Effect of Testosterone on Physio-Biochemical Parameters and Male Accessory Sex Glands of Black Bengal Goat

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Abstract— Testosterone exerts both androgenic and anabolic effects. The study was conducted to uncover the effect of testosterone on physio-biochemical parameters and male accessory sex glands of black Bengal goat. Goats were divided into Group-A: Goats with deficient testosterone (castrated), Group-B: Control and Group-C: Goats with excess testosterone (exogenous IM administration of testosterone enanthate, TE @ 125 mg/goat weekly for 2 months). The physio-biochemical parameters were analyzed by auto analyzer and histomorphological study was conducted by routine staining technique. Castration decreased significantly the red blood corpuscles (RBC), packed cell volume (PCV), lymphocytes, total protein, albumin and glucose level accompanied with significantly increased mean corpuscular volume, mean corpuscular hemoglobin, neutrophils, total cholesterol, triglycerides (TG) and low density lipoprotein (LDL). Administration of TE significantly increased in RBC, PCV and decreased in total leucocytes, neutrophils, TG and LDL. There was a significant difference on the biometric values of seminal vesicles and bulbourethral glands among groups of goats. The length and width of secretory units of sex glands were markedly reduced in castrated and increased in TE treated goats. Testosterone affects significantly in certain blood constituents and lipid & protein profile and confirmed the developmental and functional dependence of the male accessory sex glands on testosterone in goats.

Keywords— Accessory sex glands, black Bengal goat, castration, exogenous testosterone, hematology, serum biochemistry.

I. INTRODUCTION

Goat is an important species of animals in respect of Bangladesh (Goat = Poor women’s cow). Reproduction is an important phenomenon in livestock sector and soundness of testis and male accessory sex glands are essential for effective male reproduction. Despite the social and economic values of goats as source of meat, milk and hides, with a great production potential, research on goats, especially on black Bengal goats (Capra hircus) usually neglected in Bangladesh. Livestock is an integral component of agricultural economy of Bangladesh. Black Bengal goat is an important animal resource that plays an immense role in the development of livestock sector, to alleviate the poverty from our country and takes a great part in the increment of GDP of Bangladesh.

The goats’ revaluation depends on various factors, including the great prevalence of diseases, poor management practices and extensive production systems (Babeker and Elmansoury, 2013). So it is necessary to take initiatives for large scale research on Black Bengal goats for the development of livestock sector and ultimately the agricultural economy of our country.

Testis is the principle organ of male reproduction (reproductive system) and responsible for production of male germ cells (spermatozoa) and androgens, mainly testosterone. The accessory genital glands of males in goat include the ampullae, the seminal vesicle, the prostate gland and the bulbourethral glands (Getty, 1975; Ghosh, 1995; Dyce et al., 2002; Archana et al., 2009). Accessory sex glands secrete additional fluids, which when combined with the sperm and other secretions from the epididymis, form the semen. They contribute greatly to the fluid volume of semen. Their secretions are solution of buffers, nutrients and other substances needed to assure optimum motility and fertility of spermatozoa (Hafez, 1974; McDonald, 1980; Bone, 1988) and acts as a buffer against excess acidity of the female genital tract (Cunningham, 2002; Frandson and Spurgeon, 1992). These secretions are added quickly and forcibly during the mating to propel sperm into the urethra (Frandson and Spurgeon, 1992).

Testosterone, the principal androgen, secreted by Leydig cells, exerts both androgenic effects involving growth stimulation and functional maintenance of the male reproductive tract and anabolic effects involving growth stimulation of nonreproductive organs, such as muscle, kidney and liver (Barbara et al., 2006) and also affects the hemogram of animals (Aydilek and Aksakal, 2005).

Testosterone is involved in regulating the oxidative phase of carbohydrate metabolism (Barbara et al., 2006) and also improves the lipid metabolism (Gupta et al., 2008).

