Egypt. J. Vet. Sci. **Vol. 49,** No. 2 pp. 167-177 (2018)

Beneficial Effects of Non-Conventional Feedstuffs on Carcass Characteristics And Ileal Mucosal Morphology of Finisher Pigs

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THIS STUDY investigated differences in carcass characteristics and ileal mucosal morphology in pigs offered 4 isocaloric grower-finisher diets formulated using non-conventional feedstuffs from 99-180 days of age upon which barrows were slaughtered. The diets consisted of a basal maize-soybean meal diet, a 20% cold-pressed canola meal diet, 20% rice polishing diet and 20% rice bran diet. The 20% rice polishing diet resulted in a higher ($p \leq 0.05$) average daily gain compared to pigs on the basal diet. Rice polishing diet resulted in an increase in killing-out percent, 24.5% increase in loin eye area which implied better lean tissue deposition and a 19.3% decrease in villous height, and noted increases were significantly different ($p \leq 0.05$). The 20% rice bran diet resulted in a higher ($p \leq 0.05$) average daily gain compared to pigs on the basal diet and larger loin eye size ($p \leq 0.05$) implying better lean tissue deposition. Ileal villi were significantly longer ($p \leq 0.05$) in in pigs fed rice bran diet and was attributed to higher dietary fibre. The 20% Canola meal diet increased ($p \leq 0.05$) back-fat thickness and an increase ($p \leq 0.05$) in ileal crypt depth. The study concludes that high NDF rice bran has reduces backfat and increases gut surface area thereby improving utilisation of dietary fibre. Low protein non-conventional feedstuff in finisher pigs had beneficial effects on ileal epithilia. Further studies on the role of dietary lipids and glycosinolates commonly present in Canola meal on changes in intestinal epithelial morphology should be done.

Keywords: Non-convetional feedstuff, Backfat thickness, Gut epithilia, Loin eye.

Introduction

The cost of feeding accounts for up to 80% of the entire pig enterprise costs. As a result, pig farmers use non-conventional feedstuffs to minimise losses and improve sustainability of these enterprises. Previous studies [1,2,3] concluded that non-conventional feedstuffs are rich in some nutritional components and therefore could be beneficial as pig feed in tropical production systems. However, most non-conventional feedstuffs vary in their dietary composition and this often reflects on finished diets. Such differences may affect growth rates and carcass characteristics of finished pigs with implications on the market value of pork. Pig diets have been shown to induce significant changes in gut weight with obvious effects on killing out percent. Findings of several studies [4-7] concluded that an increase in dietary fibre results in an increase in gut length and weight which would reduce the killing out percentage. Pigs fed raw potato starch instead of corn starch over a long period significantly increased the weight of the stomach and large intestines thereby reducing the dressing percentage [8].

Pig diets have been reported to have significant effects on backfat thickness (BFT) where a study [8] reported a decrease in BFT when pigs were

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DOI: 10.21608/ejvs.2018.5040.1047

fed on raw potato starch. In the same study, there was also a decrease in the concentration of short chain fatty acids (SCFA) in the colon. The pattern of gut digestion of starch may affect BFT and growth performance of gilts [9]. Consumption of diets with a high amylose: amylopectin ratio decreased intramuscular fat content and increased loin eye area (LEA) through reduced hepatic lipogenesis [10]. One study [11] reported an inverse relationship between BFT and lean meat content. Resistant starch which escapes digestion in the upper small intestines may act as a potential prebiotic favouring butyrate production with a likelihood of less subcutaneous fat and more lean tissue deposition [12].

