MEAT QUALITY OF PORK FED DIETS WITH DIFFERENT LEVELS OF PALM KERNEL MEAL AS ALTERNATIVE SOURCES OF CORN

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Abstract –The objective of this study was to evaluate the different levels of palm kernel meal (PKM) on pork quality as an alternative material for corn. A total of 90 crossbred growing pigs ([Yorkshire × Landrace] × Duroc, average body weight 110.8 kg) were allotted to five treatments in a randomized block design. The treatments were 0, 4, 8, 12, or 16% of PKM in each treatment diet (ME=3295 kcal/kg) instead of corn. In fatty acid composition of pork loin obtained from the experiment, C16:0 and total saturated fatty acids were increased by the levels of PKM were increased. There were no significant differences in TBARS value among treatments during 7 days of storage. However, the hardness decreased by levels of PKM increased at day 7. In sensory evaluation, there were no differences found by treatments. In conclusion, feeding PKM for pig as an alternative energy source of corn up to 16% had no adverse effect on pork quality.

Key Words – Alternative carbohydrate source, Growing pig, Pork loin

I. INTRODUCTION

Corn is the most common energy source in pig diets. However, the price of corn has been increased rapidly due to large demand for bio-fuel [1]. In pig production, the feed cost occupied large portion from 65% to 75%. Therfore, there is a great need to replace corn with alternative carbohydrate sources in the pig diets [2].

Palm kernel meal (PKM) is a by-product after palm oil extraction. PKM is aflatoxin free, palatable and has considerable potential as a carbohydrate and protein source. There is an economical benefit to use the PKM in livestock diets due to its cost effectiveness, compared to conventional feedstuffs [3].

Proper rate of PKM is invaluable in supplying nutritions to ruminants, poultry, and pigs [4]. Kim et al. [5] fed PKM to pigs as an alternative source of soybean meal and there were no differencese in carcass traits compared to pig fed corn. Rhule et al. [6] also reported that feed conversion ratio, slaughter weight, carcass length, and back fat thickness of grower-finisher pigs were not differentiated by feeding PKM or control.

Even though many aspects of PKM have been studied as pig diet, there were limited studies available for the effect of PKM on pork quality. Therefore, the aim of this study was to evaluate the pork quality from pig fed different levels of PKM as an alternative carbohydrate source.

II. MATERIALS AND METHODS

Experimental design and diet

A total of 90 crossbred growing pigs ([Yorkshire × Landrace] × Duroc) were allotted into each treatment by body weight and sex (half males and half females) in 3 replicates with 6 pigs per pen in a randomized complete block design. The treatments were different levels of PKM (0, 4, 8, 12, and 16%). All phases were adjusted the same ME, 3295 kcal/kg. When the pigs were raised at 12 weeks (average live weight, 110. 8 kg), the pigs were slaughtered in a commercial slaughterhouse and loin was obtained from the carcass.

Fatty acid composition

Lipid in the loin samples (5 g) were extracted with Folch's solution and fatty acid composition was measured by the method of Jung et al. [7].

Measurement of lipid oxidation

Lipid oxidation was measured by 2-thiobarbituric acid reactive substances value (TBARS) by the method of Jayasena et al. [8].

Hardness

Pork loin (3 cm in diameter, 1 cm in thickness, 30 g) was cooked to an internal temperature of 75℃. The cooked loin sample was compressed twice to 75% of their original height using a texture analyzer (LLOYD, Ametek Lloyd Instruments Ltd., West Sussex, UK) attached with a compression plate at a test speed of 2.00 mm/s and a trigger force of 1 N.

Sensory evaluation

The loin sample (1 × 3 × 0.5 cm) was cooked to an internal temperature of 75℃ using a pan. Ten panelists evaluated the samples for color, flavor, taste, tenderness, off-odor, and overall-acceptability by using a 9-point hedonic scale, where 9 indicates “extremely like” and 1 indicates “extremely dislike”. Off-odor was assessed as follows: 9, very strong; and 1, no off-odor. Sensory evaluation was conducted 3 different days at 3 PM using the loin stored for 3, 4, and 5 days in a refrigerator.

Statistical analysis

Statistical analysis was performed by a one-way analysis of variance (ANOVA), and significant differences were determined by the Duncan’s multiple comparison test at a confidence level of $P<0.05$.

