

# Effect of Fermented Kepok Banana Corm Inclusion in the Diet on the Nutrient Digestibility and Mineral Ca and P Retention of Growing Pigs

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## Abstract

Sixteen crossbred growing pigs Duroc x Landrace, (10 weeks of age; initial body weight  $27 \pm 3.92$  kg) were allotted into four treatments in a randomized block design to evaluate the effects of inclusion of fermented kepok banana corm (FKBC) in the diet on the nutrient digestibility and mineral ca and p retention of growing pigs. There were four treatments diets offered: basal diets without FKBC (R0); basal diets + 7

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**Index terms**— corm, fermented, nutrient digestibility, mineral retention, growing pig.

## 1 Introduction

ig production in East Nusa Tenggara (ENT) Province, Indonesia is not only to fulfil meat demands, it also uses as savings, as social status and for religious ceremonies, respectively (Anonymous, 2017). The ENT pig population is estimated at  $\pm 1.70$  million (Anonymous, 2014), with  $\pm 85\%$  being owned by smallholder farmers (ACIAR, 2010). Pig demand in ENT was 1,134,552 animals per year and pork are a critical source of protein for domestic consumption where about 90% of the population of 5 million are non-Muslim and considered as pork eaters (Anonymous, 2017). However, pig production in this area is still low due to the insufficient of feed both quantity and quality (Anonymous, 2010). In addition, most of raw materials used in the feed industry such as corn and wheat are imported, and consequently resulting in the increase of cost production ??Dwyanto and Priyanti, 2009). The utilization of local feed from agricultural by products, on the other hand, are less desirable due to its low nutrients quality. Alternatively, processing such products that locally available through fermentation by utilizing yeast (*Saccharomyces cerevisiae*) and fungus (*Aspergillus niger*) prior to offered to animal as source of feed is necessarily important.

Kepok banana corm (*Musa paradisiaca*) or locally known as fried banana (plantain banana) is usually left in the farm after harvesting the banana fruits and it classified as waste, with its potential production about 40% (Emaga et al., 2011). The kepok banana corm utilization as feed sources for livestock, however, is still constrained by the presence of high crude fiber, complex carbohydrates and antinutrition. It has been reported that the starch composed of amylose and amylopectin, which would be hard to be digested by digestive enzymes ??English et al., 2007). Therefore, complex molecules of starch of kepok banana corm is expected to reduce, through fermentation since yeast (*Saccharomyces cerevisiae*) and fungus (*Aspergillus niger*) contained some enzymes that can broke down the hard part of starch. Previous studies reported that yeast (*Saccharomyces cerevisiae*) contained ?-amilase, glukamilase, selulase, sakrosidase dan lipase (Aiyer, 2005; Winarno, (Sembiring et al., 2017). However, there is limited information regarding the utilization of yeast and fungus in kepok banana corm fermentation in ENT province, Indonesia. Therefore, the present study aimed to evaluate the kepok banana corm fermented with yeast and fungus on grower pig nutrient digestibility and mineral Ca and P retention. The hypothesis was that the II.

## 2 Materials and Methods

### 3 a) Animals, experimental design and feeding management

The study was conducted in Noelbaki Village, Kupang-ENT Province, the village located at distance of  $\pm 25$  km to the capital of the ENT Province -Kupang, with altitude of  $\pm 100$  m. Sixteen crossbred growing pigs Duroc x Landrace, (10 weeks of age; initial body weight  $27 \pm 3.92$  kg), which were obtained from the local farm nearby Kupang city were used. The animals were randomly allotted into one of the four treatments in a randomized block design ( $n = 4$  in each treatment groups). The treatments were consisted of R0: basal feed without FKBC; R1: feed + 7% FKBC; R2: feed + 14% FKBC and R3: feed + 21% FKBC. Feed and water were offered ad libitum throughout the course of experiment. The animals were offered feed at three times (08.00, 12.00 and 17.00 o'clock) daily to ensure ad libitum intakes. Water was provided separately in the bucket.

