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IMPROVEMENT IN MAKING CLOVER HAY BY USING THE TRIPOD METHOD WITH PARTICULAR REFERENCE TO CAROTENE AND CHLOROPHYLL

By

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Summary

This work was carried out to study the possibility of conserving Egyptian clover for summer feeding using both tripod and ground-drying methods for hay-making. The experiments were conducted with the 1st and 3rd cuts of clover harvested on January and April respectively. The two experiments were carried out in two periods of very dissimilar weather.

Hay-making following the two methods was accompanied by considerable losses in total dry matter percentage; losses of 12.2 and 40.67% were recorded for the tripod and ground-curing methods respectively.

Losses in *a* — & B — carotenes and chlorophyll a were observed in hay dried with both methods. Reduction was more persistent with the ground-curing method. Hay dried with the tripod method ((11 weeks from harvest) contained 22.22 mg *a* — carotene, 4.11 mg. B - carotene and 135.38 mg chlorophyll a/100 g dry matter. The respective figures with the ground-curing method were 9.57, 1.69 and 86.08. During warm weather the tripod method showed slight advantage in conserving the carotene contents over the ground-curing method.

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INTRODUCTION

The most important problem for feeding livestock in Egypt is the shortage of food in summer and the ill-distribution of food available for animals throughout the year.

During the winter feeding the nutrient requirements of ruminant animals can be met cheaply by the green clover (Trifolium alexandrinum). Statistical data by Raafat et al (1960) showed that there is a surplus of about 330,000 tons of starch value during the winter feeding (the amount produced from clover is about 3.20 million tons, while the requirements are 2.87 million tons), while there is a shortage of 2.41 million tons of starch value during the summer feeding.

In order to achieve better distribution of foodstuffs, more clover should be preserved for summer feeding. Hay making is still the most common process of conservation on the farm. Recent workers recommend that some hay should always be fed to lactating cows (Dijkstra 1959).

In Egypt, the amount of hay prepared from clover during the winter does not exceed 87.000 tons. Heavy losses in the feeding value of clover hay occur because of its improper preparation and storage.

During the first cut, the clover contains relatively high moisture percentage and the weather is humid. As a general practice, the Egyptian farmer avoids hay-making from this cut. Therefore any improvement in hay-making from the first cut of clover to hasten its drying and prevent mechanical losses during handling, is urgently needed.

Drying hay using the tripod method appears to be a promising method as indicated by Watson (1948), Brown and Robinson (1952), Murdoch (1955, Brandsma and Dijkstra (1956) and Watson & Nach (1960). It improves the quality and total yield of hay under bad conditions. The material is subjected to less mechanical work.

Therefore, this study was undertaken to compare the ground-curing method with the tripod method (pyramid) using the 1st and 3rd cuts of "miskawi" clover. In this study the rate of drying and the effect of drying with both methods on the yield, carotene and chlorophyll contents of the hay was investigated. Since it is now known that the different isomers of carotene have different physiological activity, it was considered important to ascertain precisely in which form the carotene was present whenever it was detected.

MATERIAL AND METHODS

Source of clover :

An area of 2000 m^2 was sown at the Experimental Farm, Faculty of Agriculture, Cairo University, Giza. The green clover taken for hay making was 64 days old and about 50 cm. long. The crop yield was 2422 kgm. and was used for Experiment I.

The second experiment (No. 2) was conducted with the 3rd cut clover, when the plants were 52 days old, about 62 cm. long and in the very early blooming stage (as recommended by Mironenko, (1949).

Method of drying :

The control method used was as that recommended by Ghoneim et al (1951) by drying the unbundled plants directly in the sun. The green material after being cut and weighed was left for wilting for 3 days. It was spread in a layer of about 25 cm. height. A representative wilted sample of 260 kgm. was divided into 13 batches. Each batch was spread on an area of about 1.5 m- with a thickness of about 25 cm. One of these batches was chosen for taking samples for daily moisture determination and occasional chemical analysis. The plant material was turned upside down daily at 10 A.M. after dew disappearance.

The tripod method started by wilting for 3 days in the same manner as above ; the wilted material was treated as recommended by Raafat (1959). The pyramid like arrangement was set up by using 3 wooden posts (3 m. in length, the cross section being 6 × 10 cm.) hinged at the top together by an iron ring to form 3 triangular areas meeting together at an apex of ca 2 m. above the ground. Thick ropes in a net like form (locally made from cheap fibers of the palm tree covered the tripod to increase its loading capacity. It was loaded with 80 kg. of the wilted clover. Four tripods were set up one of which was kept for daily moisture determination and for occasional chemical analysis.

