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EFFECT OF VARYING LEVELS OF MOLASSES AND GROUNDNUT CAKE ON SEMEN MORPHOLOGICAL CHARACTERISTICS AND TESTICULAR PARAMETERS OF RED SOKOTO BUCKS

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ABSTRACT

An experiment was conducted to determine the effect of varying levels of energy and protein on some reproductive parameters of Red Sokoto bucks. Twenty Red Sokoto bucks of aged 5-6 months weighing 8.5±10 kg were randomly allotted to five dietary treatments in a complete randomized design with four animals per treatment. Treatments compared were T_1, T_2, T_3, T_4 and T_5 receiving 0, 10, 20, 30 and 40% molasses and 40, 30, 20, 10 and 0% Groundnut cake (GNC) in a mixed ration respectively. The result reveals that the right and left testes filtrate ranged from 14.32 – 29.14 mls and 14.67 – 34.12 mls respectively, being higher ($P<0.05$) on T_2 and T_4 than other treatments. The right and left homogenate values ranged from 3.90 – 5.80 mls and 3.40 – 5.05 respectively, being higher ($P<0.05$) on T_2 and T_3 than other treatments. The right and left epididymal length were higher for T_4 compared to other treatment groups while the right and left epididymal weight were higher for T_1 compared to other treatment groups. The semen morphological characteristics showed significant ($P<0.05$) difference amongst treatment except for semen volume and mid piece abnormality which showed no significant ($P>0.05$) effect. Based on these findings, it clearly shows that level of molasses (40%) in the diet of goats (bucks) has no significant ($P>0.05$) effect on the reproductive performance of Red Sokoto goats (bucks).

Keywords: Testicular, histometry, Morphometry, Gonadal, Molasses, Groundnut cake

INTRODUCTION

Red Sokoto (RS) goats are one of the most important goat breeds found in Nigeria. This breed of goats are kept as a source of food and investment. Red Sokoto goats are more adaptable to the climatic conditions of northern Nigeria and has the ability to breed all year round, their fertility characteristics have not been fully documented to facilitate effective genetic improvement by selection and crossbreeding at all levels of production. There is the need to establish measurable criteria for judging breeding soundness and guiding selection of males for breeding. These criteria include scrotal measurements, libido and semen quality tests (Michelson *et al*., 1981; Ogwuegbu *et al*., 1985) and the relationships between them.

Semen quality parameters such as motility, sperm number and sperm morphology are of value in identifying animals of low fertility in pastoral herds (Parkinson, 2004). Of the component of semen quality, spermatozoa morphology is of utmost importance in animals extensively reared in the tropics (Chacon, 2001). Abnormalities of the spermatozoa occur due to disorder of the seminiferous tubules, during ejaculation or in manipulation of the ejaculate including excessive agitation, over-heating to rapid cooling, mixture of water, urine or antiseptic in the semen (Hossain *et al*., 1990). Spermatozoa with abnormal morphology are the most important factor that has direct bearing on fertility of animals for successful AI programmes. The morphological

characteristics of spermatozoa are influenced by several factors including the genetic make-up and physiological stage of the animal, nutrition, season, climatic factors, and disease (Dana *et al*., 2000). Poor sperm morphology is an indicator of decreased fertility in many species, including goats (Chandler *et al*., 1988). An accurate morphological examination of spermatozoa thus enables the elimination of males with low fertility prior to the preservation of their semen (Rodriguez-Martinez and Barth, 2007).

The utilization of molasses and groundnut diets is a fundamental component of the feeding strategy in order to balance nutrients for improved performance. Low rate of production is an index of poor nutrition, often defined by growth and reproduction. It also affects the immune system and the ability of an animal to fight disease. Death can occur in extreme conditions of malnutrition. In many breeding production systems, approximately two-thirds of improvements in livestock productivity can be attributed to improved nutrition. Due to its distinct flavor and high nutritional value, the use of molasses as a refined sugar substitute is on the increase (Cheavegatti-Gianotto *et al*., 2011). Several positive biological activities have been attributed to molasses (Singh *et al*., 2015). Molasses has also been strongly associated with low sperm quality and altered testicular steroidogenesis (Chiu *et al*., 2014). Rahman and Pool (2010a and 2010b); Chandra *et al*. (2018) reported that molasses was observe to cause endocrine disruption.

