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SEMEN CHARACTERISTICS, REPRODUCTIVE TRACT DEVELOPMENT, FEED EFFICIENCY AND SOME BLOOD PARAMETERS OF BALADI BULLS AND THEIR CROSSBREEDS WITH ABONDANCE AND TARENTAISE

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ABSTRACT

Twenty four Bovine males representing three genotypes: Pure local "Baladi" (B), 1/4 Baladi 3/4 Abondance (BA×A) and 1/4 Baladi 3/4 Tarentaise (BT×T). Eight males in each genotype were subjected to evaluate their semen characteristics, reproductive tract development, growth rate, feed efficiency, some blood parameters, thermo-regulatory parameters and body dimensions at puberty and sexual maturity. BT×T bulls showed the best feed efficiency compared with those of BA×A and B bulls. Serum total protein, albumin, globulin, glucose, cholesterol, T_3 and testosterone in BT×T had the highest values, followed by BA×A, while B bulls had the lowest ones, either at puberty or sexual maturity. Total weight gain and daily weight gain were significantly higher in BT×T compared to BA×A and B bulls. Thermo-regulatory parameters and body dimensions were affected by the different genotypes. Crossbreeds bulls (BT×T and BA×A) reached age of puberty, sexual maturity and slaughter weight (60 days post sexual maturity) earlier than Baladi bulls. Semen characteristics among the three genotypes were highly significant ($P<0.0001$) especially of BT×T followed by BA×A compared to B bulls. Testes parameters of BT×T bulls had the highest values for all studied parameters, followed by BA×A, while those of B were the lowest. Sperm production per gram of testicular tissue was also significantly higher in BT×T bulls than the other two genotypes. This study indicated that the superiority of crossbreed bulls especially; BT×T in growth, reproductive performance and feed efficiency compared with pure Baladi bulls.
Keywords: Genotypes, semen, reproductive tract, feed efficiency, puberty and maturity.

INTRODUCTION

Reproductive performance of bulls is a complex trait because of several physiological processes such as the development of reproductive system from birth to puberty, spermatogenesis, ejaculation and mating behavior, which involves libido and copulation. For optimum semen quality, all these physiological processes should be coordinated. Spermatogenic activity of animals is a genetically controlled process and might be affected by many factors including breed or genotype, body weight, age and nutritional status (AbdEl-Hakeam *et al*., 1994).

Quantification of the sperm production capacity in breeding animals allows for assessment of the efficiency of spermatogenesis in males kept under different environmental conditions and enhances critical evaluation of season effect, breed, age, bioclimatic factors, hormones, chemicals and drugs (Amann, 1981). Reproductive success is essential for calves' producers to be profitable (Hansen, 2006).

Crossbreeding between two breeds is well recognized as a method for improving productivity of animals (Dahman *et al*., 1985).

All factors related to testicular degeneration, including hereditary and pathological conditions should be carefully considered as they may seriously affect semen quality via testicular development. Hoogenboezem and Swanepoel (2000) reported that testicular degeneration might be due to exposure to heat stress, nutritional deficiencies and management-related factors such as fat deposition in the scrotum and poor body condition.

Studying the reproductive tract development and the epididymal sperm reserves in different genotypes, age and feed efficiency might provide some information on the factors which may play a significant role in improving the reproductive efficiency of males and subsequently improving breeding programs (Murray *et al*., 1990).

Therefore, this work was conducted to study reproductive performance of some genotype bulls through its weight of reproductive organs, semen characteristics, epididymal sperm reserves as affected by feed efficiency, thermo-regulatory parameters and body dimensions.

MATERIALS AND METHODS

The present study was carried out at Sids Experimental Station, located at Bani Suef governorate in middle Egypt, belonging to Animal Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture.

Twenty four Bovine males representing three genotypes: Pure local "Baladi" (B), 1/4 Baladi 3/4 Abondance (BA×A) and1/4 Baladi 3/4 Tarentaise (BT×T). Eight males in each genotype were subjected in this study. The experiment started at puberty age of animals (Abd El-Hafeez *et al*., 2015). All males were healthy, showing no symptoms of malnutrition or any disease.

Management and feeding:

Males were housed under open sheds belonging to Sids Experimental Station and individually fed to cover their requirements of dry matter (DM), crude protein (CP) and total digestible nutrients (TDN) according to NRC (1988). Feeding allowances were monthly adjusted according to changes in body weight until they were slaughtered.

The experimental ration was formulated to contain 40% concentrate feed mixture (CFM), 30% berseem hay (BH) and 30% rice straw (RS). Whereas CFM was offered twice daily (at 8 am and 4 pm), berseem hay and rice straw were given twice daily (at 9 am and 5 pm). Fresh

and clean drinking water was available at all times. Body weight of males was recorded monthly before morning feeding. Daily gain, average feed intake and feed efficiency were determined. Also, thermal regulatory parameters and body dimensions were monthly measured.

