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The Effect of Adding Various Levels of Bokashi from Gliricidia Leaves and Goat Faeces on the Growth, Production and Chemical Composition of Arbila's (*Phaseolus lunatus* L.) Forage

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ABSTRACT

This study aimed to evaluate the effect of adding various levels of bokashi from gliricidia leaves and goat faeces on the growth, production and chemical composition of arbila's forage, has been carried out for 5 months, was designed with completely randomized, 4 treatments with 5 replications, consisting of P0: without bokashi, P5: 5 tons bokashi/ha, P10: 10 tons bokashi/ha, and P15: 15 tons bokashi/ha. Variables measured were number of root nodules, percentage of effective nodules, nitrogen uptake, stem diameter, increase in number of leaves, stem and leaf ratio, forage production (fresh, dry matter (DM), organic matter (OM) and crude protein (CP), and chemical composition. Data were analyzed by variance analysis and followed by Duncan's test. Result of the research, the treatment had a very significant effect ($P \leq 0.01$) on the increase number of leaves, OM dan CP forage productions. Futhermore, had a significant effect ($P \leq 0.05$) on the number of root nodules, nitrogen uptake, stem diameter, fresh and DM forage productions, content of DM, OM, CP, crude fiber (CF), nitrogen free extract (NFE), and ash, but did not affect on percentage of effective nodules, stem and leaf ratio, and extract ether (EE) content of forage. Duncan's test showed that the P15 produced the highest number of root nodules, N uptake, leaf growth, fresh, DM, OM and CP production, and the content of OM, CP, NFE in arbila's forage. It was concluded that this bokashi can improve the growth, production and chemical composition of arbila's forage and the best level is 15 tons bokashi/ha.

Keywords: Arbila (*Phaseolus lunatus* L), Bokashi from gliricidia leaves and goat feaces, Nodules, Nitrogen uptake, Nutrient value

Introduction

The provision of quality and sustainable forage is one of the factors in the success of the ruminant livestock industry. One of the obstacles often faced by ruminant farmers in East Nusa Tenggara (ENT) is the limited availability of quality feed in sufficient quantities, especially during the dry season. This condition occurs due to the lack of water availability and high temperatures during the dry season which disrupt the growth and production of forage.

The development of forage plants that are able to survive in the agro-climate in ENT needs to be done. One of them is the legume arbila (*Phaseolus lunatus* L.), which is a legume native to ENT, which usually lives in natural pastures, grows in vines (1 - 4 m), has a wide adaptation range to the growing environment and has high production capacity, resistant to drought, and can grow in almost all types of soil. The forage of the arbila contains 21.21% crude protein (CP) and 24.21% crude fiber (CF) while the skin of the arbila bean pod contains 18.80% CP and 17.5% CF (Koten *et al.*, 2013). The skin of arbila peas contained 18.80% CP, 0.06% CF, 4% ash, 17.5% CF and 59.1% nitrogen-free extract (NFE). The seeds contain 27.2% CP, 0.9%CF, 5.5% Ash, 5.2% CF and 61.2% NFE (Tarruco-Uco *et al.*, 2009).

Various efforts have been made to increase the production of arbila, one of which is fertilizer application. Bokashi is an organic fertilizer produced from the fermentation of organic materials such as compost and manure by utilizing the help of microorganisms as decomposers (Wea *et al.*, 2017), so that it contains more macro and micro nutrients that are ready to be absorbed by root of plants.

Goat feaces and leaves of gliricidia sepium are materials that can be used as bokashi fertilizer. Gliricidia has high biomass production, contain 3 - 6% N, contains quite high nitrogen with low ratio of C/N, causing this plant biomass to be easily decomposed (Oviyanti *et al.*, 2016). Bokashi from gliricidia contain 2.58% N, 0.31% phosphor (P), 1.32% Kalium (K), 38.43% C organik dan ratio C/N 14,89 (Mulyanti *et al*, 2015). The benefits value of this bokashi will increase if it is added with other materials such as goat feaces. The content of N, P, K, C-organic, C/N ratio, and water in goat feaces were 1.45%, 0.35%, 1.03%, 47.34%, 32.65, and 35.91%, which becomes higher in quality when added with other ingredients such as coconut fiber (Trivana and Pradhana, 2017).