Groundnut cake is a by-product obtained after extraction of oil. The cake which is a rich source of protein is indigenously used as animal feed. The cake contains 45–60% protein, 22–30% carbohydrate, 3.8–7.5% crude fibre and 4–6% minerals (Desai *et al*., 1999). Utilization of meal or defatted meal into food products could be an excellent vehicle for enhancing the utilization of groundnut protein in the diets. Groundnut cake blends easily and enhances or enriches the nutritive value of feeds (Njidda *et al.* 2022). Utilization of defatted groundnut meal with mild processing treatment is becoming increasingly popular in other developing countries (Gopala Krishna, (2007).

Since molasses and groundnut cake are gaining increasing acceptability as energy and protein source, this study was therefore designed to study the effects of molasses and groundnut cake on male reproductive functions in Red Sokoto bucks.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Teaching and Research farm of University of Abuja, Faculty of Agriculture, located in Gwagwalada area council of the Federal Capital territory Abuja. Gwagwalada lies between latitude 08^0 51″ and 09^0 37″N and longitude of 70 20″ and 7^0 51″E. It is characterized by two distinct seasons which are the rainy season from May to October and the dry season from November to April. Rain in this area is unimodal with its peak in August and sometimes September. Annual rainfall ranges from 1,100 to 1,450mm (Ishaya and Grace, 2007). Temperature in this area is generally high ranging from 30 to 37^0C (Balogun, 2001).

Experimental Animals and Treatment

Twenty (20) Red Sokoto bucks between 5 and 6 months of age with an average weight of 8.6±0.67 Kg were purchased from Mandala market, Abuja. Five (5) dietary treatment were offered in a Completely Randomized Design (CRD) with four animals per treatment. Treatments compared were T_1, T_2, T_3, T_4 and T_5 receiving 0, 10, 20, 30 and 40% molasses and 40, 30, 20, 10 and 0% Groundnut cake (GNC) in a mixed ration respectively (Table 1). All the animals were treated against external and internal parasites, using ivermectin and albendozole respectively. Terramycin long acting (TLA) injection was used to take care of subclinical bacterial infections. The animals were confined in individual well ventilated raised pens within a common house. The roof of the house was relatively

high so as to reduce heat. Proper hygiene of the house was ensured all through the period of the experiment. The experiment lasted for 12 weeks.

Table 1: Composition of Experimental Diet

	T_1	T_2	T_3	T_4	T_5
Molasses	0.00	10.00	20.00	30.00	40.00
Groundnut cake	40.00	30.00	20.00	10.00	0.00
Wheat offal	10.00	10.00	10.00	10.00	10.00
Sorghum Stover	20.00	20.00	20.00	20.00	20.00
Cowpea husk	25.00	25.00	25.00	25.00	25.00
Premix	3.00	3.00	3.00	3.00	3.00
Salt	2.00	2.00	2.00	2.00	2.00
Total	**100**	**100**	**100**	**100**	**100**

T_1 (0% molasses), T_2 (10% molasses), T_3 (20% molasses), T_4 (30% molasses), T_5 (40% molasses)

Epididymal measurement?
The epididymal dimensions were measured at the onset and subsequently on weekly basis before semen collection.

Testicular length (TL): This was measured in centimeters with a flexible tape as the distance along the caudal surface of the scrotum, from its point of attachment to the tip of the scrotum as described by Bratte *et al*. (1999) and Akpa *et al*. (2012).

Semen collection and evaluation

Semen samples were collected from each animal for the period of the study using an electro-ejaculator and samples were labeled accordingly. These were done in the morning throughout the duration of the experiment. The sampled semen were evaluated immediately for colour, volume, motility and pH as described by Zemjanis (1970). Sperm concentration, sperm morphology and live/dead ratio were evaluated in the laboratory.

Semen evaluation

Semen colour
The colour of semen samples collected were noted visually immediately after collection.

Semen volume
The semen samples were collected into transparent and calibrated plastic test tubes. The volume of each sample was read through the tubes and the figure recorded in millilitres.

Semen pH
The hydrogen ion concentration (pH) of individual samples collected was determined using Chemo craft pH paper. This is a pH paper calibrated from 1 to 14 with different colours. One inch of the paper was inserted into the semen for five seconds, after which was removed and air dried. The colour change was observed after drying and was placed to the colour chart on the pH paper. The corresponding pH number for the colour on the chart was recorded as the pH of the sample.

