Performance and economic analysis of growing pigs fed diets supplemented with different multi-enzymes complexes

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Abstract

Consumption of high-fibre diet with non-starch polysaccharides (NSP) has the potential to adversely affect energy and nutrient utilization with consequent reduction in pig performance. This study was carried out to investigate the efficacy of three different enzymes cocktail on growth performance of growing pigs fed high-fibre diets. The basal diet served as control (T1). Treatment 2 (T2) contained 0.3 g/kg diet of A (Xylanase, Cellulase, Protease, Alpha-amylase, Beta-glucanase, Phytase and Pectinase), treatment 3 (T3) contained 0.5 g/kg diet of B (Carbohydrases, Beta-glucanase, Pectinase, Protease) while treatment 4 (T4) contained 0.25 g/kg diet of C (Xylanase, Phytase, Alpha – amylase, Protease, Bacillolysin). Sixty grower pigs of an average initial weight of 26.06 ± 0.78 kg were randomly assigned to four dietary treatments (T) in a completely randomized design with three replicates per treatment and five animals in each replicate. Feed and water were supplied ad libitum. Feed intake and weight gain of the pigs were monitored weekly. Data were subjected to analysis of variance (ANOVA) using the General Linear Model procedures of SAS (2002). There were no significant differences ($P > 0.05$) in the performance indices of the pigs though those fed enzyme cocktails had improved daily weight. Lowest feed cost per kg weight gain (₦345.38/kg) was observed in pigs fed diet supplemented with enzyme cocktail at 0.25g/kg. It was concluded that cocktail of enzymes improved daily weight gain of growing pigs fed diets containing non-starch polysaccharides. Also, enzymes cocktail (0.25g/kg) reduced feed cost per kilogram weight gain of the pigs.

Keywords: Growing pigs, enzymes cocktail, Non-starch polysaccharides, weight gain, economic analysis

Performance et analyse économique de porcs en croissance nourris avec des régimes supplémentés de différents complexes multi-enzymatiques

Résumé

La consommation d'aliments riches en fibres avec des polysaccharides non amylacés (NSP) a le potentiel d'affecter négativement l'utilisation de l'énergie et des nutriments avec une réduction conséquente des performances des porcs. Cette étude a été réalisée pour étudier l'efficacité de trois cocktails d'enzymes différents sur les performances de croissance de porcs en croissance nourris avec des régimes riches en fibres. Le régime de base a servi de contrôle (T1). Le traitement 2 (T2) contenait 0,3 g/kg de régime A (Xylanase, Cellulase, Protéase, Alpha-amylase, Bêta-glucanase, Phytase et Pectinase), le traitement 3 (T3) contenait 0,5 g/kg de régime B (Carbohydrases, Bêta -glucanase, Pectinase, Protease) tandis que le traitement 4 (T4) contenait 0,25 g/kg de ration de C (Xylanase, Phytase, Alpha –

amylase, Protease, Bacillolysin). assignés à quatre traitements diététiques (T) dans une conception complètement randomisée avec trois répétitions par traitement et cinq animaux dans chaque répétition. La nourriture et l'eau étaient fournies ad libitum. La prise alimentaire et le gain de poids des porcs ont été surveillés chaque semaine. Les données ont été soumises à une analyse de variance (ANOVA) à l'aide des procédures du modèle linéaire général de SAS (2002). Il n'y avait pas de différences significatives ($P > 0,05$) dans les indices de performance des porcs bien que ceux nourris avec des cocktails enzymatiques aient amélioré leur poids quotidien. Le coût alimentaire le plus bas par kg de gain de poids (~~4~~345,38/kg) a été observé chez les porcs nourris avec un régime supplémenté avec un cocktail d'enzymes à 0,25 g/kg. Il a été conclu que le cocktail d'enzymes améliorait le gain de poids quotidien des porcs en croissance nourris avec des régimes contenant des polysaccharides non amylacés. De plus, le cocktail d'enzymes (0,25 g/kg) a réduit le coût des aliments par kilogramme de gain de poids des porcs.

Mots clés : Porcs en croissance, cocktail d'enzymes, Polysaccharides non amylacés, prise de poids, analyse économique

Introduction

Soluble nonstarch polysaccharides (NSP) have anti-nutritional effect and cannot be degraded by pigs because pigs cannot excrete NSP enzymes. Therefore, there has been considerable interest in applying exogenous non-starch polysaccharides degrading enzyme preparations for potential benefits. The effects of exogenous enzymes on growth performance and nutrient digestibility may be influenced by enzyme preparations, the physiological status of the animal and feed ingredient. Soluble nonstarch polysaccharides (NSP) have anti-nutritional effect and cannot be degraded by pigs because pigs cannot excrete NSP enzymes. Therefore, there has been considerable interest in applying exogenous non-starch polysaccharides degrading enzyme preparations for potential benefits. The effects of exogenous enzymes on growth performance and nutrient digestibility may be influenced by enzyme preparations, the physiological status of the animal and feed ingredient. Soluble nonstarch polysaccharides (NSP) have anti-nutritional effect and cannot be degraded by pigs because pigs cannot excrete NSP enzymes. Therefore, there has been considerable interest in applying exogenous non-starch polysaccharides degrading enzyme preparations for

potential benefits. The effects of exogenous enzymes on growth performance and nutrient digestibility may be influenced by enzyme preparations, the physiological status of the animal and feed ingredient.

