value. This fall was characterised by a series of rapid fluctuations of small amplitude. In some experiments the same cycle of initial rise and subsequent fall was repeated. Significant changes in the colour of the discharge[3] accompany these fluctuations; in the absorption regime when the voltage is increasing, the colour of the discharge is that of hydrogen, during the regime of de-absorption, when the voltage is falling, there is a preponderance of the bluish white colour.

Figs. (1) and (2) show two typical curves giving these fluctuations as function of time. Observations showed that they were present even after a lapse of two hours, which is very remarkable. In Fig. (2) curves A, B, C show the changes after successive additions of hydrogen.

In view of the repetition of cyclic changes in some of the cases, the results cannot be explained in terms of breaking up of an initial

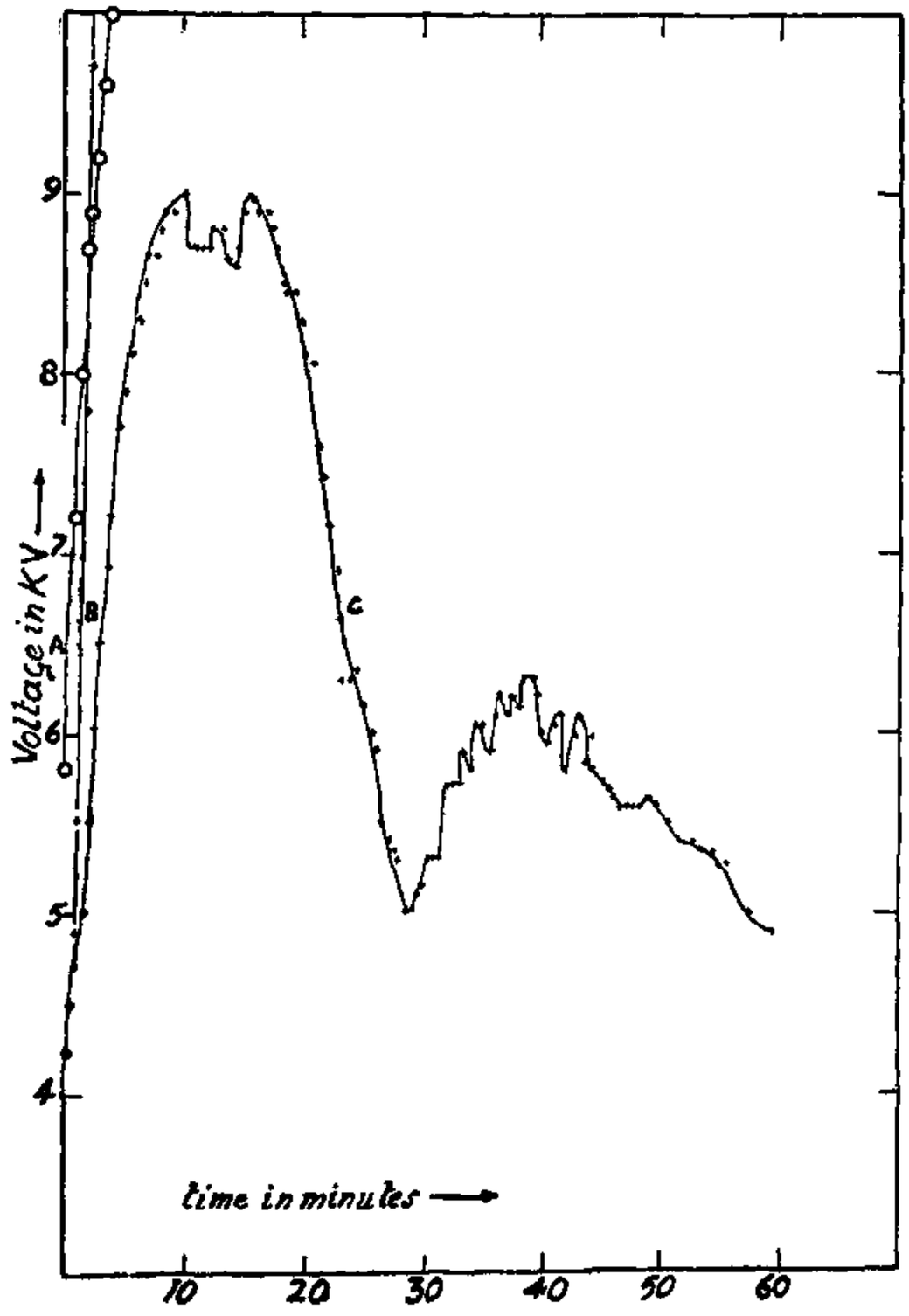

FIG. 2

layer on film by the subsequent effects of the discharge thermal or otherwise. One is led, therefore, to conclude that it is an instance of a periodic reaction (possibly adsorption). The pressures of the gas used in these experiments are of the order $10^{-2} - 10^{-3}$ cm. of mercury. The electrodes are both of aluminium.[4]

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[2] Chiplonkar, V. T., *Proc. Ind. Sci. Congress*, Lahore, 1939, *Phys. Maths. Section*, pp. 25–26.

[3] Delaplasse, R., *Comptes Rendus*, 1936, **202**, 1986.

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The Effect of Muscular Work on Protein Metabolism in the Ruminant

A review of the extensive literature on the effect of muscular work on the metabolism of proteins reveals the existence of two conflicting schools of thought, the one led by Mitchell, holding the view, that normally, and given a diet of sufficient calorigenic intake, increased protein metabolism is "not an inevitable consequence" of muscular work; and the other led by Cathcart, that work results in a definite, though often small, increase in nitrogen output, calling for an augmented protein intake to meet the extra needs.