Semen collection and evaluation

Semen ejaculates were collected starting from puberty and continued till sexual maturity to evaluate their semen production. Semen was collected between 8.00 and 10.00 am using an artificial vagina. Each male was sexually stimulated by allowing two false mounts and 2-3 min. restraint before collection. Two successive ejaculates were collected biweekly from each male in an interval of one hour. Ejaculate volume was recorded using graduated collecting tube. Sperm motility and pH of the freshly collected semen were immediately recorded after collection using a microscope with warmer stage and pH meter. Number of spermatozoa/ml was counted using hemocytometer. Total and motile sperm output/ejaculate were calculated.

Bulls were considered sexually mature when produced two successive ejaculates containing one billion sperm /ml (Hafez, 1987). Age, body weight and testes circumference at sexual maturity were also recorded.

Three animals were slaughtered after 60 days of sexual maturity. Live body weight and testes circumference (TC) before slaughter were recorded for each animal. After slaughtering, the genital tract was removed and trimmed from fat, then separated to its organs. Testes and epididymis (T+E) including tunica vaginalis were weighted to the nearest gram. After removal of tunica vaginalis and separation of epididymis from testes, weights were separately recorded for each part (cauda, corpus and caput).

Accessory sex glands weights (ampulla, seminal vesicles and Cowper's glands), penis weight and penis length were also recorded. Total epididymal sperm reserves and its distribution in cauda, corpus and caput were measured by direct count technique as described by AbdEl-Hakeam *et al*. (1978). Sperm cells were counted using the hemocytometer.

Blood samples and serum analysis:

Blood samples of animals were individually collected from the jugular vein in the morning before excess to drinking and feeding at the beginning of the experiment and monthly until the sexual maturity. The collected blood samples were centrifuged at 3000 r.p.m. for 15 minutes and the obtained clear samples serum were stored at -20º C until analysis. Concentrations of total protein and albumin were estimated in serum using kits of Diamond Diagnostic, EC Hannover, Germany. Globulin level was calculated by the difference between total protein and albumin. Glucose and cholesterol were quantified in serum by using kits of Spinreact, S.A.U. Ctra. Santa Coloma, 7 E-17176 Sant Esteve de Bas (GI) Spain by means of spectrophotometer. Direct radioimmunoassay (RIA) technique was performed for assessment of total serum tri-iodothyronine (T_3) concentrations. Ready antibody-coated tube kits (Total T_3 RIA KIT. REF IM 1699-2013-08-14-IM3287) was used according to the procedure outlined by the manufacturer. Assessment of total testosterone concentration was performed according to the method of Jaffe and Behman (1974) using Coat-A-count I125 radioimmunoassay (RIA) kits purchased from diagnostic products Corporation, Loss Angeles, California, 90045 USA by the manufactures information, the antiserum is highly specific for testosterone. The cross activity was 20% with 4-Estern-17-01-3-one, 16% with 11-keto-testosterone, 3.3% with 5-dihydro testosterone, 1.7% with Methyl test, 1.2 with 11-B-Hydroxtestosterone and less than 1% with other steroids.

Statistical analyses:

All collected data were statistically analyzed using the general linear model procedure (SAS, 2002). The differences among means were tested using Duncan's Multiple-rang test (Duncan, 1955). The model in statistical analysis was:

$$\mathbf{Y_{ij} = \mu + G_i + e_{ij}}$$

Where:

Y_{ij} = an observation

μ = overall means

G_i = effect of genotype (i = B, BA×A, BT×T)

e_{ij} = random error

RESULTS AND DISCUSSION

***A*- Growth performance, feed intake and feed efficiency:**

Data of Table 1 indicated that the total weight gain and daily weight gain of bulls were significantly affected by genotype. It was clear from the present results that total gain and daily gain were significantly higher in BT×T compared to BA×A and B bulls. The difference between BA×A and B bulls was not significant. These results may be related to the levels of total protein (TP), albumin (Alb), globulin (Glob), glucose (Glu) and tri-iodothyronine (T_3) concerning BT×T, which recorded the highest values followed by BA×A; while B bulls recorded the lowest values (Table 2). These results are in agreement with Abd El-Hafeez *et al*. (2015), they reported that total and daily weight gain were significantly higher in BT×T than those in growing Baladi calves.

Comparisons among genotypes indicated that total DM, TDN and CP intakes in BT×T and BA×A were significantly higher than that in B bulls (Table 1). These results are in agreement with Abd El-Hafeez *et al. (*2015) who indicated that total DM and TDN intakes were significantly higher in male of BT×T compared to B calves. However, Ibrahim *et al*. (2005) indicated that Baladi and its crosses with Abondance and Tarentaise did not differ in the daily feed intake under the middle Egypt conditions.

Feed efficiency expressed as kg of DMI, TDN and CP required to producing one kg gain is presented in Table 1. It was observed that BT×T bulls had the best feed efficiency as DM, TDN and CP compared with those of BA×A and B bulls. This result might be due to the higher daily gain for this group. The same trend was obtained by Ibrahim *et al*. (2005). They reported that grading-up of Baladi with Abondance and Tarentaise resulted in an increase in feed consumption per kg gain.

Table 1: Growth performance, feed intake and feed efficiency of Baladi bulls and their crossbreds with Abondance and Tarentaise.

