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ORIGINAL RESEARCH ARTICLE

Growth Performance and Carcass Attributes of Pubertal Boars Fed Dietary Neem (*Azadirachta indica* A. Juss) Kernel

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ABSTRACT

The increasing cost of maize as a source of dietary energy for swine necessitates investigation into unconventional alternative energy sources. Neem kernel (NK) has a higher dietary energy hence, the growth and reproductive potential of growing male pigs fed with diets in which maize was partially replaced with NK was investigated. Forty crossbred (Large White x Landrace) male weanling pigs were allotted into experimental treatment in a completely randomised design to evaluate the influence of NK inclusion in swine diets at 0, 50, 100 and 150 g/kg on feed intake (FI), weight gain (WG), feed conversion efficiency (FCE) and dressing percentage. Data were analysed using descriptive statistics and ANOVA. Pigs on 100 and 150 g/kg WNK diets showed significantly (P<0.05) lower FI (80.01kg, 74.89kg) compared to control with 88.53 kg Pigs on 50 g/kg gave similar FI (89.53kg) to those on control. Mean values of WG and FCE observed were not significant across treatment. Pigs on 50 g/kg NK diet had a superior (P<0.05) dressing percentage of 59.21 compared to those on control with 57.83 This investigation indicated that neem kernel can be included up to 150 g/kg in swine diets without deleterious effects on boars' growth performance and dressing percentage.

Keywords: Pigs, neem kernel, growth performance, dressing percentage

INTRODUCTION

The primary objective of pork production is to produce lean meat in a cost effective and sustainable manner. From a nutritional perspective, energy is perhaps the most critical nutrient, because it is the most expensive to provide in the diet and because gut capacity may limit the ability of the pig to consume sufficient quantities to achieve their full genetic potential for growth (Patience *et al.*, 2004). Feeding pigs a balanced diet is an essential part of the pig profit equation. Since feed accounts for 55 to 75 % of total costs, feeding and nutrition can make a huge difference to pig farm profits. However, formulating balanced diets for pigs is both tasking and costly due to various factors. It therefore becomes imperative to investigate the effect of the utilization of unconventional feedstuffs in swine feed formulation. Neem kernel holds some promise because of its potential as a high energy source for swine feeding with the possibility of replacing some quantity of maize that is the major source of energy in livestock production in Nigeria. The bitter and toxic triterpenoids such as salannin, azadirachtin and deacetyl nimbin in neem cake have restricted its use as an animal feed. Several workers have attempted to improve its nutritive value by different processing methods and water washing was found to be the most effective (Nath *et al.*, 1983, Agrawal *et al.*, 1987, Sastry and Agrawal, 1992, and Verma *et al.*, 1995). Their studies indicated that water washing either completely detoxified the neem bitters or that the residual bitters did not have any adverse effects. However, a 22 % dry matter loss occurs through this process. To avoid this loss, ensiling neem cake in an alkaline medium using fertilizer grade urea without further washing with water was effective and economical for feeding growing buffalo calves (Reddy, 1992) and broiler chicks (Nagalakshimi, 1993). Also attempts have been made to detoxify neem kernel meal using natural lactic fermentation and treatment with Lyle for pigs' feeding which resulted in considerable reduction of the bitter principles (Annongu, *et al.*, 2003).

However, because pig farming in Nigeria is primarily a smallholder concern (Ajala, 2003; Pathiraja, 1986), it is imperative to advance research applications that can be easily adopted by these sets of farmers. Thus the aim of this investigation is to ascertain the effect of heat treated Neem kernels' inclusion in swine diets on some performance characteristics such as feed intake, weight gain, feed conversion efficiency, protein efficiency ratio and dressing percentage.

Table 1: Composition of experimental diets

Ingredients	Dietary Neem kernel (g/kg)			
	0	5	10	15
Maize	40.00	35.00	30.00	25.00
Neem kernel	0.00	5.00	10.00	15.00
Groundnut cake	15.00	15.00	15.00	15.00
Palm kernel cake	10.00	10.00	10.00	10.00
Wheat offal	13.00	13.50	14.00	15.00
Corn bran	15.00	15.00	15.00	15.00
Fish meal (65%)	2.00	2.00	2.00	2.00
Bone meal	1.00	1.00	1.00	1.00
Oyster shell	0.50	0.50	0.50	0.50
Salt	0.40	0.40	0.40	0.40
Premix†	0.50	0.50	0.50	0.50
Lysine	0.30	0.30	0.30	0.30
Methionine	0.30	0.30	0.30	0.30
Vegetable oil (Palm oil)	2.00	1.50	1.00	0.00

