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STUDY OF LOSSES IN HAYMAKING AS INFLUENCED BY THE STAGE OF CUTTING

By

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SUMMARY

This work was carried out to study nutritional losses during haymaking when using the ground-drying method. Hay under investigation was made from Miskawi berseem in two experimental years. Berseem was harvested at average heights of 30—35 cm. and 60—70 cm. Early cutting resulted in one more cut per year than late cutting. Eighteen digestibility trials were conducted to determine the nutritive value of green berseem and its hay in the first experimental year. Losses were determined by subtracting the different nutrients and starch value of hay per feddan from their original yield in berseem. The following results were obtained :

(1) Losses of the different nutrients and starch value fluctuated in the successive cuts, being higher in the first and last cuts and lower in the intermediate cuts.

(2) The seasonal losses in dry matter, digested crude protein and starch value were 39.11, 43.27 and 59.74%, respectively, in early cut hay. The corresponding losses in late cut hay were 39.64, 51.66 and 60.64%.

(3) Losses in the various nutrients during haymaking from the early cut berseem were generally slightly lower than those from the late cut berseem.

(4) Losses in the mineral matter during haymaking fluctuated within wide limits without any special trend. The losses during the whole season in case of early cut hay were 30.55, 34.21 and 41.97% for P, Ca and Mg, respectively. The corresponding losses in late cut berseem were 37.90, 43.60 and 54.78%.

(5) The main losses were among the various digestible nutrients, especially crude protein and N.F.E.

(6) The higher crude fibre deduction for hay than for green berseem contributed to the reduced starch value of hay. This factor, calculated on the assumption that there were no other losses during drying accounted for 6.84—17.34%. of the losses in starch value of hay.

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INTRODUCTION AND REVIEW OF LITERATURE

Surpluses of green berseem should be made into hay or silage. There are two ways for haymaking: natural drying (field curing) or artificial drying. Losses are greater during natural drying. than in artificial one.

Natural drying of berseem is applied by both the ground and the tripods methods. Weigner (1926), Landis (1932), Nodenberg (1928), Edin (1933) and Kellner (1926) have concluded that drying clover on the gound is the best method of haymaking in favorable weather.

In U.A.R. Ghoneim, (1955) reported that the losses by the ground drying of berseem were as high as 70.23.% of digested crude protein and 69.39% starch value. Badr, (1955) found that the losses in the digested crude protein ranged between 28.24% and 30.78% and from 30.39% to 33.89% in the starch value.

The losses of nutrients during haymaking are mainly due to respiration, fermentation, mechanical damage and weather damage.

According to Hildebrandt, (1926 and 1930), Grasemann, (1937), Watson and Ferguson, (1937), Camburn et al, (1944), Bender, (1947) and Morrison, (1957), losses in field cured hay were 8-30% of dry matter, 10-35% of digestible dry matter, 25-50% of starch equivalent and 25-35% of digestible protein.

Many workers have proved that artificial drying of forages increases the nutritive value of hay over the field curing method, but Hodgson et al, (1948) recorded that the feeding value of field cured hay was higher than tha' of artificially dried hay. They reported digestible protein to be 8.2 and 8.0% and T.D.N. to be 63.3 and 61.8%, respectively, in field cured and artificially dried hay.

Brandsma and Dijkstra, (1956) found that field cured hay in swaths after spreading, and on pyramids showed no significant differences in composition or digestibility of nutrients which could be attributed to the curing procedures.In the pyramid method losses were 20% in dry matter, 31% in digestible crude protein and 41% in starch equivalent. The corresponding values for ground drying were 18,27 and 38%, respectively.

The results of other workers using the tripod-drying method for haymaking differed from those obtained by Brandsma and Dijkstra ; e.g. Watson and Nach, (1960) reported that the tripod method gave better values than the other methods and it increased the yield of the hay by 20-25% in weight. Laila (1962) using the tripod method with first cut berseem, found losses in dry matter of 12.2% compared to 40.67% with the ground-drying method.

Because of the variations of these results, this work was conducted to study carefully losses of haymaking from berseem. The ground-drying method was used in this study.

EXPERIMENTAL AND METHODS

The work was undertaken at the Experimental Farm, Faculty of Agriculture, Cairo University, Giza, U.A.R. Eighteen feddans were cultivated with Miskawi berseem in two successive years (1959-61) as the source of experimental material. The area was divided into two sectors. In the first sector cutting was performed when the average height of plants was 30-35 cm., while it was at 60-70 cm. in the second one. Early cutting of berseem resulted in one more cut than late cutting, there being five and four cuts, respectively.

