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Effect of Commercial Complete Feed Substitution with Leaf Flour Moringa (Moringa Oleifera) Against Consumption and Digestibility of Calcium and Phosphorus in Pig Growers

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ABSTRACT: The purpose of the study was to determine the effect of commercial complete feed substitution with moringa leaf flour on the consumption and digestibility of calcium and phosphorus in pigs in the grower phase. The material used was 12 castration landrace castration boars aged 3-5 with an initial weight of 38-55 kg with an average of
45.17 kg (KV=13.31%). This study used a Complete Randomized Design (RAL) with four treatments and three replicates. The treatment is R0: 100% commercial complete feed, R1: 90% commercial complete feed + 10% moringa leaf flour, R2: 85% commercial complete feed + 15% moringa leaf flour, R3: 80% commercial complete feed + 20% moringa leaf flour. The research variables were calcium and phosphorus consumption and digestibility. The results of the statistical test showed that the use of R1 and R2 was not significantly different (P>0.03) in the consumption and digestibility of Ca and P, while R3 was significantly different (P<0.05) compared to R0. The substitution of 20% moringa leaf flour had a real effect (P<0.05) on the consumption and digestibility of calcium and phosphorus in the grower phase pigs. Based on the results and discussion, it can be concluded that the use of moringa leaf flour (Moringa oleifera) at the level of 10-15% does not affect the consumption and digestibility of Ca and P, at the use of 20% increases Ca consumption, P consumption and P digestibility, while decreasing Ca digestibility.

KEYWORDS: Pigs, calcium and phosphorus moringa leaf flour

INTRODUCTION

The productivity of pig livestock is affected by the balance of feed nutrient content (Nguru et al., 2024). Feed is an important factor because feed plays a very important role in producing fast and efficient growth (Nguru et al., 2024). The balance of energy and protein content greatly determines the quality of feed. Feed management is an aspect that needs to be considered because it affects the productivity of pigs (Mindung et al., 2025). Pigs are monogastric livestock that are able to grow quickly and efficiently and can produce meat in a relatively short period of time (Nguru et al., 2024). Pigs can also consume various types of feed and maintenance is easier compared to other types of livestock.

The feed mill has produced feed whose content is balanced and adjusted to each growth phase. But the high price of feed materials affects the high cost of production. One of the factors that affect the high price of feed is the dependence on the import of feed ingredients that are rich in protein. The increase in feed prices is closely related to the amount of protein in the feed. Feed with high protein content tends to have a higher price. This causes smallholder farmers to often use feed with lower protein content for livestock that require more protein intake. One of the problems faced by farmers is the difficulty of meeting the availability of feed, both in quality and quantity (Nguru et al.,2022). To overcome this problem, it is necessary to add several alternative sources of protein to be able to meet the needs of pigs.

The addition of alternative protein sources to the low-protein ration can increase the protein content of feed and the balance of amino acids which then affect the digestibility of nutrients and the growth of pigs, depending on the source of feed protein used (Florou-Paneri et al., 2014). The addition of a protein source in the form of 5% moringa leaf flour in the ration had the same effect as without adding to the linear body size of the *starter-finisher pig* (Hau et al., 2023) (Missa et al., 2023), digestion of dry matter and organic matter (Luluporo et al., 2023), Calcium and phosphorus digestion (Sene et al., 2023). A mixture of 12% moringa leaf flour and 3% katuk leaf flour also has no effect on the digestion of dry matter and organic matter (Pereira et al., 2023), protein dan energy (Nggadas et al., 2023) babi stater - grower. If the feed given to pigs is lower than the standard requirement, then the addition of alternative protein sources can increase the protein ration, lower the price, and can provide good growth and carcass of pigs (Parrini et al., 2023), can reduce the price of feed according to the type of protein source used to achieve the optimal slaughter weight of pigs (Wea et al., 2022).