Intestinal gut morphology can be affected by a variety of factors. Raw potato starch was reported to increase intestinal mucosal thickness when compared to corn starch in pig diets [8]. Use of probiotics and prebiotics has also been associated with beneficial effects on intestinal mucosal morphology. One study showed that that using Enterococcus faecium culture, mannan-oligosaccharides and organic acids in pig diets resulted in increased jejunal villous height [13]. Low concentration of branched-chain fatty acids and lactic acid in the proximal colon was also associated with increased villous height and gut development [14]. Changes in the morphology of intestinal mucosa such as villous atrophy and increased crypt depth due to enterocyte proliferation are often associated with decrease in digestive and absorptive capacity of the gut and vice versa [15].

In spite of the wide usage of non-conventional feeds in pig diets, it is not clear how these diets affects the performance of pigs. The current study investigated the effects of using non-conventional feedstuffs in pig diets on carcass characteristics and changes in morphology of ileal epithelia which has an implication on food digestion and assimilation.

Materials and Methods

Experimental site

The experiment was conducted at Egerton University University Tatton Farm in Njoro, Kenya, located 0^0 22’ South and 35^0 55’ East and 2286 metres above sea level. The annual average rainfall is 1200mm while the mean temperatures over the experimental period varied between 18^0 and 23^0 Centigrade.

Experimental diets

The 4 isocaloric grower- finisher diets used in this study consisted of; (i) a maize-soybean meal diet, (basal) (ii) a diet containing 20% cold pressed canola meal to replace soybean meal as a protein source (CPCM diet) (iii) a diet containing 20% rice polishing to replace maize (RPL diet) and (iv) a diet containing 20% rice bran to replace maize (RBN diet) as shown in Table 1.

TABLE 1. Dietary composition of experimental diets in percentage

Feed Component (%)	Diet			
	Basal	**CPCM**	**RPL**	**RBN**
Maize (White)	65.60	59.80	49.10	47.30
Soybean meal	22.80	6.80	19.50	18.50
Fish meal	5.00	5.00	5.00	5.00
Canola meal	0.00	20.00	0.00	0.00
Rice polishing	0.00	0.00	20.00	0.00
Rice bran	0.00	0.00	0.00	20.00
Lysine	0.50	0.60	0.50	0.50
Methionine	0.40	0.30	0.40	0.40
Limestone	2.50	2.50	2.50	2.50
DCP	2.50	2.50	2.50	2.50
S/W Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Vegetable oil (Canola)	0.20	2.00	0.00	2.80
Total	100.00	100.0	100.0	100.0

Key: CPCM=cold pressed canola meal diet, RPL=rice polishing diet, RBN=rice bran diet, DCP=dicalcium phosphate, S/W=sow and weaner,Vitamin and mineral premix provided per kilogram of diet: 450 mg Fe; 400 mg Cu; 250 mg Zn; 150 mg Mn; 0.5 mg I; 0.25 mg Se; 8,000 IU vitamin A; 2,000 vitamin D3; 37.5 mg vitamin E; 0.925 mg vitamin K-3; 8.43 mg vitamin B2; 0.04 mg vitamin B12; 34.5 mg nicotinic acid; 26 mg pantothenic acid.

Management of experimental pigs

Experimental pigs with an average weight of 24.52 kg and 99 days of age were selected randomly to participate in this study where 2 barrows and 2 gilts were randomly assigned to each of the 4 diets. The pigs were housed in 4 pens each measuring 5 X 6 metres such that pigs on a similar diet were housed in one pen. The pens were equipped with drinking nozzles which served to provide water throughout the day. The feed troughs were sufficiently long to minimise the effects of pen dominance on feeding. Wide variation in temperature was kept minimal by housing the pigs in-door pens. Pen cleaning was done every morning to minimise accumulation of ammonia while floor disinfection was done weekly. Pigs were fed up to the age of 180 days at the rate of 3.5% of their body weight daily in 2 portions at a 6 hourly intervals. At the start of the experiment, water was provided using watering buckets to ensure that pigs that had not learned to drink from drinking nozzles had sufficient drinking water. Constant observation was done to ensure that pigs were free from any kind of distress. Regular observation of pigs for any signs of ill health was done to facilitate prompt treatment. The study lasted for 80 days.