### 4 b) Banana corm processing and fermentation

Fresh kepok banana corms, were obtained from local farmers in the district of Kupang, ENT-Indonesia. The microbial yeast (*Saccharomyces cerevisiae*) used had  $1.25 \times 10^{13}$  CFU/g and *Aspergillus Niger* had  $1.03 \times 10^{12}$  CFU/g, as determined by the Laboratory of Microbiology, Faculty of Veterinary Medicine, Nusa Cendana University (2015). Kepok banana corms fermentation: Fresh banana corms were sliced from the peel, cut and sun dried for 3 days and ground into flour through a 2 mm screen. Steamed kepok banana corm flour (substrate) was inoculated with the liquid culture at 10% w/v, as recommended by Azizah et al. (2012). The inoculated substrates were enclosed within sealed polybags (2 kg capacity) and fermented under aerobic conditions. The fermentation product was inactivated by drying at 60 °C for 24 h, as described by Ozturk et al. (2009) and Jenses et al.

(2013) with modifications, and then stored in sterile plastic bags at 4°C until analysis.

The composition of the feeds used in the present experiment were locally available in this area and commonly used by pig farmers such as corn flour, concentrate, rice bran, fish meal, salt and pigmix. Regarding the present study, corn and rice bran were used as a source of energy and fish meal as a source of protein. The nutrient content of feed used is presented in Table 1. The banana corm used in the present study was a fermentation product using a combination of yeast and mold. The treated feeds tested on pigs were formulated with the composition and nutrient content as in Table 2.

### 5 \*Determined values from Table 1 c) Data collection and measurement

The measurement of feed consumption included intake of dry matter (DM), organic matter (OM), Crude protein (CP) and energy were calculated by subtracting the daily refusal weight from the weight of the feed offered in the previous day. The digestibility of DM, OM, CP and energy were calculated as the difference between the amount of feed eaten and the amount voided in the faeces. Body weight gain of the pigs were obtained by weighed the animal every week or at the commencement of the study and the end of the study and feed conversion was calculated by deviding the daily intake of nutrients from the body weight gain of the pigs. Retention Mineral Ca and P were calculated by subtracting the daily refusal weight of mineral from the weight of the mineral feed offered in the previous day.

### 6 d) Statistical analysis

Data were analysed by analysis of variance (ANOVA) with treatment as the sole source of variation in the model. The ANOVA was performed using the IBM SPSS statistics for windows, version 22. Duncan multiple range test was also performed where the level of significant was set at  $P < 0.05$ .

## 7 III.

## 8 Results and Discussion

### 9 a) Chemical composition of the experimental diets

The kepok banana corm was chosen in the present study as an alternative feed supplementation to pigs due to its potential production during harvesting seasons but low utilisation particularly in ENT Province, Indonesia where the quantity and quality of feed is mainly constrained on pig production. The diets contained FKBC in the feed composition contain crude protein as high as 21.00%, which indicates high quality feed for growing pigs. The crude protein and energy concentrations are suited and slightly above the needs of grower pigs (Table 3) based on the recommendations of NRC (1998). Mineral P in feed from vegetable was generally low and almost insufficient to meet the needs of animals (Anselme, 2006). Minerals content of the diets used in the study are still as recommended needs for growing pigs.

The FKBC used in the diet test contained DM and OM of  $89.35 \pm 1.06$  and  $86.36 \pm 1.12\%$ , respectively. The crude protein content and crude fat were 4.40 and 1.32%. The content of crude fibre, NDF and energy were

96 17.51±0.99 and 41.23±1.12% and 3511±48.29 Kcal /kg respectively. The content of starch, resistant starch and  
97 total sugar were 35.54±8.43, 25.91±6.85 and 4.11±2.54 g/100g, respectively (Laboratory of the Department of  
98 Food Science and Technology, FTP-IPB-Bogor, Indonesia, 2015). Proximate analysis results of the diets was  
99 shown in Table 3. Dry matter intake of pigs fed the control diets were significantly higher than those fed the test  
100 diets ( $P < 0.05$ ; Table 4). The DM intake in this study is consistent with results of previous studies (Cloutier  
101 et al., 2015) using growing pigs with body weight of 25-50 kg, given a diet containing the amino acid lysine as  
102 a supplement, proved that intake of dry matter was 1840 g/day and the mean body weight gain of 802 g/day.  
103 The pig intake and growth can be affected by types of feed used and also influenced by different individual pigs.  
104 Mwesigwa et al., (2013) stated that feed sources helped influence feed intake. Total feed intake can also be  
105 influenced by the concentration of energy, palatability, nutritional content, breed and growth rate (Tillman et al,  
106 1989;Kyriazakis, 1994;Ngoc et al., 2013).

