Nig. J. Anim. Prod. 2018, 45(2): 176 - 184

High quality cassava peel mash supplemented with direct fed microbial as an alternate source of energy supplement: Effects on performance and blood parameters in growing pig

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Abstract

The feeding trial was carried out to determine the effect of feeding high quality cassava peel mash (HQCP) with or without multi-strain direct fed microbials (DFM) as replacement for maize in the diet of growing pigs on growth, cost benefit, haematology and serum biochemical indices. A total of 90 growing pigs with an initial weight of 25.36±0.87 kg were randomly assigned to five dietary treatments in a 2×2+1 factorial arrangement in a completely randomised design. The factors were 2 levels of HQCP (7.5% and 15%), two DFM inclusions and a control diet with neither HQCP nor DFM. Pigs on T1 were given corn (40%) based diet without HQCP, T2 had 18.75% of Maize (7.5kg) replaced by HQCP and T3 had 37.5% of total Maize (15kg) replaced by HQCP. The pigs in T4 were given same diet as in T2 with addition of multi-strain DFM and animals on T5 were given the same diet with those on T3 with addition of multi-strain DFM microbial. Each treatment group had three replicates with six animals per replicate. No significant (P>0.05) difference was observed in the performance characteristics of the growing pigs among the diets. The body weight gain ranged between 10.97 and 13.56 Kg in T5 and T3, respectively. The least feed conversion ratio of 3.98 was observed in T3 while the highest feed conversion ratio (4.77) was observed in T5. All the haematological and serum biochemical indices examined were not significantly (P>0.05) different among the treatments. There was no significant (P>0.05) effect of HQCP, DFM or their interaction on all the haematological parameters analysed. There was significant effect of HQCP and DFM interaction on the serum cholesterol (p=0.0062), high density lipoprotein (p=0.05) and low density lipoprotein (p=0.0018). It can be concluded from this study that growing pigs can utilize HQCP up to 15% in their diet without any adverse effect.

Keywords: Direct fed microbials, High quality cassava peels, Maize, Multi-strain direct fed microbials, Pigs.

