Response of Growing Pigs to Diet Physical Form and Allzyme® SSF Supplementation in a Palm Kernel Meal-Based Diet

AO Akintunde*, CA Omole, OA Sokunbi, TT Lawal and O Alaba

Department of Animal Science, University of Ibadan, Ibadan, Nigeria
Telephone: +2348034784244
***Corresponding author e-mail: yinkaoye2k3@yahoo.com**

Abstract. The increasing cost of conventional feeds calls for the unconventional ones. The effect of Allzyme®SSF and diet physical form on performance, haematological and serum biochemical indices of growing pigs fed with palm kernel meal-based diet was determined. Twenty four growing pigs comprising of twelve male and twelve female weighing 8.95±1.01Kg were assigned into four dietary treatment groups involving dry mash diet, wet mash diet, dry mash diet+ Allzyme®SSF and wet mash diet+ Allzyme®SSF in a completely randomized design. After feeding experiment for six weeks, haematological and serum biochemical parameters were determined. Growth performance was observed on a weekly basis for six consecutive weeks. The results showed that the diet physical form and Allzyme®SSF supplementation in a palm kernel meal-based diet did not significantly affect the haematological and serum biochemical parameters; however weight gain and feed conversion ratio were significantly influenced by the diet physical form and Allzyme®SSF supplementation, thus making dry mash diet + Allzyme®SSF the best dietary treatment. The experiment showed that the diet physical form and Allzyme®SSF supplementation in a palm kernel meal-based diet did not have any negative effect on the growing pigs and growth performance was not hindered; therefore palm kernel meal-based diet in wet or dry mash form with or without Allzyme® SSF supplementation could be fed to growing pigs.

Key Words: Allzyme® SSF, supplementation, performance, haematology and biochemistry

Introduction

In recognition of the potential of the pig as a prolific and fast growing animal, as well as a good converter of feed to meat, many Nigerian farmers have embarked upon intensive production of pigs. This is an effort geared towards increasing animal protein supply, at reduced cost for human consumption (Adesehinwa et al., 1998). Pig production represents the fastest means of correcting animal protein shortage in Africa. This is because apart from their high rate of reproduction, poultry and pigs are characterized by the best efficiency of nutrient transformation into high quality protein (meat despite the high transportation cost (Tewe and Egbunike, 1988). Therefore, nutrient supply has to be judiciously manipulated to ensure the production of meat at economic rates. There exists in the country some agro industrial by-products and crop residues that can be used as total or partial replacements of conventional ingredients in finished livestock feeds. Pigs are capable of converting these agro-industrial by-products or 'wastes' of all kinds (which will normally be discarded by humans) into wholesome animal protein (Adesehinwa, 2008).

Fibrousness of feeds (mostly the by-products of plant origin) is important in relation to the feeding value to pigs. The fibrous components of plant materials are cellulose, hemicellulose and lignin. The influence of crude fiber on organic matter digestibility varies among feeds, depending on the special characteristics of the crude fiber in each feeds (Kidder and Manners, 1978). The fibrous

portion of feed, being indigestible to pigs, influences the digestibility of the other constituents by excreting a protective action, encasing these constituents in a digestion-proof shield, as it were. However, for efficient pig feeding, some forms of physical treatment of cereal grains are essential to break down the fiber, encapsulating the more soluble constituents so that digestive secretions can penetrate more completely (Kidder and Manners, 1978).

The use of agro-industrial byproducts for livestock feeding especially in the developing countries is seen as a measure for sustainable livestock development. However, Oluwafemi and Akpodiete (2010) concluded that inclusion of 40 and 60% palm kernel cake with or without enzyme supplementation as replacement for maize in weaning pigs ration had no negative effect on nutrient utilization as well as the overall performance characteristics of the animals. Therefore, palm kernel cake (PKC) can be used as energy feed ingredients in formulating weaning pigs' ration up to 60% inclusion level. The addition of proteolytic, fibrolytic or carbohydrate-degrading enzymes to PKC-based diets has great potential in releasing unavailable nutrients and energy.

Palm kernel meal (PKM) has been extensively studied on various monogastric species including poultry, pigs and rabbits (Perez et al., 2000). Palm kernel meal is a by-product of red palm oil industry. It is a common feed ingredient used in practical pigs feeding (Fatufe et al., 2007). Research has shown that PKM can be incorporated at low level (10 to 30 %) in pigs diet (Agunbiade et al., 1999).