107 Organic matter intake tends to decline with increasing levels of FKBC in the diet. However, there were no  
108 significant difference between the four treatments ( $P > 0.05$ ) on OM intake (Table 4). This is due to the energy  
109 content in the feed is relatively same. Results of previous studies in pigs fed diets containing wheat bran can  
110 increase the intake of OM (protein and energy) compared to those containing feed mixed with corn bran and  
111 corn seeds (Mwesigwa et al., 2013). This result implies energy sources may influenced the OM intake figures of  
112 pigs.

113 Intake value in the study tends to decrease was because of high starch content in the diet which is still  
114 difficult to be digested by the digestive tract of growing pigs. The starch in the FKBC diets is still wrapped by  
115 polysaccharides.

116 The DM and OM digestibility tended to decrease at inclusion level of FKBC of 21%. Diet containing 7%  
117 FKBC (R1) was not significantly ( $P > 0.05$ ) reduced digestibility of either DM or OM compared with the control  
118 diet (R0). Feeding growing pigs with 7% FKBC in the diet (R1), however had higher values of DM and OM  
119 digestibility than the other treatments.

120 DM and OM digestibility were not significantly different ( $P > 0.05$ ) among treatments R0 compared to R1 and  
121 between treatment R2 to R3 (Table 4). This finding indicates increasing the level using of the FKBC from 14  
122 up to 21% has not been significantly reduced digestibility of DM and OM. This results are in line with Hanson  
123 et al., (2012) states that utilization of available energy and other nutrients may increase the production of feces  
124 and excretion of nutrients.

125 In this study, DM and OM digestibility tended to decrease indicated that high content of crude fiber and starch  
126 in FKBC resulted in duration of component digesta in the digestive tract be short (Ngoc et al., 2013). Since  
127 polysaccharide consisting of high starches and resistant starch in the feeds, it will difficult to digest (Englyst et  
128 al., 2007;Cummings and Stephen, 2007). The ability of the digestive tract to digest and absorb carbohydrates  
129 (polysaccharide) is influenced by the degree of polymerization, starches physical shape, size and structure of the  
130 constituent starch granules (Bijttebier et al., 2008).

131 Digestibility of feed containing high starch was also affected by balancing level of amylose: amylopectin of the  
132 starch, the higher the amylose content resulted in the lower the digestibility (Yin et al., 2010), the consequence is  
133 the value of the glycemic index increase and occur insulin response (Jun et al., 2010 ). Intake of CP and energy  
134 tended to decrease with increase level of FKBC inclusion. Duncan test on intake of CP and energy indicated  
135 that pigs fed the control diets had significantly higher compared to the rest of treatment diets ( $P < 0.05$ ; Table  
136 5). CP digestibility decreases was also due to feed composition, nutrient levels and the possibility of containing  
137 protein inhibitors, tannin and saponin. Levels of tannin and saponin in FKBC used in the feed composition were  
138 915.98 and 360 mg/100g. Tannins in feeds, especially high condensed tannin in nonruminant feeds can lead to  
139 be less digest and absorb, less palatable due to bitter taste and the protein bond (Huisman, 1989;Lipsa et al.,  
140 2012) and also due to bind starch and resistant starch bond (Zeeman et al., 2010).

141 The study showed that using FKBC up to the level of 21% significantly decreased both intake and digestibility  
142 of energy. High starch content in FKBC of 350.50 g/kg, resulted in decreasing the energy digestibility of grower  
143 pigs. June et al., (2010) stated that starch as a source of energy has low digestibility especially when a proportion  
144 of amylose: amylopectin is wide. Decomposition of the starch in the digestive tract becomes difficult to digest if  
145 containing high amylopectin (Carre, 2004).

## 146 **10 d) Effect of treatment on pig performances**

147 The present study noted that feed intake of pigs fed R3 diet tended to decrease (Table 6). In other word, the  
148 higher the level of FKBC, the lower the feed intake. It was notable that the animal offered R3 diets had the  
149 lowest average daily gain (ADG) compared to those fed the control diets. Pigs given feed containing 21% FKBC  
150 (R3) tend to consume less feed and less average daily gain. The intake of growing pig was influenced by individual  
151 animal, age and environment (Reeds et al., 1993), and affected by the concentration of energy (Kyriazakis, 1994),  
152 palatability, nutrient content, breeds and the rate of growth (Ngoc et al., 2013). Feed with high fibers can cause  
153 feed conversion increased as a result of duration of digesta in the digestive tract become shorter (Ngoc et al.,  
154 2013).