Data collection

Proximate and detergent fibre analysis on experimental diets was done using the previously described procedures [16, 17] at Egerton University, Department of Animal Science, Nutrition laboratory. Pigs were weighed at the beginning of the experiment, days 120, 150 and 180 using a livestock weighing scale model 58SX (UmaTECH Scales; Tamil Nadu, India). All barrows (8) were slaughtered at 180 days of age to facilitate measurement of carcass characteristics. Killing-out percent (KO%) was computed as the hot carcass weight after evisceration and decapitation as a fraction of the pig live weight immediately before slaughter. Back fat thickness (BFT) was determined by measuring the thickness of the adipose tissue layer at 3 levels; at the first rib, the tenth rib and the first lumbar vertebrae. The measurement was done at a point 6 inches (approximately 14.6 centimetres) lateral from the dorsal spinous process as per the approach used previously [18]. Measurement was done by first tracing the back fat width on labeled transparent acetate paper using an indelible marker then measuring this width at an accuracy of 0.01mm. The loin eye was identified after making a clean cut perpendicularly across the long axis of the vertebral column at the junction of the 10^{th} and 11^{th} thoracic vertebrae so as to give the view of the transverse section of the *longissimus dorsi* muscle. The loin eye area was determined in triplicates by tracing the loin eye on acetate paper using an indelible marker and placing it on an area grid.

Following evisceration, 3 sections of the ileum measuring approximately 2 cm each were excised at a point approximately 10cm proximal to the ileo-caeco-colic junction and placed in labeled glass jars containing 10% formalin fixative. The samples were then delivered to the University of Nairobi, Veterinary Pathology Laboratory for preparation of histological sections permanently mounted on microscope slides using the procedures described previously [19]. Hematoxylin and eosin dye was used to stain the specimens. Microscopic examination was done at a magnification of 100 which allowed for measurement of intestinal villous height and crypt depth using the stage micrometer on the microscope platform. One slide with tissue section from each of the slaughtered pigs was selected for examination. On each slide, 2 optical views were randomly examined so that 2 villi with clear lamina propria were selected from each view for estimation of height in triplicates. This resulted in 12 measurements per pig and therefore 24 measurements for each of the 4 diets. The same procedure was followed in measurement of crypt depth.

Data analysis

Data analysis was done by computing analysis of variance using PROC ANOVA and PROC GLM commands of SAS systems [20] to compare diets, weight gain, carcass and morphological characteristics. Sex of pigs was used as a co-variate in PROC GLM procedures. To establish the normality of data, the PROC UNIVARIATE NORMAL PLOT command was applied. The p-value was set at 0.05. Non-normality was addressed by determining possible measurement and data entry errors and resulting outliers omitted during analysis.

Results

Comparison of composition of experimental diets

The mean value of ether extract (EE) in CPCM diet (48.2 ± 1.2 g/kg) was higher than that of the basal diet (16.1 ± 0.1 g/kg); $t = 26.19$, $p \leq 0.05$. The mean values of EE in RPL and RBN diets were also higher than that of the basal diet (45.7 ±

0.04 g/ kg, t = 201.15, $p \leq 0.05$ and 20.6 ± 0.5 g/ kg, t = 8.0, $p \leq 0.05$ respectively). The mean gross energy (GE) value of RPL diet was higher than that of the basal diet (4049 ± 19.55 kcal/kg versus 3811.57 kcal/kg, t = 12.18, $p \leq 0.05$). The mean value of dry matter (DM) of RBN diet was higher than that of the basal diet (92.64% versus 91.31%, t = 8.06, $p \leq 0.05$). The mean crude protein (CP) value of RBN diet was lower than that of the basal diet, (149.3 ± 3.3 g/kg versus 197.1 ± 11.5 g/kg, t = 3.98; $p \leq 0.05$). The mean neutral detergent fibre (NDF) for RBN diet (367.1 ± 1.24 g/kg) was 26% higher than that of the basal diet (29.06 ± 3.94 g/ kg). Based on the proximate and detergent fibre values, CPCM diet was a standard protein (CP ≥ 18%) high EE diet, RPL diet was a low protein (CP ≤ 16%), high EE diet while RBN diet was considered as low protein, high NDF diet.