Recent trends in the demand and supply of conventional feedstuffs necessitate swine producers around the globe to look for low-cost alternatives such as co-products from milling industries to feed their pigs at the expense of feed costs reduction (Woyengo *et al.*, 2014). Many of these co-products have been reported to have a high energy and nutrient content but they are also fibrous in nature. When fibrous co-products are integrated into pig diets, the carbohydrate structure inevitably deviates from a high-starch diet toward a diet with less starch and more non-starch polysaccharides (NSP), which are the major components of dietary fibre (Agyekum and Nyachoti, 2017). Pigs lack ability to secrete the digestive enzymes required to break down non-starch polysaccharides, but have the capacity to secrete the enzymes needed to hydrolyze starch (Zijlstra *et al.*, 2012). Generally, diets that are rich in dietary fibre have a lower nutritive value for monogastric animals, including pigs, because these animals' digestive enzymes are not capable of degrading non-starch polysaccharides (Bedford and Schulze,

1998). These non-starch polysaccharides have been proven to be unbroken by the activities of endogenous enzymes, therefore causing adverse effect by encapsulating other nutrients, increasing the endogenous nutrient loss, and then result in lower nutrient and energy digestibility (Adeola and Cowieson, 2011; Kerr and Shursn, 2013). The consumption of high-fiber diets also has the potential to adversely affect energy and nutrient utilization and consequently results in lower pig performance (Agyekum *et al.*, 2014; Agyekum *et al.*, 2015). Therefore, it is of utmost importance to supplement the appropriate NSP enzyme, especially NSP enzyme cocktail (NSPEC), in a variety of feeds to degrade the anti-nutrient factor (NSP) and improve growth performance of animals. According to Agyekum and Nyachoti (2017), quite a number of approaches have been employed to ameliorate the adverse effects linked with the consumption of high-fiber diets in pigs and to improve the nutritive value of such diets. The use of exogenous fibre-degrading enzymes to improve nutrient utilization and pig performance has been widely accepted. Previous studies showed that the supplementation of NSP enzyme complex (β -glucanase and xylanase) improved average daily gain of weaned and growing pigs (Prandini *et al.*, 2014). In addition, some studies observed that a complex of non-starch polysaccharide-degrading enzymes could improve the growth performance of the weaned piglets and growing-finishing pigs (Jo *et al.*, 2012; Yi *et al.*, 2013). However, (Olukosi *et al.*, 2007) did not observe a positive effect of enzyme cocktail supplementation on growth performance of pigs. The effects of fibre-degrading exogenous enzymes in fiber-rich pig feeds among studies remain inconsistent. This may be attributed to variations in the components of the enzyme cocktail. Many of the aforementioned

studies used enzyme cocktail of two or three enzymes combinations. Therefore, the study was aimed at assessing the effect of cocktail enzymes on the growth performance of grower pigs fed diets containing non-starch polysaccharides.

Materials and methods

Experimental location and duration

The experiment was conducted at AK Research Farms located at Eleyele, Ibadan, Oyo state, Nigeria and it lasted for a period of 63 days.

Experimental diets, animals and management

A basal diet that met the nutrient requirement of growing pigs was formulated using National Research Council (2012) as a guide. The diet was formulated using maize, palm kernel cake, wheat bran, corn bran and groundnut cake. The basal diet served as a control treatment (T1) and contained no enzyme supplementation. Three additional treatments (T) were prepared by adding different cocktail of enzymes (A, B and C) to the basal diets. Treatment 2 (T2) contained 0.3 g/kg diet of A (Xylanase, Cellulase, Protease, Alpha-amylase, Beta-glucanase, Phytase and Pectinase), treatment 3 (T3) contained 0.5 g/kg diet of B (Carbohydrases, Beta-glucanase, Pectinase, Protease) while treatment 4 (T4) contained 0.25 g/kg diet of C (Xylanase, Phytase, Alpha – amylase, Protease, Bacillolysin). These enzymes were sourced from Agro allied companies in Nigeria. Sixty growing cross bred (Large white $\times$ Landrace) pigs of average initial live weight of 26.06 ± 0.78 kg were used for the study. The pigs were allotted to the four experimental treatments. Each treatment consisted of three replicates and each replicate had five animals. The animals were placed in concrete pens with concrete water trough and semi-automatic feeders. The animals were fed with the experimental

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diets throughout the experimental period. Feed and water were given unrestrictedly.

