



Exploring Soybean Alternatives for Sustainable Animal Nutrition

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Abstract. Soybean meal is a major protein source in animal feed, its production is associated with concerns about environmental issues, economic volatility, and ethical implications. This study examined alternative protein sources to replace or reduce soybean meal in animal diets while maintaining or improving animal performance and general feed efficiency. The study aimed to point out and identify suitable substitutes of soybean for animal feed from local feed resources, both ruminants and non-ruminants. Velvet bean (*Mucuna pruriens*), jack bean (*Canavalia ensiformis*), pigeon pea (*Cajanus cajan*), and hyacinth bean (*Lablab purpureus*) were identified as potential soybean substitutes in animal feed in tropics. These legumes possessed comparable protein content, amino acid profiles, and other essential nutrients making them viable alternatives. Velvet beans excel in tropical climates and have high protein content, but careful processing is needed due to anti-nutritional factors. Jack bean is another protein powerhouse with potential for livestock feed, though its toxicity requires proper handling. Pigeon pea is a versatile legume with good protein quality and adaptability to various conditions. Hyacinth bean, while less commonly studied, shows promise as a forage and protein source.

Keywords: soybean alternatives, animal nutrition, sustainability, protein sources, legumes

1 Introduction

In Indonesia, soybean has long dominated the food and feed industry due to its high protein content. According to a report from the US Department of Agriculture's Foreign Agricultural Service (FAS), 2.86 million tonnes are estimated to be consumed in 2024-2025 and the largest user of imported soybeans is the tempeh and tofu industry, which uses about 90% of the supply [1]. Soybean is not only a source of high-quality food for humans, but also a source of protein in animal feed, particularly for poultry due to high quality of protein and amino acid profile except methionine. Despite the high demand, Indonesia relies heavily on soybean imports to meet its domestic needs. Indonesia imported a substantial portion of its soybean supply to meet domestic demand. [2] revealed the data regarding soybean import volume in 2023 about 2.27 million tonnes. Meanwhile, the import volume of soybean meal is estimated increase to 5.75 million tonnes in 2024 [1]. However, the environmental impacts of soybean cultivation,

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including deforestation and biodiversity loss, necessitate the search for more sustainable options. Therefore, this study looks at alternative protein sources to replace or reduce soybean meal in animal diets while maintaining or improving animal performance and general feed efficiency. The nutritive value of soyabean meal were shown in Table 1. The study aimed to identify alternatives by investigating the potential of local feed resources that have not been widely used for both ruminants and non-ruminants.

Table 1. The nutritive value of soyabean meal (as dry matter basis)

Item	
Dry matter	88.01
Crude protein	49.38
Ether extract	0.96
Crude fiber	5.61
Neutral detergent fiber	10.91
Acid detergent fiber	4.58
Ash	6.74
Gross energy (MJ/kg)	19.30

Source: [3]

2 Materials and Methods

The data were prepared from the literature study. There were more than thirty papers, conferences, books, and publications from reputable journals about four potential legumes that could replace soybean meal as an animal feed protein source. The information from the references summarized and informed descriptively.

3 Results and Discussion

The growing demand for sustainable animal nutrition has led researchers to investigate alternatives to soybean meal (which is extensively utilized in livestock feed). One particularly promising option is the incorporation of legume grains, such as velvet bean, jack bean, pigeon pea, and hyacinth bean. A study conducted by [4] illustrated that a mixture of legumes could effectively replace soybean meal in dairy ewe diets without compromising productivity. The legume-fed group not only sustained milk production levels comparable to those on a soybean diet; however, it also displayed significantly higher yields of milk protein and lactose. This finding suggests that legumes can function as an effective and sustainable substitute for soy-based feeds, while also enhancing nutritional outcomes. Although some may question the viability of such alternatives, the results indicate a compelling case for their integration into animal nutrition.

3.1 Velvet Bean (*Mucuna pruriens*)

The use of velvet beans (*Mucuna pruriens*) as animal feed presents a compelling opportunity to enhance animal nutrition, although it is not without challenges due to its anti-nutritional factors. Velvet beans (Fig. 1) are rich in protein, lipid, and fiber, making them an attractive supplement for various livestock diets. It contains 30-32% of crude protein [5] and the protein has relatively good amino acid profile [6]. However, the presence of these anti-nutritional compounds can significantly hinder their effectiveness when used unprocessed [7]. Anti-nutritional factor includes trypsin inhibitors, phytate, cyanogenic glycosides, tannins, phenols, amylase inhibitor and L-3,4, dihydroxy-phenylalanine (L-Dopa) [6]; [8]. Therefore, the processing of velvet beans through methods such as soaking and cooking is crucial to mitigate these negative effects and improve their nutritional profile.



