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Effect of Dietary Partial Replacement of Corn Grains by Mango Seeds on Productive and Reproductive Characterization of Damascus Goat Bucks at Prepubertal Stage

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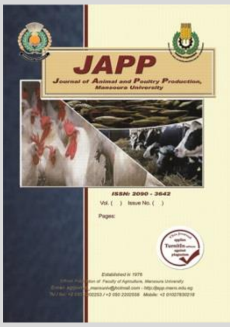

ABSTRACT

This study aimed to evaluate the effect of, replacing corn grains in concentrate feed mixture (CFM) with mango seeds (MS) in Damascus goat buck's diets, on productive and reproductive characteristics at prepubertal stage (weaning-prepuberty). Corn grains in CFM were replaced with mango seeds at levels of 0% MS (G1, control), 15% (G2) and 30% (G3). Results revealed that G3 showed the highest ($P<0.05$) LBW and average daily gain (ADG). Feed conversion ratio, all nutrients digestibility, feeding values, and economic feed efficiency were improved ($P<0.05$) in G2 and G3 compared with G1. Animals in G2 and G3 showed earlier ($P<0.05$) ages to produce the 1st ejaculation than control. Testosterone concentration one-month prepuberty increased ($P<0.05$) in G2 compared with G1 and G3. Testicular measurements and scrotal circumference in G2 as well as only testicular length in G3 increased ($P<0.05$) in comparing with G1. Mediastinum width increased in G2, decreased in G3 compared with G1 ($P<0.05$). Tunica albuginea was thicker ($P<0.05$) in G2 and G3 than in G1. Scrotal septum was wider ($P<0.05$) in G3 than in G2. Prostate and vascular gland were longer ($P<0.05$) and wider in G2 and G3 than in G1. This study concluded that replacement of corn grains with mango seeds at level of 30% in diets of Damascus goat bucks has a positive effect on productive performance. The replacement at a level of 15% MS improved reproductive characterization of bucks raised for semen production for breeding programs.

Keywords: Goat bucks, prepuberty, corn grains, mango seeds, growth, 1st ejaculate.

INTRODUCTION

Nutrition is an important factor controlling the productive and reproductive development of small ruminants. Several studies on nutrition demonstrated that diet may have an effect on the testis volume and sperm production (Brown, 1994). Animal ration formulation is depending on corn grains, as a main source of energy, which is expensive and increases the costs of animal feeding. A lot of efforts, time and resources have been invested to search for alternative high energy feed sources for domestic animals. Searching for other cheap protein and energy resources is required for solving this problem (Oyenuga, 1999). Using the agro-industrial by-products in animal feeding, involving potentially polluting materials could have an essential element to achieve the competition and scarcity problems of feeds (Olivera *et al*., 2006).

In general, mango fruit is rich in carbohydrates and organic acids, which are important energy and flavor providers, with volatile compounds as the factors responsible for the flavor (Liu *et al*., 2013). Mango seed (MS) as a potential feed ingredient and human feed by-product, is considered a good source of soluble carbohydrate (80%, Dhingra and Kapoor, 1985), high quantities of proteins and fat (Diarra and Usman, 2008; Diarra *et al.*, 2011), starch (58-80%, Sandhu and Lim, 2007), and high metabolisable energy in comparable to that of corn (Diarra *et al*., 2011). The MS contains 6-13% CP (Fowomola, 2010; Diarra *et al.*, 2011), essential amino acids such as lysine and methionine (Fowomola, 2010; Jadhav and Siddiqui, 2010), 6-16% oil (Jadhav and Siddiqui, 2010; Medina *et al.*, 2010; Diarra *et al.*, 2011), and fatty acids like stearic (24-57%) and oleic (34-56%), which can be fractionated to yield olein and stearin (Gunstone, 2006). Although there are reports of the consumption of MS as porridge this by-product has limited food, feed or industrial uses in most mango producing countries thus making it readily available. The major problem affecting the nutritional value of MS is that it contains various antinutritional factors (El Saadany *et al.*, 1980; Opeke, 1982). Tannin, hydrocyanic acid (HCN), trypsin inhibitor activity and oxalate in MS could be reduced by in boiling. Also, boiling in alkali was most efficient in reducing phytic acid content. Moreover, boiling following soaking reduced the concentration of the anti-nutritional factors in mango kernel (Dakare *et al.*, 2012; Abdullahi, 2012). Maximum tannin reduction and enhancement of MSK proteins were obtained by the combined action of soaking and autoclaving (Messay and Shimelis, 2012).

