BIOMETRICAL STUDIES OF LIVER IN BUFFALO (*BUBALUS BUBALIS*)

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ABSTRACT

The biometrical studies of the 24 buffalo livers (12 male and 12 female) were carried out. The average weight of liver of male and female buffalo was 5949±340.10 gm and 6358.33±243.23 gm, respectively. The average volume of liver of male and female buffalo was 5075+277.95 cc and 5350±212.67 cc, respectively. The average density of liver of male and female buffalo liver was 1.16+0.02 gm/cc and 1.19+0.02 gm/cc, respectively. The average curvature length on parietal surface of liver of male and female buffalo liver was 54.77+1.33 cm and 55.25+1.38 cm, respectively. The average width at falciform ligament of liver of male and female buffalo liver was 16.42+0.62 cm and 17.54+0.47 cm, respectively. The average curvature width on the middle of parietal surface of liver of male and female buffalo was 28.08+0.89 cm and 29.17+0.51 cm, respectively. The average curved length on visceral surface from portal vein to apex of liver of male and female buffalo liver was 23.24+2.09 cm and 20.95+1.11 cm, respectively. The average maximum length of caudate lobe of liver of male and female buffalo liver was 11.52+0.94 cm and 11.88+0.50 cm, respectively. The average maximum width of caudate lobe on visceral surface of liver of male and female of buffalo liver was 7.90+0.27 cm and 7.90+0.20 cm respectively. The average curvature width on visceral surface from umbilical fissure to esophageal notch of liver of male and female buffalo liver was 21.013+0.39 cm and 21.11+0.34 cm, respectively. The average curvature width on the middle of visceral surface of liver of male and female buffalo liver was 30.63+0.76 cm and 31.56+0.50 cm, respectively. The average curvature length from umbilical fissure to portal vein of liver of male and female buffalo liver was 20.55+0.78 cm and 21.51+0.25 cm, respectively. The average curvature length from portal length to esophageal notch of liver of male and female buffalo liver was 20.51+1.09 cm and 19.86+8.83 cm, respectively. The average curvature length from esophageal notch to umbilical fissure of liver of male and female buffalo liver was 19.55+0.66 cm and 19.95+0.66 cm, respectively. The average curved length of ridge separating the omasal and reticular impression of liver of male and female buffalo liver was 29.33+1.12 cm and 31.01+1.48 cm, respectively. The average curvature length from esophageal notch to tip of main lobe of liver of male and female buffalo liver was 37.50+0.92 cm and 37.37+0.95 cm, respectively. The average length from tip of main lobe to tip caudate lobe of liver of male and female buffalo liver was

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7.16+0.34 cm and 6.63+0.20 cm, respectively. The average curvature length from caudate length from caudate lobe to umbilical fissure of liver of male and female buffalo liver was 30.03+1.26 cm and 28.30+1.49 cm, respectively.

Keywords: *Bubalus bubalis*, buffaloes, biometry, liver

INTRODUCTION

Very scanty literature is available on the biometry of the liver in buffaloes. Hence the present study is made.

MATERIALS AND METHODS

The present study was carried out on normal livers 12 male and 12 female adult buffaloes (*Bubalus bubalis*) of Murrah breed. The liver was examined insitu and all attachment and other particulars were recorded. The specimens were collected immediately after slaughter at Deonar Abattoir, Mumbai. The livers were separated from the pluck and cleared by remobing the fascia, blood vessels, nerves etc. in order to facilitate the observations. These separated livers were washed under running tap water to remove all blood clotm exudateand tissue debris. The organs were brought to the laboratory in ice- cooled box for further study.

The biometrical observations of the different parameters of liver were recorded as follows.

Weight: The weight of each liver was recorded in grams (gm) with the help of scientific spring balance.

Volume: The volume of liver was measured in cc by using Archimedies principle.

Density: Density of each liver was calculated by using the following formula:

$$\text{Density} = \frac{\text{Weight}}{\text{Volume}}$$

Curvature length on parietal surface (cm): the curvature length on parietal surface was measured by non - stretchable thread and calculated with the help of scientific scale. Width at falciform ligament of the liver (cm): the width of the falciform ligament was calculated with the help of scientific scale. Curvature width on the middle of parietal surface (cm): the curvature width on the middle of parietal surface was measured by non - stretchable thread and calculated with the help of scientific scale. Curved length on visceral surface from portal vein to apex of ventral border (cm): the curved length on visceral surface from portal vein to apex of ventral border was measured by non stretchable thread and calculated with the help of scientific scale. Maximum length of caudate lobe on visceral surface (cm): The maximum length of caudate lobe on visceral surface was measured with the help of scientific scale. Maximum width of caudate lobe on visceral surface (cm): The maximum width of caudate lobe on visceral surface was calculated by scientific scale. Curvature width on visceral surface from umbilical fissure to esophageal notch (cm): the curvature width on visceral surface from umbilical fissure to esophageal notch was measured by non stretchable thread and calculated by scientific scale. The curvature width on the middle of visceral surface (cm): the curvature width on the middle of the visceral surface was measured with the help of scientific scale. Curvature length from umbilical fissure to portal vein (cm): The curvature length from umbilical fissure to portal

