

*Short Communication*

## ANATOMICAL STUDIES ON THE GALL BLADDER OF BAKERWALI AND NON-DESCRIPT GOATS OF UNION TERRITORY OF JAMMU AND KASHMIR, INDIA

Lovish Sethi, Shalini Suri, Kamal Sarma, Jasvinder Singh Sasan\*

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**ABSTRACT:** A comparative gross morphological and histological study on the gall bladder Bakerwali and non-descript goats of union territory of Jammu and Kashmir, India, was conducted. Biometrical values were significantly higher in Bakerwali goats as compared to non-descript goats of the Jammu region. Length showed an increasing pattern with advancing age in both breeds. Mean length was more in Bakerwali goat as compared to non-descript. Mean width within the adult age group of Bakerwali and non-descript goats showed a significant difference ( $p \leq 0.05$ ). Mean width was significantly more in Bakerwali goat as compared to non-descript. Mean values of width and thickness of gallbladder were found lesser in senile age groups irrespective of breeds. In the neck region of the gall bladder, serous glands were observed in Bakerwali goats whereas, in the body and fundus region, mucous glands were predominant. In non-descript goats, the glands were predominantly mucous type irrespective of the region of the gallbladder. All the micrometrical values showed non-significant differences between the breeds ( $p \leq 0.05$ ).

**Key words:** Bakerwali goat, Gall bladder, Histology, Gross morphology, Biometry.

The goat (*Capra hircus*) is a multipurpose animal, providing meat, milk, hide, wool and fur. It is sometimes referred to as the “Poor Man’s Cow” in India and the ‘wet nurse’ of infants in Europe (Iqbal *et al.* 2008). Jammu and Kashmir are bestowed with unique breeds of goat and one of them is Bakerwali (*Kahani*).

Research on this species has been largely neglected (Bhattarai 2012), especially its anatomy. Literature is available on the gross and topographic anatomy of the gall bladder of ruminants (Dyce *et al.* 1996), pigs (Nickel *et al.* 1973) and dogs (Evans and de Lahunta 2013). Caple and Heath (1971) studied the function of the gallbladder in sheep. An anatomical study has been done on the gallbladder of Philippine water buffalo (Cortez and Maala 2010) and Indigenous Gazelle (Dawood and Mustafa 2017). Choudhury and Singh (2019) studied the gross morphological studies on the gallbladder of sheep during postnatal development. The histomorphological features of gallbladder had also been described in various mammals such as cattle (Banks 2007), dogs (Macpherson *et al.* 1983), Indian buffalo and goat (Singh 1986). Some sporadic studies are performed on this species (Hatami-Monazah and Abdallah 1978, Bamaniya

*et al.* 2016). Gross morphological, biometrical, and histomorphometric information on the gall bladder of the Bakerwali goat is meager. Hence, the present study was planned to study the gross morphology, biometry, and histomorphometry of the gall bladder of adult Bakerwali goats and to compare it with non-descript goats.

### The study

The present study was carried out in the Division of Veterinary Anatomy, F.V.Sc & A.H., SKUAST-Jammu. Gall bladder samples of Bakerwali goats were collected from slaughterhouses of Nagrota of J&K UT. The same samples of non-descript goats were collected from slaughterhouses in and around Jammu city. The samples procured from both goats were divided into three age groups (Young: below 1 year, Adult: 2-3 years, and Senile: 4 years and above) as per the dentition of the goats. Six samples from each group of goat breeds were utilized. Immediately after collection, the samples were brought to the laboratory in an ice pack and subjected to the recording of the gross morphology and biometrical parameters. Gross biometrical parameters were recorded with the help of a thread, scale, and Vernier caliper. The

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*Division of Veterinary Anatomy, Faculty of Veterinary & Animal Husbandry, SKUAST-J, R.S Pura, Jammu and Kashmir, India.*

\*Corresponding author. e-mail: jssasan216@gmail.com

data was subject to statistical analysis (Snedecor and Cochran 2004). Following biometrical parameters were measured.

1. Length of the gallbladder (cm): Distance between starting of the neck to the apex of the fundus at the visceral surface.

