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Alternative Fermented Feeds in Ruminant Nutrition: Effects on Rumen Fermentation and Milk Production (A Review)

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ABSTRACT

The continuous rise in feed costs and the increasing competition for feed resources have made the search for innovative feeding strategies in ruminant production increasingly urgent. This paper reviews the effects of fermented feeds—including fermented total mixed rations (FTMR) and fermented concentrate ingredients such as soybean meal, corn gluten meal, yellow wine lees, and rapeseed by-products—on rumen fermentation, milk yield, and milk composition. Fermented feeds have received growing attention in recent years, as they have been shown to improve nutrient digestibility, enhance the activity of beneficial ruminal microorganisms, and positively influence fermentation processes. Evidence suggests that their inclusion not only improves milk yield and composition but also enhances feed efficiency and overall animal health indicators. Furthermore, some studies report increased profitability, although available data on cost-effectiveness remain limited. Overall, the use of fermented feeds represents a promising approach to addressing the challenges of modern livestock production and may contribute to the development of more economical and sustainable ruminant husbandry.

Keywords: fermented feed, FTRM, rumen fermentation, milk production, sustainability

1. INTRODUCTION

Animal feed supply is gradually decreasing due to human population growth and various natural phenomena, resulting in high feed costs. In recent decades, feed production costs have increased significantly, placing a heavy burden on farmers. To address this problem, many researchers have focused on developing new, low-cost alternative feeds (Sirohi et al., 2001). According to Jeong et al. (2016), by-products may be the only option for the production of affordable feeds. These by-products, derived from food processing and manufacturing, are not suitable for human consumption (Xu et al., 2007). Feeding strategies such as the use of industrial by-products can help reduce competition for fodder crops and optimize rumen

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efficiency. The incorporation of agro-industrial by-products into diets offers strategic advantages for livestock production by lowering feed costs, reducing food competition, and mitigating environmental impacts (Salami et al., 2019).

2. THE IMPORTANCE OF FERMENTED FEED

In ruminant nutrition, traditional preservation methods such as haymaking, silage, and haylage continue to play a fundamental role. Although hay can be stored for long periods, considerable nutrient losses may occur during harvesting and drying, particularly with easily degradable components (Zamudio et al., 2024). By contrast, silage is produced through anaerobic fermentation, during which microorganisms convert carbohydrates into organic acids, primarily lactic acid. This rapid decline in pH effectively suppresses the growth of undesirable microorganisms (Muck, 2017). The advantages of silage include higher nutrient yields per hectare and greater compatibility with mechanized production systems. Haylage, with a dry matter content of 40-60 %, represents an intermediate form between hay and silage. It ensures better nutrient preservation than hay, although it is more sensitive to packing and ensiling conditions (da Silva et al., 2019). In Western Europe, silage has progressively replaced hay as the dominant preserved forage, whereas in developing regions, inadequate preservation practices often compromise forage quality.

The popularity of fermentation technologies is often attributed to technological advantages such as simple equipment design, low cost, and environmentally friendly characteristics. However, in the context of animal nutrition, the true value of fermentation lies in its ability to ensure the long-term preservation of feed and to significantly enhance nutrient utilization. According to the review by Katu et al. (2025), fermentation is an effective method for restoring the nutritional value of alternative feed ingredients, reducing costs, and simultaneously maintaining or improving the biological value of diets, particularly by enhancing digestibility and reducing antinutritional factors.

Two primary technologies are applied in the production of fermented feeds. Solid-state fermentation (SSF) takes place on low-moisture solid substrates (e.g., soybean meal, rapeseed cake). Its advantages include low water requirements, reduced risk of contamination, and the use of substrates that can be directly applied in animal diets. However, SSF is limited by the difficulty of controlling temperature and moisture, as well as the need for specialized equipment (Couto & Sanromán, 2006). In contrast, submerged fermentation (SmF) occurs in high-moisture media, offering easy control of parameters and scalability at industrial levels. Its disadvantages are high water, and energy demands and the reliance on costly bioreactors (Subramaniyam & Vimala, 2012). For the production of ruminant feeds, SSF is generally considered more practical, whereas SmF plays a supplementary role, primarily in the preparation of microbial starter cultures.