For improving the herd reproductive efficiency, the selection of males with high reproductive ability and fertilizing capacity is very important (Silva *et al.*, 2002). Puberty, as an economic factor, reaching the early ages at puberty and sexual maturity positively impacted animal longevity and productivity. For breeding male selection. there are pronounced physiological signs and/or phenotypic features occur at puberty. Prepubertal stage

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(weaning to puberty) is very important interval to prepare good raising of males for breeding programs. This stage is associated with a gradual alleviation in blood testosterone level to precede the puberty incidence (Thompson *et al.*, 1972). Prior to puberty, development in the sexual organs is required to the sexual instincts being prominent and reproduction is possible (Abdel-Raouf, 1960).

In sheep, the testicular measurements and biometric parameters at early ages are standards of reproductive performance and fertility, which are useful as selection criterions for breeding males (Belkhiri *et al.*, 2017). The diagnosis of the testicular disorders and sex organ structures at early ages (Pechman and Eilts, 1987) is very important for prediction of reproductive efficiency of males. The testicular anatomical development, testicular parenchyma echogenicity, and mediastinum are evaluated by ultrasound (Chandolia *et al.*, 1997; Clark *et al.*, 2003). Also, ultrasound can be used accurately to examine the accessory glands (Urt, 2014).

Several authors studied the effect of MS inclusion in the diet on growth performance of sheep (Aragão *et al.*, 2012), goats (Silva *et al.*, 2016), and rabbit (Teye *et al.*, 2020). The information on the influence of MS replacement in the diets on reproductive performance of small ruminants is rare. Therefore, the current study aimed to evaluate the effect of partial replacing of corn grains in CFM with mango seeds in diet of Damascus goat bucks on productive performance and reproductive characteristics at prepubertal stage.

MATERIALS AND METHODS

Study location:

The present study was conducted in sheep and goats farm at Sakha Animal Production Research Station belonged to Animal Production Research Institute, Agricultural Research Center, Egypt, during the interval from April 2019 to March 2020.

Animals:

In this experiment, 18 weaned Damascus male goat kids having 18-20 kg LBW were divided into 3 similar groups according to their LBW, 6 in each.

Experimental diets:

Three experimental diets were used in feeding animal for an experimental period from weaning until prepuberty. All diets contained concentrate feed mixture (60%), berseem hay (25% BH), and wheat straw (15% WS). Corn grains in concentrate feed mixure were replaced with mango seeds at levels of 0% MS (G1, control), 15% (G2), 30% (G3). Ingredients of the CFM are shown in Table 1. Chemical composition of CFM ingredients, BH, and WS is presented in Table 2.

Mango seeds consist of about 68% kernel, 29% shell and 3% testa (Odunsi, 2005). Mango seeds were soaked with water for 3 days to decrease the anti-nutritional factors, air-sundried for 48 hours, then crushed in a forages machine.

Animals in all groups were fed in group feeding, and the tested diets were offered in equal amounts for all groups twice daily at 8 a.m. and 3 p.m., while fresh water was available at all times. Offered amounts of CFM and roughage were adjusted every two weeks according to the changes in live body weight. Diets were formulated to meet requirements of growing goats according to NRC (2007).

Table 1. Ration ingredients (on DM % basis).

CFM ingredient (%)	Diet of G1	Diet of G2	Diet of G3
Yellow corn grains	32	27.2	22.4
Mango seeds	0	4.8	9.6
Wheat bran	24	24	24
Uncorticated cotton-seed meal	38	38	38
Molasses	3	3	3
Limestone	2	2	2
Common salt	1	1	1
Total	100	100	100

Table 2. Chemical analysis of CFM ingredients and feedstuffs, and CFM and the tested diets of experimental groups.

Item	DM %	Chemical analysis (%, on DM basis)					
		OM	CP	EE	CF	NFE	Ash
CFM ingredients and feedstuffs:							
Yellow corn grains	91.58	98.70	9.29	1.7	2.2	85.51	1.3
Wheat brane	90.50	93.80	14.30	2.7	11.8	65.0	6.2
Uncorticated cotton-seed meal	90.98	93.30	27.49	5.64	24.26	35.91	6.7
Mango seeds	88.33	98.21	7.13	4.81	22.21	64.06	1.79
Berseem hay	90.31	90.98	14.98	2.10	31.81	42.09	9.02
Wheat straw	91.75	85.95	2.96	1.59	25.8	55.60	14.05
CFM*:							
G1 (Control)	85.6	89.54	16.85	3.33	12.75	56.61	10.46
G2 (15% MS)	85.44	89.51	16.75	3.48	13.72	55.56	10.49
G3 (30% MS)	85.28	89.49	16.64	3.63	14.68	54.54	10.51
Experimental diets*:							
G1 (Control)	81.70	89.36	14.30	2.77	19.47	52.82	10.64
G2 (15% MS)	81.60	89.35	14.24	2.86	20.05	52.20	10.65
G3 (30% MS)	81.51	89.33	14.17	2.95	20.63	51.58	10.67

*** Calculated chemical composition**

Experimental procedures:

Growth parameters:

Throughout a feeding period from weaning up to 9 month of age, LBW and feed intake of different feedstuffs were bi-weekly recorded, then average daily weight gain and feed conversion ration were calculated. Economic feed efficiency as feed cost and prices of weight gain were estimated based on marketing price 2020.

