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Millets as Feed and Fodder for Livestock and Poultry

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Introduction

Millets are small-seeded grasses and cereal crops native to India, Africa and other Asian countries. India is the largest grower of millets accounting 41% of total millet production followed by Niger (11.5%) and China (7.6%). Various millet varieties are cultivated across the country, including Pearl Millet (Bajra), Sorghum (Jowar), Finger Millet (Ragi), Foxtail Millet, Kodo Millet, Barnyard Millet, Proso Millet, Little Millet, and pseudo-millets like Buckwheat and Amaranth. India produced about 9.5 million metric tons of pearl millet (bajra) and 4.4 million metric tons of sorghum (jowar). Rajasthan was the top millet-producing state in India, followed by Uttar Pradesh. Millets are resilient crops that thrive in hot, drought-prone and semi-arid regions, making them ideal for cultivation in unpredictable climates and nutrient-deficient soils. These grains are rich in essential nutrients and bioactive compounds, making them beneficial for both human and animal nutrition. Millets contain phenolic acids, flavonoids and tannins, which exhibit antioxidant properties and contribute to health benefits. Due to the rising demand for maize in various industries, alternative grains like millets have gained attention as sustainable feed options. In India, animal nutrition primarily relies on agricultural by-products such as rice/wheat straw, oil cakes, corn silage, brans and supplements. Integrating millets into animal husbandry can enhance sustainability by providing a cost-effective and nutritious feed alternative, ensuring a stable income for farmers despite agricultural uncertainties. States like Uttar Pradesh, Maharashtra, Karnataka, Rajasthan and Andhra Pradesh, which actively engage in animal husbandry and dairy farming, also contribute significantly to millet production. Recognizing the benefits of millets for animal nutrition can foster a sustainable value chain, promoting an eco-friendly and economically viable approach to livestock management.

Nutritional profile of millets

The nutrient composition of millets is comparable and, in some cases, superior to, conventional cereals. They play a crucial role in both human and animal diets due to their high energy content and rich concentrations of calcium, iron, zinc, lipids, and high-quality proteins. Additionally, millets serve as excellent sources of dietary fibre and essential micronutrients. The starch content in various pearl millet grains ranges from 62.8% to 70.5%, with soluble sugars varying between 1.2% and 2.6%. In contrast, finger millet has a total carbohydrate content ranging from 72% to 79.5%. Pearl millet contains approximately 11.6% protein, which is higher than that of rice (7.2%), barley (11.5%), and maize (9%). The fat content in pearl millet is estimated to be around 5%–7%, compared to 3.21%–7.71% in maize. Shweta, 2015 reported that pearl millet contains higher energy compared to rice and wheat, and is considered a signifcant source of thiamine, niacin, and ribofavin as stated by Taylor et al. 2004. The lipid content in finger millet is about 1%, while pearl millet contains approximately 5%. Pearl millet is particularly rich in fatty acids such as palmitic, stearic, and linoleic acids. The ash content in both pearl millet and maize ranges from 1.6% to 3.6% and 0.86% to 1.35%, respectively. Moreover, pearl millet has higher concentrations of essential minerals, including calcium, phosphorus, magnesium, manganese, zinc, iron, and copper, compared to maize (Adeola and Orban, 1995).

Finger millet is notably high in calcium, with levels ranging from 162 mg/100 g to 487 mg/100 g, while its magnesium content varies between 84.71 mg/100 g and 567.45 mg/100 g.

Health benefits of millets

Millets are rich in polyphenols, particularly phenolic acids and tannins, which act as powerful antioxidants and play a crucial role in strengthening the immune system. The most common phenolics found in millets are hydroxycinnamic acids, primarily present in the insoluble-bound fractions of phenolic acids. Among them, ferulic acid is the most prevalent hydroxycinnamic acid and is widely recognized for its antioxidant properties. Antioxidants help in reduce free radical damage in the body and exhibit anti-inflammatory effects. The high concentration of phenolic compounds in millets makes them an excellent source of natural antioxidants. Millet grains contain a variety of naturally occurring bioactive compounds, including phenolic acids, flavonoids, and tannins, along with xylo-oligosaccharides, insoluble fibres, and peptides.

Anti-nutritional factors present in millets

Anti-nutritional factors are compounds that reduce nutrient availability in animal feed. In millets, these factors can limit protein and starch digestibility, hinder mineral bioavailability, and interfere with the activity of proteolytic and amylolytic enzymes. Key anti-nutrients found in millets include phytic acid, polyphenols and tannins, which can restrict their effectiveness as animal feed. The antinutrient tannin is believed to decrease feed intake and feed efficiency (Kumar et al. 2016). Studies indicate that pearl millet contains between 354 and 796 mg/g of phytic acid. In this form, phosphorus is not bioavailable to monogastric animals, as they lack the enzyme phytase needed to release phosphorus from the phytate molecule. Additionally, tannins in millets reduce feed intake and efficiency. Among millets, finger millet has the highest tannin content, ranging from 0.04% to 3.74% in catechin equivalents. However, the levels of these anti-nutritional factors can be reduced through various processing techniques. Methods such as dehulling, milling, malting, blanching, parboiling, acid and heat treatments, and fermentation have been shown to lower anti-nutrient content in pearl millet. Notably, germination and de branning, when combined with autoclaving, have proven effective in reducing phytic acid and polyphenol levels.

