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Mulberry leaves (*Morus alba*) as a potential alternative forage for rabbits: a review

Daun murbei (Morus alba) sebagai hijauan alternatif potensial untuk kelinci: review

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Abstract. The success of rabbit farming largely depends on the availability of economical and highly nutritious forage. White mulberry leaves (Morus alba) are a promising option, as they contain over 20% crude protein, more than 80% digestibility, and a balanced profile of amino acids. These leaves are also rich in minerals, vitamins, and bioactive compounds with antioxidant, immunostimulant, and antibacterial properties that support rabbit health and performance. Research shows that including mulberry leaves at up to 50% of the diet can improve feed efficiency, growth, and immune response without compromising meat quality. However, for meat with better flavour and a juicier texture, a lower inclusion rate below 10% is preferable. Age-related differences are important; feeding young rabbits diets containing 20% or more mulberry leaves may slow growth. Despite their benefits, mulberry leaves also contain antinutritional factors such as tannins, phytic acid, crude fibre, and 1-deoxynojirimycin (DNJ), which may reduce digestibility and nutrient absorption. To minimise these limitations, appropriate inclusion rates should be used, and processing methods such as wilting, drying, fermentation, or producing leaf meal can be employed to lower antinutritional levels. In conclusion, mulberry leaves are a safe and valuable forage for rabbits with recommended dosage 20% until 50% DMI.

Keywords: Alternatif feed, forage, livestock nutrition, mulberry leaves, rabbit feed

Abstrak. Keberhasilan usaha ternak kelinci sangat dipengaruhi oleh ketersediaan hijauan yang ekonomis dan bernutrisi tinggi. Daun murbei putih (*Morus alba*) merupakan salah satu sumber hijauan potensial karena mengandung protein kasar lebih dari 20%, kecernaan di atas 80%, serta profil asam amino yang seimbang. Daun ini juga kaya akan mineral, vitamin, dan senyawa bioaktif dengan sifat antioksidan, imunostimulan, serta antibakteri yang mendukung kesehatan dan performa kelinci. Sejumlah penelitian menunjukkan bahwa pemberian daun murbei hingga 50% dalam ransum dapat meningkatkan efisiensi pakan, pertumbuhan, dan respons imun tanpa menurunkan kualitas daging. Namun, untuk menghasilkan daging dengan rasa lebih enak dan tekstur lebih juicy, tingkat pemberian yang lebih rendah, yaitu di bawah 10%, lebih disarankan. Faktor umur juga perlu diperhatikan, sebab pemberian lebih dari 20% pada kelinci muda dapat menghambat pertumbuhan. Meski bermanfaat, daun murbei juga mengandung faktor antinutrisi seperti tanin, asam fitat, serat kasar, dan 1-deoxynojirimycin (DNJ) yang dapat menurunkan kecernaan serta penyerapan nutrien.

Untuk mengurangi dampak tersebut, daun murbei sebaiknya diberikan pada proporsi yang tepat dan melalui pengolahan seperti pelayuan, pengeringan, fermentasi, atau diolah menjadi tepung daun. Kesimpulannya, daun murbei merupakan hijauan yang aman dan bernilai tinggi bagi kelinci dengan pemberian 20-50% bahan kering.

Kata kunci: Daun murbei, nutrisi, pakan alternatif, kelinci

INTRODUCTION

Rabbits are monogastric herbivores that depend on fibrous feed as the core part of their daily diet. Fibre-rich feed is essential, as rabbits need high fibre levels to support digestive health and optimise production performance (Liao et al., 2017; Nasihin, 2025). The importance of fibrous feed in rabbit farming makes optimal feed management essential, both economically and nutritionally. Poor-quality feed can result in reduced productivity and negatively impact animal health, behaviour, and welfare (Makkar, 2016).

Fibre can be supplied through forage in rabbit diets. Forages such as alfalfa are widely used in rabbit farming worldwide due to their high nutritional value and various benefits (Latif et al., 2023). Nonetheless, the relatively high cost and limited availability of alfalfa in tropical regions create difficulties for rabbit farmers. Consequently, there is a need for more affordable, highly nutritious, and locally accessible forage options in tropical areas.

