



Forage Quality of Sword Bean (*Canavalia gladiata*) Leaves as Influenced by Harvest Stage

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ABSTRACT

Background: The *Canavalia gladiata* species is one among the important legumes for food and feed and possesses potential for ruminant feed. Studies were carried out to assess the nutritional composition of the leaves of sword bean and the purpose of the study was to determine the effect of various plant ages on the nutrient content of sword bean leaves as feed forage.

Methods: The experiment was laid out in a completely randomized design. The treatments were different ages of sword bean plants, namely 75.120 and 180 days after planting replicated eight times. The data generated as analyzed quantitatively by using the analysis of variance based on the 5% level F test and continued with Duncan's multiple distance test. The observed variables were ash, crude protein, crude fiber, calcium, phosphorus, tannin, saponin and lignin contents.

Result: The results showed that different harvest ages gave different results on the ash, crude protein, phosphorus, tannin and saponin contents. However, crude fiber, calcium and lignin contents did not show significant variation with age of the leave. The best harvest time was at 180 Days after Planting with the optimum ash (12.77%), crude protein (31.54%), crude fiber (15.52%), calcium (3.24%), phosphorus (0.25%), tannin (0.33%), saponin (5.74%) and lignin (6.16%) contents of sword bean leaves as feed forage.

Key words: Anti nutrition, Feed forage, Plant age, Sword bean leaves.

INTRODUCTION

Legume crops, such as sword bean (*Canavalia gladiata*) provide an important source of food and feed due to their high protein content and many health benefits for humans and animals. The legume population growth and the demand for products derived from legumes is likely to increase rapidly from year to year or in the future (Singer *et al.*, 2020). Some legume species offer opportunities to improve animal health with less treatment due to the presence of bioactive secondary metabolite and also has positive impact on climate change (Luscher *et al.*, 2014).

The nitrogen fixation system is a symbiotic system that plays an important role in increasing the carrying capacity of food in soils with low nitrogen content (Yusuf, 2016). Legume plants have the privilege of being able to grow in nitrogen-limiting conditions because of their ability to form endosymbionts in nodule cells infected with soil bacteria to bind nitrogen in the atmosphere, which are collectively called rhizobia (De Velde *et al.*, 2006). Rhizobium regulates hormonal and nutritional balance, induces resistance to plant pathogens and dissolves nutrients and easily absorbed by plants, thereby increasing plant growth rates (Akhtar *et al.*, 2020). The positive impact of these bacteria on plant growth and their biocontrol activity can be partly reproduced under various natural conditions (Kolesnikov *et al.*, 2024).

There is a great need for a strong focus on developing the role of legumes and their contribution to the sustainable intensification of production and livelihoods of smallholders in many parts of the world (Mitran *et al.*, 2018). Legume plants are suitable for rain-fed conditions in hilly areas and also rich in taste, smell, color, nutritional,

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medicinal value and increase soil fertility (Pandey and Kumar, 2024). Anti-nutritional factors can be classified based on their effect on nutrient value and biological response. Anti-nutritional factors can be broadly grouped into glycosides (Saponins) and polyphenolic compounds (Tannins, Lignin) as in all vascular plants (Pathaw *et al.*, 2022). Safe anti-nutritional factors can help form a good feed source for ruminant productivity (Njidda, 2010).

Canavalia gladiata is an underutilized legume that is very important for human and animal feed (Dada *et al.*, 2013). According to Bulyaba and Lenssen (2019) food diversification through legumes in the form of seeds, utilization of leaves, is a management practice to provide nutrient supplementation to reduce deficiencies. Sword bean is a herbaceous plant, has high fertility and high

biomass, resists drought, pests and diseases and produces a lot of seeds (Indriani *et al.*, 2019). Sword bean is suitable for ruminant feed source and can be planted in the shade of trees and produce pods during the long dry season. The age of harvest is closely related to the yield and quality of the sword bean. Most sword bean plant characteristics support feed forage demand for all seasons, then the study on sword bean leaves as feed forage was conducted.

