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**Submission date:** 24-May-2023 10:41PM (UTC+0800)

**Submission ID:** 2100880786

**File name:** itayani\_2022\_IOP\_Conf.\_Ser.\_Earth\_Environ.\_Sci.\_1097\_012058.pdf (792K)

**Word count:** 3252

**Character count:** 17679

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To cite this article: Evitayani *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1097** 012058

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## Effects Of *Indigofera Zollingeriana* As Substitute For Concentrate In Elephant Grass-Based Rations (*Pennisetum Purpureum*) On Availability Of Macro Minerals (Ca, P, Mg, & S) In Kacang Goat

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**Abstract.** This study aims to explore the best level of *Indigofera zollingeriana* as concentrate substitution in elephant grass-based rations on the availability of macro minerals (Ca, P, Mg, and S) in kacang goats. This study investigated 12 kacang goats weighing 11 to 12 kg were investigated. The data were collected using an experimental method with a completely randomized design (CRD), consisting of three treatments and four replications. They were P1: 60% elephant grass + 30% concentrates + 10% *Indigofera zollingeriana*; P2: 60% elephant grass + 20% concentrates + 20% *Indigofera zollingeriana*; and P3: 60% elephant grass + 10% concentrates + 30% *Indigofera zollingeriana*. The observed variables were the availability of calcium (Ca), phosphorus (P), magnesium (Mg), and sulfur (S). The statistical analysis used was the analysis of variance. Meanwhile, the mean differences were tested using the DMRT test (Duncan's multiple range test). The results showed that substitution for concentrates with *Indigofera zollingeriana* significantly affects (P<0.05) the availability of Mg and S minerals. This study concludes that the concentrate substitution with 30% *Indigofera zollingeriana* could increase the availability of calcium (Ca) and phosphorus (P) minerals, but not affect the availability of magnesium (Mg) and sulfur (S) minerals.

**Keywords:** *Indigofera zollingeriana*, Kacang Goats, Availability of Macro Minerals (Ca, P, Mg, and S)

### 1. Introduction

Indonesia continuously promotes self-sufficiency in meat to meet the independence of the animal protein needs of Indonesians. The government of Indonesia has taken several steps to develop livestock proving its seriousness in realizing the program. One of the ways taken is development beef cattle, such as goats. Goat is potential livestock to develop in Indonesia because its meat is preferred by the Indonesians and its maintenance is relatively simple. One of the ideal goats to keep in a tropical climate is kacang goats. Its ability to adapt to various environmental conditions makes kacang goats survive well [1]. Therefore, kacang goats have a lower risk of various environmental conditions that can occur during maintenance and minimize the loss of farmers. Peanut goats are ideally developed in Indonesia on smallholder and industrial farm scales. In ruminant, the Kacang goat of feeding used as forages for consumed. However, this study only used elephant grass (*Pennisetum purpureum*), an annual plant (Perennial) that can grow on various types of soil in Indonesia and have high production. Production of fresh forage elephant grass ranges from 500 to 800 tons/ha/year [2]. However, the weaknesses of this plant are containing low nutrient and mineral content and greedily using nutrients. According to [3], the mineral content of elephant grass is Ca 4.74–4.84 g/kg BK, P 5.18–5.25 g/kg BK, and Mg 2.66–3.68 g/kg BK. Meanwhile, the mineral requirement for ruminants is 1.8–8.2 g/kg BK (Ca), 1.8–4.8 g/kg BK (F), and 1.0–2.0 g/kg BK (Mg) [4].



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Plants should have sufficient quantities of mineral content because it is eaten by animals whose bodies cannot make minerals. This is crucial because minerals have an important role in the body of livestock (Pratiwi, 2016). Unfortunately, most livestock that consumes field grass in West Sumatra has deficient Ca, P, Mg, and S minerals [5]. Macro and micro mineral content of forage in this area highly vary; some grasses have mineral content below the critical level, especially in the dry season [6]. The nutritional and mineral content of elephant grass can be increased by planting a mixture of grass and legumes. Legumes functions to bind free nitrogen in the air so that they contribute to maintain soil fertility. This research used *Indigofera zollingeriana* legumes. The high crude protein and mineral content makes this plant a potential source of protein substituting for concentrate as well as a source of minerals. Studies by [7] found that *Indigofera* can meet the Ca, Mg, Zn, and Mn of ruminants but it is important to supplement the Selenium minerals and vitamin E from other sources to meet the mineral needs of ruminants. The use of *Indigofera zollingeriana* as a substitute for concentrate in goat rations fed with elephant grass will also affect the goats' nutritional quality. Forage and legumes-based feeding must also consider the balance or synchronization between the energy and protein requirements needed by livestock to meet the basic needs of life and production. Forage is a combination of grass and legumes to complement each nutrient element needed by livestock [8].