155 The average value of feed conversion showed no differences ( $P > 0.05$ ) among four diets. This means that  
156 the level of 21% FKBC can be administered to growing pigs without lowering the feed conversion. The average  
157 feed conversion values obtained are relatively similar between the treatment was due to the nutrient content of

158 feed almost the same (Table 3). Differences in feed conversion rate according to Rideout et al., (2008) is closely  
 159 connected with the process of fermentation in the intestines especially on high starch and resistant starch feeds.  
 160 Individual animals can also affect the feed conversion (Reeds et al., 1993). Feed with high crude fibre can cause  
 161 feed conversion increased (Ngoc et al., 2013).

## 11 e) Mineral Intake and Retention of Ca and P in the growing Pigs

164 Mineral intake of Ca and P found tends to decrease with increasing the levels of FKBC inclusion, as shown in  
 165 Table 7. Mineral intake of Ca and P decreased significantly ( $P < 0.05$ ) between the control diet and the rest. The  
 166 highest value was achieved in the control diet (R0) and followed by R1, R2 and R3 diets respectively. Duncan's  
 167 test show the average value of mineral Ca and P intake were no significant difference ( $P > 0.05$ ) between R2 and  
 168 R3 diet. Increasing the level of FKBC from 14 to 21% does not significantly reduced mineral Ca and P intake.  
 169 This presumably due to the mineral content in the FKBC was low.

170 Mineral Ca retention in pigs fed R0 (control) showed highly significant ( $P < 0.01$ ) compared with R2 diet,  
 171 whereas the Ca retention between diet R1, R2 and R3 were significant difference ( $P < 0.05$ ). The achievement in  
 172 study was in line with Rideout et al., (2008) stated that source of starch may influence digestibility of mineral  
 173 Ca and P in growing pigs at 30 kg body weight. Mineral Ca absorption was affected by the balance of Ca and P  
 174 in the diet (Tillman et al., 1989;Whittemore, 1993).

175 Mineral P retention was found highly significant ( $P < 0.01$ ) between control diet (R0) compare with R2 and  
 176 R3 diets. Minerals retention of Ca and P at FKBC inclusion up to 21% was decreased due to high levels of starch  
 177 and resistant starch content in the FKBC. Previous studies using corn and potato in diet at level of 2 Year 2020

## 12 Performance variables

179 Treatment diets - ?? ————— 10% fed in grower pig with body  
 180 weight of 30 kg was found significantly reduced the digestibility of crude protein and reduces the retention of  
 181 mineral Ca and P (Rideout et al., 2008). This study indicated that using diets containing high content of resistant  
 182 starch has a negative effect on mineral retention of Ca and P in grower pigs.

## 13 IV. Conclusions and Recommendations a) Conclusion

184 The inclusion of fermented kepok banana corm at the level of 7% in the diet increased the digestibility in vivo  
 185 of dry matter from 65.05 to 66.57 (2.3%) and organic matter from 68.95 to 70.48 (2.2%). Inclusion of fermented  
 186 product up to 21% was not reduce the performance of grower pigs. It can be recommended banana corm fermented  
 product can be applied as feeds at the level of 21% in grower pigs diet without retarded the intake and growth.

1

Feeds sources	Nutrient content	
	Crude Protein (%)	Gross energy (Kcal/kg)
Corn*	8.50	4426
Concentrate**	37.00	3769
Fish meal*	62.90	3770
Rice bran***	13.10	4650
FKBC****	4.40	3511

[Note: \*) Analysis of Feed Chemicals Laboratory, Faculty of Animal Science, Nusa Cendana University, 2014.  
 \*\*) Commercial Feed Concentrate for Pig. \*\*\*) Robles and Ewan, 1982. \*\*\*\*) FKBC = The fermented kepok  
 banana corm, Analysis of Livestock Breeding Center, Bogor, 2015.]