Pig weights between ages 99 - 180 days

The mean value for initial weight of experimental pigs was 24.52 ± 1.71 kg. There was no difference in the mean weight of pigs between diets and sex (F =1.89, $p \leq 0.05$ and t = -0.55, $p \leq 0.05$ respectively). At 180 days, pigs fed RPL diet were heavier (66.06 ± 2.11 kg) than pigs offered the basal diet (53.99 ± 2.02 kg) (Table 2). The mean weights (at 180 days) of pigs offered CPCM diet (57.21 ± 2.09 kg) and RBN diet (61.42 ± 2.09) were not different (F = 6.3, $p \leq 0.05$) from the mean weight of pigs offered the basal diet. Computation of least square means showed that the overall mean ADG was 439.41 g/day.

The mean values of ADG for pigs fed on RPL diet (475.71 ±17.35 g/kg) and RBN diet (468.07 ± 17.19 g/kg) were higher (F = 4.77, $p \leq 0.05$) than that of pigs fed on the basal diet (398.44 ± 16.6 g/ kg). Sex of pigs was significant (F = 15.21, $p \leq 0.05$) in the model. The mean ADG for barrows (411.36 ± 29.62 g/day) was significantly lower (t = 2.98, $p \leq 0.05$) than that of gilts (467.47 ± 15.17 g/day).

Curve estimation for pig weight against age from 99 to 180 days showed that linear regression had the best fit for the 4 diets (Table 3).

TABLE 2. Results of GLM comparing pig weight and average daily weight gain between experimental diets from 99 - 180 days

Parameter	N	Model		Diet				Type III SS (F)	
		R^2	F	Basal	CPCM	RPL	RBN	Diet	Sex
Initial weight (kg)	16	0.34	1.43	22.11[a] (1.98)	23.59[a] (1.98)	28.29[a] (1.98)	24.1[a] (1.98)	1.79	0.35
Final weight (kg)	48	0.35	5.57**	53.99[a] (2.02)	57.21[ab] (2.09)	66.06[c] (2.11)	61.42[abc] (2.09)	6.3**	5.45**
ADG (g/day)	48	0.38	6.36**	398.44[a] (16.6)	418.79[ab] (17.19)	475.71[b] (17.35)	468.07[b] (17.19)	4.77**	15.21**

Key: CPCM=cold pressed canola meal, RPL=rice polishing, RBN=rice bran, SS=errors ADG=average daily weight gain, numbers in parenthesis indicate standard errors, superscripts indicate equality where letters are similar across rows.

TABLE 3. Linear regression with no constant of pig weight against age (between 99-180 days) for experimental diets

Diet	R^2	B coefficient	t-statistic
Basal diet	0.99	0.31	48.72
CPCM diet	0.99	0.32	26.38
RPL diet	0.99	0.37	33.76
RBN diet	0.99	0.34	32.86

Key: CPCM=cold pressed canola meal, RPL=rice polishing, RBN=rice bran.

Killing out percentage (KO %)

Pig diets explained 50.2% of variation in KO%. The overall mean KO% was 68.3%. The mean value of KO% for pigs offered RPL diet (71.05%) was higher ($F = 6.71$, $p \leq 0.05$) than that of pigs fed on the basal diet (66.89%). The mean values of KO% for pigs offered CPCM (68.2%) and RBN (67.06%) diets were not different ($F = 6.71$, $p \leq 0.05$) from that of pigs fed on the basal diet (Table 4).