Blood is an important and reliable medium for assessing the health status of individual animals (Oduye, 1976). Haemato-biochemical parameters are good indicators of the physiological status of animals (Khan and Zafar, 2005). The hematological tests served as information base for animal health assistance.
Several non-genetic factors including castration (removal of testis, the source of testosterone) affecting haematological parameters of farm animals have been observed (Carlson, 1996; Svoboda et al., 2005). Deficiency of testosterone can cause a wide range of signs and symptoms including decreased sex drive, increased risk of osteoporosis, body hair loss, reduced muscle mass and strength, weaker erections of penis, lower body weight, lowered sperm count and excess testosterone increase the risk of prostate cancer.

A few scientists (Kumar and Majumder, 1995; Tyagi et al., 1999; Hassan, 2010; Zhu et al., 2013 etc.) observed the effect of testosterone in rats, rabbits and monkeys but there was no study conducted on the effect of testosterone (either excess or deficiency) on the physio-biochemical parameters and on the texture (gross and histological structure) of male accessory sex glands of domestic animals especially on the black Bengal goat. So, this research was designed to observe the changes on physio-biochemical parameters and the gross and histological features of male accessory sex glands of male black Bengal goat due to the deficiency (castration) and excess (exogenous administration) of testosterone (testosterone enanthate) which is necessary to know for a Professional to evaluate the status of breeding soundness of a breeding buck. This study may also help to understand health status and normal reproduction process, to increase the production in livestock sector.

II. MATERIALS AND METHODS

Animals

Fifteen male goats (4 months old) were used in this experiment. The goats were purchased from the near local market and housed in a well ventilated house. The goats were administered with the board spectrum anthelmintic (Albencid®) to free them from parasites. The goats were divided into three groups; Group-A: goats with deficient testosterone (elimination of testosterone by castration), Group-B: control group and Group-C: goats with excess testosterone (exogenous IM administration of testosterone enanthate). Goats of group-A were castrated immediately after purchase and maintained post-operative hygienic care. Before 7 days of castration, goats were vaccinated with Vaxitet® (0.5 ml absorbed Tetanus Toxoid/buck, IM; Incepta Vaccine Limited, Dhaka) to prevent tetanus. Goats of group-C were administered testosterone enanthate (TE) (Testosterone Enanthate injection®, 250 mg/ml, Rotexmedica, Trittau, Germany) intramuscularly @ 125 mg/goat weekly for a period of 2 months.

The goats were purchased at mid-January, 2013 and after rearing of four months, the goats were slaughtered at mid-May, 2013.

Collection of blood samples

Before slaughter, 7.5 mL of blood from each goat was collected by jugular venipuncture using a sterile needle and syringe. 5 mL of it was put into commercially prepared tubes containing EDTA as the anticoagulant, while 2.5 mL was put in separate tubes without an anticoagulant. The samples were taken before 10 am in the morning when the animals were calm and the ambient temperature was low. Thereafter, the samples were immediately taken to the laboratory for analyses.

Hematological analysis

The hematological analysis was carried out byAutomated Mythic-22 Hematology Analyzer, Switzerland.

Biochemical analysis

The biochemical analysis was performed by HUMALYZER-2000, Germany. The glucose, protein and lipid profiles were measured using end point method and serum enzyme (SGOT & SGPT) level was measured using kinetic method.

Anatomical study

After slaughter, the accessory sex glands (semenal vesicles, prostate glands and bulbourethral glands) were collected. The location and shape were observed and the length, width and weight of them were measured and preserved in Bouin’s solutions immediately after slaughter.

Histological study

The selected samples were processed in the laboratory for histological studies following standard histological techniques, and the paraffin sections then cut at 6 μm thickness using microtome. After cutting, the sections were floated on luke-warm water in a floatation bath at 37°C for stretching, then the sections were attached on cleaned glass slides using egg albumin and dried on a hot plate of slide warmer boxes. The sections then were stained with routine Hematoxylin and Eosin stain (Gridley, 1960) for histomorphological study. After staining, the sections were rehydrated in descending grades of alcohol, cleared in xylene and mounted with “DPX”. The stained sections of seminal vesicles, prostate glands and bulbourethral glands were studied thoroughly under compound microscope using 4, 10, 40 and 100 objectives.
Measurement
The thickness of capsule of bulbourethral glands, thickness of lamina muscularis and adventitia of seminal vesicle and histological cross sectional length and width of the glandular secretory units of seminal vesicle and prostate glands were measured (at 10X) using calibrated scale by ocularometer (12.5X).