In the initial stages of feed fermentation, the pH remains relatively high because acid production is still limited, and the abundance of lactic acid bacteria and other beneficial microorganisms is low. As the process progresses, microbial activity increases, primarily due to the proliferation of lactic acid bacteria, which produce organic acids (mainly lactic acid). Consequently, the pH gradually decreases while the acidity increases. This decline in pH is one of the most important indicators of fermentation, as it inhibits the growth of undesirable microorganisms and contributes to the long-term stability of the feed (Muck, 2017; Kung et al., 2018). Thus, microbial fermentation not only preserves feed but also enhances its nutritional value by converting starch and sugars into fermentation products such as lactic acid, other organic acids, and alcohols (Eun et al., 2007). For example, the fermentation of apple pomace (Rodriguez-Muela., 2015), soybean

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meal (Feizi et al., 2020., Wang et al., 2021) and rapeseed meal (Rehemujiang et al., 2023) can increase the nutritional value of feed. The selection of the right microbial strains is key to the success of the process, as it influences the quality of the final fermentation products. The available evidence shows that the use of lactic acid bacteria (LAB) is one of the most popular methods to improve the nutritional value and palatability of feed (Gomez-Alarcon et al., 1990). This is because these bacteria produce a variety of organic acids, aromatic compounds and other nutrients during fermentation that contribute to improve feed quality (Verni et al., 2019; Yang et al., 2016). They are also an effective method for killing pathogenic microorganisms that remain in feed (Niba et al., 2009). Fermented feeds are associated with a range of beneficial effects on the gastrointestinal system. A reduction in abomasal pH has been reported, resulting in a more acidic environment that promotes digestive processes, enhances nutrient utilization, and may contribute to improved protection against enteric pathogens (Canibe & Jensen, 2012; Scholten et al., 1999). In ruminants, however, supplementation with fermented concentrates has been observed to increase ruminal pH, suggesting modifications in fermentation dynamics and microbial community structure, which may subsequently influence nutrient digestibility and overall metabolic responses (Lee et al., 2023). A study by Zhang et al. (2017) found that the inclusion of microbially fermented feeds in a 50 % concentrate mixture significantly increased the nutrient digestibility of the feed and the average daily gain in goats. Microbially fermented feeds significantly alter the rumen fermentation process, including increasing the number of rumen microorganisms, enhancing nutrient flow and improving feed digestibility. According to Piamphon et al. (2017), the use of microbially fermented feeds increases the number of microorganisms in the rumen, which contributes to more efficient nutrient utilisation. Although previous studies have acknowledged the nutritional benefits of fermented feeds, much of this research has been conducted with monogastric animals such as pigs and poultry. In the case of ruminants, a considerable number of studies have investigated fermented forages and silages; however, research specifically addressing the fermentation of concentrate feedstuffs for ruminants remains limited. Therefore, while the general nutritional effects of fermented feeds in ruminant nutrition are relatively well documented (*Table 1*), further studies are required to clarify the specific role and potential benefits of fermented concentrates in ruminant feeding systems.

3. NEW TYPE OF FEED FOR RUMINANTS

The study of fermented feeds is receiving considerable attention in the field of animal nutrition *(Table 1)*. Total mixed ration (TMR) was originally developed as a complete feed for dairy cows and has been associated with numerous nutritional and economic advantages (Sirohi et al., 2001). In recent years, increasing attention has been directed toward its fermented form, fermented total mixed ration (FTMR), which combines the well-established benefits of TMR with the additional advantages of microbial fermentation—such as improved nutrient digestibility and enhanced feed efficiency (Wang et al., 2024; Paul et al., 2023). Fermented total mixed ration (FTMR) is a feed mixture containing concentrate and roughage, fermented in anaerobic conditions in a sealed tank for 21 days using lactic acid bacteria. This fermentation process improves the utilization of nutrients from the feed, making FTMR a simple and efficient solution for livestock production (Wognen et al., 2009). Vasupen et al. (2005) found that FTMR increases nutrient utilization, while Vasupen et al. (2006) found that FTMR positively affects the nutrient digestibility of diets in dairy cattle. In addition, FTMR extends the shelf life of feed, which provides additional benefits to farmers. One of the characteristic features of fermented total mixed ration (FTMR) is the variation in nutritional value