2. Width of the gallbladder (cm): Distance between medial and lateral border at the body.

3. Thickness of gallbladder (cm): Distance between the parietal and visceral surface of the body (Mandal *et al.* 2001).

After recording the gross parameters, small pieces of gall bladder tissue (2mm) samples were collected from different areas from each group and fixed in 10% Neutral Buffered Formalin. The fixed tissues were processed for paraffin block preparation by alcohol-benzene schedule (Luna 1968). Tissue sections of 5  $\mu$ m thickness were obtained and sections were stained with Haematoxylin & Eosin stain for routine histomorphology (Luna 1968). The micrometrical observations were recorded with the help of an ocular micrometer duly calibrated with a stage micrometer. Various micrometrical observations recorded were the height of epithelium ( $\mu$ ), the diameter of the nucleus ( $\mu$ ), the diameter of serous acinus ( $\mu$ ), the height of epithelium of serous acinus ( $\mu$ ), the diameter of the nucleus of serous acinus ( $\mu$ ), the diameter of mucous acinus ( $\mu$ ), the height of epithelium of mucous acinus ( $\mu$ ), the height of nucleus of mucous acinus ( $\mu$ ) and thickness of tunica muscularis ( $\mu$ ). All the recorded data were subjected to Standard Statistical procedures (Snedecor and Cochran 2004) to find the Student's "t" test using the 11.0 version of SPSS software.

## Results and discussion

### a. Gross morphology and biometry

The gallbladder of both breeds was related to the visceral surface of the liver (Fig. 1-2). A part of it was within the cystic impression or fossa of the liver. The fossa extended from the porta to the ventral border as earlier reported by Choudhury and Singh (2019). The remaining part was in contact with the abdominal wall. Similar observations were made by Pareek (2000) in sheep, Modekar *et al.* (2003) in goats, and Bamaniya *et al.* (2016) in Marwari goats. In the present study, it was observed that its caudal end was located at the 8th intercostal space. This was similar to the observations of Pareek (2000) in sheep and Bamaniya *et al.* (2016) in the Marwari goat. It had a large part called the fundus or body and a narrow part called the neck.

The gall bladder was a pear-shaped sac, whitish-yellow in both breeds which were similar to the findings made

by Khatra and Aziz (1986) in buffalo and goat, Cortez and Maala (2010) in the Philippine water buffalo and Bamaniya *et al.* (2016) in Marwari goat. Singh (1986) observed that the shape of the gallbladder of goats varied from oblong to oval. Dyce *et al.* (1996) observed more elongated gallbladders in small ruminants.

All the biometrical data on the gall bladder of Bakerwali and non-descript goats are presented in Table 1. The mean length of the gallbladder of Bakerwali goats in different age groups was 11.08 $\pm$ 1.32 cm, 14.04 $\pm$ 1.02 cm, and 14.02 $\pm$ 0.71 cm in the young, adult, and senile, respectively. Similarly, the mean length of the gallbladder of non-descript goats in different age groups was 6.48 $\pm$ 2.20 cm, 7.56 $\pm$ 2.40 cm, and 8.92 $\pm$ 3.03 cm in the young, adult, and senile, respectively. Biometrical values were significantly higher in Bakerwali goats as compared to non-descript goats of the Jammu region. Length showed an increasing trend with advancing age in both the breeds under study as also earlier noticed by Aziz and Khatra (1985) in adult sheep. Mean within the adult age group of Bakerwali and non-descript goats showed a significant difference ( $p \leq 0.05$ ). Mean length was more in Bakerwali goat as compared to non-descript. May (1970) measured the length of the gallbladder of sheep to be 10 cm. Hatami-Monazah and Abdallah (1978) found that the average length of the gall bladder of the goat was 6.5 cm which was following the findings in non-descript goats in the present study. Singh (1986) also recorded the length of the gallbladder of an adult goat as 6.57  $\pm$ 0.506 cm. Aziz and Khatra (1985) found that in lambs and adult sheep, the gall bladder was tubular with a uniform diameter. The average length in adult sheep was 7.11 cm.

The mean width of the gallbladder at mid (neck level) of Bakerwali goats in different age groups was 2.21 $\pm$ 0.21 cm, 3.40 $\pm$ 0.44 cm, and 2.06 $\pm$ 0.28 cm in the young, adult, and senile, respectively. Similarly, the mean width of the gallbladder of non-descript goats in different age groups was 1.25 $\pm$ 0.40, 1.40 $\pm$ 0.32 cm, and 1.77 $\pm$ 0.57 cm in the young, adult, and senile, respectively. Mean within the adult age group of Bakerwali and non-descript goats showed significant differences ( $p \leq 0.05$ ). Mean width was significantly more in Bakerwali goat as compared to non-descript. Hatami-Monazah and Abdallah (1978) found that the average greatest width of the gall bladder of the goat was 2.0 cm.

