Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension
Volume 21 Number 2 (April 2022) pp. 140 - 142
ISSN 1119-7455

Short Communication

SEMEN CHARACTERISTICS OF NIGERIAN ROOSTERS FED DIETS CONTAINING *Curcuma longa* POWDER

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ABSTRACT

Semen quality is critical to avian reproduction and chiefly influenced by feeding. Improving the seminal features of local poultry with dietary technologies is significant to fortifying man's deficient dietary resource. Hence, this study evaluated the semen quality indices of Nigerian roosters fed grower diets containing different levels of Curcuma longa powder (CLP) in a 70-day feeding trial. The experiment randomly placed test roosters (n = 36) into four distinct groups (T_1-T_4), having replications of 3 birds per replicate in a completely randomized design. The birds were fed ad libitum on grower feeds containing CLP inclusions according to groups, i.e., T_1, T_2, T_3, and T_4 respectively had 0, 20, 35, and 50 g of CLP kg^{-1} feed. Routine vaccinations and prophylaxis was duly administered during experimentation. Semen collection and sampling for physical seminal features were conducted and analyzed. The results showed significant ($p < 0.05$) effects of dietary CLP on sperm concentration (SC), live spermatozoa (LS), and dead spermatozoa (DS) of the test roosters. High SC and LS of roosters fed on CLP diets were significantly different ($p < 0.05$) from control, just as DS of T_1 was higher ($p < 0.05$) than CLP groups. Thus, placing Nigerian roosters on diets scented with up to 50 g of Curcuma longa powder per kilogram of feed improved their seminal characteristics.

Key words: artificial insemination, *Curcuma longa*, heavy ecotype, fragrant botanical

INTRODUCTION

The heavy ecotype is one of the nondescript varieties of local chickens indigenous to Nigeria. The birds are hardy with unique reproductive inadequacies such as; low implantation, embryonic failures, and poor quality seminal features (Ndofor-Foleng *et al.,* 2015). Conservation and exploitation of genetic potentials of these local birds was postulated to salvage the deficient intake of essential amino acids in developing countries, thus improving the amount of poultry products available to citizens in the near future (Oleforuh-Okoleh *et al.,* 2012). Regardless of this feat, paucity of interest among experts subsists towards harnessing the inherent wide genetic diversity of these birds. Efficient reproduction is considered significantly indispensible in the genetic improvement of poultry stocks due to the unique nature of their gametes which requires provisional aid to breed true (Uzochukwu *et al.,* 2019). Artificial insemination (AI) has been valuable in assisting efficient reproduction of poultry birds. The quality of semen used for insemination is primary to the success of AI and critically affected by feed nutrients (Mohan *et al.,* 2018). Interestingly, Al-Jef and Del (2019) outlined the adverse impacts ensuing from incessant use of feed additives to promote performance of farm animals.

Plant blends that are used as feed constituents (phytogenics) to advance performance traits have attained prominence in animal feeding as being safe, natural and residue free. *Curcuma longa* is the culinary spice that is topically used as fragrant botanical to improve feed intakes and efficiency of feeding in farm animals due to high biological and flavouring activity of the constituent phytochemicals, especially curcumin (Foldesiova *et al.,* 2015; Johannah *et al.,* 2018; Olarotimi, 2018). However, the ephemeral nature of curcumin has been found to hinder performance grade of animals due to their low bio-availability index (Taoheed *et al.,* 2017). This bioavailability feature was suggested to influence the rapid use and loss of curcumin in metabolism, thus positioning the spice as "limiting" in animal feeding (Burgos-Moron *et al.,* 2010). Hence, the optimum dietary inclusions of *C. longa* that could improve semen characteristics of Nigerian roosters were evaluated in the present study.