Hay was made by the ground method as used by Abou-Hussein et al (1963). Eighteen digestibility trials were performed with two full grown rams to determine the nutritive value of berseem and its hay in the first experimental year.

The losses which occurred during haymaking from berseem per feddan were determined by subtracting the yield of the different nutrients (both crude and digested nutrients) in hay from their original yield in the green berseem. Starch value losses were calculated in the same manner.

RESULTS AND DISCUSSION

1.—Losses in crude nutrients.

Details of the losses of the crude nutrients are shown in Table (1). The losses in crude nutrients fluctuated in the different successive cuts, varying within wide limits. The data show that losses in the various crude nutrients tended to be higher with the first and the last cuts, while they seemed to be lower with the intermediate cuts. Generally, minimum losses in the crude nutrients of early cut berseem hay were observed in the third cut, while in late harvested hay, they were found in the second cut.

The losses in the dry matter with field curing of hay observed in this study were comparable to those reported by Hodgson, (1948), Ghoneim, (1955) and Laila (1962), which were 36.1, 41.0, 38.57 and 40.67%, respectively. Lower losses of 20.0, 12.64-18.22 and 18.0% were reported by Camburn et. al, (1944), Badr (1955) and Brandsma and Dijkstra, (1957), respectively.

TABLE 1.—**Average losses of crude nutrients during haymaking over two years**

The Cuts	Dry matter	Crude protein	Ether extract	Crude fibre	N.F.E.	Ash
	%	%	%	%	%	%
Early cut						
1st cut	45.08	50.50	63.55	26.20	47.49	45.01
2nd cut	44.33	44.36	48.43	34.59	49.06	43.82
3rd cut	28.56	22.59	45.94	18.16	38.89	21.94
4th cut	35.32	34.31	56.79	27.99	37.11	35.18
5th cut	48.04	62.26	57.02	43.75	47.64	37.85
Av. total ..	39.11	42.28	53.76	29.91	42.77	37.44
Late cut						
1st cut	42.72	46.44	55.78	27.69	44.44	45.59
2nd cut	37.69	32.24	56.91	27.28	44.44	36.80
3rd cut	39.19	39.16	36.10	36.66	40.29	44.50
4th cut	45.87	62.56	51.94	39.20	43.92	42.16
Av. total ..	39.59	42.17	48.32	33.01	43.44	41.78

2.—**Losses in minerales** :

The losses in minerals fluctuated in the successive cuts without any special trend, as shown in Table (2). These losses varied within wide limits. On the average the data indicate that early cutting of berseem decreased the losses in minerals compared to late cutting. It also appears that the losses in P were lower than thos of either Ca or Mg.

TABLE 2.—**Average Losses of P, Ca and Mg. During Haymaking over Two years**

The Cut	Early Cut			Late Cut		
	P	Ca	Mg.	P	Ca	Mg.
	%	%	%	%	%	%
1st. cut	41.85	51.24	27.85	39.27	44.27	68.68
2nd. cut	43.74	42.32	55.15	18.48	38.34	51.59
3rd. cut	12.21	13.94	36.70	38.54	46.86	41.16
4th. cut	24.20	28.78	24.41	40.05	39.38	65.83
5th. cut	41.58	41.50	42.80	—	—	—
Av. total ..	30.55	34.21	41.97	33.40	43.05	54.78

3.—Losses in the digested nutrients.

The losses in the digested nutrients and their percentages are shown in Table (3). These losses fluctuated within wide limits among the different cuts, being at a minimum in the third cut with both early and late cut berseem hay.

From these data, it can be noticed that losses in digested crude fibre of early cut berseem hay were nearly the same as late cut hay. On the other hand, the losses in digested crude protein were lower with the former than with the latter.

The losses of digested crude protein observed in this work were in agreement with the 58.25% loss recorded by Ghoneim (1955). On the other hand, Badr, (1955) and Brandsma and Dijkstra, (1957) reported lower losses between 27.0 and 30.78%.