Figure 1: Table 1 :

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<sup>1</sup>Effect of Fermented Kepok Banana Corm Inclusion in the Diet on the Nutrient Digestibility and MineralCa and P Retention of Growing Pigs

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**2**

Feed sources	Diet			
	R0	R1	R2	R3
Corn meal (%)	48.00	47.00	46.50	45.50
Concentrate (%)	17.50	18.00	18.00	18.50
Fish meal (%)	12.00	12.50	13.00	13.50
Rice bran (%)	21.00	14.00	7.00	-
FKBC (%)	-	7.0	14.0	21.00
Pigmix (%)	1.00	1.00	1.00	1.00
Salt (%)	0.50	0.50	0.50	0.50
Total	100	100	100	100
Nutrient composition				
Gross energy (Kkal/kg)	4068	3985	3950	3925
Crude protein (%)	20.85	20.65	20.33	20.13

Figure 2: Table 2 :

**3**

Composition	Diet			
	R0	R1	R2	R3
Dry matter (%)	92.07	90.92	89.61	90.54
Organic matter (%)	89.02	88.90	87.48	84.88
Crude protein (%)	22.79	22.27	22.73	21.00
Crude fat (%)	6.50	5.32	5.98	5.45
Crude fibre (%)	5.39	5.52	5.82	6.04
CHO (%)	59.73	62.70	60.90	64.09
NFE (%)	54.34	57.18	55.08	58.05
Gross energy (Kcal/kg)	4.303	4.299	4.305	4.294
Ca (%)	0.95	0.81	0.79	0.70
P (%)	0.53	0.51	0.50	0.50

Analysis of feed Chemical Laboratory, Faculty of Animal Science, Nusa Cendana University (2015). CHO = Nitrogen Free Extract

b) Intake and digestibility of dry matter and organic matter

Figure 3: Table 3 :

4

Variables	Treatment diets				Anova P val- ues
	R0	R1	R2	R3	
DM intake	1870,99 ± 37,62 c	1654,70 ± 28,92 b	610,07 ± 47,93 a	1610,07 ± 42,95 a	0.718
OM intake	1665,19 ± 33,48 c	1595,32 ± 26,11 b	1482,77 ± 42,95 a	1457,75 ± 54,95 a	0.892
DM digestibility	65,05 ± 5,45 bc	66,57 ± 6,34 c	60,90 ± 1,50 ab	57,21 ± 2,64 a	0.010
OM digestibility	68,95 ± 4,72 bc	70,48 ± 6,34 c	65,21 ± 1,35 ab	62,04 ± 2,64 a	0.013

a,b,c, values within a row with different superscripts differ, P < 0.05; n = 4 pigs/group  
 c) Intake and digestibility of crude protein and energy

Figure 4: Table 4 :

5

Variables	Treatment diets				Anova P values
	R0	R1	R2	R3	
CP intake	426,30 ± 10.89 b	393.48 ± 12.53 a	376.11 ± 6.44 a	338.11 ± 42.95 a	0.979
Energy intake	8049.49 ± 161.89 c	7596.96 ± 124.36 b	7596.92 ± 124.36 b	7125.05 ± 256.39 a	0.908
CP digestibility	83.74 ± bc	66,57 ± 6,34 c	60,90 ± 1,50 ab	57,21 ± 2,64 a	0.810
Energy digestibility	68,95 ± 4,72 bc	70,48 ± 6,34 c	65,21 ± 1,35 ab	62,04 ± 2,64 a	0.724

[Note: a,b,c, values within a row with different superscripts differ, P < 0.05; n = 4 pigs/group]

Figure 5: Table 5 :

6

a,b, values within a row with different superscripts differ, P < 0.05; n = 4 pigs/group

Figure 6: Table 6 :

7

Variables	Treatment diets				Anov P value
	R0	R1	R2	R3	
Ca intake	17,82±0,35 d	14,32±0,23 c	13,20±0,38 b	11,28±0,41 a	0.989
P intake	9,91±0,19 d	9,08±0,14 b	8,35±0,24 a	8,06±0,29 a	0.949
Ca retention	15,08±1,18 d	11,87±0,86 c	10,77±0,78 b	8,59±0,75 a	0.978
P retention	8,20±0,57 c	7,49±0,49 b	6,66±0,30 a	6,30±0,17 a	0.932

a,b,c,d values within a row with different superscripts differ, P < 0.05; n = 4 pigs/group

Figure 7: Table 7 :



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