Introduction

The increase in the demand for cassava root is increasing daily. The increased utilisation of cassava roots as food for human consumption and its use for the production of flour, starch and ethanol for industrial purposes may affect its availability for use as livestock feed ingredient as a result of increased cost per unit. Cassava peel which is considered a by product in the processing of cassava for industrial and domestic use has been identified as potential source of energy in the diet of livestock. Being a by-product from processing of cassava root, it is cheaper than cassava root (Adesehinwa *et al.,* 2016) and most conventional energy source such as maize, millet and guinea corn used in livestock feed production. However, fresh cassava peel contains large amount of cyanogenic glycosides and phytate (up to 1% DM) (Tewe, 1992; Salami *et al*, 2003; Oboh, 2006) and rotten easily because of its high moisture content. The International Livestock Research Institute (ILRI, 2015), developed an innovative method of processing cassava peels by grating, pressing, sieving and drying to produce High Quality Cassava Peel (HQCP) mash (Okike *et al.,* 2015) thereby eliminating the anti-nutritional factors that limit the use of cassava peel as livestock feed ingredients. Adesehinwa *et al.* (2016) reported that HQCP can be included up to 30% in the diet of growing pigs. The addition of feed additives to the diet of pigs may also enhance the utilisation of HQCP as an alternate energy source in the diet of growing pigs. The relevance of use of feed additives in animal production for improved feed utilisation, health and productivity cannot be over-emphasized. While the use of some additives are encouraged because of their enormous beneficial effects, the use of antibiotics growth promoters as an additive in the diets of livestock is being discouraged because of the challenge of anti-microbial resistance that pathogens develop and possible transference of this from animal to human microbiota as a result of routine use of antibiotics. This resulted in the emergence of organic acids and their salts, phytogenic additives, prebiotics and direct fed microbials (probiotics) as alternatives to antibiotic growth promoters. Direct fed microbials (DFM) are live (viable) naturally occurring micro-organisms fed to animals to improve the gut microbial environment for the benefit of the host and this includes bacteria, fungi and yeast. DFMs are beneficial to the host by maintaining normal intestinal microflora by competitive exclusion and antagonism (Kabil *et al.*, 2005; Flint and Garner, 2009; Kabir, 2009; Kizerwetter-Swidaand Binek, 2009). They alter metabolism by increasing digestive enzyme activity and decreasing bacterial enzyme activity and ammonia; improve feed intake and digestion and also stimulating the immune system (Kabil *et al.*, 2005; Kabir, 2009; Kizerwetter-Swida and Binek, 2009; Chaucheyras-Durand and Durand, 2010). For example, *Lactobacillus acidophilus as reported by* Flint and Garner (2009) *could control/prevent invasion* of the epithelial wall of the gastrointestinal track by *Escherichia coli*, *Yersinia pseudo-tuberculosis* and *Salmonella enterica* ssp. *enteric* (Bernet *et al.,* 1994; Tindal *et al.,* 2005; Flint and Garner, 2009). The *Bacillus* ssp. and *Saccharomyces cerevisiae* have been reported to perform immune-stimulatory functions (Flint and Garner, 2009). However, using multi-strain or multi-species probiotics have been discovered to be more effective than mono-strain or single-species probiotics (Timmerman *et al*., 2004). The health status of an animal is reflective in the haematological and serum biochemical indices of such animal. Haematological and serum biochemical indices are also good indicators of the physiological status of an animal (Khan and Zafar, 2005). As part of the process of digestion in the gastrointestinal tract, nutrients are absorbed into the blood stream through different mechanism. Isaac *et al.* (2013) reported that animals with good blood composition are likely to show good performance. Thus, this study aimed at investigating the effect of supplementing high quality cassava peel mash with direct fed microbials as an alternate energy source in the diet of growing pigs on the performance characteristics, cost benefit, haematological and serum biochemical indices.

Materials and methods

Experimental location, animals, design and diet

This experiment was carried out at AK farms, Eleyele, Ibadan, Oyo State, Nigeria. A total of ninety growing pigs which are crosses of Large White and Landrace with an average weight of 25.36±0.87 kg (± SE) were used for this study. The animals were randomly allotted to five dietary treatments in a 2 × 2 +1 factorial arrangement in a completely randomized design. Each treatment was replicated three times with six pigs per replicate. The factors in the factorial arrangement were two (2) levels of HQCP (7.5 and 15% of the diet), two (2) direct fed microbial (DFM) inclusions and a (1) control diet which had neither HQCP nor DFM inclusion. The diets were formulated to meet the nutrient requirement for growing pigs according to National Research Council (1998) recommendation for growing pigs. The diets across the treatments were formulated to be isonitrogenous and isocaloric. The gross composition of the experimental diet is as shown in Table 1. The basal diet composed of maize, groundnut cake and Palm kernel cake. High Quality Cassava peel replaced maize in basal diet in treatment 2 to treatment 5. The Pigs placed on T1 were given maize (40%) based diet with neither HQCP nor DFM; those in T2 had 7.5kg HQCP replacing 18.75% of the maize portion of the diet while T3 were fed 15kg HCQP replacing 37.5% of the maize portion in the diet. The pigs on T4 were given the same diet as those in T2 except with the addition of multi-strain DFM, while T5 were fed same diet with those on T3 with the addition of the multi-strain DFM. The multi-strain DFM contained 11×10^{5} CFU/g Saccharomyces, 1×10^{8} CFU/g Lactobacillus sp, 4×10^{12} CFU/g Bacillus sp and 99.9% water and it was added to the feed at 1.6ml/kg of feed. The pigs were fed *ad-libitum* throughout the feeding trial which spanned 56 days.

