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Turn-over of Rumen Fluid and Effect of Sampling Time on the Dynamic Pattern of Na,K, Ca and Mg Dumen Fluid and Serum

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THE RUMEN fluid volume of four mature Rahmany rams fed on clover hay was determined using lithium sulphate as a marker. A remarkable changes in the concentration pattern of Na, K, Ca and Mg in rumen fluid were observed after feeding. K, Ca and Mg increased after feeding, whereas Na was decreased. On the other hand no such changes were observed in serum.

It has been shown that molases ash, phosphorus, iron, sodium, potassium, calcium, magnesium, cholorine and sulphur stimulate and involved in cellulose digestion and in rumen bacterial physiology (Burroughs *et al.*, 1951). Addition of alfalfa ash to a low quality roughage improved the crude fiber and dry matter digestibilities (Chappel *et al.*, 1952 and 1955).

Lampila (1964) has shown that location and sampling times have a significant effect on the concentration of dissolved minerals in the rumen fluid. The concentration of any metabolite in the rumen is a function of the rumen fluid volume and total quantity of that metabolite. Mongan and Wright (1968) have used lithium sulphate at a low concentration to measure the rumen fluid volumes in sheep and cattle.

The aim of this work is to determine the rumen fluid volume, its turnover and the effect of sampling time after feeding of clover hay on dynamic patterns of Na, K, Ca and Mg in rumen fluid and serum of Rahmany dams.

Material and Methods

Animals

Four rumen fistulated fat tailed Rahmany rams one year old, maintained on clover hay (1.5 kg/day) were used in this study. Experimental period was about one month. During the last three days, rumen fluid samples were taken with considerable care to sample each time from the same location in the rumen.

Dynamic patterns of minerals, blood samples from jugular vien were obtained eight times at hourly intervals starting just before the morning feeding. Rumen fluid samples were taken in the same times in two successive days. After straining the rumen fluid through four layers of cheese close, an aliquot 10 ml from each sample was centrifuged for 30 min (10,000 rpm). Two ml of the supernatant fluid was diluted with 0.1 N HCl.

Rumen fluid volume

At the last day of the experiment the rumen fluid volume was determined using lithium sulphate as a marker (Mongan and Wright, 1968). The volume was calculated using the following equation :

$$\text{Rumen fluid volume} = \frac{Q - (C.V.)}{C - Co}$$

Where Q = quantity of the marker (Li +) added to the rumen.
V = volume of solution added to the rumen.
Co = Concentration of marker before addition.
C = estimated concetration of marker at the time of addition as determined by extrapolation on a logerithmic scale.

Determination of Li, Na, K, Ca and Mg

A pye Unicam Atomic Absorption Spectrophotometer Sp 1900 was used in this work. Lithium was only detemined in rumen fliud diluted five times with 0.1N HCl. However, Na, K, Ca and Mg were determined in both rumen fluid and serum diluted 20 times with0.1 HCl. Na, K, and Li were determined using the emmision technique while Ca and Mg were determind using the absorption one. The conditions for the analysis were identical to those described by the Pye Unican methods sheets.

Results and Discussion

Rumen fluid volume :

It could be noticed from Fig. 1 that the concentration of the rumen fluid volumes was 5.95 to 0.354 litres as illustrated in Table 1.

In this connection Mangan and Wright (1968) found that rumen fluid volumes of sheep ranging from 4.63-12.87 litres. The decided that Li do not diffuse through the rumen epithilium. Ferreira *et al.* (1966 b) have shown from measurements of the electrical potential between the rumen contents and the blood of anaesthetised sheep that Li + behaves differently from Na+ and K +. In experiments with isolated rumen epitheilum, Ferraira, *et al.* (1966 a) found that Li+ would not replace Na + in the active transport system of this tissue.

It could be noticed, also from Table 1, that the average turnover time ($T_{\pm}$), or cycle time, of rumen fluid was about 6.731 ± 0.587 hr and the corresponding turnover rate constant (K/hr) was 0.152 ± 0.013/hr *i.e.* 15.2% or 890 ± 31.0 ml, of rumen fluid is renewable every hour. This also means that all of the rumen fluid content is renewable 3.645 ± 0.307 times every day. These findings are in good agreement with Corbett, *et al.* (1959) who found, by using polythylene glycol in cattle that K/hr and turnover/day were 0.156 and 3.7, respectively. Dynamic patterns of Na, K, Ca and Mg.

