Ensiling safflower (*Carthamus tinctorius*) as an alternative winter forage crop in Israel

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Introduction Israel is a subtropical country in which the rainy season is in winter, with frequent droughts. Wheat is the major winter forage crop in Israel, along with legumes as rotation crops. Alternative forage crops are sought that would be suitable for semi-arid areas. Safflower (*Carthamus tinctorius*) is usually grown as a source for oil and pigments but spineless cultivars could be used as fodder. Leshem *et al.* (2001) reported DM yields up to 22 t/ha and high DM digestibility when used for heifers. When safflower silage substituted maize and wheat silage in the rations of lactating cows, milk yields and milk fat were similar in the two groups (Landau *et al*., 2004). Safflower was preserved satisfactorily by ensiling in mini-silos (Weinberg *et al*., 2002). However, on some farm scale trials, safflower silages spoiled upon aerobic exposure. The objective of the current experiments was to further study the ensiling characteristics of safflower.

Materials and methods Safflower was grown in two locations in southern Israel. In one location (S) it was grown on winter rain (210 mm rainfall) and ensiled in a bunker silo. On the day of ensiling, two rows of 5 dacron bags that contained the chopped crop were buried in the centre along the bunker silo. When the unloading front reached the bags they were brought to the laboratory for analysis and subjected to an aerobic stability test lasting 5 days. In addition, the safflower from S was ensiled in fifteen 1.5 l anaerobic jars, three of which were sampled on days 2, 5, 8, 13 and 120 after ensiling. In the other place (L) experimental plots received fresh or sewage irrigation and various levels of nitrogen fertilisation. The safflower from L was wilted for 24 h and samples from each treatment were ensiled in nine 1.5 l anaerobic jars, three of which were sampled on days 2, 6 and 30 after ensiling. The final silages from all treatments were subjected to an aerobic stability test.

Results The mean DM and water soluble carbohydrate contents of the fresh safflower in S and L was 350 and 250 g/kg, and 100 and 35 g/kg, respectively. The safflower from S ensiled well in the jars and the pH decreased rapidly and was around 3.9 already after 8 days of ensiling. The samples from L did not ensile well and the pH remained between 4.5 and 5.8 throughout the ensiling period. The samples from the bags were of good quality, their pH was around 4.0 and there were no visible yeasts or moulds. The aerobic stability of the samples from the jars varied from fair to unstable according to treatment; the samples from the bunker silo were quite stable (Table 1).

Discussion The safflower has potential as a forage crop and can be ensiled successfully. It might well be that the safflower from L did not ensile well because of its low WSC content. The reason for the difference in WSC between the two locations is not as yet clear. Commercial safflower silages might be unstable upon aerobic exposure; therefore, the use of lactic acid producing bacteria such as *L. buchneri* should be considered.

Table 1 Results of the aerobic stability test of safflower silages after 5 days

Source	Sealed silage pH	Exposed silage pH	CO_2 (g/kg DM)	Yeasts	Moulds
L (jars)	4.8-5.8	4.6-6.9	10.8-35.0	5.1-9.1	4.5-8.0
S (jars)	4.0	4.0	1.6±0.2	3.4	3.7
S (bunker silo)	4.0±0.1	4.1±0.1	7.4±5.7	9.5	3.7

Yeast and mould numbers are given as $\log_{10}$ CFU/g DM.

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