Standard management practices were duly followed.

Table 1: Gross composition of the experimental diet

Ingredients (%)	T1	T2 + A	T3 + B	T4 + C
Maize	15.00	15.00	15.00	15.00
Palm kernel cake	50.00	50.00	50.00	50.00
Corn bran	10.00	10.00	10.00	10.00
Wheat bran	10.00	10.00	10.00	10.00
Groundnut cake	11.00	11.00	11.00	11.00
Bone meal	2.30	2.30	2.30	2.30
Oyster shell	1.20	1.20	1.20	1.20
Salt	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20
Premix	0.25	0.25	0.25	0.25
Threonine	0.03	0.03	0.03	0.03
Anti-fly guard	0.05	0.05	0.05	0.05
Enzymes	-	0.03	0.05	0.025
Total	100.33	100.33	100.33	100.33
Calculated values				
Metabolizable energy Kcal/kg	2617.50	2617.50	2617.50	2617.50
Crude protein	17.54	17.54	17.54	17.54
Crude fibre	8.51	8.51	8.51	8.51

Note: the total does not include the enzymes

A: Enzyme cocktail (Xylanase, Cellulase, Protease, Alpha -amylase, Beta-glucanase, Phytase and pectinase), B:enzyme cocktail (Carbohydrases (beta -glucanase), Pectinase, Protease), C: enzyme cocktail (Xylanase, Phytase, Alpha – amylase, Protease, Bacillolysin)

Data collection and statistical analysis

Weekly feed intake and body weight gain were monitored. Feed conversion ratio average daily weight gain and average daily feed intake were calculated. Feed conversion ratio was calculated by dividing total feed consumed by each animal by its respective total body weight gained. Daily weight gained was derived by dividing total body weight gained by the number of experimental days while daily feed intake was calculated by dividing the actual feed intake of each animal by the number of experimental days.

Economic of production

The cost per kg of the diet was calculated by multiplying the percentage composition of the feedstuffs with the prevailing price per kg of each feedstuff and summing all. Total feed intake and cost per kg of feed was used to calculate the total feed cost. Feed cost per

kg weight gain was calculated by multiplying feed conversion ratio (FCR) with cost per kg diet. Data were subjected to analysis of variance (ANOVA) appropriate for completely randomized design using the General Linear Model procedures of SAS (2002). Statistical significance was assessed at $P < 0.05$ (95% confidence) while means were separated using Duncan's Multiple Range Test.

Results and discussion

Growth performance of growing pigs fed different cocktail enzymes

Table 2 shows the performance characteristics of grower pigs fed the experimental diets. There was no significant ($p > 0.05$) effect of the treatment on the growth performance indices of the animals. The final body weight ranged from 46.37 to 48.14 kg with pigs fed diet contained

cocktail enzymes B (Carbohydrases, Beta-glucanase, Pectinase and Protease) having the highest final body weight while cocktail enzyme C (Xylanase, Phytase, Alpha – amylase, Protease, Bacillolysin) had the lowest final body weight. In terms of body weight gain, pigs fed cocktail enzyme supplemented diets had improved body weight gains compared those fed non-supplemented diet (control). The pigs fed control diet had body weight gain of 19.36 kg while those in supplemented groups had values ranged from 21.40 to 22.04 kg. Among the enzyme-supplemented groups, pigs fed diet supplemented with cocktail enzymes B had better body weight gain (22.04 kg) than those fed diets supplemented with cocktail enzymes A and B . There were 9.5, 12.2 and 9.5% improvements in body weight gains of pigs fed diets with enzyme supplementation respectively for cocktail of enzymes A, B and C when compared with those pigs on control diet. It is worthy of note that pigs fed diet supplemented with cocktail enzymes had same body weight gains despite the differences in their compositions. Although, cocktail of enzymes A contained all the components of cocktail of enzymes C with the exception of Bacillolysin in addition with cellulase, beta-glucanase and pectinase. Bacillolysin in cocktail of enzymes C seems to have performed altogether the functions of cellulase, beta-glucanase and pectinase in cocktail of enzymes A which probably resulted in no significant difference in the body weight gains of the pigs. The daily weight gain of the pigs across the treatments followed similar pattern with their body weight gains. The daily weight gains ranged from 0.307 to 0.350 kg. There exists no significant ($p>0.05$) differences in the daily feed intake and feed conversion ratio (FCR) of the pigs across the treatments. The daily feed intake ranged from 1.339 to 1.507 kg. Pigs fed diet supplemented with cocktail of enzymes B

had higher daily feed intake while those on the control diet has the lowest daily feed intake. The feed conversion ratios were also similar among the treatments with pigs fed diet supplemented with cocktail of enzymes C having the least FCR (4.126) while the highest FCR (4.362) was noticed in pigs fed non-supplemented diet (control).