The initial weight of the pigs was determine at the beginning of the study and they were weighed weekly thereafter till the end of the study using a measuring scale. The body weight gain was estimated as the difference between the finial and the initial weight. The feed intake of the pigs was determined daily as the weight difference between the feed given and the leftover. The feed conversion ratio was estimated as the ratio of feed given to weight gain.

At the end of the feeding trial, blood was sampled through the jugular vein of the animals using hypodermic needle and syringe. Blood sampled for haematological and serum biochemical analyses were emptied into sample bottles with anti-coagulant and without anti-coagulant respectively.

The proximate composition of the diets was determined according to the method of AOAC (2005). Data obtained were subjected to analysis of variance (ANOVA) appropriate for factorial design using the general linear model procedures of SAS. Statistical significance was assessed at $P < 0.05$.

Results and discussion

The determined proximate composition of the experimental diets as highlighted in Table 2 showed that the diets are isonitrogenous and isocaloric. The crude protein ranged between 17.53 and 18.84 in T1 and T5 respectively. This is similar to what was recommended by Irekhore *et al.* (2015) as adequate to support the performance of growing pigs. The highest crude fibre content of 6.29% was determined in diet T3 with 15% HQCP without DFM while the least (5.84) was recorded in T1. The determined fiber fraction of the experimental diet is as shown

Table1: Ingredient composition of diets having graded level of high quality cassava peel mash

Ingredients %	T1	T2	T3	T4	T5
Maize	40	32.5	25	32.5	25
HQCP	0	7.5	15	7.5	15
Wheat bran	10.5	9.5	8.5	9.5	8.5
Palm oil	1.5	2.5	3.5	2.5	3.5
Other	48	48	48	48	48
Total	100	100	100	100	100
Calculated analysis					
Crude fibre (%)	5.06	5.48	5.90	5.48	5.90
Crude protein (%)	20.55	20.20	19.86	20.20	19.86
Metabolizable energy (kcal/kg)	2754.85	2782.47	2810.10	2782.47	2810.10
Calcium	1.67	1.68	1.69	1.68	1.69
Phosphorus	0.80	0.79	0.79	0.79	0.79
Lysine	1.09	1.07	1.04	1.07	1.04
Methionine	0.38	0.36	0.35	0.36	0.35

Others (%): Groundnut cake meal 20, Fish meal 3, Palm kernel cake 20, Limestone 1.3, Bone meal 2.5, Salt 0.5, Dl-Methionine 0.05, L-Lysine 0.40, Vitamin-mineral premix 0.25. HQCP= High quality cassava peel; Grower premix supplied the following per kg diet:Vitamin A 10000000 IU; Vitamin D 32000000 IU; Vitamin E 8000 IU; Vitamin K 2000 mg; Vitamin B1 2000 mg; Vitamin B2 5500 mg; Vitamin B6 1200 mg; Vitamin B12 12 mg; Biotin 30 mg; Folic acid 600 mg; Niacin 10000 mg; Pantothenic acid 7000 mg; Choline chloride 500000 mg; Vitamin C 10000 mg; Iron 60000 mg; Mn 80000 mg; Cu 800 mg; Zn 50000 mg; Iodine 2000 mg; Cobalt 450 mg; Selenium 100 mg; Mg 100000 mg; Anti-oxidant 6000 mg

in Table 3. The Neutral detergent fibre was seen to be 5.84, 6.08, 6.14, 6.24 and 6.29% in T1, T4, T2, T5 and T3, respectively. This similar trend was observed in other fibre fractions except for Hemicellulose. The NDF in T4 (47.54 %) and T5 (48.40 %) was observed to be numerically lower to what was recorded in T2 (47.61 %) and T3 (48.67 %), respectively despite having the same level of all ingredients except for the presence of DFM in T4 and T5 was observed to have lower NDF. Similar trend was observed in the other fibre fractions including the Hemicellulose. This could be attributed to the addition of DFM to the diets.

