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Review Article

Effects of Locally Available Non-Conventional Feeds for Nutritional Security of Ruminant Animals

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ABSTRACT

The review carried out on different locally available non-conventional feeds with the objective of determining the effect of different locally available non-conventional feeds on the nutritional security of ruminant animals. Non-conventional feeds are feeds that are not usually common in the market and are not the traditional ingredients used for commercial feed production. Non-conventional feed resources include feeds like residues of local drinks like *Areke*, *Tella*, *Khat* left over, fruits and vegetables left over, poultry manure, waste products of animal processing, such as offals from fish or Monogastric animals, and feather meal. Those non-conventional feed resources are partially richer in energy and protein. It is well known that the inclusion of non-conventional feed resources in livestock feeding at different levels meets the objective of bridging the gap between demand and availability of feed and reducing the cost of feed as well as production. They can also improve the productivity of livestock that are kept on overgrazed pastures and crop residues. However, care should be taken to avoid the negative effects of these feeds on animals by using various methods to improve the utilization of non-conventional feeds. Finally, current review concluded that locally available non-conventional feeds as important for nutritional security of ruminant animals.

Keywords: Local Feed, Quality, Ruminant Animals

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INTRODUCTION

Ethiopia possesses a large livestock population in Africa, and the estimated population in the country is to be about 70 million cattle, 42.9 million sheep, 52.5 million goats, 2.15 million horses, 10.80 million donkeys, 0.38 million mules, 8.1 million camels, and 56.87 million poultry at country level (CSA, 2021). Livestock play an important role in providing export commodities in the form of live animals, hides, and skins (FAO, 2009) and food and income sources to farm households and communities (Anteneh *et al.*, 2010). In spite of its significant importance to the country's economy and the livelihood of the farming community, the expected return from the large livestock population is too low because of low livestock productivity mainly due to a shortage of feed and the traditional livestock husbandry system practiced in the country. Among livestock, ruminants occupy an important economic and ecological niche in agricultural systems throughout developing countries (Devedera, 2005). They supply meat in quantities that can be readily utilized within households and could be a source of cash needs, a means of wealth accumulation, and a starting point for investment (Markos, 2006). However, the production has been impacted by feed shortages due to the shrinking of available grazing land and the expansion of cropping areas in intensively cultivated areas because of growing human population pressure. Solomon *et al.,* (2010) noted that, feed shortage is one of the limiting factors for increasing the production and productivity of ruminant animals in most of the agro-ecological zones in Ethiopia. Although diverse sheep and goats' resources are found in Ethiopia, their productivity is low mainly because of inadequate year-round nutrition, both in terms of quantity and quality (Markos *et al.*, 2010). The contribution of ruminants is increasing, whereas sustaining large ruminants are facing difficulty during season of critical feed shortage (Legesse *et al.*, 2008). Most of the available feed resources in the country cannot meet the nutritional requirements of animals throughout the year in many parts of the country, either due to inadequate supply, poor quality or both (Adugna, 2009). The major feed resources for ruminants include grazing on communal natural pastures, private pastures, crop stubble, fallow grazing, roadside grazing, crop residues, grains, improved forages, and non-conventional feeds including household food leftovers, weeds from crop fields, tillers from dense crop fields, fillers, and traditional brewer's grains (Solomon *et al.*, 2010). Most of the forages from communal grazing areas and crop residues contain CP below 7% and NDF above 55% of dry matter (Solomon *et al.*, 2008), both of which indicate poor nutritive value and are not capable of meeting rumen microbial requirements, particularly with regard to CP content (Van Soest, 1994). In addition to these, the quality of forages decreases greatly during the dry season, leading to substantial weight loss in animals. In the dry season, dry forages even not available. The situation is acute in numerous developing countries like Ethiopia, where chronic annual feed deficits and increasing animal populations are common. This phenomenon requires

the alleviation of nutrient deficiencies faced by animals through the implementation of different feed utilization strategies. Thus, non-conventional feeds could partly fill the gap in the feed supply, decrease competition for food between humans and animals, reduce feed cost, and contribute to self-sufficiency in nutrients from locally available feed sources. Thus, to bridge the gap between demand and availability of feeds for livestock, optimum production and utilization of non-conventional feeds appear more hopeful. Therefore, taking this gap into consideration, effects of different non-conventional feed sources on the nutritional security of ruminant animals were reviewed in this paper.

