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ORIGINAL RESEARCH ARTICLE

Growth and reproductive potential of pubertal boars fed dietary neem (*Azadirachta indica* A. Juss) kernel

Sokunbi, O. A

Animal Physiology Laboratory, Department of Animal Science, University of Ibadan, Nigeria
Correspondence: jide.sokunbi@gmail.com; +2348055302569

ABSTRACT

The increasing cost of maize as a source of dietary energy for swine necessitates investigation into unconventional alternative energy sources. Thus, neem kernel (NK) was assessed with diets in which maize was partially replaced with NK for growth and reproductive performance of growing male pigs. In the study, 40 crossbred (Large White x Landrace) male weanling pigs were allotted into four experimental treatments in a completely randomised design with eight replicates to evaluate the effects 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), reproductive tract characteristics and daily sperm production (DSP). Data were analysed using descriptive statistics and analysis of variance at p=0.05. Pubertal boars on 100 and 150 g/kg NK diets showed significantly (p<0.05) lower FI at79.99kg and 74.89kg respectively while that of WG were18.30kg and 16.58kg respectively compared to control (88.53 kg and 21.26kg respectively). Significant (p<0.05) effects were observed for most of the reproductive parameters evaluated. Similar testes density and DSP values were observed at 0, 50 and 100 g/kg NK diets, while a significant (p<0.05) decrease was indicated at 150 g/kg NK diet. It is concluded that neem kernel can be included up to 100 g/kg to replace maize in boars' diets without deleterious effects on growth and reproductive performance.

Keywords: Pigs, neem kernel, growth performance, reproductive characteristics

INTRODUCTION

The primary objective of pork production is to produce lean meat that is cost effective and sustainable 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). Moreover, because pig farming in Nigeria is primarily a smallholder concern (Pathiraja, 1986; Ajala, 2003), it is imperative to advance research applications that can be easily adopted by these sets of farmers. 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. There are many factors that affect the reproductive efficiency of the pig. Reproductive efficiency can be reduced because of improper nutrition. It was suggested by Etches *et al.* (1979) that production of defective spermatozoa and their failure to ascend the oviduct properly is due possibly to defective carbohydrate metabolism. However, it has been shown that neem cake retards spermatogenesis in male mammals without inhibiting sperm production (NRC, 1992) and the effect seemed to be temporary. Thus the aim of this investigation was to ascertain the effect of neem kernels' inclusion in swine diets on feed intake, weight gain, feed conversion efficiency, dressing percentage and reproductive performance of growing pigs.

MATERIALS AND METHODS

Experimental animals, diets, design and management

Forty cross bred (Large White x Landrace) weanling male pigs were randomly allotted to four diets (Table 1). The diets were formulated to be iso-nitrogenous and iso-calorific with graded levels of neem kernel; 0 g/kg (diet 1), 50 g/kg (diet 2), 100 g/kg (diet 3) and 150 g/kg (diet 4). The pigs were housed in individual pens in a completely randomised design with eight replicates per treatment. All the pigs were penned in a dwarf-walled well-ventilated cement-floored building. The pigs were fed with commercial pigs' grower diet for two weeks to acclimatise them and then placed on the experimental diets for another 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. The pigs were weighed before feeding at the commencement of the feeding trial and every 7 days thereafter till they

Table 1: Ingredient composition (g/kg) of experimental diets

Ingredients	Dietary neem kernel			
	0	50	100	150
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 Vitamin A (10,000,000.00 I.U.); Vitamin D_3 (2,000,000.00 I.U.); Vitamin E (20,000.00 mg); Vitamin K_3 (2,000.00 mg); Vitamin B_1 (3,000.00 mg); Vitamin B_2 (5,000.00 mg); Niacin (45,000.00 mg); Calcium Pantothenate (10,000.00 mg); Vitamin B_6 (4,000.00 mg); Vitamin 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)

Source: Sokunbi (2007)

attained puberty. Feed intake and weight gain were determined using standard procedures.

Testicular, epididymal and pubertal characteristics, accessory glands and daily sperm production of pubertal boars

Egbunike (1979) put the age at puberty of boars raised in the tropics between 4 and 6 months. Gilts were routinely introduced to the male pigs when they were four months of age following the procedure of Egbunike (1979). The male pigs were closely observed for sexual behaviours such as nosing the side of the gilt, ano-genital sniffing, grunting, mounting, penile protrusion and thrusting. This introduction was initially done twice weekly, and daily when sexual behaviours from the male pigs became strong. A sexually active male pig when detected was placed together with a group of oestrus manifested gilts. Attainment of puberty was determined by microscopic examination of sperm cells from preputial smears obtained from boars that mounted and extended their penis or assisted using the massage technique. Positive preputial smears were later confirmed by the presence of copious amounts of spermatozoa in the exudates of caudal epididymides of the pigs after sacrifice (Nelsson *et al*., 1982). Immediately after sacrificing the pigs, the vesicular gland, bulb of prostate gland, bulbourethral gland, the testes, caudal, corpus and caput epididymides were closely trimmed and weighed. The volume of the testes was determined using Achimedes' principle of water displacement.