Table 2: Proximate composition of experimental diets

Parameters (%)	T1	T2	T3	T4	T5
Dry matter	93.25	92.35	91.35	91.90	90.95
Crude Protein	17.53	17.74	18.64	17.83	18.84
Crude Fibre	5.84	6.14	6.29	6.08	6.24
Crude fat	3.6	3.64	3.7	3.68	3.74
Ash	6.32	6.41	6.51	6.45	6.60
NFE	57.395	56.845	55.735	56.775	55.50
Gross energy (kcal/kg)	4.010	4.042	4.025	4.037	4.033

NFE - Nitrogen Free Extract

Table 3: Fiber fraction of experimental diets

Parameters (%)	T1	T2	T3	T4	T5
Crude Fibre	5.84	6.14	6.29	6.08	6.24
NDF	45.14	47.61	48.67	47.54	48.40
ADF	20.06	23.58	25.15	23.51	25.10
ADL	6.60	6.67	6.90	6.64	6.78
Hemicellulose	25.08	24.04	23.52	24.03	23.30
Cellulose	13.46	16.91	18.25	16.86	18.32

NDF- Neutral Detergent Fiber, ADF- Acid Detergent Fiber, ADL- Acid Detergent Lignin, % - percent

Direct fed microbials (DFM) are fed to livestock to improve the health and feed utilization of the animal. The growth of growing pigs fed high quality cassava peel (HQCP) supplemented with direct fed microbial (DFM) is shown in Table 4. The highest final weight of 40.25 kg was recorded in diet T2 fed 15kg HQCP as replacement for maize portion of the diet. This is however not significantly (P>0.05) different from what was recorded in other treatments. The lowest final weight (36.77 kg) was recorded in diet T4. The supplementation of the DFM(1×10^8 CFU/g *Lactobacillus sp*, 4×10^{12} CFU/g *Bacillus sp* and 11×10^5 CFU/g *Saccharomyces cerevisiae*) was not seen to significantly (P>0.05) influence the body weight gain and FCR of the growing pigs among the treatments in this study. This result corroborates the work of Chen *et al.* (2005) and Giang *et al.* (2011) where feeding of combination of *Bacillus subtillis*, *Saccharomyces* ssp and a lactic acid bacteria (LAB) was not found to significantly (P>0.05) influence growth response of growing pigs. According to Stavric and Kornegay (1995), probiotics are more effective in animals during microflora development or when microflora stability has been impaired. The feed intake among the treatments was not significantly influenced by the inclusion of HQCP and DFM in the diets of the pigs. The least FCR of 3.98 was recorded in T3 while the highest (4.77) was recorded in diet T5. The effect of HQCP, DFM and their interactions on weight gain, feed intake and feed conversion ratio were shown in Table 5. The single effect of the DFM and HQCP level were not significant (P>0.05) for all the growth parameters, likewise, their interactions were also not significant for all the growth performance parameters taken. This is an indication that growing pig can effectively utilize the diets without any adverse effect.

Table 4 : Growth response of growing pigs fed high quality cassava peel supplemented with direct fed microbial

Parameters	T1	T2	T3	T4	T5	P Value	SEM
Initial weight (Kg)	25.95	26.97	23.81	23.77	26.28	0.70	0.87
Final weight (Kg)	38.92	40.25	37.36	36.77	37.25	0.93	1.31
BWG (Kg)	12.97	13.28	13.56	13.00	10.97	0.49	0.49
DWG (g)	308.90	316.22	322.75	309.52	261.24	0.49	11.76
TFI (g)	53128	55468	49493	51628	50058	0.71	1430.24
ADFI (g)	1265.00	1320.70	1178.40	1229.20	1191.80	0.71	34.05
FCR	4.50	4.40	3.98	4.35	4.77	0.51	0.14

BWG - Body weight gain, DWG - Daily weight gain, TFI - Total feed intake, ADFI - Average daily feed intake, FCR – Feed conversion ratio, SEM - Standard error of mean

Table 5 : Interaction between high quality cassava peel level and direct fed microbial on performance of grower pigs fed experimental diets