Photography
The photographs were taken from the studied slides with the help of OPTICA photo-microscope (B-350), Italy.

Statistical analyses
All data were analyzed by one–way analysis of variance (ANOVA). The specific group differences (I. between castrated and control; II. between control and testosterone treated group) were determined using student’s t-test.

III. RESULTS
Effect of testosterone on erythrocyte indices of goats
Deficiency of testosterone of the goats caused a significant decrease in red blood corpuscles (RBC) and packed cell volume (PCV); accompanied with significantly increased mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH). Treatment with exogenous testosterone (TE, testosterone enanthate) hormone caused a significant increase in RBC and PCV. Hemoglobin concentration insignificantly decreased in castrated goats and increased in testosterone treated goats. Both the castration and exogenous testosterone did not affect much the mean corpuscular hemoglobin concentration (MCHC) (Table 1).

Effect of testosterone on leucocytes indices of goats
The effect of deficiency and excess of testosterone on leucocytes indices of goats of present study has been shown in Table 2. Total number of white blood cells (WBC) was increased in castrated goats but in TE treated goats, WBCs were significantly (p<0.05) reduced. In current study, there was a significant increase (p<0.01) in the percentage of number of neutrophils accompanied with a significant decrease (p<0.01) in the percentage of number of lymphocyte in testosterone deficient (castrated) group. The reverse case was observed in TE treated group. There were no major changes observed between groups (castrated, control and TE treated) in basophil, eosinophil and monocyte count.

Effect of testosterone on serum biochemistry of goats
The current study showed that the elimination of testicular androgens by castration results in a significant (p<0.05) increase in the levels of total cholesterol (TC), triglycerides (TG), low density lipoprotein (LDL) in castrated goats group compared with control group (Table 3). Administration of testosterone hormone (TE) caused an insignificant decrease in the level of TC and a significant decrease (p<0.05) in the levels of TG and LDL compared with control group (Table 3). Total serum protein (TP) and albumin were significantly (p<0.05) reduced in castrated group and insignificantly raised in TE treated group. Serum glucose level was significantly (p<0.01) lowered in castrated group. The study showed no significant difference between groups in high density lipoproteins (HDL), globulin and in serum enzyme (SGOT and SGPT) level (Table 4).

Effect of testosterone on male accessory sex glands
Seminal vesicle
Seminal vesicles were the paired accessory sex glands in goats and situated on the caudodorsal aspect (near to the neck) of the bladder and the initial part of the pelvic urethra, lateral to the ampullae of the ductus deferens. In present observation, the average length and width of the left vesicular glands were higher than the right glands. The significant difference was observed in biometric values of different groups of goats (Table-5).

Histologically, the vesicular gland of black Bengal goats of all three groups was lobulated compound tubulo-alveolar gland. Each lobe of the gland showed folded tunica mucosa (comprising of lamina epithelialis and lamina propria), tunica propria submucosa, tunica muscularis and tunica adventitia. The glandular end pieces (secretory units) of the vesicular glands were lined by pseudostratified columnar epithelium, consisted of tall columnar type cells and short basal type cells (Fig 1-3). The glandular or vesicular secretion was stored in the lumen of secretory units. It was also found that the myoepithelial cells were present around the secretory cells of glandular end pieces of seminal vesicle in all three groups of goats (Fig 1-3) that helped in the excretion of vesicular secretion.

The study measured the thickness of tunica muscularis and adventitia (together) and the length and width of glandular end piece (secretory units) of seminal vesicle of all goats (Table 6). Though there was no statistically significant difference among the mean values of three groups, the length and width of secretory units of seminal vesicle were increased according to the increased level of testosterone.
### Table 1
Values of red blood cell count, hemoglobin concentration, packed cells volume and erythrocyte indices of castrated, control and testosterone treated goats