Minerals have quite important functions in the body. Thus, the deficient mineral will interfere with the body's work because goats need minerals to support growth and physiological processes in their bodies. However, the fact shows that mineral deficiencies frequently occur. This condition is supported by [9], who states that grass and legumes in several locations in West Sumatra contain low to marginal Ca, P, Mg, and S minerals from the soil. As a result, goats living in these locations have poor mineral status.

## 2. Methodology

### 2.1 Experimental Cattles

This study investigated 12 Kacang goats aged 10-12 months and weighing about 11-12 kg.

### 2.2 Experimental Cages and Equipment

This study employed an individual metabolic cage, a stage cage of 1.5 x 0.5 meters equipped with containers to eat and drink. The research equipments were the scales to measure the bodyweight of livestock, buckets, shovels, fecal collection nets, scales to accommodate goats' feces, plastic, and laboratory equipment and chemicals to analyze samples.

### 2.3 Trial Ration

The rations used in this study were elephant grass, *Indigofera zollingeriana*, soybean meal, tofu dregs, and corn formulated and arranged as complete rations.

### 2.4 Research Methods

#### Research Designs and Treatment Rations

This study employed a completely randomized design (CRD) with three treatments and four replications. The treatments used in this study are as follows.

P1 = 60% elephant grass + 10% *Indigofera zollingeriana* + 30% concentrate

P2 = 60% elephant grass + 20% *Indigofera zollingeriana* + 20% concentrate

P3 = 60% elephant grass + 30% *Indigofera zollingeriana* + 10% concentrate

### 2.5 Research Parameter Measurement

The macro mineral was analyzed using the inductively coupled plasma (ICP) with an AES type. The availability value of macro minerals was calculated using the following equation.

Availability of minerals (Ca)

$$= \frac{\text{Consumption of Ca -Ration Total Ca in Feces}}{\text{Consumption Ca in Ration}} \times 100\%$$

Availability of P mineral

$$= \frac{\text{Consumption of P in ration- Total of P in feces}}{\text{Consumption in P ration}} \times 100$$

Availability of Mg mineral

$$= \frac{\text{Consumption of P in ration - Total of Mg in feces}}{\text{Consumption of Mg in ration}} \times 100$$

Availability of S mineral

$$= \frac{\text{Consumption of S in ration - Total S in Feses}}{\text{Consumption of S in ration}} \times 100$$

#### Statistic Analysis

The mathematical model of this research refers to [11].

$$Y_{ij} = \mu + r_i + \varepsilon_{ij} \quad (1)$$

#### Abbreviations

ns :

$Y_{ij}$  : The results of observations on the i-th treatment and j repetition

$\mu$  : General means

$r_i$  : Effects of treatment -i

$\varepsilon_{ij}$  : Effects of treatment i and repetition -i

I : Several treatments (1, 2, and 3)

J : Tests (1, 2, 3, and 4)

#### 2.6 Measured Parameter

The parameter measured in this study was the availability of macro minerals of C, P, Mg, and S.

#### 2.7 Implementation of Animal Feed Preparation Research

The prepared animal feed consisted of forage and concentrate. The forages used in this research were elephant grass and the legume *Indigofera zollingeriana*. They were then given to livestock in the form of flour by considering the determined ration formulation, which consisted of rice bran, corn, soybean meal, and tofu dregs.

**2.8 Cage Cleaning and Livestock Inspection**

The cages were cleaned and sterilized using a disinfectant. Meanwhile, the livestock's health condition was confirmed and administered with the worm medicine. These steps were done in order to prepare and familiarize livestock with the experimental environment and treatment rations.

**2.9 Adaptation Periods**

During this period, the accustom has been given the materials used to prepare the treatment ration. This period lasts for one week to accustom the cattle to the treatment rations and the experimental environment.

**2.10 Preliminary period**

During this period the cattle were given treatment rations; animal feed, drink, and the goats' bodies were weighed. This seven-day period aims to eliminate the influence of the previous rations.

**2.11 Feces Collection**

During this period, feces were collected for five days. The feces that came out for 24 hours were collected by being accommodated and weighed entirely after being mixed homogeneously. Furthermore, 10% of the feces samples were taken and dried to determine the dry weight of the air. Afterward, the dried, crushed, and decomposed samples were analyzed to investigate their nutrient content.

**3. Results and Discussion**

Availability of Calcium (Ca)

The average availability of calcium (Ca) is presented in Table 7.

**Table 1. Average Availability of Ca Mineral**

Treatments	Average Availability (%)
P1	95.63 <sup>b</sup>
P2	96.80 <sup>a</sup>
P3	95.88 <sup>b</sup>
SE	0.17

Note: Different letters in the same column show significantly different effects ( $P < 0.01$ ).