One promising alternative is using mulberry leaves (*Morus alba*). Mulberry is a shrub species that has spread globally, including tropical areas such as Indonesia (Wulandari et al., 2018). *Morus alba*, or white mulberry, is commonly found growing wild or cultivated as feed for silkworms. However, several studies have shown that mulberry leaves have great potential as livestock feed due to their rich nutritional content (Hutasoit et al., 2016). Mulberry leaves are a promising forage alternative due to their high palatability and digestibility. Moreover, they are rich in nutrients, particularly crude protein, have a balanced amino acid profile, and their nutritional quality is comparable to that of concentrate feeds. These characteristics make mulberry leaves a high-quality forage, comparable to legumes such as alfalfa (Cai et al., 2019; B. Wang & Luo, 2021), (Neto et al., 2018).

Incorporating mulberry leaves into animal feed has been proven to improve growth performance, production, and immune response in various livestock species, with varying effects depending on the dosage used (Geng et al., 2024). Despite its promising potential, using mulberry leaves as feed for animals such as rabbits is still rarely practised. Given its high nutritional value, better availability, and affordable cost, mulberry leaves deserve consideration as an alternative rabbit feed. Therefore, this review aims to explore the potential of mulberry leaves as rabbit feed, focusing on their impact on growth, health, and productivity. Through this review, it is expected that a practical solution can be found to improve the efficiency of rabbit feeding by utilising high-quality local resources.

MATERIALS AND METHODS

This paper was prepared through a literature review based on secondary data from journal articles and relevant proceedings. The literature was gathered from scientific databases such as Google Scholar using keywords like “Morus alba”, “mulberry leaves”, “rabbit feed”, and “alternative forage”. The selected studies were thematically analysed, focusing on nutritional content, growth performance, health benefits, and anti-nutritional factors related to the use of mulberry leaves in rabbits.

RESULTS AND DISCUSSION

General Characteristics

White mulberry (*Morus alba*) is one of the most suitable types of mulberry used for animal feed because it can produce about 25-30 tons of leaf biomass per hectare per year, with a 9-10 week harvest interval. The leaves of *Morus alba* can be given to livestock either fresh or further processed for longer storage, especially as a feed reserve during periods of feed

scarcity in certain seasons (Hassan et al., 2020). Mulberry leaves have very good nutritional content, making them a high-value alternative feed option for rabbits. The nutritional content of Morus alba leaves in several processed forms is presented in Table 1.

Table 1. Nutritional content of *Morus alba*

Type of Feeds	DM	CP	NDF	ADF	EE	Ash	Reference
Fresh	-	21,8	35,5	23,8	3,31	15,3	Khan et al. (2019)
	11	24,46	29,92	25,08	6,01	8,89	Adetomiwa et al. (2022)
	22,8	22,4	-	-	-	-	Noa-lobaina & Lafargue-savón (2022)
Powder	75,73	24,45	-	-	2,15	11,31	Dias et al. (2022)
	91,8	15,7	35,2	20,2	7,16	15,7	Tesfay et al. (2017)
	88,92	22,3	-	-	5,12	11	Huikhiaw et al. (2021)
	90,53	22,96	17	16	-	10,88	Shehata et al. (2021)
Dried	91,7	16,9	36,1	15,8	-	-	Ebrahim et al. (2017)
	91,96	22,96	26,05	13,26	1,65	-	Hnokaew et al. (2024)
	89,15	19,25	-	-	5,5	11,75	Al-Musawi & Al-Jbory (2021)
Silage	-	16,78	56,04	55,91	3,1	9,03	Divyashree & Chandrashekhar (2020)

Note: DM (Dry Matter), CP (Crude Protein), NDF (Neutral Detergent Fiber), ADF (Acid Detergent Fiber, EE (Ether Extract)

According to Table 1 shows that the nutritional composition of mulberry (*Morus alba*) varies depending on its processing form (fresh, powdered, dried, or silage). Fresh leaves generally contain 21–24% CP, 30–35% NDF, 23–25% ADF, 8–15% ash, and 3–6% EE, indicating their value as a protein-rich and energy-contributing forage comparable to legumes such as alfalfa. Mulberry leaf powder maintains high protein levels (22–24% CP), relatively lower fiber (17–35% NDF; 20–27% ADF), 10–11% ash, and 2–7% EE, making it more digestible and suitable as a substitute for concentrate feeds. Dried leaves contain slightly lower protein (16–23% CP), with moderate to high fiber (26–36% NDF; 23–31% ADF), 10–12% ash, and 2–4% EE, which still provide a good source of protein, minerals, and energy. In contrast, mulberry silage shows a marked decline in quality, with lower protein (16–17% CP), very high fiber levels (NDF and ADF exceeding 55%), around 9% ash, and only 2% EE, which together reduce digestibility and nutritional availability. Overall, mulberry leaves consistently supply high protein, minerals, and moderate energy, but their nutritional value is strongly influenced by processing methods. Among the different forms, mulberry leaf powder is considered the most advantageous due to its higher protein retention, moderate fiber content, and practical application in rabbit diets.