Back- fat thickness

Pig diet explained 35.2% of variation in back-fat thickness (BFT). The mean BFT for pigs offered CPCM diet (15.77mm) was significantly higher ($F = 3.61$, $p \leq 0.05$) than that of pigs fed on the basal diet (9.48mm) (Table 4). The mean BFT for pigs offered RPL and RBN diets were not significantly different ($F = 3.61$, $p \leq 0.05$) from that of pigs offered the basal diet.

Loin eye area

The analysis of variance model was significant ($F = 9.63$, $p = 0.01$) and explained 59% of variation of the loin eye area (LEA). The LEA of pigs offered RBN diet (29.21cm^2) was significantly higher ($F = 9.63$, $p \leq 0.05$) than that of pigs fed on the basal diet (20.46cm^2). The LEA of pigs offered CPCM diet (24.11cm^2) and RPL diet (26.46cm^2) were not significantly different ($F = 9.63$, $p \leq 0.05$) from that of pigs fed on the basal diet (Table 4).

Villous height and crypt depth

An illustration of the measurements taken for villous height and crypt depth is shown on Figure 1. Pig diet explained 72.4% of variation in villous height (Table 5). The mean ileal villous height of pigs fed on RBN diet (307.71 ± 9.03µm) was significantly higher ($F = 13.23$, $p \leq 0.05$) than that of pigs fed on the basal diet (283.58 ± 8.61 µm). Pigs fed on RPL diet had a significantly lower ($F = 13.23$, $p \leq 0.05$) mean villous height (237.72 ± 7.63 µm) compared to that of pigs fed on the basal diet.

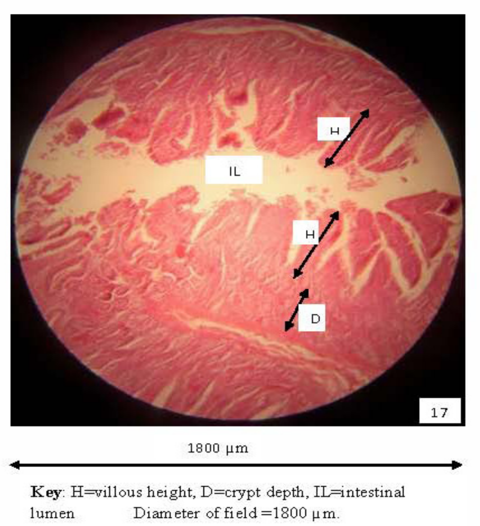

Fig. 1. An ileal section illustrating measurement of ileal villous height and crypt depth

TABLE 4. Results of Analysis of variance on carcass characteristics between experimental diets

Index	N	R^2	Diet				F
			Basal	CPCM	RPL	RBN	
KO%	24	50.2	66.89^b	68.2^{ab}	75.01^a	67.06^b	6.71**
BFT mm	24	35.2	9.48^a	15.77^b	13.68^{ab}	15.05^{ab}	3.61**
LEA cm^2	24	59.01	20.46^c	24.11^{bc}	26.46^{ab}	29.21^a	9.63**

Key: CPCM=cold pressed canola meal, RPL=rice polishing, RBN=rice bran, KO=killing out, BFT=back fat thickness, LEA=loin eye area, superscripts indicate equality where letters are similar across rows.

TABLE 5. GLM results of ileal villous height and crypt depth of pigs fed on 4 diets

Morphological feature	N	R^2	Diet				F
			Basal	CPCM	RPL	RBN	
Villous height in µm	96	72.4	283.58^a (8.61)	268.43^a (7.14)	237.72^b (7.63)	309.71^c (9.03)	13.23***
Crypt depth in µm	96	69.1	158.23^a (6.66)	192.58^b (6.66)	159.39^a (5.68)	175.4^{ab} (7.69)	6.19***

Key: CPCM=cold pressed canola meal, RPL=rice polishing, RBN=rice bran, numbers in parenthesis indicate standard errors, superscripts indicate equality where letters are similar across rows, µm=micrometers.