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of the feed changes whit the length of the fermentation period, caused by the production of minor metabolites (Kondo et al., 2016). During prolonged storage, losses of protein and soluble sugar fractions may occur (Nishino et al., 2003). Soluble sugars are primarily converted into lactic acid and other organic acids, while proteins may undergo proteolysis, leading to the formation of peptides, amino acids, and, in some cases, ammonia, which can negatively affect feed quality and animal health (Wang & Nishino., 2013). Another feature of FTMR is that it contains high concentrations of microbiota, which perform important metabolic functions and can aid in nutritional modification. For example, after 56 days of fermentation, *Lentilactobacillus buchneri* and *Pediococcus acidilactici* became dominant in FTMR, whereas in fresh TMR no clear dominance of specific bacterial taxa was observed. This indicates that fermentation time plays a crucial role in shaping the microbial community structure of FTMR (Hu et al., 2015). Also found that bacterial strains are key factors influencing the nutrient content of FTMR. During the fermentation process, different bacterial strains perform different metabolic activities that affect the final nutritional value of FTMR. During longer fermentation periods, the composition of the microbiota changes, which may lead to further nutritional modifications in the FTMR (Xie et al., 2020). Overall, nutritional modifications of FTMR and microbiota composition are closely related to the length of fermentation periods and the presence of bacterial strains. Together, these factors influence the final nutritional value of FTMR. Therefore, the fermentation of total mixed rations has gained increasing attention due to its potential to improve nutrient digestibility and animal performance.

In addition to the fermentation of whole TMR, promising results have also been obtained with the fermentation of individual concentrate ingredients. Among these, soybean meal (SBM) deserves particular attention, as it represents the most important source of vegetable protein in livestock production (Boguhn et al., 2008). The preparation of fermented soybean meal (FSBM) has been described by Rezazadeh et al. (2019). In brief, dried SBM containing 90 % dry matter was hydrated by immersion in distilled water (385 g water/1000 g SBM) for 60 minutes until its moisture content increased to approximately 35 %. The hydrated SBM was subsequently heat-treated in a steam bath at 65 °C for one hour, cooled to room temperature, and then inoculated with Bacillus subtilis GR-101 (4 log cfu/g SBM). The inoculated substrate was mixed thoroughly and fermented in a bed-packed incubator for 48 hours. After fermentation, the FSBM was dried at 50-60 °C to reduce its moisture content to around 10 % and then ground in a hammer mill. The fermentation of SBM results in the partial hydrolysis of proteins, leading to increased concentrations of small peptides and free amino acids that are more readily utilized by ruminal microbes and the host animal (Liu et al., 2007). Furthermore, fermentation reduces antinutritional factors such as trypsin inhibitors, lectins, and oligosaccharides, thereby improving protein utilization and gastrointestinal health (Hong et al., 2004). Consequently, FSBM is considered a superior protein source compared to untreated SBM, offering improved digestibility, enhanced microbial protein synthesis in the rumen, and better overall nutrient utilization in ruminants (Rezazadeh et al., 2019). Cider is a traditional Chinese alcoholic beverage made from rice, sorghum or wheat. It has been popular in China for centuries and the yellow wein lees (YWL) produced during its production are a major by-product. YWL has high crude protein content (315-413 g/kg dry matter), which makes it particularly valuable for livestock production. Its price is one third of the price of SBM (soybean meal), making it an economical source of protein in China (Hu et al., 2014). However, YWL has an unbalanced amino acid (AA) profile and is difficult to preserve due to its high moisture content (Zheng and Qian., 2007). A previous study showed that microbial pretreatment can improve the nutritional value of YWL. The study found that the fermented YWL had higher crude protein and peptide content, improved amino