Traits	Genotype			±SE	P. value
	B.	BA×A	BT×T		
Initial weight at puberty, kg	244.33^{c}	255.67^{b}	263.67^{a}	1.342	0.0001
Final weight at slaughter, kg	424.67^{c}	437.33^{b}	459.50^{a}	3.685	0.0001
Total gain, kg	180.34^{b}	181.66^{b}	195.83^{a}	4.192	0.03
Daily gain, g	663.43^{b}	708.23^{b}	794.44^{a}	20.104	0.0009
Average daily feed intake/head:					
DM, kg	8.26^{b}	8.88^{a}	9.05^{a}	0.094	0.0002
TDN intake, kg	4.42^{b}	4.76^{a}	4.84^{a}	0.043	0.0001
CP, g	829.80^{b}	901.20^{a}	904.00^{a}	5.437	0.0001
Feed efficiency:					
DM/ gain, kg/kg	12.45^{a}	12.54^{a}	11.39^{b}	0.218	0.0001
TDN/ gain, kg/kg	6.66^{a}	6.72^{a}	6.09^{b}	0.152	0.0001
CP/ gain, g/g	1.25^{a}	1.27^{a}	1.14^{b}	0.035	0.0001

$^{a,b\ and\ c}$: Means within each row with different superscripts are significantly differ (P<0.05).

***B*- Blood parameters:**

Blood parameters are important index of physiological, pathological and nutritional status of the organism. Changes in blood parameters when compared to the normal values could be used to interpret the metabolic status of the animal and perhaps nutrient adequacy of feed consumed (Nworgu *et al.*, 2007). Data presented in Table 2 showed that TP, Alb and Glob in BT×T had the highest values, followed by BA×A, while B bulls had the lowest ones, either at puberty or sexual maturity. This superiority in BT×T and BA×A compared to B bulls may be due to the higher feed intake (Table 1), metabolic rate and enzymes activity, which was reflected on the blood metabolites (Table 2). The same trend was obtained by Abd El-Hafeez *et al.* (2015) who found that serum TP, Alb and Glob in BT×T recorded the highest values, followed by BA×A, while B bulls recorded the lowest ones. In addition, Ashmawy *et al.* (2002) indicated that plasma TP level was higher in Friesian crossbred than B bulls.

Table 2: Some blood parameters at puberty and sexual maturity of Baladi bulls and their crossbreds with Abondance and Tarentaise.

Traits	Genotype			±SE	P. value
	B.	BA×A	BT×T		
	At puberty				
Total protein (g/dl)	6.32^{c}	6.89^{b}	7.35^{a}	0.101	0.0001
Albumin (g/dl)	4.19^{b}	4.39^{ab}	4.59^{a}	0.106	0.0001
Globulin (g/dl)	2.13^{b}	2.50^{ab}	2.76^{a}	0.151	0.0001
A/G ratio	1.97^{a}	1.76^{a}	1.66^{a}	0.161	0.0001
Glucose (mg/dl)	67.03^{c}	79.34^{b}	98.61^{a}	2.509	0.0001
Cholesterol (mg/dl)	122.31^{b}	157.14^{a}	171.15^{a}	6.168	0.0002
T_3 (nmol/L)	2.28^{c}	2.82^{b}	3.33^{a}	0.089	0.0001
Testosterone level (ng/ml)	0.803^{c}	0.893^{b}	0.993^{a}	0.021	0.0001
	At sexual maturity				
Total protein (g/dl)	6.88^{c}	7.40^{b}	7.70^{a}	0.070	0.0001
Albumin (g/dl)	4.51^{b}	4.67^{ab}	4.79^{a}	0.050	0.0001
Globulin (g/dl)	2.37^{b}	2.71^{ab}	2.91^{a}	0.089	0.0001
A/G ratio	1.90^{a}	1.73^{ab}	1.65^{b}	0.081	0.0001
Glucose (mg/dl)	75.48^{c}	90.27^{b}	113.79^{a}	4.311	0.0001
Cholesterol (mg/dl)	139.78^{c}	170.39^{b}	188.40^{a}	5.625	0.001
T_3 (nmol/L)	2.87^{c}	3.71^{b}	4.31^{a}	0.171	0.0001
Testosterone level (ng/ml)	1.08^{c}	1.40^{b}	1.68^{a}	0.087	0.0001

$^{a,b\ and\ c}$: Means within each row with different superscripts are significantly differ (P<0.05).

Serum glucose (Glu) values (Table 2) followed the same trend as that of TP, Alb and Glob, either at puberty or sexual maturity. This superiority of BT×T and BA×A compared to B bulls may be due to the increasing of feed intake as DM and TDN (Table1). The same finding was reported by Ashmawy *et al.* (2002) who found that plasma Glu level was higher in crossbred than B calves. Also, Ibrahim *et al.* (2005) reported that serum Glu levels were 52.36, 92.13 and 75.19 mg/dl for B, AxB and BxT bulls, respectively.