The mean thickness of the gallbladder at the fundus level of Bakerwali goats in different age groups was 0.51 $\pm$ 0.11 cm, 0.71 $\pm$ 0.14 cm, and 0.59 $\pm$ 0.10 cm in the young, adult, and senile, respectively. Similarly, the mean thickness of the gallbladder of non-descript goats in different age groups was 0.61 $\pm$ 0.04, 0.73 $\pm$ 0.05 cm, and

**Table 1. Biometrical measurements (in cm) of gall bladder of Bakerwali goats and non-descript goats in different age groups.**

Parameters	Age group					
	Young		Adult		Senile	
	Bakarwali goats	Non Descript goats	Bakarwali goats	Non Descript goats	Bakarwali goats	Non Descript goats
Length	11.08±1.32 (6.00-14.80)	6.48±2.20 (5.00-9.40)	14.02±0.71 <sup>a</sup> (12.00-15.50)	7.56±2.40 <sup>b</sup> (2.00-13.70)	14.04±1.02 (10.50-16.00)	8.92±3.03 (1.70-16.50)
Width	2.21±0.21 (1.40-3.00)	1.25±0.40 (1.00-2.20)	3.40±0.44 <sup>a</sup> (2.30-4.80)	1.40±0.32 <sup>b</sup> (0.30-2.00)	2.06±0.28 (1.30-3.00)	1.77±0.57 (1.00-3.50)
Thickness	0.61±0.11 (0.33-0.89)	0.61±0.04 (0.30-0.80)	0.71±0.14 (0.34-1.12)	0.73±0.05 (0.67-0.95)	0.59±0.10 (0.34-0.89)	0.63±0.13 (0.45-0.90)

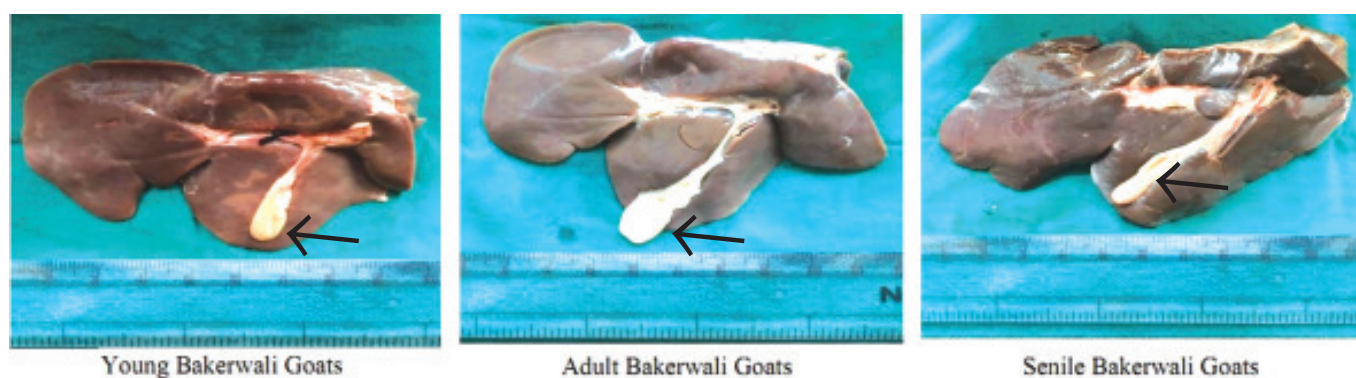
\*Mean with different superscripts with in respective age group (young, adult and senile) in a row differ significantly ( $p \leq 0.05$ ).

0.63±0.13 cm in the adult and senile respectively. Mean within the respective age group (young, adult, and senile) showed a non-significant difference ( $p \leq 0.05$ ). Mean values of width and thickness of gallbladder were found lesser in senile age groups irrespective of breeds under study may be due to reduced function.