Sperm motility
The motility of the sperm cells (wave pattern of semen) of each sample collected was measured by microscopically evaluating non-diluted semen at 100x magnification power. The wave patterns were recorded in percentage. Mass motility was estimated as percentage score according to the procedure outlined by Melrose and Laing (1970).

Sperm concentration

The concentration of the spermatozoa was determined using the Red Blood Cell counting chamber of a hemocytometer that were crossed with microscopic grids containing 25 large squares with each containing sixteen smaller squares. The total number of smaller squares on the hemocytometer is 400. Sperm cells were counted diagonally from top left to the bottom right and from top right to the bottom left in five large squares or a total of 80 smaller squares (Rekwot *et al.,* 1997). Prior to counting, formaldehyde was used as a dilution reagent. A drop of semen was taken from each sample using a pipette and diluted with formaldehyde solution at 1:100. The hemocytometer was mounted into the microscope and an absorbable tube and O-no pipette was used to pipette a drop of the solution into the haemocyto meter chamber. The absorbable tube and the O-no pipette were blown before pipetting to avoid air bubbles in the O-no pipette. After appropriate counting in the 5 large squares, the number obtained was multiplied with 100 (dilution factor), 16 (the number of smaller squares in a larger square and the volume of the semen sample collected, multiplied by 10^6). The result obtained was recorded as the sperm cell concentration for the sample.

Sperm morphology

The same slides prepared for live and dead ratio were used for the morphology studies. Live and abnormal spermatozoa percentages were counted using a tally counter. Fifty spermatozoa were examined from each sample. The total number of abnormal spermatozoa was counted and recorded.

Types of abnormality observed were: detached mid-piece and tail, detached head, mid-piece droplet, coiled and bent tail, and acrosomal abnormality (acrosome membrane detached, acrosome outlines and acrosome cap defect). Acrosomal abnormalities were determined by using smears made from the raw semen and stained by Giemsa stain according to Watson (1975).

Chemical analysis

The feed samples were analysed for proximate constituent according to AOAC (2005). Samples were oven-dried at 60 °C for 96 h while DM was determined by oven-drying at 100 °C for 24 h. Neutral detergent fibre (NDF), acid detergent fibre (ADF) and 2acid detergent lignin (ADL) were determined according to the procedures of Van Soest *et al.* (1991).

Statistical Analysis

The data was analyzed with the analysis of variance ANOVA using the SAS (2002) package. Duncan multiple range test (DMRT) of the same software was used for separating significant differences among means and significance were declared at $P \leq 0.05$.

RESULTS

The results of the chemical composition of the experimental diets is shown in Table1. There was no significant ($P<0.05$) difference was obtained among diets except for Neutral Detergent Fibre, Non-fibre Carbohydrates and energy,

The Dry matter (DM) content ranged between 914.80 to 919.00 g kg^{-1} DM with T_1 having the highest value. Decrease with increase in the level of molasses was observed for crude protein content across treatment diets. The crude fibre content ranged from 127.20 to 138 g Kg^{-1} DM) respectively. The results also indicated a level of 56.00 – 67.90 g Kg^{-1} DM for ether extract on diets T_5 and T_1 respectively. Acid Detergent Fibre (ADF) spanned from 224.10% on diet T_5 to 239.10 g Kg^{-1} DM on diet T_1. The values were observed to decrease with increase in the levels of molasses, though there was a significant difference ($P<0.05$) in Neutral Detergent Fibre content, with diets T_1 (394.00 g Kg^{-1} DM having the highest and diet T_5 (352.00 g Kg^{-1} DM %) having the lowest.

Non-fibre carbohydrate range from T_1 (301.90 g kg^{-1} DM) to T_5 (341.00 g kg^{-1} DM). There was a significant ($P<0.05$) difference amongst the treatment group for Non-fibre carbohydrate. The values were observed to increase with increase in the level of molasses. Ash content of the diets

ranged from 81.00 on diet T_1 to 86.40 g kg^{-1} DM on diet T_4. Lignin values range from 102.20 to 116.20 g kg^{-1} DM. Metabolizable energy was significantly higher ($P<0.05$) on diet T_5 (2668.70 kcal/kg) and lowest on diet T_1.