Wilting trials were carried out in two periods of very dissimilar weather. In Experiment No. 1 of 4 days it was cold and overcast with some rain on the first two nights. These conditions were obviously unlikely to produce a quick reduction in moisture. In Experiment No. 2, the period of 3 days was warm and sunny which reduced the moisture content considerably.

Storage of hay :

Hay from Experiments 1 and 2 was stored in wooden covered boxes. Samples were taken from the stored hay for analysis.

Analytical methods :

Moisture was determined at 105°C up to a constant weight. Fresh material was primarily dried at 60°C in a hot air oven.

Carotene and chlorophyll determinations :

It followed the same procedure of the A.O.A.C. (1955) with slight modifications according to Ridi (1959). Extraction of the carotenes were performed by soaking 1 gm. of

the ground hay with 30 ml. of hexane acetone mixtures (7 : 3 v./v.).

Soaking was done for overnight in a stoppered flask under nitrogen atmosphere. The green extract was filtered, the residue was washed with hexane and the volume was brought up to 100 ml. This solution was used for the chromatographic separation of carotenoids. Light activated magnesia was used for the separation of α — and B — carotenes. (Activation was performed by heating light magnesia Merch grade, in muffle furnace on 300°C). Chlorophyll a was determined in the green extract by direct spectrophotometric reading on 670 mu in hexane using E 1% at 670 mu = 1025 according to Comar (1942).

RESULTS AND DISCUSSION

Rate of drying of hay from 1st and 3rd cuts clover using the ground and tripod methods :

The results of Experiment No. 1, presented in figure No. 1, showed a slight reduction in moisture content (89.41 down to 86.37%) during the wilting period (3 days starting from 26th December). Slow drying was due to bad weather and occasional rain fall. After wilting, drying continued in a slow manner in both the ground drying and tripod methods. In most of the cases the material on the tripod contained less moisture. The lower limit of moisture in the tripod was reached on the 19th day being 15.08%, while with ground drying it was delayed to the 24th day with a relatively high moisture content of about 25.56%.

After the curing period (25 days), a further study of the moisture content in both hays was extended for about two weeks. It was found that occasional fluctuations of the moisture occured in both hays, most likely due to

changes in atmospheric humidity and occasional rainfall. When the hay was stored after 49 days, the moisture was reduced to a suitable level for storage. After 6 months the moisture was reduced to 10.5 and 10.1% in the tripod and ground hays respectively.

From this study, it was clear that during this season, the ground drying failed to produce a hay containing a reasonable moisture content suitable for storage, such moisture is usually not more than 16% as reported by Ghoneim (1955).

In Experiment No. 2 and figure No. 2 with the 3rd. cut clover starting on 9th April, wilting for three days reduced the moisture content considerably from 81.04 down to 56.72%. This was undoubtedly due to the warm and dry sunny weather. This means that starting with 100 gk. fresh material containing 81.05 kg. moisture would produce 43.9 kgs. wilted material containing 24.9 kgs. moisture (neglecting losses in respiration). Therefore a reduction of 69.3 and 56.1% occurred in the moisture and weight of the starting material respectively. This showed the great efficiency of wilting during this season for rapid reducing of the moisture and the bulk of the clover while still keeping the leaves from falling (berseem leaves shattered when the moisture content became 35% ; Ghoneim et al, 1951).

Moreover, the lower limit of mositure was reached within 6 days with the tripod method (6.08%) and 7 days with the ordinary drying (10.08%). The lower limit in both cases was far below that permissible in hay before storage. Generally, the two methods, in good weather appeared to be practically equally successful in curing hay in about 7 days after which the hay could be safely stored.

During storage up to nine weeks, it was found that the moisture did not exceed 16%.

Losses in dry matter from 1st cut clover :

The starting material (after wilting) contained 13.63% dry matter. The data for the losses in dry matter in the prepared hay after curing and storage were as follows :

	Tripod drying	Ground drying
Dry matter in starting material kg. ...	32.71	32.71
Dry matter after 77 days kg.	28.72	19.41
% loss in dry matter	12.20	40.57

This indicated that losses in dry matter with the tripod method were permissible but they were too high in the ground drying. In this connection Brown and Robinson (1952) found 3-16.5% and 9-27% losses in dry matter using the tripod and ground drying respectively. It appears that the weather plays an important role in governing the losses during curing. When Kirch and Jantzon (1942) cured the two hays in good weather, they obtained low similar losses (8.9 and 9.6% for the tripod and ground drying respectively).