The results in Table 2 indicated that serum cholesterol values were significantly higher (P<0.001) in BT×T and BA×A compared with B bulls at puberty. At sexual maturity, the values were significantly higher (P<0.001) in BT×T followed by BA×A, while those of B were the lowest. This result may be attributed to the increases in voluntary feed intake (Table 1), rumen fermentation, enzymes activities and high thyroid gland secretion (Table 2). Abd El-Hafeez *et al. (*2015) reported that serum cholesterol level was significantly

higher in BT×T followed by BA×A compared with B bulls. On the other hand, Abd El-Hafeez *et al.* (2014) found that serum cholesterol concentration was 153.33, 172.67 and 193.33 mg/dl for B, BT×T and BA×A cows, respectively.

Mean values of T_3 of the three different genotypes studied are shown in Table 2. The data indicated that T_3 concentration were significantly higher (P<0.0001) in BT×T than BA×A followed by B bulls, either at puberty or sexual maturity. T_3 value is proportionally correlated with the live body weight being low in lighter bulls (Baladi) and high in heavier bulls (crossbreeds) as indicated in Tables 1 and 2. Collier *et al.* (1984) reported that the pituitary thyroid axis is an important physiological factor controlling metabolic processes. Thyroid hormones synergize with other hormones to promote growth (Lapierre *et al.*, 1990).

The present results showed that BT×T crossbreed bulls had the highest values of T_3 (3.33 and 4.31 nmol/ L), but Baladi bulls had the lowest values (2.28 and 2.87nmol/L) at puberty and sexual maturity, respectively. These results were in harmony with Abd El-Hafeez *et al.* (2014) who found that T_3 and T_4 values of lighter cows (B) were significantly lower than those of heavier cows (BT×T and BA×A).

Levels of testosterone of different genotype groups at puberty and sexual maturity are shown in Table 2. It was observed that testosterone level was significantly higher (P<0.0001) in BT×T and BA×A than B bulls, either at puberty or sexual maturity, where BT×T group recorded the highest concentration followed by BA×A, while B group recorded the lowest ones. The obtained data showed a gradual increase in testosterone concentration with advancing of age and weight. Such rise was due to the continuous development of testicular tissue as a result of age and weight progress toward puberty and sexual maturity. The present results are in agreement with Mokhless and Ibrahim (1990). They reported that there were increases in blood testosterone with advancing of age. Abd El-Moty *et al.* (2001) also found highly significant positive correlation coefficients among body weight, testes circumference and testosterone levels in both Buffalo and Friesian bulls. In addition, Sajjad *et al.* (2007) reported that the levels of blood serum testosterone were correlated with scrotal circumference and semen volume.

Generally, the obtained results of blood parameters studied indicated normal physiological and healthy status of all experimental bulls.

***B*- Thermo-regulatory parameters:**

The average values of skin temperature (ST), rectal temperature (RT), respiration rate (RR) and pulse rate (PR) of B and their crossbreds BA×A and BT×T bulls at puberty and sexual maturity are presented in Table 3. The present data indicated that ST and RT significantly increased (P<0.04) with BA×A and insignificantly increased with BT×T compared to B bulls at puberty, while, ST was significantly increased (P<0.0001) in both BA×A and BT×T compared to B bulls at sexual maturity. However, RT was not significantly different between BT×T and B bulls at sexual maturity. The diurnal change in rectal temperature was more pronounced in crossbreds than B bulls. This pattern of response could be attributed to the fact that B bulls were relatively more heat tolerant than crossbreds (BA×A and BT×T) bulls. This result is in agreement with that of Abd El-Hafeez *et al.* (2015) who indicated that ST insignificantly increased in BA×A and BT×T compared to B bulls, while RT significantly increased in BA×A and insignificantly increased with BT×T compared to B bulls. Also, Ashmawy *et al.* (2002) found that body temperature was significantly increased in Friesian crossbreed compared to Baladi calves. At puberty, the mean value of RR was significantly increased (P<0.0001) by 4 and 2 breath/min for BA×A and BT×T than B bulls, respectively, the same trend was obtained at sexual maturity that may explain the greater rise in RR in crossbreeds, which depends on respiratory evaporative cooling mechanism to dissipate heat load for maintaining homoeothermic. This result is in harmony with Ashmawy *et al.* (2002) who reported that RR significantly higher in Friesian crossbreed than Baladi calves. It is of interest to note that present data of PR among the different experimental genotypes (Table 3) followed the same trend as that of RR in males, either at puberty or sexual maturity. This result may confirm the positive relation between RR and PR.

Table 3: Thermo-regulatory parameters of Baladi bulls and their crossbreds with Abondance and Tarentaise at puberty and sexual maturity.

Traits	Genotype			±SE	P. value
	B.	BA×A	BT×T		
	At puberty				
Skin temperature (°C)	38.70^{b}	39.07^{a}	38.97^{ab}	0.098	0.04
Rectal temperature (°C)	37.65^{b}	38.40^{a}	38.3^{a}	0.114	0.001
Respiration rate, (breath/min.)	33.83^{c}	37.83^{a}	35.83^{b}	0.342	0.0001
Pulse rate (pulse/min.)	32.17^{b}	35.33^{a}	34.67^{a}	0.325	0.0001
	At sexual maturity				
Skin temperature (°C)	38.20^{b}	39.13^{a}	38.88^{a}	0.101	0.0001
Rectal temperature (°C)	37.80^{b}	38.50^{a}	38.08^{b}	0.110	0.001
Respiration rate, (breath/min.)	28.50^{c}	32.17^{a}	29.67^{b}	0.292	0.0001
Pulse rate (pulse/min.)	27.83^{b}	30.83^{a}	28.83^{b}	0.342	0.0001

[a,b and c]: Means within each row with different superscripts are significantly differ (P<0.05).