Literature Review

Non-conventional feeds

Non-conventional feeds are feed resources that are not commonly used as livestock feed (Nitis, 1999). According to Devendra (2005), non-conventional feed resources (NCFRs) are feeds that are not usually common in the markets and are not the traditional ingredients used for commercial feed production. Similarly, as defined by Kang *et al.,* (1995), non-conventional feeds are feeds that are not regular ingredients in the diet of farm animals. In tropical countries, fertilizer grade urea with or without molasses and blood meal with or without bone meal are used as non-conventional supplements to improve digestibility and reduce weight loss in cattle fed low-quality hay during the dry season (Stares *et al.*, 1992).

The purchasing potential of farmers in different regions of the world and related government policies will not allow resource poor farmer to compete for high-quality feeds (Zemmelink, 1986). Therefore, the use of non-conventional feed resources in the ration of livestock has become indispensable to keep pace with the shortage of feed and fodder for livestock, to improve productivity, and to formulate inexpensive rations for the well-being of subsistence farmers (Sharma, 2000). Thus, it is necessary to identify the prospects of utilizing non-conventional feed resources in order to promote the production characteristics of livestock.

Ruminants form the major proportion of all the livestock, and it is a well-established fact that these ruminants are “recyclers”, which recycle feed into various valuable compounds like milk, meat, wool, hair, manure, etc., which are of prime importance for the human population and form the very basis of innumerable food chains around the globe. But these animals also require nutrition to safeguard human nutrition (Abdulla, 2017). It is well known that the inclusion of non-conventional feed resources in livestock feeding at different levels would meet the objective of bridging the gap between demand and availability of feed and reduce the cost of feeding as well as production. These feedstuffs can be put to use for animal feeding as they provide no competition from their human counterparts.

Mostly, these are the by-products that are obtained after the removal of the main product for human use (Abdulla, 2017). Non-conventional feed can also improve the productivity of livestock that are kept on overgrazed pastures and crop residues, but care should be taken for toxic substances or anti-nutritional factors, since they are the major constraint in the utilization of non-conventional feeds (Ranjhan, 1997).

Non-conventional feed resources as a supplement

Non-conventional feed resources (NCFRs) include feeds like residues of local drinks like *Areke*, *Tella, Khat* left over, fruits and vegetables leftover (Solomon, 2011), poultry manure, waste products of animal processing, such as offals from fish or Monogastric animals, and feather meal (Torto and Rhule, 1997). The by-products from homemade breweries are richer in energy and protein than the residues from factories (Ibrahim, 1998). It is important to note that using these materials as feed does not only contribute nutrients and offset feed costs but also utilizes waste materials, as these materials are usually considered to reduce potential environmental hazards (IAEA, 2002).

Atella

There are many people in Ethiopia who brew local breweries regularly, and most of their economy is dependent on it. *Tella* is a traditional home-brewed local beer in Ethiopia, and *Atella* is a residue of it (Demeke, 2007). *Atella* is produced in large amounts all year round in Ethiopia. Only a small proportion of *Atella* is used as feed, and large quantities accumulate at production sites, causing disposal and public health problems (Demeke, 2007). Home brewing is a widespread practice in the traditional smallholder sector, and by-products of this activity are very high in nutrient content and can be used to supplement animals in the dry season (IAEA, 2002). *Atella* is a typically urban by-product that is used in more than 80% of intra-urban dairy farms in Ethiopia (Mekasha *et al.*, 2003). *Atella* is reported to be more available in the central than in the eastern zone of Ethiopia (Tesfay *et al.*, 2016). It has high moisture, low fiber, and relatively higher protein and energy contents than most brewers' grains that increase the intake, digestibility, N retention and performance of growing small ruminant diets based on low-quality forage (Ajebu *et al.*, 2014).

The chemical composition of *Atella* varies according to the ingredients used to make it. The crude protein contents of *Atella* range from 13-24% DM, with the highest crude protein (24%) being obtained from tella made from sorghum grains (Alemayehu *et al.*, 2011). *Atella* can be a valuable feedstuff for livestock, and its use in animal feeding could alleviate the environmental issues due to the disposal of *Atella* in the vicinity of Tella production sites (Demeke, 2007). In Ethiopia, *Atella* is part of the farmers' practice aiming at enhancing the energy and/or protein status of diets based on crop residues and low-quality roughages (Mekasha *et al.*, 2003). *Atella* is mixed

with other feeds and fed to livestock. Supplementing low-quality residues with green feed and providing mixtures of oil cakes and wheat bran soaked with water and *Atella* is a common strategy to improve the edibility of crop residues, and the whole nutritional quality of the diet (Tesfay *et al.*, 2016).