Digestibility trials:

At the last week of the feeding trial, three animals from each group, weighing approximately 38 ± 2 kg LBW, were housed individually in metabolic cages, allowed the quantitative collection of hard feces, and urine, for seven days as a collection period. Samples were collected from each animal and representative samples were taken for analyses. Chemical analysis of CFM ingredients, BH, WS and feces were performed according to the method of A.O.A.C (2005), chemical composition of CFM and the tested diets was calculated. Values of the total digestible nutrients (TDN) were calculated according to the classic formula of Maynard *et al*. (1978), on a dry matter basis (DM).

Reproductive morphometrics:

During a period from 22 wk of age up to the production of the 1st ejaculation (just prepuberty), testicular length was measured bi-weekly from top of the tail to the head of the epididymis for each testis using caliper (Islam and Land, 1977). All testes length was done for both right and left one. At the same time, scrotal circumference at the median portion was measured by tape (Ahmed and Noakes, 1995).

Reproductive ultrasonography:

Ultrasonography imaging of the testes and accessory glands was carried out bi-weekly in three bucks of each group starting from age of week 22 (pre-puberty) to puberty age after clipping the hairs of scrotum. Before examination all bucks fasted from eating for 12 h. For ultrasonography examination, advanced ultrasound machine (ESAOTE Pie Medical Aquila Pro Vet with Probe 6.0 Mhz Rectal Veterinary transducer) was used. The buck was restrained by two assistants, one of whom also lifted its tail; no sedatives were used. Following clipping of scrotal hairs, the testicles were pulled downwards within the scrotum and retained in that position. The testicles were not grasped, but were left pending; however, the examiner's left hand was placed on the surface opposite to the one where the transducer was applied on, in order to stabilize the organs. The probe was placed on the surface of testicles along their longitudinal axis and moved from one side to another for monitoring the testicular parenchyma. The accessory glands (Bulbourethral gland, prostate, and vascular gland) measurements were determined from the rectum by using rectal probe using lubricant for easy insertion. Scrotal circumference was measured by measuring steel tape (Ahmed and Noakes, 1995). Testis length was measured from top of the tail to the head of the epididymis for each testis using caliper (Islam and Land, 1977). All testes length was done for both right and left one.

Blood samples and analysis:

Blood samples were taken at two and one-month prepuberty. Blood samples (5 ml) were collected from the jugular vein of each animal, three animals from each group. Blood samples were centrifuged at 3000 rpm for 15 min to separate serum. The blood serum was decanted into fresh test tubes and stored at -20°C to be analyzed for testosterone by electrochemiluminescene immunoassay (ECLIA) is intended for use on Elecsys Cobas e immunoassay analyzers according to Nieschlag and Behre (2004).

Statistical analysis:

The obtained data of body weight, age, nutrient digestibility, scrotal and accessory glands measurements, and testosterone concentration were subjected to one-way-ANOVA (Snedecor and Cochran, 1980) to study the effect of tested diets. Data of testicular morphometric and ultrasonography measurements were subjected to factorial design (3 tested diets x 2 side). The general linear model of SAS (2004) program was used in processing measured parameters. The difference between means was statistically measured for significance at $P<0.05$ according to Duncan's Multiple Range test (Duncan, 1955).

RESULTS AND DISCUSSION

Results

Productive performance:

Live weight and daily gain:

Results illustrated in Figure 1 showed that live body weight of male kids was higher ($P<0.05$) in treatment groups (G2 and G3) than in G1 (control) at all ages from weaning to puberty. At weaning the differences in body weight among the experimental group were not significant, while body weight at puberty was higher ($P<0.05$) in G2 and G3 by about 7.3 and 11.2% than that in G1 (Table 3 and Fig. 1). Average daily gain (AVDG) at pre-pubertal stage or from weaning to puberty was higher ($P<0.05$) in treatment groups than in control one. Male kids in G3 showed the highest ($P<0.05$) body weight and AVDG (Table 3).