Testicular and epididymal sperm reserve: This is the total number of spermatozoa and late spermatids counted in testicular/epididymal aqueous suspension. The process involved the homogenisation of known weight of testes and epididymides in ice-cold physiological saline for two minutes, and counting sperm cells with the Neubuar haemocytometer (Egbunike *et al*., 1975).

Daily sperm production (DSP): The DSP was calculated from gonadal sperm reserve using a formula proposed by Amann (1970):

$$DSP = \frac{\text{Spermatozoa count}}{\text{Time divisor}}$$

A time divisor of 4.37 also proposed by Amann (1970) was utilized.

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

Feed intake, weight gain and feed conversion efficiency of pubertal boars fed dietary neem kernel

Presented in Table 2 are the mean values of performance characteristics of growing male pigs fed with diets containing neem kernel at varying level.

Table 2: Performance characteristics of growing male pigs fed diets containing neem kernel

Parameters	Dietary neem kernel (g/kg)				Group SEM
	0	50	100	150	
Initial body weight (kg)	14.55	14.54	14.75	14.88	0.44
Final body weight (kg)	35.80	35.88	33.05	31.45	0.96
Weight gain (kg)	21.26[a]	21.34[a]	18.30[b]	16.58[b]	0.51
Feed intake (kg)	88.53[a]	89.53[a]	79.99[b]	74.89[c]	1.61
Feed conversion efficiency	0.240	0.240	0.230	0.225	0.05

SEM = Standard error of the mean, and a, b, c = means in the same row with different superscripts differ significantly (P <0.05).

The feed intake for male pigs was significantly reduced (P < 0.05) at 100 g/kg NK diet. Results of the feed intake for the male pigs indicated that pigs on 50 g/kg NK diet compared favourably with those on the control diet, and they ate more, though non-significantly. Weight gain was significantly affected by the inclusion of NK at 100 and 150 g/kg. Though non-significant, male pigs on 50 and 100 g/kg NK diets gained slightly weight than those on control diet. Differences in FCE mean values of the experimental diets were non-significant. However, depression in mean values was observed as NK in the diets increased.

Testicular, epididymal and pubertal characteristics, accessory glands and daily sperm production of pubertal boars

The results presented in Table 3 indicated significant (p < 0.05) differences between mean values for all testicular and epididymal parameters investigated. This also holds for the accessory glands. A 15.51% reduction in paired testes weight was observed in pubertal boars on 50 g/kg NK diet when compared to those on control diet. Further reductions of 26.99 and 39.39 % were observed from pubertal boars on 100 and 150 g/kg NK diets respectively. A significant (P < 0.05) reduction of 16.86, 27.77 and 38.01 % in paired testes volume were observed from pubertal boars on 50, 100 and 150 g/kg NK diets respectively when compared with those on control diet. These significant (P < 0.05) reductions in mean values also hold true for paired epididymidal weight with observed reductions in weights when compared with that of control of 15.18, 25.97 and 37.98% from young boars on 50, 100 and 150 g/kg NK diets respectively. However, these significant (p < 0.05) reductions were not as pronounced in weights for relative epididymides 11.54, 11.54 and 19.23% from pubertal boars on 50, 100 and 150 g/kg diets respectively when compared to values observed for relative testes of 19.75, 17.28 and 22.22% from pubertal boars on 50, 100 and 150 g/kg NK diets respectively.

The effect of NK on the accessory glands was not as severe as that observed for testicular and epididymal parameters. Significant (P < 0.05) increases were observed from pubertal boars on 50 g/kg NK diets for the three accessory glands when compared to those on control. Significant (P < 0.05) depressions occurred in pubertal boars on 100 and 150 g/kg diets for bulb of prostate and seminal vesicle, while a significant (P < 0.05) depression was evident at 150 g/kg NK diet in pubertal boars for bulbourethral. Presented in Table 4 are the mean values of age and weight at puberty, testes density, spermatozoa reserves of testes and caudal epididymides, and daily sperm production. Significant (P < 0.05) differences were observed in all parameters. However, unlike what occurred in the case of testicular and epididymal characteristics, the results indicated similarity between experimental diets from 0 to 100 g/kg NK diets for all parameters evaluated. Pubertal boars on 150 g/kg NK diet indicated significant (P < 0.05) reductions in mean values for all parameters except for pubertal age, which significantly (P < 0.05) increased by 4.08%. Although non-significant, pubertal boars on 50 g/kg NK diet gave higher mean values for weight at puberty, testes density, testes and caudal epididymal spermatozoa reserves and daily sperm production.