Parameters	T2	T3	T4	T5	SEM	P Value		
						DFM	HQCP LEVEL	DFM* HQCP LEVEL
Initial weight (Kg)	26.97	23.81	23.77	26.28	1.056	0.86	0.88	0.19
Final weight (Kg)	40.25	37.36	36.77	37.25	1.56	0.57	0.71	0.60
BWG (Kg)	13.28	13.56	13.00	10.97	0.56	0.20	0.44	0.31
DWG (g)	316.22	322.75	309.52	261.24	13.32	0.20	0.44	0.30
TFI (g)	55468	49493	51628	50058	1711	0.64	0.28	0.53
ADFI (g)	1320.70	1178.40	1229.20	1191.80	40.74	0.64	0.28	0.53
FCR	4.40	3.98	4.35	4.78	0.16	0.24	1.00	0.18

BWG - Body weight gain, DWG - Daily weight gain, TFI - Total feed intake, ADFI - Average daily feed intake, FCR – feed conversion ratio, SEM - Standard error of mean., DFM - Effect of direct fed microbial, HQCP LEVEL - Effect of high quality cassava peel level, DFM* HQCP LEVEL – Interaction between level of high quality cassava peel and direct fed microbial.

The cost benefit analysis of feeding HQCP and DFM in the diet of growing pigs is shown in Table 6. Feed constitute 60-80% of the variable cost of production in a livestock enterprise. Achieving a comparable good performance by feeding at reduced cost will be beneficial in production. The feed cost among the treatments differs significantly (P<0.05) from one another. The significantly (P<0.05) lowest feed cost of ₦131.75/kg of feed was recorded in diet T3 fed the highest level of HQCP without DFM while the significantly highest feed cost of ₦137.76/kg was recorded in T4. The addition of DFM to diet as in T4 and T5 increased the cost of the feed when compared with T2 and T3 respectively that has the same level of HQCP but without DFM. The feed cost per weight gain showed no significant difference among the treatments and ranged between ₦524.31 and ₦643.79 in treatment T3 and T5, respectively.

Table 6: Economic analysis of feeding high quality cassava peel and direct fed microbials in the diet of growing pigs

Parameters	T1	T2	T3	T4	T5	±SEM
Cost of feed (₦/Kg)	137.37[b]	134.56[d]	131.75[e]	137.76[a]	134.95[c]	0.23
Total Feed Intake (Kg)	53.13	55.47	49.49	51.63	50.06	1.43
Average Daily Feed Intake (Kg)	1.27	1.32	1.18	1.23	1.19	0.03
Total cost of feeding (₦)	7298.1	7463.6	6520.6	7112.1	6755.2	194.49
Average cost of feed per day (₦)	173.77	177.70	155.25	169.34	160.84	4.63
Feed Gain Ratio	4.50	4.40	3.98	4.35	4.77	0.14
Feed Cost/kg Weight Gain (₦/Kg)	618.53	592.48	524.31	598.85	643.79	19.35

SEM - Standard error of mean

The effect of feeding HQCP supplemented with DFM in the diets of growing pigs on the haematological parameters is shown in Table 7. There was no significant (P>0.05) difference observed in all the parameters examined. The highest concentration of lymphocyte (54.00 %) was recorded on T1 where the diet contained no inclusion of HQCP and DFM while the lowest concentration of the lymphocyte was observed in T3. The values obtained for haematological parameters in this study falls within the physiological normal range of a healthy pig (Merck Manual, 2012). The level of RBC and WBC recorded from this study indicates that no pathological effect was induced and thus, the health of the animals was not comprised. This support the report of Chen *et al.* (2005) and Ojebiyi *et al.* (2015) that the addition of direct fed microbials (DFM) to diet of livestock does not illicit pathogenic effect on the host. The interactive effect of feeding HQCP and DFM to growing pigs on haematological parameters is as displayed in Table 8. No significant (P>0.05) effect of HQCP, DFM or their interaction was observed on the PCV, haemoglobin concentration, erythrocyte, leukocytes, lymphocytes, neutrophils, monocytes, eosinophils and platelets.

