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On the Determination of Digestibility and Dry Matter Intake of Forage by Grazing Sheep

A.S.* El-Shobokshy, H. El-Shaer,
A.A. Younis and F.Z. Swidan*

Departement of Animal Production, Desert Institute, Mataria, Cairo, and Department of Animal Production, Faculty of Agriculture, Univelsity of Zagazig, Zagazig, Egypt.*

TWENTY FOUR one year old, cross-breq Merino male lambs were used to investigate the practicability of using different methods for estimating digestibility ano dry matter intake of berseem by grazing sheep. Lambs were divided into three experimental groups; one fed individually indoors (I) the second group was allowed to graze after being fitted with faeces collection bags and the faeces were totaly collected (II), the third group as II but the faeces were collected as grap samples (III). All groups were fed on berseem *ad iibitum* for the same number of hours daily. Chromogen ratio, chromogen faecal index and faecal nitrogen index techniques were used to estimate dry matter digestibility and dry matter intake.

Results showed that faecal nitrogen index method was less accurate in predicting digestibility or dry matter intake. Results indicated as well that partly collection of faeces (grap sample) may be used in practice with a reasonable accuracy compared to the total collection of faeces.

Knowledge on forage intake for grazing sheep is necessary for the full assessement of any grazing system, and for estimation of the production potential of the pasture. Different methods were suggested by several workers, among which is the conventional one, *i.e* dividing the yield of a certain area by the number of animals allowed to graze and thus obtaining the average daily consumption of each animal. However, this method has some approximation which may exerted a certain amount of error on the validity of the estimates especially for experimental purposes. Other methods with more accuracy were suggested by other workers. These methods are based on the use of external markers or internal indicators (Kotb and Luckey, 1972). Accuracy required and efffort involved in the determination of forage intake would determine to a great extent the choice of any one method.

The present study was undertaken to compare different methods for the determination of berseem intake by grazing sheep.

Material and Methods

This experiment was carried out at Maryout Experimental Station which is located some 30 km West of Alexandria, and belongs to the Desert Institute, Egypt.

Experimental animals

Twenty four, one year old, crossbred Merino male lambs with an average liveweight of 35.9 kg were divided into three experimental groups, each of 8 lambs.

Experimental design and management

The three experimental groups were randomly alloted to one of the following treatments. Treatment 1 : lambs of this group were kept indoors in individual pens and were fed on berseem (*Trifolium Alexandrinum*) *ad libitum* for a period equal in length to that of the other treatment groups (grazing groups), and considred as control. Treatment 2 : lambs were allowed to graze the berseem for about 7 hr per day and each lamb was fitted with a faeces collection bag. Treatment 3 : as 2, but the collection of faeces was practised periodically, and considered a grap sampling group.

The experiment started on 19 March, 1974 and extended for 4 weeks. Lambs of treatment 1 were used for estimating the digestibility of berseem, the first 10 days of feeding were considered as a preliminary period, followed by another 10-day collection period.

Lambs in groups 2 and 3 were allowed to graze the berseem separately for two grasing periods, the first from 08.00 h to 13.00 h, the second from 16.00 h to 18.00 h. Berseem intake for the grazing groups (2 and 3) was determined by estimating the berseem yield just before grazing as well as the amount refused. It should be emphasized that berseem used for the control group was cut at the same length as that which was left by the grazing sheep in order to ensure similar berseem quality for all groups.

For all groups, fresh water and adequate shelter were available all the time throughout the experimental period.

Sampling and chemical analysis procedures

Daily samples from feed offered and refused were taken for dry matter (DM) determination and chemical analysis. Total faeces yield of lambs in groups 1 and 2 were recorded and samples were used to determine D M content and chemical analysis (20 % of the samples were first kept in deep-freeze prior to analysis). For group 3, however, three samples from each animal were taken daily using grap-sample technique, and a daily composite sample was taken and was treated as metioned above.

Proximate analysis for feed and faeces were determined according to the standard methods outlined by A.O.A.C. (1975).

Chromogen in forage and faeces was determined using the methods reported by Reid *et al.* (1950 and 1952) using potassium chromate instead of sodium chromate.

Statistical procedures

Regression analysis was applied according to Snedecor and Cochran (1970) to test the significance of the different equations obtained. Duncans multiple range test was also applied to rank treatments means.

Results

Chromogen recovery

Average chromogen recovery was 97.19% ranging from 83.1 to 109.9%, either for berseem or faeces extracts using wave length of 406 mu.

Dry matter digestibility (DMD %)

a - Determined by chromogen techniques

Dry matter digestibility coefficients of berseem using the chromogen ratio and chromogen faecal index techniques are summarized in Table 1. Dry matter digestibility of berseem determined by the conventional method (group 1) was found to be 72.68%. However, when the formula of Reid *et al.* (1952) of the chromogen ratio was used, *viz*,

$$D\ M\ D\ \% = 100 - (100\ \frac{\text{Units of chromgen/g of forage D M)}}{\text{Units of chromogen/ g of forage D M }}$$

the predicted values for D M D were 71.9, 78.2 and 77.9% for groups 1, 2 and 3, respectively.

