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# MAIZE COBS TREATED WITH NaOH IN RATIONS FOR GROWING CATTLE

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The growth of young Holstein cattle (220 kg initial liveweight) was evaluated for 100 days with diets based on I) ground maize cobs without NaOH treatment or II) ground maize cobs with treatment with 50 g NaOH/kg dry matter or III) ground maize cobs with the alkali mixed another ingredient of the diet (molasses). The Consumption Index (kg DM/100 liveweight/d), rate of liveweight gain (g/d) and feed conversion for the respective diets were: I) 2.86, 406 and 16.7; II) 3.13, 700 and 10.8; III) 2.74, 433 and 13.8. The growth of animals was significantly improved by the NaOH treatment of the ground maize cobs, and this was associated with an increased availability of energy in the alkali treated residue.

Key words: Cattle, alkali treatment, maize cobs, intake, liveweight gain.

Fibrous agricultural residues (residues from harvesting crops, fibrous residues from agro-industry, animal excreta and urban wastes) are being recognized as valuable sources of animal feed, energy and fertilizer (Dyer et al 1975; Ward 1978; González 1981). However, the use of these materials for animal feed is limited by their low density, high humidity, requirement for transportation, high content of lignified cell wall and hence low digestibility, deficiency of some nutrients, low voluntary intake, etc. (Van Soest 1976; Ørskov 1977; Anderson 1978). Various physical and chemical methods have been developed to improve the nutritive value of these materials, the most commonly used being grinding, and treatment with sodium hydroxide (NaOH) or ammonium hydroxide (Pigden 1971; Donefer 1973; Rexen et al 1976; Jackson 1977).

Maize cobs are a fibrous residue generated during the separation of maize grain from the cobs either at the level of the farm or by agro-industry. In Venezuela these maize cobs are usually burnt. To utilize this material for animal feed it must be ground and supplemented with other nutrients, and if used as a high proportion of the diet an increase in the availability of energy is desirable. The present study was intended to evaluate, in growing cattle, the effect NaOH treatment with rations based on maize cobs.

## Materials and Methods

*Treatments and design:* The experimental treatments were I) Ground maize cobs (20 mm screen) without NaOH treatment II) Ground maize cobs treated with 5% NaOH III) Ground maize cobs incorporating the NaOH in another ration ingredient (molasses). A randomized block design was used with 4 animals for each treatment. The experiment consisted of a 25 d adaptation period and 75 d experimental period.

*Animals*: Twelve male Holstein steers born in Maracay Venezuela with a initial liveweight of 220 ± 15 kg were used. All animals were treated for intestinal parasites before the experiment was commenced.

*Diets*: The treated and untreated maize cobs were ensiled for one week before feeding with addition of 80 l water or 80 l water plus 5 kg NaOH per 100 kg maize cob DM. The mixture was placed in 200 l drums lined with plastic bags at an ambient temperature of 23°C. For treatments I and II molasses-urea (85% molasses, 10% water and 5% urea) was mixed with the maize cobs, while for treatment II the molasses-urea was mixed with NaOH in the ratio of 6 kg NaOH and 94 kg of molasses-urea and then mixed with the maize cobs.

For all the treatments 825 g/d of a concentrate supplement (cotton-seed meal 91.5%, minerals 6.1%, premix of vitamins and minerals 1.2% and sulphur 1.2%) and fresh Elephant grass pasture (*Pennisetum purpureum*); 1% of liveweight, as a source of long fibre, was given to each animal.

*Procedures*: The maize cobs and molasses were mixed (60/40 respectively) before being offered to the animals. The forage and concentrate were given at the same time as the maize cobs and molasses, but in a separate feed trough. The animals had free access to water and were housed in individual pens (3 x 6 m) partially paved and roofed.