Table 7: Effect of direct fed microbials and high quality cassava peel on the haematology of growing pigs

Parameters	T1	T2	T3	T4	T5	P Value	SEM
PCV (%)	34.500	34.500	31.000	32.750	35.250	0.7500	1.047
H.b	11.500	11.498	10.335	10.913	11.750	0.7504	0.35
RBC (10^6)	6.120	6.700	6.453	6.053	7.060	0.8442	0.29579
WBC (10^3)	8638	8950	7175	7613	9838	0.7463	645.450
Lymp (%)	54.00	51.75	47.25	49.75	48.50	0.1825	0.965
Neut (%)	39.25	41.50	45.50	44.25	44.75	0.2030	0.958
Mono (%)	3.50	2.75	2.75	2.25	3.00	0.4910	0.225
Eos (%)	3.25	4.00	4.75	5.00	3.75	0.4550	0.327
Platelet	148250	199750	147750	125000	171500	0.5307	13711.21

Note: SEM = Standard error of mean, DFM = Direct fed microbial, PCV = Packed cell volume, Hb = Haemoglobin, RBC = Red blood cells, WBC = White blood cells, Lymp = Lymphocyte, Neut – Neutrophils, Mono = Monocytes, Eos = Eosinophils.

Table 8: Interactive effect of directfed microbials andhigh quality cassava peelon haematology of growing pig

Parameters	T2	T3	T4	T5	SEM	P Value		
						DFM	HQCP LEVEL	DFM* HQCP LEVEL
PCV (%)	34.500	31.000	32.750	35.250	1.224	0.6352	0.8489	0.2654
H.b (g/dL)	11.498	10.335	10.913	11.750	0.41	0.6365	0.8526	0.2653
RBC (10^6)	6.700	6.453	6.053	7.060	0.35	0.9795	0.6272	0.4265
WBC (10^3)	8950	7175	7613	9838	690.07	0.6483	0.8766	0.1835
Lymp (%)	51.75	47.25	49.75	48.50	1.06	0.8655	0.2092	0.4676
Neut (%)	41.50	45.50	44.25	44.75	1.00	0.6376	0.2982	0.4142
Mono (%)	2.750	2.7500	2.2500	3.00	0.26	1.0000	0.6573	0.3809
Eos (%)	4.00	4.75	5.00	3.75	0.33	1.0000	0.7153	0.1610
Platelet	199750	147750	125000	171500	16076.12	0.4434	0.9333	0.1518

Note: SEM = Standard error of mean, PCV = Packed cell volume, Hb= Haemoglobin, RBC = Red blood cells, WBC = White blood cells, Lymp = Lymphocite, Neut – Neutrophils, Mono = Monocytes, Eos = Eosinophils, DFM - Effect of direct fed microbial, HQCP LEVEL - Effect of high quality cassava peel level, DFM* HQCP LEVEL–Interaction between level of high quality cassava peel and direct fed microbial.

The serum biochemical analysis helps in providing information about state of tissues, organs and metabolic state of the body. The serum biochemistry of growing pigs fed HQCP and DFM in the diet is as presented in Table 9. The serum biochemical indices observed in this study did not differ significantly (P>0.05) among the treatments. This result is similar to the report of Chen *et al.* (2005) who stated that determined haematology and serum chemistry parameters including Albumin, total protein, RBC, WBC and lymphocyte were not affected by the addition of *Lactobacillus acidophilus* 1.0×107 CFU/g, *Saccharomyces cerevisae* 4.3×106 CFU/g and *Bacillus subtilis* 2.0×106 CFU/g to diet of growing pigs. The lower cholesterol level in observed in diet T5 with probiotics supplementation could be attributed to probiotics effect and its ability to bind cholesterol in the small intestines (Ojebiyi *et al.*, 2015). The serum biochemical value reported in this study falls within the normal physiological range of a healthy animal (Merck Manual, 2012). In another study reported by Adesehinwa *et al.* (2016), replacing maize with HQCP up30% in the diet of growing pigs did not influence the haematological and serum biochemical properties of the pigs negatively.