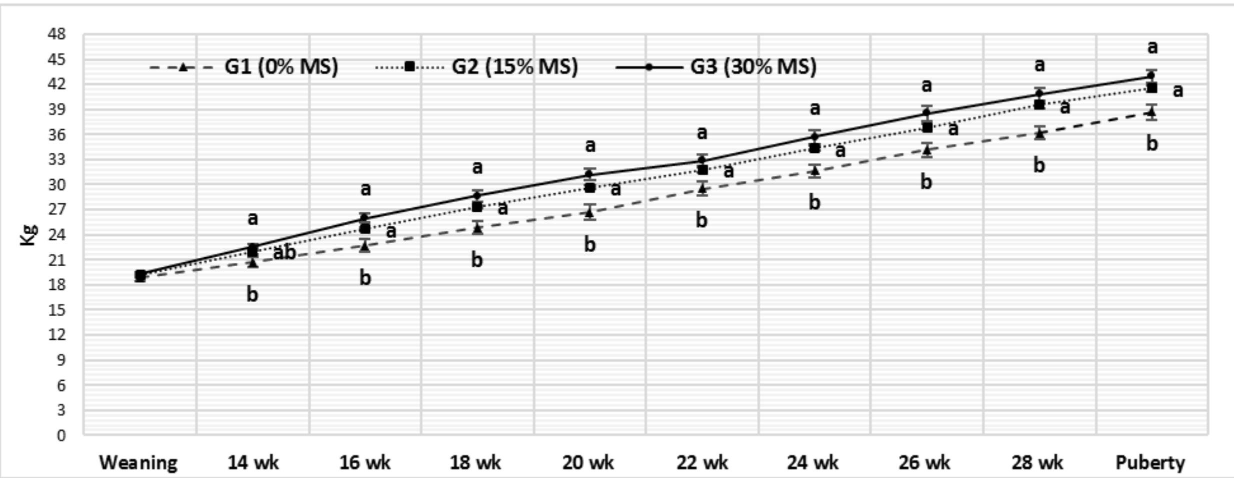

Fig. 1. Change in live body weight of male kids in the experimental groups from weaning to puberty.

Table 3. Live body weight and average daily gain in male kids during the period from weaning to puberty in the experimental groups.

Item	G1 (0% MS)	G2 (15% MS)	G3 (30% MS)
Live body weight (kg):			
Weaning	18.83±0.40	19.17±0.31	19.33±0.21
Puberty	38.67±0.88[b]	41.50±0.43[a]	43.00±0.77[a]
Average daily gain (g/h/d):			
Pre-pubertal stage	144.44±5.56[b]	169.44±3.51[a]	179.17±5.16[a]
Weaning to puberty	146.91±5.21[b]	165.43±3.12[a]	175.31±4.55[a]

a, b: Significant group differences at 0.05 level.

Digestibility coefficients and feeding values:

Results of the digestibility trail indicated marked improvement (P<0.05) in all nutrients digestion. The digestibility coefficient of DM, CP, EE and CF increased (P<0.05) by increasing the level of MS. The digestibility of OM and NFE, and feeding values, as TDN and DCP were higher (P<0.05) in G2 and G3 than in G1, being the highest in G3 (Table 4).

Table 4. Digestibility coefficients and feeding values of the tested diets by male kids in the experimental groups.

Item	G1 (0%MS)	G2 (15% MS)	G3 (30% MS)
Digestibility coefficients (%):			
DM	68.53±0.32[c]	72.28±0.27[b]	74.60±0.31[a]
OM	69.87±0.26[b]	73.13±0.31[a]	74.16±0.41[a]
CP	70.55±0.26[c]	73.90±0.31[b]	74.81±0.18[a]
EE	61.48±0.26[c]	66.51±0.42[b]	68.49±0.20[a]
CF	63.34±0.29[c]	65.87±0.31[b]	67.51±0.28[a]
NFE	72.42±0.35[b]	75.54±0.42[a]	76.68±0.28[a]
Feeding value (%):			
TDN	64.52±0.28[b]	67.63±0.50[a]	68.63±0.24[a]
DCP	10.09±0.04[b]	10.52±0.04[a]	10.60±0.03[a]

a, b, c: Significant group differences at 0.05 level.

Average daily feed intake and feed conversion ratio:

There was no statistical analysis for feed intake, and animals were group-feeding. Average daily feed intake from feedstuffs (CFM, BH, and WS) or DM, TDN, and DCP was slightly higher in treatment groups than control group. Feed conversion ratio revealed that the amounts of DM and DCP per kg weight gain were better (P<0.05) in treatment groups than in control one. However, there was no significant differences in TDN conversion among different groups (Table 5).

Table 5. Average daily feed intake and feed conversion ratio of the tested diets by male kids in the experimental groups.

Item	G1 (0% MS)	G2 (15% MS)	G3 (30% MS)
CFM (g)	900.7	930.7	960.3
BH (g)	374.8	388.3	400.0
WS (g)	229.5	233.0	239.7
Total			
DM (kg)	1.505	1.525	1.600
TDN	0.971	1.030	1.100
DCP	0.152	0.160	0.170
Feed conversion:			
Kg DM/kg gain	10.45±0.39[a]	9.59±0.30[b]	9.30±0.42[b]
Kg TDN/kg gain	6.74±0.32	6.36±0.60	6.40±0.21
Kg DCP/kg gain	1.06±0.30[a]	0.99±0.07[b]	0.99±0.05[b]

a, b : Significant group differences at 0.05 level.