*Measures*: The animals were weighed each 15 days (08:00 h) and on 3 consecutive days at the beginning and end of the experiment. The rate of liveweight gain was calculated from the linear regression of liveweight and time. The food offered and refused was weighed and subsampled each day, and following drying was analysed for crude protein (A O A C 1965), cell wall constituents (Van Soest and Wine 1967) and *in vitro* digestibility (Alexander and McGowan 1966). The pasture and concentrate supplement were always completely consumed. Statistical comparisons between treatment means were made using Duncan's Multiple Range Test (Steele and Torrie 1960).

## Results

Mean values for chemical composition and organic matter *in vitro* digestibility for the ingredients and experimental rations are given in Table 1. The chemical treatment significantly increased the digestibility of the maize cobs and this was associated with a reduction in cell wall content.

The increase in digestibility of Diet III in comparison with Diet I indicated that there was a relatively high content of free NaOH in the molasses that reacted with the maize cobs during and after the mixing of these dietary constituents. However the effect of the alkali was less

*Table 1:*

*Chemical composition and in vitro digestibility of organic matter (OMDIV) of the ingredients and experimental rations.*

| Material | Crude protein (% MS) | Cell wall (% MS) | OMDIV (%) |
|---|---|---|---|
| Maize cobs with NaOH | 3.1 | 80.5[a] | 31.1[a] |
| Maize cobs without NaOH | 3.2 | 71.0[b] | 53.4[b] |
| Concentrate supplement | 36.0 | 23.9 | 71.6 |
| Forage | 8.0 | 74.5 | 36.4 |
| Maize cobs-molasses (urea) | 10.3[a] | 54.7[a] | 47.3[a] |
| Maize cobs-molasses (urea + NaOH) | 9.7[ab] | 46.7[b] | 54.5[b] |
| Maize cobs (NaOH) - molasses (urea) | 9.3[b] | 45.5[b] | 66.2[c] |
| Diet I | 13.3[a] | 51.9[a] | 49.7[a] |
| Diet II | 12.2[b] | 44.5[b] | 65.4[c] |
| Diet III | 13.2[a] | 45.2[b] | 55.8[b] |

Values are the mean of 4 samples.

Means with different letters in the same column and within each group of data are significantly different ($P < 0.01$).

*Table 2:*

*Mean values for intake, rate of liveweight gain and food conversion.*

| | Diets | | |
|---|---|---|---|
| | Control (I) | Maize cobs NaOH(II) | Molasses-NaOH(III) |
| Intake (kg/d) | | | |
| Maize cobs | 3.31[b] | 3.80[c] | 2.87[a] |
| Molasses-urea | 2.20[b] | 2.53[c] | 1.91[a] |
| Concentrate | 0.82 | 0.82 | 0.82 |
| Forage | 0.36 | 0.36 | 0.36 |
| Total DM | 6.70[b] | 7.52[c] | 5.97[a] |
| Liveweight change (kg/d) | 0.406[a] | 0.700[b] | 0.433[a] |
| Consumption index[1] | 2.86 | 3.13[b] | 2.74[a] |
| Feed conversion[2] | 16.7[a] | 10.8[c] | 13.8[b] |

[1] Feed intake kg DM/100 kg liveweight per day.

[2] Feed intake kg DM liveweight gain.

Mean values with different letters in the same line are significantly different ($P < 0.05$).

than that observed for Diet II. This can be explained by the lesser time for reaction and by the partial neutralization of NaOH by the molasses. The crude protein content of Diet II was less then that of the other diets.

Significant differences were observed in the voluntary intake of DM, liveweight gain and food conversion. The best response was obtained with treated maize cobs (Diet II). The incorporation of NaOH in the molasses reduced intake, increased food conversion and did not affect liveweight gain as compared to the control (Table 2).

In Table 3 are given the estimates of mean intake of digestible DM, crude protein and metabolizable energy. These estimates show clearly the differences in energy and protein intake between treatments, intake with Diet II being considerable greater then with Diets I and III.

*Table 3:*

*Intake of crude protein, digestible DM and metabolizable energy.*

| Intake | Diets | | |
|---|---|---|---|
| | I | II | III |
| Digestible DM (kg/d) [1] | 3.33 | 4.92 | 3.33 |
| Crude protein (g/d) | 894 | 915 | 790 |
| Metabolizable energy (MJ/d) [2] | 48.9 | 72.4 | 48.9 |

[1] Estimated from DM intake and *in vitro* digestibility.