Table 2: Proximate Composition of Experimental Diets (g kg^{-1} DM)

	TREATMENTS					
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**SEM**
Dry matter	919.00	917.80	915.00	913.60	914.80	1.33^{NS}
Crude protein	162.20	150.80	145.70	143.00	140.10	2.15^{NS}
Crude fibre	138.00	129.20	128.50	128.00	127.20	1.92^{NS}
Ether extract	67.90	59.20	58.80	57.10	56.00	0.98^{NS}
Acid Detergent Fibre	239.10	229.70	227.00	225.60	224.10	1.23^{NS}
Neutral Detergent Fibre	394.00^{a}	384.20^{a}	378.20^{ab}	365.00^{c}	352.00^{d}	0.04*
Non-fibre Carbohydrates	301.90^{c}	329.00^{ab}	325.50^{ab}	335.00^{a}	341.00^{a}	1.79*
Ash	81.00	82.20	85.00	86.40	85.20	0.92^{NS}
Lignin	102.20	114.00	116.20	110.60	109.20	1.21^{NS}
Energy (kcal/kg)	2550.20^{e}	2591.00^{d}	2601.40^{c}	2665.30^{b}	2668.70^{a}	0.28*

a, b, c, d, e = Means within the same row with different superscripts differed significantly; * = ($P<0.05$), SEM = Standard Error of the Mean, NS = Not significant

Testicular homogenate and filtrate of Red Sokoto bucks fed molasses and groundnut cake in a mixed ration

The results of the testicular homogenate and filtrate of Red Sokoto bucks is shown in Table 3 The result reveals that the right and left testes filtrate ranged from 14.32 – 29.14 mls and 14.67 – 34.12 mls respectively, being higher ($P<0.05$) on T_2 and T_4 than other treatments. The right and left homogenate values ranged from 3.90 – 5.80 mls and 3.40 – 5.05 respectively, being higher ($P<0.05$) on T_2 and T_3 than other treatments.

Table 3: Testicular homogenate and filtrate of Red Sokoto bucks fed molasses and groundnut cake in a mixed ration (ml)

	TREATMENTS					
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**SEM**
Right testes filtrate	21.16^{c}	34.94^{a}	20.76^{c}	29.14^{b}	14.32^{d}	2.11
Left testes filtrate	18.98^{d}	34.12^{a}	21.17^{c}	30.33^{b}	14.67^{d}	1.24
Right testes homogenate	4.00^{b}	5.80^{a}	5.15^{a}	3.90^{b}	4.60^{b}	1.31
Left testes homogenate	4.00^{b}	5.00^{a}	5.05^{a}	3.40^{a}	4.70^{b}	0.05

a, b, c, d, e = Means within the same row with different superscripts differed significantly; * = ($P<0.05$), SEM = Standard Error of the Mean, NS = Not significant

Epididymal length and weight of Red Sokoto Buck fed molasses and groundnut cake in a mixed ration

The right epididymal length, the left epididymal length, the right epididymal weight and the left epididymal weight (Table 4) values ranges between 2.85 - 8.75 cm, 2.70 - 8.10 cm, 2.35 - 7.50 cm and 2.24 - 6.78 cm respectively. All the parameters evaluated under this study were significantly (P<0.05) influenced by the experimental treatments. The right and left epididymal length were higher for T_4 compared to other treatment groups while the right and left epididymal weight were higher for T_1 compared to other treatment groups.

Table 4: Epididymal length and weight of Red Sokoto Buck fed molasses and groundnut cake in a mixed ration (CM)

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Right epididymis Length	7.60^{a}	2.85^{c}	7.90^{b}	8.57^{a}	8.75^{a}	0.5
Left epididymis Length	7.35^{b}	2.70^{c}	8.00^{a}	8.07^{a}	8.10^{a}	0.01
Right epididymis Weight	7.50^{a}	2.35^{d}	2.21^{c}	4.51^{b}	2.23^{d}	0.06
Left epididymis Weight	6.78^{a}	2.34^{d}	3.27^{c}	4.47^{b}	2.24^{d}	0.72

a, b, c, d, e = Means within the same row with different superscripts differed significantly; * = (P<0.05), SEM = Standard Error of the Mean, NS = Not significant

Semen Quality and Morphology of Red Sokoto Buck Fed Molasses and Groundnut Cake in a Mixed Ration

The result of the semen morphological characteristics is shown in Table 5. The semen volume ranged from 0.1 – 0.35 ml. there was no significant (p>0.05) effect for semen volume. Semen motility, semen pH, percentage live, abnormality percentage, head, tail and sperm concentration ($\times 10^9$/ml) values showed significant (p<0.05) effect of feeding molasses and GNC to red Sokoto bucks in a mixed ration.