Morus alba offers several nutritional benefits compared to other types of mulberry. Fresh *Morus alba* leaves typically contain crude protein levels of up to 20% of dry matter, with a digestibility rate exceeding 80%. The leaves are also rich in amino acids, with a composition

similar to soybean meal, especially in essential amino acids, making them a valuable nutrient source. In addition to protein, *Morus alba* leaves have a relatively high mineral content, with ash levels usually ranging from 10 to 15%, depending on soil conditions. *Morus alba* also contains numerous beneficial macro and microelements, including a high level of calcium (Martín et al., 2017).

A study by Sánchez-Salcedo et al. (2017) showed that the levels of calcium (Ca), nitrogen (N), potassium (K), magnesium (Mg), and crude protein in *Morus alba* leaves were higher compared to those in *Morus nigra*. The leaves are also reported to contain bioactive compounds such as alkaloids, anthraquinones, glycosides, saponins, steroids, and tannic acid (Witoyo et al., 2020). Furthermore, Yang et al. (2023) added that flavonoids are the main bioactive compounds in these leaves, offering various health benefits such as antibacterial, anti-inflammatory, lipid-lowering, glucose-regulating, and antioxidant effects. Morus alba leaves also contain important vitamins, +including vitamin C, vitamin B1, folic acid, carotene, folinate, and vitamin D (Fatima et al., 2024).

Benefit for Growth and Meat Quality

Morus alba leaves have been the subject of numerous recent studies as a potential alternative forage for rabbits. Several studies have shown that *Morus alba* leaves can markedly improve growth, health, and meat quality in rabbits. Khan et al. (2019) found that feeding fresh mulberry leaves at levels of 25-50% can improve nutrient and energy digestibility in rabbits. This offers advantages for rabbit farmers because feeding *Morus alba* leaves enhances nutrient absorption efficiency, ultimately supporting better growth performance.

Moreover, Saucedo et al. (2023) reported that fresh *Morus alba* leaves could be included at 20-40% in rabbit diets without negatively affecting feed intake, average daily weight gain, or feed conversion efficiency. *Morus alba* leaves can also be given in wilted form at 50%, which has a positive effect on growth and carcass yield without adverse effects on meat quality (Khan et al., 2020).

The use of mulberry leaf powder has also been widely explored. Lan Phuong et al. (2022) reported that substituting 50% of fish meal protein with 50% Morus alba leaf powder resulted in optimal growth with the best Feed Conversion Ratio (FCR). This indicates that mulberry leaf powder can serve as an effective alternative protein source that is more affordable and readily available. Biasato et al. (2023) added that using 10% mulberry leaf powder could replace alfalfa meal without affecting growth performance or mortality rates.

Mulberry leaf powder also improves rabbit meat quality. This finding aligns with Hou et al. (2020), who found that feeding up to 15% mulberry leaf powder significantly enhanced growth and meat quality. However, Brugiapaglia et al. (2024) found that including 10% mulberry leaf powder reduced intramuscular fat content, resulting in drier, less juicy meat. Despite this, the meat's flavour was liked by panellists. This effect may be due to the addition of mulberry leaves influencing fatty acid metabolism and oxidation processes through gene and protein activities related to lipid metabolism, contributing to changes in fat production and fatty acid composition (Cao et al., 2024). Therefore, to achieve a juicier texture and better flavour in the meat, it is recommended to include less than 10% mulberry leaf powder in the diet.

Benefits and Risks for Health

Besides its nutritional benefits, mulberry leaves also have significant health effects. Various studies have shown that *Morus alba* exhibits a wide range of pharmacological activities such as antidiabetic, antimicrobial, antimutagenic, antioxidant, anticancer, anxiolytic, anthelmintic, anti-stress, immunomodulatory, hypocholesterolemic, nephroprotective, and hepatoprotective properties (Sanghi & Mushtaq, 2017). The high content of bioactive compounds in *Morus alba* leaves makes them a promising feed ingredient that not only improves feed quality but also helps reduce production costs in livestock feeding systems. Research indicates that adding *Morus alba* leaves to animal feed can enhance antioxidant activity, which helps lower stress levels in animals (Potu et al., 2023).

