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Effects of Fermented Banana Stem as Corn Substitutes on Performance and Protein Utilization in Growing-Finishing Pigs

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ABSTRACT

The objective of this study was to test banana stem silage as a substitute for corn on the performance and protein utilization rate of Duroc crosses pigs in the rearing phase. A total of 12 Duroc crosses pigs in the rearing phase with an average initial weight of 51.25 kg (KV = 7.02%). A completely randomized design (CRD) with 4 treatments and 3 replicates was used in this study. The treatments were T0: ration without a mixture of fermented banana stems (FBS), T1: ration with 5% FBS instead of cornmeal, T2: ration with 10% FBS instead of cornmeal, and T3: ration with 15% FBS instead of cornmeal. The variables measured were ration consumption, daily weight gain, ration utilization and protein utilization efficiency. The results showed that the use of FBS up to 15% (instead of 40% corn) had no effect on ration consumption, daily weight gain, ration utilization and protein utilization efficiency. Therefore, it can be concluded that banana stems can be used at 15% in the ration of Duroc crosses pigs in the rearing phase as a substitute for corn meal.

Keywords: banana stems fermentation; corn substitution; pig performance; protein efficiency.

INTRODUCTION

Commercial swine feeding still relies on corn as the main energy source and competes with human and poultry farming. Corn production in Indonesia is 963,183 tons/year and 685,081.00 tons/year in East Nusa Tenggara (NTT) [5], but is mainly used as food. The development of both small and large livestock farms requires a large amount of corn, so the demand for corn continues to increase as livestock numbers increase, leading to further increases in feed prices. To reduce the use of corn, agricultural by products from factory waste and food crop waste can be used. Food crop wastes that can be used as feed components include banana stems after harvest.

Indonesia produced 8,741,147 tons of bananas in 2021, of which 256,741 tons were produced by NTT [5], with banana stems as a by-product after the fruit is harvested. The percentage of fruits, leaves and banana stems in dry matter is 37%, 25% and 39%, respectively [44]. It is known that banana stems have a low crude protein content of 3.01%, a high crude fiber content of 29.40%, a crude fat content of 14.23% [34], dry matter of 8.00%, ash of 19.50%, crude protein of 1.01%, crude fiber of 19.50%, crude fat of 0.75%, and BETN of 59.24% [43], so they need to be processed to improve their quality [4]. Fermentation technology is a method to preserve agricultural waste by increasing digestibility and protein value of feed [49]. After fermentation, crude fiber content of banana stem decreased by 14.05% without decreasing BETN value [9], protein increased from 9.54-14.51%, and crude fiber decreased from 18.07% to 13.99%, which makes it a good pig feed [18].

The fermentation process can increase the content of reduced sugar and soluble protein by breaking down carbohydrate and protein components. Fermentation enhances the process of breaking down complex structures into simpler structures, making them easier to digest in the digestive tract [31]. Fermented banana stems can be used up to 30% in rabbit rations and provide good growth [33]. Feeding FBS is likely to be well consumed and digested by pigs, so they also grow well. Thus, FBS can reduce the use of corn and reduce feed costs. The digested protein diet reflects the amount of protein that can be used to increase the body weight of pigs, so the use of feed protein is more efficient.

RESEARCH MATERIALS AND METHODS

Animals and experimental cage

Twelve fattening pigs of the Duroc crosses breed, aged 3 to 5 months, with an average body weight of 51.25 kg (KV = 7.02%) were used as experimental animals. The pigs were housed in 12 individual pens provided with feed and drinking water.

Ration for research

The ration was prepared from corn meal, rice bran, KGP-709 concentrate, minerals, coconut oil and fermented banana stem as a substitute for corn.

The nutritional requirements of breeding pigs weighing 20-50 kg are 15-18% protein and 3160-3200 (Kcal/kg) metabolic energy [26].

Research Method

The method used in this research is an experiment or experimental method. The experimental design used was a complete randomized design (CRD). Which consisted of 4 treatments and 3 replicates, so there were 12 experimental units. The treatment rations tested were as follows: T0 (ration without a mixture of fermented banana stems (FBS), T1: ration with 5% FBS replacing corn, T2 (ration with 10% FBS replacing corn), and T3 (ration with 15% FBS replacing corn). The composition and nutrient content of the treatment rations are shown in Table 1.

