DETERMINATION OF LIVER FUNCTION, PLASMA AND BLOOD VOLUMES IN KETOTIC COWS, USING BROMSULPHALEIN


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The bromsulphalein test revealed a significantly lower liver function, and significantly lower plasma protein-bound levels also were found in ketotic cows. Blood hematocrits, plasma and blood volumes per kg. of body weight, were insignificantly higher in the ketotic than in the control group. Editor.

Robertson et al. (9) have reported that ketosis cows have elevated levels of plasma-free 17-hydroxycorticosteroids and low levels of plasma protein-bound iodine, as compared to appropriate control cows, suggesting that ketosis is due to a relative adrenal-cortical insufficiency, as a consequence of hypothyroidism. However, Brown et al. (3) and Klein et al. (4) have reported that the metabolism and conjugation of both exogenous and endogenous corticoids are defective in patients suffering from liver diseases. Liver disorders might be the cause also of elevated corticoids in ketosis cows.

Many workers (5, 10-14) have reported histopathological changes occurring in the livers of cows exhibiting spontaneous ketosis, and Shaw et al. (13) have observed that fasting ketosis will cause the appearance of fat in the liver. No reports on specific liver function tests in ketosis cows have come to the attention of the authors.

Vigue (15) has presented a limited amount of data which suggested that ketosis cows may have low blood volumes per kg. of body weight, and high blood hematocrits.

The purpose of this study was to compare liver function in ketosis cows to that in normal cows and simultaneously to determine blood and plasma volume relationships, using the dye bromsulphalein. A preliminary report of this work has been made (8).

METHODS

Protein-free blood filtrates for blood sugar determination were prepared by the method of Weichselbaum and Somogyi (16), and the assay was according to Benedict (1). Plasma acetone was determined on a semiquantitative basis.

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using the Denco Acetone Test\textsuperscript{4} (nitroprusside), in which the plasma samples were rated on an arbitrary 0 to 4+ scale. Plasma protein-bound iodine (PBI) was determined according to the method of Brown \textit{et al.} (2). Liver function, blood and plasma volume determinations, were made simultaneously, according to the methods of Mixner and Robertson (7), using the dye bromsulphalein (BSP). The "BSP fractional clearance" was the measure of liver function employed, and was defined as the fraction of the total blood plasma volume which is cleared of BSP per minute on an instantaneous basis, after the intravenous injection of the dye.

The six ketosis (Holstein) cows in this study were in private herds, which were under the veterinary supervision of one of the authors (W. W. B.). The five control (Holstein) animals for the study were animals in the herd of the Dairy Research Farm, New Jersey Agricultural Experiment Station, and were studied in the period between one and four weeks post-partum.

\textbf{RESULTS AND DISCUSSION}

A summary of the results is presented (Table 1). The BSP fractional clearance was markedly depressed in the ketosis cows, as compared to their controls (0.089 and 0.192, respectively). The difference was highly significant statistically ($P<0.01$). The difference in the PBI levels of the two groups approached statistical significance at the one per cent level and confirmed the earlier finding (9) that the PBI levels are low in ketosis cows. Blood hematocrit values for the two groups of animals were very similar, indicating that hemo-

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|c|}
\hline
Cow No. & Body weight & Blood sugar & Plasma acetone & BSP fractional clearance & Plasma protein-bound iodine & Volume per kg. body wt. \\
& (kg.) & (mg. %) & (0 to 4+) & (b) & (mg. %) & Plasma & Blood \\
\hline
\hline
Normal lactating cows, one to four weeks post-partum & & & & & & & \\
H795 & 607 & ...... & 0 & 0.196 & 2.98 & 38 & 43.5 & 67.2 \\
H864 & 544 & ...... & 0 & 0.191 & 3.74 & 38 & 34.3 & 53.4 \\
H775 & 507 & ...... & 0 & 0.164 & 2.84 & 34 & 29.1 & 42.7 \\
H530 & 575 & ...... & 0 & 0.175 & 3.53 & 31 & 44.9 & 63.4 \\
H847 & 457 & ...... & 0 & 0.235 & 4.51 & 37 & 38.6 & 59.1 \\
Mean & 558 & ...... & 0 & 0.192 & 3.52 & 35.6 & 38.1 & 57.2 \\
\hline
Ketosis cows & & & & & & & \\
16B & 626 & 17.5 & 4+ & 0.115 & 2.49 & 40 & 41.8 & 67.0 \\
27B & 555 & 25.9 & 2+ & 0.110 & 2.95 & 34 & 51.2 & 75.4 \\
18B & 574 & 31.4 & 1+ & 0.091 & 1.88 & 42 & 41.1 & 67.8 \\
10B & 595 & 37.9 & 2+ & 0.050 & 2.28 & 34 & 63.9 & 93.8 \\
21B & 623 & 29.7 & 1+ & 0.090 & 2.69 & 37 & 44.4 & 68.1 \\
24B & 545 & 27.3 & 2+ & 0.078 & 2.89 & 35 & 44.4 & 66.2 \\
Mean & 586 & 28.3 & 2+ & 0.089 & 2.53 & 37.0 & 47.8 & 73.1 \\
\hline
\end{tabular}
\caption{Liver function, plasma protein-bound iodine, and plasma and blood volume measurements in normal and ketosis cows}
\end{table}

concentration had not occurred in the ketosis cows. The ketosis cows had higher plasma and blood volumes per kg. of body weight than the control cows, but the differences in each instance were not statistically significant at the five per cent level. These results are in contrast to those of Vigue (15).

Ideally, the BSP fractional clearance should be performed on animals in a basal metabolic condition. This is quite impractical in mature ruminant animals, and there is, accordingly, the general assumption inherent in the use of this measure that the animals to be tested remain on a fairly constant metabolic plane of nutrition. Very likely, there was some restriction of food intake in the ketosis animals; whereas, the control animals were not fasted. However, experiments by Mixner et al. (6) showed that total starvation of small dairy bull calves for 48 hours caused only a small and transitory decrease in BSP fractional clearance, but at the same time caused a marked decrease in PBI.

These experiments provided definite evidence that liver function was impaired in ketosis cows, as might be predicted on the basis of prior histopathological evidence. It is interesting to speculate as to whether it may be incident to hypothyroidism, as evidenced by low PBI values in the ketosis cows. The finding of Robertson et al. (9), that ketosis cows have high plasma levels of free 17-hydroxycorticosteroids, must be examined with reference to the demonstrated low liver function.

SUMMARY

Liver function in six ketotic cows was markedly depressed, as compared to five normal control cows, as shown by the bromsulphalein (BSP) fractional clearance method, being 0.089 and 0.192, respectively. The differences in these values were highly significant statistically (P<0.01). These findings are in accordance with prior histopathological evidence for liver damage in ketosis cows. Plasma protein-bound iodine levels were also lower in the ketosis cows, 2.53 µg. %, as compared to 3.52 µg. % for the controls, the difference being statistically significant at the five per cent level, confirming our earlier observation. The blood hematocrits, plasma and blood volumes per kg. of body weight were 35.6 and 37.0%; 38.1 and 47.8 ml., and 57.2 and 73.1 ml., for the control and ketosis cows, respectively. Although in all instances the values for the ketotic cows were higher, none of the differences was statistically significant.

REFERENCES