Fig.1. Velvet bean (*Mucuna pruriens*)

Research has demonstrated that processed velvet bean meal can effectively replace traditional protein sources like soybean meal without compromising growth performance in broiler chickens. Specifically, studies have shown that incorporating up to 40% processed velvet bean meal in poultry diets resulted in improved growth rates compared to control diets [7]. This indicates that when appropriately processed, velvet beans can serve as a viable alternative protein source while also contributing to feed cost reduction.

Despite the advantages of using processed velvet beans in animal feed, it is essential to remain cautious regarding their incorporation levels and processing methods. Unprocessed velvet beans have been shown to depress pig performance significantly and can be toxic to poultry even at low levels [9]. It is imperative for producers to adopt proper processing techniques before integrating this legume into livestock diets. Overall, with appropriate handling and formulation strategies, velvet beans represent a sustainable option for enhancing animal nutrition while addressing global feed resource challenges.

The incorporation of velvet beans (*Mucuna pruriens*) into ruminant diets has garnered attention due to their high protein content and potential benefits for livestock. Velvet beans are known to contain approximately 310 g/kg crude protein in their unprocessed form, making them an appealing supplement for small ruminants [10].

However, the palatability of these beans remains a significant concern; unensiled beans are less palatable compared to ensiled ones, which can lead to variations in feed intake and overall animal performance. Despite this drawback, the nutritional profile of velvet beans presents an opportunity for enhancing the dietary composition of ruminants when appropriately processed.

Research indicates that while ensiling improves palatability and increases feed intake in goats, it may also lead to decreased protein content and lower milk production compared to conventional commercial feeds [10]. This finding raises questions about the practicality of using velvet beans as a primary protein source in ruminant diets. Although nitrogen retention is satisfactory across various diets including velvet beans, the overall productivity may not meet industry standards required for optimal livestock management.

3.2 Jack Bean (*Canavalia ensiformis*)

In recent years, the search for sustainable and cost-effective alternatives to traditional animal feed sources has gained momentum. One promising candidate is jack bean (*Canavalia ensiformis*), which has been investigated for its nutritional properties as a substitute for soybean meal in animal feed formulations. This legume (Fig.2) offers several advantages, including a comparable protein content and metabolizable energy levels, making it an appealing alternative for livestock nutrition [11]. The crude protein content about 22.8-35.3% [12]; [13].

The research conducted by [14] highlights the potential of jack bean meal as a viable substitute for soybean meal in poultry diets. The study found that both peeled and unpeeled jack bean meals exhibited similar metabolizable energy values and protein digestibility when compared to conventional soybean meal. Notably, peeled jack bean meal outperformed soybean in terms of certain nutritional metrics, suggesting that it could serve effectively in enhancing poultry growth and overall health while potentially reducing dependency on soybeans.



Fig.2. Jack bean (*Canavalia ensiformis*)

Despite these promising findings, further research is warranted to fully elucidate the long-term effects of incorporating jack bean into animal diets. Factors such as palatability, anti-nutritional factors present in raw jack beans, and the economic feasibility of large-scale production must be addressed before widespread adoption can occur. It has the unusual toxic amino acids canavanine and canaline, alkaloids, polyphenolic, saponins, trypsin inhibitors and immuno-protein [15]; HCN [16]. On the other hand, one of the main limiting factors in jack beans seems to be leucine [13]. In summary, while preliminary studies indicate that jack bean could replace soybean in animal feed formulations effectively, comprehensive evaluations are necessary to confirm its efficacy across different livestock species and feeding conditions.

Jack bean (*Canavalia ensiformis*) presents a promising avenue for ruminant nutrition, particularly when processed appropriately to mitigate its antinutritional factors. Raw jack beans contain compounds such as canavanine and lectin concanavalin A, which can hinder growth and feed intake in livestock [17]. This raises concerns regarding their direct use in ruminant diets without prior treatment. The detoxification of jack beans through methods like roasting has been shown to significantly reduce these harmful substances, thereby enhancing feed palatability and nutritional value.