† Micro-Mix Growers: 2.5 kg of premix contains
Vit. A (10,000,000.00 I.U.); Vit. D_3 (2,000,000.00 I.U.); Vit. E (20,000.00 mg); Vit. K_3 (2,000.00 mg); Vit B_1 (3,000.00 mg); Vit. B_2 (5,000.00 mg); Niacin (45,000.00 mg); Calcium Pantothenate (10,000.00 mg); Vit. B_6 (4,000.00 mg); Vit. B_{12} (20.00 mg); Folic Acid (1,000.00 mg); Biotin (50.00 mg); Choline Chloride (300,000.00 mg); Manganese (120,000.00 mg); Iron (100,000.00 mg); Zinc (80,000.00 mg); Copper (8,500.00 mg); Iodine (1,500 mg); Cobalt (300.00 mg); Selenium (120.00 mg); Anti-Oxidant (120,000.mg)

MATERIALS AND METHODS

Proximate composition determination for whole neem kernel

Neem fruits were harvested from mature trees and samples of the harvest were analysed for proximate analysis. One kg per sample of neem fruits was soaked in water for 24 hours to soften the coats, so that the seeds could easily be pressed out. The seeds were sun dried, shelled and the endosperms (kernels) thus separated were analysed for moisture content by dehydration in an oven at 65 ºC (for 24 hours) and proximate composition using the analytical methods of A.O.A.C. (1990).

Experimental animals, diets, design and management

Forty cross bred (Large White x Landrace) weanling male pigs were randomly allotted to four diets (Table 1) formulated to be iso-nitrogenous and iso-calorific with graded levels of NK (0 g/kg, 50 g/kg, 100 g/kg and 150g/kg) such that each diet had ten pigs in individual pens in a completely randomised design. The pigs were penned in a dwarf-walled well-ventilated cement-floored building. The pigs were fed a commercial pigs' grower diet for two weeks to stabilize them and then placed on the experimental diets for twelve weeks. The pigs were treated against parasitic infestation (external and internal) with Ivomectin® (1 ml kg^{-50} body weight) during the two weeks period of adjustment and feeds were provided twice daily at 8.00 hours and 16.00 hours, and animals were weighed before feeding at the commencement of the feeding trial and every 7 days thereafter until the end.

Feed intake, weight gain, feed conversion efficiency and dressing percentage

During the feeding trials, feed intake and weight changes were monitored for individual pigs, for the determination weight gain and feed conversion efficiency (FCE) of pigs on each diet. To elucidate the effect of NK on the growth pattern of the pigs the first six weeks (week 1 to week 6) is referred to as the first feeding phase and the subsequent six weeks (week 7 to week 12) referred to as the second feeding phase. The experimental pigs were sacrificed at the end of the feeding trial for dressing percentage determination.

Statistical analysis

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

RESULTS

Proximate composition of whole neem kernel and experimental diets

Presented in Table 2 is the proximate composition of neem kernel and maize. The analysis showed that NK had similar crude protein content as maize that was replaced in the experimental diets. Table 3 shows the proximate composition of the experimental diets. The

proximate analysis of the diets indicated similarities in organic matter and crude protein contents in all four diets with slight differences for other parameters, where a linear increase was evident from 0 g/kg to 150 g/kg of NK in the diets for crude fibre, ether extract and ash.

Feed intake, weight gain, feed conversion efficiency and dressing percentage

Presented in Table 4 are the mean values of performance characteristics of pubertal boars to diets containing NK at varying levels. The feed intake for the pigs was significantly reduced ($P < 0.05$) at 100 g NK/kg diet and a linear decrease from 50 g NK/kg diet to 150 g NK/kg diet was observed at the first feeding phase. This linear decrease was also evident at the second feeding phase but a significant depression ($P < 0.05$) was only indicated at 150 g NK/kg diet. Results of the feed intake for the pigs indicated that pigs on 50 g NK/kg diet compared favourably with those on the control diet, and they consumed more, especially at second feeding phase though non-significantly.

Table 2: Proximate composition of neem kernel

Parameters (%)	Neem kernel	Maize†
Dry matter	92.48	86.00
Crude protein	10.06	9.80
Crude fibre	7.63	2.40
Ether extract	40.92	4.20
Nitrogen free extract	36.33	82.30
Ash	5.06	1.30

† Source: McDonald, P., Edwards, R.A., Greenhalgh, J.F.D. and Morgan, C.A. (1999). Animal Nutrition. (Fifth Edition). Addison-Wesley, England.