[2] Estimated by: Digestible organic matter (% of DM) x 0.19 DE(MJ/kg DM) x 0.81 ME (MJ/kg DM).

## Discussion

The effect of alkali on digestibility of maize cobs observed in the present experiment was similar to previous reports (Klopfenstein 1978; Singh and Jackson 1971; Escobar and Parra 1979). For 15 experiments reviewed by Escobar and Parra (1981) with cattle fed diets where fibrous residues constituted 64.4 17.4 % of the total ration, the mean increases due to alkali treatment in feed intake, rate of liveweight gain and feed conversion were 21.6, 67.4 and 40.1 % respectively. The respective increases observed in the present experiment of 12.2, 72.4 and 35.3 % are similar to the mean responses cited above, although the maize cobs constituted only 50% of the diet in the present experiment.

In a previous experiment where similar rations were fed to sheep (Escobar and Parra 1983). a relatively greater response was observed with alkali treatment. However in these experiments a large proportion of the residue was ground before NaOH treatment and greater responses to grinding of feed are usually observed in sheep than in cattle (Greenhalgh and Wainman 1972). The differences between the two experiments may be associated with the physical rather than the chemical treatment, although the present experiments do not provide a definitive answer.

The incorporation of NaOH in the molasses significantly reduced volu·ary intake indicating that there was a negative effect of a high leve of residual alkali. However, the increase in feed conversion with the ame consumption index suggests more efficient use of metabolizable energy, possibly associated changes in rumen dilution rate, rumen fermentation patterns and sites of digestion. An increased rumen dilution rate may occur by an increased ruemn liquid osmotic tension and a higher water consumption. In this experiment, no water consumption was measured. However, it is a constant response by animals fed with treated FAR diets (Jackson 1977, Maeng et al 1971).

An increased rumen dilution rate has been found by infusing $NaHCO_3$ (a product which can be found with NaOH residue in rumen)into rumen (Harrison et al 1975). An increased rumen dilution rate may associated with increased YATP in the rumen (Isaacson et al 1975; Prigge et al 1978) and an increased proportion of dietary protein escaping fermentation in the rumen (Hespell 1979).

Liveweight gain observed with diets I and III was similar to the expected gain on the basis of ARC (1980) requirements and the measured intake of metabolizable energy and protein. However, the expected gain form the intake of metabolizable energy and protein with Diet II was greater than 1000 g/d whereas the observed gain was only 700 g/d. This is in agreement with the experiments of Holzer et al (1980) with diets of NaOH treated wheat straw where observed liveweight gain was less than that expected from the intake of metabolizable energy. digestibility tends to overestimate digestibility of alkali-treated residues (Escobar and Parra 1981), and therefore overestimation of metabolizable energy intake with alkali treatment may explain in part the apparent low efficiency of utilization of metabolizable energy in the present experiment. However the pattern of ruminal and postruminal digestion end products may also be involved.

## References

A R C 1980 The nutrient requirements of ruminant livestock C A B England 351 p.

Anderson G D 1978 Use of cereal residues in beef cattle production systems Journal of Animal Science 46:849-861.

A O A C 1965 Official methods of analysis (10th ed) Association of Official Agricultural Chemists Washington.

Alexander R H & M McGowan 1966 The routine determination of *in vitro* digestibility of organic matter in forages an investigation of the problems associated with continuous large-scale operation Journal British Grassland Society 21:140-147.

Dyer I A, E Riquelme, L Barrido & B Y Couch 1975 Resíduos de celulosa como fuente energética para producir proteínas de origen animal Revista Mundial de Zootecnia (FAO) 15:39-43.

Donefer E 1973 Effect of processing on the nutritive value of roughages from agriculture for animal feeding: physical treatment at comercial and farm level En: Technical Consultation on new feed resources, FAO. Roma pp. 17-24.