Feeding with low protein can cause disruption in livestock production such as lower body weight and increased feed

consumption. This problem can be solved by giving supplements that are able to improve the performance of pigs on low-protein feeds. The difference in the protein level of the ration of 1.5 % did not affect the growth of pigs after weaning until the finisher (Han et al., 2023). Alternative protein sources in the form of moringa leaves in the form of solutions can improve. Pig feed efficiency (Suryani et al., 2021). Moringa leaf supplementation in liquid feeding at the level of 15% improves energy consumption, protein consumption, energy digestion but has no effect on protein digestion (Sijung et al., 2020). The addition of leaf meal is expected to improve the quality of low-protein feed, reduce feed costs and improve pig growth. In addition to the adequacy of protein and energy, pig growth requires the adequacy of the main minerals, namely calcium and phosphorus, The need for calcium and phosphorus in pigs depends on several things, including: the adequacy of each mineral in the ration is in accordance with the growth or reproduction of pigs, the ratio of Ca and P must be appropriate. The function of one of the minerals will be disturbed if the ratio of calcium and phosphorus minerals is unbalanced which results in a decrease in livestock performance.

RESEARCH MATERIALS AND METHODS

Research Materials

Livestock: in this study, 12 male pigs were used in the castration of the landrance phase of the grower phase

Research enclosures: What is used is an individual cage consisting of two rows facing each other so that there are 12 plots with each measuring 2 m × 1.5 m.

Equipment: The equipment used in this study is a drinking water place and a feed place in each cage plot. Other equipment is a Three Goats brand hanging drum with a capacity of 50 kg, and a scale with a capacity of 150 kg to weigh feed materials, and livestock, knives, measuring cup containers, writing stationery, shovels, skewers, buckets, sacks, dipsticks, plastic bags, and cameras.

Research rations: The feed used is a commercial complete feed that is circulating on the market produced by PT Gold Coin with the code Classic I which contains 15% protein. Moringa leaf flour is used for the substitution of such commercial feed at different levels. The nutritional content of the feed used in the treatment feed is seen in table 1, while the composition and nutritional content of the treatment ration can be seen in table 2.

Table 1. Nutritional content of feed ingredients that make up the treatment ration

Feed Ingredients	Nutritional Content							
	EM (Kkal/kg)	PK (%)	LK (%)	SK (%)	BK (%)	Ca (%)	P	(%)
Complete Feed Classic I [a]	3257	15,00	3,00	7,00				
Moringa leaf flour [c]	1.318,20	30,30	6,13	12,48	0	2,66	0,95	

Source: a) label on classic sack I produced by PT Gold Coin , b) Saragih (2016), c) Sjofjan (2008).Table 2. Composition and nutritional content of treatment rations

Feed ingredients	Treatment			
	R0 (%)	R1(%)	R2 (%)	R3 (%)
Complete feed	100	90	85	80
Moringa leaf flour	0	10	15	20
Total	100	100	100	100
Nutritional content				
Gross Energi (Kkal/kg)[a]	4.210,05	4.154,93	4.196,48	4.271,08
EM (Kkal/kg)[a]	3.321,73	3.278,24	3.311,02	3.369,88
Dry Ingredients (%)[a]	88,79	87,85	87,60	88,03
Organic Ingredients (%)[a]	90,58	90,58	90,63	90,94
Protein Kasar (%)[a]	15,40	16,11	16,31	16,70
Crude Fat (%)[a]	5,10	3,86	4,93	6,77
Crude Fiber (%)[a]	5,18	5,20	5,61	6,07
Ca (%)[b]	1,11	1,20	1,24	1,27
P (%)[b]	0,77	0,78	0,79	0,79

Remarks: [a] Results of proximate analysis of the FPKP Undana Feed Chemistry Laboratory, 2024

[b] Results of proximate analysis of the Soil Chemistry Laboratory of Faperta Undana, 2024

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Research Methods

This study uses an experimental method or experimental method, and the experimental design used is a Group Random Design (RAK) analysis consisting of 4 treatments with 3 replicas so that there are 12 experimental units. The treatment is :

R0: low protein feed

R1: 90% P0 + 10% moringa leaf flour R2 : 85% P0 + 15% moringa leaf flour R3 : 80% P0 + 20% moringa leaf flour

Research procedure

This research was carried out with the following procedure Moringa leaf flour making

The procedure for making moringa leaf flour is as follows

1. Fresh moringa leaves that have been separated from the stems and stalks are dried by aerating until they can be kneaded by hand
2. After drying, moringa leaves are weighed to obtain their dry weight and then ground so that fine moringa leaf flour is obtained to be used in feed mixtures.

