

Factors Affecting the Utilization of Food by Dairy Cows

3. The Specific Gravity of Digesta from the Reticulo-Rumen of Cows

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(Received 20 June 1950)

The specific gravity of individual particles of digesta may be of importance in determining the length of time such particles remain in the reticulo-rumen (Schalk & Amadon, 1928; Magee, 1932). This paper is an account of a short series of determinations of the specific gravity of such digesta made during a wider investigation on the importance of the rate of passage of foods as one of the factors affecting their digestibility and utilization (Balch, 1950).

METHODS

Samples of digesta were obtained from two cows with large rumen fistulas. Throughout the experiment the cows were being fed an ample all-hay diet. The rumen fistulas were closed by means of the cannula and bung described by Balch & Johnson (1948).

After removal from the cow 2-4 hr. after feeding the samples of digesta were strained through cotton gauze stretched across a filter funnel of wide bore. It was found that the amount of liquid that drained from the digesta from the ventral sac was much greater than that draining from the digesta from the dorsal sac of the rumen.

The specific gravity of representative samples of digesta. The specific gravity of small samples of digesta from which free water had drained was determined by means of a specific-gravity bottle using kerosene (tractor vaporizing oil) of known specific gravity as the liquid to be displaced.

The separation of particles of different specific gravity in digesta. Four mixtures of kerosene and bromobenzene were prepared having specific gravities varying from 0.977 to 1.601. These values were first checked by hydrometer and varied slightly in the course of the experiments. About 200 ml. of each mixture were prepared. They were placed in 250 ml. measuring cylinders (internal diameter 3.7 cm.) and after about 10 g. digesta had been gradually added the cylinder was vigorously shaken and the contents stirred with a wire plunger. Several minutes were then allowed for separation of the particles, this process being aided by very gentle stirring. After separation, floating particles were skimmed off and those remaining were separated by filtration, both fractions being subsequently dried and weighed. By this means it was possible to calculate the percentage, by dry weight, of the digesta having a specific gravity greater or less than that of each of the four mixtures.

RESULTS

Replicated determinations showed that the percentage of digesta floating on any of the liquids could be obtained with an accuracy of $\pm 5\%$. In view of the varied nature of hay and the small samples used for the measurement this was considered satisfactory.

The results, summarized in Table 1, show that the agreement between values for the mean specific gravity of the digesta and for the different fractions determined by the two different methods was good. Thus it was found that in sample 1 from the

Table 1. *Specific gravity of digesta from the reticulo-rumen*

Position in reticulo-rumen	Cow	Sample no.	Percentage of the dry weight of digesta with specific gravity greater than						Mean specific gravity of digesta	
			0.977	1.015	1.019	1.022	1.037	1.055		1.601
Dorsal sac	W	1	99	—	—	75	58	0	—	1.039
		2	98	—	—	98	46	0	—	—
		3	—	70, 90, 97	—	—	83, 83, 71	—	—	—
		4	97	89, 96	—	90, 97, 100	—	46	—	—
	Y	1	100	—	—	96	66	0	—	—
		2	100, 100	—	—	—	—	63	0	—
Ventral sac	W	1	100	—	—	100	78	0	—	1.038
		2	100	—	100	—	56	0	—	—
		3	—	—	—	—	88, 91, 95	—	—	—
		4	—	97, 94, 100	—	99, 98, 92	—	—	—	—
	Y	1	100	—	100	—	100	0	—	—
		2	100, 100	—	—	—	—	0, 0	—	—

dorsal sac of cow W, 22% of the digesta had a specific gravity in the range 1.022–1.037, and 58% in the range 1.037–1.055, whereas the overall value for the sample was 1.039. The method does not show whether the 22% lay nearer to 1.022 than to 1.037.

The specific gravity of the digesta in the dorsal sac of the rumen covered a slightly greater range than that of digesta in the ventral sac. Particles from both regions with negligible exception sank in the liquid of specific gravity 0.977 but, whereas those from the dorsal sac usually tended to float in liquids of specific gravity less than 1.022, those from the ventral sac did not. Separation was only once complete in the liquid of specific gravity 1.037 and it may be presumed that the majority of digesta had a specific gravity slightly above 1.037 as was confirmed by the two mean determinations of 1.039 and 1.038 in Table 1. The slight differences between digesta from the two parts of the reticulo-rumen suggested that those in the ventral sac were slightly less heterogeneous and perhaps slightly denser than those in the dorsal sac.