vein was measured by scientific scale. Curvature length from portal vein to esophageal notch (cm): the curvature length from portal vein to esophageal notch was measured by scientific scale. Curvature length from esophageal notch to umbilical fissure (cm): the curvature length from esophageal notch to umbilical fissure was measured by scientific scale. Curved length of ridge separating the omasal impression and reticular impression (cm): the curved length of ridge separating the omasal impression and reticular impression was measured by non - stretchable thread and calculated by scientific scale. Curvature length from esophageal notch to tip of main lobe (cm): the length from esophageal notch to tip of main lobe was measured with the help of non- stretchable thread and calculated by scientific scale. Length from tip of main lobe to tip caudate lobe (cm): the length from tip of main lobe to tip of caudate lobe was measured with the help of non- stretchable thread and calculated by scientific scale. Curvature length from caudate lobe to umbilical fissure (cm): the curvature length from caudate lobe to umbilical fissure was measured by non - stretchable thread and calculated with the help of scientific scale.

RESULT AND DISCUSSION

The present study was carried out to know the gross anatomy, biometry, histology, histochemistry and micrometry of the liver of 12 male and 12 female adult Murrah buffaloes. The perusal of literature on the biometry of the liver in buffalo was not traceable in the reviewed work except the weight of the liver.

Weight (gm)

The average values of the weight of female were higher as compared to the average values of weight of male liver. The average values of these observations significantly higher in female as compared to male. The weight of the liver was in the range of 3.69 to 7.50 kg in male, while 4.90 to 7.80 kg in female buffaloes. The average weight reported by various scientists as 2.7 to 5.4 kg in ox by Raghavan (1964), 4.5 to 5.4 kg by Getty (1975), 3 to 10 kg by Ommer and Harshan (1995), 450 gm in calves by Dyce *et al.* (1996), 5 kg by Frandson (1986) and 3 to 5 kg by Ghosh (1998). This variation in the weights as recorded by various scientist might be due to feeding habit of the animal as liver stores fat and glycogen; breed, size and age.

Volume (cc)

The average volume of the liver in female was higher than the male since the weight of liver in female was also high. The average value of these observation showed significant difference between male and female.

Density (gm/cc)

The average values of the density of liver was higher in female as compared to that of male. This difference was statistically highly significant.

Length

The average values of the length from tip of main lobe to the tip of caudate lobe of liver was higher in male, while maximum length of caudate lobe of liver was higher in female. These average values of both sex showed non significant results.

Width

The average values of the width of falciform ligament and maximum width of caudate lobe on visceral surface of liver were higher in female as compared to the average values observed in male.

Table 1. Biometrical observations of the various parameters of liver of 12 adult male Murrah buffaloes.

Sr. No.	Parameters	1	2	3	4	5	6	7	8	9	10	11	12
1	Weight (gm)	3690	6000	6700	6400	7500	5500	4800	7200	5600	6000	4500	7500
2	Volume (cc)	3050	5050	5300	5250	6450	4900	4400	64.50	4900	5050	4100	6300
3	Density (gm/cc)	1.21	1.19	1.26	1.03	1.18	1.12	1.09	1.17	1.14	1.19	1.09	1.19
4	Curvature length of parietal surface (cm)	52.9	54.1	54.5	53.9	60.1	54.1	46.3	62.1	50.4	52.9	54.0	62.0
5	Width at falciform ligament (cm)	12.9	17.8	18.4	17.4	17.9	14.7	18.5	19.0	15.2	17.6	13.2	18.1
6	Curvature width on the middle of parietal surface (cm)	23.6	31.4	31.9	32.0	25.2	27.2	25.2	29.4	28.6	30.8	23.9	27.2
7	Curved length on visceral surface from portal vein to Apex of ventral border (cm)	35.0	17.2	18.7	17.4	26.7	18.4	16.5	26.5	19.0	17.6	36.1	29.8
8	Maximum length of caudate lobe (cm)	7.9	10.2	10.1	10.6	14.6	11.6	10.5	13.8	10.9	10.2	8.1	19.8
9	Maximum width of caudate lobe on visceral surface (cm)	6.6	7.8	7.6	7.8	8.8	9.7	7.3	8.4	8.1	7.4	6.5	8.9
10	Curvature width on visceral surface from umbilical fissure to esophageal notch (cm)	20.1	20.8	21.9	20.9	22.1	17.9	21.7	22.5	21.4	20.4	20.7	23.2
11	Curvature width on the middle of fisceral surface (cm)	26.7	29.3	30.7	29.3	33.9	31.7	29.5	34.6	31.2	29.6	26.9	34.2
12	Curvature length from umbilical fissure to portal vein (cm)	13.1	21.4	21.9	21.7	21.8	21.9	19.2	22.5	21.5	21.7	17.9	22.0
13	Curvature length from portal vein to esophageal notch (cm)	25.9	18.0	18.3	17.5	22.8	20.4	13.0	23.2	20.4	18.0	25.7	23.0
14	Curvature length from esophageal notch to umbilical fissure (cm)	18.3	17.6	18.2	18.5	23.2	17.4	19.7	23.1	18.6	17.6	18.5	23.9
15	Curved length of ridge separating the omasal and reticular Impression (cm)	25.8	30.4	36.6	35.5	25.7	28.3	27.7	26.5	30.2	33.2	26.0	26.1
16	Curvature length from esophageal notch to tip of main lobe (cm)	39.7	36.6	37.8	36.7	40.4	35.5	29.8	41.1	36.7	35.4	40.2	40.2
17	Length from tip of main lobe to top of caudate lobe (cm)	9.2	7.0	5.9	6.2	7.0	6.9	7.1	7.4	6.7	5.8	9.6	7.2
18	Curvature length from caudate lobe to umbilical fissure (cm)	31.5	27.5	34.2	33.8	34.6	24.9	22.9	25.1	26.8	30.0	32.8	35.6

