



Comparative Biometrical Studies on the Trachea and Lungs in Adult Pashmina, Bakerwali and Non-descript Goats of Jammu & Kashmir State

Neelofar Nabi¹, Kamal Sarma¹, S. Suri¹, Jonali Devi² and M.M.S. Zama³

¹Division of Veterinary Anatomy, Faculty of Veterinary Sciences and A.H., Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, R.S. Pura, Jammu (J&K), INDIA

²Division of Veterinary Physiology and Biochemistry, Faculty of Veterinary Sciences and A.H., Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, R.S. Pura, Jammu (J&K), INDIA

³Division of Veterinary Surgery, Faculty of Veterinary Sciences and A.H., Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, R.S. Pura, Jammu (J&K), INDIA

*Corresponding author: K Sarma; E-mail: kamalsarma73@yahoo.com

Received: 04 June, 2019

Revised: 21 July, 2019

Accepted: 01 Aug., 2019

ABSTRACT

This present study was conducted on the trachea and lungs of adult Pashmina, Bakerwali and non-descript goats to compare the biometrical features of these organs among these breeds. For this, a total of 10 samples from each goat breed were collected. The mean length of the trachea in adult Pashmina, Bakerwali and non-descript goats were recorded as 19.70±0.55 cm, 27.35±0.43 cm and 27.24±1.02 cm, respectively. It was found that the length of the trachea was significantly shorter in case of Pashmina goat as compared to the other two breeds. Also, the width of the middle segment of the trachea was found to be significantly lesser in Pashmina goat. Similarly, the mean weight of the two lungs and their length at various levels in regard to different lobes showed variations among these three breeds and were significant for some biometrical parameters.

Keywords: Biometry, trachea, lungs, Pashmina, Bakerwali, non-descript goat

The ruminants like buffalo, goat and sheep represent varied potentials of biological adjustments of their pulmonary system especially to the diverse ecological shifts resulting from variation in different climatic conditions (Suman *et al.*, 2007).

Anatomical study on the respiratory system has been conducted in domestic mammals (Hare, 1975; Suman *et al.*, 2005; Baba and Choudhary, 2008; Kumar *et al.*, 2013; Danacu *et al.*, 2015). However, goat shows the distinctive organization of respiratory organs as compared to large ruminants (Kalita, 2014).

There has been no systemic study on the probable variations of the morphology of trachea and lungs in high altitude habitant breed of goat like the Pashmina with migratory breed of goat like Bakerwali and low altitude inhabitants like non-descript goats of Jammu & Kashmir. Keeping these facts in view, the present study

was undertaken to record the comparative biometrical features of trachea and lungs of high altitude Pashmina goats, migratory Bakerwali goats and non-descript goats, which are habitats of low altitude regions. This is the first ever study of its kind in these three breeds of goats.

MATERIALS AND METHODS

The present study was conducted in the Division of Veterinary Anatomy, F.V.Sc. & A.H., R.S. Pura, Jammu. For this study, trachea and lung samples from adult Pashmina goats (irrespective of sex) were collected from slaughter houses of Ladakh of J&K state. Similar organs of Bakerwali and non-descript goats were collected from

How to cite this article: Nabi, N., Sarma, K., Suri, S., Devi, J. and Zama, M.M.S. (2019). Comparative biometrical studies on the trachea and lungs in adult Pashmina, Bakerwali and non-descript goats of Jammu & Kashmir state. *J. Anim. Res.*, 9(4): 01-06.

slaughter houses in and around Jammu city. Ten samples from each goat breed (2-3 years of age) were collected. Immediately after collection, the trachea and lungs were promptly subjected for recording of the various biometrical parameters as detailed below:

Trachea

The trachea was incised just posterior to the cricoid cartilage proximally and at the level of tracheal bifurcation distally. The biometrical observations of the trachea included the recording of length, width, thickness and weight (Table 1).

Lungs

The lungs were removed from the trachea by cutting the trachea just before the emergence of Primary bronchi into it.