According to Yang *et al.* (2015), Lactic acid bacteria (LAB) can inhibit pathogenic bacteria by competing for nutrients in the gut or at binding sites in the intestinal epithelium (Malago and Koninkx, 2011) and thus prevent them from eliciting pathogenic effect on the host (Havenaar *et al.*, 1992). As indicated in Table 10, there was significant effect of HQCP and DFM interaction on the serum cholesterol (p=0.0062), high density (p=0.05) and low density lipoprotein cholesterol (p=0.0018).

Table 9: Serum biochemistry of growing pigs fed high quality cassava peel and direct fed microbials

Parameters	T1	T2	T3	T4	T5	P Value	SEM
Chol (mg/dl)	142.50	129.17	176.25	170.42	119.58	0.0805	8.03
UR (mg/dl)	22.23	18.99	19.29	22.01	21.66	0.1949	0.57
CRT (mg)	1.50	1.58	1.50	1.70	1.25	0.4252	0.07
HDL (mg/dl)	59.45	49.72	63.89	59.45	52.78	0.5182	2.73
LDL (mg/dl)	19.945	21.910	17.020	17.705	18.62	0.0672	0.61
Thio (mg/ml)	17.04	16.73	18.68	17.83	16.78	0.5413	0.40
AST (I.U/l)	25.92	16.55	23.22	30.98	24.41	0.3980	2.25
ALP (I.U/l)	46.25	50.72	48.22	48.39	51.52	0.9251	1.85

Note: SEM - Standard error of mean, Chol– Cholesterol, UR – Urea, CRT – Creatinine, Thio – Thiocyanate, AST – Aspertate amino transferase, ALP – Alkaline phosphatase, HDL – High density lipoprotein LDL - Low density lipoprotein

Table 10: Interactive effect of direct fed microbials on serum parameters of growing pigs fed experimental diets

Parameters	T2	T3	T4	T5	SEM	P Value		
						DFM	HQCP LEVEL	DFM* HQCP LEVEL
Chol (mg/dl)	129.17	176.25	170.42	119.58	129.17	0.6118	0.9012	0.0062
UR (mg/dl)	18.99	19.29	22.01	21.66	18.99	0.0449	0.9846	0.7941
CRT (mg)	1.58	1.50	1.70	1.25	1.58	0.7126	0.1391	0.2799
HDL (mg/dl)	49.72	63.89	59.45	52.78	49.72	0.8890	0.4573	0.0542
LDL (mg/dl)	21.910	17.020	17.705	18.62	21.910	0.0971	0.0178	0.0018
Thio (mg/ml)	16.73	18.68	17.83	16.78	16.73	0.6420	0.5968	0.0941
AST (I.U/l)	16.55	23.22	30.98	24.41	16.55	0.1636	0.9924	0.2320
ALP (I.U/l)	50.72	48.22	48.39	51.52	50.72	0.9185	0.9476	0.5587

Note: SEM - Standard error of mean, Chol – Cholesterol, UR – Urea, CRT – Creatinine, HDL – High density lipoprotein, LDL – Low density lipoprotein, Thio – Thiocyanate, AST – Aspertate amino transferase, ALP– Alkaline phosphatase, DFM - Effect of direct fed microbial, HQCP LEVEL- Effect of high quality cassava peel level, DFM* HQCP LEVEL–Interaction between level of high quality cassava peel and direct fed microbial.

Conclusion

The addition of multi-strain direct fed microbials to high quality cassava peel in the diet of growing pigs was not seen to enhance the performance of the animal. It can be concluded from this study that high quality cassava peel can be used up to 15% inclusion in the diet as replacement for 37.5% maize in the diet of growing pigs without direct fed microbials.

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Received: 11th November, 2017
Accepted: 3rd March, 2018