Pig diet explained 69.1% of the variation in crypt depth. The mean ileal crypt depth of pigs fed on CPCM diet (192.58 ± 6.66 μm) was significantly larger ($F = 6.19$, $p \leq 0.05$) than that of pigs fed on the basal diet (158.23 ± 6.66 μm). The mean ileal crypt depth of pigs fed on RPL (159.39 ± 5.68 μm) and RBN (175.4 ± 7.69 μm) diets were not significantly different($F = 6.19$, $p \leq 0.05$) from that of pigs fed on the basal diet.

Discussion

Pig growth between 99 - 180 days of age

This period was characterised by a linear growth pattern for all 4 diets which implied that tissue accretion was also linear in this phase of growth. Similar results were described by others [21,22] who showed that protein deposition increased linearly with increased energy intake until maximum protein deposition is reached, after which no further protein deposition occurs. Tissue accretion occurs such that the retained tissue is similar in amino acid composition as the proportion of dietary protein retained, known as the ideal protein [23]. However, in the current study, the plateau phase of the growth curve was not reached because the point of maximum protein (Pr_{max}) accretion is a function of a growth coefficient and genetically predetermined mature weight [24] which in this case was not reached by the end of the experimental period.

The findings of the study showed that finisher pig diets that were lower in protein were able to support good growth rates which can be explained by the fact that the diets were isocaloric. The interaction of ME and amino acids is critical in determining protein retention since limiting energy supply results in lower values of Pr_{max} [25, 26].

This finding corroborated the finding of [27] who associated higher daily gain in low protein and high fibre diets with a decreased incidence of scours associated with high levels of dietary protein. The faster growth in high NDF diets could also have been attributed to pig's ability to utilise dietary fibre more efficiently for energy production as they grow. This paradigm has been associated with an increase in the fibrolytic microbial population in the ileum, caecum and the large intestines [28-30]. Among the main products of lower gut (between the distal ileum to the rectum) fermentation in pigs are gases (such as hydrogen, carbon dioxide and hydrogen), lactic acid and short chain fatty acids (SCFA) such as butyric acid. SCFA are rapidly absorbed into the blood stream and contribute up to 30% of energy requirements of growing pigs [31-33].

Killing out percentage

This study showed that pigs with the highest live weight at slaughter and average daily gain also had the highest killing out percent. Among the factors that affect killing out percentage are breed, sex, diet, and environmental factors that affect growth such as type of housing, stocking density, ambient temperature and humidity. In the study however, these variables with the exception of diet were held constant. The finding of increased killing out percentage with increased live weight corresponds to findings of Wood *et al.* [34] which showed that the contribution of non-carcass components such as offals, omental fat and diaphragm to live weight of an animal decreased with an increase in live weight, thereby increasing killing out percent. Various studies [4-7] have shown that an increase in dietary fibre results in an increase in gut length and weight which would reduce the killing out percentage. However, this study did not establish a relationship between high fibre diet and a decrease in killing-out percentage but rather with higher live weight.

Back fat thickness

Higher levels of dietary lipids in were found to increase subcutaneous fat accretion in high protein diets. When dietary protein was low, higher dietary lipid levels did not increase fat accretion. This implies that in low protein diets (140 -150g/kg), increasing the concentration of ether extract to approximately 45g/kg could be useful in energy compensation without compromising back fat deposition compared to the basal diet. In the current study, preliminary findings showed that Canola meal used in pig diet had an ether extract concentration of 80.1 ± 3.9 g/kg owing to its rich content of mono and polyunsaturated fatty acids primarily 62% oleic acid, 22% linoleic acid and 10% linolenic acid [35] common in cold pressed vegetable oil seed meals. Therefore, cold pressed canola meal when incorporated in CPCM diet resulted in a higher amount of unsaturated fatty acids in the diet. Results of another study [36] also reported that diets high in unsaturated fatty acid resulted in more lipogenic activity in rats and pigs. Another study [37] reported that fat deposition on the carcass is a reflection of dietary fat present in feeds, such that inclusion of unsaturated fats in diets resulted in subcutaneous fat deposition while saturated fats such as tallow in pig diets resulted in increased intramuscular fat deposition. Inclusion of fats rich in unsaturated fatty acids in low protein diets could therefore be benefitial in reducing subcutaneous fat deposition while compensating for dietary energy.