***C*- Body dimensions:**

The values for withers height (WH), body length (BL), heart girth (HG) and rump width (RW) for B, BA×A and BT×T crossbred bulls are presented in Table 4. The BA×A had significantly higher values of WH, BL, HG and RW as compared with B genotype, either at puberty or sexual maturity. The BT×T showed some superiority in BL, either as compared with BA×A at sexual maturity or with B bulls in BL, HG and WH at puberty or sexual maturity. El-Barbary *et al.* (1995) and Ibrahim *et al.* (2005) indicated that all body measurements (except body length) were affected by age and genetic type, in such way, rump width was greater in Friesian pure breed than in F×B. Also, Essi *et al.* (1987) reported that grading-up B with the Holstein-Friesian (HF) breed would result in an increase in body measurements.

Table 4: Body dimensions (cm) at puberty and sexual maturity of Baladi bulls and their crossbreds with Abondance and Tarentaise.

Traits	Genotype			±SE	P. value
	B	BA×A	BT×T		
	At puberty				
Withers height (WH)	126.00^{b}	128.17^{a}	127.33^{ab}	0.616	0.0423
Body length (BL)	122.33^{c}	139.83^{a}	130.17^{b}	0.983	0.0001
Heart girth (HG)	125.33^{b}	135.50^{a}	136.17^{a}	1.357	0.0001
Rump width (RW)	30.00^{b}	33.50^{a}	32.17^{a}	0.635	0.0049
	At sexual maturity				
Withers height (WH)	138.50^{b}	146.17^{a}	147.17^{a}	1.877	0.0099
Body length (BL)	146.00^{c}	159.33^{b}	171.83^{a}	1.868	0.0001
Heart girth (HG)	174.17^{b}	182.67^{a}	183.50^{a}	1.373	0.0004
Rump width (RW)	38.00^{b}	43.67^{a}	44.50^{a}	1.159	0.0023

$^{a,b\ and\ c}$: Means within each row with different superscripts are significantly differ (P<0.05).

***D*- Reproductive performance:**

1- Age, weight and testes circumference during different sexual periods:

Age, weight and testes circumference at puberty, sexual maturity and at slaughter (60 days post sexual maturity) are presented in Table 5. Crossbreeds (BT×T and BA×A) reached age of puberty, sexual maturity and slaughter time earlier than Baladi bulls. Body weight and testes circumference were observed starting at puberty and continued to-more pronounced and significant at sexual maturity and slaughter time.

Results in Table 5 showed significant differences (P<0.0001) in age, body weight and testes circumference at puberty, sexual maturity and slaughtering among three genotypes. These significant positive differences were reflected in an increase of serum testosterone levels (Table 2). The present result indicated that hastened age of puberty and sexual maturity was related to heavier body weight and larger testicular size. These traits are related to each other. Ahmed *et al.* (1984) reported that there was pre-pubertal increase in testicular growth rate in Buffalo bulls but at considerably later stage of development (15-25 months) based on measurement of scrotal circumference as an index of testicular size. An increase in testicular weight during later part of pre-pubertal development has also been described in Holstein bulls (Curtis and Amann, 1981) and has been related to corresponding peak in levels of growth hormone (Joakimsen and Blom, 1976) and increased testosterone levels (Sundby and Velle, 1980). AbdEl-Hakeam *et al.* (1998) reported highly significant positive correlation coefficients among body weight, testes circumference and testosterone levels in both Buffalo and Friesian bulls.

Table (5): Age, body weight and testes circumference at puberty, sexual maturity and slaughter time of Baladi bulls and their crossbreds with Abondance and Tarentaise.

Items	Genotype			±SE	P. value
	B.	BA×A	BT×T		
Puberty:					
Age (day)	396.00^{a}	364.50^{b}	339.33^{c}	3.219	0.0001
Body weight (kg)	244.33^{c}	255.67^{b}	263.67^{a}	1.342	0.0001
Testes circumference (cm)	23.67^{c}	24.17^{b}	25.83^{a}	0.149	0.0001
Sexual maturity:					
Age (day)	607.83^{a}	561.00^{b}	525.83^{c}	3.620	0.0001
Body weight (kg)	402.00^{c}	414.67^{b}	443.33^{a}	3.655	0.0001
Testes circumference (cm)	30.17^{c}	32.83^{b}	34.00^{a}	0.310	0.0001
Slaughter:					
Age (day)	667.83^{a}	621.00^{b}	585.83^{c}	3.620	0.0001
Body weight (kg)	424.67^{c}	437.33^{b}	459.50^{a}	3.685	0.0001
Testes circumference (cm)	33.17^{b}	35.58^{a}	36.00^{a}	0.248	0.0001

$^{a,\ b\ and\ c}$: Means within each row with different superscripts are significantly differ (P<0.05).

