

MICROMETRICAL OBSERVATIONS OF LIVER IN BUFFALO (*BUBALUS BUBALIS*)

Pravin Narayan Thakur\* and Padmakar Jayram Kapadnis

## ABSTRACT

The micrometrical observations livers of 24 buffaloes (12 females and 12 males) were conducted. The overall average diameter of hepatocytes of male and female buffalo liver was  $14.36 \pm 0.48 \mu$  and  $14.6 \pm 0.49 \mu$  respectively. The average values showed non significant difference between sex, while The male showed a very significant difference and the female did not show a significant difference between regions. The overall average diameter of hepatic sinusoids of male and female buffalo liver was  $6.50 \pm 0.46 \mu$  and  $4.75 \pm 0.29 \mu$  respectively. The average values showed significant difference between sex, while male and female showed highly significant difference between the regions.

The overall average diameter of Von-Kupffer cells of male and female buffalo liver was  $6.74 \pm 0.35 \mu$  and  $8.65 \pm 0.30 \mu$ , respectively. The average values showed highly significant difference between sex, While the male showed a very significant difference and the female did not show a significant difference between the region. The overall average number of binucleated cells of male and female buffalo liver was  $1.32 \pm 0.64$  per  $\text{mm}^2$  and  $1.97 \pm 0.90$  per  $\text{mm}^2$ , respectively. The overall average distance between adjacent central vein of male and female buffalo liver was  $80.21 \pm 3.31 \mu$  and  $61.24 \pm 3.1 \mu$ , respectively.

The average values showed highly significant difference between sex, While the male showed a very significant difference and the female did not show a significant difference between the region. The overall average number of Von-Kupffer cells per  $\text{mm}^2$  of male and female buffalo liver was  $262.06 \pm 14.31$  per  $\text{mm}^2$  and  $281.61 \pm 12.81$  per  $\text{mm}^2$ , respectively. The average values showed non significant difference between sex, while male and female showed non significant difference between the regions. The overall average number of central vein per  $\text{mm}^2$  of male and female buffalo liver was  $3.58 \pm 0.15$  per  $\text{mm}^2$  and  $2.89 \pm 0.11$  per  $\text{mm}^2$ , respectively. The average values showed a very significant difference between sex, while the difference between male and female was not significant.

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

## INTRODUCTION

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

## MATERIALS AND METHODS

The present study was conducted in normal livers of 12 male and 12 female adult buffaloes (*Bubalus bubalis*) of Murrah breed. The liver was examined in situ and all attachment and other details were recorded. Samples were collected immediately after slaughter at Deonar Abattoir, Mumbai. The livers were separated from the pluck and cleared by removing fascia, blood vessels, nerves, etc. to facilitate observations. These separate livers were washed under running tap water to remove all blood clot and tissue debris. For further study, the organs were brought to the laboratory in an ice-cooled box. Micrometric observations of various components of the liver have been recorded in microns (i.e., atoms) as per the Culling method (1969). Micrometric observations for the following parameters have been recorded by calculating the mean of 3 to 4 fields of each prepared slide.

- Hepatocyte diameter
- Diameter of the hepatic sinusoid
- Diameter of the Von-Kupffer cell
- Number of binucleate cells per mm<sup>2</sup>
- Distance between adjacent central veins
- Number of Von-Kupffer cells per mm<sup>2</sup>
- Number of central veins per mm<sup>2</sup>

Statistical analysis was carried out for biometrical and micrometrical observations according to Snedecor and Cochran (1994). The tissue sections of various regions stained with various stains were microphotographed.

## RESULT AND DISCUSSION

Micrometric observations of various components of the liver were conducted in the present study on 24 normal livers (12 females and 12 males) collected from adult Murrah buffaloes.

The perusal of literature on micrometry of the liver in buffalo was not traceable in the reviewed work.

For micrometrical study, total seven parameters have been taken for observations. These parameters were diameter of hepatocytes ( $\mu\text{m}$ ), diameter of hepatic sinusoids ( $\mu\text{m}$ ), diameter of Von-Kupffer cells ( $\mu\text{m}$ ), Distance between adjacent central vein ( $\mu\text{m}$ ), number of Von-Kupffer cells per mm<sup>2</sup>. and number of central vein per mm<sup>2</sup>. Binucleated cells were observed in only one sample of all the regions, except caudate lobe at the apex in female, while the binucleated cells were absent in all regions collected from male buffalo except neck of the all bladder. Therefore 't' value of the number of binucleated cells per mm<sup>2</sup> was not recorded.