The added bokashi fertilizer from goat feaces and gliricidia leaves has an impact on soil quality, and the amount of nutrients that can be absorbed by plants. Bokashi levels up to 20 tons/ha affect soil quality and the amount of nutrients in the soil, which are used for growth and production of soybean plant (Birnadi, 2014). Bokashi levels made from cow feaces and cromolaena up to 40 tons/ha have been shown to increase the growth and forage production of arbila (Koten *et al.*, 2020). However, each plant will respond differently to the fertilizer used. This study aimed to evaluate the effect of adding various levels of bokashi from gliricidia leaves and goat faeces on the growth, production and chemical composition of arbila's forage.

Materials and Methods

The research was conducted at the Forage Crop Livestock at the Kupang State Agricultural Polytechnic for 5 months (July – November 2020).

The materials used were arbila seeds, 50 m^2 of land, 20 x 40 cm polybags, leaves of gliricidia and goat feaces, EM4 (Effective Microorganisms 4), granulated sugar, and water. The tools used are scales with a capacity of 50 kg with the smallest scale of 100 g, digital scales from Camry brand with a capacity of 5 kg with the smallest scale of 1 g (for weighing soil and forage), machetes, crowbars, hoes, shovels, buckets, plastic cups, thermohygrometer, vernier calipers, tarpaulin, bokashi plastic and wileymill.

Bokashi making. The leaves of gliricidia were dried, crushed and weighed for 100 kg. Dried goat feaces were crushed and weighed for 10 kg. Leaves of gliricidia and goat feaces were then spread on tarpaulin. EM4 solution (EM4 1 L mixed with 200 g of granulated sugar in 40 L of water, stirred until homogeneous) then sprinkled on the bokashi material while mixed until evenly distributed. The mixture was put in a bokashi bag and semi-aerobic fermented for 21 days. Stirring was done every week (Wea *et al.*, 2017).

Preparation of planting media and bokashi application. The soil was dismantled, crushed, sifted, put into polybags of 10 kg each and placed at a distance of 50 x 50 cm. 3 polybags for each treatment. Bokashi was added 7 days before planting.

Planting and maintenance of plants. Each polybag planted with 5 seeds. Thinning was done on day 14 to leave the 2 best plants. Plant maintenance was done by watering and controlling weeds.

Variable observation. Root observations were carried out at the age of 40 days. The root nodules ware separated between the effective and the ineffective. Stem diameter was observed at the age of 60 days. Plants were harvested at the age of 60 days. After that the stems and leaves are separated, weighed and put into an envelope. The samples were dried to dry, and weighed, then ground, and sifted with a sieve diameter of 1 mm, and analyzed for nutrient content (AOAC, 2016).

Research design. This research was carried out using a completely randomized design (CRD) consisting of 4 treatments and 5 replications, where: P0 = without bokashi fertilizer (control), P5 = bokashi 5 tons/ha, P10 = bokashi 10 tons/ha, P15 = bokashi 15 tons/ha.

Observed variables are: 1) number of root nodules (nodules) which is total root nodules attached to the root, The percentage of effective root nodules (%) which is the number of effective nodules divided by the total number of nodules multiplied by 100%; 2) nitrogen uptake which is dry matter production (g/polybag) multiplied by the N content of plant canopy (%) (g/polybag); 3) the increase in leaf number (number/week) which is the difference between the number of leaves this week minus the number of leaves in the previous week, stem diameter (mm) measured 20 cm from the top of the root base; 4) production of fresh forage material (grams/polybag) which is the weight of forage that is weighed immediately after harvest; 5) forage dry matter production (grams/polybag) which is the total dry matter content multiplied by forage dry matter production; 6) production of forage organic matter (grams/polybag) which is the organic matter content (laboratory analysis results) multiplied by the production of dry forage matter; 7) production of forage crude protein (grams/polybag) which is the crude protein content of forage as a result of laboratory analysis multiplied by Forage dry matter production; 8) chemical composition of forage (% DM) is the result of a proximate analysis based on AOAC (2016) which consists of dry matter (DM), organic matter (OM), CP, CF, crude fat (CF), NFE, and ash.