MATERIALS AND METHODS

This research was conducted at the experimental *inceptisol* garden of the Animal Food Crops Laboratory, Faculty of Animal Husbandry, Padjadjaran University, Jatinangor, Sumedang district, Indonesia in 2019. The experiment was laid out in completely randomized design with three treatments, *viz.*, the age of sword bean plants-75 days after planting (DAP), 120 DAP and 180 DAP, replicated eight times, with a total of 24 sword bean plants. The land available for research was 14×14 m² and spacing adopted was 2 m×2 m. The results of the study were analyzed using analysis of variance on the 5% level F test and continued with Duncan's multiple distance test. Statistical calculation was completed by the SAS 9.4 version software. The various response variables include the content of ash, crude protein, crude fiber, calcium, phosphorus, tannin, lignin and saponin of the sword bean leaves.

RESULTS AND DISCUSSION

The nutrient content of the sword bean leaves at various harvest times are shown in Table 1 and Table 2 and the field conditions are shown in Fig 1 to Fig 4.

The ash content of sword bean leaves from Table 1 at harvest age of 75 DAP (11.44%) and 180 DAP (12.77%) were not significantly different to each other but were significantly higher than the ash content at 20 DAP (8.47%). Crude protein content (Table 1) at the harvest age of

180 DAP (31.54%) was significantly higher than the harvest age at 120 DAP (20.17%) and 75 DAP (25.15%). In the studies (Table 1), the crude fiber content of sword bean leaves was not affected by the age of the plant. The crude fiber content was not significantly different in the leaves of the sword beans which were harvested at the age of 75.120 and 180 DAP (17.11%, 16.46 and 15.52% respectively). The calcium content in the leaves of the sword bean (Table 1) was not significantly different for all harvest ages. At harvest age of 75 DAP, the calcium content was 2.71%. The phosphorus content of the leaves in the study (Table 1) was directly proportional to the crude protein content of the leaves in various ages of the sword bean plant. At the age of 180 days, the phosphorus content (0.25%) was significantly higher than that harvested at 75 and 120 DAP.

The tannin content in sword bean leaves (Table 2) at 75 DAP (0.33%) and 180 DAP (0.33%) were the same and significantly lower than 120 DAP (0.76%). The saponin content in sword bean leave between plants aged 75 DAP (4.82%) and 180 DAP (5.74%) were not significantly different, but they were significantly lower than 120 DAP (6.99%). The treatment of various plant ages for lignin content in sword bean leave of 75.120 and 180 DAP, was not significantly different.

Nodule is the most important thing in legume like sword bean. The nutrient content of leaves is affected by nodule development stages. In the previous study showed that there was a nodule weight of 10.70 grams for a single sword bean plant with SP36 fertilizer of 100 kg/ha (Indriani *et al.*, 2018). According to Tansley (2005), despite being degenerative, nodule aging is an active process in development in which the reactive oxygen species (ROS), antioxidants, hormones and proteinases have the key rolesancehave the key roles.

The ash content of sword bean leaves was similar to the research by Susilawati *et al.* (2019) at harvest age of

Table 1: The nutrient content of the sword bean leaves at various harvest times.

Harvest time	Nutrient content				
	Ash	Crude protein	Crude fiber	Calcium	Phosphorus
75 DAP	11.44 a	25.15 b	17.11 a	2.71 a	0.20 b
120 DAP	8.47 b	20.17 c	16.46 a	2.41 a	0.16 c
180 DAP	12.77 a	31.54 a	15.52 a	3.24 a	0.25 a

Note: The different letters in the same column show the significant differences, DAP (Days after planted).

Table 2: The anti nutrient content of the sword bean leaves at various harvest times.

Harvest time	Anti nutrition		
	Lignin	Tannin	Saponin
75 DAP	0.33 b	4.82 b	5.80 a
120 DAP	0.76 a	6.99 a	5.03 a
180 DAP	0.33 b	5.74 ab	6.16 a

Note: The different letters in the same column show the significant differences, DAP (Days after planted).