Soddium, K, Ca and Mg of clover hay content (on DM basis) was 1.30, 1.64, 1.22 and 1.01%, respectively.

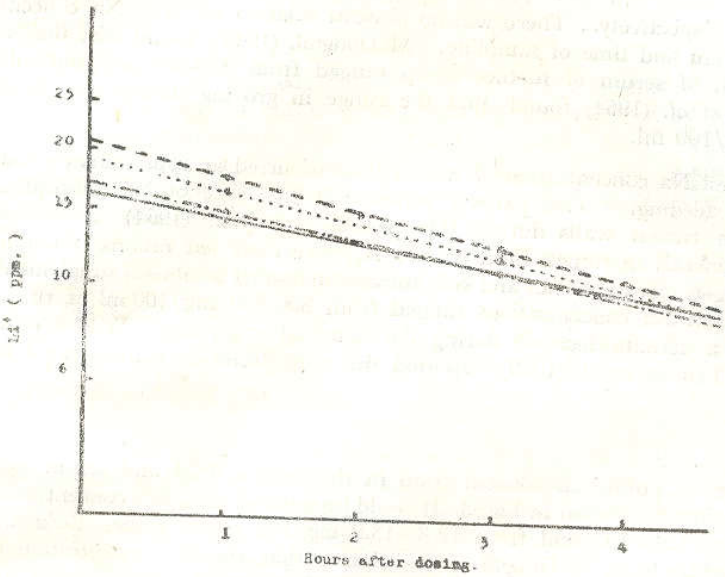

Fig. 1. Loss of lithium from the rumen fluid of four Rahmany rams.

TABLE 1. Rumen fluid volume and its turnover of Rahmany rams maintained on clover hay.

Ram No. Ram	R F V(l) (litre)	T(2) t (hr)	K/hr(3)	Flowrate ml/hr	T-/day t
1	6.679	8.167	0.122	818.	2.938
2	5.130	5.772	0.173	889.	4.158
3	5.609	5.772	0.173	971.	4.158
4	6.383	7.215	0.138	886.	3.326
AV.±	5.950±	6.731±	0.152±	890.9±	3.645±
S.E.	0.354	0.587	0.013	31.0	0.307

(1) AFV = Rumen fluid volume.
(2) Tt = Turnover time.
(3) K/hr = Turnover rate constant.

Sodium

Changes ofsodium concentration in the rumen fluid and serum as a function of time are shown in Fig 2. It could be noticed that Na concentrations ranging from 212-232 and from 308-312 mg/100 ml of rumen fluid

and serum, respectively. There was no obvious relation between Na concentration of serum and time of sampling. McDougail, (1948), found that the Na concentration of serum of mature sheep ranged from 350-380 mg/100 ml ; while Telle *et al.* (1964) found that the runge in groving lambs was from 354-405 mg/100 ml.

The lowest Na concentration of rumen fluid occurred at approximately four hours after feeding. This pattern reflect the high rate of Na absorption through the rumen walls during this period. Lampila, (1964) determined dissolved minerals in rumen fluid of two Ayrshire cows fed rations consisting of hay, mangels or wheat bran and concentrates including a mineral supplement. He found that Na concentrations ranged from 300-390 mg/100 ml of rumen fluid, with a definite decrease during the hours after feeding. Wilson *et al.* (1967) and Fenner *et al.* (1969), reported the same trend as demonstrated by our study.

Potassium

Changes of potassium concentration in the rumen fluid and serum as a function of time are shown in Fig. 3. It could be noticed that, this concentration ranging from 151 - 197 and from 12.8 --13.9 mg/100 ml of rumen fluid and serum, respectively. McDougal (1948) found that the K concentration of serum ranging from 30-40 mg/100 ml, while Telle *et al.* (1964) found this range was from 9.79-16.4 mg/100 ml.

It could be noticed from Fig.3, that there was an increasing trend of K concentration in rumen fluid after feeding the maximum concentration of K was obtained at the second hour after feeding.

Calcium

Changes of Ca concentration in the rumen fluid and serum as a function of time are shown in Fig. 4. It could be noticed that this concentration ranging from 14.4-34.0 and from 9.5-10 mg/100 ml of rumen fluid and serum, respectively. NcDougal (1948) and Telle *et al.* (1964) found that Ca concentration in serum ranged from 10-11 and from 13.4-15.0 mg/100 ml, respectively.