Nearly all the available evidence on this subject has been obtained with experiments on humans. In the course of an investigation in this laboratory, on the protein requirements of working bullocks, it was noticed that muscular work resulted inevitably in a heightened catabolism of protein, reflected in an increased output of urinary nitrogen.

The experiments were conducted on four experimental animals, Bullocks of the Kangayam breed, well known for their hardiness and capacity for work, of as similar physical conditions as possible, with a live weight of 900–1,000 lbs. The ration fed consisted of Cholam (Sorghum) straw of uniform quality, and cotton seed as concentrate, throughout the long series of experiments. The roughage was

fed *ad lib.* all residues being measured to the nearest gram, the concentrate being adjusted by a preliminary run of nitrogen balance experiments to give a nitrogen equilibrium with the mixed ration fed, as determined by the balance sheet method. The muscular work performed was baling water at the Mhote for a measured number of hours, the number of buckets raised per hour being recorded by a hand-operated tally (45–50 buckets per hour), the lift being 20–25 feet for 40 gallon buckets. The nitrogen metabolism was studied for three 4-day intervals during continuous periods of work for 4, 6 and 8 hours of work.

From the results obtained for the nitrogen balance by determining intake and output in fæces and urine, linear regression equations were determined for the total nitrogen requirement at different levels of work, and their adequacy tested by the usual statistical methods. The results are given below:—

Equation (i) $y = 4{\cdot}79x + 46{\cdot}7$,

where y = Total nitrogen requirement (gms. per diem)

and x = Number of hours of work at the Mhote.

TABLE I

Fitted Regression

(Total nitrogen. Grams/Diem)

Hours of work	Actual value Y	Calculated value y	$(Y - y)$	$(Y - y)^2$
0	46	46·7	− 0·7	0·49
4	67	65·9	1·1	1·21
6	76	75·4	0·6	0·36
8	84	85·0	− 1·0	1·00

TABLE II

Analysis of Variance

(Total nitrogen)

Variation between hours of work due to	Degrees of freedom	Sum of squares	Mean square
Linear regression	1	801	801
Deviation from linear regression	2	4	2
TOTAL ..	3	805	..