Allzyme SSF is produced by a carefully selected strain of *Aspergillus niger*, which expresses over seven enzyme activities when grown on wheat bran. In feed, the enzymes in the complex work synergistically to break down the different substrates. As a result, more nutrients are available to the animal, thus improving growth and economic efficiency. The seven major enzyme activities in Allzyme SSF are amylase, cellulase, phytase, xylanase, beta-glucanase, pectinase and protease. It was recommended that the inclusion rate of Allzyme SSF should be 0.02% or 200 gram/tonne for creep/starter, weaning, grower and finisher pigs (Alltech, 2009). Allzyme SSF is a natural complex that improves profitability by maximizing nutrient release, produced by solid-state fermentation (SSF) process. SSF allows for flexibility in feed formulation through the inclusion of by-products and alternative raw materials, or by reducing the nutrient density in the diet, while maintaining a high level of performance. It can be used for pigs and poultry. Allzyme SSF may be added directly to complete mash or pellet feeds or via premix (Alltech, 2009).

The physical form of diet has been observed to affect the animals' performance, carcass quality and haematology. The physical form of the diet could be in dry form-pelletized, powder and liquid. Liquid feed has been reported to stimulate the increasing intake post-weaning and thus increase post-weaning growth rate (Brooks et al., 1996; Mikkelsen and Jensen, 1998).

Mikkelsen and Jensen (1998) summarized the result of ten studies of first stage pigs and found that average daily gain (ADG) was increased by 12% compared to dry feeding. Furthermore, ADG of fermented wet pigs was 13% higher than that of fresh wet feeding. Regardless the type of wet feed for the weaned pigs, deterioration in feed conversion efficiency (FCE) is normally relative to dry-fed pigs.

Physical form of the diet has a large impact on growth performance of early-weaned pigs (Kim et al., 2001). The accelerated growth rates were supported by increased feed intakes and gain/feed ratios. They however concluded that the physical form of the diet during the immediate post-weaning period could have an immediate and lasting impact on pig growth performance.

This study was aimed to determine the effect of diet physical form and Allzyme® SSF supplementation in a palm kernel meal-based diet on performance, haematological and serum biochemical parameters of growing pigs.

Materials and Methods

The experiment was carried out at the swine unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria (located at latitude 07° 20'N and longitude 03° 50'E). Palm kernel meal was obtained from a commercial feed meal. Twenty-four (24) growing pigs of 8.95±1.01 kg body weight were randomly assigned into four dietary treatments; each contained 3 male and 3 female growing pigs. Each treatment comprised three replicates; each was made up of female and male growing pig. Diet 1 was PKM based diet in dry mash form. Diet 2 was PKM based diet in wet mash form. Diet 3 was PKM based diet plus Allzyme® SSF in dry mash form. Diet 4 was PKM based diet plus Allzyme® SSF in wet mash form.

Table 1. Composition of experimental diets

Ingredients (kg)	
Maize	25.00
Palm kernel meal	30.00
Groundnut cake	20.00
Wheat offal	8.00
Corn bran	10.00
Fish meal (65 %)	2.00
Bone meal	1.00
Oyster shell	0.50
Salt	0.40
Premix	0.50
Lysine	0.30
Methionine	0.30
Palm oil	2.00

Allzyme® SSF included in diets 3 and 4 (0.02g/kg); nutrient value (calculated): crude protein 25.528%; crude fibre 8.764% and energy 2481.571 kcal/g/DM

The animals were fed with their respective diets *ad libitum* and water was made available, feed intake for each animal was monitored daily and live weight changes were taken weekly throughout the experimental period. At the end of the feeding trial, blood samples were collected from the anterior vena cava of all the experimental pigs in the sample bottles containing Ethylene diaminetetraacetic acid (EDTA) for haematological analysis. The blood samples for serum analysis were allowed to clot. The blood sample was centrifuged and the serum was separated and stored for serum analysis. The collected serum samples were stored in a deep freezer for future analyses of chemical components; serum proteins; total serum protein, albumin and globulin.

The packed cell volume (PCV) and haemoglobin (Hb) were determined using the micro- haematocrit method and cyanmethehemoglobin method respectively as described by Mitruka and Rawnsley (1977). Erythrocyte count (RBC) and Leukocyte count (WBC) were determined using the improved Neubauer haemocytometer after the appropriate dilution (Schalm et al., 1975). Differenti leukocyte counts were determined by scanning Giemsa's stained slides in the classic manner (Schalm et al., 1975). Blood indices and corpuscular constants, the mean of corpuscular volume (MCV), corpuscular haemoglobin (MCH) and corpuscular haemoglobin concentration (MCHC) were determined using the appropriate formulae (Jain, 1986). Total serum protein was determined using the Buiret method. Albumin was determined using BCG (Bromocresol green) method as described by Peters et al. (1982). Globulin was determined by difference. Albumin-globulin ratio was determined according to the method of Coles (1986).