The biometrical observations of the lungs included the recording of:

1. Length (in cm): both left and right lungs.
2. Length of the apical lobe (in cm): both left and right lungs.
3. Length of the cardiac lobe (in cm): both left and right lungs.
4. Length of the Diaphragmatic lobe (in cm): both left and right lungs.
5. Length of the Accessory lobe (in cm): of the right lung.
6. All these data on lengths were recorded using Vernier Callipers.
7. Weight (gm): The lung was removed by incising the trachea just before the emergence of tracheal bronchus into it and its weight was recorded using Monopan Electronic Balance.

All the data were subjected to Standard Statistical Analysis (Snedecor and Cochran, 2004). The data were presented by showing mean and standard error. The significant differences of values for different parameters studied were statistically analysed by the Two Way ANOVA.

RESULTS AND DISCUSSION

Trachea

Various biometrical parameters viz., length, width (at cranial, middle and distal parts), thickness and weight of the trachea of Pashmina, Bakerwali and non-descript goats under study have been depicted in Table 1.

The findings of the study showed that the mean length of the trachea was the highest in non-descript goat (27.24 ± 1.02 cm), followed by Bakerwali (27.05 ± 0.43 cm) and Pashmina (19.70 ± 0.55 cm) goats, respectively. But in contrary to the present findings, (Kaptanoglu *et al.*, 2007) reported higher values in regard to these biometrical parameters in sheep. Also, these parameters were found to be higher except the length of trachea in case of an adult donkey as reported by Bello *et al.* (2017). Furthermore, these present values were much higher than the same in pigs (15 cm) but less than ox (65 cm) as reported by Sisson and Grossman (1954). Comparable lengths of the trachea were also reported in goat (Maqsd *et al.*, 2011 and Byanet *et al.*, 2014) and sheep (Saffia, 2015). In our study, it was found that the trachea of Pashmina goat was significantly ($P < 0.05$) shorter than the same of both Bakerwali and non-descript goats. The trachea was much longer in the horse (70-80 cm) and camel (87 cm) as reported by Al-Zghoul *et al.* (2006) than the same of goats recorded in our present study. In contrary to this, the trachea of cats was shorter (12.7 ± 0.52 cm) as compared to goat and sheep

Table 1: Biometrical values (MEAN \pm S.E.) of the trachea of adult Pashmina, Bakerwali and non-descript goats

	LENGTH (cm)			WIDTH (g)			THICKNESS (cm)			WEIGHT (g)
		Cranial	Middle	Distal	Cranial	Middle	Distal			
Pashmina	19.70V \pm 0.55	1.43 ^a \pm 0.05	1.35 ^a \pm 0.10	1.47 \pm 0.07	1.27 \pm 0.072	1.17 \pm 0.08	1.33 \pm 0.11	47.17 \pm 1.14		
Bakerwali	27.35V \pm 0.43	1.79 ^{ab} \pm 0.10	1.87 ^b \pm 0.17	1.63 \pm 0.21	1.84 \pm 0.20	1.70 \pm 0.22	1.55 \pm 0.21	50.78 \pm 3.91		
Non-descript	27.24V \pm 1.02	2.12 ^b \pm 0.19	2.22 ^b \pm 0.17	1.78 \pm 0.12	1.65 \pm 0.11	1.76 \pm 0.14	1.42 \pm 0.11	57.70 \pm 5.51		

*Means bearing similar superscript in a column do not differ significantly.

(Shakir and Rabab, 2013). Also, Adel and Ibrahim (2016) reported that the length of trachea from the first to the last tracheal ring to be 92-101 cm with a mean value of 95 ± 0.77 cm, which was also much higher than our present findings. Such variations in tracheal length might be due to the specific morphological characteristics of different species.