The antimicrobial and antioxidant properties of mulberry leaves may also benefit the digestive tract of rabbits. The phytochemicals contained in the leaves can protect the intestinal microvilli and suppress the growth of pathogenic microorganisms (Aziz-Aliabadi et al., 2025). A study by Kim et al. (2024) found that *Morus alba* leaves have strong antibacterial activity against pathogens and promote the proliferation of probiotics, thus optimizing gut microbial balance and intestinal epithelial health. According to Nani et al. (2022), mulberry leaves have effects similar to acarbose in controlling digestive enzymes without causing excessive side effects. Huang et al. (2021) stated that digestive enzymes such as α-amylase, trypsin, and chymotrypsin play roles in fiber breakdown; therefore, a balanced enzyme activity can affect nutrient digestibility and rabbit growth. Stable regulation of these enzymes helps improve fiber utilization efficiency, maintain gut microbiota balance, and support overall health and growth performance.

Other health benefits reported by Chen et al. (2022) include oral administration of mulberry leaf extract at 10 ml/kg body weight, which showed significant antibacterial and anti-inflammatory effects, especially in treating conjunctivitis in rabbits. Another study found similar results, showing that mulberry leaf extract can prevent cell damage in the lacrimal glands of rabbits with androgen hormone deficiency, helping maintain tear production. Although weaker than androgen hormones, mulberry leaf extract has the potential to be a natural remedy for dry eyes and reduce the risk of side effects associated with long-term synthetic hormone use (Cheng et al., 2021).

Additional health benefits were reported from feeding rabbits pellets made from mulberry leaf powder combined with carob seed powder (1.5%:1.5%), which had positive effects in lowering glucose, cholesterol, triglycerides, and insulin levels (Faisal & Al-saadi, 2024). Gent et al. (2018) also documented a decrease in glucose and cholesterol levels following administration of *Morus alba* leaf extract. The glucose-lowering effect is linked to the presence of 1-Deoxynojirimycin (1-DNJ), a potent α-glucosidase inhibitor that reduces glucose and carbohydrate levels (Ntalouka & Tsirivakou, 2024).

Despite many positive effects from feeding *Morus alba* leaves to rabbits, the outcomes depend on the method of administration. Although mulberry leaves are rich in nutrients, their anti-nutritional factors may inhibit digestion and nutrient absorption if consumed in excessive amounts. Anti-nutrients such as crude fiber, tannins, and phytic acid can limit nutrient uptake by animals (M. Wang et al., 2022). Another anti-nutritional factor, 1-Deoxynojirimycin (DNJ), can negatively affect gut microorganisms if given in high doses. Research has shown that high DNJ doses reduce daily weight gain, alter intestinal villi structure, and change the balance of microbial populations and short-chain fatty acid metabolism in rabbits (Li et al., 2024).

Studies also show that feeding large amounts of fresh mulberry leaves (75-100%) can reduce nutrient digestibility (Khan et al., 2019). Similarly, giving 75-100% mulberry leaf powder negatively impacts growth performance and feed efficiency, so it is not recommended to exceed 50% inclusion (Lan Phuong et al., 2022). The dosage should also be adjusted according to the rabbit's age, as feeding ≥20% mulberry leaf powder to young rabbits can hinder growth (Hou et al., 2020).

Fresh mulberry leaves can be fed directly to animals. However, treatments such as fermentation can make mulberry leaves safer for livestock consumption without negatively affecting performance or meat quality (Geng et al., 2024). Fermented mulberry leaves have greater benefits in improving growth performance, meat quality, and antioxidant activity compared to non-fermented leaves (L. Wang et al., 2022). Moreover, silage processing can help preserve the nutritional content of mulberry leaves (Neto et al., 2018). Further processing, such as drying and powdering the leaves, can reduce the negative effects of anti-nutrients while maintaining nutritional value. The simplest method is to wilt the leaves by air drying or sun drying (Yanuartono et al., 2020).

CONCLUSION

White mulberry leaves (*Morus alba*) have great potential as an alternative forage for rabbits due to their high nutritional content and digestibility, as well as their wide-ranging health benefits. They can improve growth, meat quality, feed efficiency, and immunity, but excessive use may have negative effects. Therefore, mulberry leaves should be given at recommended levels of 20–50% for growth improvement, while less than 10% inclusion is preferable for enhancing meat quality. The inclusion level should also consider the age of the rabbits, as young rabbits may experience growth retardation when fed ≥20% mulberry leaves due to the presence of antinutritional factors such as tannins, phytic acid, crude fibre, and 1-deoxynojirimycin (DNJ). Processing methods such as wilting, drying, fermentation, or powdering are recommended to minimise these antinutritional effects.

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