In Ethiopia, *Atella* is available during the dry season; it can be used as a major protein source for ruminants and can be fed at low cost (Abebe *et al.*, 2013; Mekasha *et al.*, 2003). It has been indicated that, DM, N and OM intake and digestibility was improved for rams/sheep fed pulse haulms/wheat straw and supplemented with sole *Atella* (Yoseph, 1999). Supplementation of wheat straw with *Atella* resulted in weight gains similar to those observed in sheep supplemented with concentrates (Nurfata, 2010). Supplementation of low protein hay (crude protein 5.5% DM) with *Atella* improved total intake without affecting the intake of the basal forage, and greatly improved protein and energy intake (Mekasha *et al.*, 2003). Supplementation of dried *Atella*, noug seed cake and their mixture fed finger millet straw as a basal diet has a positive effect on feed intake, digestibility, and live weight change (Almaz, 2008).

Tomato Pomace

Tomato pomace is the main tomato by-product available for animal feed (OECD, 2008). It is the mixture of tomato peels, crushed seeds, and small amounts of pulp that remains after the processing of tomatoes for juice, paste, and ketchup (Ventura *et al.*, 2009).This tomato by-product is a highly heterogeneous product. Its physical form, chemical composition, and subsequent nutritional value depend on the relative proportions of peels, seeds, and other remaining materials left by the various steps of the process, which themselves depend on the target tomato product. For instance, the crude protein and fat content of tomato pomace vary with the number of seeds, which are richer in protein and fat than the 10 peels (Denek and Can, 2006).

Tomato pomace can be used as a valuable by-product in ruminant nutrition (Aghajanzadeh-Golshani *et al.*, 2010). Tomato by-products are usually fed to ruminants due to their high fiber content. They can be bitter and should then be used together with more palatable feeds. They are valuable source of protein, energy, fiber, and cost-effective (Caluya *et al.*, 2003). In the Philippines, Caluya *et al.* (2003) recommend including tomato pomace at up to 50% of the daily roughage requirement, irrespective of whether it is fresh, dry, or ensiled. The pomace should be given before the roughage or mixed thoroughly particularly when dry with the chopped roughage.

Birint

Some of the cereal grain by-products, particularly fermentation residues from alcoholic drinks and beverages, are abundant in some parts of the country. *Katicala* is a traditional home brewery product in Ethiopia, and *Birint* is a residue of it.

Birint is a wet residue produced after ground mixtures of wheat, maize, and barley are fermented for extended periods (more than a week) and the fermented product is distilled to obtain volatile organic compounds for human consumption. *Birint* is more available during the dry season when other green fodders are low (Tassew and Seifu, 2009). Traditionally processed *Birint* containing 18% crude protein resulted in high nitrogen intake (15.8 g per day) in sheep fed wheat straw (Nurfata, 2010). The crude protein content of dry *Birint* is 21 % *(*Yoseph, 1999; Demeke, 2007), but it varies according to the input for the preparation of *Katicala*.

In urban and per-urban areas, with growing sheep fed on a straw-based diet, *Birint* in combination with poultry litter and coffee pulp, instead of *Birint* alone, improved nitrogen digestibility, nitrogen retention, and basal forage intake, without impairing performance. This combination could save concentrate feeds (Nurfata, 2010). Supplementation of *Birint* with Niger cake is commonly practiced for sheep fattening (Abebe *et al.*, 2013). However, sheep fed on *Birint* had a higher level of rumen ammonia and volatile fatty acids, concomitant with lower microbial N supply and efficiency. This could be due to the fact that *Birint* is extensively fermented during brewing, and thus yields less energy during rumen fermentation (Mekasha *et al.*, 2003).

Poultry Manure

Broiler litter is the richest non-protein nitrogenous source, but poor palatability and the presence of certain pathogens, not aflatoxin, limit its use in animal feeding (Makkar, 2002). It also contains many other basic nutrients and unidentified growth factors (Smith 1981). Rumen microbes have the ability to degrade uric acid into ammonia at a relatively slower rate than urea, so it can be used more efficiently by ruminants (Oltjen *et al.*, 1968). It has been observed that properly processed animal waste reduces pathogens, enhances its keeping quality and palatability, and has no undesirable effects on animal health (Adesehinwa et al 2010).

On account of its high nutrient value, it has attracted the researchers to consider it a feed ingredient due to the fact that the conventional feed stuff can no longer meet the needs of rapidly growing livestock (Abeke *et al.*, 2003). Poultry litter includes excreta, bedding, wasted feed, and feathers. Bedding may consist of wood shavings, sawdust, straw, peanut hulls, or other fibrous materials. Most of the poultry litter is obtained from broiler production. The litter may be from one crop of broilers or accumulate over several crops of birds. The litter usually contains 20 to 25% moisture. Broiler litter contains 25 to 50% crude protein and 55 to 60% TDN, dry matter basis, and is rich in essential minerals. Thus, the nutritional value is similar to or higher than good quality legume hay. An important aspect is the effect of feeding animal waste on the quality of animal products. In different experiments, it has been found that feeding

broiler litter does not adversely affect the carcass quality. Furthermore, feeding the litter did not affect taste of the meat.

