Distension of the reticulum decreased food but not water intake by sheep[1]

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Summary. The intakes of pelleted alfalfa by hungry sheep were depressed in a rectilinear manner in relation to the amount of water (0–800 ml) added to a balloon in the reticulum ($p < 0.005$). Since the consumption of water by thirsty sheep was not altered by these treatments, the reduction in food intake produced by distending the reticulum was a specific response. The intakes of food were not significantly affected by distending the rumen with 800 ml water in a balloon so it is possible that the amount of fill in the reticulum rather than in the rumen may be important in signalling satiety in sheep.

Methods of increasing the intakes of roughage diets by ruminants must be sought to ensure their continued high outputs of agricultural commodities in the event of shortages of grain in world markets. The intake of a long hay diet by ruminants is thought to be limited by distension of the reticulo-rumen[2–6]. The rumen rather than the reticulum has been considered as the site of the satiety signals. Distension of the rumen of cows with 45 l water in balloons depressed their ad libitum intakes by 2400 g/day[7] but the addition of 1290 ml water to a balloon in the rumen of the goat had no effect on intake in 1 meal[8]. The possibility that distension of the reticulum rather than the rumen signalled satiety was investigated in the study now reported because the density of tension receptors in smooth muscle was found to be much greater in the reticulum and the cranial sac than in the rumen[9,10]. Since food of high specific gravity was observed to drop mainly into the cranial sac and reticulum of cattle during a meal[11] it is possible that distension of these organs can signal satiety.

Materials and methods. 5 crossbred wethers weighing 73.8 ± 6.6 kg were held in metabolism cages in a room that was illuminated continuously. Water and pelleted alfalfa were available ad libitum except that prior to the experimental sessions the sheep were deprived of food or water to generate hunger or thirst. Just before the end of the deprivation period a polyethylene tube with a collapsed ballon tied on the end was directed through the rumen cannula and into the reticulum of the sheep. The placement of the balloon was verified by recording biphasic and triphasic pressure waves from the reticulum in association with the normal mixing and regurgitation of digesta respectively. Immediately prior to feeding or drinking, the reticulum of each sheep was either not distended (control) or distended with either 200, 400, 600 or 800 ml water in the balloon. A 5 × 5 Latin square design was used in both instances. The effect on intake of distending the rumen was tested in a similar manner to that described above except that a crossover design was used to compare the influence of the balloon containing 800 ml water to that of the balloon alone. 5 sheep were used and the experiment was replicated twice.

Results and discussion. The results reported in table 1 indicated that distending the reticulum of sheep deprived of water but not food for 6.8 h did not suppress water intake. Subsequent to a food deprivation period of 5.6 h, the intakes of alfalfa during 10, 20 and 30 min of reticular distension were measured (table 2). The significant depressions in intakes were rectilinearly related to the degree of distension and after 30 min of feeding, intakes were suppressed by 0.211 g/ml of distension. However the intakes during 20 min of feeding after the balloons were removed from the animals bore a positive relationship to the previous degree of distension ($p < 0.005$; table 2). The regression coefficient of + 0.206 g/ml meant that the previous deficits in consumption were almost completely recouped. There was no adverse or long lasting influence of reticular distension on the sheep as is indicated by the insignificant effects of reticular distension on intakes for the duration of the experiment (50 min). The upper limit of 800 ml distension in the treatments was not excessive considering the volume of 500 g alfalfa pellets that the sheep consumed in 50 min of feeding, exclusive of saliva and other fluids entering the stomach during the meal, was 670 ml. If all of the food that was consumed stayed in the reticulum during the meals, the volume of the meal could be at least in part a signal of satiety.

Table 1. Effect of distending the reticulum on water intake by sheep after being deprived of water but not food for 6.8 h

Time after deprivation (min)	Analysis of variance of 5 × 5 Latin square Mean water intakes (ml)					F*	RSD (ml)
	Distension of balloons (ml)						
	0	200	400	600	800		
0–10	1596	1540	1756	1078	1454	NS	396
0–20	1668	1574	1798	1274	1474	NS	359
	Drinking after balloons were removed						
20–40	8	36	28	52	188	NS	151
	Total intakes for the experiment						
0–40	1676	1610	1826	1326	1662	NS	276

* Significance level; NS, not significant.