Loin eye area

Low protein, high fibre diet is beneficial in increasing lean growth in pigs of 99 - 180 days as was the case with pigs offered RBN diet. Pigs offered the RPL diet which was low in protein and high in lipids also had a larger loin eye size than pigs offered the basal diet. Results of others [38] showed similar results where pigs fed on diets supplemented with different ratios of unsaturated fatty acid to saturated fatty acid had larger loin eye size compared to pigs that were fed on a control diet with no lipid supplementation. Results in this study also corroborated another [27] which concluded that lowering dietary protein in finisher pig diets did not have any negative effect on carcass yield. A previous study [39] showed that the protein value of rice bran protein was much higher than that of vegetable proteins and was comparable to that of casein; therefore, could be used as a substitute to animal protein which are ideal proteins [40]. This could also have contributed to a larger loin eye size since amino acid balance of a diet is an important determinant of muscling in pigs [41].

Intestinal morphology

Studies in pig nutrition have indicated the significant role played by diets in changing the histological appearance of the gut [42]. The findings of this study showed that high fibre RBN diet had beneficial effects on gut mucosa with longer ileal villi compared to pigs offered the basal diet. This finding corroborates with other studies [3, 43, 44] which reported that diets rich in fibre were associated with an increase in proliferation of mucosal cells with resultant increase in mucin production, increased villous height and crypt depth. Increase in villous height is important in that it results in increased total luminal absorptive surface area and subsequently results in satisfactory digestive enzyme action and higher transport of nutrients at the villous surface [45] Pigs offered high lipid low fibre RPL diet had shorter villi compared compared to pigs fed on the basal diet. Though insoluble fibres have been reported to have an abrasive effect on the intestinal mucosa, the ability of dietary fibre to alter intestinal epithelial morphology depends on the digesta viscosity which is influenced by solubility of dietary non-starch polysaccharides [46].

Higher value for crypt depth in pigs offered the high protein high lipid CPCM and a lower value for pigs offered the low protein high lipid RPL diet indicated that protein concentration in the diet couldplays a role in variation in intestinal mucosal morphology. This finding corroborated [47] who concluded that reducing dietary protein level in broiler diets resulted in higher villous height in the duodenum and ilium. Increased crypt depth is related to enterocyte proliferation associated with villous atrophy [48] which then implies reduced intestinal digestive and absorptive surface area. It is therefore likely that inclusion of Canola meal in pig diets could have resulted in ileal enterocyte damage leading to increased enterocyte proliferation with increased crypt depth.

Conclusion

This study concluded that finisher diets formulated with non-conventional feedstuffs with lower protein concentrations result in higher growth rates with higher lean carcass yield. Diets high in lipids such as those formulated using cold pressed canola meal were associated with higher backfat thickness. Higher levels of dietary fibre and low dietary protein had benefial effects on ileal epithilia and were associated with increased the ileal surface area due to inceased villous height. The role of higher levels of dietary lipids on variation in the morphology of the ileal epithilia was not clear and this study recommends further investigation. This study also recommends further investigation into the possible role of lipids glycosinolates usually present in Canola on changes in gut epithelial morphology.

Acknowledgement

Authors wish to acknowledge the German Academic Exchange Service (DAAD) and the International Centre for Development and Decent Work (ICDD) in Kassel University, Germany for funding this research and Egerton University through the Department of Animal Sciences for availing facilities for laboratory analysis. We acknowledge Dr Paul Onyango Okumu of the University of Nairobi, Department of Veterinary Pathology for his assistance in preparation of histological slides.