Carotene and Chlorophyll contents during hay making from 1st and 3rd cuts using the ground and tripod methods :

The fresh green material in experiment No. (1) table No. (1) contained an amount of 3.73 mg. alpha and 6.71 mg. beta carotenes and 45.86 mg. chlorophyll a per 100 g. After 11 weeks when the moisture was below 13 %, the percentage of beta carotene was reduced more noticeably than with alpha carotene. The reduction in both ingredients was greater in the ground drying.

Badr (1955) using the ground drying with Egyptian clover obtained hay containing total carotene of 12 - 17mg./ 100 g dry matter. These figures were lower than those obtained here with the tripod method, and they were similar to those obtained by Badr (1960) (14.5 mg./100 g. Drymatter who dried Egyptian clover artificially by blowing unheated air.

Effect of storage of the carotene content :

After 28 weeks from hay making, alpha and beta carotenes showed pronounced reduction with the tripod hay, but at that stage the carotene content was similar in both methods. The percentage of alpha carotene fell down to 7.26 and 7.99 mg./100 g dry matter in the ground and tripod hays respectively. The corresponding figures at an earlier date of storage (11 weeks) were 9.57 and 22.22 mg.

With chlorophyll, although further storage reduced its content, yet the tripod hay contained about double that of the ground hay (77.11 against 33.08 mgm./100 gm. hay).

Results are clearer when dealing with the moisture-free material. There were considerable losses in alpha and beta carotenes as well as in the chlorophyll a content. Reduction was more persistent with the ground hay (after 11 weeks) from cutting but values appeared the same in tripod and ground hay after long storage (28 weeks from cutting), with chlorophyll losses were less in the tripod method.

It is clear that the rate of beta carotene destruction was greater than that of alpha carotene as indicated from

the ratio alpha : beta carotene. This ratio widened progressively most likely due to the higher succeptibility of beta carotene to atmospheric conditions than alpha carotene. The results resembled those obtained by Wagner (1954).

Concerning Experiment No. 2 from 3rd cut clover a reasonable destruction was found after one week in the percentage of alpha, beta carotenes and chlorophyll a particularly when comparison was made on dry matter basis. In this third cut the percentage of the three ingredients were practically the same in both methods within two weeks. Wilting was likely to cause serious loss in fine and sunny weather as previously mentioned by Waite and Sastry (1949). As would be expected during good weather conditions, the tripod method showed no advantage in conserving the hay over the ground curing method. The hays were low in carotene than those of the 1st cut.

TABLE 1.—Changes in carotene and chlorophyl contents of hay during the curing period and after storage using the ground and triped methods with 1st and 3rd cuts berseem.

Age after cuting in weeks	Analysis during airdrying				α and B Carotenes I.U.	Analysis on dry matter basis mg/100 g			Ratio α : B Carotene
	Moisture %	α — Carotene mg/100g	B Carotene mg/100g	Choropyll a mg/100g		α — Carotene	B Carotene	Chlorophyl 1—	
1st Cut	90.93	6.71	3.73	45.86	11809	74.00	41.10	505.6	1.80
11 weeks.									
G.	11.35	8.49	1.49	76.30	9558	9.57	1.69	86.08	5.40
T.	12.97	19.34	3.58	117.81	22084	22.22	4.11	135.38	5.70
28 weeks.									
G.	10.10	6.53	0.80	33.08	67.75	7.26	0.89	36.80	8.16
T.	10.50	7.09	1.10	77.11	7741	7.99	1.23	86.15	6.44
3rd Cut o (Fresh)	81.04	6.82	3.16	28.85	10950	35.97	16.66	152.16	2.15
1 week									
G.	10.08	14.22	2.23	67.02	15567	15.81	2.48	74.58	6.37
T.	8.00	12.04	5.73	73.62	19583	a3.08	6.11	81.88	2.10
2 weeks.									
G.	10.54	8.55	1.90	67.61	10292	9.55	2.12	75.57	4.50
T.	16.29	8.49	2.54	62.23	11308	10.13	3.03	74.34	3.34