### A) Upper third of parietal surface

The average values of diameter of hepatocytes, diameter of Von-Kupffer cells and distance between adjacent central veins were higher in male, while remaining average values were higher in female.

Distance between adjacent central veins showed highly significantly difference, diameter and number of Von-Kupffer cells showed significant difference, while other parameters showed non significant result between male and female.

### B) Middle of the liver at the centre

The average values of diameter of

Table 1. Micrometrical observations in various components of different regions of liver in adult 12 male Murrah buffaloes.

Sr. No.	Parameters	1	2	3	4	5	6	7	8	9	10	11	12
<b>A) UPPER THIRD OF PARIETAL SURFACE</b>													
1	Diameter of hepatocytes (mm)	08.80	12.32	15.84	19.36	15.84	10.56	17.60	19.36	15.84	14.08	15.84	19.36
2	Diameter of the hepatic sinusoid (mm)	05.28	03.69	02.64	02.64	02.99	02.81	02.28	02.64	03.16	03.34	04.22	04.40
3	Diameter of the Von-Kupffer cells (mm)	12.32	05.28	12.32	08.80	10.56	10.56	05.28	10.56	10.56	07.04	10.56	10.56
4	Distance between adjacent central vein (mm)	93.60	70.20	97.50	78.00	78.00	62.40	85.80	101.4	140.4	140.4	117.0	156.00
5	No. of Von-Kupffer cells per mm <sup>2</sup>	296.10	335.58	394.80	315.84	236.88	177.66	118.44	197.40	217.14	196.10	236.88	256.62
6	No. of central vein per mm <sup>2</sup>	04.16	03.12	05.20	02.08	02.08	03.12	03.12	02.08	04.16	03.12	02.08	03.12
<b>B) MIDDLE OF THE LIVER AT CENTER</b>													
1	Diameter of hepatocytes (mm)	15.84	14.08	10.56	16.72	16.54	14.96	13.02	14.96	16.54	10.56	16.54	16.36
2	Diameter of the hepatic sinusoid (mm)	05.28	03.52	07.80	23.40	23.40	15.60	07.80	07.80	15.60	15.60	23.40	15.60
3	Diameter of the Von-Kupffer cells (mm)	08.80	05.28	05.28	03.52	05.28	05.28	07.04	05.28	03.52	05.28	03.52	03.52
4	Distance between adjacent central vein (mm)	117.0	117.0	101.4	109.2	93.60	78.00	70.20	74.10	93.60	101.4	93.60	109.2
5	No. of Von-Kupffer cells per mm <sup>2</sup>	177.66	157.92	138.18	236.88	296.1	276.36	394.8	217.14	256.62	375.6	355.32	335.58
6	No. of central vein per mm <sup>2</sup>	03.12	03.12	05.20	04.16	03.12	03.12	03.12	04.16	04.16	03.12	02.08	05.20

Table 1. Micrometrical observations in various components of different regions of liver in adult 12 male Murrah buffaloes.