A similar equation was fitted for the nitrogen excretion in urine, as determined by analysis, representing the endogenous nitrogen metabolism of the animals. The results are given below:—

Equation (ii) $y = 2{\cdot}56x + 16{\cdot}6$,

where y = Endogenous nitrogen output (gms. per diem)

and x = Number of hours of work at the Mhote.

TABLE III

Fitted Regression

(Endogenous nitrogen. Grams/Diem)

Hours of work	Actual value Y	Calculated value y	$(Y - y)$	$(Y - y)^2$
0	17	16·6	0·4	0·16
4	26	26·8	− 0·8	0·64
6	33	32·0	1·0	1·00
8	37	37·1	− 0·1	0·01

TABLE IV

Analysis of Variance

(Endogenous nitrogen)

Variation between hours of work due to	Degrees of freedom	Sum of squares	Mean square
Linear regression ..	1	229	229
Deviation from linear regression	2	2	1
TOTAL ..	3	231	..

From the results presented above, the following conclusions may be drawn:—

(i) Muscular work is necessarily followed by an increase in the metabolism of protein, as is shown by the need for increased protein in the diet to produce nitrogen equilibrium to meet the increased output of endogenous nitrogen.

(ii) The quantum of dietary protein required to produce nitrogen equilibrium at different levels of work is a linear function of the quantum of work performed.

(iii) The quantum of protein metabolised is also a linear function of the quantum of work performed.

(iv) The increment in dietary protein necessary to restore the animal to nitrogen equilibrium for each increment in work (about 5 grams for an increment in work of 2 hours) is small, and reckoned in terms of the energy liberated by the extra protein metabolised, is entirely inadequate to account for the energy required for the extra work performed. The significance of this small increase in the protein of the diet is, therefore, to be sought in causes other than inadequate calorie intake.

Studies of the nitrogen partition of the urine of the animals during the course of the work, showed that the major part of the increased output of endogenous nitrogen was in the form of Urea + Ammonia, indicating that the deaminisation phase of protein metabolism was the most active. Creatine occurred sporadically but in insignificant amounts. Creatinine excretion was very regular (2·5–3·0 gm. per diem) at all levels from rest to intense work, indicating that during muscular work even at high levels, tissue breakdown did not result in the excretion of creatine or creatinine; the metabolism of these compounds obeyed Folin's law, for rest as well as intense muscular work.

The coefficient of digestibility of the dietary nitrogen remained unchanged at all levels of work.

Full details of this investigation will be published elsewhere shortly.

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Optical Activity of Lac

It is surprising that the optical rotatory power of lac has, so far, not been investigated; this is probably due to the circumstance that lac possesses a deep orange red colour. The colour of lac can be removed either by treatment with decolourising carbons or by bleaching with hypochlorite. Both treatments yield a product sufficiently colourless to enable an accurate determination of its optical activity.

An alcoholic solution of *Kusum* seed lac (10 per cent.) was treated with norit and filtered under suction over a bed of Kieselguhr. The clear but slightly yellow coloured solution which was thus obtained was employed for the determination of its optical activity.

The decolourised solution of lac was fractionated into (1) sclerolac and (2) soft lac by the addition of 10 volumes of ether to a given volume of the alcoholic solution of lac; the optical activity of the two lac fractions was determined in alcoholic solutions.

Analogous experiments were carried out with a sample of *Kusum* lac which was bleached by hypochlorite. Table I gives the results.

Table I

Specific Rotation $[\alpha]_D^{25°C.}$

	Lac decolourised by norit	Lac bleached by hypochlorite
Whole lac	+ 60·71	+ 59·29
Sclerolac fraction	+ 54·83	+ 51·26
Soft lac fraction	+ 63·60	+ 59·96

Further work on the isolation of the optically active constituents of the sclero- and the soft-fractions of lacs is in progress. The optical activity of lac is a property which should be of great value in studying the reactions of lac with ureas, fatty acids and other substances.

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