Procedure of mixing rations

Each feed ingredient is weighed according to the percentage of each feed (table 2). After weighing the feed ingredients are mixed, before giving the mixture the two ingredients are mixed with water to get the same and more homogeneous shape. The ratio between water and feed is 2:1.

Research Variables

The variables observed in this study are

1. Calcium Consumption (Ca)

Consumption Ca = Total consumption ration (gram) x dry matter ration (%) x Ca ration.

2. Phosphorus Consumption (P)

Consumption P = Total consumption ration (gram) x ration curling material (%) x P ration

3. Calcium Digestibility (Ca)

The digestibility of calcium (Ca) is calculated by the formula according to the instructions of Tillman, et al. (1989) are: KCCa = $\frac{I-F}{}$ X 100%

Description: KCCa = Calcium digestibility/digestible coefficient (%) I = The amount of calcium (Ca) consumed.

F = Total (Ca) excreted through feces.

(Ca feces = Number of feces x % BK feces x Ca results of Lab analysis)

4. The digestibility of Phosphorus (P) is calculated by the formula according to the instructions. Tillman, et al. (1989) are: KCP = $\frac{I-F}{}$ x 100%

Remarks: KCP= Phosphorus digestibility/digestibility (%) I = Amount of Phosphorus (P) consumed

F = The amount of Phosphorus (P) excreted through the feces

(Number of P = Number of feces x % BK feces x P results of Lab analysis).

Data Analysis

The data collected were analyzed using Analysis of Variance (ANOVA) and then to test the differences between treatments used by the Duncan multiple spacing test according to Gaspersz (1991)

Table 3. Data on ration consumption, Ca, P consumption and Ca and P digestibility of research pigs

RESULTS AND DISCUSSION

The results of the experiment on the effect of moringa leaf flour level treatment in low-protein feed on ration consumption, Ca and P digestion consumption of Ca and P can be seen in the table

Table 3. Data on ration consumption, Ca, P consumption and Ca and P digestibility of research pigs

VARIABEL	TREATMENT				P- VALUE
	R0	R1	R2	R3	
Consumption of Rations	2105,00±22,13^{a}	2095,00±316,89^{a}	2226,67±172,98^{a}	2261,66±120,45^{a}	0,703
Calcium Consumption (g/e/h)	23,37±2,54^{a}	25,14±3,80^{ab}	26,78±2,15^{ab}	28,71±1,53^{b}	0,16
Calcium Digestibility (%)	31,00±10,78^{a}	38,04±3,45^{ab}	42,30±4,07^{ab}	45,05±2,27^{b}	0,10
Phosphorus Consumption(g/e/h)	16,21±1,76^{a}	16,55±2,50^{a}	17,06±1,37^{a}	28,72±1,53^{b}	0,00
Phosphorus Digestibility	90,88±1,38^{a}	90,53±0,68^{a}	90,45±0,88^{a}	90,19±0,30^{b}	0,00

(%)					

Remarks: the average value with different superscripts on the same line shows a noticeable difference (P<0.05).

Effect of Treatment on Ration Consumption

Table 3 shows that the highest ration consumption was achieved by cattle receiving R3 treatment with a figure of 2261.67 gr/e/h, followed by R2 treatment of 2226.67 g/e/h, R1 treatment reaching 2095.00 g/e/h, and the lowest consumption was found in cattle with R0 treatment which recorded 2105.00 g/e/h.

The results of the variance analysis (ANOVA) of the use of moringa leaf flour at various levels did not have an unreal effect (P>0.05) on ration consumption in pigs. The provision of moringa leaf flour as much as 10-20% as a substitute for commercial feed with low protein content has an unreal effect on the consumption of pig rations. The unreal difference in the ration consumption of each treatment is suspected to be due to the palatability of the four treatment rations being relatively the same, the physical form of the ration has been equalized where the form of commercial feed pellets has been mixed until homogeneous by wetting the feed. After further tests, Duncan showed that the treatment on the ration was not real (P>0.05). The administration of a mixture of moringa leaf flour as much as 10-20% as a substitute for conventional low-protein rations, has an unreal effect on the consumption of pig rations. Ration consumption is influenced by the form and physicality of feed, frequency of feeding, and anti-nutrients in the ration. Ration consumption was influenced by the age of the livestock, the nutrient content in the same experimental ration and the environment (Nguru et al., 2022).