SE: Standard errors

The analysis of variance shows that the use of *Indigofera zollingeriana* as a substitute for concentrate in the diet significantly affects the availability of Ca minerals in kacang goats ( $P < 0.01$ ). The DMRT test has revealed that the increasing use of *Indigofera zollingeriana* from 10% (P1) to 20% (P2) in the diet as a substitute for concentrate significantly increases the availability of Ca minerals from 95.63% to 96.80% ( $P < 0.01$ ). In contrast, the increasing use of *Indigofera zollingeriana* from 10% (P1) to 30% (P3) in the rations has a significantly different effect ( $P > 0.05$ ) on the availability of Ca minerals by 95.88%. The increasing use of *Indigofera zollingeriana* from 20% (P2) to 30% in the P3 ration significantly reduces the availability of Ca minerals from 98.8% to 95.88% ( $P < 0.01$ ). The availability of Calcium (Ca) minerals increases due to the use of legumes, such as *Indigofera zollingeriana*, in plants that grow in soils high in Calcium (Ca) and have a mineral source as a substitute for concentrates. This finding is supported by [12] who states that the availability of Ca in plants has closely related to the availability of Ca in the soil; the higher the availability of nutrients in the soil, the higher the minerals are produced by plants. This finding is also in line with [9], who explains that Ca, P, Mg, and S in soil, grass, and legumes in several locations in West Sumatra have a low to marginal diagnosis. As a result, goats living in these locations have good availability of minerals. This study has found that kacang goats have high availability of calcium (Ca) because they eat a combination of elephant grass and *Indigofera zollingeriana*. It is proven that this combination could increase the availability of calcium minerals in the livestock's body. This statement agrees with [13], who states that supplementation of Ca mineral in



organic form can increase its availability; thus, it can be more significantly absorbed by livestock's body and will greatly help optimize the utilization of agricultural, plantation, and agro-industrial waste as alternative feed ingredients. High consumption of Ca mineral can decrease live weight gain and suppress the use of protein, fat, and some minerals [14].

The high availability of Ca is also caused by the high content of crude protein and minerals in *Indigofera zollingeriana*. Calcium (Ca) in the body of livestock functions to form bones and teeth, conduct several enzymes' activities, perform muscle contraction, and transmit nerve impulses. This finding is in accordance with [15], who opines that calcium (Ca) is the most needed mineral by livestock to grow bones and teeth.

### 3.1 Availability of Phosphorus (P) Minerals

The average availability of phosphorus (P) minerals is presented in the following table.

**Table 2.** Average Availability of P Mineral

Treatments	Average Availability (%)
P1	88.86 <sup>C</sup>
P2	95.36 <sup>b</sup>
P3	96.53 <sup>a</sup>
SE	0.21

Note: Different letters in the same column show significantly different effects ( $P < 0.01$ ).

SE: Standard errors

The results of the variance analysis demonstrate that the use of *Indigofera zollingeriana* as a substitute for concentrate in the diet has a very significant effect on the availability of phosphorus (P) minerals in Kacang goats ( $P < 0.01$ ). The DMRT test has revealed that the increasing use of *Indigofera zollingeriana* from 10% (P1) to 20% (P2) in the diet as a substitute for concentrate significantly increases the availability of Ca minerals from 88.86% to 95.36% ( $P < 0.01$ ). Moreover, the increasing use of *Indigofera zollingeriana* from 10% (P1) to 30% (P3) in the ration has a very significant effect ( $P < 0.01$ ) on the availability of Ca minerals by 96.53%. The increasing use of *Indigofera zollingeriana* from 10% (P1), to 20% (P2), and finally 30% (P3) significantly ( $P < 0.01$ ) increases the availability of Ca minerals from 88.86%, 95.36%, and 96.53%.

### Availability of Mineral Magnesium (Mg)

The average availability of magnesium (Mg) is summarized in Table 3

**Table 3.** Average Availability of Mg Mineral

Treatments	Average Availability (%)
P1	94.19
P2	92.89
P3	94.05
SE	0.57

Description: Values in the same column show no significant differences ( $P > 0.05$ ).

SE: Standard errors

### 3.2 Availability of Sulfur (S) Minerals

The average availability of sulfur (S) is presented in Table 4.

**Table 4.** Average Availability of Mg Mineral

Treatments	Average Availability (%)
P1	92.12
P2	90.32
P3	91.26
S	0.96

Description: Values in the same column show no significant differences ( $P > 0.05$ ).

SE: Standard errors

#### 4. Conclusion

This study concludes that replacing concentrate with *Indigofera zollingeriana* up to 30% could increase the availability of calcium (Ca) and phosphorus (P) minerals. However, this replacement does not affect the availability of magnesium (Mg) and sulfur (S) minerals.

#### Acknowledgments

The authors thank the Directorate of Research and Community Service, the Directorate-General for Higher Education of the Ministry of Education and Culture of Indonesia for financially supporting this master' research with contract numbers: T/30/UN/16.17/PT 01.03/PTM-2020 Pangan.

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