Table 2. Biometrical observations of the various parameters of liver of 12 adult female Murrah buffaloes.

Sr. No.	Parameters	1	2	3	4	5	6	7	8	9	10	11	12
1	Weight (gm)	4900	6600	5400	7800	6300	6900	5600	6000	7000	6800	5800	7200
2	Volume (cc)	3650	5350	4850	6500	5300	5750	4950	5100	5850	5500	5150	6250
3	Density (gm/cc)	1.34	1.23	1.11	1.20	1.21	1.20	1.13	1.20	1.20	1.24	1.13	1.15
4	Curvature length of parietal surface (cm)	47.5	55.5	54.0	62.0	54.0	50.1	51.0	53.7	59.2	57.0	55.0	64.0
5	Width at falciform ligament (cm)	19.0	18.2	14.5	18.9	17.9	18.3	15.2	17.9	18.5	17.8	15.2	19.1
6	Curvature width on the middle of parietal surface (cm)	26.0	32.0	27.4	29.4	31.0	30.0	28.0	31.4	28.7	28.2	28.0	29.8
7	Curved length on visceral surface from portal vein to Apex of ventral border (cm)	16.5	18.4	18.2	26.4	17.2	24.0	18.8	17.8	25.2	24.3	18.6	26.1
8	Maximum length of caudate lobe (cm)	10.5	10.0	11.8	14.2	10.5	11.2	10.7	10.1	14.6	13.9	11.2	13.9
9	Maximum width of caudate lobe on visceral surface (cm)	7.2	7.4	9.2	8.6	7.8	8.2	7.9	7.3	8.3	8.1	8.2	6.6
10	Curvature width on visceral surface from umbilical fissure to esophageal notch (cm)	21.4	21.5	18.0	22.4	20.5	21.9	21.2	20.8	21.9	21.4	20.3	22.1
11	Curvature width on the middle of fisceral surface (cm)	29.5	30.2	32.0	34.2	29.1	32.1	31.0	29.8	32.6	31.7	32.2	34.4
12	Curvature length from umbilical fissure to portal vein (cm)	19.3	21.6	22.2	22.0	21.4	22.3	21.7	21.3	21.7	20.4	21.9	22.4
13	Curvature length from portal vein to esophageal notch (cm)	13.2	18.0	20.4	23.0	17.6	19.2	20.7	17.9	22.3	21.9	21.1	23.1
14	Curvature length from esophageal notch to umbilical fissure (cm)	19.7	18.6	17.2	23.4	18.2	19.3	18.4	17.4	22.6	22.0	19.2	23.4
15	Curved length of ridge separating the omasal and reticular Impression (cm)	31.0	38.6	28.0	26.1	37.1	39.1	30.2	34.0	25.9	24.7	31.1	26.3
16	Curvature length from esophageal notch to tip of main lobe (cm)	29.3	37.4	35.2	42.3	36.9	38.4	36.7	35.9	40.1	38.3	37.0	41.0
17	Length from tip of main lobe to top of caudate lobe (cm)	7.2	5.7	6.8	7.1	6.1	6.4	6.9	5.0	7.2	6.8	7.1	7.3
18	Curvature length from caudate lobe to umbilical fissure (cm)	22.4	36.3	25.4	25.0	34.2	34.1	27.1	30.3	24.7	22.3	29.2	25.7

Table 3. Statistical analysis of various biometrical parameters of 24 adult buffalo livers (12 males and 12 females).