III. RESULTS AND DISCUSSION

Fatty acid composition

It is generally accepted that the dietary change of fat source can easily affect the fatty acid composition in the meat of monogastric animal [9]. In current study, total saturated fatty acids and C16:0 (palmitic acid) of pork loin was increased by the increase of PKM supplementation to the pig diet (Table 1). Contrary to present study, when the pigs were added palm oil in diets high in palmitic (C16:0) and palmitoleic acid (C16:1) and fed 2.8% palm kernel oil high in lauric (C12:0), myristic (C14:0), and stearic acid (C18:0) in diets, C16 and C18 barely influenced by dietary concentrations, conversely, the concentration of C12:0 and C14:0 affected in adipose tissue and muscle. These results are explained that the C16 and C18 saturated and monounsaturated fatty acids are mostly synthesized in the animal internally, then it has limit when provide for dietary supplementation. Conversely, C12:0 and C14:0 are mainly supplied from diet [10].

Lipid oxidation

TBARS value of pork loin was the highest at day 3 and there were no differences among treatments during the storage (Table 2). It was suggested that TBARS losses at 7 day of storage were demonstrated that the malondialdehyde and other TBARS were metabolized by spoilage bacteria in pork. The increase in TBARS values were explained by the malondialdehyde and other TBARS are reacted amines produced by bacterial metabolism [11].

Table 1. Fatty acid composition (%) of pork fed diets with palm kernel meal at day 0

	Level of palm kernel meal (%)					SEM[4)]
	0	4	8	12	16	
C14:0	1.83	2.17	1.87	1.82	2.00	0.158
C16:0	22.26^{c}	22.47^{bc}	23.55^{ab}	24.08^{a}	23.98^{a}	0.392
C16:1	4.18	4.11	4.42	4.13	3.96	0.294
C18:0	11.48	11.47	11.25	11.51	11.41	0.342
C18:1n9c	38.26	38.14	38.02	38.58	38.47	0.505
C18:2n6c	12.66	12.41	12.27	11.69	11.83	0.495
C18:3n3	0.77	0.68	0.60	0.64	0.76	0.069
C18:3n6	0.36	0.35	0.31	0.35	0.34	0.046
C20:0	0.18	0.18	0.16	0.15	0.16	0.012
C20:1	0.83	0.86	0.74	0.66	0.63	0.070
C20:2	0.78	0.71	0.61	0.57	0.64	0.065
C20:3n6	1.12	1.14	0.96	0.98	1.02	0.092
C20:4n6	3.36	3.41	3.43	3.10	3.07	0.245
C22:0	0.82	0.80	0.81	0.78	0.81	0.102
C22:6n3	1.11	1.10	1.02	0.95	0.95	0.120
∑SFA[1)]	36.58^{c}	37.09^{bc}	37.63^{ab}	38.35^{a}	38.34^{a}	0.328
∑MUFA[2)]	43.26	43.11	43.17	43.37	43.05	0.481
∑PUFA[3)]	20.16	19.80	19.20	18.28	18.61	0.583

[1)]SFA: Saturated fatty acids
[2)]MUFA: Monounsaturated fatty acids
[3)]PUFA: Polyunsaturated fatty acids
[4)]Standard error of the means (n=20)
[a-c]Values with different letters within the same column differ significantly ($P<0.05$).

Hardness

Tenderness of pork is one of the most important attributes to consumers. The hardness was not changed by the level of PKM until 3 days of storage while it was decreased at day 7 when pigs were fed 4% and 16% PKM (Table 3). The fat content was important factor to enhance the tenderness of meat. Previous study demonstrated that fat content of pork loin negatively correlated with hardness. Considering the fact that there was no difference in fat content among the samples by different levels of PKM in the diet in the present study (data not shown), the difference in hardness must be come from the PKM supplementation in the diet [12].

Table 2. 2-thiobarbituric acid reactive substances (TBARS) values (mg malondialdehyde/kg meat) of pork fed diet with palm kernel meal

Level of palm kernel meal (%)	Storage day			SEM[1)]
	0	3	7	
0	0.33^{y}	0.50^{x}	0.34^{aby}	0.015
4	0.32^{y}	0.49^{x}	0.37^{ay}	0.024
8	0.30^{z}	0.48^{x}	0.34^{aby}	0.008
12	0.30^{y}	0.48^{x}	0.32^{aby}	0.008
16	0.30^{y}	0.49^{x}	0.30^{by}	0.015
SEM[2)]	0.014	0.014	0.017	

[1)]Standard error of the means (n=9), [2)](n=15)
[a,b]Values with different letters within the same column differ significantly (P<0.05).
[x-z]Different letters within the same row differ significantly (P< 0.05).

Sensory evaluation

There was no difference in color, tenderness, off-odor by different levels of PKM at 0 day (Table 4). The loins from pig fed 4% and 16% PKM showed higher flavor score than that of 8%. The sample of 16% PKM supplementation showed higher score in taste. Overall acceptability showed higher in the loin from pig fed 4% than that fed 12%. Even though the sensory result was fluctuated, general trend indicated no adverse sensory effect by supplementation of PKM for pig diet.

