THE SUBSTITUTION OF MAIZE FLOUR BY MAIZE COBS TREATED WITH ALKALI IN COMPLETE RATIONS FOR DAIRY COWS

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16 milking cows were used to evaluate the effect of partial substitution of maize flour by maize cobs treated with 50 g of sodium hydroxide/kg. In a Latin Square design 4 rations were compared, three of these with treated cobs at 20, 40 and 60% of the ration added at the expense of the maize flour and a fourth ration with 40% untreated maize cobs. Milk productions were 12.9. 12.5, 10.9 and 9.5 kg/d ($P < 0.01$) and dry matter consumption were 11.30, 10.29, 8.43 and 6.40 kg/d ($P< 0.01$) respectively. Fat content of the milk was lower in the ration containing 20% treated maize cobs than in the other rations ($P< 0.01$).

Key words: Dairy cows, alkali treatment. maize cobs, milk yield

Maize cobs are an agricultural by-product after removing the grain and are normally burned in our country. Treatment with alkali can appreciably increase the digestibility of the cob (Berger et al 1979; Escobar 1979; Kategile and Frederiksen 1979) and allows its inclusion in dairy rations, not only as a source of fibre but also as an energy source that could substitute in part, the cereal of the ration (Soper et al 1977). The maize cob has other advantages in that it accumulates in centres where maize is processed and can be used in the dry season when forage resources become scarce. This work was designed to investigate the effect of partial substitution of maize flour by maize cobs treated with sodium hydroxide in complete rations for dairy cows.

Materials and Methods

The trial was started on 18th February 1980 using 16 dairy cows, 8 of which were Holstein and the other 8 were Brown Swiss, 71 ± 20 days into their lactation. The animals were allocated to a 4 x 4 Latin Square with six week periods with the last four weeks of each period used in the analysis. The Holstein cattle were allocated to two of the groups of the Latin Square and the Brown Swiss to the other two. The four treatments were complete rations, three of which had 20, 40 and 60% of maize cobs (on airdry basis) treated with alkali and the fourth had 40% of non-treated maize cobs (40N) (Table 1). The cobs substituted a part of the maize flour and the crude protein content of the ration was balanced using urea. Rations were available ad libitum allowing about 105 refusals daily, The cows were permanently yolked except for the two milkings. At the start and mid-way through the trial a dose of 2.500 000 IU of vitamin A, 375.000 IU of vitamin D3 and 250 mg of vitamin E was given intramuscularly to each animal. (Vitamins A, D3, E McKeeson Laboratories, U S A). The results were compared using Duncan's Multiple Range test (Steel and Torrie 1960).

All the maize cobs were obtained as one lot before the start of the experiment from an industrial processor and were milled in a hammer mill with a 20 mm screen.

The cobs were treated in small quantities calculated to last three days. Sodium hydroxide was added at the rate of 50 g of alkali per kg of cobs and allowed to react for at least 24 hr before being fed to the cattle. The cobs were stored in 200 1 drums which were covered with plastic sheets. The treated cobs were mixed with the other feed ingredients on a daily basis, before offering. them to the cattle. The complete ration containing the untreated cob was mixed on a monthly basis as were all the ingredients, with the exception of the cobs, for the other diets.

Table 1:
Ration formula and chemical composition

	Rations			
Composition rations (Air-dry basis,%)	40N	60	40	20
Maize cob	40*	60+	40+	20+
Maize waste flour	35	15	35	55
Cottonseed cake	22.5	22.5	22.5	22.5
Urea	1.2	1.8	1.2	0.5
Commercial mineral mix	2.0	2.0	2.0	2.0
Proximate analysis (Dry matter basis,%)				
Dry matter[1]	90.3	62.6	70.2	80.5
Crude protein	20.2	18.7	19.6	19.3
Cell wall fraction	45.4	53.0	42.6	30.7
Acid detergent fibre	24.6	35.7	26.4	18.2
Hemicellulose	20.8	18.1	16.2	12.5
Cellulose	17.6	25.6	19.5	13.3
Lignin	6.1	7.4	6.5	4.4
Ash	6.9	10.4	8.5	7.3
Digestible organic matter (in vitro, %)	61.1	62.9	69.0	75.6

[1] As fed
* Non-alkali-treated maize cob
\+ Maize cob treated with 5% NaOH

Samples from each diet were taken daily, bulked and frozen for experimental periods, Samples were later dried at 80°C, milled and analysed for ash and protein (A.O.A.C. 1965). for cell wall fraction (CWF) (Van Soest and Wine 1967), acid detergent fibre (ADF), cellulose and lignin (Van Soest and Wine 1968) and in vitro digestibility (Alexander 1969). The hemicellulose component was estimated by subtraction of ADF from CWF.

Milk production was measured daily and a weekly sample was taken for fat analysis (Milko-Tester), protein (Udy 1956) and solids not fat by density. The cows were weighed twice weekly and changes in liveweight were estimated by regression of liveweight with time.