It was also recorded in this study that the mean thickness of the trachea was the highest in Bakerwali goat (1.84 ± 0.20 cm) at its cranial and distal levels. However, it was the maximum in non-descript goats at the middle level (1.70 ± 0.22 cm). The trachea of Pashmina goats had the lowest values in regard to its thickness at all three levels (1.33 ± 0.11 cm) (Table 1). The mean weight of the trachea was found to be the highest in non-descript goat (57.70 ± 5.51 g), followed by Bakerwali (50.78 ± 3.91 g) and Pashmina (47.17 ± 1.14 g) goats, respectively. The reduced size of the trachea might be correlated to its adaptation to the climatic conditions of the high altitude. These findings were in contrary to the results reported by Bello *et al.* (2017) in case of donkey in which the weight of trachea was much more (250 ± 5.0 gm). This was again due to species variations.

Right Lung

Various biometrical values viz., weight and length (apical, cardiac, diaphragmatic and accessory lobe) of the right lung of Pashmina, Bakerwali and non-descript goats have been depicted in Tables 2 and 3. It was found that, the right lung weighed more in all the breeds of goat as compared to the left one due to the presence of accessory lobe (Table 2 and 3). The observations for the length of the whole lungs and the length of different lobes of lungs showed a significant difference between all the breeds of goat under study. The length of all the lobes of lungs in Pashmina goat was lesser as compared to Bakerwali and non-descript goats.

The weight of the right lung was found to be the highest in non-descript goat (216.90 ± 16.64 g) followed by Pashmina (184.83 ± 3.09 g) and Bakerwali (181.74 ± 22.04 g) goats. The mean length of the right lung was found to be the highest in non-descript goat (25.36 ± 0.84 cm), followed by Bakerwali (23.17 ± 0.86 cm) and Pashmina (20.02 ± 0.77 cm) goats. These findings were comparable with the findings of Maqsd *et al.* (2011) in goat who found that the weight of the right lung was 336 ± 37 gm. Also, Hossain

Table 2: Biometrical values (MEAN \pm S.E.) of right lung of adult Pashmina, Bakerwali and non-descript goats

	WEIGHT	LENGTH	APICAL LOBE		CARDIAC LOBE		DIAPHRAGMATIC LOBE		ACCESSORY LOBE	
			CC	DV	CC	DV	CC	DV	CC	DV
Pashmina	184.83 ± 3.09	23.02 ± 0.77	6.77 ± 0.69	$7.87^a \pm 0.39$	5.90 ± 0.77	$7.43^a \pm 0.77$	$11.12^a \pm 0.32$	$8.42^a \pm 0.16$	4.38 ± 0.37	$5.22^a \pm 0.51$
Bakerwali	181.74 ± 22.04	23.17 ± 0.86	6.74 ± 0.61	$11.59^b \pm 0.47$	5.33 ± 0.30	$11.30^b \pm 0.55$	$13.50^b \pm 0.8$	$10.66^b \pm 0.47$	4.22 ± 0.27	$6.53^b \pm 0.48$
Non-descript	216.90 ± 16.64	25.36 ± 0.84	7.51 ± 0.44	$11.07^b \pm 0.33$	5.00 ± 0.20	$10.89^b \pm 0.88$	$13.80^b \pm 0.57$	$10.67^b \pm 0.39$	4.48 ± 0.18	$7.27^b \pm 0.23$

*Means bearing similar superscript in a column do not differ significantly.

Table 3: Biometrical values (MEAN \pm S.E.) of left lung of adult Pashmina, Bakerwali and non-descript goats

	WEIGHT	LENGTH	APICAL LOBE		CARDIAC LOBE		DIAPHRAGMATIC LOBE	
			CC	DV	CC	DV	CC	DV
Pashmina	140.47 ± 5.02	19.03 ± 0.42	7.17 ± 0.87	$5.47^a \pm 0.67$	5.01 ± 0.71	$8.01^a \pm 0.94$	10.61 ± 0.48	$8.48^a \pm 0.36$
Bakerwali	122.98 ± 13.37	20.82 ± 0.41	7.10 ± 0.49	$6.04^{ab} \pm 0.30$	3.95 ± 0.30	$11.39^b \pm 0.72$	11.54 ± 0.54	$10.21^b \pm 0.50$
Non-descript	149.90 ± 10.50	22.50 ± 0.69	7.55 ± 0.54	$6.94^b \pm 0.47$	4.42 ± 0.19	$10.31^{ab} \pm 0.88$	12.64 ± 1.08	$10.63^b \pm 0.31$

*Means bearing similar superscript in a column do not differ significantly.