The data obtained were analyzed for variance based on CRD and on treatments that showed differences were further analyzed by Duncan's test (Gomez and Gomez, 2010).

Results and Discussion

Research overview

The average ambient temperature during the study was 28 - 30°C; at 06.00 am the temperature was recorded at 35°C, while at 12.00 and 06.00 pm it was recorded at 27°C. The temperature, both in the morning and in the evening, is in accordance with that suggested by

Purbajanti (2013), which is between 5 - 30°C for the growth of feed plants. The conditions of the planting media (vertisol soil) are listed in Table 1. The growing media contained total N, P and C/N ratios in the medium amount category and contained K and cation exchange capacity (CEC) values in the high category (based on soil class values) (Jaya, 2017). Soil pH was in the range of neutral soil pH as suggested by Yuniarti *et al.* (2020). The N and K levels of this bokashi were higher than that of bokashi made from cow feces and cromolaene, namely 0.09% and 1.23% (Koten *et al.*, 2020). However, arbila plants were still observed to show good growth.

Effect of treatment on growth and production of arbila

Data on the effect of treatment on growth and production of arbila are shown in Table 2. The results of the study showed that the level of bokashi had a very significant effect (P<0.01) on the increase in leaf number, OM and CP production of forage and had a significant effect (P<0.05). on the number of root nodules, nitrogen uptake, stem diameter, FM and DM production. In addition, the treatment did not significantly affect the percentage of effective root nodules, and the ratio of stems and leaves of arbila. Further it is seen that the P15 treatment showed higher yields on several variables, namely the number of root nodules, N uptake, the increase in the number of leaves, and the production of OM, DM and CP compared to other treatment groups. However, high forage organic matter production was also found in P10. P0 showed the lowest yield on several variables, namely the number of nodules, the increase in the number of leaves, the production of OM and the production of CP.

The low number of root nodules at P0 was due to the denser soil compared to the soil treated with bokashi. This affects the development of roots and microorganisms that live around them. The higher number of root nodules at P15 was due to the addition of bokashi levels which caused changes in the physical, chemical and biological conditions of the soil. In looser soil, nutrients such as N, P, K are easier to be absorbed and utilized by plants. The high rate of this process was expressed in the high number of leaves and the increase in biomass and arbila production. Koten *et al.* (2020) stated that the physical condition of the soil affects the formation of root nodules and the presence of nitrogen-fixing bacteria. The addition of bokashi can increase the number of microorganisms in the soil so that the rhizobium bacteria that live around the roots can more optimally infect the roots in the process of nodule formation. Marhani (2019) proved that rhizobium will develop well if bokashi fertilizer is added to the growing media.

Bokashi increases soil nutrients, especially N, P and K which are important in plant growth and production (Marhani, 2019). Nitrogen has a significant effect on plant growth which can stimulate the growth of roots, stems and leaves and increase in plant height (Mulyanti *et al.*, 2015). However, the performance of growth and production of arbila forage was higher when arbila get bokashi made from cow feces and chromolaene (Koten *et al.*, 2020). This is due to the higher potassium content and CEC in bokashi made from cow feces and cromolene than this study.

Table 1. Soil and bokashi conditions in the study

	Soil	Bokashi
N (%)	0,27	
P (%)	0,007	1,18
K (%)	1,05	2,14
CEC Cmol(+) /Kg	39,15	
C/N ratio	11,17	30,17
pH	7,23	6,61
Fraction composition (%)		
Sand	58	
Dust	32,67	
Clay	9,33	
Texture class	Sandy loam	

Source : Analysis Results from the Laboratory of Soil, Faculty of Agricultura, University of Nusa Cendana Kupang (2021).