2-Semen characteristics:

Some physical properties, especially ejaculate volume, pH, sperm motility, sperm concentration, motile sperm and abnormal sperm at puberty and sexual maturity are shown in Table 6. The differences in volume (ml) of semen among the three genotypes were highly significant (P<0.0001). The ejaculate mean values were 1.12, 1.37 and 1.82 ml at puberty and 1.82, 2.27 and 2.92 ml at sexual maturity for B and their crossbreeds BA×A and BT×T, respectively.

Volume of semen varies from one breed to another (Raja and Rao, 1982; Ahmed *et al.*, 1993 and Hossain *et al.*, 2012) and influenced by a number of factors such as age, breed, weight and season. Laing *et al.* (1988) reported that high fertility bull produced greater semen volume than that low fertility bull. Thus, ejaculate volume may be a good indicator of fertility.

Sperm cells concentrations of BT×T were significantly higher (P<0.0001) compared with BA×A and B. The highest concentration of sperm (424.17 $x10^6$ and 1.64 $x10^9$ /ml) was obtained from BT×T and the lowest (318.50 $x10^6$ and 1.05 $x10^9$ /ml) from Baladi bulls at puberty and sexual maturity, respectively. The number of viable spermatozoa deposited in the female reproductive tract influences the fertilizing ability of the cow up to an upper level (Schenk *et al.*, 1987 and Gerard and Humblot, 1991). Sperm concentration in the ejaculate is one of the important criteria of semen characteristics to qualify fertile males for breeding purposes (Graffer *et al.*, 1988). These results are in agreement with Graffer *et al.* (1988) and Shelke and Dhami (2001), they reported that significant differences in sperm concentration had been shown in semen from different bulls. A positive correlation between sperm concentration and motility had been reported (Everett *et al.*, 1978 and Mathevon*et al.*, 1998) which relies on over estimation of motility in more concentrated samples (Everett *et al.*, 1978).

Generally, it was observed from Table 6 that most physical semen characteristics at puberty and sexual maturity of BT×T crossbreed bulls were significantly higher (P<0.0001) followed by BA×A compared to B bulls. This improvement of semen characteristics could be related to increasing of body weight, testes size and weight, in which they had higher values for BT×T crossbreed than Baladi bulls. Also, testosterone had higher values in BT×T and BA×A than B bulls (Table 2). Testosterone plays the major role in the development of reproductive organs and their functions (Hafez, 1987). Yassen and Mohamed (1972) found that there was a positive relationship between body weight and testicular size and their production of semen. During puberty, the androgenic effects resulting from increased testicular steroidogenesis are manifested by growth of the testes, external genitalia and the male accessory reproductive glands (prostate, seminal vesicles and bulbourethral), and beginning of secretory activity. Furthermore, the secondary sexual characteristics manifested during puberty can be divided into those that are a result of androgenic and anabolic effects (Kicman, 2008).

Table 6: Some physical semen characteristics at puberty and sexual maturity of Baladi bulls and their crossbreds with Abondance and Tarentaise.

Semen characteristics	Genotype			±SE	P. value
	B.	BA×A	BT×T		
	At puberty				
Seminal volume (ml)	1.12^{c}	1.37^{b}	1.82^{a}	0.080	0.0001
Motility (%)	23.50^{c}	29.17^{b}	35.83^{a}	1.363	0.0001
Semen pH	7.05^{a}	6.95^{a}	6.92^{a}	0.074	0.439
Sperm concentration/ml ($x10^6$)	318.50^{c}	391.00^{b}	424.17^{a}	9.180	0.0001
Sperm output/ejac. ($x10^6$)	357.18^{c}	549.23^{b}	771.52^{a}	36.451	0.0001
Motile sperm/ml ($x10^6$)	74.71^{c}	114.11^{b}	152.83^{a}	6.991	0.0001
Motile sperm/ejac. ($x10^6$)	82.83^{c}	160.00^{b}	277.41^{a}	14.998	0.0001
Abnormal sperm (%)	47.83^{a}	42.33^{b}	39.00^{b}	1.430	0.002
	At sexual maturity				
Seminal volume (ml)	1.82^{c}	2.27^{b}	2.92^{a}	0.080	0.0001
Motility (%)	72.67^{b}	78.17^{a}	82.33^{a}	1.547	0.001
Semen pH	7.07^{a}	6.91^{b}	6.93^{b}	0.029	0.003
Sperm concentration/ml ($x10^9$)	1.05^{c}	1.28^{b}	1.64^{a}	0.023	0.0001
Sperm output/ejac. ($x10^6$)	1.91^{c}	2.92^{b}	4.78^{a}	0.136	0.0001
Motile sperm/ml ($x10^6$)	76.41^{c}	100.30^{b}	134.82^{a}	3.039	0.0001
Motile sperm/ejac. ($x10^6$)	138.23^{c}	228.20^{b}	393.55^{a}	12.474	0.0001
Abnormal sperm (%)	21.00^{a}	17.33^{ab}	15.00^{b}	1.271	0.01

$^{a,b\ and\ c}$: Means within each row with different superscripts are significantly differ (P<0.05).