90 days show that the ash contents of *Calopogonium mucunoides*, *Centrosema pubescens* and *Pueraria phaseoloides* were 10.57%, 7.78% and 10.20% respectively. According to Okello *et al.* (2018), ash content is important because it helps to determine the amount and the type of minerals in food.

The harvest age of 180 DAP is the right time to harvest both the pods and the leaves. The results of research by Baloyi *et al.* (2008) show that the high crude protein content up to the post-flowering stage in legumes indicate that the plant is still growing vegetatively. According to research by Baloyi *et al.* (2013), the crude protein of the Lablab bean plant (*Lablab purpureus*) harvested at 15 weeks (105 days) was 22.7%. In the study of Susilawati *et al.* (2019) the crude protein content of 90 days harvested *Calopogonium mucunoides*, *Centrosema pubescens* and *Pueraria phaseoloides* were 14.93, 24.86 and 19.76% respectively. Patil *et al.* (2021) stated that high protein in sword bean is one of protein source and gives beneficial for sustainable livestock production at low cost.

Cell walls are mostly composed of crude fibers (cellulose, hemicellulose and lignin) which are abundant in stems. According to research by Daning and Foekh (2018), the crude fiber content of the gamal plant (*Gliricidia sepium*) is similar to the sword bean leaves, which is 15.7%. According to Sutaryono *et al.* (2019) Moringa legumes at various cutting ages produced no different crude fiber content, namely 18.57% (1 month cutting age), 18.76% (2 months cutting age) and 18.92% (3 months cutting age). The results of the research by Susilawati *et al.* (2019) stated that at 90 days of harvest, the crude fiber content of *Calopogonium mucunoides* (34.92%), *Centrosema pubescens* (32.04%) and *Pueraria phaseoloides* (34.66%) were found. Bulyaba and Lenssen, (2019), stated that the use of legume leaves as forage can increase ruminant nutrients. Hidosa (2017) stated that forage legumes have an important role in improving ruminant nutrients because it can be rapidly degraded in the rumen which is useful for meeting the needs of rumen microorganisms for the efficiency of low quality fiber degradation.

At harvest age of 75 DAP, the calcium content was 2.71% and higher than the research of Indriani *et al.* (2016) at harvest age of 90 DAP of *Centrosema pubescens* yielded 1.16%. According to research by Baloyi *et al.* (2013) that the average Ca content of five *Lablab purpureus* varieties with a harvest age of 15 weeks (105 days) was 2.73%. According to Stavarache *et al.* (2014) calcium is a key element that cannot be replaced in basic metabolic functions by other cations.

Similar results show that the average phosphorus content of 5 *Lablab purpureus* varieties was 0.27% at harvest age of 15 weeks or 105 days (Baloyi *et al.*, 2013). Phosphorus (P) is the limiting nutrient after nitrogen for plant growth, production and quality. The demand for phosphorus is high during root proliferation, pod formation and seed maturation stages (Bagale, 2021). According to Bargaz *et al.* (2012), a significant decrease in growth was found for shoots, roots and nodules under low P soil

compared to sufficient P soil. According to Stavarache *et al.* (2014) which states that along with nitrogen, phosphorus is a basic element of plant nutrients, which is involved in energy production (ATP, ADP, NAD) and different nucleic acid molecular architectures.

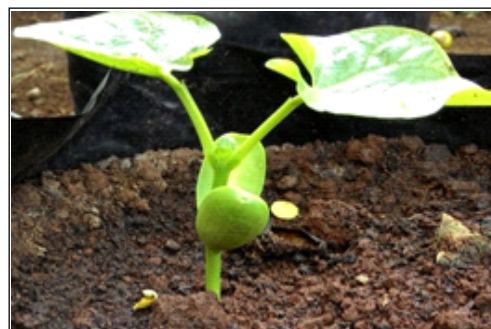


Fig 1: Sword bean plant at 16 days.