Determination by hydrometer of the specific gravity of the liquid remaining after the larger particles of digesta had been strained off gave a mean of 1.012.

DISCUSSION

When cows eat diets containing roughage such as hay, the digesta in the reticulo-rumen roughly separate into two layers, an upper layer of dry fibrous material and a lower layer of more fluid consistency. Schalk & Amadon (1928) drew attention to these layers, and Balch (1950) showed that the mean dry-matter content in the dorsal and ventral regions may vary by as much as 10%, but varies by much less when all the hay in the diet is ground. With such hay the proportion of dry matter in the contents of the ventral sac was often double that with diets of unground hay.

Schalk & Amadon considered that the low specific gravity of hay and the contractions of the reticulo-rumen resulted in the accumulation of the majority of the fibrous digesta in the dorsal sac of the rumen. These workers claimed that as the particles of digesta became saturated and partly decomposed the specific gravity of the particles increased and they tended to sink into the ventral regions of the reticulo-rumen, thus increasing their chances of passage to the omasum and abomasum.

No marked difference between the specific gravity of particles of digesta in the dorsal and ventral sacs of the rumen was demonstrated. It is therefore likely that the position of the mass of fibrous material found in the dorsal sac during the feeding of certain diets is maintained largely by the contractions of the reticulo-rumen. Since, however, this mass of digesta apparently floats, although few single particles lighter than rumen liquid were found, it is likely that a mass has a lower specific gravity than its individual particles. This could result from the entrapping of bubbles of the gases produced during microbial fermentation among the fibres of the digesta. The maintenance of the mass in the dorsal sac must be largely effected by the pressure of digesta against the walls of the sac so that even when no contraction is taking place the mass does not readily drop back into the ventral sac. In this concept the main factor determining the time needed for the release of a given particle of digesta from the general mass would be the time required for rotation of the mass so that the particle at length reached the lower rumen and was released from its supporting bubbles and surrounding digesta by the eroding action of the rumen liquids.

In studies of digestion in the reticulo-rumen, indigestible particles resembling particles of digesta in all physical properties are sometimes required. Such particles should have a specific gravity in the region of 1.04.

SUMMARY

1. Methods are described for determining the overall specific gravity and the range of specific gravity in samples of the digesta from the reticulo-rumen.
2. When cows were fed on hay only there was little difference between the specific gravity of digesta from the dorsal and ventral sacs of the rumen, but digesta from the ventral sac were more homogeneous and possibly slightly denser.
3. The majority of the digesta examined had a specific gravity of between 1.022 and 1.055 with a mean value of approximately 1.038–1.039.
4. The implications of these findings are discussed.

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Further Studies of the Conversion of β -Carotene to Vitamin A in the Intestine*

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(Received 23 June 1950)

We have already reported in full some of our findings on the formation of vitamin A in the intestine (Thompson, Ganguly & Kon, 1949). The present paper deals with further evidence, in particular that derived from observations on the appearance of vitamin A in the portal and systemic circulations of pigs and in the mesenteric lymph of pigs and rats.

EXPERIMENTAL

The methods and materials used were in the main as described in the earlier paper (Thompson, Ganguly & Kon, 1949) with the following additions or modifications.

Colloidal carotene and vitamin A

These were prepared by the method of With (1939) and, except for the experiment described on p. 406, were mixed for feeding with the fat-free vitamin A-deficient diet (Thompson, Ganguly & Kon, 1949).

Portal cannula

One of London's (1935) cannulas was established in the portal vein of pigs, at first fairly close to the liver but later so as to tap only the mesenteric stream (Copher & Dick, 1928). For ease of insertion the cannula was modified by making it in two parts, the stainless steel circular knurled head being threaded on to the stainless steel shaft. In this way the size of the stab wound could be reduced to that of the diameter of the tube. In position, the cannula was protected by a Perspex dome, 3 in. in diameter and 1 in. high, with a central hole, 1 in. in diameter, which allowed the flange restricted movement (see Pl. 1).

Simultaneously with the withdrawal of samples of portal blood, samples of systemic blood were obtained from an ear vein.

* Read in part before the Biochemical Society (Thompson, Braude, Cowie, Ganguly & Kon, 1949; Coates, Thompson & Kon, 1950).