(2012) reported that the weight of fresh goat lungs was 450 ± 100 gm, right apical lobe 47 ± 11 gm, right cardiac 83 ± 10 gm, right diaphragmatic 153 ± 16 gm. In another study, the weight of the right lung was recorded to be 555 gms in sheep (Kaptanoglu *et al.*, 2007). Such higher biometrical values reported in goat and sheep by these workers than those recorded in our present study, might be due to breed and species variations, respectively. However, the weight of right lung was found to be lesser (12.5 ± 0.7 gm) in cat (Shakir and Rabab, 2013) than our present findings in goat, which again draws the same interpretation. Lesser lengths of the lungs as recorded in Pashmina goats as compared to Bakerwali and non-descript goats might be due to its smaller size.

Again, the mean values in regard to the cranio-caudal length of apical lobe were recorded as 6.77 ± 0.69 cm, 6.74 ± 0.61 cm and 7.51 ± 0.44 cm for Pashmina, Bakerwali and non-descript goats, respectively. The same value was the highest in non-descript goat and lowest in Pashmina goats. The mean values recorded for dorso-ventral length of apical lobe were 7.87 ± 0.39 cm, 11.59 ± 0.47 cm and 11.07 ± 0.33 cm in Pashmina, Bakerwali and non-descript goats, respectively. This dorso-ventral length of the apical lobe was found to be the highest in Bakerwali goat and the lowest value was recorded in Pashmina goat. The mean values for the cranio-caudal length of cardiac lobe were recorded as 5.90 ± 0.77 cm, 5.33 ± 0.30 cm and 5.00 ± 0.20 cm for Pashmina, Bakerwali and non-descript goats, respectively. This cranio-caudal length of the cardiac lobe of right lung was found to be highest in Pashmina goat and the lowest value was recorded in non-descript goat. Again, the mean values recorded for dorso-ventral length of cardiac lobe of the right lung were 7.43 ± 0.77 cm, 11.30 ± 0.55 cm and 10.89 ± 0.88 cm for Pashmina, Bakerwali and non-descript goats, respectively. The mean dorso-ventral length of the cardiac lobe was the highest in Bakerwali goat followed by non-descript and Pashmina goat.

The mean values for cranio-caudal length of diaphragmatic lobe of the right lung were recorded as 11.12 ± 0.32 cm, 13.50 ± 0.88 cm, 13.80 ± 0.57 cm for Pashmina, Bakerwali and non-descript goats, respectively. The highest value was found in non-descript goat while the lowest was recorded in Pashmina goat. In the present study, the mean values for dorso-ventral length of diaphragmatic lobe were found to be 8.42 ± 0.16 cm, 10.66 ± 0.47 cm and 10.67 ± 0.39 cm for Pashmina, Bakerwali and non-descript goats, respectively.

Similarly, the mean values for cranio-caudal length of accessory lobe were 4.38 ± 0.37 cm, 4.22 ± 0.27 cm and 4.48 ± 0.18 cm for Pashmina, Bakerwali and non-descript goats, respectively. This cranio-caudal length of the accessory lobe was found to be the highest in non-descript goat and the lowest value was recorded in Bakerwali goat. The mean values recorded for dorso-ventral length of the accessory lobe of the right lung were recorded as 5.43 ± 0.51 cm, 6.53 ± 0.48 cm and 7.27 ± 0.23 cm for Pashmina, Bakerwali and non-descript goats, respectively. The mean dorso-ventral length of the accessory lobe was the highest in non-descript goat followed by Bakerwali and Pashmina goats. These findings were in accordance with the findings of Maqsd *et al.* (2011) in goat, who reported that the length of the right apical lobe was 8.8 ± 2 cm, the right cardiac lobe was 9.6 ± 1 cm, right the diaphragmatic lobe was 15.25 ± 1 cm and accessory lobe was 6.9 ± 1 cm.