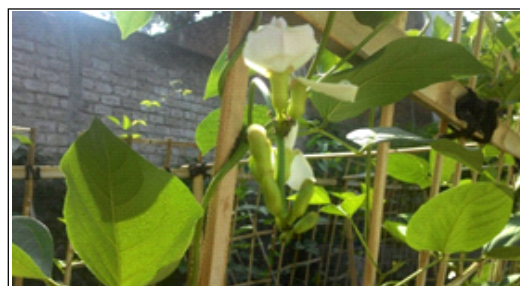


Fig 2: Flowering stage of sword bean plant.

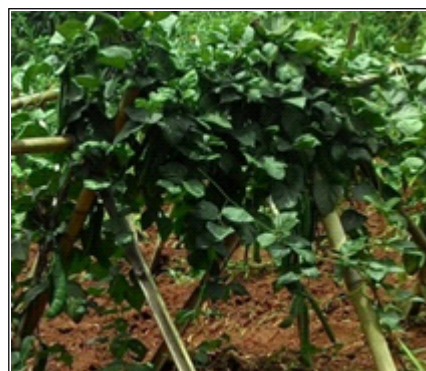


Fig 3: Sword bean plant at 120 days.



Fig 4: Sword bean pod harvested at 180 DAP.

According to Meier and Bowman (2008), that high phenolic including tannins, can have a negative impact on the growth of surrounding plants by limiting the supply of N. Arnoldi *et al.* (2020) say that secondary plant metabolites such as tannins mediate ruminants food plant interactions and also has an influence on decomposition and nutrient cycling in plants. Haki *et al.* (2015) that total forage (combined stems and leaves), around 80% of the crude protein fraction is effected by plant age/harvest and cutting time.

Forage legumes (*Vigna unguiculata* and *Lablab purpureus*) significantly reduce enteric methane production in ruminants. This is achieved by the presence of tannins in the forage and a lower fiber content (Washaya *et al.*, 2018). Forages or by-products that are naturally rich in tannins can still be useful for reducing the environmental impact of providing protein feed to ruminants (Herremans *et al.*, 2020). Providing tannin can increase N retention, reduce nitrogen excretion and increase N metabolism in sheep (Sharifi and Chaji, 2019).

The main effect of saponins in the rumen appears to be inhibition of protozoa (defaunation), which may increase the efficiency of microbial protein synthesis and protein flow to the duodenum. Saponins can also selectively affect certain rumen bacteria and fungi, which can alter rumen metabolism beneficially or detrimentally (Patra and Saxena, 2009). However, with the increasing development of science, it is known that saponins also have a positive impact on both livestock and humans (Yanuartono *et al.*, 2017).

Saponins and tannins have been considered as chemical compounds that can reduce enteric methane fermentation. The addition of tannins and saponins at optimal doses can reduce methane production, metanogan populations and protozoa populations, as well as increase total and partial VFA production (especially propionate), rumen bacterial populations and does not interfere with the digestibility of feed ingredients (Hidayah, 2016).

Moore and Jung (2001) stated that lignin is a polymer formed from monolignols derived from the phenyl propanoid pathway in vascular plants. It is deposited in the cell walls of plants as part of the process of cell maturation. Frei (2013) reported that in animal nutrition, lignin is considered an anti-nutritional component in forage because it is not easily fermented by rumen microbes. In terms of energy yield from biomass, the role of lignin depends on the conversion process (Frei, 2013).

CONCLUSION

It can be concluded that different harvest ages gave different results on the ash, crude protein, phosphorus, tannin and saponin contents. However, crude fiber, calcium and lignin contents did not show significant variation with age of the leave. The best harvest time was at 180 Days after Planting with the optimum ash (12.77%), crude protein (31.54%), crude fiber (15.52 %), calcium (3.24%), phosphorus

(0.25%), tannin (0.33%), saponin (5.74%) and lignin (6.16%) contents of sword bean leaves as feed forage as well as harvesting pods.

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Conflict of interest

All author declare that they have no conflict of interest.

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