Recent studies have explored the potential of extruded jack bean products, such as KOROPASS, as supplements for beef cattle. Research indicates that the inclusion of KOROPASS at 9% significantly improves dry matter intake, organic matter digestibility, and overall protein consumption among cattle [18]. These enhancements not only contribute to increased average daily weight gain but also improve feed efficiency and economic performance for producers. Such findings suggest that processed forms of jack beans could be effectively integrated into ruminant diets. While there is limited research specifically addressing the suitability of raw or roasted jack beans for ruminants beyond supplementation contexts, the existing evidence supports their potential as a valuable feed source when adequately processed. Therefore, further investigations into optimal processing techniques and long-term impacts on ruminant health are warranted to fully realize the benefits of jack beans in livestock nutrition.

3.3 Pigeon Pea (*Cajanus cajan*)

Pigeon pea (*Cajanus cajan*) has emerged as a valuable component in animal feed, particularly in tropical and subtropical regions where it serves as an economical source of high-quality protein. The crude protein content of pigeon pea ranges from 21.9% to 28.5% [19]; [20] and it is characterized by low levels of the essential amino acid methionine and the presence of protease inhibitors within its seeds [21], the presence of the anti-nutritional factors, trypsin inhibitors, haemagglutinin and saponin [22]. According to [20], the incorporation of pigeon pea and its by-products into animal diets significantly enhances feeding performance for both ruminants and non-ruminants. The versatility of pigeon pea allows for various forms of utilization, including dried grains, fresh aerial portions, and green pods. This adaptability not only contributes to improved growth rates but also aligns with sustainable agricultural practices by reducing reliance on conventional feed sources.

The importance of pigeon pea (Fig.3) extends beyond mere nutritional value; it is also linked to broader economic and environmental goals. Further empirical evidence supports the efficacy of pigeon pea in animal nutrition. [23] conducted research on goats that revealed favorable performance outcomes when fed different ratios of pigeon pea leaves mixed with neem leaves compared to traditional concentrates. This study not only highlighted the potential for cost savings through alternative feed sources but also underscored the necessity for innovative approaches in addressing feed shortages without compromising animal health or productivity.



Fig.2. Pigeon pea (*Cajanus cajan*)

Pigeon pea (*Cajanus cajan*) has emerged as a valuable feed source for ruminants, particularly due to its high nutritional profile and adaptability in various climates. A study by [24] demonstrated that pigeon pea seeds (PPS) possess superior digestibility and palatability compared to pigeon pea leaves (PPL). Specifically, PPS exhibited a digestibility rate of 72.2% dry matter (DM), while PPL lagged at 50.2% DM. This significant difference underscores the potential of PPS not only to replace traditional protein sources like soybean meal but also to enhance the overall nutrient intake when used alongside low-quality roughages. Moreover, the inclusion of PPL in ruminant diets has shown promise as an economical protein supplement. Research conducted by [25] indicated that incorporating up to 30% PPL into concentrate mixtures for crossbred dairy cows did not adversely affect feed intake or milk yield compared to control groups. These findings suggest that PPL could serve as a cost-effective alternative for dairy farmers in developing regions, contributing both to economic sustainability and improved animal health.

The broader implications of utilizing pigeon pea in ruminant nutrition align with global agricultural goals aimed at enhancing food security and rural development. According to [26], pulses such as pigeon pea are integral not only for their nutritional benefits but also for promoting sustainable agricultural practices. As countries strive towards achieving the UN's Zero Hunger initiative, integrating pigeon pea into livestock feeding strategies can play a pivotal role in addressing these challenges while fostering economic growth. This is also aligned with the goal of preventing stunting in rural Indonesian areas.

3.4 Hyacinth Bean (*Lablab purpureus*)

Hyacinth bean (*Lablab purpureus*) has garnered attention as a potential source of animal feed due to its high protein content and nutritional value. While primarily recognized for its role in human nutrition, where it can contribute to food security [27], the implications of utilizing this underutilized crop for livestock feeding are significant. As global demand for sustainable animal feed sources increases, exploring alternative crops like hyacinth bean could alleviate pressure on traditional feed resources while enhancing livestock productivity. Hyacinth bean contains anti-nutritional factors like tannins, phytate, trypsin inhibitors and polyphenols [28]; [29], meanwhile the grains contain 20-28% protein with high contents of vitamins A, B and C [30].