Left Lung

Various biometrical parameters viz., weight and length of apical, cardiac and diaphragmatic lobes at different levels of the left lung of Pashmina, Bakerwali and non-descript goats under study have been depicted in Table 3.

The weight of the left lung was found to be the highest in non-descript goat (149.90 ± 10.50 g) followed by Pashmina (140.47 ± 5.02 g) and Bakerwali (122.98 ± 13.37 g) goats. These findings were in accordance with the reports of Maqsd *et al.* (2011) in case of goat who observed that the mean weight of the left lung was 178 ± 37 g. Our findings were also comparable with those observed by Hossain (2012), who studied the goat lungs and reported that the weight of fresh lungs, left apical lobe, left cardiac lobe and left diaphragmatic lobe were 450 ± 100 gm, 29 ± 6 gm, 41 ± 7 gm and 160 ± 21 gm, respectively. But in contrary to the present finding in goat, Kaptanoglu *et al.* (2007) found that the weight of left lung was 448 gm in sheep. This huge difference in lung weight might be due to species variation and due to the difference in size of the animals.

In this study, the mean length of the left lung was found to be highest in non-descript goat (22.50 ± 0.69 cm), followed by Bakerwali (20.82 ± 0.41 cm) and Pashmina (219.03 ± 0.42 cm) goat, respectively. The mean values for the cranio-caudal length of apical lobe were 7.17 ± 0.87 cm, 7.10 ± 0.49 cm and 7.55 ± 0.54 cm in Pashmina, Bakerwali and non-descript goats, respectively. The

highest value was recorded in non-descript goat, while the lowest value was seen in Pashmina goat. Again, the mean values recorded for dorso-ventral length of apical lobe were 5.47 ± 0.67 cm, 6.04 ± 0.30 cm and 6.94 ± 0.47 cm and in Pashmina, Bakerwali and non-descript goats, respectively. The dorso-ventral length of the apical lobe was recorded to be the highest in non-descript goat followed by Bakerwali and Pashmina goats. Similarly, the mean cranio-caudal length of cardiac lobe were recorded to be 5.01 ± 0.71 cm, 3.95 ± 0.30 cm and 4.42 ± 0.19 cm in Pashmina, Bakerwali and non-descript goats, respectively. Also, the mean dorso-ventral length of cardiac lobe were found to be 8.01 ± 0.94 cm, 11.39 ± 0.72 cm and 10.31 ± 0.88 cm in Pashmina, Bakerwali and non-descript goats, respectively. The mean dorso-ventral length of cardiac lobe was the highest in Bakerwali goat followed by non-descript and Pashmina goat.

In the present study, the mean values with regard to the cranio-caudal length of diaphragmatic lobe were recorded as 10.61 ± 0.48 cm, 11.54 ± 0.54 cm and 12.64 ± 1.08 cm in Pashmina, Bakerwali and non-descript goats, respectively. Again, the mean values for the dorso-ventral length of diaphragmatic lobe were recorded to be 8.48 ± 0.36 cm, 10.21 ± 0.50 cm and 10.63 ± 0.31 cm for Pashmina, Bakerwali, non-descript goats, respectively. These findings were in accordance with the observations of Maqsud *et al.* (2011) in goat, who reported that the length of the left apical lobe was 6.9 ± 1 cm, left cardiac lobe was 10.8 ± 2 cm and left diaphragmatic lobe was 10.10 ± 4 cm. It was apparent that the weight of the both right and left lungs of Pashmina goat was found to be more than that of Bakerwali goat, which is a migratory type of goat of Jammu & Kashmir state. This might draw the interference that this increased weight of the lungs in Pashmina goat which is directly proportionate to an increased mass of the alveolar parenchymatous tissue might be due to meet the demand of oxygen in a chronic hypoxic conditions at high altitudes in its natural habitat of Leh and Ladakh region of Jammu & Kashmir state. Similar increased weight of lungs of yaks living in high altitude as compared to the low altitude living bovines had also been reported by Anthony *et al.* (1993), which supports our present findings.

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