#### b. Histology and micrometry

Gallbladder consisted of three histological layers namely tunica mucosa, tunica muscularis, and tunica serosa

(Fig. 3). The tunica mucosa showed numerous folds (plicae) in an empty state, and as these folds turned flattened and showed smoother mucosal surface when gallbladder was full. Tunica mucosa consisted of an epithelial layer and lamina propria. Tunica mucosa of the gallbladder was lined with simple columnar epithelium extending into mucosal crypts (Fig. 4). Cortez and Maala (2010) in Philippine water buffalo and Bahura *et al.* (2016) in male Indian buffalo calves observed tall columnar epithelium in the gallbladder. Cortez and



**Fig. 1. Photograph of visceral surface of liver of Bakerwali goat showing gall bladder (arrow).**



**Fig. 2. Photograph of visceral surface of liver of non-descript goat showing gall bladder (arrow).**

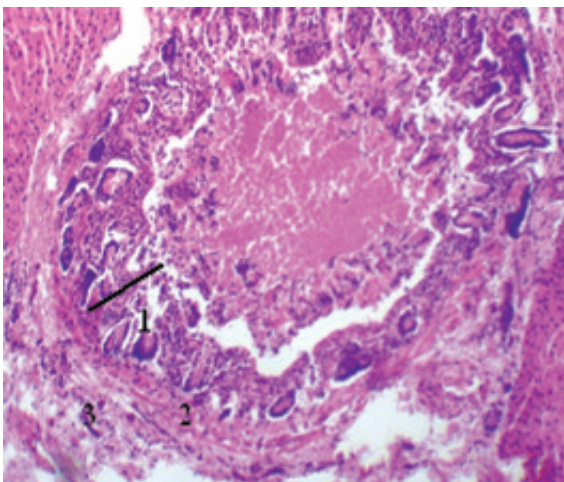
**Table 2. Micrometry of gall bladder ( $\mu\text{m}$ ) of adult Bakerwali goat and non-descript goat (400X).**

Parameters	Bakerwali goat	Non-descript goat
Height of epithelium	18.75 $\pm$ 1.38 (13.50-22.50)	18.75 $\pm$ 1.80 (13.50-22.50)
Diameter of nucleus	11.25 $\pm$ 1.00 (9.00-13.50)	10.50 $\pm$ 0.94 (9.00-13.50)
Diameter of serous acinus	48.00 $\pm$ 6.32 (27.00-63.00)	56.25 $\pm$ 7.23 (36.00-76.50)
Height of epithelium of serous acinus	14.25 $\pm$ 2.14 (10.00-22.50)	14.75 $\pm$ 2.14 (11.50-27.00)
Diameter of nucleus of serous acinus	9.75 $\pm$ 0.75 (9.00-13.50)	9.05 $\pm$ 1.50 (9.00-12.00)
Diameter of mucous acinus	86.25 $\pm$ 9.61 (54.00-112.50)	90.00 $\pm$ 25.45 (90.00-119.00)
Height of epithelium of mucous acinus	19.00 $\pm$ 1.89 (16.00-21.50)	19.25 $\pm$ 2.14 (10.00-22.50)
Height of nucleus of mucous acinus	10.25 $\pm$ 1.00 (9.00-13.50)	10.50 $\pm$ 0.94 (9.00-13.50)
Thickness of tunica muscularis	46.66 $\pm$ 2.93 (35.00-54.00)	50.00 $\pm$ 3.53 (35.00-58.50)

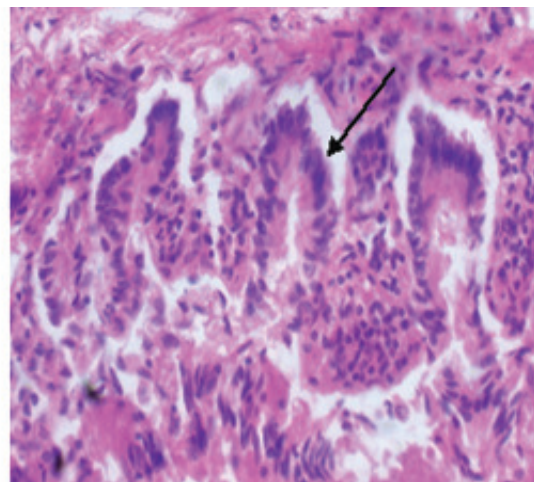
\*Mean with different superscripts in a row differ significantly ( $p \leq 0.05$ ).