Sr. No.	Parameters	1	2	3	4	5	6	7	8	9	10	11	12
<b>C) BELOW THE PORTAL VEIN</b>													
1	Diameter of hepatocytes (mm)	21.12	14.43	16.54	15.84	14.08	16.72	14.96	22.88	14.96	13.02	22.00	16.36
2	Diameter of the hepatic sinusoid (mm)	05.28	05.28	07.04	05.28	05.28	03.52	05.28	05.28	07.04	05.28	03.52	05.28
3	Diameter of the Von-Kupffer cells (mm)	05.28	03.52	05.28	07.04	12.32	05.28	03.52	05.28	08.80	07.04	07.04	05.28
4	Distance between adjacent central vein (mm)	31.20	23.40	78.00	70.20	62.40	54.60	39.00	93.60	66.30	97.50	58.50	35.10
5	No. of Vov-Kupffer cells per mm <sup>2</sup>	59.22	39.48	177.66	157.92	394.8	296.1	394.8	217.14	335.58	296.10	236.88	236.88
6	No. of central vein per mm <sup>2</sup>	03.12	05.20	02.08	04.16	03.12	05.20	03.12	04.16	05.20	03.12	05.12	04.16
<b>D) NECK OF GALL BLADDER</b>													
1	Diameter of hepatocytes (mm)	10.56	07.04	12.32	12.32	14.08	08.80	10.56	05.28	07.04	08.80	08.80	15.84
2	Diameter of the hepatic sinusoid (mm)	05.28	03.52	05.28	03.52	05.28	05.28	07.04	07.04	07.04	05.28	05.28	04.40
3	Diameter of the Von-Kupffer cells (mm)	08.80	07.04	03.52	05.28	05.28	08.80	05.28	07.04	05.28	05.28	03.52	08.80
4	No. of binucleate cells per mm <sup>2</sup>	-	19.74	-	-	19.74	-	-	19.74	-	-	19.74	-
5	Distance between adjacent central vein (mm)	70.20	70.20	101.4	70.20	85.80	62.40	54.60	54.60	70.20	70.20	85.80	85.80
6	No. of Vov-Kupffer cells per mm <sup>2</sup>	236.88	375.06	315.84	434.28	335.58	296.10	394.8	98.70	59.22	157.92	177.66	138.18
7	No. of central vein per mm <sup>2</sup>	05.20	05.20	04.16	04.16	03.12	02.08	04.16	05.20	05.20	02.08	03.12	02.08

Table 1. Micrometrical observations in various components of liver in adult 12 male Murrah buffaloes. (Continue)

Sr. No.	Parameters	1	2	3	4	5	6	7	8	9	10	11	12
<b>E) APEX OF CAUDATE LOBE</b>													
1	Diameter of hepatocytes (mm)	17.60	15.84	19.36	15.84	10.56	14.08	15.84	08.80	15.84	14.08	12.32	15.84
2	Diameter of the hepatic sinusoid (mm)	03.52	03.52	07.04	05.28	03.52	03.52	05.28	07.04	05.28	03.52	03.52	07.04
3	Diameter of the Von-Kupffer cells (mm)	03.52	12.32	07.04	05.28	08.80	08.80	10.56	05.28	03.52	03.52	05.28	05.28
4	Distance between adjacent central vein (mm)	78.00	70.20	93.60	78.00	54.60	70.20	78.00	46.80	62.40	70.20	62.40	78.00
5	No. of Von-Kupffer cells per mm <sup>2</sup>	98.70	89.96	355.32	315.84	493.50	296.10	394.8	434.28	335.88	315.84	493.76	236.88
6	No. of central vein per mm <sup>2</sup>	05.20	05.20	04.16	03.12	02.08	03.12	04.16	02.08	02.08	02.08	02.08	05.20

Table 2. Micrometrical observations in various components of different regions of liver in adult 12 female Murrah buffaloes. (Continue)

Sr. No.	Parameters	1	2	3	4	5	6	7	8	9	10	11	12
<b>A) UPPER THIRD OF PARIETAL SURFACE</b>													
1	Diameter of hepatocytes (mm)	15.84	17.60	12.32	07.04	19.36	14.08	10.56	08.80	15.84	14.08	15.84	21.12
2	Diameter of the hepatic sinusoid (mm)	04.40	03.52	03.69	02.64	03.87	04.40	04.40	03.52	02.28	03.52	02.64	04.40
3	Diameter of the Von-Kupffer cells (mm)	08.80	05.28	12.32	08.80	07.04	10.56	05.28	07.04	08.80	05.28	10.56	07.04
4	No. of binucleate cells per mm <sup>2</sup>	-	-	-	19.74	-	-	-	-	-	-	-	-
5	Distance between adjacent central vein (mm)	39.00	70.20	23.40	62.40	97.50	54.60	39.00	31.20	23.40	70.20	62.40	46.80
6	No. of Vov-Kupffer cells per mm <sup>2</sup>	276.36	394.8	177.60	335.58	217.14	296.1	138.18	355.32	414.54	454.02	296.1	315.84
7	No. of central vein per mm <sup>2</sup>	03.12	02.08	02.08	04.16	02.08	05.20	03.12	03.12	04.16	02.08	03.12	04.16
<b>B) MIDDLE OF THE LIVER AT CENTER</b>													
1	Diameter of hepatocytes (mm)	21.12	14.08	08.80	12.32	10.56	15.84	12.32	15.84	08.80	19.36	15.84	19.36
2	Diameter of the hepatic sinusoid (mm)	05.28	03.52	03.52	04.40	07.04	04.40	03.52	04.40	03.80	03.52	03.52	02.64
3	Diameter of the Von-Kupffer cells (mm)	07.04	07.04	10.56	10.56	08.80	12.32	05.28	08.80	08.80	12.32	15.84	08.80
4	No. of binucleate cells per mm <sup>2</sup>	-	-	-	-	-	-	-	39.48	-	-	-	-
5	Distance between adjacent central vein (mm)	97.50	78.00	39.00	54.60	46.80	39.00	39.00	46.80	70.20	31.20	85.80	117.00
6	No. of Vov-Kupffer cells per mm <sup>2</sup>	256.62	375.06	157.92	315.84	197.4	276.36	118.44	335.58	394.8	434.28	276.36	296.1
7	No. of central vein per mm <sup>2</sup>	2.08	3.12	3.12	3.12	03.12	04.16	02.08	02.08	03.12	03.12	02.08	03.12