Sr. No.	Parameters	Range		Mean±S.E.		% of C.V.		't' value
		Male	Female	Male	Female	Male	Female	
1	Weight (gm)	3690-7500	4900-7800	5949.16±340.10	6358.33±243.23	20.27	13.25	03.047**
2	Volume (cc)	3050-6450	3650-6500	5075.00±277.95	5350.00±221.67	18.97	13.77	02.485*
3	Density (gm/cc)	01.3-01.26	01.11-01.34	01.16±0.02	01.19±0.02	05.48	05.19	19.498**
4	Curvature length of parietal surface (cm)	46.30-62.00	47.50-64.00	54.77±1.33	55.25±1.38	08.43	08.65	02.972**
5	Width at falciform ligament (cm)	12.90-19.00	14.50-19.10	16.72±0.62	17.54±0.47	12.78	09.24	00.245^{NS}
6	Curvature width on the middle of parietal surface (cm)	23.60-32.00	26.00-32.00	28.08±0.89	29.17±0.51	10.92	06.04	12.930**
7	Curved length on visceral surface from portal vein to apex of ventral border (cm)	16.50-35.00	16.50-26.40	23.24±2.09	20.95±1.11	31.22	18.36	00.462^{NS}
8	Maximum length of caudate lobe (cm)	07.90-19.80	10.00-14.60	11.52±0.94	11.88±0.50	28.16	14.53	00.292^{NS}
9	Maximum width of caudate lobe on visceral surface (cm)	06.50-09.70	06.60-09.20	07.90±0.27	07.90±0.20	11.88	08.84	00.296^{NS}
10	Curvature width on visceral surface from umbilical fissure to esophageal notch (cm)	17.90-23.20	18.00-22.40	21.13±0.39	21.11±0.34	06.45	05.53	00.193^{NS}
11	Curvature width on the middle of fisceral surface (cm)	26.70-34.60	29.10-34.40	30.63±0.76	31.56±0.50	08.57	05.45	01.037^{NS}
12	Curvature length from umbilical fissure to portal vein (cm)	13.10-22.50	19.30-22.40	20.55±0.78	21.51±0.25	13.10	04.09	01.186^{NS}
13	Curvature length from portal vein to esophageal notch (cm)	13.00-25.90	13.20-23.10	20.51±1.09	19.86±8.83	18.45	14.41	00.414^{NS}
14	Curvature length from esophageal notch to umbilical fissure (cm)	17.40-23.90	17.20-23.40	19.55±0.66	19.95±0.66	11.78	11.45	00.492^{NS}
15	Curved length of ridge separating the omasal and reticular impression (cm)	25.70-36.60	24.70-38.60	29.33±1.12	31.01±1.48	13.27	16.59	00.902^{NS}

Table 3. Statistical analysis of various biometrical parameters of 24 adult buffalo livers (12 males and 12 females). (Continue)

Sr. No.	Parameters	Range		Mean±S.E.		% of C.V.		't' value
		Male	Female	Male	Female	Male	Female	
16	Curvature length from esophageal notch to tip of main lobe (cm)	29.80-41.10	29.30-42.30	37.50±0.92	37.37±0.95	08.46	08.82	00.098^{NS}
17	Length from tip of main lobe to top of caudate lobe (cm)	05.80-09.60	05.00-07.30	07.16±0.34	06.63±0.20	16.22	10.69	01.374^{NS}
18	Curvature length from caudate lobe to umbilical fissure (cm)	22.90-35.60	22.30-37.30	30.03±1.26	28.30±1.49	14.49	18.21	00.963^{NS}

S.E. = Standard Error, % C.V. = Percent of covariance, ** = Significant at 1% (P≥0.01), * = Significant at 5% (P≥0.05), and N.S. = Non significant.

These average values showed non significant results between the male and female.

Curvature length

The average values of the curvature length of parietal surface, length from umbilical fissure to portal vein, length from esophageal notch to umbilical fissure and curved length of ridge separating the omasal and reticular impression were higher in female. Whereas, the average values of length from portal vein to esophageal notch, length from esophageal notch to tip of main lobe and length from caudate lobe to umbilical fissure were higher in male as compared to the opposite sex. These average values showed non-significant results between male and female except curvature length on parietal surface.

Curvature width

The average values of the curvature width on the middle of parietal surface was higher in female as compared with the male. The average value showed highly significant difference between both sex. The average value of curvature width on visceral surface from umbilical fissure to esophageal notch was higher in male. Similarly the average value of curvature width of the middle of visceral surface of liver was higher in female as compared to that of opposite sex. These average values showed non-significant difference between male and female.

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