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Red Blood Corpuscles 10^3/µl</th>
<th>Hemoglobin (g/dl)</th>
<th>Packed Cell Volume %</th>
<th>MCV (fl)</th>
<th>MCH (pg)</th>
<th>MCHC (g/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Castrated Goats</strong></td>
<td>7.18±0.44**</td>
<td>7.78±0.61</td>
<td>23.62±1.03*</td>
<td>32.71±1.13*</td>
<td>10.91±0.24*</td>
<td>32.91±0.42</td>
</tr>
<tr>
<td><strong>Control Goats</strong></td>
<td>10.26±0.68</td>
<td>9.56±0.92</td>
<td>28.83±0.78</td>
<td>27.79±1.08</td>
<td>9.23±0.27</td>
<td>33.13±0.48</td>
</tr>
<tr>
<td><strong>Testosterone Treated Goats</strong></td>
<td>12.47±0.50*</td>
<td>11.09±1.05</td>
<td>32.50±0.95*</td>
<td>26.05±0.72</td>
<td>8.70±0.37</td>
<td>34.20±0.49</td>
</tr>
</tbody>
</table>

*p<0.05 and ** p<0.01 (t-test)

### Table 2
Total leukocyte and differential leukocyte values of castrated, control and testosterone treated goats

<table>
<thead>
<tr>
<th>Parameter</th>
<th>White Blood Cells x10^3/µl</th>
<th>Neutrophil %</th>
<th>Eosinophil %</th>
<th>Basophil %</th>
<th>Lymphocyte %</th>
<th>Monocyte %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Castrated Goats</strong></td>
<td>13.47±0.34</td>
<td>47.±1.54**</td>
<td>3.±0.50</td>
<td>0.±0.24</td>
<td>46.2±1.24**</td>
<td>2.2±0.49</td>
</tr>
<tr>
<td><strong>Control Goats</strong></td>
<td>12.06±0.56</td>
<td>36.±0.81</td>
<td>4.±0.50</td>
<td>0.±0.24</td>
<td>55.4±1.72</td>
<td>2.4±0.51</td>
</tr>
<tr>
<td><strong>Testosterone Treated Goats</strong></td>
<td>8.91±0.53*</td>
<td>31.6±1.63*</td>
<td>5.4±0.50</td>
<td>0.8±0.37</td>
<td>59.2±1.46</td>
<td>3.0±0.55</td>
</tr>
</tbody>
</table>

*p< 0.05 and ** p< 0.01 (t-test)

### Table 3
Values of total serum cholesterol, triglyceride, high and low density lipoproteins of castrated, control and testosterone treated goats

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cholesterol mg/dl</th>
<th>Triglyceride mg/dl</th>
<th>High Density Lipoproteins (HDL) mg/dl</th>
<th>Low Density Lipoproteins (LDL) mg/dl</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Castrated Goats</strong></td>
<td>84.67±3.76*</td>
<td>63.00±3.21*</td>
<td>35.00±1.53</td>
<td>31.00±3.51*</td>
</tr>
<tr>
<td><strong>Control Goats</strong></td>
<td>67.33±3.38</td>
<td>44.33±1.45</td>
<td>40.33±2.08</td>
<td>17.66±1.45</td>
</tr>
<tr>
<td><strong>Testosterone Treated Goats</strong></td>
<td>58.33±2.60</td>
<td>32.67±2.60*</td>
<td>41.33±3.48</td>
<td>11.66±1.20*</td>
</tr>
</tbody>
</table>

*p<0.05 (t-test)

### Table 4
Values of total serum proteins, albumin, globulin, glucose and enzymes of castrated, control and testosterone treated goats

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Total Serum Protein g/dl</th>
<th>Albumin g/dl</th>
<th>Globulin g/dl</th>
<th>Glucose g/dl</th>
<th>SGPT Unit/L</th>
<th>SGOT Unit/L</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Castrated Goats</strong></td>
<td>4.71±0.23*</td>
<td>2.74±0.26*</td>
<td>1.97±0.15</td>
<td>49.77±1.83**</td>
<td>10.27±0.55</td>
<td>15.27±1.76</td>
</tr>
<tr>
<td><strong>Control Goats</strong></td>
<td>6.66±0.26</td>
<td>3.91±0.14</td>
<td>2.75±0.36</td>
<td>70.23±2.71</td>
<td>11.21±0.37</td>
<td>16.73±0.75</td>
</tr>
<tr>
<td><strong>TE Treated Goats</strong></td>
<td>7.13±0.20</td>
<td>4.11±0.19</td>
<td>3.01±0.08</td>
<td>81.87±3.29</td>
<td>13.35±0.55</td>
<td>20.80±1.38</td>
</tr>
</tbody>
</table>