TABLE 1: Composition and nutrient content of research rations

Feed ingredients	Treatment (%)			
	T0	T1	T2	T3
Cornstarch	37.00	32.00	27.00	22.00
FBS	0.00	5.00	10.00	15.00
KGP-709 concentrate	32.00	32.00	32.00	32.00
Mineral-10	0.50	0.50	0.50	0.50
Coconut oil	1.50	1.50	1.50	1.50
Rice bran	29.00	29.00	29.00	29.00
Total	100.00	100.00	100.00	100.00
Nutrient content				
GE (kkal/kg)	4315.31	4259.64	4285.36	4156.94
ME (kkal/kg)	3404.78	3360.86	3381.15	3279.83
BK (%)	92.15	95.60	96.14	95.95
Abu (%)	10.01	10.73	10.83	10.82
BO (%)	82.14	84.87	85.31	85.13
PK (%)	14.76	15.56	15.84	15.89
LK (%)	1.38	1.36	1.32	1.34
SK (%)	8.87	8.92	8.91	8.93
Ca (%)	1.61	1.62	1.64	1.65
P (%)	1.14	1.12	1.10	1.08

Note: Results of the analysis of the Laboratory of Soil Chemistry of the Faculty of Agriculture of the University of Nusacendana (2021). Energy is the result of the analysis of the Laboratory of Feed Nutrition of the Polytechnic of Agriculture (2021).

Preparation of banana stem fermentation

The preparation of banana stem fermentation refers to the research conducted by (Muhammad and Pello, 2016). The procedure for the preparation of fermented banana stem is as follows:

(a) The materials used are crushed banana stems with size ± 1-2 cm, weathered to reduce water content, 10% rice-bran, 2% sugar, 5 ml EM4/1 lt water.

(b) Preparation of banana stem fermentation: 1. banana stems were cut into small pieces, 2. water, sugar and EM4 were mixed until they were evenly distributed, 3. rice-bran was added until it was evenly distributed, and then the chopped banana stems were added to the container, 4. all the ingredients that were added to the container were mixed again until they were evenly distributed, 5. the container was then tightly closed, 6. the fermentation process lasted 2-3 days, after which the fermentation could be given to pigs.

The variables measured are:

(1) ration consumption: total ration consumption is the amount of ration administered minus the amount remaining for 24 hours [47].

(2) body weight gain: body weight gain is calculated by reducing the body weight at the end of weighing with the initial body weight per week divided by the number of days in the week, which gives the daily body weight gain (g/head/week) [47].

(3) ration conversion: ration conversion is calculated from total feed consumption divided by weight gain (F/G). Weekly ration consumption is calculated by dividing the amount of ration consumed each week by the additional body weight per week. The daily conversion rate is calculated by dividing the average daily ration consumption by the average daily body weight gain [37].

(4) protein utilization efficiency: protein utilization efficiency is the ratio between body weight gain and protein consumption [51].

(5) Protein utilization efficiency is calculated as weight gain divided by protein consumption.

Data analysis

The collected data were analyzed using analysis of variance (Anova) with completely randomized experimental design, while Duncan's multiple range test was used to test for treatment differences (SPSS-21).

RESULTS AND DISCUSSION

Effect of treatment on ration consumption

The highest average ration consumption was observed in T3 with 2800.83 g/head/day, followed by T2 with 2780.55 g/head/day, T1 with 2740.56 g/head/day and the lowest value in T0 with 2710.00 g/head/day (Table 2).

TABLE 2: Effects of treatment on research variables

Variables	Treatment (%)				SEM	P_{Value}
	T0	T1	T2	T3		
Ration consumption (g/head/day)	2710.00[a]	2740.56[a]	2780.55[a]	2800.83[a]	20.31	0.835
BW gain (g/head/day)	714.29[a]	730.16[a]	746.03[a]	753.97[a]	8.80	0.841
Ration conversion	3.8[a]	3.77[a]	3.74[a]	3.72[a]	0.02	0.968
Protein consumption (g/head/day)	368.60[a]	407.67[ab]	423.44[b]	431.70[b]	6.10	0.026
Efficiency of protein utilization	1.94[a]	1.79[a]	1.76[a]	1.75[a]	0.04	0.381

Note: The same superscripted letters after the numbers in the same row mean no significant difference (P>0.05).