Maala (2010) also noticed few intra-epithelial lymphocytes as seen in the present study also (Fig. 5). Bamniya *et al.* (2020) also observed tall columnar ciliated epithelium with occasional goblet cells. The gallbladder epithelium consisted of two types of columnar cells: the most

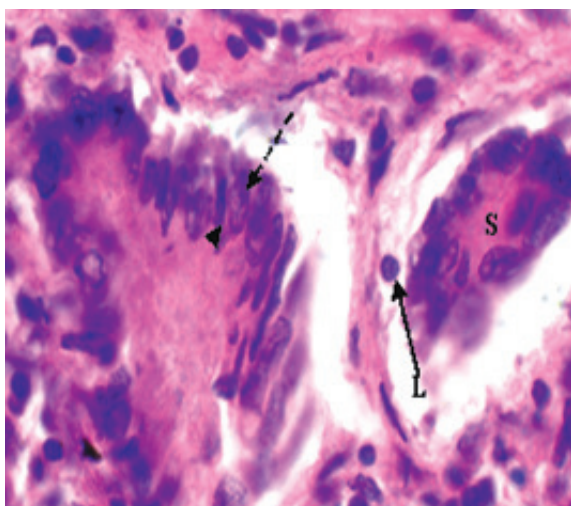
common were “light cells” with pale cytoplasm and the less numerous type were “dark cells” having dark and dense cytoplasm (Fig. 5). The dark cells were found scattered among the light cells. The nucleus of “dark cells” was more heterochromatic than that of “light cells”. The cytoplasm was composed of a lighter apical zone and a darker basal zone as earlier observed by Bahura *et al.* (2016) in Indian buffalo calves. These columnar cells presented elongated nuclei. Distinct goblet cells were not observed in the epithelium. In large ruminants, the occasional occurrence of goblet cells among epithelial cells was reported (Stinson and Calhoun 1981). Lamina propria was composed of loose connective tissue containing collagen fibers. Since lamina muscularis was absent, the lamina propria blended with submucosa without any demarcation. Similar observations were made by Stinson and Calhoun (1981) in domestic animals. The glands were observed in the mucosa of the gallbladder in both breeds of goats. Serous and mucous glands were also observed in the lamina propria submucosa of the gallbladders in both Bakerwali and non-descript goats. In the neck region of the gallbladder predominantly serous acini were observed in the Bakerwali goats (Fig. 6) whereas in the body and fundus region of the gallbladder mucous glands were predominant (Fig. 7). Hatami-Monazah and Abdallah (1978) also noticed more serous glands at the neck region of caprine gallbladder mucosa and mucous glands predominated in its fundic region. In non-descript goats, the glands were predominantly mucous type irrespective of the region of the gallbladder. Tunica muscularis comprised two layers of smooth muscle cells with an abundance of loose inter-muscular connective tissue (Fig. 7). Similar observations were made by



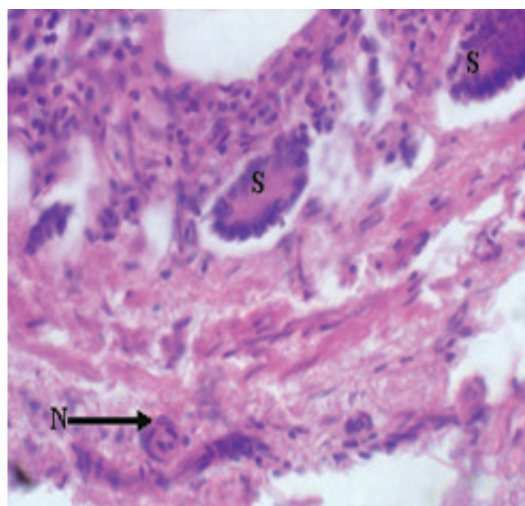
**Fig. 3. Photograph of gall bladder (neck) showing tunica mucosa (1), tunica muscularis (2) and tunica serosa (3). (H&E, 100x)**



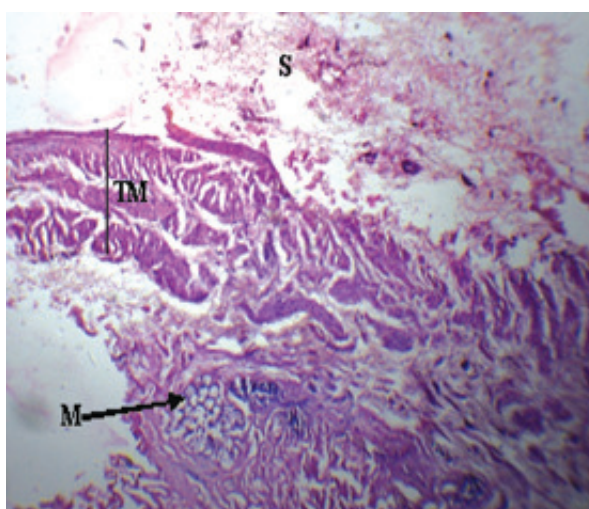
**Fig. 4. Photograph of gall bladder (neck) showing simple columnar epithelium of gall bladder (arrow). (H&E, 400x)**