It could be noticed from Fig. 4, that Ca concentration in rumen fluid increased after feeding and the maximum increase was near the fourth hour, followed by gradual decrease. Garton (1951) reported that Ca levels ranged from 27-41 mg/100 ml rumen fluid of sheep. Lampila (1964) and Wilson *et al.* (1967), found that Ca level increased in the rumen fluid during the first hour after feeding and decreased during the last hour before feeding.

Magnesium

Changes of magnesium concentration in the rumen fluid and serum as a function of time are showing in Fig. 5. It could be noticed that this concentration ranging from 6.5-15.0 and from 4.0.4.30 mg/100 ml of rumen fluid and serum, respectively. McDougall (1948) and Telle *et al.* (1964)found

that mg concentration in serum renging from 2-6 and from 1.1-1.47/100 ml respectively.

It could be noticed from Fig. 5. that mg concentration in rumen fluid reached the peak at one hour after feeding and followed by graduai decrease. In this connection Garton (1951), found that Mg concentration in rumen fluid of sheep ranged from 7-13 mg/100 ml. Lampila (1964) and Wilson *et al.* (1967) reported that Mg concentration in rumen fluid of cows ranged from 6.6-24 and 3.5-10 mg/100 ml.

Ferreira *et al.* (1966 b), reported that the contents of the reiculo rumen in the sheep were electrically negative by about mV relative to the blood. It is also well known that sodium moves from rumen to blood stream by "active transport" process, on the other hand, potassium behaves as a passively diffusing ions.

It could be concluded from our study that using lithium sulphate, for rumen fluid volume determination, has the analytical advantage that it is rapidly and easily estimated by atomic absorption spectrophotometer or flame photometer. Obvious changes in the concentration pattern of Na, K Ca and Mg in the rumen fluid were observed after feeding. The proportion of K, Ca and Mg increased after feeding whereas the Na decreased. On the other hand, no obvious change in the dynamic pattern of these minerals found in serum.

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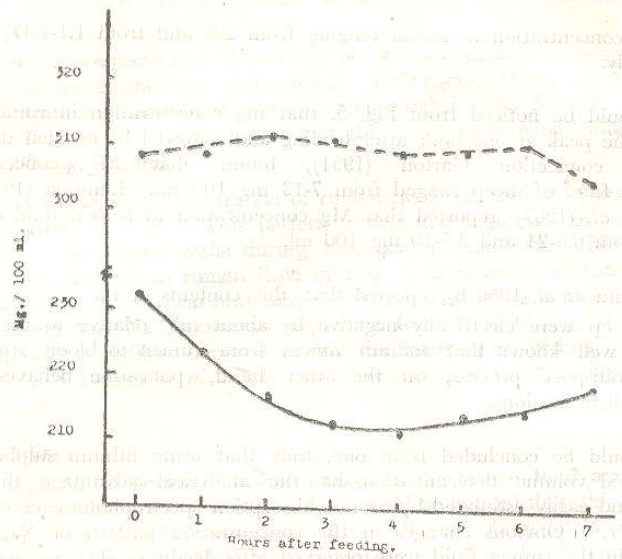

Fig. 2. Concentration of Na in rumen fluid (——) and serum (·····)of Rahmany rams as affected by sampling time after feeding.

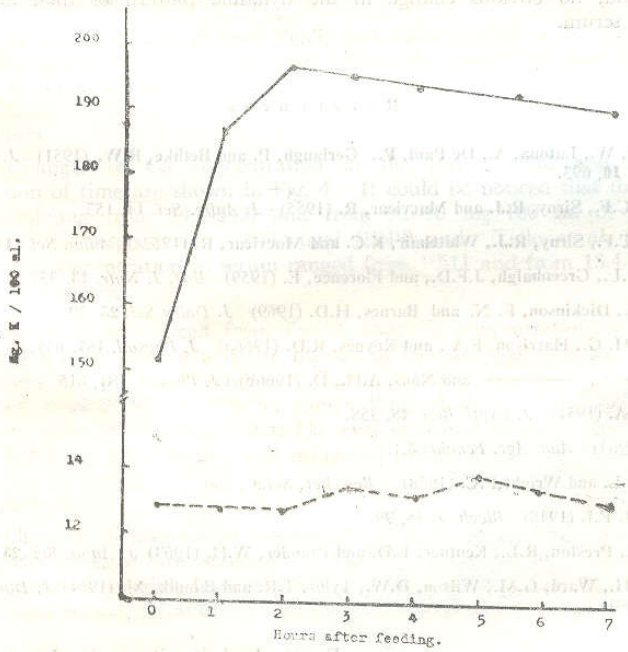

Fig. 3. Concentration of K in rumen fluid (——) and serum (·····) of Rahmany rams as affected by sampling time after feeding.