The effect of time was also reflected by the improvement of feed intake by the pigs on the treated diets at the second feeding phase with pigs on 100 g NK/kg diet comparing favourable with those on control diet and those on 150 g NK/kg diet narrowing the difference in feed intake to those on control diet, though the observed difference was significant ($P < 0.05$). Weight changes observed for the male pigs were not significant among diets at the end of the two feeding phases. Notwithstanding, a linear decrease as NK in the diets increased was observed at both feeding phases. Weight gain was significantly affected by the inclusion of NK at 100 g/kg and 150 g/kg in phase 1 while this was not repeated in phase two. Though not significant, pigs on 50 g/kg and 100 g/kg NK diets gained slightly more weight than those on control diet. Differences in FCE mean values of the experimental diets for both feeding phases were not significant. However, a linear decrease was observed as NK in the diets increased in phase 1 while this was not evident in phase 2, where male pigs on 100 g/kg WNK diet had a higher FCE mean value than those on the control diet. The differences in mean values of dressing percentage of the experimental male pigs were significant ($P<0.05$). Pigs on 50 g/kg NK diet had a superior dressing percentage to those on other diets.

DISCUSSION

Proximate composition of neem kernel

Proximate analyses by Fajinmi *et al.* (1988), Nath *et al.* (1983) and Girish-Kumar (1988) have shown that various forms of neem seed kernels are moderately high in protein. The crude protein content of NK used for this study was lower than that reported by Salawu *et al.* (1994) and Annongu *et al.* (2003). Wide variations in crude protein (11.20 to 25.40 %) and ether extract (11.00 to 47.00 %) have been reported by Girish-Kumar (1988) for neem seed cake. This could be due to differences in the prevailing environmental conditions in the areas of collection of the fruits and kernels.

Feed intake, weight gain, feed conversion efficiency and dressing percentage

The characteristic foul odour and bitter taste associated with neem (Sankaram *et al.*, 1986) may suggest that untreated NK cannot be accepted by livestock, therefore the acceptance of NK by pigs used for this study up to 100 g/kg NK in the diet without any substantive or expensive treatment apart from exposure to moderate heat through oven drying is encouraging.

Table 3: Proximate composition of experimental diets

Parameters (%)	Dietary neem kernel (g/kg)			
	0	50	100	150
Organic matter	97.70	96.92	98.22	97.86
Crude protein	17.29	17.47	17.50	17.69
Crude fibre	8.13	9.12	10.45	11.29
Ether extract	9.08	10.92	11.92	13.33
Nitrogen free extract	61.00	57.39	54.60	51.60
Ash	4.50	5.00	5.60	6.08

Table 4: Performance characteristics of pubertal boars fed diets containing neem kernel

Parameters	Dietary neem kernel (g/kg)				Group SEM	Level of significance
	0	50	100	150		
Initial Body Weight (kg)	14.55	14.54	14.75	14.88	0.44	NS
Body Weight–Phase 1 (kg)	25.48	25.48	22.51	22.40	0.72	NS
Body Weight-Phase 2 (kg)	35.80	35.88	33.05	31.45	0.96	NS
Weight Gain-Phase 1 (kg)	10.93^{a}	10.94^{a}	7.76^{b}	7.53^{b}	0.51	P<0.05
Weight Gain-Phase 2 (kg)	10.33	10.40	10.54	9.05	0.33	NS
Feed Intake-Phase 1 (kg)	42.31^{a}	42.50^{a}	35.54^{b}	33.91^{b}	1.04	P<0.05
Feed Intake-Phase 2 (kg)	46.21^{a}	47.03^{ab}	44.48^{a}	40.98^{c}	0.66	"
Feed Intake-Total (kg)	88.53^{a}	89.53^{a}	80.01^{b}	74.89^{c}	1.61	P<0.05
FCE-Phase 1	0.260	0.258	0.220	0.225	0.01	NS
FCE-Phase 2	0.228	0.220	0.238	0.225	0.01	NS
FCE-Total	0.240	0.240	0.230	0.225	0.01	NS
Dressing Percentage	57.83^{a}	59.21^{b}	58.30^{a}	57.95^{a}	0.22	P<0.05

NS= Not significant, SEM= Standard error of the mean, and abc= means in rows followed by different superscripts differ significantly.

