CCXIX. MILK SECRETION IN RELATION TO BLOOD COMPOSITION. THE UREA CONTENTS OF BLOOD AND OF MILK-SERUM.

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THE following experiments deal with the urea contents of milk, arterial blood and mammary venous blood and with the rate of milk secretion. Though only intended to be preliminary to a series of investigations concerning the rate of elimination of various constituents in milk, they have been recorded here, together with the lines for future work which they indicate, since the author is unable to continue them at present.

The work has been carried out by the use of methods which have been very similar to those that are generally employed in determination of the blood-urea clearance by the kidney [see Peters and Van Slyke, 1932]. The udder of each experimental cow was first thoroughly emptied at the usual hour of morning milking. The cow was then thoroughly milked out on two occasions, the intervals between these three milkings (1 to 2 hours each) being measured accurately. The yield of milk was weighed on a spring balance recording to 1/100 lb. A blood sample from the abdominal subcutaneous (mammary) vein was taken a few minutes after the middle milking.

The specific gravity and fat content of the milk samples (by hydrometer and the Gerber methods, see Ling [1930]) and the urea contents of the whole blood and whole milk samples (by the method of Peskett [1934]) were determined. From the data, the urea content of the fat-free serum of the milk samples was calculated assuming no urea to be contained in the fat; also the rate of secretion of fat-free serum for each of the two test periods. The results are shown in Table I.

Table I. *Rate of secretion and urea content of milk-serum and blood.*

Name of cow	Duration of test periods (mins.)		Rate of secretion (ml. milk-serum/min.)		Urea content of milk-serum (mg./100 ml.)		Urea content of whole blood (mg./100 ml.)
	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2	
Gertie 3	72	83	4.4	4.6	28	29	28
Peach 3	69	83	2.5	13.7	28	34	33
Rosey G	78	94	4.2	9.9	35	40	37
Winsome 2	79	90	3.8	7.5	33	33	29
Pearl	79	91	10.0	5.5	44	45	44
Lottie 8	85	100	10.3	8.7	36	36	38
Fanny 2	95	118	18.2	6.4	38	37	41

As might be expected, urea being freely diffusible, the urea contents of blood and fat-free milk-serum are identical within the limits of experimental error, and this relation is unaffected by the rate of milk secretion. It may be noted that the largest difference between blood and milk-serum urea contents occurred

in Period 1 of the experiment on Peach 3, when the rate of secretion was very small; the smallest, indeed, of the series.

No significant differences have been observed between the urea contents of blood samples from the mammary vein and from the internal iliac artery. These have been examined in a different group of cows (Table II).

Table II. *Urea content of bovine arterial and mammary venous blood*
(mg./100 ml.).

Name of cow	Peggy	Flora 11	Flora 18	Cora 1	"Phosphor"	"Phosphor"
Arterial	19	18	21	45	27	29
Mammary venous	17	19	22	43	25	31

The experiments described in this note show that urea is not concentrated by the mammary gland as it is by the kidney. Further, they suggest that the blood-urea of the cow can be determined as well on the fat-free serum of milk as on the blood itself. If, as seems probable, the same conclusions apply to all mammals, then a simple alternative method of determining blood-urea is available during lactation, obviating the need for withdrawal of blood samples.

As continuation of this work I had planned to investigate the elimination rate of other milk constituents and, at the same time, to determine their concentration in mammary venous and iliac arterial bloods, thus combining the two types of experiment recorded above. By comparing the absorption of calcium and potassium, for example, from the blood flowing through the mammary gland with the amount of their secretion in the milk-serum, I hoped to calculate the volume of blood which must pass through the udder to produce a given volume of milk. This problem has so far received attention only, as in the work of Lintzel [1934], in experiments dealing with the alleged milk precursors absorbed from the blood, which obviously undergo complex metabolic change in the gland and may appear in the milk in a different phase, *e.g.* the fat. In addition, I anticipated obtaining information of the rate of blood flow through the udder and of its relation to the rate of milk secretion, a major problem of lactation on which no information is at present available.

SUMMARY.

In the cow, whole blood and the fat-free serum of milk have the same urea contents irrespective of the rate of milk secretion. Mammary venous blood is not significantly different from arterial blood in this respect.

During lactation milk may be used as an alternative to blood for determination of blood-urea.

A method is suggested for estimating the volume of blood which participates in the formation of a given volume of milk and for determining the approximate rate of blood flow through the mammary gland.

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