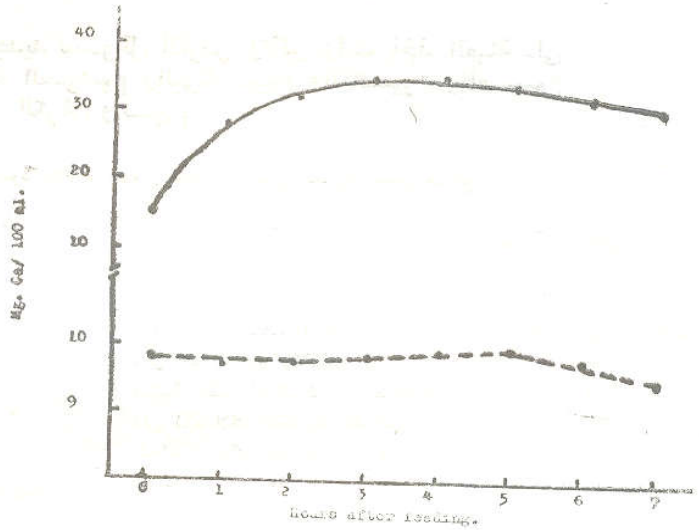

Fig. 4. Concentration of Ca in rumen fluid (——) and serum (·····) of Rahmany rams as affected by sampling time after feeding.

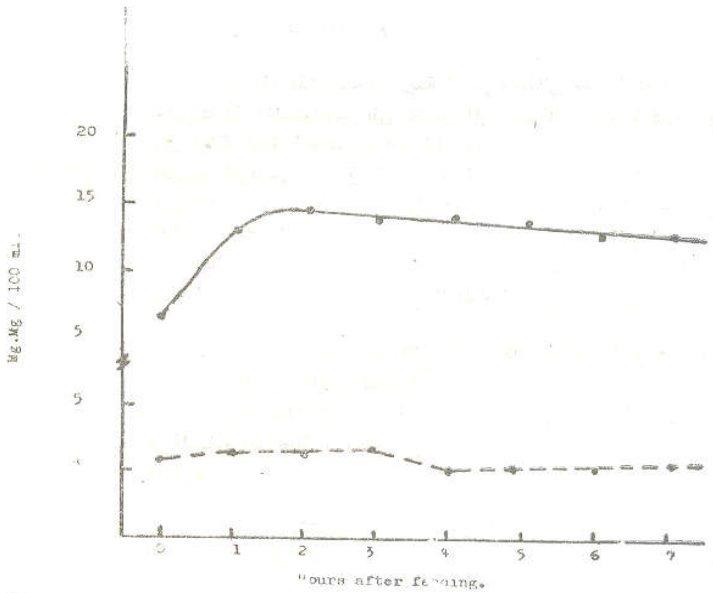

Fig. 5. Concentration of Mg in rumen fluid (——) and serum (·····) of Rahmany rams as affected by sampling time after feeding.

معدل تجديد سوائل الكرش وتأثير وقت أخذ العينة على ديناميكية الصوديوم والبوتاسيوم والكالسيوم والمغنسيوم فى سوائل الكرش والسيرم

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أظهرت الدراسات السابقة أن اضافة رماد المولاس الى بعض العناصرالمعدنية مثل الكالسيوم والصوديوم والبوتاسيوم أو المغنسيوم أو الكبريت ينشط هضم السليولوز . كذلك وجد أن اضافة رماد البرسيم الحجازى الى الأعلاف الخشنة قد أدى الى تحسين هضم الألياف الخام والمادة الجافة . وكما هو معروف فان تركيز أى مكون غذائى فى سوائل الكرش هو داله لحجم هذه السوائل وكمية هذا المكون الغذائى .

والهدف من هذا البحث هو تقدير حجم سوائل الكرش ومعدل تجديدها وتأثير وقت أخذ العينة من الكرش (بعد تغذية الأغنام الرحمانى على دريس البرسيم) على ديناميكية الصوديوم والبوتاسيوم والكالسيوم والمغنسيوم فى سوائل الكرش والسيرم .