The data obtained were subject to statistical analysis using the analysis of variance procedure of statistical analysis software (SAS, 1999). The treatment means were presented with group standard errors and the significant was compared using the Duncan procedure of the same software.

Results and Discussion

The diet did not significantly affect (P>0.05) feed intake however, weight gain was

significantly affected (P<0.05) by the diet physical form and Allzyme® SSF supplementation. Pigs fed on the dry mash diet with Allzyme® SSF supplementation had the highest gain in weight while pigs fed on the wet mash diet with Allzyme® SSF supplementation had the least. Thus, the dry mash diet supplemented with Allzyme® SSF was proven the best form in terms of gaining weight (Table 2).

Feed conversion ratio was significantly affected (P<0.05). The feed conversion ratio was best for growing female pigs fed on dry mash diet with Allzyme® SSF. This implied that pigs fed on dry mash diet had the best feed conversion.

The haematological parameters (PCV, Hb, RBC, WBC, MCV, MCH and MCHC) observed showed no significant difference (P>0.05) among treatments (Table 3). The different leukocytes counts were not significantly influenced as well (P>0.05) by Allzyme® SSF supplementation and the diet physical forms. Serum total protein concentrations including serum albumin, globulin and albumin-globulin ratio showed no significant differences (P>0.05) among treatments.

The results obtained from this study was also in accordance with the findings of Adesehinwa (2007) who observed no adverse effect on dry matter intake, weight gain and feed conversion ratio as a result of the addition of palm kernel cake to the diets of growing pigs. The findings also agreed with the report of Alltech (2009) that Allzyme® SSF inclusion at the recommended rate will significantly improve weight gain and feed conversion ratio. Moreover, in this study, the enzyme- Allzyme® SSF did not significantly affect (P>0.05) feed intake but weight gain and feed conversion ratio, thus contrary to the report of Adesehinwa et al. (2010). This may be due to different physical forms in which the diets were offered (dry and wet) as reported by Kim et al.(2001) that the physical form of diet during the immediate post weaning period can have an immediate and lasting impact on pig growth performance. However, variations in feed intake and weight gain were not many and it is in line with the report of Scott et al. (1998) that variation in bird performance is reduced when enzymes are added to the feed. Also, Oluwafemi and Akpodiete (2010) in a study on response of weaned pigs to enzyme supplemented palm kernel cake as replacement for maize in their diets, stated that there were no significant differences (P>0.05) between the average total weight gain of weaner pigs on the control diet and those on diets of 40% PKC with and without enzyme. Akintunde et al. (2010) in an experiment to study the effect of Allzyme* SSF supplementation on the utilization of differently processed pigeon pea seeds by broiler chickens reported that Allzyme SSF supplementation in the diet did not significantly affect (P>0.05) final body weight, average daily weight gain, feed to gain ratio, feed cost per Kg gain and mortality. Yeong et al. (1981) also found no significant difference in daily feed intake and daily weight gain when growing chickens were fed with various levels of palm kernel meal in isonitrogenous, isocaloric diets but feed conversion ratio significantly improved when given diets containing lower levels of PKM namely isonitrogenous and isocaloric in this study. Haematological and blood biochemistry are routinely used to evaluate the health status of the animal. All the haematological indices assayed showed no significant difference (P>0.05). Dietary protein intake is known to affect the live weight and haematological parameters of animals (Mafuvadze and Erlwanger, 2007). Gouche et al. (1991) reported lowered albumin content to be specifically influenced by dietary protein shortage. Reduction in concentrations of erythrocytic parameters (such as Packed Cell Volume, red blood cell counts and haemoglobin concentration) and elevation in Mean Corpuscular Volume (MCV) are indications of

Table 2. Growth performance of growing pigs fed on different physical form diets with and without Allzyme® SSF

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	SEM	LOS
Initial live	8.87	8.53	11.00	7.40	1.01	NS
Final live weight	16.33	14.55	18.48	12.73	1.44	NS
Feed intake	6.58	6.55	6.67	6.42	0.17	NS
Weight Gain	1.24^{b}	1.00^{a}	1.25^{b}	0.89^{a}	0.08	*
Feed Conversion	5.08^{a}	9.92^{b}	3.50^{a}	8.17^{b}	1.10	*

a,b: Means with different superscripts on the same row are significantly different (P<0.05); LOS: Level of significance; NS: No significant difference (P<0.05); *: Significant difference (P<0.05); SEM: Group standard error of mean