Table 2. Micrometrical observations in various components of different regions of liver in adult 12 female Murrah buffaloes. (Continue)

Sr. No.	Parameters	1	2	3	4	5	6	7	8	9	10	11	12
<b>C) BELOW THE PORTAL VEIN</b>													
1	Diameter of hepatocytes ( $\mu\text{m}$ )	17.6	14.8	17.6	19.36	17.60	15.84	10.56	15.84	17.60	15.84	12.32	08.80
2	Diameter of the hepatic sinusoid ( $\mu\text{m}$ )	5.28	12.32	8.8	10.56	10.56	07.04	08.80	07.04	08.80	05.28	08.80	10.56
3	Diameter of the Von-Kupffer cells ( $\mu\text{m}$ )	12.32	5.28	8.8	8.8	12.32	07.04	05.28	08.80	05.28	10.56	07.04	05.28
4	No. of binucleate cells per $\text{mm}^2$	19.74	-	-	-	-	-	19.74	-	-	-	-	-
5	Distance between adjacent central vein ( $\mu\text{m}$ )	93.6	78	70.2	97.5	93.60	62.40	23.40	101.4	97.50	85.80	31.20	54.60
6	No. of Vov-Kupffer cells per $\text{mm}^2$	236.88	138.18	177.66	157.92	296.10	256.62	355.32	118.44	236.88	217.14	197.40	98.70
7	No. of central vein per $\text{mm}^2$	2.08	2.08	2.08	3.12	04.16	02.08	04.16	02.08	03.12	02.08	03.12	02.08
<b>D) NECK OF GALL BLADDER</b>													
1	Diameter of hepatocytes (mm)	12.32	15.84	08.80	21.12	19.36	15.84	17.6	15.84	19.36	17.60	15.84	15.84
2	Diameter of the hepatic sinusoid (mm)	03.52	03.52	03.69	3.52	04.40	02.64	04.4	04.40	03.52	03.87	04.40	03.69
3	Diameter of the Von-Kupffer cells (mm)	12.32	08.80	10.56	08.80	07.04	08.80	10.56	08.80	07.04	08.80	05.28	08.80
4	No. of binucleate cells per $\text{mm}^2$	-	19.74	-	-	-	-	-	-	-	-	-	-
5	Distance between adjacent central vein (mm)	70.20	70.20	39.00	62.40	97.50	62.40	24.4	23.40	62.40	54.60	54.60	39.00
6	No. of Vov-Kupffer cells per $\text{mm}^2$	296.1	414.54	197.4	355.32	236.88	197.40	197.4	157.92	375.06	434.28	473.76	315.84
7	No. of central vein per $\text{mm}^2$	03.12	02.08	04.16	02.08	04.16	03.12	02.08	04.16	02.08	02.08	03.12	03.12

Table 2. Micrometrical observations in various components of different regions of liver in adult 12 female Murrah buffaloes. (Continue)