*p< 0.05 and ** p< 0.01 (t-test)

### Table 5
Length, width and weight of seminal vesicles in goats (mean ± SE)

<table>
<thead>
<tr>
<th>Measurement of Seminal Vesicle</th>
<th>Castrated Goats</th>
<th>Control Goats</th>
<th>Goats Treated with Exogenous Testosterone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (cm)</td>
<td>Right Mean ± SE</td>
<td>Left Mean ± SE</td>
<td>General Mean ± SE</td>
</tr>
<tr>
<td></td>
<td>1.077±0.021</td>
<td>± 0.035</td>
<td>±0.030**</td>
</tr>
<tr>
<td>Width (cm)</td>
<td>0.632±0.007</td>
<td>± 0.011</td>
<td>±0.011**</td>
</tr>
<tr>
<td>Weight (gm)</td>
<td>0.886±0.034</td>
<td>± 0.028</td>
<td>±0.031**</td>
</tr>
</tbody>
</table>

*p<0.05 and ** p<0.01 (t-test)
Prostate gland was the unpaired accessory sex glands in goats. The prostate gland of goats consisted only of pars disseminata as the corpus prostate didn’t find in any goats of the present study. So, it was impossible for gross anatomical study but the samples from the dorsal portion of the pelvic urethra were collected for histological study.

Histologically, the prostate consisted of a varying number of individual tubuloalveolar glands derived from the epithelium of the pelvic urethra. In the present study, the disseminate portion, pars disseminata was located in the dorsal walls of pelvic urethra (propria-submucosa) of all three groups of goats. The parenchyma comprised of cisternae and ducts with luminated secretory end pieces. The epithelium showed a great variation in different glands and alveoli and even in a single alveolus. The secretory tubules, alveoli and intraglandular ducts of the prostate gland were lined by a simple cuboidal to columnar epithelium with occasional basal cells (Fig 4). The cytoplasm contained secretion granules.

The study measured the length and width of lobules and glandular secretory units of prostate glands of all three groups of goats (Table 7). The length and width of lobule of prostate glands of castrated goats were significantly decreased (p<0.05 and p<0.01 respectively in t-test) than the control goats. On the other hand, the length of lobules of prostate glands of goats those treated with exogenous testosterone significantly increased (p<0.05). The average length and width of secretory units of prostate glands were insignificantly increased or decreased according to the level of testosterone (Table 7).

Bulbourethral gland

The paired bulbourethral glands was consisted of right and left club-shaped independent lobes in all goats of present study, which lied on the dorsal surface of the caudal part of the pelvic urethra at the level of ischial arch under the covering of a layer of fibromuscular tissue and was closely related to the bulb of penis. The bulbourethral glands were well visible and somewhat round bodies.
The present study found a significant difference on anatomical parameters of bulbourethral glands among three groups of goats (Table 8).

Histologically, the paired bulbourethral gland was a compound tubular surrounded by the bulbocavernous muscle in all three groups of goats. The secretory portions (secretory units) of the gland were irregular in size and shape in all three groups of goats and lined with a tall simple columnar epithelium and occasional basal cells. Most of the columnar cells were of the mucous type, with the nuclei basally placed and the cytoplasm contained the secretion granules (Fig 5).

The study measured the capsular thickness of bulbourethral glands of all three groups of goats. The average thickness was 96.80 ± 9.93 μ in testosterone deficient (castrated) goats; 76.00 ± 5.37 μ in control goats and 47.40 ± 7.47 μ in TE treated goats. There was found a clear effect of testosterone on bulbourethral glands of goats. The thickness of capsule of castrated goats (deficit testosterone) was insignificantly increased than the control goats whereas the thickness of capsule of goats those were treated with exogenous testosterone (excess testosterone) was significantly reduced (p<0.05).
Testosterone exerted a profound effect on leukocytes indices. Total number of WBC was increased in testosterone deficient (castrated) goats but in TE treated goats, WBCs were significantly (p<0.05) reduced. In current study, there was a significant increase (p<0.01) in the percentage of number of neutrophils accompanied with a significant decrease (p<0.01) in the percentage of number of lymphocyte in castrated group. The reverse case was observed in TE treated group. The changes due to castration and TE administration made an agreement with the findings of AL-Zghoul et al., 2008 and Hassan, 2010.