Research indicates that incorporating hyacinth beans into animal diets may yield mixed results. A study by [31] assessed the impact of dietary inclusion of hyacinth beans at levels of 15% and 20% in broiler feeds. The findings revealed a decline in key performance metrics such as weight gain and feed conversion ratio, suggesting that while these legumes possess potential as a protein source, their inclusion must be optimized to prevent adverse effects on growth performance. This highlights the necessity for further investigation into the appropriate incorporation rates and processing methods to enhance their viability as animal feed.

Moreover, studies exploring various processing techniques have shown promise in improving the nutritional profile of processed hyacinth beans [32]. Techniques such as cooking or roasting may mitigate antinutritional factors present in raw beans, thereby enhancing digestibility and nutrient availability for poultry. However, conclusive recommendations regarding optimal processing methods remain elusive and warrant additional research. Therefore, while hyacinth bean presents an intriguing option for animal feed development, comprehensive studies are essential to fully understand its benefits and limitations within livestock nutrition.

Hyacinth bean (*Lablab purpureus*) has garnered attention as a potential solution for improving the nutritional quality of ruminant diets, particularly in tropical regions where feed shortages are prevalent. As a drought-resistant legume, hyacinth bean is adaptable to various environmental conditions and offers several advantages for livestock nutrition. Its high protein content contributes significantly to enhanced milk production and overall animal health [33]. Furthermore, this versatile plant can be utilized in multiple forms such as pasture, hay, silage, or even as a companion crop. Additionally, its role as a cover crop or as green manure helps improve soil health by enhancing nitrogen fixation and organic matter content.

Despite the promising benefits associated with hyacinth bean cultivation, its widespread adoption remains limited due to economic barriers and farmers' resistance to changing established practices. Many smallholder farmers face challenges related to seed access and affordability, which can hinder their willingness to incorporate new forage options into their existing systems [33]. Moreover, there is often an inherent conservatism among agricultural communities regarding novel crops or farming techniques. This reluctance may stem from concerns about the reliability of yield or potential risks associated with unfamiliar plants.

In conclusion, while hyacinth bean presents significant potential for enhancing ruminant diets in tropical regions through its nutritional profile and adaptability, addressing economic limitations and fostering acceptance among farmers are crucial steps toward realizing its full benefits. Future research should focus on developing cost-effective seed distribution strategies and educational programs that emphasize the agronomic advantages of incorporating this legume into traditional farming systems.

4 Conclusion

It is important to consider the opportunity to substitute the protein source for animal feed from expensive (import) to local raw feed materials that have not been widely used. There were 4 (four) legumes which promising as soybean alternatives though limited research on agronomy aspect.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

References

1. S. Reidy, "Indonesia soybean consumption to increase," *World Grain*, 2024. <https://www.world-grain.com/articles/19791-indonesia-soybean-consumption-to-increase#:~:text=Consumption>.
2. BPS, "Imports of Soybean by Major Country of Origin, 2017-2023." 2024, [Online]. Available: <https://www.bps.go.id/en/statistics-table/1/MjAxNSMx/imports-of-soybean-by-major-country-of-origin--2017-2023.html>.
3. K. Wang *et al.*, "The nutritive value of soybean meal from different sources for sows during mid-and late gestation," *J. Anim. Sci.*, vol. 100, no. 11, pp. 1–10, 2022, doi: 10.1093/jas/skac298.
4. S. Vouraki, V. Papanikolopoulou, M. Irakli, Z. Parissi, E. M. Abraham, and G. Arsenos, "Legume Grains as an Alternative to Soybean Meal in the Diet of Intensively Reared Dairy Ewes," *Sustain.*, vol. 15, no. 2, pp. 1–13, 2023, doi: 10.3390/su15021028.
5. O. O. Emenalom, A. B. I. Udedibie, B. O. Esonu, E. B. Etuk, and H. I. Emenike, "Evaluation of unprocessed and cracked, soaked and cooked velvet beans (*Mucuna pruriens*) as feed ingredients for pigs," *Livest. Res. Rural Dev.*, vol. 16, no. 5, pp. 39–45, 2004.
6. P. Siddhuraju, K. Vijayakumari, and K. Janardhanan, "Chemical Composition and Protein Quality of the Little-Known Legume, Velvet Bean (*Mucuna pruriens* (L.) DC.)," *J. Agric. Food Chem.*, vol. 44, no. 9, pp. 2636–2641, 1996, doi: 10.1021/jf950776x.
7. V. Vadivel, M. Pugalenthii, A. Doss, and T. Parimelazhagan, "Evaluation of velvet bean meal as an alternative protein ingredient for poultry feed," *Animal*,