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acid profile and better in vitro rumen digestibility (Yao et al., 2018). This suggests that fermented YWL may be a suitable protein feed for ruminants. The use of microbially fermented YWL may not only provide a more economical alternative to conventional feeds but may also contribute to sustainable feeding practices. During the fermentation process, micro-organisms break down the complex molecules in YWL, making them more digestible for animals. In addition, the bioactive compounds produced during fermentation can improve animal health and performance. Fermentation of yellow wine lees (YWL) converts complex macromolecules, such as structural carbohydrates, proteins, and antinutritional factors, into simpler, more digestible compounds. At the same time, bioactive metabolites (organic acids, peptides, antioxidants) are produced, which enhance nutrient utilization, gut health, and immune function, ultimately improving animal performance (Kara & Öztaş, 2023).

Corn gluten meal is a major by-product of the wet milling of corn and is used mainly as a source of protein in animal feed. However, due to its imbalance in the amino acid profile and low water solubility (Zhuang et al., 2013), corn gluten meal is difficult to use directly as a protein ingredient in calf feed. Research has shown that by fermentation of corn gluten meal, its large proteins are hydrolyzed into small peptides, which significantly improves the nutritional quality and water solubility of proteins in various substrates (Neumann et al., 2010).

Rapeseed production has become the largest source of oilseeds in the European Union. Rapeseed oil production involves the pressing of rapeseed to produce crude rapeseed cake (RC), which is known for its rich protein, fibre and mineral content. This by-product can be a potential source of protein in animal feed (Bayat et al., 2021; Gao et al., 2022). Goiri et al. (2021) showed that lactating dairy cows fed diets containing RC had increased milk production. However, despite the many promising effects of RC, it is recommended to use it in limited amounts as it might contains antinutritional factors such as glucosinolates, phytic acid, alkaloids, erucic acid and tannins (Negawoldes., 2018; Song et al., 2022).

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Table 1: Alternative fermented feeds for ruminants

Feed	Inoculum	Animals	Effects	References
Total mixed ration	*Lactobacillus acidophilus Saccharomyces cerevisiae*	Hanwoo steers (3)	Better Acetate/Propionate	Kim et al. (2012)
	Lactobacillus plantarum *Lactobacillus buchneri*	Lactating Holstein Frisian (36)	Higher milk fat concentration, Milk fat yield, DM and CP degradation, estimated microbial CP yield and feed, Higher VFA efficiency higher	Zhang et al. (2020)
	Lactobacillus acidophilus *Bacillus subtilis*	Hanwoo steers (3)	Lower rumen pH Higher acetate, propionate, and total VFA content microbial population was not affected	Miguel et al. (2021)
Cottonseed meal and rapeseed meal	Not specified	Lactating Holstein Frisian (4)	Unsaturated fatty acids in milk fat lower	Wongnen et al. (2009)
	Bacillus clausii	Male Hu sheep (51)	No negative effects on rumen microbiota Increased VFA yield	Rehemujiang et al. (2023)
Soybean meal	*Bacillus substilis*	Holstein Frisisan calves (39)	Increase calf performance	Feizi et al. (2020)
	Lactobacillus spp. *Bacillus subtilis Saccharomyces cerevisae*	Lactating Holstein Frisian (24)	Modulated rumen fermentation and rumen bacterial microbiota	Wang et al. (2021)
	Not specified	Lactating Holstein Frisian (18)	Modified the rumen fermentation, improved the ruminal bacterial composition, and enhanced the milk composition, FCM, and milk componens yield	Amin et al. (2022)
	Saccharomyces cerevisiae Bacillus subtilis	Lactating Holstein Frisian (48)	Altered the rumen fermentation parameters and bacterial community Increased serum prolactin level	Zhang et al. (2024)
Broussonetia Papyrifera	Not specified	Guanhang dairy goats (18)	Increase the milk production	Zhao et al., (2022)
Chinese herbals	Not specified	Lactating Holstein frisian (40)	Improve milk performance and immune function	Shan et al. (2018)