Castration has been shown to elicit physiological stress, anti-inflammatory reactions (indicated by acute phase proteins), pain-associated behaviour, suppression of immune function, and a reduction in performance (Ahmed and Ahmed, 2011; Fisher et al., 1997; Molony et al., 1995) to varying degrees. During castration, it is needed to fight infection that is performed by increased number of WBC. Surgical castration causes increased haptoglobin and decreased gamma-interferon production. Haptoglobin exerts a suppressive effect on lymphocyte function, and reduction of gamma-interferon results in suppression of the immune system's cell-mediated immunity and response to antigens and increases in neutrophil numbers and the neutrophil : lymphocyte ratio (Fisher et al., 2001) or the possible increased in the white blood cells count which was accounted for mainly by changes in the number of neutrophils.

Androgens exert potent regulatory influence over the immune system, although the full nature of these effects and mechanism underlying hormone–induced changes in host immunity are poorly understood. Several observations indicate that sex hormones serve as important regulators of lymphopoiesis. Thymic involution that occurs during puberty is associated with the onset of sex hormone production and can be delayed by castration prior to puberty (Tartakovsky et al., 1981; Thomas et al., 2001). Castration of mice after puberty reverses thymic involution and leads to thymic hypertrophy, a process that can be reversed by replacement of androgen or estrogen (Tartakovsky et al., 1981). The production of B lymphocyte is regulated by physiologic level of androgens (Thomas et al., 2001).

Serum biochemistry has been found to be important and reliable means for assessing an animal’s health status and might give an indication of the degree of damage to host tissue as well as severity of infection (Otesile et al., 1991). Testosterone plays a role in protein and lipid metabolism. The elimination of testicular androgens by castration caused a significant (p<0.05) increase in the levels of total cholesterol (TC), TG, LDL.
This result agree with Moorjani et al., 1988; Jockenhövel et al., 1999; Hassan, 2010 and suggest that the increase in plasma LDL is due to an increase in the number of LDL particles. The increase in the number of LDL particles in the present study could result from reduction LDL uptake by the LDL receptor (Briggs et al., 1996). Bai and Kurup (2011) concluded that castration significantly increased TC, TG, HDL-C and LDL-C levels and may be attributed to the decrease of hepatic lipase (HL) and lipoprotein lipase (LPL) activities due to the absence of gonadal hormones.

One could argue that alteration in the plasma lipoprotein profile after castration could be the result to an increase in the secretion of hepatic very low density lipoprotein VLDL of cholesterol. Circulating VLDL particles are then catabolized into LDL cholesterol particles by the action of lipoprotein lipase (LPL). Furthermore, direct hepatic secretion of LDL incastration animals could explain the increase levels of plasma LDL, even though this metabolic pathway is not a major contributor to circulating LDL particles in normal animals. Androgen through surgical castration results in an atherogenic lipid profile (Xu et al., 2003). It is also remarkable that after castration, androgens could possibly favor their antagonistic effect on the action of estrogens on LDL receptor expression (Leblanc et al., 2004).

Administration of testosterone hormone (TE) caused an insignificant decrease in the level of TC and a significant decrease (p<0.05) in the levels of TG and LDL compared with control group. Total serum protein (TP) and albumin (p<0.05) and glucose level (p<0.01) were significantly reduced in testosterone deficient (castrated) group. The findings about serum biochemistry of the present study were similar to the findings of Tyagi et al., 1999; Jockenhövel et al., 1999; Hussein et al., 1999; Hassan, 2010. The majority of cross sectional studies have found a positive correlation of endogenous testosterone with HDL and a negative correlation with total cholesterol, LDL and triglycerides (Oppenheim et al., 1989). Exogenous testosterone has been reported to increase the activity of hepatic lipoprotein lipase (LPL), an enzyme involved in HDL catabolism, therefore suggesting that testosterone treatment should reduce HDL levels (Zmuda et al., 1993). Dihydrotestosterone (DHT) inhibited the differentiation of hMSCs into adipocytes, as well as lipid accumulation in existing adipocytes. DHT also inhibited the maturation of pre-adipocytes into mature adipocytes (Gupta et al., 2008).