DISCUSSION

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

The characteristic foul odour and bitter taste associated with neem (Sankaram *et al.*, 1986) would suggest that untreated NK may not 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. The remarkable reduction in feed intake in pigs on 150 g/kg NK diet could be explained by the unacceptable 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. The ability of the pubertal boars to give a comparable gain in weight at 50g/kg NK may be associated with an increased

Table 3: Testicular and epididymal characteristics, and accessory glands of pubertal boars fed diets containing neem kernel

Parameters	Dietary neem kernel (g/kg)				Group
	0	50	100	150	SEM
ve weight at slaughter (kg)	38.29[a]	40.34[a]	33.56[b]	29.55[c]	0.98
Testicular characteristics					
Left testis weight (g)	151.23[a]	133.76[b]	109.65[c]	95.54[d]	4.94
Right testis weight (g)	157.53[a]	127.12[b]	115.80[c]	91.60[d]	5.48
Paired testes weight (g)	308.76[a]	260.88[b]	225.45[c]	187.14[d]	10.34
Relative testes weight (%)	0.81[a]	0.65[b]	0.67[b]	0.63[c]	0.02
Left testis volume (ml)	146.80[a]	126.20[b]	105.10[c]	94.20[d]	4.63
Right testis volume (ml)	151.00[a]	121.40[b]	110.00[c]	90.40[d]	5.06
Paired testes volume (ml)	297.80[a]	247.60[b]	215.10[c]	184.60[d]	9.64
Epididymal characteristics (g)					
Left epididymis	53.88[a]	43.46[b]	37.48[c]	32.00[d]	1.87
Caput	18.86[a]	15.21[b]	13.12[c]	11.20[d]	0.66
Corpus	8.08[a]	6.52[b]	5.62[c]	4.80[d]	0.28
Cauda	26.94[a]	21.73[b]	18.74[c]	16.00[d]	0.94
Right epididymis	46.76[a]	41.90[b]	37.02[c]	30.42[d]	1.40
Caput	16.37[a]	14.67[b]	12.96[c]	10.65[d]	0.49
Corpus	7.02[a]	6.29[b]	5.55[c]	4.56[d]	0.21
Cauda	23.38[a]	20.95[b]	18.51[c]	15.21[d]	0.70
Paired epididymides	100.64[a]	85.36[b]	74.50[c]	62.42[d]	3.25
Relative epididymides weight (%)	0.26[a]	0.23[b]	0.23[b]	0.21[c]	0.05
Accessory glands (g)					
Bulb of prostate	4.54[a]	4.68[b]	4.39[c]	4.30[c]	0.04
Seminal vesicle	37.81[a]	39.04[bc]	36.70[c]	36.32[c]	0.31
Bulbourethral	62.31[a]	63.14[a]	62.27[a]	57.30[b]	0.78

SEM = standard error of the mean and a, b, c, d = means in the same row with different superscript differ significantly ($P < 0.05$).

tolerance to the anti-nutritional factors present in NK and possibly a yet to be identified growth modulating principle (Salawu *et al*., 1994) in neem offered to livestock at low concentrations. Verma *et al.* (1995) reported that 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 the control diet. Sastry and Agrawal (1992) and Agrawal *et al.* (1987) reported the same observation in pigs and buffalo calves, respectively. However, at a level in excess of 100 g/kg NK in the diet, the peculiar strong odour and bitter taste diet appeared to give increasing problems with intake by growing pigs leading to poor acceptability at 150 g/kg diet. This observation was therefore, reflected in the reduced gain in weight.

Table 4: Pubertal characteristics, testes density, sperm reserves and daily sperm production of pubertal boars fed diets containing neem kernel

Parameters	Dietary neem kernel (g/kg)				Group
	0	50	100	150	SEM
Pubertal characteristics					
Age (days)	171.60[a]	172.20[a]	173.80[a]	178.60[b]	0.96
Weight (kg)	35.62[a]	37.59[b]	31.50[c]	28.34[d]	0.84
Testes density (g/ml)	1.04[a]	1.06[a]	1.05[a]	1.02[b]	0.05
Spermatozoa Reserves (x 10^9)	2.11[a]	2.23[a]	2.05[ab]	1.86[b]	0.04
Testes					
Cauda epididymides	4.01[a]	4.24[a]	3.89[ab]	3.54[b]	0.08
Daily Sperm Production (x 10^9)	0.48[a]	0.51[a]	0.47[ab]	0.43[b]	0.05

SEM = standard error of the mean and a, b, c, d = means in the same row with different superscript differ significantly ($P<0.05$).