Table 3. Hardness of pork fed diets with palm kernel meal

Level of palm kernel meal (%)	Storage day			SEM[1)]
	0	3	7	
0	34.19	34.09	34.94^{a}	0.519
4	37.14^{x}	33.15^{xy}	29.98^{by}	1.693
8	33.20	30.38	31.60^{ab}	1.220
12	33.23	32.48	32.30^{ab}	1.284
16	34.37^{x}	32.98^{xy}	29.51^{by}	1.227
SEM[2)]	1.226	1.440	1.045	

[1)]Standard error of the means (n=9), [2)](n=15)
[a,b]Values with different letters within the same column differ significantly (P<0.05).
[x,y]Different letters within the same row differ significantly (P< 0.05).

Table 4. Sensory scores of pork fed diets with palm kernel meal at day 0

	Level of palm kernel meal (%)					SEM[1)]
	0	4	8	12	16	
Color	4.65	4.05	4.15	4.30	4.60	0.259
Flavor	4.55^{ab}	5.20^{a}	4.10^{b}	4.75^{ab}	5.10^{a}	0.257
Taste	5.05^{ab}	5.25^{ab}	4.55^{b}	4.55^{b}	5.30^{a}	0.230
Tenderness	5.45	4.90	5.05	5.40	5.10	0.290
Off-odor	2.45	2.75	1.95	2.55	2.75	0.380
Acceptability	4.95^{ab}	5.45^{a}	4.65^{ab}	4.60^{b}	5.20^{ab}	0.266

[1)]Standard error of the means (n=50),
[a,b]Values with different letters within the same row differ significantly (P<0.05).

IV. CONCLUSION

The present study indicates that the feeding PKM up to 16% in pig can be available to an alternative material of corn as there were no significant differences in quality of pork between control and treatments.

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REFERENCES:

1. De Gorter, H., Drabik, D., & Just, D. R. (2013). Biofuel policies and food grain commodity prices 2006-2012: all boom and no bust? Agbioforum 16: 1-13.
2. Wachenheim, C. J., Novak, P., DeVuyst, E. A., & Lambert, D. K. (2006). Demand estimation for agricultural processing coproducts. Great Plains Research 16: 85-94.
3. Sundu, B., Kumar, A., & Dingle, J. (2006). Palm kernel meal in broiler diets: effect on chicken performance and health. World's Poultry Science Journal 62: 316-325.
4. Alimon, A. R. (2005). The nutritive value of palm kernel cake for animal feed. Palm Oil Developments 40: 12-14.
5. Kim, B. G., Lee, J. H., Jung, H. J., Han, Y. K., Park, K. M., & Han, I. K. (2001). Effect of partial replacement of soybean meal with palm kernel meal and copra meal on growth performance,

nutrient digestibility and carcass characteristics of finishing pigs. Asian-Australasian Journal of Animal Science 14: 821-830.
6. Rhule, S. W. A. (1996). Growth rate and carcass characteristics of pigs fed on diets containing palm kernel cake. Animal Feed Science and Technology 61: 167-172.
7. Jung, S., Choe, J. H., Kim, B., Yun, H., Kruk, Z. A., & Jo, C. (2010). Effect of dietary mixture of gallic acid and linoleic acid on antioxidative potential and quality of breast meat from broilers. Meat Science 86: 520-526.
8. Jayasena, D. D., Kim, H. J., Yong, H. I., Park, S., Kim, K., Choe, W., & Jo, C. (2015). Flexible thin-layer dielectric barrier discharge plasma treatment of pork butt and beef loin: Effects on pathogen inactivation and meat-quality attributes. Food Microbiology 46: 51-57.
9. Larick, D. K., Turner, B. E., Schoenherr, W. D., Coffey, M. T., & Pilkington, D. H. (1992). Volatile compound content and fatty acid composition of pork as influenced by linoleic acid content of the diet. Journal of Animal Science 70: 1397-1403.
10. Wood, J. D., Enser, M., Fisher, A. V., Nute, G. R., Sheard, P. R., Richardson, R. I., Hughes, S. I., & Whittington, F. M. (2008). Fat deposition, fatty acid composition and meat quality: A review. Meat Science 78: 343-358.
11. Kim, J. K., Jo, C., Kim, H. J., Lee, K. H., Kim, Y. J., & Byun, M. W. (2004). Relationship of specific microbial growth and TBARS value in radiation-sterilized raw ground pork. Preventive Nutrition and Food Science 9: 312-316.
12. Cheng, Q., & Sun, D. W. (2005). Application of PLSR in correlating physical and chemical properties of pork ham with different cooling methods. Meat Science 70: 691-698.