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Influence of dietary copper supplementation of puberty boars on the fertility of sows

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ABSTRACT

Thirty-two male male Large White weanling pigs of 8-9 weeks of age averaging 7.50 ± 0.36kg were used to evaluate the effect of dietary copper on fertility of pubertal sows. The animals were randomly assigned in a Completely Randomized Design experiment to 4 diets containing 0, 100, 200 and 300ppm Cu/kg constituting the control(diet 1), diets 2, 3 and 4 respectively, in a 6-month feeding trial such that each treatment had 8 animals. The feeding trial was divided into 3 physiological phases [weanling (starter), pre-pubertal (grower) and pubertal (finisher)]. At the end of the feeding trial, 4 treated boars selected at random from each treatment were mated to 8 gilts (i.e. 1 boar to 2 gilts) following the gilts' synchronization to determine the fertility rate of the boars. The mated gilts were sacrificed at the end of the 1st trimester and their uteri cut open longitudinally to check for conception, count the number of embryos therein and the embryo survival rate determined. The results showed significant ($p<0.05$) difference on fertility parameters assessed except foetal crown-rump length and litter weight. The conception rate tended to be constant across the treatment except for treatment 3 with 75%. The study revealed that male weanling pigs for breeding can be fed dietary Cu of between 100-300ppm for optimum reproductive performance.

Introduction

The use of Copper as trace nutrient in agriculture was not recognised until 1920. Before then Copper was believed to be used for medicinal purpose only (Berger, 1993). Evidence that Copper is a dietary essential was however obtained in 1924 as reviewed by McDonald et al. (2002), when experiment with rat showed that Copper was necessary for haemoglobin formation.

The majority of agricultural research into Copper as a growth promoter involved field demonstration with application of small amount of Copper supplement to livestock especially pigs (Jendreville et al., 2002).

The methods of Copper application reported are inclusion in drinking water, mixed with feed ingredient during the milling process or administered by intravenous injection (Zhou et al., 1994b).

Research have reported physiological responses to include good bone formation, normal blood cell formation, normal myelination of brain cell and spinal cord while its deficiency is known to cause anaemia, diarrhoea, bone disorder, impaired glucose and lipid metabolism and a depressed immune system (Davis and Mertz,1978).

Copper accumulates mainly in the liver and other tissues containing high level concentration of copper are the heart, brain and kidney. Lower levels are found in muscles and are predominant is faeces (Aoyagi, et al., 1995)

The growth promoting ability as well as feed intake, feed efficiency and feed conversion ratio of copper in animal have been documented (Cromwell et al., 1989; Skrivan et al., 2002; Adu, 2010). However interest in these areas had far outweighed the effects on the reproductive efficiency of animals.

Materials and Methods

Experimental Materials and Operations:

Thirty two clinically normal female Large White weaned piglets of about 8-9 weeks of age averaging 7.50 + 0.36kg were sourced from the Piggery Unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria. The animals were housed individually in concrete-floor indoor pens, and were randomly assigned into one of the four diets (eight per treatment) after a 2-week physiological adjustment period.

The feeding trial, which was conducted at the Animal Physiology Unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria (7o20'N, 3o50'E, 200m above sea level with an average daytime temperature of 24-25oC and relative humidity 80-85%) during the early dry season, lasted 6 months. The feeding was divided into 3 physiological phases [weanling (starter), pre-pubertal (grower) and pubertal (finisher)]. The composition of the diets fed ad libitum for 6, 10 and 8 weeks during the weanling, pre-pubertal and pubertal phases, respectively are shown in Table 1. The diets satisfied the nutrient requirements of the animals at the various physiological phases as recommended by National Research Council (NRC, 1998).

Determination of Fertility Rate:

To determine the fertility rate of the pubertal boars fed varied dietary Cu, 4 treated boars selected at random from each treatment, were each mated to 8 gilts (i.e. 1 boar to 2 gilts) following the gilts' synchronization with PG–600® (Intervet America Inc.). At the end of the 1st trimester, the mated gilts were sacrificed and their uteri cut open longitudinally to check for conception, count the embryos therein and measure the

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crown-rump lengths as well as the weights of the embryos. The embryo survival rate was determined as described by Egbunike (1979).