Dry matter digestibility of the berseem determined by the chromogen faecal index methods, however, was 72.81 %.

The equation used for this estimation was,

$Y = 52.76 + 0.312 \pm 0.0052\ X$; where X is units of chromogen in faeces dry matter. For groups 2 and 3 the predicted values using the same equation were respectively 78 and 79.33%.

b - *Determined by faecal nitrogea indcx*

Table 2 represents the concentrations of nitrogen and chromogen in both berseem and faeces. Dry matter digestibility coefficients determined by faecal nitrogen index method for the different experimental groups are presented Table 1. These values were obtained by applying the following equation :

$$\text{Predicted DMD\%} = 100 - (100\ \frac{\text{Units of chromogen/g forage}}{\text{Units of chromogen/g faeces}}\ \frac{\text{DM}}{\text{DM}} \times \frac{\text{Crude protein \% in faeces}}{\text{Crude protein \% in forage}}$$

The predicted values were 76.70, 76.08 and 77.3 % for groups 1, 2 and 3, respectively.

TABLE 1. Digestibility coefficients (%) of berseem dry matter measured by different techniques.

Group	Conventional	Chromogen ratio	Chromogen	Faecal-M index
1	72.68*a	71.88a	72.81a	76.70 b
2	—	78.24 a	78.00 a	76.08 a
3	—	77.90 a	79.33 a	77.32 a

* Means, on the same row, having the same symbol do not differ significantly at 5 % level.

TABLE 2. Concentration of chromogen and nitrogen in dry matter of forage (Berseem) and faces.

	Cohromogen units/g D.M.			Nitrogen %		
	Groups :1	2	3	1	7	3
In forage	179	175	183	2.43	2.29	2.31
In faces :						
Animal No. 1	582	777	923	2.08	2.34	2.28
2	636	776	792	1.95	2.50	2.35
3	629	885	1088	2.07	2.48	2.42
4	637	751	787	1.96	2.41	2.33
5	648	810	700	2.26	2.69	2.20
6	565	773	1088	2.05	2.51	2.40
7	724	754	644	2.08	2.44	2.42
8	718	916	799	2.00	2.54	2.52
Average	642	805	853	2.06	2.49	2.37

Dry matter intake (D M I)

a - Determined by the chromogen techniques. Table 3 summarizes dry matter intake (DMI) of, berseem by lambs in different experimental groups. Average actual DMI was 1590.1, 1789.7 and 1800.3 g/day, for groups 1, 2 and 3, respectively (see materials and methods for the determination of berseem intake). It is apparent that both chromogen techniques gave predicted values of DMI close to the actual ones for groups 1 and 2. For group 3, however, the predicted daily DMI were 1749.7 and 1854.1 g, using the chromogen ratio and chromogen faecal index methods respectively, being 3 percent lower or higher than the actual one. The daily faecal output of the lambs in this group was estimated first using the following formula :

Faecal output =

$$\frac{\text{Av. actual forage intake} \times \text{units of chrom./8 DM of forage}}{\text{Units of chromogen / g D M of faeces} \times \text{recovery \%}}$$

then applying the different equations pointed out in Table 3.

b - Determined by nitrogen faecal index.

Values of average daily DMI by lambs in different experimental groups as predicted by nitrogen faecal index methods, are presented in Table 3. These values were obtained using the following equation: $Y = -340.4 + 216.91 \pm 43.027 \times$; where Y = DMI g/day and $\times$ = daily faecal nitrogen output g. This equation was derived from the relationship between the actual DMI and daily faecal nitrogen output, where $r = 0.93$. The predicted DMI for lambs in group 1 and 2 were again very close to the actual values. For group 3, however, the predicted value was lower by about 13% than the actual one.

Discussion

In the present study, chromogen in berseem and faeces extracts was recovered with an average value of 97.2%. Such value is in close agreement with that reported by Reid *et al.* (1952). However, it is rather higher than that reported by Davis *et al.* (1967) for alfalfa (91 %). The incomplete recovery of chromogen in some experiments could be due to that chromogen may be changed during digestion to give different light absorption values (Harris *et al.*, 1959).

Dry matter digestibility coefficient values predicted by the chromogen techniques in the present study, were higher than the actual value by about 8 %, on average. Many other workers reported a difference of about 9% between the actual and predicted values for DMI (Reid *et al.*, 1952 and Davis *et al.*, 1967). This difference could be, indeed, in part attributable to that grazing animals (groups 2 and 3) are under less stress than those fed indoors (group 1) or that grazing animals tend to select the more nutritionous portions of the pasture. On the other hand, the discrepancy between the actual value of DMD % and the predicted one, using the faecal nitrogen index method agree with values reported elsewhere (Davis *et al.*, 1967 and Engels *et al.*, 1975). In the present study, average faecal nitrogen output (g/100 g of dry matter intake) was 0.56 which is the same value obtained by Lambourne and Reardon (1962).

TABLE 3 Average daily dry matter intake of grazing lambs estimated by different tecniques (g/day).