MOISTURE CONTENT OF PLANT MATERIAL DURING THE CURING PERIOD OF CLOVER HAY FROM 1st CUT. STARTING 26_12_1959

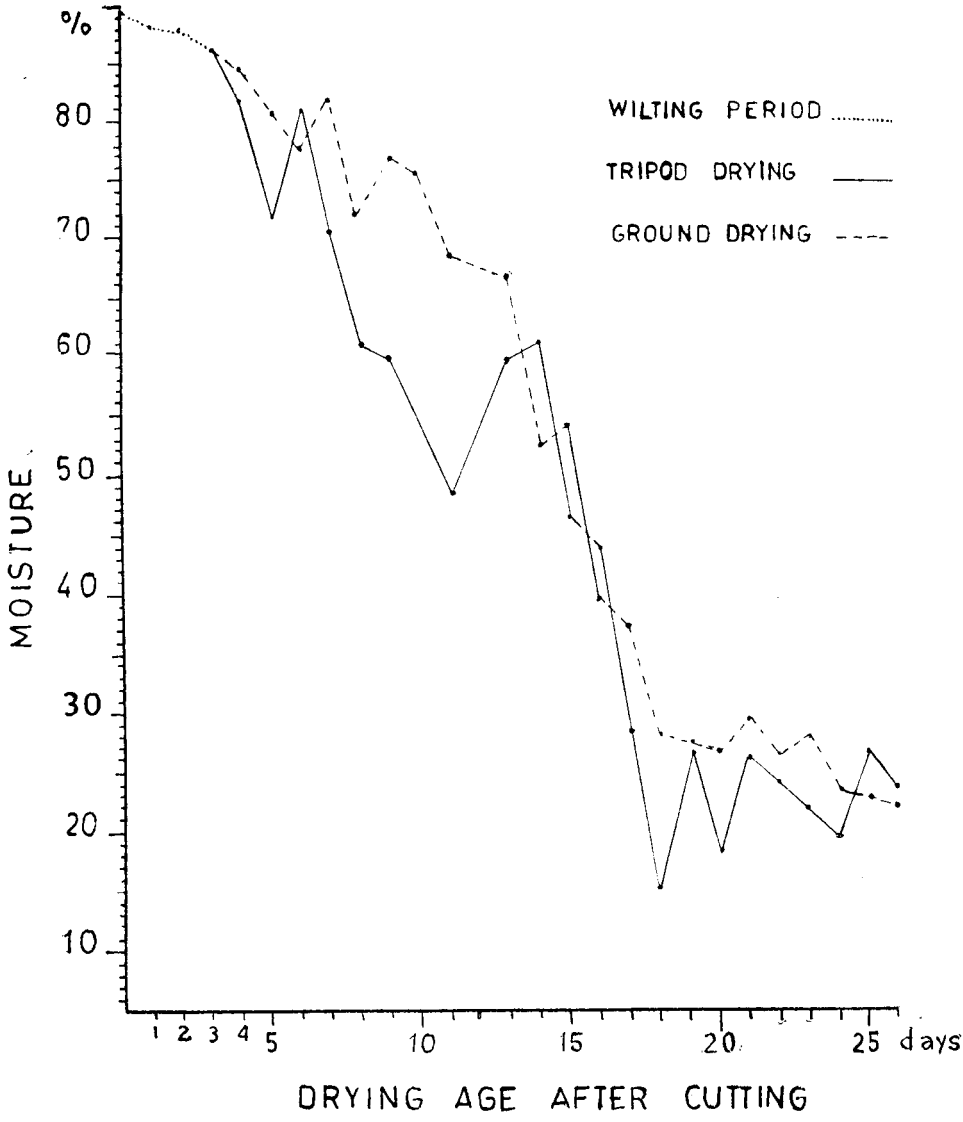

FIG.1

MOISTURE CONTENT OF PLANT MATERIAL DURING THE CURING PERIOD OF CLOVER HAY FROM 3rd. CUT STARTING 9_4_1960

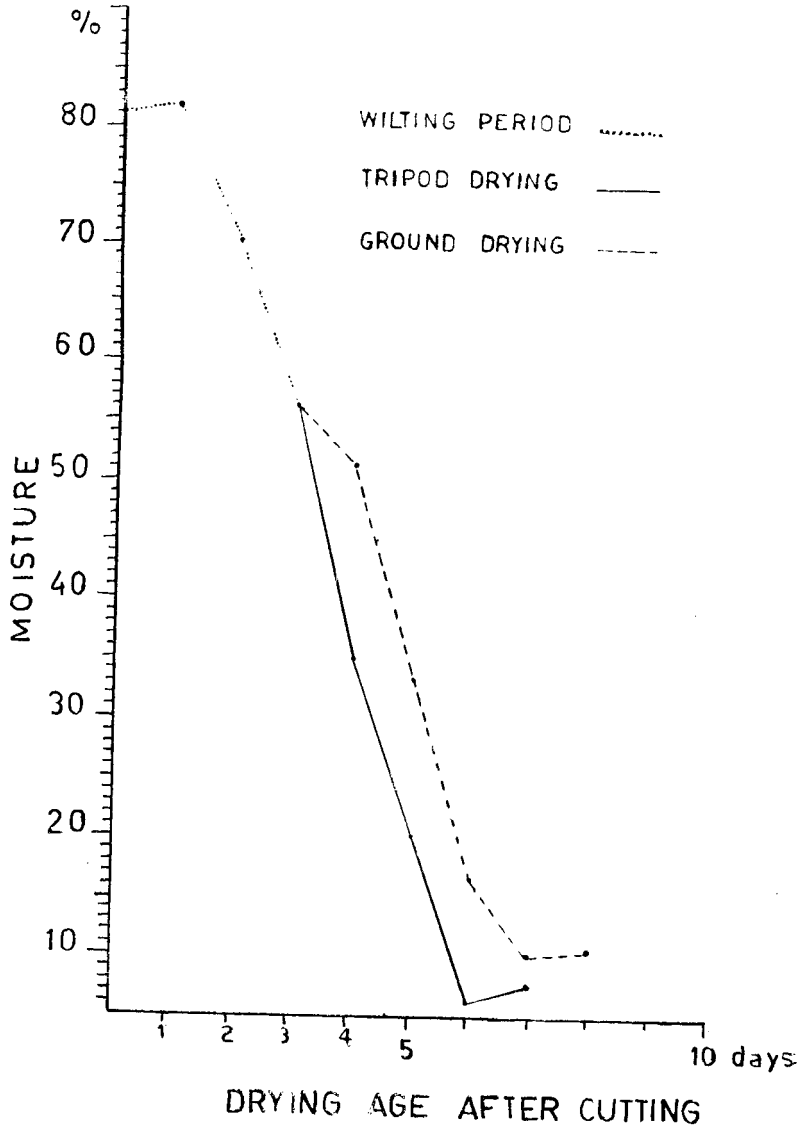

FIG. 2

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الملخص

تحسين طريقة عمل الدريس باستعمال الحوامل المثلثة وأثر ذلك على محتوياته من الكاروتين والكلوروفيل

شملت التجارب برسيماً من الحشتين الأولى والثالثة تم قطعهما فى شهرى يناير وأبريل على التوالى ، وقد أجريت تجربتين على البرسيم تمت كل منهما تحت ظروف جوية مخالفة .

وفى كلا التجربتين تبين أن الدريس الناتج قد حدث فيه فقد فى المادة الجافة بلغ ٢ر١٢٪ و ٦٧ر٤٠٪ فى طريقة الحوامل المثلثة والتجفيف الأرضى على التوالى .

كما لوحظ أن هناك فقداً أيضاً فى كاروتين ألفا و بيتا وفى الكلوروفيل فى الدريس الناتج من الطريقتين . إلا أن النقص كان مستمراً وواضحاً فى طريقة التجفيف الأرضى .

وقد تبين أن الدريس المجفف على المثلثات فى عمر ١١ أسبوعاً قد احتوى على ٢ر٢٢ مجم ألفا كاروتين و ١١ر٤ مجم بيتا كاروتين و ٣٨ر١٣٥ مجم كلوروفيل فى كل ١٠٠ جم من المادة الجافة مقابل ٥٧ر٩ مجم ، ٦٩ر١ مجم ، ٠٨ر٨٦ مجم من هذه المواد على التوالى فى الدريس المجفف أرضاً . هذا وقد اتضح أيضاً أن طريقة المثلثات لا تمتاز كثيراً فى نتائجها عن التجفيف الأرضى فى حالة الجو الدافىء والتقليب المستمر فى التجفيف الأرضى للدريس — أما فى الجو الرطب فإن طريقة التجفيف على المثلثات تكون ذات نتائج ممتازة وتفوق التجفيف الأرضى كثيراً .