Khat Leftover

The increasing cultivation of *Khat* as a cash crop allowed wide use of *Khat* leftover as feed for small ruminants, rendering it to play a major role in filling the gap in feed shortages particularly in eastern and southern Ethiopia, where grazing land is an almost unavailable resource. *Khat* leftover is reported to be one of these non-conventional feed resources with great potential for small ruminant feeding (Mesganaw, 2010). Together with agro-industrial by-products, *Khat* leftovers could be used as an alternative feed resource to improve small ruminant productivity (Yoseph, 2007). Getinet and Yoseph (2014) reported that concentrate (wheat bran and dried brewery grain) and *Khat* leftover inclusion in the goat diet at (2:1) improved the growth performance of goats. Similarly, Genbisewu *et al.*, (2019) indicated that concentrate (NSC) and *Khat* leftover inclusion in the sheep diets at (2:1) increased the body weight gain of sheep. *Khat* leftover is an inexpensive feed resource with high GE and Ca, moderate CP and a small fiber fraction, it is also leftover confirmed to improve feed dry matter and nutrient intake (Yoseph, 2007), which indicates that *Khat* is not only consumed by human beings as a stimulant, but also animals are known for scavenging Khat leftover in almost all towns and rural areas (Ismael, 2005).

According to Yoseph (2007), *Khat* leftovers contain 12.6% CP and 50.4% DM. A sufficient amount of Ca (2.45) and P (0.33) was also reported for Khat leftovers. The nutritional value of *Khat* leftovers appears moderate to high, with 11–13% CP, 92% OM, 31–46% NDF, 20.4 MJ/kg DM gross energy, and 73% in vitro true OM digestibility (Ismael, 2005). The results of Yoseph (2007) showed that feeding indigenous Ogaden bucks with *Khat* leftovers *adlibtum* resulted in increased live weight gain and body condition scores, suggesting *Khat* leftovers and agro-industrial by-products could be used as alternative feed resources to improve goat productivity under smallholder farming systems in Ethiopia, provided costs are kept to a minimum. Similarly, (Tamir and Ismail, 2006) reported that *Khat* leftover are a cheap protein supplement for goats in rural areas, where it is cheaper and more readily available than conventional protein supplements.

Constraints to the Uses of Non-Conventional Feed Resources

Non-conventional feed resources are underutilized, and several reasons for this are:

- ✓ Processing non-conventional feed is usually difficult and can be problematic in certain cases.
- ✓ Lack of managerial and technical skills in the utilization of such feeds *in situ*.
- ✓ The uncertainty about the marketability of the end products.
- ✓ The availability in terms of time, location, seasonality, and storage.

- ✓ High moisture content.
- ✓ Presence of anti-nutritional factors.
- ✓ Mould growth such as aflatoxin, which may cause toxicity (Devendra 2005).

CONCLUSION AN RECOMMENDATIONS

The major reason for low levels of animal production in countries is the inadequate supply and low level of feeding due to a serious shortage of feedstuffs. A distinctive gap exists between the requirements and supplies of nutrients for livestock. It is desirable that adequate feed resources be built up. The African continent has considerable amounts of non-conventional feed. Several factors, however, may account for their limited use, among which are their low nutritive values and difficulty in handling and using for extended periods. It is essential to increase feeds by growing more fodder, propagating agro and social forestry, improving the nutritive value of crop residues, and utilizing other non-conventional feed resources.

Based on the review, non-conventional feed resources are feeds that are not usually common in the market and are not the traditional ingredients used for commercial feed production. It is well known that the inclusion of these non-conventional feed resources in livestock feeding at different levels would meet the objective of bridging the gap between demand and availability of feed and reduce the cost of feed. They can also improve the productivity of livestock that are kept on overgrazed pastures and crop residues. Therefore, based on the review the following recommendations are forwarded;

- ✓ Farmers should feed their animals locally available non-conventional feeds like tomato pomace, *Atella, Birint*, poultry litter, and *Khat* leftovers because of their low cost and availability, on the other hand, feeding these feeds to animals is one of the methods to reduce the environmental waste from these by-products.
- ✓ Special attention should be given to the efficient utilization of non-conventional feed resources.
- ✓ The involvement of local extension agencies in technology development, assessment, and transfer is also an important factor.
- ✓ Care should be taken for toxic substances or anti-nutritional factors, since they are the major constraint in the utilization of non-conventional feeds.

CONFLICT OF INTERESTS

The authors declare no potential conflict of interest is reported regarding the subject matter of this manuscript either for financial, commercial, or intellectual purposes.

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