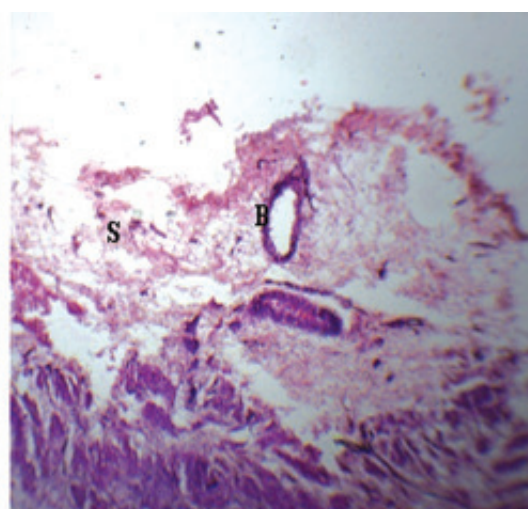
**Fig. 5.** Photograph of gall bladder with epithelial lining showing dark (arrow head) and light cells (dotted arrow). Few lymphocytes (L) are also seen along with serous acinus (S) (H&E, 1000x).



**Fig. 6.** Photograph of gall bladder showing serous acini (S) in propria-submucosa. Nerve (N) seen in tunica serosa (H&E, 400x).



**Fig. 7.** Photograph of gall bladder (body) showing mucous acini (M) in propria-submucosa, tunica muscularis (TM) and tunica serosa (S) (H&E, 40x).



**Fig. 8.** Photograph of gall bladder showing presence of blood vessels (B) in tunica serosa (S) (H&E, 40x).

Singh *et al.* (1973) in buffalo calves. The muscle was arranged in an inner circular and outer longitudinal layer. Tunica serosa formed an outer thick layer with abundant connective tissue (Fig. 8). This layer was rich in blood vessels and nerves.

All the micrometrical data are presented in Table 2. The height of glandular epithelium in serous acini was  $18.75 \pm 1.38 \mu$  in Bakerwali goat and  $18.75 \pm 1.80 \mu$  in non-descript goat. Singh *et al.* (1973) described the histomorphometry of the gall bladder of buffalo calves of 1 year of age and recorded that the average height of

columnar epithelium varied from 20-36  $\mu$  in all three regions of the gall bladder. Aziz (1984) in sheep reported columnar cell height as 24.65, 24.75, and 22.91  $\mu$  in the fundus, body, and neck respectively. Singh (1986) in goats reported columnar cell height as  $25.1 \pm 1.22$ ,  $25.9 \pm 1.63$ , and  $23.9 \pm 1.04 \mu$  in the fundus, body, and neck respectively. The diameter of the nucleus was slightly more in Bakerwali goats ( $11.25 \pm 1.00 \mu$ ) as compared to non-descript goats ( $10.50 \pm 0.94 \mu$ ). For serous acini, the values of diameter and epithelium height were more in non-descript goats than the Bakerwali goats whereas

nuclear diameter was higher in Bakerwali goats. For mucous acini, the values were higher for non-descript goats as compared to the Bakerwali goat. The thickness of the muscular layer was also higher for non-descript goats. All the values showed non-significant differences between the breeds ( $p \leq 0.05$ ).

The gall bladder of both breeds was pear-shaped and related to the visceral surface of the liver with a large part called the fundus or body and a narrow part called the neck. Gross biometrical values were significantly higher in Bakerwali goats as compared to non-descript goats of the Jammu region. Histologically, the gall bladder consisted of three layers namely tunica mucosa, tunica muscularis, and tunica serosa. Tunica mucosa consisted of a simple columnar epithelial layer and lamina propria. Lamina muscularis was absent. The glands were observed in the mucosa of the gallbladder in both breeds of goats. In the neck region of the gall bladder of Bakerwali goats serous glands were observed whereas, in the body and fundus region, mucous glands were predominant. In non-descript goats, the glands were predominantly mucous type irrespective of the region of the gallbladder. Tunica muscularis comprised of inner circular and outer longitudinal layers. Tunica serosa formed an outer thick layer with abundant connective tissue. All the micrometrical values showed non-significant differences between the breeds.

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