Although, there was no significant difference but the improvement in body weight gain observed in this study is in agreement with the earlier finding of Prandini *et al.* (2014), who reported better weight gain in weaned and growing pigs fed diets supplemented with cocktail of enzymes (beta-glucanase and xylanase). The earlier report of Wang *et al.* (2018) disagreed with the findings of this study. The authors reported improvement in the weight gain of weanling pigs as a result of inclusion of multi-enzyme in a corn-soyabean meal-based diet. The disparity in the outcomes could be due to age difference of the experimental animals. Insignificant effect of the cocktail of enzymes in this study may be an indication that grower pigs have a well-developed gastro-intestinal tract (GIT) with sufficient amount of beneficial microbes while significant effect of multi-enzymes reported by Wang *et al.* (2018) served as a shred of evidence that the GIT of weaner pigs is underdeveloped with insufficient endogenous enzymes and microbiota. The earlier findings of Kim *et al.* (2008) on combination of xylanase with phytase and protease showed positive effects on energy and nutrient digestibility in barrows fed diet containing 20% distiller's dry grain. This is not in consonant with the results of the present study; even though the present study did not evaluate nutrient digestibility but better growth performance. In an experiment with broilers chicken, increased fermentation of xylans in the caeca of birds fed xylanase supplemented diet was noted in older but not younger birds, suggesting that there is

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indeed an adaption of the microbiome over time, enabling it to utilize xylan as a significant fuel for production of volatile fatty acids (Lee *et al.*, 2017a). The illustration above further strengthens the

notion that enzymes may not make any significant difference in older animals compare to younger ones because of the capability of older animals to secrete endogenous enzymes and proliferation of beneficial microbes.

Table 2: Performance of growing pigs fed experimental diets

Parameters (per pig)	T1	T2	T3	T4	SEM	P-value
Initial body weight (Kg)	27.214	25.967	26.107	24.967	0.7826	0.8018
Final body weight (Kg)	46.571	47.367	48.143	46.367	1.2558	0.9607
Body weight gain (Kg)	19.357	21.400	22.036	21.400	0.8838	0.7470
Daily weight gain (Kg)	0.307	0.340	0.350	0.340	0.0140	0.7470
Daily feed intake (Kg)	1.339	1.432	1.507	1.403	0.0288	0.4106
Feed conversion ratio	4.362	4.212	4.306	4.126	0.2328	0.8413

SEM; standard error of means

Economic analysis of growing pigs fed diet with different cocktail of enzymes

In order to have meaningful conclusions on whether to recommend a particular product for farmers, economic benefits of using such a product must be clarified. The economic analyses of using each of these products are presented in Table 3. The cost of feed per kilogram ranged from – 82.62 to – 84.77 with control diet having the least value while the highest value was observed in diet supplemented with enzyme cocktail B. The variations observed in the cost of feed across the treatments were as a result of differences in the price of the supplements. Total costs of feeding throughout the experiment were not significantly ($p>0.05$) different from one another. The animal placed on diet with enzyme cocktail B consumed more feed than the rest, hence higher total cost of feeding (– 8,047). Total cost of feeding animals on the control diet

was the least (– 6,973). Total costs of feeding animals placed on diets supplemented with enzyme cocktail A and C were in close range due to similar cost of feed and feed consumption. Similar trends were noticed in the average cost of feeding per day. The cost of feed that was consumed by the animal that yielded a kilogram live weight of the animal was also estimated. The cost of producing a kilogram live weight of the animal was highest (– 366.52) in pigs fed diet supplemented with enzyme cocktail B while the least value (– 345.38). This means it was cheaper to produce a kilogram live weight of pig using enzyme cocktail C when compared with enzyme cocktail A and B under the nature of this experimental basal diet. Feeding diets supplemented with enzyme cocktail C is more economical than enzyme cocktail A, B and the control diet.

Table 3: Economic analysis of growing pigs fed experimental diets

Parameters	T1	T2	T3	T4	SEM	P-value
Cost of feed (– /kg)	82.62	83.33	84.77	83.42	-	-
Total cost of feeding (–)	6973	7516	8047	7376	345.25	0.8115
Average cost of feeding/day (–)	110.69	119.29	127.73	117.08	5.623	0.8115
Feed cost/kg weight gain (– /kg)	361.40	350.06	366.52	345.38	8.624	0.8542

SEM; standard error of means

Conclusions and recommendation

The study concluded that cocktail enzymes supplementation did not improved daily weight gain of growing pigs. However, supplementing cocktail enzyme C to diet with non-starch polysaccharide produced a kilogram live weight of pig at a cheaper rate, therefore enzyme cocktail C could be recommended.

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Competing interest

The authors declare no conflict of interest.

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