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Yellow wine lees	*Calathea utilis Bacillus subtilis*	Hu sheeps (3)	Improved the MCP and VFA synthesis Enhanced the digestibility	Yao et al. (2018)
	Not specified	Lactating Holstein frisian (15)	Higher milk yield greater VFA concentration and molar proportion of acetate	Yao et al. (2020)
Rapeseed cake	Not specified	Lactating Holstein Frisian (3/4/20)	Lowered ruminal acetate Increased propionate proportion Increased beneficial fatty acid content in milk	Gao et al. (2023)

4. EFFECT OF FERMENTED FEED ON RUMEN FERMENTATION

There is a lot of research on the impact of fermented feeds on rumen fermentation. In a study by Kim et al. (2012), three different diets were investigated: T1 (FTMR 18,4 %, high chenille, mammoth wild rye feed and whole barley), T2 FTMR 17,9 %, rice straw and whole barley) and T3 (rice straw, whole barley and probiotics, but not fermented feed).The production of volatile fatty acids (VFA) increased with the progression of the fermentation period, reflecting enhanced microbial activity and feed degradation. This not only indicates improved digestibility of the feed but also suggests greater energy availability for the host animal, since VFAs represent the primary energy source for ruminants (particularly acetate, propionate, and butyrate). Jiang et al. (2019) determined how supplementation with fermented corn gluten meal (FCGM) affects growth, rumen fermentation and plasma metabolites of post-weaning calves. Calves fed the FCGM diet had higher rumen levels of ammonia-nitrogen, acetate, propionate, total volatile fatty acid, microbial protein and proteinase. Rumen pH was lower in the FCGM group. The relative abundance of *Bacteroidetes* and *Prevotellaceae* was higher in the FCGM group, while the proportion of *Ruminobacter* was lower compared to the control (not supplemented with FCGM) group. Yao et al. (2020) evaluated the effects of replacing soybean meal (SBM) with unfermented and microbially fermented yellow wein lees (YWL) on in vitro rumen fermentation characteristics. Two different mixtures containing 400 g/kg YWL at different ratios (1:0, 1:1, 1:2, 1:5 and 0:1, w/w) were prepared to replace SBM. Microbial fermentation of YWL significantly increased the digestibility of microbial protein (MCP; $p < 0.01$) and in vitro crude protein (CP; $p < 0.01$) and also improved nitrogen utilization efficiency ($p < 0.01$). The YWL ratio used to replace SBM had linear and quadratic effects on MCP ($p < 0.01$), total volatile fatty acids (VFA; $p < 0.01$), in vitro CP digestibility, and nitrogen utilization efficiency ($p < 0.01$), with the optimal substitution ratio being 1:1. Another study also investigated the effect of replacing soybean meal (SBM) with fermented soybean meal (FSBM) on rumen fermentation and the bacterial community of Holstein calves. Thirty-nine calves were divided into three groups: (1) control: 27 % SBM + 0 % FSBM (FSBM0, n = 13); (2) 18 % SBM + 9 % FSBM (FSBM9, n = 13); and (3) 13.5 % SBM + 13.5 % FSBM (FSBM13, n = 13). While conventional SBM contained a high proportion of large peptides (3-10 amino acids), FSBM was characterized by higher concentrations of ammonium nitrogen (NH_3-N), free amino acids, and small peptides (2-3 amino acids). Calves in the FSBM13 group exhibited lower concentrations of acetic acid, NH_3-N, and acetate/propionate (A/P) ratios, together with higher levels of caproic, valeric, and isovaleric acids in the rumen fluid. These parameters are generally considered beneficial, since reduced NH_3-N indicates more efficient