Table 5: Semen Quality and Morphology of Red Sokoto Buck Fed Molasses and Groundnut Cake in a Mixed Ration.

Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**SEM**
Semen Volume (ml)	0.30	0.35	0.05	0.1	0.1	0.47^{NS}
Semen Colour	Milky	Milky	Milky	Creamy	Milky	
Semen Motility (%)	87.5^{b}	89^{a}	25.00^{d}	20.00^{e}	40.00^{c}	2.25
Mass Activity	+++	+++	++	++	+++	
Semen pH	7.00^{a}	7.00^{a}	3.50^{b}	7.00^{a}	3.50^{b}	0.04
Percentage Live (%)	90^{b}	92.5^{a}	30^{d}	25^{e}	42.5^{c}	1.72
Abnormality (%)	7.00^{a}	5.50^{bc}	6.00^{b}	5.50^{bc}	2.50^{d}	0.92
Head	2.50^{a}	1.50^{c}	2.00^{b}	2.50^{a}	0.50^{d}	0.04
Mid Piece	0.50	0.50	1.00	1.00	0.50	0.04^{NS}
Tail	4.00^{a}	3.50^{a}	3.00^{ab}	2.50^{c}	1.50^{d}	0.12
Sperm Concentration ($x10^9$/ml)	1.60^{a}	1.30^{b}	0.45^{d}	0.55^{d}	0.60^{c}	0.04

a, b, c, d, e = Means within the same row with different superscripts differed significantly; * = (P<0.05), SEM = Standard Error of the Mean, NS = Not significant

DISCUSSION

The CP content of the feeds is higher (140.10 – 162.20 g kg^{-1} DM) than the values (893.00 – 944.00 g kg^{-1} DM) reported by Njidda (2019). The higher CP content of the diets may be attributed to the level of GNC content since groundnut cake contains higher level of CP (450.00-600.00 g kg^{-1} DM) reported by Desai *et al*. (1999). The CP contents of all the diets were above the level suggested as adequate to meet the nutritional requirements for moderate weight gain in goats (NRC 2007). Norton (1994) recommended a diet with 8 % CP for moderate live-weight gains in goats and according to these criteria all the diets had sufficient CP content. The dry matter content of the experimental feed (913.60 – 919.00 g kg^{-1} DM) was similar to the values 927.40 and 916.00 g kg^{-1} DM reported by Abdu *et al*. (2012) and Taiwo *et al*. (2009) respectively. However, the value was lower than the 267.00 and 203.00 g kg^{-1} DM g kg^{-1} DM reported by Omokanye *et al*. (2001) and Taiwo *et al.* (2009). The NDF and ADF in this study were lower than the 641.10 and 427.90 g kg^{-1} DM than the values reported by Njidda *et al*. (2019). The lower values may be due to the low content of fibre in molasses. Molasses has been reported to contain 0% fibre (Solomom *et al*., 2011)

The differences in the chemical composition of feed ingredients may be due to natural variations as a result of genetic background, environment, cultivation method, variations due to sample preparations and analysis (Brisibe *et al*. 2009; Njidda, 2019). The chemical composition of experimental diets showed that the diets contained adequate dry matter and crude protein to support normal rumen functions.

The testicular homogenate and filtrate volume show some differences in this present study. This result is in agreement with the findings of Raji *et al.*, (2008) who observed variations among the testicular homogenate and filtrate volume of Red Sokoto bucks were fed diet containing cotton seed cake. Fadason, (2001) reported that the only difference between homogenate volume and filtrate volume is the tissue and its rate of absorbing water. The difference could be attributed to difference in testicular shape, size and the mass. The homogenate and filtrate volume of the testes were not found to be affected by dietary treatments. The values obtained were similar to those obtained by Shoyombo *et al*. (2012) who reported mean values of 49.05 to 50.46 ml for bucks between 6 to 12 months of age. However, Nasir *et al* (2014) recorded values which were slightly higher than the ones obtained in the present study. This variation could be attributed to the differences in environmental factors, management or diet composition.