The significant hypoproteinemia observed in castrated goats may be related to the immune status of the animal as well as a reduction in acute phase proteins, which are indicative of pain related stress in biological systems as reported by Molony et al., 1995. Testosterone has an important effect on lipoprotein metabolism and plays a key role in defining the lipoprotein profile (Goldberg et al., 1985). Testosterone supplementation reduced visceral fat accumulation, improved fasting glucose levels, glucose tolerance, and mean arterial pressure, while having no statistically significant impact on total cholesterol or triglyceride levels (Herring et al., 2013).

Male reproductive system consists of the testis (the principle organ, the male gonad, the source of spermatozoa and also of male sex hormones called androgens), the excretory or ejaculatory ducts including the epididymis, the ductus deferentes (transport the spermatozoa from the testes to the exterior and allow their maturation on the way), the penis (the male copulatory organ) and accessory sex glands including the seminal vesicles, the prostate and the bulbourethral (Cowper's) glands (secrete fluids that help to form the seminal fluid and need to assure optimum motility and fertility of spermatozoa) (Getty, 1975; Bone, 1998; Dyce et al., 2002). Accessory sex glands are the important components of male genital system and play an important role in animal reproduction.

There was a significant difference on the biometric values of seminal vesicles and bulbourethral glands among groups of goats. Similar contentions regarding biometric values of male accessory sex glands have been held by earlier author (Neves et al., 2013) in different species of animals. The findings of this study provide clear evidence of an influence of the testosterone on accessory sex glands in goats. Raeside et al. (1997) claimed the same. Analyzing weight of the vesicular and bulbourethral glands, they observed a significant difference between experimental groups comparing castrated and non-castrated breed sheep. Neves et al. (2013) studied the values of length, width and height of the sheep (castrated and non-castrated) reproductive glands, there was significant difference between castrated and non-castrated animals. These results confirm the assertions of Nunes, 1982 and Risbridger and Taylor, 2006 who had observed the functional dependence of the reproductive accessory glands on testosterone.

The length and width of secretory units of seminal vesicle and prostate glands were markedly reduced in testosterone deficient (castrated) and increased in TE treated goats.
The findings of the present study support the comments of Frandson and Spurgeon, 1992; Raeside et al., 1997 and Olamide et al., 2007. Androgen deprivation elicited by surgical or chemical castration induces apoptosis in the prostatic epithelium and the number of glandular cells of prostate gland was significantly reduced (a 66% decrease) (English et al., 1987). Huttunen et al. (1981) found prostatic atrophy in castrated experimental animals. Olamide et al. (2007) claimed that the prostatic enlargement occurs in the aging prostate (in increased level of testosterone).

The capsular thickness of bulbourethral glands was insignificantly increased in testosterone deficient goats and significantly reduced (p<0.05) in TE treated goats. The findings of the present study support the comments of Frandson and Spurgeon, 1992 and Raeside et al., 1997. The findings provided a clear evidence of an influence testosterone on bulbourethral glands in the postnatal life of bucks and it can be concluded that testosterone helps in the development of the glandular parenchyma of male accessory sex glands that are essential for glandular secretion.

We would like to conclude that testosterone affects significantly in certain blood constituents and lipid & protein profiles in goats. The present study also confirms the developmental and functional dependence of the male accessory reproductive glands on testosterone in the postnatal life of black Bengal goats though the mechanism is still poorly understood.

Acknowledgements

Authors would like to express special thanks and appreciations to University Grants Commission (UGC) of Bangladesh for giving financial support to conduct this research. Thanks are also extended to Professor Dr. Biswanath Sikder, Department of Genetic Engineering and Biotechnology, University of Rajshahi, Bangladesh to allow us to work in the Professor Joarder DNA & Chromosome Research Laboratory.

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International Journal of Emerging Technology and Advanced Engineering