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nitrogen capture by ruminal microbes, while a lower A/P ratio reflects a metabolic shift toward propionate, the main glucogenic precursor in ruminants. Moreover, calves receiving FSBM13 showed a higher prevalence of *Prevotella ruminicola*, a genus associated with improved protein and carbohydrate utilization, whereas the relative abundance of *Ruminococcus albus* and *Butyrivibrio fibrisolvens*—fiber-degrading species linked to higher acetate production—was reduced compared to the control. Network analysis further revealed that the prevalence of *Ruminococcus albus* correlated positively with large peptides, while butyric acid was associated with small peptides, supporting the view that peptide composition influences microbial community structure. Collectively, these findings suggest that FSBM supplementation enhances calf performance by promoting more efficient nitrogen utilization, favouring glucogenic fermentation pathways, and enriching bacterial taxa associated with improved nutrient digestibility (Feizi et al., 2020). Zhang et al. (2020) show that the FTMR diet improves the concentration of volatile fatty acids in the rumen, increases the molar ratio of acetate and ammonia-N concentration, while reducing the digestibility of butyrate, organic matter, NDF, and ADF. According to the findings of Rehemujiang et al. (2023), ruminal pH was significantly higher in the control group compared to animals fed fermented TMR, which contradicts the statement reported in the abstract. Furthermore, microbial crude protein (MCP) concentrations were significantly greater in the fermented TMR group. Distinct shifts in rumen microbiota composition were also observed: fermented TMR promoted the proliferation of Firmicutes and Prevotella, while reducing the abundance of Bacteroidetes. Collectively, these results indicate that fermented TMR exerts beneficial effects on rumen fermentation and microbial protein synthesis.

5. EFFECT OF FERMENTED FEED ON MILK COMPONENTS AND MILK PRODUCTION

Vasupen et al. (2006) compared the effects of feeding total mixed ration (TMR) and fermented total mixed ration (FTMR) on the performance of dairy cows. Voluntary feed intake, milk yield, milk protein and fat content, microbial counts, and rumen pH did not differ significantly between the two groups ($P > 0.05$). However, the digestibility of dry matter (DM), organic matter (OM), acid detergent fiber (ADF), and non-structural carbohydrates (NSC) was significantly higher in cows fed FTMR compared with those fed TMR ($P < 0.05$). These findings indicate that while FTMR does not alter intake or milk yield parameters, it improves nutrient digestibility, which may contribute to enhanced feed efficiency. Wognen et al. (2009) did not observe significant effects of FTMR on milk yield, milk composition, or rumen fermentation parameters. Yao et al. (2020) evaluated the effects of unfermented yellow wine lees (UYWL) and fermented yellow wine lees (FYWL) as alternative protein sources in the diets of lactating cows. Cows fed FYWL exhibited higher dry matter intake, milk yield, milk protein yield, and energy-corrected milk yield compared with those fed UYWL. Although milk composition, feed efficiency, and nitrogen conversion rates did not differ significantly between the two groups, cows on the UYWL diet showed lower nitrogen intake, blood urea nitrogen, urinary nitrogen, microbial protein, and metabolizable protein. These findings suggest that fermentation of yellow wine lees enhances nitrogen utilization and contributes to improved production performance. However, when FTMR was fed with wet corn gluten feed (WCGF) and corn starch instead of alfalfa hay, the FTMR ration has resulted in higher crude protein (CP) and lactic acid content and lower pH in the rumen. Milk fat concentration, milk fat yield, DM and CP breakdown, estimated microbial CP yield and feed efficiency were higher in cows fed the FTMR diet. However, cows fed the FTMR diet had lower DM intakes. In this study, it was also reported that

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cows fed FTMR diets significantly increased IOFC (IOFC = income over feed cost the IOFC was calculated by subtracting feed costs from milk income) compared to cows fed unfermented TMR, as the low cost of fermentation reduced feed expenditure while milk production revenue remained unchanged (Zhang et al., 2020). One study aimed to evaluate the rumen microbiota, milk composition and milk component yield of Holstein cows supplemented with fermented soybean meal (FSBM). Supplementation with FSBM increased milk urea nitrogen levels, milk protein yield, fat corrected milk and milk fat yield, while decreasing milk somatic cell count. In the rumen, the relative abundance of *Fibrobacterota* and *Spirochaetota* phyla increased due to the presence of fermented soybean meal in the ration, while the proportion of Proteobacteria was lower (Amin et al., 2022).