Please cite as: Dim C.E., Ekere S.O. and Pius H.O. (2022). Semen characteristics of Nigerian roosters fed diets containing *Curcuma longa* powder. *Agro-Science*, **21 (2),** 140-142. DOI: https://dx.doi.org/10.4314/as.v21i2.17

MATERIALS AND METHODS

Ethics, Location and Duration of the Study

The ten-week research was executed at the Poultry Unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka (UNN). The site is located within latitudes 5° 50′ and 7° 00′ N and longitude 6° 52′ and 7° 54′ E at a land elevation of ~500 m asl (Ugwu *et al.,* 2020). Onyenucheya and Nnamchi (2018) reported the study area to be of tropical climate, receiving adequate sunshine all year round even during wet and dry seasons (Mar. through Sep. and Oct. till Apr., respectively). The conduct of the experiment was in line with the ethical guidelines on the use of animals for experimentation provided by the Animal Welfare and Ethics Committee, UNN.

Experimental Animals, Management and Design

The study involved 36 (heavy-ecotype) Nigerian roosters (~2.00 kg) that were raised on deep litter and fed diets containing *Curcuma longa* powder (CLP) inclusions on *ad-libitum* basis. The completely randomized experimental design was adopted to randomly place the birds into four distinct triplicate groups (T_1-T_4), such that birds in each group had unrestricted access to test feeds with CLP inclusions, i.e., T_1 was the control group, while T_2, T_3 and T_4 individually contained 20, 35, and 50 g CLP kg^{-1} diet. The rhizomes of *Curcuma longa* were harvested from the Demonstration Plots of Department of Crop Science, UNN. They were trimmed of extraneous attachments, weighed and subsequently spread on dry concrete floors to air-dry for 14 days (under ambient temperature) so as to achieve less moisture in the rhizomes just before milling to CLP. The CLP were placed in plastic containers and stored under ambient conditions during the experiment. Prior to the study, experimental pens were cleaned, disinfected and properly ventilated. The pen flooring was made of concrete with coarse wood shavings spread as bedding material. Ample feeders and drinkers were provided, just as stale feed and water from previous feeding were replaced before fresh feeding on a daily basis. Proximate compositions of the experimental feeds alongside the test CLP were determined according to standards (AOAC, 2007) and shown in Table 1. The vaccination procedure for fowl pox and the prophylactic treatments (Embazin forte®) administered during the study were respectively according to manufacturer's recommendations.

Semen Collection and Analysis

Body weights were determined on a 10-kg capacity Camry® weighing balance according to the study groups at the start of the experiment, and subsequently on a weekly basis till the termination of study. From the 7th week of study, roosters were routinely trained for semen collection prior to test collections on the 8-10th week, during which a bird per replicate was massaged (Burrows and Quinn, 1937) for semen collections twice in a week (collected with a 0.01 ml calibrated test tube) to determine semen volumes, percentages of live and dead spermatozoa, seminal concentration and pH of test roosters. Seminal pH was routinely determined using a pH meter (Sperm 360® by Sperm Processor Pvt. Ltd., Aurangabad MS-431005 India). Sperm cell count was done using a haemocytometer (450 × magnification). The number of spermatozoa was counted in five large diagonal squares and multiplied by 10^9 to determine the sperm concentration in millilitre (ml) per ejaculate (Peters *et al.,* 2008). However, percentiles of live and dead spermatozoa were determined using the technique of (Ernst and Ogasawara, 1970) Data were subjected to analysis of variance using SPSS. Significant differences among treatment means were separated using the Duncan's new multiple range test.

RESULTS AND DISCUSSION

The effect of dietary inclusions of CLP on the semen characteristics of Nigerian roosters are shown in Table 2. The results indicated significant

Table 1: Proximate compositions of experimental feeds and test *Curcuma longa* powder