Table 3. Haematological indices of growing pigs fed different physical form diets with and without Allzyme® SSF

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	SEM	LOS
Erythrocytes (10^{12}/L)	5.75	5.59	6.07	5.69	0.20	NS
Haemoglobin (g/L)	11.56	11.28	11.61	11.94	1.50	NS
MCV (fl)	61.02	60.67	57.50	63.52	4.10	NS
MCH(μμ/g)	20.28	20.23	19.16	21.17	1.38	NS
MCHC (%)	33.33	33.33	33.33	33.33	0.01	NS
PCV (%)	34.67	33.83	34.83	35.83	1.42	NS
Neutrophils (10^{9}/L)	27.83	29.50	27.83	26.50	3.31	NS
Eosinophils (10^{9}/L)	1.50	1.33	1.00	1.50	0.49	NS
Lymphocytes (10^{9}/L)	69.17	66.33	69.83	70.33	3.44	NS
Monocytes (10^{9}/L)	1.50	2.50	1.17	1.67	0.49	NS

LOS: Level of significance; NS: No significant difference (P<0.05); SEM: Group standard error of mean

macrocytic (regenerative) anemia emanating from increased destruction and subsequently enhanced erythropoiesis at liver, spleen and kidneys (Tripathi et al., 2008). However this was not the case in this study as the total protein, albumin, globulin and haematological parameters were not significantly influenced by the diet physical forms and Allzyme® SSF supplementation. It suffices to say that the nutrient profile of the diets was adequate to support the performance of the growing female pigs. This however agrees with the findings of Adesehinwa (2007) who supplemented palm kernel cake with cassava flour waste as energy source for pigs, and haematological parameters, total protein, albumin and globulin were not significantly affected (P>0.05).

Proteins form the basic unit of cells and other substances that are necessary for bodybuilding, repairs and maintenance of homeostasis, regulation of vital body functions, energy source and defense against infectious agents (Adesehinwa, 2008). Protein deficiency has been reported to reduce most haematological and serum parameters (Mafuvadze and Erlwander, 2007) through reduced or impaired synthesis of the blood cells which are largely proteinaceous.

Serum total protein concentrations, albumin, globulin and albumin-globulin ratio showed no significant differences (P>0.05) among treatments (Table 4). The results obtained from this study was in agreement with the findings of Adesehinwa (2009) who supplemented palm kernel meal based diet with cassava flour waste for pigs, the total serum protein, albumin, globulin and glucose concentrations in the serum were not significantly (P>0.05) affected. In conclusion, the results showed that the protein levels in

Table 4. Serum biochemistry of growing female pigs fed on different physical form diets with and without Allzyme® SSF

Parameter	Diet A	Diet B	Diet C	Diet D	SEM	LOS
Total Protein (g/dl)	6.12	5.77	6.04	5.49	0.41	NS
Albumin (g/dl)	3.65	3.92	3.40	3.65	0.30	NS
Globulin (g/dl)	2.47	1.85	2.62	2.01	0.37	NS
Albumin/ Globulin	1.59	2.51	1.37	2.94	0.55	NS

LOS: Level of significance; NS: No significant difference (P<0.05); SEM: Group standard error of mean

the diets were able to support the normal protein reserve in the growing pigs in all groups.

Allzyme® SSF did not significantly affect nutrient utilization in this study because the non- starch polysaccharides in palm kernel meal are 78% mannan, 3% arabinoxylans, 3% glucoronoxylans and 12% cellulose. To make the nutrients in palm kernel meal available, three main enzymes have been recommended namely mannanase, galactosidase and celullase to digest mannan, cellulose and the alpha-galactosidic side chains as reported by Balasubramaniam (1976) but the major enzymes in Allzyme® SSF are amylase, cellulose, phytase, xylanase, beta-glucanase, pectinase and protease.

Conclusions

Diet physical form and Allzyme® SSF supplementation in a palm kernel meal based diet did not affect nutrient utilization, performance, haematological and serum biochemical parameters. Consequently, diet physical forms and Allzyme® SSF supplementation in a palm kernel meal-based diet did not have any negative effect on the health of the growing female pigs.

However, PKM-based diet with Allzyme® SSF supplementation in dry form can be fed to growing pigs for better weight gain and feed conversion ratio.

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