Table 3 shows that 0%, 5%, 10% and 15% FBS in the ration as a substitute for corn was well consumed by the pigs. This indicates that the pigs preferred the taste of the banana stems. Consumption increased slightly as more FBS were used. This increase was due to the slightly reduced energy content of the treated ration. Kusnadi et al. (2014) found that feeds with lower energy content were consumed more, while feeds with higher energy content were consumed less. Statistical analysis showed that replacing corn meal with FBS had no significant effect (P>0.05) on ration consumption of growing and finishing pigs.

This result is consistent with the research findings reported by Mustopa et al. (2019) that the use of banana stems in feed as a mixture had no significant effect (P>0.05) on feed consumption. Banana plant waste such as banana stems, when fermented, can be consumed by monogastric animals including broiler chickens [14]. The consumption of the treatment ration is the same as that of the control ration, indicating that the fermented banana stems are preferred by the pigs, in other words, the palatability of the ration is the same. Factors affecting ration consumption include palatability, physical form of the ration, body size, sex, ambient temperature, and hormonal balance [40]. Banana stems were processed into small pieces and fermented so that they could be readily consumed by the pigs.

The process of fermentation of banana stems causes the nutrients in banana stems to be properly digested by pigs [1], so the nutrients in rations containing banana stems as a substitute for corn are adequate and balanced for pigs. The addition of fermented ingredients increases the biological, biochemical and palatability values so that pigs eating fermented banana stems can achieve good growth [7]. Fermented banana stems mixed with other feed ingredients to form a ration with adequate and balanced nutrient content will result in the same feed consumption in each treatment [32], and palatability is also an important factor determining high and low consumption rates [41], which includes the shape, odor, taste, color, and texture of the feed administered [36]. Banana stems can replace 20% corn-starch, reduce feed costs by 20%, and achieve the same quality of pig carcasses as the control [2].

Effect of treatment on body weight gain.

The highest average weight gain was observed in T3 with 753.97 g/head/day, followed by T2 with 746.03 g/head/day, T1 with 730.16 g/head/day and the lowest gain was observed in T0 with 714.29 g/head/day (Table 3). The range of weight gain of the results of the study is within the range of daily weight gain of pigs in the rearing phase recommended by NRC (1998), which is 450-750 g/head/day. The results of statistical analysis showed that treatment with FBS as a substitute for corn meal had no effect (P>0.05) on animal weight gain. In agreement with the results of Mena'u (2020), that the use of FBS had no effect on the daily weight gain of pigs in the rearing phase.

It is hypothesized that the lack of effect of the treatment on daily weight gain was due to the complex nutrients in the banana stems that were broken down by the fermentation process, allowing the nutrients to be more easily digested and absorbed and metabolized by the pig's digestive tract. If the nutrients that can be metabolized are adequate and balanced, growth will be good, as evidenced by weight gain of the cattle [50]. Dietary fiber in banana stems can be improved in biological value after fermentation by breaking down crude fiber components such as lignin and cellulose and increasing protein content [10]. According to Silalahi et al. (2012), the level of animal weight gain determines the growth rate, which is strongly influenced by the amount of ration consumed. Good metabolism increases the absorption of nutrients and thus affects growth and body weight. Digestibility and absorption of nutrients in the body follow feed intake, so body size increases or vice versa. FBS can be well digested and absorbed, resulting in better growth, carcass and meat quality (8).

Body weight gain of fattening pigs in this study was not significantly different from the control, indicating that carbohydrate content and other nutrients can be utilized by fattening pigs up to 15%. This result is consistent with the findings of Thiet et al. (2022) in male pigs that administration of <20% FBS can increase body weight gain, while >20% can decrease body weight gain. This is in contrast to the results of Arjin et al. (2021), which indicated that FBS can be used up to 50% when mixed with concentrates (a mixture of different feed ingredients), resulting in the same weight gain in pigs as with banana stems without fermentation. In broilers, the use of FBS resulted in the best weight gains up to 10% [28]. Treated banana stems could be used up to 20% in pig feed mixtures [6]. These results indicate that banana stems can be consumed to some extent, depending on the components of the mixture with other feed ingredients and processing, so that the nutrients can be absorbed and metabolized for meat formation, as shown by body weight gain. Sinaga and Martini (2010) argue that the form and accumulation of consumption, digestibility and absorption of nutrients in the body of animals is reflected in the weight gain of animals.