Ethical approvals

Requisite authority to conduct the study was obtained from Kenya National Commission for

Science, Technology and Innovation (NACOSTI-Kenya); which issued a research clearance permit number 15393. Authority to use Egerton University Tatton Farm animals for the study as well as the pig unit was obtained from the Egerton University Tatton Agricultural Park farm committee. Measures to maintain biosecurity were put in place since the farm is a quarantine area. Ethical approval to carry out the study was obtained from the Animal care and Use Committee of the Institute of Primate Research (Kenya). The study was carried out in compliance with international code of animal ethics in research.

Conflicts of interest

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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(Received 05/09/2018;
accepted 09/12/2018)

التأثيرات المفيدة للأعلاف غير التقليدية على خصائص الذبيحة والشكل المورفولوجى للغشاء الميوكوزى المبطن للامعاء على نضوج الخنازير

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بحثت هذه الدراسة الاختلافات في خصائص الذبيحة والشكل الظاهرى للاغشية المخاطية المبطنة للامعاء في الخنازير التى تم تغذيتها على عدد اربعة من الاعلاف الناهية باستخدام العلائق غير التقليدية لمدة 180-99 يوما قبل سن الذبح . وتتكون الاعلاف من نظام غذائي قائم على الذرة الصفراء وفول الصويا ، و 20٪ من وجبات الكانولا المعبأة بالتبريد ، و 20٪ من نظام قشرة الأرز ، و 20٪ من حبوب نخالة الأرز. نتج عن التغذية على 20٪ من قشرة تلميع الأرز ارتفاعًا معنويا (p≤0.05) يوميًا مقارنةً بالخنازير على التى تتغذى على الاعلاف التقليدية (النظام الغذائي الأساسي). نتج عن التغذية على العليقة التى تحتوى على تلميع الأرز زيادة في نسبة القتل إلى الخارج ، وزيادة بنسبة 24.5٪ في منطقة العين الخاصة مما يدل على زيادة تكوين الأنسجة الخالية من الدهون وخفض بنسبة 19.3٪ في الارتفاع الزغابي ، ولاحظت أن الزيادات كانت مختلفة بشكل كبير (p ≤ 0.05). نتج عن حمية نخالة الأرز بنسبة 20٪ زيادة في متوسط (p≤0.05) يومي مقارنة بالخنازير على النظام الغذائي الأساسي وحجم العين الخاص الأكبر (p ≤ 0.05) مما يعني وجود ترسيب أفضل في الأنسجة الرخوة. الزوائد الزهرية كانت أطول بكثير (p ≤ 0.05) في الخنازير التي غذيت غذاء نخالة الأرز ونسبت إلى الألياف الغذائية الأعلى. النظام الغذائي وجبة كانولا 20 ٪ (P ≤ 0.05) زيادة الدهون الخلفية وزيادة (p ≤ 0.05) في عمق الطبقة الطلائية المبطنة للامعاء الدقيقة . وخلصت الدراسة إلى أن نخالة الأرز عالية NDF يقلل من الرواسب ويزيد من مساحة سطح الأمعاء وبالتالي تحسين الاستفادة من الألياف الغذائية. وكان للعلف غير التقليدي منخفض البروتين في الخنازير تأثيرات مفيدة على الطبقة الطلائية المبطنة للامعاء الدقيقة. وينبغي إجراء مزيد من الدراسات حول دور الدهون الغذائية و glycosinolates التي توجد عادة في وجبة الكانولا على التغييرات في المورفولوجية الظاهرية المعوية.

الكلمات الرئيسية: الأعلاف غير التقليدية ، سمك الدهون فى المؤخرة ، جدار الامعاء ، الأمعاء .