The significantly reduced (P < 0.05) feed intake observed from pigs on 150 g/kg NK diet could be explained by the unpalatable nature of NK. Salawu *et al.* (1994) shared this view from their study on the utilization of full fat neem seed meal by rabbits and broiler chicks. Verma *et al.* (1995) reported that the bitter taste and toxic nature of neem seed kernel cake due to the triterpenol derivatives such as nimbin, azadirachtin, salannin and diacetyl-nimbin it contains limits its utilization as livestock feed. Several authors such as Nath *et al.* (1983), Sastry and Agrawal (1992), Agrawal *et al.* (1987) and Agrawal and Nath (1989) reported the suitability of neem seed kernel cake for animal feeding after washing with water to reduce these bitter principles. The pigs performed better on NK in the second feeding phase compared with the first feeding phase. The poor performance of the pigs on NK in phase 1 possibly reflected an effect of NK inclusion in swine diets on nutrients' availability.

In phase 2 there was compensation for both the reduced intakes and growth rates in phase 1 with pigs on 50 g/kg NK diet performing particularly well to produce a non-significant but outstanding result compared with those obtained from pigs on control diet. This improved performance of pigs on the NK diets could have reflected an increased tolerance to the anti-nutritional factors present in NK and possibly a yet to be identified growth modulating principles (Salawu *et al*., 1994) in neem offered to livestock at low concentrations. Verma *et al.* (1995) reported that although non-significant, goats on experimental diets, especially on 15 % water washed neem seed kernel cake incorporated in their diets, grew faster and utilized feed more efficiently than those on control diet. Sastry and Agrawal (1992) and Agrawal *et al.* (1987) reported the same observation from pigs and buffalo calves respectively. Verma *et al.* (1995) postulated that their findings indicated that residual neem bitters remaining after water washing, in neem seed kernel cake were not harmful, but may even be beneficial. Salawu *et al.* (1994) in their own study reported that the mean weekly weight gain, food conversion and protein efficiency ratio of birds on the control diet were significantly (P < 0.05) better than those recorded on all the full fat neem seed meal diets in the starter phase initially. However in the finisher phase a different picture was presented, with birds on 50 g full fat neem seed meal per kg particularly performing better. The FCE, weight gain and PER of birds on diets with concentration up to 75 g full fat neem seed meal per kg did not differ significantly from those recorded on the control diet. They also speculated that the acceptance of full fat neem seed meal at a higher level without significant reduction in performance by growing rabbits when compared to the negative response by chicks at this level indicates a difference in response to neem diets between livestock species. They suggested that the presence of large populations of microorganisms of numerous types in rabbits' large intestine might impart an ability to digest and metabolise greater varieties of feeds than other simple stomached animals. Phytotoxins such as azadirachtin have been shown to being broken down by enzymes and microbial hydrolysis (Yosiok *et al.*, 1966).

However at a level in excess of 100 g/kg NK in the diet, the peculiar strong odour and bitter taste diet appear to give increasing problems with intake by growing pigs leading to poor acceptability at 150 g/kg diet. Treatment methods employed by Annongu *et al.* (2003) in their study incidentally included ultraviolet photolysis when the kernels were sun dried (photo-degradation of

azadirachtin has been reported under field condition by Redknap (1981) and Lange (1984). It is important to note that their treatment process on neem kernel meal involved sun curing twice and the second exposure could actually be longer than the previous, having soaked the kernels in Lyle for 48 hours. It will be interesting to know the degree of degradation by lactic fermentation and treatment with Lyle of neem kernels before exposure to ultra violet rays during sun curing. They reported that their experimental pigs consumed more of the feed containing treated neem kernel meal than those pigs fed diets containing raw neem kernel meal because of the bitter alkaloids with unpleasant odour in neem kernels. It is important to note that the weight gained by pigs fed treated neem kernel meal (where they reported the residual limonoids remaining in the kernels after treatment to be negligible) was significantly reduced when compared to pigs on control diet. They suggested the possibility of the presence of anti-nutritional factors even after treatment of neem kernels included in pigs diet. Salawu, *et al.* (1994) had earlier implicated the possibility of the presence of high concentration of beta-glucans.

Results indicated a better dressing percentage from pigs on 50 g NK/kg diet when compared to those on control diet. It is also important to note that pigs on higher level of inclusion of NK up to 150 g/kg in their diet gave a slightly higher though non- significant dressing percentage to that of control. It thus appears that inclusion of NK up to 150 g/kg in swine diets will not affect negatively their dressing percentages.

CONCLUSION

Neem kernel can be included up to 100 g/kg in boars' diets without deleterious effects on their growth. Results also indicated positive influence of neem kernel inclusion in swine diets on dressing percentage.

CONFLICT OF INTEREST

Authors declare that there is no conflict of interest concerning the submission of this manuscript for publication.

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