Results

The treated maize cobs kept well for the first three or four days after preparation but after this there was some fungal growth. The maize was not compacted in the containers and nor were the containers hermetically sealed. The animals adapted quickly to their ration with the exception of the 40N group where some animals required one week to normalise their intake. Milk production in the Holsteins was higher than for the Brown Swiss (13.1 and 9.8 kg/d, P< 0.10). The interaction of breed and ration was not significant in any of the measurements made. Means are presented in Table 2 for all the animals. Mean liveweight was 423 ± 54 kg.

Table 2:
Consumption, liveweight change, milk production and composition for the four rations

	Rations				
	40N	60	40	20	$SE_{\bar{x}}$
Milk production (kg/d)	9.5^{b}	10.9^{b}	12.5^{a}	12.9^{a}	0.37
Fat corrected milk (4%)(kg/d)	9.5^{b}	11.1^{a}	12.1^{a}	10.9^{a}	0.31
Composition (%)					
Fat	4.1^{a}	4.2^{a}	3.8^{a}	3.1^{b}	0.10
Protein	3.1	3.1	3.1	3.1	0.06
Solids not fat	8.5	8.6	8.6	8.6	0.08
Liveweight change (kg/d)	−0.21	−0.02	−0.02	0.17	0.132
Intake (kg DM/d)	6.40^{c}	8.43^{b}	10.29^{ab}	11.30^{a}	0.497

Values with different superscripts in the same row are significantly different (P<0.01)

The substitution of maize flour by cobs had a marked effect on the fibre fraction of the diets, increasing as the level of maize cobs increased (Table 1). The ration digestibility decreased with the proportion of cobs. Digestibility was higher in the diet with 40% treated cobs than in the ration with the same level of untreated cobs. Highest milk production and intakes were on the rations with 20 and 405 cobs, and lowest when 40% untreated cobs were - included in the ration (Table 2). There were no significant changes in liveweight but trends tended to follow milk production and feed intake. Fat content of milk dropped appreciably on ration 20 relative to the other substitution levels. Production of fat corrected milk (4%) was lower on diet 40N, but protein and solids not fat levels were not affected by the diet.

Discussion

The results obtained in this trial indicate that maize flour can be substituted by treated maize cobs at up to 53% (40% treated maize cobs in the diet),in milking cows of moderate production potential, without any large effect on consumption or milk production (Table 2). Milk production corrected to 4% fat was lower on ration 20 probably because of the depressing effect of low fibre level on milk fat. The ADF content of this ration is below that of the level recommended by N.R.C. (1978) to maintain milk fat. Soper et al (1977) substituted 0, 12 and 23% maize flour for treated maize cobs and did not observe a negative effect on milk fat although they used complete rations with 50% maize silage. Maize cobs did not form the main fibre source in their rations . With 23% substitution these workers found a drop of 7% in milk production in animals giving 20 kg/d. Other work with high fibre diets treated with alkali and fed to milking cows has resulted in high levels of milk production. Greenhalgh et al (1976) obtained 19.0 kg/d of milk when 50% of treated barley straw was fed and Randel et al (1972) obtained 17.2 kg/d of milk when a complete ration containing 40% of alkali treated sugar cane bagasse was fed. In a series of trials Kristensen et al (1978) obtained similar levels of milk production to those just quoted but with a lower percentage (17-32%) of treated barley straw in the diet.

The increase in the percentage of treated maize cobs to 60% in the diet reduced both consumption and milk production (Table 2). Available information does not tell if this is because of a reduced available energy level in the diet or a high level of NaOH . Rex en et al (1976), in an experiment with milking cows fed a diet of 60% barley straw treated with 5% of NaOH, found that the consumption of straw increased from 8.7 to 10.4 kg/d when neutralized with hydrochloric acid. The high pH's in these diets may have a detrimental effect on intake.

The ration with 40% untreated maize cobs had lower intake and milk production than the other rations. Moreover, the lower digestibility of this diet and its physical characteristics could have effected consumption. The particles of untreated maize cobs are markedly harder to the feel than those treated with alkali and the total ration is also drier and dustier than the other diets in which water was added in the alkali solution to allow mixing of the sodium hydroxide with the cobs (Table 1). The treatment of the cob (with this level of alkali) had a marked effect on consumption (Table 2). Comparisons between diets containing other fibrous materials non-treated or treated with alkali, have demonstrated a beneficial effect on consumption and milk production in treated over untreated (Randel et al 1972; Greenhalgh et al 1976; Rexen et al 1976).

The change-over design used did not allow the effect of high levels of treated cobs to be seen in terms of animal health because the periods were too short. However, rations based on treated maize cobs have a potential, in particular during the dry season, when conventional forages are scarce and further, offer a method of reducing feed costs.

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