Economic efficiency:

Results in Table 6 showed that daily feed cost was nearly similar in all groups, but feed cost per kg weight gain decreased (P<0.05) by increasing level of MS. However, price of daily gain, economic feed efficiency (EFE) and relative EFE increased (P<0.05) by increasing MS level. These results were reflected in higher EFE for male kids by 11.5 and 17.6% in G2 and G3 than in control (G1).

Table 6. Economic feed efficiency of experimental diets fed by male kids in different groups.

Item	G1 (0% MS)	G2 (15% MS)	G3 (30% MS)
Daily feed cost(L.E./animal)	6.33±0.27	6.38±0.50	6.41±0.45
Feed cost (L.E./kg weight gain)	43.09±0.30[a]	38.57±1.67[b]	36.56±2.33[b]
Price of daily gain (L.E./animal)	9.36±0.42[c]	10.53±0.42[b]	11.18±0.88[a]
Economic feed efficiency (EFE%)	148.00±7.49[b]	165.00±7.56[a]	174.00±8.53[a]
EFE relative to control (%)	100.00±9.90[b]	111.50±11.70[a]	117.60±5.06[a]

a, b, c: Significant group differences at 0.05 level.

Prices of diets (L.E./Kg): D1: 4.65 L.E., D2: 4.50 L.E., D3: 4.36 L.E., BH: 3 L.E., WS: 0.60 L.E. live Weight: 65 L.E.

Reproductive performance:

Age at 1st ejaculation and testosterone profile:

Prior to puberty incidence, male kids in treatment groups showed earlier (P<0.05) ages to produce the 1st ejaculation than control. Testosterone concentration did not differ (P≥0.05) 2 months prepuberty stage, but increased (P<0.05) in G2 compared with G1 and G3 one-month prepuberty (Table. 7).

Table 7. Age at 1st ejaculation and serum testosterone profile of male kids in the experimental groups at prepuberty stage.

Item	G1 (0% MS)	G2 (15% MS)	G3 (30% MS)
Age 1st ejaculate	228.67±2.33[a]	194.67±8.09[b]	190.00±4.51[b]
Testosterone concentration (ng/ml):			
Two-month prepuberty	0.31±0.08	0.54±0.15	0.52±0.21
One-month prepuberty	1.59±0.15[b]	3.57±0.72[a]	1.67±0.18[b]
Overall mean (2-mo pre to puberty)	0.95±0.30[b]	2.05±0.75[a]	1.10±0.28[b]

a, b: Significant group differences.

Morphometric measurements of the testes:

At pre-pubertal stage, the morphometric measures, including the testicular length and width, and scrotal circumference in G2 as well as only testicular length in G3 increased (P<0.05) in comparing with G1. Scrotal thickness showed an opposite trend, being thinner (P<0.05) in G2 and G3 than in G1. As affected by the side, the testicular length and width increased (P<0.05) on the left than the right side (Table 8).

Table 8. Morphometric measurements of testes and scrotum of male kids in the experimental groups.

Testicular measurement	G1 (0% MS)	G2 (15% MS)	G3 (30% MS)	Overall mean
Testicular length (cm):				
Left testis	5.12±0.06	6.02±0.06	5.90±0.07	5.68±0.14[a]
Right testis	4.85±0.04	5.61±0.03	5.32±0.01	5.26±0.11[b]
Overall mean	4.99±0.07[c]	5.82±0.10[a]	5.61±0.13[b]	-
Testicular width (cm):				
Left testis	2.80±0.03	3.17±0.03	2.91±0.09	2.96±0.06[a]
Right testis	2.76±0.02	3.07±0.05	2.72±0.02	2.85±0.06[b]
Overall mean	2.78±0.02[b]	3.12±0.03[a]	2.81±0.06[b]	-
Scrotal measurements:				
Circumference (cm)	13.58±0.08[b]	14.87±0.12[a]	13.72±0.19[b]	-
Wall thickness (mm)	2.20±0.00[a]	1.90±0.10[b]	1.90±0.00[b]	-

a, b, c: Significant group differences at 0.05 level.

Ultrasonography measurements of the testes:

The ultrasonographic measurement including mediastinum width increased in G2, while decreased in G3 as compared to G1 (P<0.05). Tunica albuginea increased (P<0.05) in treatment groups in comparison with control. Width of scrotal septum did not differ (P≥0.05) in G2 and G3 from that in G1, but was higher in G3 than in G2. Mediastinum width increased, while tunica albuginea decreased on the right than left side (P<0.05, Table 9).