استخدم فى هذا البحث أربعة كباش رحمانى مجهزة بفستيولات فى الكرش وغذيت هذه الحيوانات على دريس البرسيم لمدة شهر (٥ر١ كجم/يوم) . وفى نهاية المدة أخذت عينات قبل وبعد التغذية من الكرش وكذلك من الوريد الوداجى . وفى آخر يوم قدر حجم سوائل الكرش وذلك بحقن كبريتات الليثيوم فى الكرش واستخدامه كمرقم وقد استخدم جهاز قياس الطيف للامتصاص الذرى وذلك لتقدير الصوديوم والبوتاسيوم والمغنسيوم فى سوائل الكرش والسيرم وكذلك لتقدير الليثيوم فى سوائل الكرش . وقد أمكن الحصول على النتائج التالية :

وجد أن متوسط حجم سوائل الكرش كان ٩٥٠ر٥ ± ٣٥٤ر٠ لترا . ووجد أيضا أن الوقت اللازم لتجديد سوائل الكرش ٦ر٧٣١ ± ٥٨٧ر٠ ساعة ، وبالتالى فان معدل تجديد هذه السوائل هو ٢ر١٥٪ أو ٨٩٠ ٣١ سم٣ فى الساعة الواحدة . وهذا أيضا يعنى أن سوائل الكرش تتجدد فى اليوم الواحد ٣ر٦٤٥ ± ٣٠٧ر٠ مرة .

وجد أن تركيز الصوديوم فى سوائل الكرش يتراوح مابين ٢١٢ – ٢٣٢مجم / ١٠٠ سم٣ وفى السيرم ما بين ٣٠٨ – ٣٢١ مجم / ١٠٠ سم٣ ، ولم يكن هناك ارتباط بين تركيز الصوديوم فى السيرم ووقت أخذ العينة . كان أقل تركيز للصوديوم فى الكرش بعد أربع ساعات من التغذية وهذا يعكس المعدل العالى لامتصاص الصوديوم خلال هذه الفترة .

وجد أن تركيز البوتاسيوم فى سوائل الكرش يتراوح ما بين ١٥١ – ١٩٧ مجم / ١٠٠ سم٣ ،ولم يكن هناك ارتباط بين تركيز الصوديوم فى السيرم ووقت أخذ العينة . كان أقل تركيز للصوديوم فى الكرش بعد أربع ساعات من التغذية وهذا بعكس المعدل العالى لامتصاص الصوديوم خلال هذه الفترة

وجد أن تركيز البوتاسيوم فى سوائل الكرش يتراوح ما بين ١٥١ – ١٩٧ مجم / ١٠٠ سم٢ وفى السيرم مابين ١٢ر٨ – ١٣ر٩ مجم / ١٠٠ سم٢ وقد لوحظ اتجاه واضح لزيادة تركيز البوتاسيوم فى الكرش بعد التغذية ، وكانت أقصى زيادة بعد ساعتين .

وجد أن تركيز الكالسيوم فى سوائل الكرش يتراوح ما بين ١٤ر٤ – ٣٤ مجم / ١٠٠ سم٢ وفى السيرم ما بين ٥ر٩ – ١٠ مجم / ١٠٠ سم٢ . وقد لوحظ زيادة تركيز الكالسيوم فى الكرش بعد التغذية وكانت أقصى زيادة بعد حوالى أربع ساعات ثم تلاها انخفاض تدريجى .

وجد أن تركيز المغنسيوم فى سوائل الكرش يتراوح بين ٥ر٦ – ١٥ مجم/ ١٠٠ سم٢ وفى السيرم ما بين ر٤ – ٣ر٤ مجم / ١٠٠ سم٢ . وقد لوحظ أن أعلى تركيز فى الكرش كان بعد ساعة من التغذية ثم تلاه انخفاض تدريجى.

مما سبق يمكن القول أنه يمكن استعمال كبريتات الليثيوم فى تقدير حجم سوائل الكرش بكفاءة وامتياز لسهولة تقديرها . كذلك أمكن ملاحظة تغير واضح بعد التغذية فى ديناميكية الصوديوم والبوتاسيوم والكالسيوم والمغنسيوم فى سوائل الكرش ولم يلاحظ تغير مماثل فى السيرم .