Research Note

DIGESTIBILITY OF HAMMER-MILLED OKRASEED (ABELMOSCHUS ESCULENTA)

Surplus okraseed resulting from agronomic experiments was supplied by the Mayagüez Institute of Tropical Agriculture[1] for use in this study. Digestibility of the hammer-milled seeds was determined by the difference method[2], in a two-phase experiment employing four steers (2 Holstein and 2 Brown Swiss), maintained in stalls designed for fecal collection.

The basal ration consisted of stargrass (*Cynodon nlemfuensis*) hay ground in a hammer mill through a 6.35 mm screen, plus a commercial concentrate feed, offered apart from the hay (though in the same feeder) at 100 g per 400 g of hay. The concentrate was a guaranteed minimum 18% crude protein (CP) product, without added non-protein nitrogen. During phase 1, the animals also received okraseed, hammer-milled through a 6.35 mm screen[3]. This was fed in a 1:1 proportion with the basal ration. Thus, the over-all ration consisted of hay, concentrate and okraseed in the respective proportions 4:1:5. Preliminary observations had revealed that milled okraseed was consumed reluctantly and erratically. Therefore, for it to be eaten more readily, this rather unpalatable ingredient, was mixed with the concentrate in the appropriate proportion (5:1). However, even this mixture was not uniformly well accepted by the animals. A quantity judged to be about maximum sustained intake for each animal was selected as the daily allowance. Amounts of total ration offered varied from 4.2 kg to 5.0 kg per head daily, divided into two equal proportions.

After 7 days of constant feeding, there was a 6-day feces collection period, in which it was assumed that 48 hours elapsed from the ingestion of a given meal until the elimination of the indigestible residue of that meal. Each day the total feces from each animal were weighed, generally between 8:00 and 9:00 a.m., and a representative sample taken for determination of dry matter (DM) percent by oven drying at 80° C; the daily output of fecal DM was thereby established. The daily fecal samples were combined in aliquot amounts for ash and CP determination by

[1] Courtesy of Dr. Franklin W. Martin.

[2] Lloyd, L. E., McDonald, B. E., and Crampton, E. W. 1978. Fundamentals of Nutrition, 2nd ed, W. H. Freeman and Company, San Francisco.

[3] Of a 1000 g sample of hammer-milled okraseed, 770 g passed through a 2 mm. U. S. Standard Sieve, while 230 g were retained.

incineration at 600° C and macro-Kjeldahl[4] methods, respectively. The same analyses were performed on samples of the three feeds employed. In phase 2, the same amounts of hay and concentrate were fed as previously, but okraseed was eliminated from the ration. After 7 days of readjustment, a second feces collection of 6 days was carried out. The animals were weighed twice, at the start of the first collection period, and again 19 days later, at the end of phase 2. At both weighings the animals had received neither feed nor water since the previous afternoon.

During phase 1 small amounts of feed were regularly refused. Mean

TABLE 1.—*Daily consumption, fecal elimination and digestibility of dry matter during the two phases of the experiment*

Animal	1	2	3	4	Mean
		Phase 1			
Dry matter consumption					
Hay (g)	1776	1598	1492	1847	
Concentrate (g)	436	392	368	453	
Okraseed (g)	2180	1961	1839	2263	
Total (g)	4392	3951	3699	4563	
Total (% liveweight)	1.87	1.65	1.68	1.85	1.76
Dry matter in feces from					
Hay + concentrate (g)	821	705	757	865	
Okraseed (g)	1352	1247	1054	1516	
Total (g)	2173	1952	1811	2381	
Dry matter digestibility (%)	50.5	50.6	51.1	47.8	50.0
		Phase 2			
Dry matter consumption					
Hay (g)	1776	1598	1492	1847	
Concentrate (g)	446	402	375	464	
Total (g)	2222	2000	1867	2311	
Total (% liveweight)	1.00	.89	.92	1.01	.96
Dry matter in feces (g)	825	707	760	868	
Dry matter digestibility (%)	62.9	64.6	59.3	62.4	62.3

daily refusals by the four respective animals during the 6 days of fecal collection were 48, 118, 70, and 97 g. Since the orts were almost all okraseed-concentrate mixture, it was assumed that hay consumption had been complete. The leftovers of okraseed and concentrate were subtracted in computing feed intakes. There were no feed refusals during phase 2.