3- Reproductive organs and epididymal sperm reserves:

French crossbreed (BT×T and BA×A) bulls had the highest values (P<0.01) for all of reproductive organs compared with Baladi bulls. The results obtained in Table 7 indicated significant (P<0.01) genotype variations of the testes parameters with BT×T bulls had the highest values in all parameters, followed by BA×A and B. Testes weights and testes mass index were 433.41, 377.23, 325.39 g and 0.95, 0.86, 0.77 in BT×T,

BA×A and B, respectively. BT×T bulls had higher values (P<0.05) of testes mass index than both BA×A and B. Moreover, total epididymis weight and accessory sex glands were much obvious in BT×T bulls, in which the percent increase was 21.15% and 23.91%, respectively. However, vas deferens weight was not significant different among the three genotypes, but still BT×T bulls had the highest values than others.

These results are in agreement with Addass *et al.* (2013) who reported that significant (P<0.001) genotype variability were observed for all testes parameters. The significant (P<0.05) breed difference on paired testicular measurements of bulls in this study was in agreement with many authors (Hamilton and Stark, 2000; Perry and Petterson, 2011 and Addass *et al.*, 2013), they found that scrotal and epididymal traits in bulls are closely related to body weight and other measurement.

It has been established that maturation of spermatozoa occurs during the transit time through the epididymis and that the environment surrounds the spermatozoa in the cauda provides factors that enhance fertilizing ability. Therefore, spermatozoa from cauda epididymis give higher fertility than those from the caput and corpus epididymis (Hunter *et al.*, 1976 and Hafez, 1987). Epididymis and vas deferens growth depends upon steroids of testicular origin, especially testosterone, and then testosterone should be high enough to support the growth (Wildeus *et al.*, 1990 and Clark *et al.*, 1996).

Testosterone concentration (Table 2) may be important for epididymal growth as well as vas deferens and other parts of the male genital tract. This hormone could diffuse through the tunica albugenia and influence the epididymis and subsequently vas deferens and other male genital tract organs (Abdel-Raouf, 1960).

Table 7: Reproductive organ weight (g) and length (cm) of Baladi bulls and their crossbreds with Abondance and Tarentaise at slaughter (60 days post maturity).

Traits	Genotype			±SE	P. value
	B.	BA×A	BT×T		
Body weight at slaughter, Kg	424.67^{b}	437.33^{b}	458.67^{a}	5.981	0.0189
Testes weight	325.39^{c}	377.23^{b}	433.41^{a}	11.888	0.002
Testes mass index*	0.766^{b}	0.863^{ab}	0.945^{a}	0.030	0.0165
Epididymis weight	57.74^{c}	62.50^{b}	69.95^{a}	0.874	0.0002
Cauda weight	22.35^{c}	24.07^{b}	26.20^{a}	0.302	0.0003
Corpus weight	8.61^{c}	10.03^{b}	12.13^{a}	0.323	0.0007
Coput weight	26.78^{c}	28.40^{b}	31.62^{a}	0.454	0.0008
Accessory sex glands weight	49.22^{c}	54.95^{b}	60.99^{a}	0.674	0.0001
Cowper weight	11.48^{c}	12.86^{b}	14.36^{a}	0.277	0.001
Ampulla weight	16.56^{c}	18.89^{b}	20.44^{a}	0.412	0.001
Seminal vesicle	21.18^{c}	23.21^{b}	26.19^{a}	0.324	0.0001
Vas deferens weight	8.83	9.68	9.88	0.329	0.133
Penis weight	302.70^{b}	387.34^{a}	433.48^{a}	13.912	0.001
Penis length	82.25^{b}	85.48^{a}	87.41^{a}	0.795	0.01

$^{a,b\ and\ c}$: Means within each row with different superscripts are significantly differ (P<0.05).

***Testes mass index= testes weight (g) / body weight (kg).**

Meanwhile, significant genotypes effect on sperm production among BT×T, BA×A and B bulls was evident where BT×T had the highest values in all parameters. Total epididymal sperm reserve (Table 8) was significantly high (P<0.001) and increased in BT×T (13.78×10^{9}) followed by BA×A (10.85×10^{9}) while B had the least values (9.83×10^{9}). This significant increase due to genotype effect might be related to the significant differences among the three genotypes in body weight, testes circumference and testes weight at sexual maturity and slaughter as mentioned above.

Meanwhile, it was found that cauda epididymal sperm reserve accounted for more than 60 % of the total stored epididymal sperm reserve, while caput and corpus sperm reserve accounted for about 20% and 11% of total epididymal sperm reserve, respectively (Table, 8). These results are in agreement with Jindal and Panda (1980), AbdEl-Hakeam and El-Feel (1992) and AbdEl-Hakeam (2000). The special ability of cauda epididymis to store sperm is dependent on low scrotal temperature and the action of male sex hormone (Foldsey and Bedford, 1982).