(%)	T_1	T_2	T_3	T_4	CLP
Moisture	10.85 ± 1.19	10.87 ± 0.90	10.48 ± 1.92	10.58 ± 2.43	7.62 ± 0.04
Ash	15.36 ± 0.73	15.40 ± 0.84	15.56 ± 1.27	15.70 ± 2.06	8.04 ± 0.02
Crude fat	3.83 ± 1.18	3.79 ± 0.81	3.77 ± 1.15	3.78 ± 1.16	4.80 ± 1.00
Crude fiber	5.00 ± 0.02	5.36 ± 1.00	5.49 ± 1.10	5.50 ± 0.99	3.07 ± 0.10
Carbohydrate	45.74 ± 2.50	45.30 ± 6.30	45.20 ± 5.34	45.04 ± 2.96	65.64 ± 10.01
Crude protein	19.22 ± 1.65	19.28 ± 3.55	19.50 ± 6.21	19.40 ± 1.77	10.83 ± 1.04
Metabolizable energy, ME (MCal kg^{-1})	3.21 ± 0.02	3.33 ± 1.03	3.35 ± 0.11	3.34 ± 0.01	3.61 ± 0.40

CLP - *Curcuma longa* powder, T_1 - 0 g CLP kg^{-1} feed (control), T_2 - 20 g CLP kg^{-1} feed, T_3 - 35 g CLP kg^{-1} feed, T_4 - 50 g CLP kg^{-1} feed

Table 2: Semen characteristics of Nigerian roosters fed diets scented with CLP inclusions

Parameters	T_1	T_2	T_3	T_4	SEM
pH	7.20 ± 0.10	7.16 ± 0.11	7.30 ± 0.17	7.26 ± 0.05	0.032
SC (× 10^9 ml^{-1})	3.62 ± 0.48^{c}	4.14 ± 0.02^{b}	4.33 ± 0.24^{ab}	4.75 ± 0.09^{a}	0.141
SV (ml)	0.63 ± 0.49	1.06 ± 0.23	1.20 ± 0.79	0.66 ± 0.47	0.153
LS (%)	76.00 ± 3.00^{c}	81.00 ± 2.00^{b}	84.00 ± 2.00^{ab}	86.66 ± 0.57^{a}	1.291
DS (%)	24.00 ± 3.00^{a}	19.00 ± 2.00^{b}	16.00 ± 2.00^{bc}	13.33 ± 0.57^{c}	1.292

Numerals on the same row with distinct superscripts are significantly different at 5% probability level; SEM - standard error of mean, CLP - *Curcuma longa* powder, T_1 - 0 g CLP kg^{-1} feed (control), T_2 - 20 g CLP kg^{-1} feed, T_3 - 35 g CLP kg^{-1} feed, T_4 - 50 g CLP kg^{-1} feed, pH - semen pH, SC - spermatozoa concentration, SV - semen volume, LS - live spermatozoa, DS - dead spermatozoa

differences ($p < 0.05$) among the treatment means for sperm concentration (SC), percentiles of live sperm (LS) and dead spermatozoa (DS). However, semen pH and volume across treatments were not affected ($p > 0.05$) by dietary CLP. *Curcuma*-treated groups (T_2, T_3 and T_4) had higher ($p < 0.05$) SC (4.14, 4.33 and 4.75 × 10^9 ml^{-1} respectively) than T_1 (3.62 × 10^9 ml^{-1}). Also, the LS of CLP groups were higher ($p < 0.05$) than control, even as control recorded higher DS (24.00%) that differed significantly ($p < 0.05$) from study groups with least scores recorded for T_4. Kazemizadeh *et al.* (2018) reported *C. longa* to enhance the production of cells involved with testicular functions. The dose-dependent increase in sperm concentration could be linked to the innate active constituents of *C. longa* that stimulated progressive increase in the seminiferous tubular diameter and more so, the number of leydig and spermatogonia cells. These testicular changes could explain the increased spermatozoa concentration observed in samples from treated roosters. Fouad *et al.* (2020) highlighted *C. longa* to improve sperm membrane integrity and spermatozoa concentration by increasing testicular measure of the spermatogonia, leydig and seminiferous tubules. Interestingly, the reports of Urom *et al.* (2018) and Sharifi-Rad *et al.* (2020) are in consonance with present result, as they independently reported improved SC of poultry birds fed diets improved with *C. longa*.

CONCLUSION

It was concluded that up to 50 g of *Curcuma longa* powder in every kg of grower feeds improved the semen characteristics of Nigerian heavy ecotype roosters by modulating the preponderance and viability of their sperm cells.

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