TABLE 3.—**Losses of the Digestible Nutrients and Nutritive Value during Haymaking in the Frst Year**

The cuts	The digested nutrients					Strach value
	Dry matter	Crude protein	Ether extract	Crude fibre	N.F.E.	
	%	%	%	%	%	%
Early : cut.						
1st. cut	50.07	53.05	74.83	40.63	65.10	68.03
2nd. cut	60.42	51.97	46.93	44.03	70.79	66.13
3rd. cut	28.09	21.13	27.63	24.24	53.22	47.85
4th. cut	51.02	83.69	62.03	53.24	49.04	57.27
5th. cut	52.35	69.03	61.54	50.95	54.12	65.50
Av. total ..	48.25	43.27	54.97	48.69	56.76	59.74
Late cut :						
1st. cut	56.24	57.58	75.05	35.57	52.93	62.30
2nd. cut	50.77	43.17	51.19	51.00	53.25	61.03
3rd. cut	47.46	41.07	20.44	50.62	51.09	54.90
4th. cut	59.32	77.74	53.21	49.34	57.89	70.14
Av. total ..	51.93	51.66	44.52	48.80	53.19	60.64

4.—Digestion coefficients of the lost nutrients*

The digestion coefficients of the nutrients lost during haymaking are shown in Table (4). The digestion coefficients of the nutrients lost were higher from early cut than from late cut berseem hay.

These data show clearly that the main losses were digestible nutrients, especially in the case of protein and N.F.E. The digestion coefficients of their losses were relatively high, sometimes exceeding 100%. Digestion coefficients for ether extract and crude fibre were relatively lower when compared with those of protein and N.F.E. These results are in agreement with those found by Badr, (1946). He stated that the losses in the different nutrients except ether extract were completely digestible.

TABLE 4.—**The Digestion Coefficients of Nutrients Lost uring Haymaking.**

The cuts	Early cut				Late cut			
	Crude protein	Ether extract	Crude fibre	N.F.E.	Crude protein	Ether extract	Crude fibre	N.F.E.
	%	%	%	%	%	%	%	%
1st cut . . .	101.30	86.52	65.38	107.20	87.33	54.40	45.81	116.97
2nd cut. . .	86.97	57.47	47.60	103.42	92.86	43.62	67.69	100.88
3rd cut . .	83.33	36.05	56.69	98.73	78.74	40.22	56.00	93.24
4th cut . .	101.85	75.90	78.80	103.80	85.03	73.77	59.09	82.97
5th cut . .	78.25	80.00	52.12	88.10	—	—	—	—

5.—Losses in starch value.

The losses of starch value fluctuated among the different successive cuts, ranging between 47.85% and 68.03% for early cut and between 54.90% and 70.14% for late cut berseem hay as shown in Table (3). The total losses in the starch value during the whole season of haymaking, were 59.74% and 60.64% for early and late cut berseem hay, respectively.

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* The digestion coefficients of the nutrients lost during haymaking were calculated as follows :

$$\frac{\text{losses in digested nutrients (}e.g.\text{ losses in dig. protein)}}{\text{losses in crude nutrients (}e.g.\text{ losses in crude protein)}} \times 100$$

In this connection Ghoneim, (6955) found that the losses in starch value were 89.39% with hay obtained from the third cut of berseem, while Senior and Sheedy, (1939), Badr, (1955) and Brandsma and Dijkstra, (1957) observed losses in the starch value between 25.0% and 38.0%.

6.—Losses caused by the increase of the crude fibre deduction.

The digestion of a dry roughage such as hay requires more energy than the digestion of a soft, succulent roughage such as berseem. Hence, by converting the berseem into hay there is an additional factor of loss in starch value more than the other factors previously indicated (respiration, fermentation, mechanical damage and weather damage). This factor is the higher crude fibre deduction with hay than that with berseem when the starch value is calculated according to Kellner (1926). The deduction of crude fibre is 0.29 kg. from the theoretical starch value in green fodder and 0.58 kg. from that in hay for each per cent of crude fibre.

To illustrate the losses due to this factor the starch value of dried berseem can be calculated by means of both crude fibre and digested nutrients on dry matter basis. This calculated value represents the starch value of berseem hay assuming that there are no other losses in the different nutrients.

Thus, it can be seen that the crude fibre deduction in 100 kg. D.M. of berseem was lower than that in100 kg. D.M. of dried berseem (hay without any other losses). As the crude fibre deduction increases the starch value decreases. The results of such calculations are summarized in Table (5).