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Table 2. Effect of distending the reticulum on food intake by sheep after being deprived of their normal diet for 5.6 h

Time after deprivation (min)	Analyses of variance of 5×5 Latin square Mean food intakes (g) Distension (ml)					F+	RSD (g)	Regression analyses Intercept (g)	Slope (g/ml)	F+	r
	0	200	400	600	800						
0–10	223[a]	191[a]	163[ab]	104[b]	116[b]	****	37	220	−0.151	****	−0.55
0–20	305[a]	278[ab]	208[ab]	157[b]	183[ab]	**	64	299	−0.182	****	−0.48
0–30	371[a]	329[ab]	220[ab]	177[b]	236[ab]	*	83	351	−0.211	****	−0.48
Rebound feeding with source of distension removed											
30–40	102[bc]	89[c]	147[ab]	178[a]	166[a]	***	34	92	+0.109	****	+0.60
30–50	133[b]	143[b]	254[ab]	303[a]	259[ab]	***	66	136	+0.206	****	+0.63
Total intakes for the experiment											
0–50	504	471	474	480	494	NS	72	–	–	NS	–

+ Significance levels; NS, not significant; * $p < 0.05$; ** $p < 0.025$; *** $p < 0.01$; **** $p < 0.005$. Means with different superscripts differ significantly by a sequential variant of the Q method.

Distending the rumen did not depress the intake of food according to Student's paired t-test ($p > 0.05$). The quantities consumed with and without distension were 217 and 231 g after 10 min of feeding, 362 and 360 after 20 min and 392 and 417 after 30 min respectively. The intakes of food for 20 min after the balloons were removed from the animals were also not significantly different, the values being 136 and 105 g respectively. The depression of food intake by ruminal distension in cattle[7] but not in goats[8] and sheep may be due to the type or form of the diet as the cattle were given hay, the goats a concentrate diet and the sheep in this study pelleted alfalfa. However the suppression of intake by 0.211 g/ml distension of the reticulum is remarkable, exceeding considerably even the suppression of 0.05 g/ml distension of the rumen in cattle[7]. The greater suppression of intake seen when the reticulum was distended may have been due to its relatively small size and to its greater innervation with tension receptors[9,10] compared to the rumen. Reticular distension suppressed food but not water intake so the effect was a specific response. The receptors involved may signal satiety but the physiological significance of the results will not be appreciated dimensions of the reticulum are measured in association with the intake of food.

Simultaneous monitoring by optical techniques of respiratory chain and intracellular pH in toad ventricle strip[1]

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Summary. Intracellular pH and oxidative metabolism can be measured in toad ventricle strips simultaneously by the use of the pH indicator dye, neutral red, and a rapid scanning spectrophotometer. The effects of hypoxia and acidification on mechanical function are approximately additive. The decrease in tension due to slight acidification is probably through an effect on the portion of the twitch tension supported by anaerobic metabolism.

During hypoxia and ischemia of cardiac tissue there is a failure of the oxidative production of energy and a decrease in mechanical function. In these pathological states there is also a shift to a more acidic intracellular pH, especially in ischemia where the acid metabolites of anaerobic metabolism are not washed out. Since many of the enzymes involved in energy production are pH sensitive, such as phosphofructokinase[4] and the nicotinamide adenine dinucleotide linked substrate shuttle systems[5], it has been suggested that the fall in pH is responsible for the failure of anaerobic metabolism to supply sufficient energy to maintain mechanical function[6–8]. In this regard, it would be of interest to reliably measure intracellular pH (pH_i), mechanical function, and oxidative energy metabolism non-invasively during the development and recovery from hypoxia.

Recently, the pH sensitive indicator dye, neutral red has been applied to amphibian skeletal muscle enabling the comparison of optically detected metabolic and pH changes[9,10]. We have now been able to apply this technique to amphibian cardiac muscle[11]. The toad ventricle

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