Sr. No.	Parameters	1	2	3	4	5	6	7	8	9	10	11	12
<b>E) APEX OF CAUDATE LOBE</b>													
1	Diameter of hepatocytes (mm)	10.56	08.80	07.04	15.84	15.84	15.84	14.08	17.6	17.60	10.56	08.80	10.56
2	Diameter of the hepatic sinusoid (mm)	03.87	04.40	03.69	03.52	03.16	02.64	03.52	03.87	04.40	03.69	03.52	02.64
3	Diameter of the Von-Kupffer cells (mm)	08.8	07.04	12.32	08.80	07.04	08.80	10.56	08.8	05.28	10.56	07.04	08.80
4	Distance between adjacent central vein (mm)	39.00	78.00	62.40	46.80	62.40	70.20	23.40	62.4	97.50	78.00	70.20	70.20
5	No. of Vov-Kupffer cells per mm <sup>2</sup>	296.10	276.36	473.76	434.26	375.06	157.92	296.1	236.88	355.32	157.92	375.06	256.62
6	No. of central vein per mm <sup>2</sup>	02.08	03.12	02.08	02.08	04.16	02.08	02.08	04.16	03.12	02.08	02.02	04.16



Table 3. Analysis of statistics of various micrometrical parameters of liver in 24 adult buffalo (12 males and 12 females).

Sr. No.	Parameters	Range		Mean±S.E.		% of C.V.		't' value
		Male	Female	Male	Female	Male	Female	
<b>A) UPPER THIRD OF PARIETAL SURFACE</b>								
1	Diameter of hepatocytes (mm)	08.80-19.36	07.04-21.12	15.40±0.99	14.37±1.20	22.39	28.99	00.432 <sup>NS</sup>
2	Diameter of the hepatic sinusoid (mm)	02.28-05.28	02.28-04.40	03.34±0.25	03.60±0.21	26.79	20.93	00.620 <sup>NS</sup>
3	Diameter of the Von-Kupffer cells (mm)	05.28-12.32	05.28-12.32	09.53±0.70	08.06±0.66	25.46	28.63	02.301*
4	No. of binucleate cells per mm <sup>2</sup>	-	19.74	-	01.064±1.65	-	347.46	-
5	Distance between adjacent central vein (mm)	70.20-156.0	23.40-97.50	101.72±8.77	51.67±6.38	29.90	42.83	21.247**
6	No. of Von-Kupffer cells per mm <sup>2</sup>	118.44-394.8	138.18-454.02	248.28±22.1	305.97±27.3	30.81	30.94	02.694*
7	No. of central vein per mm <sup>2</sup>	02.08-04.16	02.08-04.16	03.12±0.28	03.20±0.2	31.78	32.37	00.043 <sup>NS</sup>
<b>B) MIDDLE OF THE LIVER AT CENTER</b>								
1	Diameter of hepatocytes (mm)	10.56-16.72	08.80-19.36	14.72±0.65	14.52±1.18	15.31	28.36	00.013 <sup>NS</sup>
2	Diameter of the hepatic sinusoid (mm)	03.52-23.40	02.64-07.04	13.73±2.09	04.13±0.32	52.68	27.50	20.638**
3	Diameter of the Von-Kupffer cells (mm)	03.52-08.80	05.28-12.32	05.13±0.46	09.68±0.82	30.88	29.52	23.233**
4	No. of binucleate cells per mm <sup>2</sup>	-	39.48	-	3.29±3.29	-	346.4	-
5	Distance between adjacent central vein (mm)	70.20-117.0	31.20-117.0	96.53±4.59	62.07±7.89	16.48	44.06	14.242**
6	No. of Von-Kupffer cells per mm <sup>2</sup>	138.18-375.6	118.44-434.18	268.18±24.8	286.23±27.3	32.10	33.07	00.238 <sup>NS</sup>
7	No. of central vein per mm <sup>2</sup>	02.8-05.20	02.08-04.16	03.64±0.22	02.86±0.18	25.84	22.60	05.603**

Table 3. Analysis of statistics of various micrometrical parameters of liver in 24 adult buffalo (12 males and 12 females). (Continue)