Table 9. Ultrasonography measurements of testes and scrotum of male kids in the experimental groups.

Measure	G1 (0% MS)	G2 (15% MS)	G3 (30% MS)	Overall mean
Mediastinum width (cm)				
Left testis	0.24±0.00	0.26±0.00	0.22±0.00	0.24±0.01^{b}
Right testis	0.26±0.00	0.26±0.00	0.23±0.00	0.25±0.01^{a}
Overall mean	0.25±0.00^{b}	0.26±0.00^{a}	0.23±0.00^{c}	
Tunica albuginea thickness (mm)				
Left testis	1.90±0.10	2.20±0.00	2.20±0.00	2.10±0.10^{a}
Right testis	1.80±0.00	2.00±0.00	2.00±0.10	1.90±0.10^{b}
Overall mean	1.80±0.00^{b}	2.10±0.00^{a}	2.10±0.10^{a}	-
Scrotal septum width (mm)	0.22±0.01^{ab}	0.20±0.00^{b}	0.23±0.01^{a}	-

$^{a, b, c}$: Significant group differences.

Ultrasonography measurements of accessory glands:

At pre-pubertal stage, average diameter of Bulbourethral glands was not affected by treatment or the side of gland. Prostate gland and vascular gland were longer (P<0.05) and wider in G2 and G3 than in G1 (Table 10).

Table 10. Ultrasonography measurements of the accessory sex glands in male kids in the experimental groups.

Measure	G1 (0% MS)	G2 (15% MS)	G3 (30% MS)
Bulbourethral gland diameter (cm)			
Left	0.92±0.014	1.00±0.02	0.87±0.07
Right	1.01±0.03	0.95±0.01	0.96±0.03
Prostate (cm)			
Length	2.97±0.04^{b}	3.13±0.03^{a}	3.15±0.02^{a}
Width	0.83±0.01^{b}	1.00±0.04^{a}	0.98±0.02^{a}
Vascular gland (cm):			
Length	2.90±0.05^{b}	3.11±0.05^{a}	3.20±0.03^{a}
Width	0.77±0.01^{b}	0.89±0.03^{a}	0.92±0.01^{a}

$^{a, b}$: Significant group differences at 0.05 level.

Discussion

In the current study, mango seeds (MS) were used as a replacement of corn grains (15 and 30%) in diets of Damascus goat male kids during the growing period from weaning to puberty. To avoid the harmful effects of antinutritional factors in MS, soaking and air drying of mango seeds was performed in our study according to the method of (El Boushy and Van Der Poel, 2000). Mango seeds are considered a high quality ingredient and could be used in animal nutrition. Concerning the growth performance parameters. Kernels and peel of MS discarded from processing could be recycled into potentially valuable sources of antioxidants that could be used as food ingredients (Ajila *et al.,* 2007). the obtained results indicated that the replacement of corn grains with 30% MS in diets had positive effects on productive performance of kids, in term of improvement in LBW, weight gain, and feed conversion ratio without significant effect on feed intake. In agreement with these results, MS meal replacement up to 37.5% in Yankasa sheep diet had positive effect on growth performance and feed conversion (Ibrahim *et al.,* 2020). However, MSK can be used to replace up to 50% of yellow corn grains in the sheep rations without any adverse effect on their feed intake, digestion coefficients, and ruminal fermentation. Consequently, MSK which is not competing and non-conventional feedstuff for animals was found useful as an economic replacement for energy materials like yellow corn grains (Omer *et al.,* 2019). Replacement of the corn grains (33%) by MSM was recommend by Silva *et al.* (2016), because of the better fermentation of fiber carbohydrates and reduces feeding costs. Aragão *et al.* (2012) evaluated corn grains replacement with MSM in sheep diets and found no effects on nutrient intake, even with 100% replacement, demonstrating its acceptability. These results may indicate that increasing MS level more than 30% in the diet may has no effect on growth performance of the animals, because MS up to 30% in our study resulted in the best productive performance of kids. In this context, Cavalcante *et al.* (2006) reported that inclusion of dehydrated mango above 36.1% DM caused a decrease in nutrient intake of sheep. Negative effects on intake and nutrient digestibility were observed by Anigbogu *et al.* (2006) in sheep fed 45 and 60% mango almonds. It is worth noting that higher productive performance of kids in our study is in association with insignificant effect of MS diets on feed intake. This agrees with the report of Ogundipe (2002), who observed that, a certain minimum daily dry matter intake is essential to satisfy an animal's appetite and to permit the proper functioning of the digestive tract, which may indicate normal palatability of MS diets. These findings suggest that MS is a good replacement of corn grains that could enhance rumination and prevent digestive disorder in the rumen. The observe improving in productive performance of kids is in concomitant the marked increased in digestibility coefficients of all nutrients and feeding values as TDN and DCP of 15 and 30% MS diets as compared to control. In accordance with this result, Abel *et al.* (2018) reported that the high DM content of mango kernel meal (MKM) enhanced DM digestibility in sheep fed diets. The digestibility of nutrients, including DM, CP, CF, EE and NFE, was the best with MS diet by the sheep (Van Soest, 1982). Diet digestibility was highest with the maximum level of MS replacement of mango meal (37.5%) in Yankasa sheep diet, however, there were no benefits in digestibility at the lower levels of MSM (Ibrahim *et al.,* 2020). A more likely explanation is the effect of the tannins in the MSK reacting with the dietary protein to increase by-pass proteins from the rumen for more efficient enzymic digestion in the intestines (Barry and McNabb, 1999). Mango has 4.89 and 6.84% of total phenols in the skin and kernel, respectively (Huber *et al.,* 2012). Depending upon the ratio of mango peels and seed kernels fed to ruminants, decreased intake and digestibility can occur due to the astringent effect of phenolic compounds, such as tannins, which interact with proteins, carbohydrates and minerals, reducing the nutritional value of the diet (Shahidi and Naczk, 1995).