The almost uniform level of ration consumption between each pig farm is greatly influenced by the energy content of the ration, the level of palatability (Heryfianto et al., 2015), Feed travel rate in the digestive tract (Ullo et al., 2020) Palatability is influenced by the aroma, taste, texture, and shape of food consumed by farm animals. (Nguru et al., 2024). The absence of differences in ration consumption indicates that the level of palatability of each treatment ration is relatively the same (Mindung et al., 2025)

Effect of Treatment on Calcium Consumption

Table 3 shows that the highest calcium consumption was achieved by cattle receiving R3 treatment with a figure of 28.72 gr/e/h, followed by R2 treatment of 26.78 g/e/h, R1 treatment of 25.14 g/e/h, and the lowest consumption was found in cattle with R0 treatment which recorded 23.37g/e/h.

The results of the variety-wide analysis (ANOVA) showed that the use of moringa leaf flour at different levels had a significant effect (P>0.05) on calcium consumption. The results of the Duncan test showed that the treatment of R1 and R2 was not real (P>0.05) compared to R0 while R3 was significantly different (P<0.05) compared to R0. The use of 10-15% moringa leaf flour did not affect calcium consumption but at the use of 20% as a substitute for conventional rations it had a noticeable effect increased (P<0.05). Ca consumption that increases at R3 due to the Ca ration is also the highest.

This result is in line with the research of Dasalaka et al., (2020) who added moringa leaf solution in the basal ration to have a very noticeable effect on calcium consumption, this is due to the amount of ration consumption and the calcium content of the ration increases. High calcium consumption is influenced by how much of the ration is consumed and the level of calcium contained in the ration (Nguru et al., 2024). Calcium consumption is influenced by the calcium content that makes up the ration. Different feed ingredients cause different consumption and calcium in different feed so calcium consumption is also different, the use of 20% moringa leaf flour causes differences in Ca in rations so that Ca is consumed differently. Likewise, feed containing katuk leaves has a slightly different calcium consumption (Ninu et al., 2025)

Effect of Treatment on Calcium Digestion

Table 3 shows that the highest calcium digestibility was achieved by cattle receiving R0 treatment with a figure of 31.00 gr/e/h, followed by R1 treatment of 38.04 g/e/h, R2 treatment of 42.30 g/e/h, and the lowest digestion was in cattle with R3 treatment which recorded 45.05 g/e/h.

The results of the variance analysis (ANOVA) showed that the use of moringa leaf flour at different levels had a significant effect (P<0.05) on calcium digestion. The results of Duncan's test showed that the treatment of Rl was different not real (P>0.05), R2 and R3 were significantly different compared to R0, R1:R2:R3 was significantly different (P<0.05) and R2:R3 was different from real (P>0.05). These results show the use of 15%-20 moringa leaf flour lowers the digestibility of Ca pig growth. Moringa leaf flour is a source of vegetable protein because it comes from plant cells will reduce digestibility compared to ingredients derived from animal proteins. The more plant-based use will lower the digestibility of feed nutrients because the plant cell walls are more difficult for the ba to digestbi (Rojas & Stein, 2017).

This shows that increased calcium digestibility occurs due to the high content of calcium minerals in the ration up to the level of 20%. Meanwhile, the level of ration consumption is relatively the same. Feed digestibility is greatly influenced by the high and low value of the benefits of feed ingredients. This is supported by the opinion of Rambet et al., (2016) that the digestibility of a feed ingredient reflects how high or low the value of the feed ingredient is. Increased ration consumption is thought to contribute to

increased digestion of calcium minerals. Kunda et al., (2017) states that the content of phytochemicals (saponins, flavonoids, polyphenols) helps the performance of the digestive tract so that moringa leaves can be digested. Nurkhasanah et al., (2017), stated that the real increase in calcium digestibility is due to the fact that the compounds in moringa leaf flour have not worked optimally, to work optimally it can be combined with other feeds. This shows that giving rations with the rate of addition of moringa leaf flour in the ration further increases calcium digestion.