- vol. 5, no. 1, pp. 67–73, 2011, doi: 10.1017/S175173111000159X.
8. A. B. I. Udedibic and C. R. Carlini, “Brazilian *Mucuna pruriens* Seeds (Velvet Bean) Lack Hemagglutinating Activity,” *J. Agric. Food Chem.*, vol. 46, no. 4, pp. 1450–1452, 1998, doi: 10.1021/jf970634y.
 9. V. Vadivel and M. Pugalenth, “Studies on the incorporation of velvet bean (*Mucuna pruriens* var. *utilis*) as an alternative protein source in poultry feed and its effect on growth performance of broiler chickens,” *Trop. Anim. Health Prod.*, vol. 42, no. 7, pp. 1367–1376, 2010, doi: 10.1007/s11250-010-9594-2.
 10. V. R. Matenga, N. T. Ngongoni, M. Titterton, and B. V Maasdorp, “*Mucuna* seed as a feed ingredient for small ruminants and effect of ensiling on its nutritive value,” *Trop. Subtrop. Agroecosystems*, vol. 1, pp. 97–105, 2003.
 11. Virly, A. M. Sutedja, C. Y. Trisnawati, V. C. Kaharso, F. Ivana, and K. Asali, “Physicochemical characteristics of jack bean (*Canavalia ensiformis* (L.) DC.) milk, a non-dairy milk alternative developed using various pretreatment methods,” *Food Res.*, vol. 8, no. 4, pp. 170–178, 2024, doi: 10.26656/fr.2017.8(4).382.
 12. A. I. Ologhobo, O. A. Jimoh, T. J. Orsar, and R. Mosenthin, “Evaluation of detoxified jack bean (*Canavalia ensiformis* (L.) (DC.) in broiler starter rations with amino acid supplements,” *Trop. J. Anim. Sci.*, vol. 1, no. 1, pp. 117–126, 1999.
 13. A. Sudarman, A. M. Jayanti, and R. Mutia, “Utilization of Jack Bean (*Canavalia ensiformis*) Meal as a Substitute for Soybean Meal in Diet for Broiler Reared for 35 Days,” *Bul. Peternak.*, vol. 42, no. 1, pp. 8–14, 2018, doi: 10.21059/buletinpeternak.v42i1.24772.
 14. R. Mutia, M. Ridla, and W. Hermana, “Physical and nutritional properties of jackbean (*Canavalia ensiformis* L.) meal: A prospective alternative ingredient for poultry feed,” *IOP Conf. Ser. Earth Environ. Sci.*, vol. 1359, no. 1, pp. 8–13, 2024, doi: 10.1088/1755-1315/1359/1/012101.
 15. R. Belmar and T. R. Morris, “Effects of Raw and Treated Jack Beans (*Canavalia Ensiformis*) and of Canavanine on the Short-Term Feed Intake of Chicks and Pigs,” *J. Agric. Sci.*, vol. 123, no. 3, pp. 407–414, 1994, doi: 10.1017/S0021859600070428.
 16. O. F. Alifianty, M. Ridla, Nahrowi, R. S. H. Martin, and S. Akhadiarto, “Optimization of Jack bean (*Canavalia ensiformis* L.) processing to reduce hydrogen cyanide content and enhance broiler chicken performance: a potential alternative to soybeans in poultry feed,” *Livest. Res. Rural Dev.*, vol. 35, no. 8, pp. 1–7, 2023.
 17. A. Mendez, R. E. Vargas, and C. Michelangeli, “Effects of Concanavalin A, Fed as a Constituent of Jack Bean (*Canavalia ensiformis* L.) Seeds, on the Humoral Immune Response and Performance of Broiler Chickens,” *Poult. Sci.*, vol. 77, no. 2, pp. 282–289, 1998, doi: 10.1093/ps/77.2.282.
 18. B. W. H. E. Prasetyono, A. Subrata, and W. Widiyanto, “Effect of KOROPASS, an extruded jack bean (*Canavalia ensiformis*)-derived supplement, on productivity and economic performance of beef cattle,” *Vet. World*, vol. 13, no. 3, pp. 593–596, 2020, doi: 10.14202/vetworld.2020.593-596.