Regarding the reproductive parameters, studies have shown that inclusions of some of the residues/wastes (apple, banana, cabbage, chicory, citrus, grape, mango, peas, pineapple, and pumpkin) in poultry and livestock rations have significantly improved the animal reproductive traits (Nkosi *et al.,* 2016; Alnaimy *et al.,* 2017). In our study, feeding goat kids on MS diet at a level of 15% resulted in earlier ages to produce the 1st ejaculation (27.81 wk) than control (32.66 wk), with testosterone concentration one-month prepuberty, being earlier (P<0.05) by about 4.9 wk than control. Shaaeldin *et al.* (2019) reported that signs of puberty in the Nubian bucks appeared around 22-24 wk. The ultrasonic imaging of the testes of goat male kids in 15% MS group at pre-pubertal stage showed the highest scrotal and testicular measurements. It is necessary to create a balance between produced free radicals and its metabolism for appropriate function of testicular cells, because if the testicular biological system fails to detoxify or repair the adverse effects of free radicals, the cells and tissue are damaged seriously (Romeo *et al.*, 2004). In this regard, antioxidants in MS can avoid this damage by counteracting free radicals or preventing their formation in the testicular cells. It is noteworthy that a part of the body antioxidant defense system, called preventive antioxidant system, is related to antioxidant enzymes such as Superoxide Dismutase (SOD), catalase, and Glutathione Peroxidase (GPX) (Nasri *et al.*, 2014; Bahmani *et al.,* 2015). These enzymes avoid oxidation by decreasing the rate of chain formation. These antioxidants can stop an oxidation chain forever by finding primer free radicals. In addition, through stabilizing metal radicals such as copper and iron, they can inhibit their oxidation, preventing various diseases (Bahmani *et al.,* 2015). Therefore, use of antioxidants and development of antioxidant therapy can break down the oxidative chain reaction and play a very significant role in increasing the capacity of the body to fight free radical-induced oxidative stress, and therefore improve the process of spermatogenesis (Asadi *et al.,* 2017). Similar findings have been reported on measurement of scrotal circumference, heart girth, and body weight in other breeds of goats and sheep (Derar *et al*., 2012). In similarity, the mean values of scrotal length, width, circumference and scrotal volume at 14 weeks of age were 2.89±0.22, 2.05±0.17, 8.82±0.72 cm and 21.36±0.93 cm^3, respectively, which then gradually and significantly (P<0.01) increased with an advancing age till 35 weeks of age reaching 10.65±0.30, 7.55±0.24, 19.45±0.65 cm and 200.45±16.67 cm^3, respectively (Chaudhari *et al.*, 2018). A tendency is for scrotal circumference of sheep to stop growing from 12 months of age, which was 32.09 cm, similar to that found in the sexually mature animals. During this period the length and width increased about 12 mm and circumference about 36 mm. This increase was almost similar to left and right testis (Souza, 2003).