TABLE 5.— **Starch value of dry matter in green berseem and dried berseem**

The Cuts	Early cut		Late cut	
	Berseem (D.M.)	Dried Berseem	Berseem (D.M.)	Dried Berseem
	kg.	kg.	kg.	kg.
1st. cut	59.80	55.71	53.82	48.22
2nd. cut	56.91	52.11	51.62	44.43
3rd. cut	52.47	46.49	46.89	38.76
4th. cut	55.73	48.95	49.71	44.22
5th. cut	49.73	43.74	—	—

The losses in starch value of hay due to the higher crude fibre deduction ranged between 6.84 and 12.17% with early cut and between 10.41% and 17.34% with late cut berseem as shown in Table (6).

TABLE 6.—**Losses due to higher crude fibre deduction**

The cuts	Early cut	Late cut
	%	%
1st. cut	6.84	10.41
2nd. cut	8.43	13.93
3rd. cut	11.40	17.34
4th. cut	12.17	11.04
5th. cut	12.03	—
Av. total ..	10.49	14.01

It is clear from these data that it is advisable to meet the nutritional requirements of Egyptian animals in winter by feeding berseem. Hay should only be made from the surplus berseem, and great care has to be taken to minimize the losses which occur during haymaking. The best method for making hay from berseem with minimum losses in the U.A.R. needs to be determined by further investigations.

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فقد المركبات الغذائية عند عمل البرسيم

الملخص

تمت دراسة تقدير الفقد فى المركبات الغذائية المختلفة وكذلك القيمة النشوية عند عمل الدريس من البرسيم بالطريقة الأرضية . وتم حش البرسيم على ارتفاعين أحدهما منخفض ٣٠ — ٣٥ سم وآخر مرتفع ٦٠ — ٧٠ سم ولقد قدر الفقد بطرح محصول الدريس من المركبات الغذائية المختلفة من مثيلاتها فى البرسيم ولقد أمكن الحصول على النتائج التالية :

(١) ازدادت نسبة الفقد فى المركبات الغذائية ومعادل النشا فى الحشات الأولى والأخيرة عن غيرها من الحشات الأخرى .

(٢) كان الفقد فى المادة الجافة والبروتين المهضوم ومعادل النشا فى الحشات المختلفة كذلك بالنسبة للموسم كله كما هو مبين بالجدول :

الحشات	برسيم حش مبكر			برسيم حش متأخر		
	مادة جافة	بروتين مهضوم	معادل نشا	مادة جافة	بروتين مهضوم	معادل نشا
	٪	٪	٪	٪	٪	٪
الأولى	٤٥,٠٨	٥٣,٠٥	٦٨,٠٣	٤٢,٦٢	٥٧,٥٨	٦٢,٣٠
الثانية	٤٤,٣٣	٥١,٩٧	٦٦,١٣	٣٧,٦٩	٤٣,١٧	٦١,٠٣
الثالثة	٢٨,٥٦	٢١,١٣	٤٧,٨٥	٣٩,٦٩	٤١,٠٧	٥٤,٩٠
الرابعة	٣٥,٣٢	٨٣,٦٩	٥٧,٨٥	٤٥,٨٧	٧٧,٧٤	٧٠,١٤
الخامسة	٤٨,٠٤	٦٩,٠٣	٦٥,٥٠	—	—	—
طوال السنة	٣٩,١١	٤٣,٢٧	٥٩,٦٤	٣٩,٦٤	٥١,٦٦	٦٠,٦٤

(٣) كانت نسبة الفقد فى حالة عمل الدريس من البرسيم المحشوش مبكرا أقل نسبيا من مثيلاتها فى الحش المتأخر فى الحشات المختلفة .

(٤) اختلفت نسبة الفقد فى المادة المدنية خلال الحشات المختلفة وكانت نسبة الفقد بالنسبة للموسم هى ٣٠٫٥٥ ، ٣٤٫٢١ ، ١٫٩٧ ٤٪ بالنسبة للفوسفور والكلسيوم والمغنسيوم فى حالة دريس البرسيم المحشوش مبكرا . أما بالنسبة للبرسيم المحشوش متأخرا فكانت نسبة الفقد ٣٧٫٩٠ ، ٣٤٫٥٠ ، ٥٤٫٧٨٪ على التوالى .

(٥) كان معظم الفقد عبارة عن مادة مهضومة خاصة بالنسبة للبروتين والكربوهيدرات الذائبة .

(٦) وجد أن زيادة الفقد نتيجة هضم الألياف عند تقدير معادل النشا عامل آخر اضافى للفقد عند عمل الدريس ولقد قدر الفقد الناتج عن زيادة الهضم عند تقدير معادل النشا بمقدار يتراوح ما بين ٦٫٨٤ — ١٧٫٣٤ ٪ .