19. N. R. L. A'yuni, Y. Marsono, D. W. Marseno, and P. Triwitono, "Physical characteristics, nutrients, and antinutrients composition of pigeon pea (*Cajanus cajan* (L.) Millsp.) grown in Indonesia," *Food Res.*, vol. 6, no. 2, pp. 53–63, 2022, doi: 10.26656/fr.2017.6(2).172.
20. B. K. Abebe, "The Dietary Use of Pigeon Pea for Human and Animal Diets," *Sci. World J.*, vol. 2022, 2022, doi: 10.1155/2022/4873008.
21. S. Tangtaweewipat and R. Elliott, "Nutritional value of pigeonpea (*Cajanus cajan*) meal in poultry diets," *Anim. Feed Sci. Technol.*, vol. 25, no. 1–2, pp. 123–135, 1989, doi: 10.1016/0377-8401(89)90113-2.
22. M. E. Abd El-Hack, A. A. Swelum, M. A. Abdel-Latif, D. Más Toro, and M. Arif, "Pigeon Pea (*Cajanus cajan*) as an alternative protein source in broiler feed," *Worlds. Poult. Sci. J.*, vol. 74, no. 3, pp. 541–548, 2018, doi: 10.1017/S0043933918000296.
23. M. F. Dida, D. G. Challi, and K. Y. Gangasahay, "Effect of feeding different proportions of pigeon pea (*Cajanus cajan*) and neem (*Azadirachta indica*) leaves on feed intake, digestibility, body weight gain and carcass characteristics of goats," *Vet. Anim. Sci.*, vol. 8, no. June, p. 100079, 2019, doi: 10.1016/j.vas.2019.100079.
24. B. Cheva-Isarakul, "Pigeon pea as ruminant feed," *AJAS*, vol. 5, no. 3, pp. 549–558, 1992.
25. T. Mekonen, A. Tolera, A. Nurfeta, B. Bradford, S. Yigrem, and J. Vipham, "Effects of pigeon pea leaves and concentrate mixture on feed intake, milk yield, and composition of crossbred dairy cows fed native pasture hay," *Animal*, vol. 16, no. 10, p. 100632, 2022, doi: 10.1016/j.animal.2022.100632.
26. P. L. Sherasia, M. R. Garg, and B. M. Bhandari, *Pulses and their By-Products as Animal Feed*. United Nations, 2018.
27. A. M. Abdel-Wahab, M. S. A. Shabeb, and M. A. M. Younis, "Studies on the effect of salinity, drought stress and soil type on nodule activities of *Lablab purpureus* (L.) sweet (Kashrangeeg)," *J. Arid Environ.*, vol. 51, no. 4, pp. 587–602, 2002, doi: 10.1006/jare.2002.0974.
28. R. K. Deka and C. R. Sarkar, "Nutrient composition and antinutritional factors of *Dolichos lablab* L. seeds," *Food Chem.*, vol. 38, no. 4, pp. 239–246, 1990, doi: 10.1016/0308-8146(90)90180-C.
29. V. Ramakrishna, P. J. Rani, and P. R. Rao, "Anti-Nutritional Factors During Germination in Indian Bean (*Dolichos lablab* L .) Seeds Department of Biotechnology , 2 Department of Biochemistry , " *World J. Dairy Food Sci.*, vol. 1, no. 1, pp. 6–11, 2006.
30. S. Singh, S. S. Kundu, A. S. Negi, and V. C. Pachouri, "Performance of growing kids on rations with lablab (*lablab purpureus*) grains as protein source," *Livest. Res. Rural Dev.*, vol. 22, no. 5, pp. 1–10, 2010.
31. H. I. Ragab, K. A. Abdel-atti, M. S. Babiker, and M. Elawad, "Effect Of Dietary Hyacinth Beans (*Lablab Purpureus*) And Enzyme Additives On Performance Of Broilers," *Online J. Anim. Feed Res.*, vol. 5, no. 6, pp. 181–188, 2015.
32. H. I. S. Ragab, K. A. A.-A. Atti, M. S. Babiker, and H. E. E. Malik, "The Influence of the Processed Hyacinth Beans (*Lablab Purpureus*) and Enzyme

- Additives on Finisher Performance of Broilers,” *Glob. J. Anim. Sci. Res.*, vol. 4, no. 1, pp. 50–58, 2016.
33. A. M. Murphy and P. E. Colucci, “A tropical forage solution to poor quality ruminant diets: A review of *Lablab purpureus*,” *Livest. Res. Rural Dev.*, vol. 11, no. 2, pp. 96–113, 1999.

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