Generally, Chaudhari *et al.* (2018) showed that all the testicular measurements were significantly affected by body condition growth rate which suggest that bucks with larger body size and good body condition might possess larger testicular size which may invariable result into a good reproductive capability, better semen quality, and thus improving the fertility of the animal (Akpa *et al.*, 2013). Based on the body weight and scrotal-testicular biometry, it could be inferred that the highest reproductive potential in Surti bucks is attained at around 9-10 months of age. The increase in testicular measurements with advancing age was in agreement with the observations of earlier workers (Souza *et al*., 2011; Moulla *et al.*, 2018) in different breeds of goat and sheep. The length, width and thickness of right and left testis differed significantly (P<0.01) between ages, bucks and due to interaction. This could be attributed to difference in body weight of bucks and individual variation. The significant age buck interaction indicated that the rate of increase in the testicular dimensions with advancing age was not uniform in different Surti bucks (Chaudhari *et al.*, 2018). After this period there was increase in these parameters but the increment was less as compared to third and fourth month (Kumari *et al.,* 2015). Rate of growth of testis was most profound from third to fourth month of age. The mediastinum testis was visualised as a linear structure of great echogenicity (Jeyakumar *et al.*, 2013; Kumari *et al.,* 2015). The development of left and right testis is exactly the same. A good correlation was shown between age, on one hand, and scrotal circumference, heart-girth and body weight, on the other hand. The body measurements reached their maximum at the age of puberty (22 - 24 weeks) (Shaaeldin *et al.*, 2018). Similar findings were also reported in sheep (Louw and Joubert, 1964). The diet of 15% MS showed positive effect on measurements of the accessory glands. The correlations between the biometry of the bulbourethral gland and scrotal circumference are similar to those reported by Camela (2015), which were significant and of medium magnitude (r=0.543; P<0.01). Archana *et al.* (2009) recorded that the average length, width and thickness of the right vesicular gland in one day old goats were 0.96, 0.59 and 0.53 cm whereas the left gland measured1.10, 0.71 and 0.54 cm, respectively, and grew in late prepubertal age.

CONCLUSION

This study concluded that the replacement of corn grains by 30% mango seeds (MS) in diets of Damascus goat bucks has positive effects on productive performance. The replacement at a rate of 15% MS improved reproductive characterization of bucks raised for semen production for breeding programs.

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تأثير الإحلال الجزئى لحبوب الذرة ببذور المانجو على الخصائص الانتاجية والتناسلية لذكور الماعز الدمشقى فى فترة ما قبل البلوغ

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تهدف هذه الدراسة إلى دراسة تأثير الاستبدال الجزئى لحبوب الذرة ببذور المانجو فى علائق ذكور الماعز الدمشقى على الخصائص الإنتاجية والتناسلية فى مرحلة ما قبل البلوغ (من الفطام حتى البلوغ). استخدم فى هذه التجربة عدد ١٨ ذكر ماعز بعد الفطام وتم توزيعها ثلاثة مجموعات متماثلة غذيت على العلائق التجريبية التى تم استبدال حبوب الذرة ببذور المانجو فى العلف المركز بمعدلات ٠، ١٥، ٣٠% للمجموعات الأولى والثانية والثالثة على التوالى. أظهرت النتائج زيادة معنوية فى وزن الجسم و معدل الزيادة يومية فى وزن الجسم فى المجموعة الثالثة. وتحسن معدل التحويل الغذائى و معاملات الهضم للعلائق و القيم الغذائية معنويا فى المجموعتين الثانية والثالثة مقارنة بالمجموعة الأولى. ارتفاع الكفاءة الاقتصادية لذكور الماعز معنويا فى المجموعتين الثانية والثالثة مقارنة بالمجموعة الأولى. أعطت حيوانات أول قذفة منوية فى عمر مبكر فى المجموعتين الثانية والثالثة بشكل معنوى مقارنة بالمجموعة الأولى. زاد تركيز هرمون التستوستيرون معنويا فى المجموعة الثانية مقارنة بالمجموعتين الأولى و الثالثة قبل شهر من البلوغ. زادت قياسات الخصية و محيط كيس الصفن معنويا فى المجموعة الثانية ، وزاد طول خصية معنويا فى المجموعة الثالثة مقارنة بالمجموعة الأولى. زاد سمك الطبقه المنصفه للخصية (mediastinum) بشكل معنوى فى المجموعة الثانية و انخفض معنويا فى المجموعة الثالثة مقارنة بالمجموعة الأولى. وزاد سمك الطبقه المغلغه للخصيه معنويا فى المجموعتين الثانية والثالثة عن المجموعة الأولى. وكان الفاصل بين الخصيتن كبير معنويا فى المجموعة الثالثة عن المجموعة الثانية. زاد طول وعرض غدتى البروستاتا والحويصلات المنويه معنويا فى المجموعتين الثانية والثالثة مقارنة بالمجموعة الأولى. توصى الدراسة بأن استبدال الذرة فى علائق ذكور الماعز الدمشقى بـ ٣٠% بذور مانجو أدى الى تأثيرات إيجابية على الأداء الإنتاجى . وأن الاستبدال بـ ١٥% بذور مانجو حسن الخصائص التناسلية للذكور من أجل زيادة إنتاج السائل المنوى لإستخدامها فى برامج التلقيح.