Statistical Analysis:

The design used for this experiment is Complete Randomized Design (CRD). All the data obtained were subjected to statistical analysis using the general linear model (SAS, 2008) and the treatment means compared using the Duncan's option of the same software.

Results and Discussion

The results of the effect of varied levels of dietary copper on fertility of pubertal boars are shown in Table 2.

The results showed that the conception rate, foetal crown-rump length, gestation length and litter weight were not influenced (p.>0.05). The litter size, embryo weight and size were significantly higher (p<0.05) with increased dietary copper and this agreed with the work of Ahmed et al. (1997) who reported improved litter size and embryo weight at birth in rabbits fed dietary copper at 60 and 120ppm.

Flowers (1997) reported the boars that consistently produce semen with 80% and above motile spermatozoa may be responsible for higher farrowing rates and litter size and this may be the reason for the higher farrowing rate and litter size in the copper fortified diets.

The results of this study showed significant differences (p.<0.05)in the litter size and embryo weight correspond with study carried out by Fascetti et al. (1998) who reported an increased litter size and weight in cats fed dietary copper at 10mg/kg compared to the control. This however is in contrast with the report of Brinster and Cross (1972) that weekly body weights and implantation data (corpora lutea, implantation sites and implantation loss) were not significantly influenced (p>0.05) in gravid Swiss mouse dosed orally with 0,10 and 30mg copper gluconate/Kg BW per day from days 6 to 14 of gestation. It was further observed that the numbers of foetuses/litter as well as foetal viability and resorption sites in treated groups were not significantly different (p>0.05) from control, and that the average weight and length of foetuses were comparable among all groups.

de la Iglesia et al.(1973) reported that diets containing copper gluconate did not affect the fertility potential of either male or female rats fed 0,3 or 30mg copper gluconate(CG)/Kg BW per day but the result of this study is contrary as all fertility parameters studied (litter size, embryo weight and size) were influenced by dietary copper.

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Table 1: Gross composition (%) of the test diets for the various physiological phases

Ingredient (%)	Weanling	Pre-pubertal	Pubertal
Maize	58.90	51.30	32.10
Groundnut cake	27.50	12.50	3.50
Wheat offal	10.00	31.10	41.80
Palm kernel cake	-	-	20.00
Lysine	0.15	0.15	0.15
Methionine	0.05	0.05	0.05
Bone meal	2.00	1.75	0.25
Oyster shell	0.75	0.50	1.5
Vitamin premix	0.20	0.20	0.20
Salt	0.45	0.45	0.45
Fish meal	-	2.00	-
Total	100.00	100.00	100.00
Analysed Nutrient			
Crude Fibre (%)	6.35	7.20	10.83
Crude Protein (%)	20.20	17.20	15.20
DE* (Kcal/Kg)	3360	3110	2906

* Digestible Energy

Table 2: Fertility of pubertal boars fed varied levels of dietary copper

Parameters	Diet 1 Control	Diet 2 100ppm	Diet 3 200ppm	Diet 4 300ppm	±SEM*
Ovulation rate	11.28[c]	11.81[b]	11.96[a]	11.90[a]	0.05
Conception rate (%)	100.00	100.00	75.00	100.00	0.56
Embryo number (litter size)	5.74[d]	7.06[c]	7.98[a]	7.21[b]	0.96
Embryo survival rate (%)	50.89[d]	59.78[c]	66.72[a]	60.59[b]	1.34
Embryo weight (g)	5.62[d]	7.64[c]	7.69[a]	7.67[a]	0.37
Foetal crown-rump length (cm)	7.48	7.54	7.58	7.61	0.18
Gestation period/length (days)	113.75	133.50	114.00	115.25	0.55
Litter weight	0.98	1.08	0.96	1.06	0.40

abcd: Means on same row with different superscripts differ significantly ($P<0.05$).