Escobar A & R Parra 1979 Efecto del tratamiento con álcali (NaOH) sobre la composición química y digestibilidad *in vitro* de diferentes RAF Informe Anual IPA 1978 Instituto de Producción Animal, Facultad de Agronomía UCV. Maracay pp 41-42.

Escobar A & R Parra 1981 Los residuos agrícolas fibrosos como recurso alimenticio En Primer Simposio Nacional sobre Desechos Agroindustriales. Fundación CIEPE 7-8 de julio de 1980 San Felipe, Yaracuy, Venezuela pp 172-223.

Escobar A & R Parra 1983 Tusa de maíz en raciones para ovinos: efecto del nivel de álcali, de tusa y de urea en la dieta sobre la respuesta animal Producción Animal Tropical (En prensa).

González Jiménez E 1981 Los residuos agrícolas fibrosos como recurso energético En Primer Simposio Nacional sobre Desechos Agroindustriales Fundación CIEPE 7-8 de julio de 1980 San Felipe, Yaracuy, Venezuela pp 148-171.

Greenhalgh J F & F W Wainman 1972 The nutritive valve of processed roughages for fattening cattle and sheep Proc Br Soc Anim Prod pp 61-72.

Harrison D G, D E Beever, D J Thomson & D F Osbourn 1975 Manipulation of rumen fermentation in sheep by increasing the rate of flow of water from the rumen Journal of Agricultural Science Cambridge 85:93-101.

Holzer Z, D Levy & Y Folman 1980 The incorporation of alkali-treated straw in fattening rations for male cattle. Animal Production 31:237-242.

Hespell R B 1979 Efficiency of growth by ruminal bacteria Federation Proceedings 38:2707-2712.

Isaacson H R, F C Hinds, M P Bryant & F N Owens 1975 Efficiency of energy utilization by mixed rumen bacteria in continuous culture Journal of Dairy Science 58:1645.

Jackson M G 1977 Review article: the alkali treatment of straws Animal Feed Science and Technology 2:105-130.

Klopfenstein T J 1978 Chemical treatment of crop residues Journal of Animal Science 46: 841-848.

Maeng J W, N D Mowat & K W Branski 1971 Digestibility of sodium hydroxide-treated straw feed alone or in combiuation with alfalfa silage Can J Anim Sci 51:743-747.

Ørskov V R 1977 Nutritional principles and evaluation of by products waste products and new feeds for ruminants Livestock Production Science 4:165-175.

Pigden W J 1971 Effect of physical and chemical processing and non-protein nitrogen (NPN) supplementation on utilization of lignocellulose. En: Report of an ad hoc consultation on the value of non-protein nitrogen for ruminants consuming poor herbages, FAO 29 de junio-3 de julio Kampala Uganda p 114-132.

Prigge E C, M L Galyean, F N Owens, D G Wagner & R R Johnson 1978 Microbial protein synthesis in steers feed processed corn rations Journal of Animal Science 46:249-257.

Rexen F, P Stigsen & V Kristensen 1976 The effect of a new alkali technique on the nutritive value of straws En: Feed energy sources for livestock. D Swan y D Lewis eds. Butterworths: London pp 65-82.

Steel G D & J H Torrie 1960 Principles and procedures of statistics McGraw-Hill Book Co Inc New York.

Singh M & M G Jackson 1971 The effect of different levels of sodium hydroxide spray treatment of wheat straw on consumption and digestibility by cattle Journal of Agricultural Science Cambridge 77:5-10.

Van Soest P J & R Wine 1967 Uses of detergents in the analysis of fibrous feeds IV Determination of plant cell-wall constituents J Ass Official Agr Chem 50:50-55.

Van Soest P J 1976 Laboratory methods for evaluating the energy value of feeds stuffs En: Feed energy sources for livestock (ed. H Swan y D Lewis) Butterworths: London pp 83-94.

Ward K J 1978 Utilization of corn and grain sorghum residues in beef cow forage systems Journal of Animal Science 46:831-840.

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