Table 5: Absolute weights of selected organs of pubertal boars fed dietary neem kernel

	Dietary Neem kernel (g/kg)				Group
	0	50	100	150	SEM
Left Kidney	47.79[a]	51.41[a]	54.49[a]	41.86[b]	1.70
Right Kidney	49.71[a]	50.13[a]	55.05[a]	42.61[b]	1.86
Left Adrenal	1.18	1.08	1.04	1.03	0.04
Right Adrenal	1.33[a]	1.06[b]	0.94[bc]	0.72[c]	0.06
Thyroid	9.66[a]	10.37[a]	11.59[a]	13.24[b]	0.47

SEM = standard error of the mean and a, b, c, d = means in the same row with different superscript differ significantly (P<0.05).

Table 6: Relative weights of selected organs of pubertal boars fed dietary neem kernel

Parameters	Dietary whole neem kernel (g/kg)				Group
	0	50	100	150	SEM
Left kidney (10^{-3})	0.14[a]	0.15[a]	0.15[a]	0.19[b]	0.05
Right kidney (10^{-3})	0.14[a]	0.15[a]	0.15[a]	0.19[b]	0.05
Left adrenal (10^{-5})	3.25	3.37	3.52	3.84	0.14
Right adrenal (10^{-5})	3.34[a]	3.31[a]	3.21[a]	2.26[b]	0.18
Thyroid (10^{-4})	2.76[a]	3.21[a]	3.28[a]	4.77[b]	0.24

SEM = standard error of the mean and a, b, c, d = means in the same row with different superscript differ significantly (P<0.05).

Annongu *et al.* (2003) attributed the negative performance to a high concentration of several anti-nutrients in neem kernels even after treatments. Salawu, *et al.* (1994) had earlier implicated the possibility of the presence of high concentration of beta-glucans.

Testicular, epididymal and pubertal characteristics, accessory glands and daily sperm production of pubertal boars

From the results presented in Tables 3 and 4 it was evident that inclusion of NK in swine diets had profound effect on the testicular and epididymal characteristics. This interesting note could immediately be attributed to the comparative effect of NK on weight gain and eventually the weight at puberty. From the mean values of the absolute and relative weights observed for the thyroid gland (Tables 5 and 6), it can be speculated that NK in swine diets could impart some negative effects on the "gonadotrophic hormones, their target gonads, the thyrotrophic hormone and the thyroid gland axes". Thyroid hormones have versatile role in the regulation of tissue differentiation, basal metabolic growth rate and reproduction. Their deficiencies result in poor growth, delayed maturity and impaired reproduction in different species of animals (Tripathi, 1999). Thyroid has an indirect effect on reproduction and as such the fertility is impaired in hypothyroidism (Mayes, 1979). Normal thyroid function is required for maintenance of pregnancy and lactation (Tripathi, 1999). The influence of NK on the thyroid gland and hence the synthesis and secretion of the hormone thyroxin could have some negative effect on testicular steroidogenesis with a concomitant drop in testicular testosterone which is essential for spermatogenesis and sperm maturation (Egbunike, 1995). Testicular and epididymal sperm reserves are highly influenced not only by age of the animals but also by the weight of the testes (Egbunike and Elemo, 1978; Egbunike *et al*, 1975; Swierstra, 1970). Also, sperm production rate is a function of testes, size and the kinetics of spermatogenesis (Egbunike, 1995). However, despite this negative effect of NK on the testicular and epididymal characteristics, pubertal age (which is very important from economic and breed selection considerations), spermatozoa reserves and daily sperm productions were impaired only at 150 g/kg NK diet. The implication of this finding is that pubertal boars appear to respond in a yet unexplained manner in sustaining spermatogenesis up to a concentration of 100 g/kg NK diet. The inclusion of NK at 50 g/kg NK diet appears to increase gonadal sperm reserves and DSP, though not apparent. This effect was also observed in local and exotic breeder cocks fed diets containing neem kernel (Sokunbi, 1994).

CONCLUSION

The results showed that neem kernel can be included up to 100 g/kg in boars' diets without deleterious effects on growth and reproductive performance.

CONFLICT OF INTEREST

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

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