Sperm production per gram testicular tissue was also significantly higher in BT×T bulls than the two other genotypes. The results obtained on sperm reserve count in the present study are consistent with those findings of Tegegne *et al.* (1992b); Britto *et al.* (2002 & 2006) and Addass *et al.* (2013), they reported breed variability in gonadal and extra gonadal sperm reserve in Bosindicus genetic group. Gonadal sperm production has been reported to be dependent on the amount of sperm produced by testicular parenchyma tissue which is mainly influenced by nutrition and breed (Tegegne *et al.*, 1992a and b). Increased sperm production had reported to be associated with fat cover and scrotal surface temperature (Britto *et al.*, 2002). Positive correlation was also reported between sperm production and scrotal testicle shape (Stephen, 2002) and body condition score (Ikhatua and Olayiwole, 1982).

Table 8: Epididymal sperm reserves of Baladi bulls and their crossbreds with Abondance and Tarentaise at slaughter time (60 days post maturity.

Semen characteristics	Genotype			±SE	P. value
	B.	BA×A	BT×T		
Total Epididymal sperm reserves ($x10^9$)	9.83^c	10.85^b	13.78^a	0.229	0.0001
Cauda sperm ($x10^9$)	6.73^b	7.03^b	8.90^a	0.166	0.0002
Corpus sperm ($x10^9$)	1.10^b	1.45^b	1.93^a	0.121	0.01
Caput sperm ($x10^9$)	1.99^c	2.37^b	2.95^a	0.026	0.0001
Sperm cell /g. testicular tissue ($x10^9$)	24.97^b	27.11^b	31.08^a	0.777	0.004

$^{a,b\ and\ c}$: Means within each row with different superscripts are significantly differ (P<0.05).

In conclusion, the superiority of crossbred bulls in growth, reproductive performance and feed efficiency especially with the second generation of Tarentaise breed with Baladi (BT×T) compared with pure Baladi bulls was clear. This conclusion could be recommended to improve growth, reproductive performance and feed efficiency.

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خصائص السائل المنوى،تطور القناة التناسلية، الكفاءة الغذائية وبعض قياسات الدم للطلائق البلدية وخلطانها مع الأبندانس والترانتيز

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تم استخدام ٢٤ حيوان ذكر تمثل ثلاثة تراكيب وراثية مختلفة هى: بلدية نقية ، ٤/١ بلدى × ٤/٣ أبندانس و ٤/١ بلدى × ٤/٣ ترانتيز ، بواقع ثمانية ذكور لكل تركيب وراثى وذلك بهدف دراسة تأثير اختلاف التركيب الوراثي على خصائص السائل المنوى، تطور الجهاز التناسلي، معدل النمو، الكفاءة الغذائية، بعض قياسات الدم، القياسات التنظيمية الحرارية وأبعاد الجسم عند البلوغ والنضج الجنسى .

ولقد أظهرت النتائج أن:طلائق خليط الترانتيز مع البلدى كانت الأفضل فى الكفاءة الغذائية مقارنةً بالطلائق البلدية أو خليط الأبندانس مع البلدى.

سجلت طلائق خليط الترانتيز مع البلدى أعلى القيم فى مستوى كلا من البروتين الكلى، الألبيومين، الجلوبيولين، الجلوكوز، الكوليستيرول، التراى أيودوثيرونين والتستستيرون فى سيرم الدم، تلتها مجموعة خليط الأبندانس مع البلدى، بينما سجلت الطلائق البلدية أقل القيم سواءً عند البلوغ أو النضج الجنسى.

لوحظ ارتفاع في معدل الزيادة الكلية والزيادة اليومية لوزن الجسم فى مجموعة طلائق خليط الترانتيز ارتفاعاً معنوياً مقارنةً بمجموعة خليط الأبندانس مع البلدى أو مجموعة الطلائق البلدية النقية.

تأثرت القياسات التنظيمية الحرارية وأبعاد الجسم باختلاف التراكيب الوراثية للحيوان عند البلوغ والنضج الجنسى، كما وصلت طلائق خليط البلدى مع الأبندانس أو الترانتيز للبلوغ والنضج الجنسى مبكراً عند أوزان مرتفعة نسبيا عن مثيلتها البلدية.

كما لوحظ أن هناك زيادة معنوية في خصائص السائل المنوي بين الثلاثة تراكيب وراثية، وخاصة في مجموعة طلائق خليط الترانتيز مع البلدى، ثم مجموعة طلائق خليط الأبندانس مع البلدى مقارنة بمجموعة الطلائق البلدية.

سجلت فياسات الخصيتين مع مجموعة طلائق خليط الترانتيز مع البلدى أعلى القيم، تليها مجموعة طلائق خليط الأبندانس مع البلدى، بينما سجلت مجموعة البلدى النقية أقل القيم.

أيضاً ارتفع عدد الحيوانات المنوية/جرام من نسيج الخصية ارتفاعاً معنوياً فيمجموعة طلائق خليط الترانتيز مع البلدى عن المجموعات الأخرى.

وعليه يمكن استنتاج تفوق التراكيب الوراثية الخليطة، خاصة خليط ٤/١ بلدى × ٤/٣ ترانتيزفي النمو والأداء التناسلي و الكفاءة الغذائية على الطلائق البلدية النقية.