Effect of Treatment on Phosphorus Consumption

Table 3 shows that the highest phosphorus consumption was achieved by cattle receiving R3 treatment with a figure of 28.72 g/e/h, followed by R2 treatment of 17.06 g/e/h, R1 treatment of 16.55 g/e/h, and the lowest consumption was in cattle with R0 treatment which recorded 16.21g/e/h.

The results of the variance analysis (ANOVA) showed that the use of a mixture of moringa leaf flour and katuk leaf flour in the ration had no significant effect (P>0.05) on phosphorus consumption. This shows that the use of moringa leaf flour mixture up to the level of 10% (a mixture of 10-20% moringa leaves) instead of basalt rations has a noticeable effect on the phosphorus consumption of pigs in the grower phase.

The actual phosphorus consumption occurs due to the consumption of almost similar rations, and the consumption of similar rations is due to the palatability and energy content in the relatively similar rations. The availability of phosphorus minerals in feed affects the level of phosphorus mineral consumption. This is supported by Ninu et al., (2025) who stated that the high use of feed is influenced by the amount of phosphorus contained in feed. Meanwhile, the level of ration consumption is closely related to the level of palatability and relatively the same energy content. This is in accordance with Kurniawan et al., (2019) reporting that the phosphorus mineral intake rate is closely related to the phosphorus mineral content in food and the amount of food consumed, therefore, the addition of minerals in feed is very necessary. Another factor that affects nutrient consumption levels (including Ca and P) is the composition of nutrients in feed.

Animal feed consumption is influenced by palatability determined by the aroma, taste, texture, and shape of food consumed by livestock (Heryfianto et al., 2015). It also added that the consumption of rations is influenced by the palatability and nutritional content of the ration (Ndolu et al., 2024).

Effect of treatment on phosphorus digestion

Table 3 shows that the highest phosphorus digestibility was achieved by cattle receiving R3 treatment with a figure of 90.19 g/e/h, followed by R0 treatment of 90.88 g/e/h, R1 treatment of 90.53 g/e/h, and the lowest digestion was found in cattle with R2 treatment which recorded 90.45g/e/h.

Based on the results of the variety-based analysis (ANOVA), it was shown that the use of a mixture of moringa leaf flour and katuk leaf flour in the ration had no significant effect (P>0.05) on phosphorus digestibility. This shows that the use of moringa leaf flour mixture up to the level of 10-20% as a substitute for basalt ration has a noticeable effect on the phosphorus digestibility of pig farms in the grower phase.

The use of moringa leaf flour mixture in rations of up to 10% showed a significant effect on phosphorus digestibility in pig farmers in the grower phase. The compounds found in moringa leaves have antimicrobial properties that can improve digestion (Bukar et al., 2010). Dasalaka et al., (2020), Yang reported that phosphorus digestibility increased as the concentration of the solution in liquid feeding increased so that the rate of food travel in the digestive tract was faster.

Increased phosphorus digestibility is due to increased phosphorus consumption. This is supported by Nguru et al., (2024) who state that the increase in the digestibility of Ca minerals is due to the high mineral content of Ca. The calcium and phosphorus content in moringa is higher than in the basic ration, so the use of a mixture of moringa can increase calcium and phosphorus levels in the ration as well as increase the consumption and digestion of calcium and phosphorus. Dalle et al., (2024) argues that increasing the digestibility of a feed is due to increased feed consumption. Another factor that can affect digestibility is the preparation of food ingredients where the treatment of several types of food, for example, the length of storage. This is supported by Sumadi, (2017) stating that biological value is the main factor that determines the high digestibility of a feed material.

CONCLUSION

Berdasarkan hasil dan pembahasan maka dapat disimpulkan bahwa penggunaan campuran tepung daun kelor (Moringa oleifera) sampai level 10 -20% memberikan pengaruh yang sama terhadap konsumsi dan kecernaanCa dan P pada ternak babi grower.

Suggestion

1. It is recommended to farmers to use a mixture of moringa leaf flour (Moringa oleifera) up to 15% in the grower phase pig ration.
2. Further studies are needed to identify the maximum limit of the use of moringa leaf flour mixture (Moringa oleifera) in rations that exerts a significant influence on the consumption and digestibility of Ca and P in pig farmer phases.

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