which can hinder nutrient absorption (Goufo and Trindade, 2014; Okafor and Aniche, 2013).

i) Pigs

Fanimo et al. (2003) evaluated the use of cashew nut rejects as a replacement for soybean meal in weaner pig diets. The study found no significant ($P > 0.05$) differences in weight gain or feed conversion ratios among groups. However, protein efficiency ratio and apparent protein digestibility were highest in pigs fed soybean meal. Pigs receiving CNM diets exhibited higher serum creatinine levels compared to those fed soybean meal, but there were no significant differences in total protein, albumin, globulin, urea, or cholesterol levels across treatment groups. It was concluded that CNM could replace soybean meal in weaner pig diets at up to 10% without adverse effects on growth performance.

ii) Poultry

Sogunle et al. (2009) conducted a trial with 9-week-old Yaafa Brown pullet chicks and found that a diet containing 10% cassava peel meal and 30% CNM improved performance in growing pullets. Freitas et al. (2006) reported that CNM could be included in broiler diets at levels up to 25% without negatively affecting performance. Similarly, Cruz et al. (2015) studied Dekalb Brown laying hens at 27 weeks of age and observed that feed intake and egg weight were unaffected by CNM inclusion. However, higher CNM levels negatively impacted egg production, egg mass, feed conversion, and yolk color. Consequently, the study recommended limiting CNM to 10% in layer diets to maintain optimal performance.

iii) Turkeys

Ogungbenro et al. (2013) tested CNM as part of a 30% CNM-maize offal combination in diets for Nicholas White strain turkeys. The results indicated that this combination could effectively replace maize, improving both performance and nutrient digestibility.

These findings highlight the potential of CNM as a feed ingredient for pigs and poultry, provided inclusion levels are carefully managed to avoid adverse effects on performance and health.

8. Processing Methods

a. Roasting

Heat treatment can significantly reduce antinutritional factors, such as trypsin inhibitors tannins, thereby enhancing protein digestibility overall nutrient availability (Pinto et al., 2020). Roasting CNM before feeding can lead to improved growth performance in livestock.

b. Fermentation

Fermentation is another effective method to reduce phytate content to enhance nutrient bioavailability. Incorporating fermented CNM into animal diets can improve growth rates and feed efficiency (Adeyeye, 2004).

c. Enzyme addition/Supplementation

To counteract the effects of antinutritional factors, enzyme supplementation (such as phytase and protease) can be beneficial, particularly in monogastric diets. These enzymes helps in breakdown of phytates thereby improve nutrient absorption and making CNM more effective in enhancing growth performance (Diarra and Usman, 2014).

9. Economic Considerations in feeding CNM to livestock

a. Lower Feed Costs

One of the most significant advantages of incorporating CNM into livestock diets is the potential for substantial cost savings. CNM is generally less expensive than conventional protein sources such as soybean meal or fish meal. Utilizing CNM can help livestock producers reduce overall feed costs, particularly in regions where cashew nuts are widely grown and processed (Pinto et al., 2020).

Research has shown that replacing traditional protein sources with CNM can yield competitive growth performance. For instance, Diarra Usman (2014) found that up to 30% of the dietary protein in ruminants could be replaced with CNM without adversely affecting animal health or performance. This shift can lead to significant savings in feed expenditures.

According to Balaga et al. (2021), cashew nut kernel meal can be included in the diet of ram lambs at levels up to 20 percent, yielding beneficial effects on their health. Additionally, it does not negatively impact palatability, enhances nutrient digestibility, improves overall performance and leads to cost-effectiveness.

b. Utilization of Byproducts

CNM provides a means to utilize agricultural byproducts that might otherwise be discarded. By integrating CNM into livestock feed, producers can take advantage of this readily available and underutilized resource, promoting sustainability in reducing waste (Goufo and Trindade, 2014). This approach not only helps in cutting costs but also contributes to environmental sustainability in agriculture.

10. Future Perspectives Research Directions of CNM feeding

Future research should prioritize a comprehensive nutritional profiling of CNM to gain a clearer understanding of its macro- and micronutrient composition. Mitigation of antinutritional factors present in CNM, can hinder nutrient absorption and limit its effectiveness as a feed ingredient. Development of innovative processing techniques can significantly enhance the nutritional value of CNM. Establishing quality control standards for CNM is essential to ensure consistent nutritional quality. Conducting life cycle assessments can help to quantify the carbon footprint, resource use and waste generation associated with CNM production and use. Developing economic models to evaluate the cost-effectiveness of using CNM in livestock diets can inform producers about its viability as a protein source. Future research should focus on species-specific feeding programs / trials that optimize the use of CNM for different livestock species.

CONCLUSION

As a byproduct of cashew processing, CNM offers several advantages, including cost-effectiveness, improved feed efficiency and favorable nutrient profile. Appropriate processing methods reduce the antinutritional compounds, enhancing the bioavailability of nutrients and thereby improving the overall effectiveness of CNM in animal diets.

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