Group	Conventional (actual)	Chromogen ratio	Chromogen faecal index*	Peacall-N** index
1	1590.1	1558.8	1590.0	1627.3
2	1789.7	1787.9	1799.8	1730.0
3	1800.3	1749.7	1654.1	1562.8

*Y = 782.4 ± 1.257 × 1.34 X ; x = Units of chromogen/g faeces dry matter.
** Y = -340.4 × 216.91 × 43.027 X ; X = Total faecal N in faeces dry matter

The results of dry matter intake of berseem estimated by either chromogen techniques or faecal nitrogen index, indicated that there is always a discrepancy between the actual value and those predicted. This discrepancy will differ in magnitude depending on the method used, though it is apparent that values of chromogen techniques were closer to the actual ones. Such results agree with those reported by Kotb and Luckey (1922).

Indeed, the choice of the proper method to determine the dry matter intake or digestibility of forage by grazing animals still questionable. Where some authors are in favour of the use of nitrogen technique (Engels *et al.*, 1975) others do prefer chromogen techniques (Mc Cullough, 1959). Others, however, believe that the use of both techniques would give better results (Davis *et al.* 1967). It is recognized that faecal nitrogen technique is less laborious compared to other techniques, however, it may has some limitations. The prediction equations derived to determine DMI are influenced by season (Greenhalgh and Corbett, 1960), leaf to stem ratio (Lambourne and Reardon, 1962). In addition, higher nitrogen applications increased the nitrogen content of the forage without a corresponding increase in its digestibility (Gallup and Briggs, 1948). On the other hand, the precision of the chromogen techniques in predicting DMI by grazing animals would depend mainly on the condition of the light during the preparation of extracts, and time lapse between extraction and reading of the optical density (Reid *et al.*, 1952 and Kennedy *et al.*, 1959). Wave length may also has an important effect.

Results of the present study clearly indicate that chromogen techniques, chromogen faecal index in particular, are more reliable in predicting DMI and digestibility, if precautions were put into considerations, *i.e.* light.

With regard to the practicability of grap sample technique, some workers suggested the use of two indicators; one naturally occurring in the forage (to be employed as an index of indigestibility) and another added to the diet of the animal in known quantity (to be used as an index for the total quantity of faeces voided per unit of time). However, in the present study one indicator has only been used (chromogen or nitrogen) and the values obtained for the D.M.D. were not very far from those of the actual ones, (72.68 *vs* 77.3 to 79.3 %). Reid *et al.*, (1952) found that there was a difference of about 9 % between the digestibility of DM of indoor fed and grazing animals. If this difference is used to correct the actual D M D % of the lambs in the grap sample group, DMD % will be 79%, such value is close to the different predicted values.

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تقدير القيمة الهضمية والمادة الجافة المأكولة من العلف الاخضر في أغنام المرعى

أحمد الشبكشى ، حسن الشاعر ، أحمد يونس و فهمى سويدان

قسم الانتاج الحيوانى ، معهد الصحراء ، المطرية ، القاهرة
و قسم الانتاج الحيوانى ، كلية الزراعة ، جامعة الزقازيق ، مصر

استخدم فى هذه التجربة ٢٤ رأس من خليط المرينو الذكور بمتوسط عمر سنة لتقدير كمية المادة الجافة التى تستهلكها أغنام المرعى من البرسيم وكذلك تقدير معامل الهضم له عن طريق استخدام الكروموجين أو النتروجين كدلائل داخلية .

قسمت الحيوانات الى ٣ مجموعات تجريبية غذيت على البرسيم تغذية حرة لعدد ثابت من الساعات الا أن :

المجموعة الأولى : غذيت الحيوانات تغذية فردية داخل الحظائر .

المجموعة الثانية : سمح للحيوانات بالرعى فى الحقل بعد تثبيت أكياس لجمع كل كمية الروث الناتجة لكل حيوان .

المجموعة الثالثة : سمح للحيوانات بالرعى على أن يتم الحصول على ٣ جمعات من الروث يوميا عن طريق المستقيم مباشرة .

دلت النتائج على أن استخدام طريقة دليل النتروجين فى الروث أدت الى نتائج أقل دقة من استخدام طريقة نسبة الكروموجين او دليل الكروموجين فى الروث .

كما دلت النتائج على أن طريقة جمع عينات الروث من المستقيم أقل دقة من الطرق التى يتم فيها الجمع الكلى للروث الناتج وخاصة فى تقدير المادة الجافة المأكولة (١٣٪ أقل من القيمة الفعلية باستخدام دليل النتروجين فى الروث ، ٣٪ أقل أو أعلى باستخدام طريقة الكروموجين) .

وقد أمكن استخراج معادلتين لتقدير كمية المادة الجافة المأكولة بالجرام فى اليوم (ص) .

ص = ٤ر٧٨٢ + ١ر٢٥٧ + ١ر٣٤ س ، س = وحدات الكروموجين فى الجم من المادة الجافة للروث .

ص = ـ٤ر٣٤٠ + ٩ر٢١٦ ± ٠ر٢٧ ٤٣ س ، س = كمية النتروجين فى المادة الجافة للروث .