Effects of treatment on ration utilization

Ration utilization is a way to evaluate animal performance. It is the ratio between the amount of feed consumed and the weight gain of a unit. A low ration utilization indicates that the pig is using the feed more efficiently [37]. The lowest ration utilization value was found at T3 with 3.72, followed by T2: 3.74, T1: 3.77 and the highest at T0 with 3.81. The results of statistical analysis showed that replacing cornmeal with FBS had no effect on ration utilization (P>0.05). The treatment did not affect ration utilization because the nutrient content, especially crude protein, metabolic energy, ration consumption rate and weight gain of the experimental pigs were almost the same.

This statement is supported by Heryfianto et al. (2015), according to which ration utilization, which is not different or almost the same in pigs, is strongly influenced by nutrient content, especially crude protein, metabolic energy and the level of ration consumption and body weight gain, which are relatively the same.

Ullo et al. (2020) reported that ration utilization is influenced by ration quality and weight gain. The better the quality of the ration consumed, the higher the weight gain and the more efficient the utilization of the ration. Another factor that affects the value of ration utilization is the level of digestibility, absorption and conversion of feed nutrients for animal growth [27]. The value of a ration is largely determined by the amount of consumption, body weight gain, and ration conversion, with ration conversion describing the amount of ration for cattle growth. The smaller the ration consumption value, the more efficient the cattle are at converting forage to meat. The ration conversion value determined in this study ranged from 3.72 to 3.81, which is higher than the expected ration conversion value in swine production according to NRC (1998), which is 3.25.

The crude fiber content of the ration determines the digestibility of the ration; low nutrient digestibility results in less than maximum weight gain of the animals. The crude fiber in banana stems can be digested by pigs because it has been crushed and then fermented with additional molasses/sugar so that the protein content is 6%, but it is not sufficient when fed alone to pigs; it must be mixed with other feed ingredients to provide the needed nutrients [29]. Fermented banana stems can be used as a substitute for energy sources such as corn and rice bran. The use of FBS mixed with taro stems in a 50:50 ratio can be as high as 30-40% and improve ration utilization in ducks [46]. Ration utilization is also influenced by the balance of amino acids included in animal rations [3].

Effects of treatment on protein utilization efficiency

The efficiency of protein utilization ranged from 1.76 to 1.94. The highest value was found in T0 treated animals with 1.94, followed by T1 and T2 treated animals with 1.79 and 1.76, respectively. The lowest energy consumption in T3 treatment was only 1.75. This result is lower than the results reported by Suryani and Aryanta (2020) that the efficiency of protein utilization in pigs consuming diets containing tamulawak meal was 1.78-1.22. High quality protein results in weight gain per unit of protein consumed [15]. Protein utilization efficiency indicates the amount of protein that can be converted to meat in the form of body weight gain [42]. The lower the amount of protein in the ration, the lower the growth, even if the energy in the ration is sufficient [12].

The results of statistical analysis showed that the treatment of substituting corn meal with FBS had no effect ($P>0.05$) on the protein utilization efficiency of Duroc pigs in the rearing phase. Protein utilization efficiency is influenced by two factors, namely protein consumption and body weight gain [22]. Iqbal et al. (2012) found that the lack of effect of protein consumption on growth was due to the fact that weight gain results from endogenous protein synthesis from consumed protein. Adequate protein intake alone will not guarantee rapid growth if energy concentration is inadequate; therefore, feed energy is very important [30]. In this study, it was found that the energy of FBS can replace the energy of corn by up to 40%.

The daily weight gain, which is not significant, can be interpreted to mean that the experimental animals consuming FBS are able to contribute sufficient amino acids and energy for daily weight gain, so that the weight gain is equivalent to the control ration. The higher protein content in the ration according to Sari et al. (2014) may indicate that the lower protein balance results in a low protein efficiency value (REP). The protein efficiency quotient is used to test the effectiveness of the ration protein. The use of FBS is well consumed, good growth, so it can reduce animal feed costs [53].

CONCLUSION

The conclusion of this study is that FBS can be used up to 15% (instead of 40% corn) without reducing consumption, body weight gain, ration utilization, and protein utilization efficiency in finishing pigs. Further research is needed to increase the use of banana stems in pig rasion.

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