Table 2. Rooting, nitrogen uptake, vegetative part and arbila forage production due to treatment

	Treatment			
	P0	P5	P10	P15
Number of root nodul (nodul)	19,20±2,42[d]	25,20±2,26[c]	29,20±2,37[b]	37,20±3,19[a]
Percentage of effective nodules (%)	13,90±0,22[ns]	24,48±0,27[ns]	18,9±0,31[ns]	4,19±0,21[ns]
Nitrogen uptake (g/polybag)	0,50±0,08[a]	0,36±0,20[b]	0,32±0,02[b]	0,50±0,02[a]
Stem diameter (mm)	2,86±0,04[ns]	2,95±0,02[ns]	2,77 ±0,03[ns]	2,77±0,04[ns]
Increase number of leaf (leaf /week)	15,80±0,25[d]	16,80±0,21[c]	21,80±0,31[b]	22,60±0,29[a]
Stem and leaf ratio	0.47+0,33	0.53±0,05[ns]	0.63±0,10[ns]	0.39±0,03[ns]
Fresh forage productions (g/polybag)	78±3,06[b]	89 ±2,68[b]	109±2,92[a]	124±3,05[a]
Dry matter forage productions (g/polybag)	20,30±2,76[b]	22,31±2,72[b]	23,43±2,69[b]	28,24±2,91[a]
Organic matter productions of forage (g/polybag)	18,04±2,75[c]	20,98±2,72[b]	21,5±2,70[a]	20,36±2,32[b]
Crude protein productions of forage (g/polybag)	3,49±2,72[c]	4,10±2,71[b]	4,27±2,69[b]	4,88±2,31[a]

[a, b] Different superscript letters in the same line shows significantly different (P≤0,05), [ns] = non signifikan (P≥0,05). P0 = without bokashi (control), P5 = 5 tons bokashi/ha, P10 = 10 tons bokashi/ha, dan P15 = 15 tons bokashi/ha.

Table 3. Nutrient composition of arbila forage due by treatment

Nutrient composition	Treatment			
	P0	P5	P10	P15
Dry matter (%)	19,34±0,54[ab]	20,4±0,43[a]	17,26±0,52[b]	18,56±0,21[b]
Organic matter (% DM)	85,41±0,52[ab]	85,18±0,52[b]	85,93±0,46[b]	86,11±0,22[a]
Crude Protein (% DM)	16,63±0,37[b]	16,97±0,27[ab]	16,11±0,32[b]	17,09±0,20[a]
Crude fiber (% DM)	23,86±0,41[a]	23,50±0,24[a]	23,95±0,42[a]	20,90±0,17[b]
Ether Extract (% DM)	4,23±0,25[ns]	4,16±0,19[ns]	4,24±0,20[ns]	4,03±0,12[ns]
Nitrogen free extract (% DM)	41,22±0,86[b]	40,56±0,80[b]	41,11±0,76[b]	44,07±0,53[a]
Ash (% DM)	14,07±0,50[b]	14,82±0,52[a]	14,59±0,42[a]	13,89±0,23[b]

[a, b] Different superscript letters in the same line shows significantly different (P≤0,05), [ns] = non signifikan (P≥0,05). P0 = without bokashi (control), P5 = 5 tons bokashi/ha, P10 = 10 tons bokashi/ha, dan P15 = 15 tons bokashi/ha.

The effect of treatment on arbila's forage chemical composition

Table 3 shows data on the effect of treatment on the chemical composition of arbila forage. The results of the study showed that the treatment had a significant effect (P<0.05) on DM, OM, CP, CF, NFE, and Ash levels but had no impact on fat content. Further it is seen that the P15 treatment resulted in the highest OM, CP, and NFE values. This is because the increasing level of bokashi increases the organic matter content of the soil. Soil organic matter is used to form forage organic matter.

Birnadi (2014) suggested that the addition of bokashi to the soil can increase the content of organic matter and soil nutrients. The higher the level of bokashi (up to 20 tons/ha), the nutrients such as N, P and K present in the organic matter have increased due to the decomposition process of the compost material by microorganisms (Trivana and Pradhana, 2017). These nutrients are then used to form nutrients that are stored in the vegetative part of the plant. The increase in the nutritional quality of arbila was also caused by the increase in the number of root nodules formed, N uptake and in the increase in the number of leaves produced. Purbajanti (2013) explained that the number of leaves and stems affects the nutritional value produced from a plant, especially the protein content which increases with the increase in the number of leaves, while the crude fiber content increases with the increase in the number of plant stems.