6. CONCLUSION

The application of fermented feeds in ruminant nutrition and production performance offers numerous advantages. Several studies have demonstrated that fermented feeds – such as fermented total mixed rations (FTMR) – enhance nutrient digestibility, stimulate ruminal microbial activity, and positively influence rumen fermentation processes. The selection of appropriate microbial strains is of critical importance for the success of fermentation, as it largely determines the quality and nutritional value of the final product. Empirical evidence suggests that fermented feeds exert beneficial effects not only on milk yield but also on milk composition. Their inclusion in ruminant diets contributes to improved animal health and enhanced production performance. Bioactive compounds generated during fermentation strengthen the immune system and promote more efficient nutrient utilization. Fermented soybean meal and corn gluten, for example, have been shown to improve rumen fermentation parameters, increase the production of volatile fatty acids (VFA), and beneficially modulate the ruminal microbial community. Although the cost-effectiveness of fermented feeds has been investigated in a limited number of studies, the available results indicate that their use can result in higher profitability. Consequently, there is a clear need for further domestic research to validate these findings under local conditions. The incorporation of fermented feeds not only increases the economic efficiency of animal production but also contributes to sustainability by reducing feeding costs and lowering environmental impacts. Future studies should focus on the long-term effects of fermented feeds, the targeted use of different microbial strains, and the optimization of the fermentation process in order to develop more sustainable feeding strategies for ruminants. In conclusion, the use of fermented feeds represents a promising approach to addressing the challenges of modern livestock production and to advancing more economically viable and environmentally sustainable husbandry practices.

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Alternatív fermentált takarmányok a kérődzők táplálkozásában: hatásuk a bendőfermentációra és a tejtermelésre (irodalmi áttekintés)

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ÖSSZEFOGLALÁS

A takarmányköltségek folyamatos emelkedése és a takarmányforrásokért folytatott verseny egyre sürgetőbbé teszi az innovatív takarmányozási megoldások keresését a kérődző-ágazatban. Jelen tanulmány áttekinti a fermentált takarmányok – köztük a fermentált teljes takarmánykeverékek (FTMR), valamint fermentált koncentrátum-összetevők, úgymint a szójadara, a kukoricaglutén, a sárgaborseprő és a repce melléktermékek – hatásait a bendőfermentációra, a tejtermelésre és a tej összetételére. A fermentált takarmányok az utóbbi években kiemelt figyelmet kaptak, mivel bizonyítottan javítják a tápanyagok emészthetőségét, elősegítik a bendőmikroorganizmusok aktivitásának fokozását, és kedvezően alakítják a fermentációs folyamatokat. Az eredmények arra utalnak, hogy alkalmazásuk nemcsak a tejhozamot és -összetételt, hanem a takarmányhasznosítás hatékonyságát is javítja, miközben kedvező hatással van az állategészségügyi mutatókra. Emellett egyes vizsgálatok a jövedelmezőség növekedését is jelezték, ugyanakkor a költséghatékonyságra vonatkozó adatok még korlátozottak. Összességében a fermentált takarmányok alkalmazása ígéretes lehetőséget kínál a modern állattenyésztés kihívásainak kezelésére, valamint hozzájárulhat a gazdaságosabb és fenntarthatóbb termelési rendszerek megvalósíthatóságához.

Kulcsszavak: fermentált takarmány, FTMR, bendő fermentáció, tejtermelés, fenntarthatóság

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