The variation observed in the testicular weight among treatments may be due to the fact that molasses inclusion in the diet had a significant effect on testicular morphology as observed in this study, while the testicular length values varied from 2.85 – 8.75 cm with T_5 (40% molasses inclusion) having the highest testicular length while T_2 (40% molasses inclusion) had the lowest testicular length. The results obtained in this studies are lower compare to the findings of Nasir *et al* (2014) who recorded high values of right testicular weight and length of 64.10 g and 64.10 cm respectively. However, Raji *et al.*, (2008) also reported high values of left testicular weight and length of 68.00 g and 65.00 cm. These variation could be attributed to the differences in environmental factors, management, breed, and age or diet composition.

Age of the animal is an important physiological factor that modifies the sperm morphological characteristics of domestic animals. This has been demonstrated by earlier studies, which found abnormal sperm head shape to be more prevalent at younger age, to gradually decrease after sexual maturity, and to become greater again at older age, provided that the animal is healthy (Amann *et al*., 2000). However, other studies found no significant ($p>0.05$) effect of age on major sperm defects (Brito *et al.*, 2002). Hallap *et al*. (2006) also reported that acrosome and total head abnormalities did not

differ (p>0.05) with age in frozen-thawed bull spermatozoa, suggesting that the large within-bull variation might have masked the true picture. Similarly, differences in total and specific sperm head abnormalities in the present study did not reach significance across the different treatments categories considered. It is known that the morphological characteristics of spermatozoa are influenced by several factors including the genetic-make up, the physiological stage of the animal, nutrition, climatic factors and disease (Dana *et al.*, 2000). Greyling and Grobbelaar (1983) also indicated that the percentage of live sperm yielded by the technique of the artificial vagina was significantly higher than those of semen collected by electro-ejaculator. These might be the reasons for lower sperm concentration as observed in the present study. On the other hand, Javed *et al*. (2000) reported 1.00±0.50 ×106 /µl; while Raizada *et al.* (1988) and Terezinha *et al.* (1991) had reported sperm concentration of 2.90 and 1.33 ×106/µl) in rams. These results are higher compare to the results of the present study. These variations may be attributed to breed, management, environmental condition, and nutrition and age differences. It can be observed in the present study that sperm concentration was higher in T_1 (0% molasses inclusion) compare to other treatments which could be attributed to the high level of groundnut cake in T_1 (0% molasses inclusion) compare to other treatments with different percentage of molasses. As the animals in T_1 (0% molasses inclusion) have access to high nutritious diet (protein) which is needed in the production of spermatozoa compare to other treatments which contain high level of energy Akpa *et al.* (2013).

A mean volume of 0.3 ml Red Sokoto goat semen was collected during electro-ejaculations, while it ranged between 0.1 mL and 0.35 mL (Table 4) for all samples. The semen contained on average 0.91 $x10^9$ /mL spermatozoa with a large range between the minimum (0.6 $x10^9$ /mL) and maximum (7.0 $x10^9$ /mL) concentrations. The mean semen pH was 5.6 ± 0.04. Spermatozoa had a total motility of 52.3 ± 2.25%, of which 65.3% on average portrayed progressive motility characteristics. Morphometry measurements indicated that Red Sokoto goats spermatozoa had a head length of 1.8 ± 0.04 µm. Head elongation, ellipticity, regularity and roughness had little variation among spermatozoa. The acrosome covered on average 55.6% of the sperm head. The two midpiece morphometrics showed a mean width of 0.7 µm. The slight variation in tail among the treatments could be related to differences in diet composition. Besides, as its occurrence in this study was small, it would not interfere with fertility as suggested earlier (Rodriguez-Martinez and Barth, 2007). Under normal conditions, however, sperm tail defects decrease across the treatments, which could be due to the increase in molasses in the experimental diet. The fact that the proportions of coiled and total tail defects were less in T_4 and T_5 (30 and 40% molasses inclusion) in the present study indicates that these abnormalities were too small to impede sperm motility.

CONCLUSION

The testicular homogenate and filtrate of the bucks were not affected by the levels of molasses inclusion. Sperm morphological abnormalities (detached head, mid piece, and tails) were also increased with increase in levels of molasses though values were lower for head and mid piece at higher levels of inclusion of molasses (40%). The testicular profiles are all within range.

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