Sr. No.	Parameters	Range		Mean±S.E.		% of C.V.		't' value
		Male	Female	Male	Female	Male	Female	
<b>C) BELOW THE PORTAL VEIN</b>								
1	Diameter of hepatocytes (mm)	13.02-22.88	08.80-19.36	16.90±0.94	15.30±0.92	19.36	20.88	01.460 <sup>NS</sup>
2	Diameter of the hepatic sinusoid (mm)	03.52-60.04	05.28-12.32	05.28±0.31	08.65±0.63	20.10	55.07	23.183 <sup>**</sup>
3	Diameter of the Von-Kupffer cells (mm)	03.52-12.32	05.28-12.32	06.30±0.70	08.06±0.76	38.52	32.86	02.880 <sup>**</sup>
4	No. of binucleate cells per mm <sup>2</sup>	-	19.74	-	03.29±2.21	-	233.5	-
5	Distance between adjacent central vein (mm)	23.04-97.50	23.40-101.4	59.15±6.69	74.10±7.63	40.33	35.69	02.113 <sup>*</sup>
6	No. of Vov-Kupffer cells per mm <sup>2</sup>	39.48-394.8	98.7-355.32	236.88±33.4	210.60±22.5	48.85	37.16	00.553 <sup>NS</sup>
7	No. of central vein per mm <sup>2</sup>	02.08-05.20	02.80-04.16	03.98±0.31	02.68±0.23	26.70	30.77	11.088 <sup>**</sup>
<b>D) NECK OF GALL BLADDER</b>								
1	Diameter of hepatocytes (mm)	05.28-15.84	08.80-21.12	10.12±0.89	16.28±0.94	30.68	20.15	22.30 <sup>**</sup>
2	Diameter of the hepatic sinusoid (mm)	03.52-07.04	02.64-04.40	05.35±0.35	3.79±0.15	22.68	14.07	16.533 <sup>**</sup>
3	Diameter of the Von-Kupffer cells (mm)	03.52-08.80	05.28-12.32	06.16±0.55	08.80±0.53	31.06	20.88	11.880 <sup>**</sup>
4	No. of binucleate cells per mm <sup>2</sup>	19.74	19.74	06.58±2.80	01.64±1.64	147.7	347.46	--
5	Distance between adjacent central vein (mm)	54.60-101.4	23.40-97.50	73.45±4.01	55.92±6.08	18.92	38.29	06.409 <sup>**</sup>
6	No. of Vov-Kupffer cells per mm <sup>2</sup>	59.22-434.28	157.92-473.96	251.68±35.9	304.32±30.8	49.39	12.35	01.236 <sup>NS</sup>
7	No. of central vein per mm <sup>2</sup>	02.08-05.20	02.08-04.16	03.81±0.37	02.94±0.25	31.59	29.53	03.767 <sup>**</sup>

Table 3. Analysis of statistics of various micrometrical parameters of liver in 24 adult buffalo (12 males and 12 females). (Continue)

Sr. No.	Parameters	Range		Mean±S.E.		% of C.V.		‘t’ value
		Male	Female	Male	Female	Male	Female	
<b>E) APEX OF CAUDATE LOBE</b>								
1	Diameter of hepatocytes (mm)	08.80-15.84	07.04-17.60	14.66±0.85	12.76±1.08	20.04	29.48	01.914 <sup>NS</sup>
2	Diameter of the hepatic sinusoid (mm)	03.52-07.04	02.64-04.40	04.84±0.44	03.57±0.16	31.49	15.78	07.253 <sup>**</sup>
3	Diameter of the Von-Kupffer cells (mm)	03.52-12.32	05.28-12.32	06.60±0.84	08.65±0.55	44.22	22.04	04.162 <sup>**</sup>
4	Distance between adjacent central vein (mm)	46.80-93.60	23.40-97.50	70.20±3.59	63.37±5.64	17.72	30.84	01.441 <sup>NS</sup>
5	No. of Vov-Kupffer cells per mm <sup>2</sup>	78.96-493.5	157.92-473.76	320.80±38.4	307.61±28.7	41.50	32.31	00.075 <sup>NS</sup>
6	No. of central vein per mm <sup>2</sup>	02.08-05.20	02.08-04.16	03.38±0.38	02.77±0.26	39.63	33.32	01.668 <sup>NS</sup>

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

Table 4. Overall statistical analysis of various micrometrical parameters of liver components in 24 adult buffaloes (12 males and 12 females).