Millet as a feed for livestock and poultry

Millet grains in ruminants' diets

Millet has been found to be beneficial for animals when fed as whole grain or in ground form. Several studies have been conducted to determine the most effective way to incorporate millet into animal diets. Research indicates that processing millet grain enhances the digestibility of dry matter and dietary nutrients, particularly for grazing beef cattle during the dry season. Millet grain can serve as an alternative to conventional grains in the diets of small ruminants. A study on lactating and growing goats revealed that replacing corn with pearl millet did not affect feed intake or milk production. However, a slight decline in daily growth rate and feed-to-gain ratio was observed when corn was entirely substituted with pearl millet. For large ruminants, millet grain is also considered a viable alternative to maize. Studies suggest that pearl millet can completely replace maize in high-supplement diets for confined cattle without negatively impacting performance.

Millet grains in chicken diets

Research has shown that whole pearl millet grain can be included in broiler diets at levels of up to 50% without negatively impacting performance. Replacing corn with pearl millet in broiler feed has been associated with significant improvements in growth rate and feed efficiency. Similarly, substituting corn with sorghum or millet in up to 50% of layer diets has shown comparable effects on egg production rates. Additionally, feeding pearl millet to laying hens offers an added advantage, as it leads to eggs with higher omega-3 fatty acid content and lower omega-6 levels. It has been suggested that pearl millet can replace 25% to 50% of maize in broiler diets without compromising performance.

Millet as a fodder for livestock

Millets serve as an excellent source of green forage and dry fodder for livestock. Single-cut sorghum and multi-cut pearl millet varieties are widely cultivated for green fodder production. Under irrigation and proper management, finger millet can yield 12–14 tonnes of green fodder per hectare in 50–60 days. When harvested 2–3 times during the growing season, the yield can reach up to 33 tonnes per hectare. Green forage from kudo

millet is highly digestible (70–75% dry matter digestibility) and readily consumed by cattle, especially up to the flowering stage. Many millets, including kudo millet, can be preserved as silage for use during the off-season. To ensure a year-round supply of green fodder, India has developed perennial Bajra-Napier hybrids. This multi-cut fodder variety, a hybrid of bajra (Pennisetum glaucum) and Napier grass (Pennisetum purpureum), has become popular due to its high yield, excellent nutritive value, digestibility, palatability, and ability to regenerate quickly after cutting. It produces more dry matter per day and contains 8–10% crude protein and 28–30% crude fibre, making it ideal for green fodder, silage, and hay production.

Millet Stover as Dry Fodder

Millet stover is a valuable fodder source, especially when cut and dried immediately after grain harvest. The heads of the millet plants are harvested manually as they ripen, while the stover is dried in the field to retain maximum nutritional value. Compared to the slender straws of paddy and wheat, millet stover has superior nutritive value, particularly in terms of nitrogen and cell-soluble nutrients. Higher stover yields of 10–15 tonnes per hectare can be obtained from well-managed sorghum and pearl millet cultivars. Urea treatment (5–10% urea with 25–50% moisture) enhances the digestibility, palatability, and crude protein content of crop residues. If the stover is wet due to rain or freshly harvested, urea can be applied without additional moisture. Treated stover should be stored in airtight conditions, where the outer untreated parts can be fed to animals with lower nutritional needs (e.g., draught bullocks or dry cows), while the inner treated part is best suited for growing and lactating animals. Treatment time may vary between 1–4 weeks.

Nutritional Benefits and Feeding Strategies

Sorghum, a major fodder crop, has a nutrient profile similar to corn, which is widely used in animal feed. However, sorghum silage contains 15% higher neutral detergent fibre (NDF) than corn silage, making it more "rumen-filling" and reducing total diet intake. Pearl millet is a promising summer fodder crop, capable of yielding 40–50 tonnes per hectare. On a dry matter (DM) basis, pearl millet silage can be incorporated at 50% in a lucerne silage/concentrate-based diet or 36% in a concentrate-based diet, sustaining a 24–26.3 kg/day milk yield in lactating dairy cows. Additionally, pearl millet grain can replace 10–30% of corn silage or maize grain in dairy cow diets without affecting dry matter intake, milk yield, or milk composition. Notably, pearl millet reduces the need for supplemental protein compared to corn-based diets. Finger millet is another excellent forage source for cattle, sheep, and goats. It is rich in methionine, an essential amino acid that improves feed digestion in dairy cattle. Finger millet straw can be used as forage in crossbred dairy cow diets when supplemented with a balanced concentrate mixture, sustaining a milk yield of 8–9 kg per day. However, due to its low nutritive value, it must be supplemented with nitrogen and energy sources to meet maintenance and production requirements. Finger millet straw is primarily used when other cereal prices are high due to its affordability and availability.

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Conclusion

Overall, millets whether utilized as green fodder, silage, or dry stover—serve as valuable feed resources for livestock. Their adaptability, high yields and nutritional benefits position them as a sustainable alternative to conventional cereals in animal feed. However, despite these advantages, several challenges hinder the widespread adoption of millets as animal feed and fodder, including limited access to quality seeds, inadequate knowledge and a lack of advanced processing technologies.

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