The DM contents of hay, concentrate and okraseed were 88.8, 89.3 and 89.3%, respectively. Corresponding figures for organic matter (OM) and CP in the DM were 89.7, 92.0 and 94.3%; and 15.5, 16.8 and 23.0%. The

[4] Scales, F. M. and Harrison, H. E. 1920. Boric acid modification of the Kjeldahl method for crop and soil analysis, J. Ind. Eng. Chem. 12:350.

good quality of the hay employed was reflected in its high CP content and also by the DM digestibility of 62.3 ± 1.1% (table 1) of the basal ration, containing 4 parts hay and 1 part concentrate. The amount of ration consumed, however, was insufficient for maintenance of the animals. In phase 1, mean daily DM intake equalled 1.76% of liveweight, which in combination with a DM digestibility of 50.0 ± .7% (table 1), should not have been adequate for maintenance. During phase 2, mean daily DM intake was only .96% of liveweight (table 1). Consequently, the animals lost weight, mean loss being 15.7 ± 1.3 kg (from 235.4 to 219.7 kg) from the first to the second weighing. This represents .83 kg per animal daily, although a considerable part was probably due to a reduction in contents of the digestive tract.

TABLE 2.—*Percent composition and digestibility of hammer-milled okraseed*

Coefficient of digestibility	Apparent digestion			Estimated true digestion[1]
	Dry matter	Organic matter	Crude protein	Crude protein
Mean	37.5	38.8	70.6	83.3
Standard error	2.0	1.8	1.1	1.1
Coefficient of variation	10.7	9.2	3.1	2.6
Limits of 95% confidence	32–43	34–44	67–74	80–87
Gross content in DM	100	94.3	23.0	23.0
Digestible content in DM	37.5	36.6	16.2	19.2

[1] Assuming metabolic fecal nitrogen equal to 4.8 g/kg DM consumed.

Hammer-milled okraseed gave uniformly low digestibilities for DM and OM (table 2). The reason for this is clear, as examination of feces voided during phase 1 revealed the presence of intact fragments of seed coat of variable size. These are exceedingly hard, and by all indications, quite indigestible. However, a curious situation was found in that CP digestibility of the hammer-milled okraseed was much higher than that of the DM, and fell within a satisfactory range, or very nearly so (table 2). This was true whether the CP digestibility was expressed as apparent digestibility or as true digestibility, estimated by assuming a value of 4.8 g of metabolic fecal nitrogen/kg of DM consumed[5]; this digestibility is interpreted to mean that digestive agents had access to the kernels, even-though the seed coat material remained intact. Hammer-milled okraseed is, therefore, a good source of protein for bovines. In this study, okraseed contained 16.2% of apparently digestible protein or 19.2% of estimated truly digestible protein in the DM (table 2).

[5] McDonald, P., Edwards, R. A., and Greenhalgh, J. F. D., 1973. Animal Nutrition, 2nd ed, Longman Group Ltd., London.

Nevertheless, in view of its large mass of indigestible material, it is doubtful that hammer-milled okraseed could find much application in animal feeding. Perhaps finer grinding and sieving could improve its digestibility and palatability, by achieving a greater degree of separation of seed coat from kernels and elimination of most of the seed coat. Martin and Ruberté[6] ground okraseed in a hand mill, then sieved it, first through a 16 mesh screen (1.5 mm) and then a 25 mesh (< 1 mm), and thereby obtained a meal containing 62% of the whole seed protein. The meal analyzed 33% CP, in addition to 32% oil, and included relatively little seed coat material. If a process of this sort could be implemented on a large scale in an economically advantageous manner, okraseed might prove to be a valuable source of both protein and energy for cattle.

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[6] Martin, F. W. and Ruberté, R., 1979. Milling and use of okra seed meal at the household level, J. Agri. Univ. P.R. 63(1): 1–7.