Sr. No.	Parameters	Range		Mean±S.E.		% of C.V.		't' value	'F' Value	
		Male	Female	Male	Female	Male	Female		Male	Female
1	Diameter of hepatocytes (mm)	5.28-22.88	007.04-021.12	14.369±0.48	14.6±0.49	25.88	25.92	0.423 <sup>NS</sup>	8.413 <sup>***</sup>	1.407 <sup>NS</sup>
2	Diameter of the hepatic sinusoid (mm)	2.28-23.40	002.28-012.32	0.650±0.46	04.75±0.29	79.34	48.25	2.34*	17.528 <sup>**</sup>	39.890 <sup>**</sup>
3	Diameter of the Von-Kupffer cells (mm)	3.52-12.32	005.28-012.32	06.74 ±0.35	08.65±0.30	39.69	27.08	4.138 <sup>**</sup>	6.192 <sup>**</sup>	0.961 <sup>NS</sup>
4	No. of binucleate cells per mm <sup>2</sup>	19.74	019.74-039.48	01.32±0.64	01.97±0.90	377.32	384.87	-	-	-
5	Distance between adjacent central vein (mm)	23.40-156.0	023.40-101.40	80.21±3.31	61.24±3.1	31.99	39.20	4.179*	9.444 <sup>**</sup>	1.633 <sup>NS</sup>
6	No. of Vov-Kupffer cells per mm <sup>2</sup>	39.48-493.8	98.70-473.76	262.06±14.31	281.61±12.81	42.30	35.25	0.895 <sup>NS</sup>	1.096 <sup>NS</sup>	2.450 <sup>NS</sup>
7	No. of central vein per mm <sup>2</sup>	02.08-0005.2	02.08-004-16	03.58±0.15	02.89±0.11	31.78	29.69	3.805 <sup>NS</sup>	1.094 <sup>NS</sup>	0.632 <sup>NS</sup>

S.E.= Standard Error, % C.V. = Percent of covariance, 't' value between male and female 'F' value between the regions,

\*\* = Significant at 1% ( $P \geq 0.01$ ), \* = Significant at 5% ( $P \geq 0.05$ ), and N.S. = Non significant

hepatocytes, diameter of hepatic sinusoids, distance between adjacent central vein and number of central vein, higher in males, while remaining average values were higher in female. The diameter of hepatocytes and number of Von-Kupffer cells showed non significant difference, while other remaining showed highly significant difference.

### C) Below the portal vein

The average values of diameter of hepatocytes, number of Von-Kupffer cells and number of central vein higher in males, while remaining average values were higher in females. The diameter of hepatocytes and number of Von-Kupffer cells showed non significant, difference while the distance between adjacent central vein showed significant difference, while other remaining showed highly significant difference.

### D) Neck of the gall bladder

The average values of diameter of the hepatic sinusoids, number of binucleated cells, distance between adjacent central vein and number of central vein, higher in males while remaining average values were higher in females. The number of Von-Kupffer cells showed non significant difference while other showed highly significant difference.

### E) Apex of caudate lobe

The average values of diameter of Von-Kupffer cells higher in females, while remaining higher in males. The diameter of hepatic sinusoids and diameter of Von-Kupffer cells showed highly significant while remaining showed non significant differences.

Sundar rao and Mariappa (1965) recorded the diameter of hepatic cells which varied from 11 to 21  $\mu\text{m}$  in calves and 14 to 27  $\mu\text{m}$  in adult

buffalo. In present study, the overall diameter of hepatocytes were 5.28 to 22.88  $\mu\text{m}$  in male and 7.04 to 21.12  $\mu\text{m}$  in female buffaloes. The present observations are within the range as observed by Sundar rao and Mariappa (1965). There was minute variation in minimum values, which might be due to breed variation.

Liman (1996) The number of hepatocytes per unit area was recorded. as 107.48 $\pm$ 6.63, 133.6 $\pm$ 7.01, and 100.84 $\pm$ 0.63 In fetuses, lambs and adult sheep, respectively. He recorded that the average diameter of sheep hepatocyte and nuclei, ratio between prenatal and postnatal stages and difference between these stages were statistically significant ( $P < 0.05$ ), while in the present study, the overall average values differed, but statistically non significant 78 among the male and female buffaloes. This variation in significance might be due to species variation.

Liman (1996) The distance between the adjacent central vein was recorded 401.2 $\pm$ 20.8  $\mu\text{m}$  in fetuses, 629.77 $\pm$ 34.7  $\mu\text{m}$  in lambs and 740.00 $\pm$ 40.35  $\mu\text{m}$  in adult sheep, while in the present observations, the overall mean was 80.21 $\pm$ 3.31  $\mu\text{m}$  in male and 61.24 $\pm$ 3.31  $\mu\text{m}$  in male and 61.24 $\pm$ 3.09  $\mu\text{m}$  in female buffalo. This variation might be due to species difference.

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