Conclusions

It was concluded that this bokashi can improve the growth, production and chemical composition of arbila's forage and the best level is 15 tons/ha.

References

AOAC. 2016. Official Methods of Analysis of the Association of Official Analytical Chemists. 20th edn. Published by The Association of Official Analytical Chemists, Maryland.

Birnadi, S. 2014. Pengaruh pengolahan tanah dan pupuk organik bokashi terhadap pertumbuhan dan hasil tanaman kedelai (*Glycine max* L.) kultivar wilis. Jurnal ISTEK 8: 29 - 46.

Gomez, K. A. and A. A. Gomez. 2010. Statistical Prosedures for Agricultural Research (Prosedur Statistik untuk Penelitian Pertanian. Alih bahasa oleh E. Syamsuddin dan J. S. Baharsyah). Edisi Kedua. UI Press, Jakarta.

Jaya, R. 2017. Eksistensi unsur hara tanah terhadap kerentanan lahan kritis DAS Alo Kabupaten Gorontalo. Bindhe – Jurnal Ilmiah Program Studi Agribisnis 2: 100 - 106.

Koten, B. B. R. D. Soetrisno, N. Ngadiyono, and B. Soewigno. 2013. Penampilan produksi hijauan hasil tumpangsari arbila *(Phaseolus lunatus)* berinokulum rhizobium dan sorghum (*Sorghum bicolor*) pada jarak tanam arbila dan jumlah baris sorghum. Jurnal Sains Peternakan 11: 26-33.

Koten, B. B., R. Wea, A. Semang, and M. E. Koten. 2020. Pertumbuhan dan produksi hijauan arbila (*Phaseolus lunatus*) sebagai pakan ternak akibat dosis bokashi gulma pastura yang berbeda di lahan kering. Jurnal Ilmiah Inovasi 20: 27-33.

Marhani. 2019. Pengaruh aplikasi rhizobium dan pupuk NPK, bokashi terhadap pertumbuhan dan produksi tanaman kedelai (*Glycine max* L Merrill) pada tanah gambut. J. Agroland 26: 49 – 57.

Mulyanti, S. S., U. Made, and I. Wahyudi. 2015. Pengaruh pemberian berbagai jenis bokashi terhadap pertumbuhan dan hasil tanaman jagung manis (*Zea mays* Saccarata). J. Agrotekbis 3: 592 – 601.

Oviyanti, F., Syarifah, and N. Hidayah. 2016. Pengaruh pemberian pupuk organik cair daun gamal (*Gliricidia sepium* (Jacq.) Kunth Ex Walp.) terhadap pertumbuhan tanaman sawi (*Brassica juncea* L.). Jurnal Biota 2: 61-68.

Purbajanti, E. D. 2013. Rumput dan Legum. Penerbit Graha Ilmu, Yogyakarta.

Tarruco-Uco, J,. L. Chel-Guerrero, A. Martinez-Ancona. 2009. Angiotensin-I converiting enzyme inhibitory and antioxidant activities of protein hydrolysates from *Phaseolus vulgaris* seeds. LWT – J. Food Sci. Tecnol. 42: 1597-1604

Trivana L. and A. Y. Pradhana. 2017. Optimalisasi waktu pengomposan dan kualitas pupuk kandang dari kotoran kambing dan debu sabut kelapa dengan bioaktivator PROMI dan orgadec. Jurnal Sain Veteriner 35: 136 – 144.

Wea, R., B. B. Koten, and B. Ndoen. 2017. Pengaruh jenis hijauan non palatable padang pengembalaan terhadap kandungan N Total dan P_2O_5 Bokashi". Prosiding Seminar Nasional ke-1 Pusat Penelitian dan Pengabdian Kepada Masyarakat Politeknik Pertanian Negeri Kupang.

Yuniarti, A., E. Solihin, and A. T. A. Putri. 2020. Aplikasi pupuk organik dan N, P, K terhadap pH tanah, P-tersedia, serapan P, dan hasil padi hitam (*Oryza sativ*a L.) pada inceptisol. Jurnal Kultivasi 19: 1040-1046.