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# EFFECT OF Ca $(OH)_2$ AND Na OH TREATMENTS ON THE NUTRITIVE VALUE OF MAIZE STALKS, SORGHUM STALKS AND DRY SWEET POTATO VINES

*By*

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Maize stalks, sorghum stalks and dry sweet potato vines were treated with 1.5% Ca $(OH)_2$ ethod 1 (soaking, washing and feeding wet), and Method 2 (soaking, draining and drying) and with Na OH. Method 3 (soakiug, washing and feeding wet). Twelve digestion trials with duplicate sheep were performed, 4 with each material using clover hay as a basal ration. The treatments increased appreciably the starch value of the residues, the increase being higher with NaOH than the other two Ca $(OH)_2$ methods which practically have the same effect. The differences among methods and plant residue and the interaction were statistically studied using the net starch value produced. With the three materials, Ca $(OH)_2$ has practically similar net effect as NaOH, but the former is cheaper and more preferable in practice.

These series of studies was a continuation of a previous work (Abou-Raya et al, 1963, Ghoneim et al, 1963 and Mohamed, 1959) which was carried out to choose the suitable alkali Ca $(OH)_2$ method for treating roughages. In Egypt although, ca. 10 million tons of plant residues are available (Ministry of Agriculture, U.A.R., 1962 a and b) yet ca. 2 million tons of wheat straw and barley straw are only used for feeding. Making full use of other roughages appeared to be essential. These includes ca. 2.6. million tons of maize stalks, ca. 0.3 million tons of its corn cobs, ca. 2 million tons from cotton stalks, ca. 0.6 million tons from sorghum stalks and 0.6 million tons of rice straw along with other residues as industrial by-products mainly extracted sugar cane, peanut hulls and onion skin. Other roughages are produced from vegetable by - products such as sweet potato vines, but it is not custmarily used for feeding. Therefore, a scheme was planned to study, systematically the response of the main plant residues or their industrial by - products to different alkali methods.

The present industrial revolution put into consideration the production of NaOH on a large commercial scale in the near future. Therefore it was necessary to study the effect of NaOH on these roughages.

Regarding the Ca $(OH)_2$ methods, it was found from previous work (Abou-Raya et al, 1963 and Ghoneim et al, 1963) that soaking methods, (1. 5% Ca $(OH)_2$ were more recommended than moistening. The method of soaking without washing then drying gives the best results followed by the method of soaking and washing then feeding wet.

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Regarding the NaOH methods, although drastic means were used at first (Engles, 1920, Honcamp et al, 1921, Honcamp et al, 1911, Watson, 1941, Williamson, 1941 and Woodman and Evans, 1947), yet mild procedures were preferred to reduce losses during the treatment. The mild methods which were adopted by several investigators were by soaking the plant material in 1-1.5% NaOH solution for 24 hours or overnight (Beckman and Sitzbert, 1919, Fingerling, 1919, Godden, 1920 and 1942, Hivdsten and Homb 1948, Homb 1948, Ewata 1962, Mc Anally, 1942, Prjanischnikov and Nesterova, 1935, Sayed, 1954, Sen et al 1942, Slade et al 1939, Wagner and Scholb, 1919, Watson, 1941 and Williamson 1941). The lowest concentration of NaOH used was 0.25% in the cold, and the shortest time for soaking was 3 hours (Ferguson 1942 and 1943 and Fingerling, 1919). Beckmann's procedure (Beek man and Sitz bert, 1919) was preferred by most workers by soaking in 1.25%. NaOH solution for 24 hours. This procedure was considered suitable in this series of investigation to make results comparable with those using the same method.

In this paper, the effect of $Ca(OH)_2$ methods and NaOH on the feeding value of maize stalks, sorghum stalks and the sweetpotato vines was studied. The first two are produced on a large scale. The sweetpotato vines were taken as an example of residues from vegetables and crops usually grown in newly reclaimed soils.

The composition and feeding value of maize stalks was recorded by Kellner, 1962 and Sayed 1954 having 20 to 23% starch value (ca. 43 T.D.N.). The maize stalks in Egypt Ministry of Agriculture U.A.R. 1962 a and b and Sayed 1954 seemed to have higher ash content than recorded abroad Kellner, 1926. The sorghum stalks from the Egyptian species (vulgare var. durra.) were neglected in animal nutrition research, while other roughages had been studied. The sweetpotato vines were fed green to cows by Harrison, 1912 and dry by Katayma, 1914. Their data indicated that the green vines have a starch value of 10.4 (12.3 T.D.N.) which was similar to that of the green clover ; the dry vines were similar to clover hay, the dry vines contained relatively high content of protein and low content of crude fibre when compared with local wheat straw.

## EXPERIMENTAL AND METHODS

### Alkali methods

Three alkali methods were used :

*Method 1 :* Soaking the plant material for 24 hours in 1.5% $Ca(OH)_2$, washing, draining and feeding wet, following the previous procedure (Abou Raya et al, 1963).

*Method 2 :* Soaking the plant material for 24 hours in 1.5% $Ca(OH)_2$, draining the alkali solution and drying then feeding dry, following the previous procedure (Ghoneim et al 1963).

*Method 3:* Soaking the plant material in 1.25% NaOH solution for 24 hours. The details of this procedure are as follows :

Two kgs. of the air dried material were soaked for 24 hours in 16 litres of water containing 200 grams of caustic soda (1.25% NaOH). Draining was then performed. Washing with fresh water was repeated for 4-5 times with about 16 litres of water till the washings became neutral. The washed residure was drained for 24 hours, weighed and offered to the rams in metabolic cages.

The digestibility trial technique, analysing food and faces, the methods of sampling, calculating the feeding value followed the same lines before (Abou-Raya et al, 1963.) using clover hay as a basal ration.

Twelve digestibility trials were performed, four with each material using duplicate sheep. The preliminary period was 10 days followed by a 10-days collection period. The maize stalks were from Zea maize grown at the Experiment Station, Faculty of Agriculture. Sorghum stalks were from sorghum vulgare var. durra obtained from Fayoum Province. The sweetpotato vines were taken from the green crop grown at the Faculty's Farm after being sun dried.

The plant material was chopped into ca. 2-4 cm. in length. It was offered to animals as such or after being treated with alkali. The maize stalks were prepared from the whole dry mature plants after taking the grains and the cobs. Some of the leaves were included in the stalks. In case of sorghum stalks, the tops containing the grains were removed leaving the stalks with some leaves.

## RESULTS AND DISCUSSION

*Composition.*

Results in Table 1 indicate that the wet alkali treated material contained 15 to 24% dry matter. The NaOH product contained 4-5 degrees of percentage dry matter less increases than the Ca $(OH)_2$ wet product. On dry matter basis, the treatment increase the ash content particularly with Ca $(OH)_2$ methods. There was also a slight decrease in the crude fibre and a noticeable decrease in the soluble carbohydrates (N.F.E.). Such decreases were undoubtedly due to the soluble and washable material during the alkali treatment being more related to the nitrogen free extractives. With sweet potato vines, the NaOH dissolved out an appreciable amount of crude protein.

*Digestion coefficients.*

Concerning the major nutrients, the digestion of the crude fibre increased very noticeably in all cases, the increase being greater with NaOH. The increase was from 40 to 50% in the untreated material to ca. 60 to 90%. With the nitrogen free extractives, the increases in digestion coefficients were negligible with maize stalks and sweet potato vines (2 to 5 degrees of percentage). It was more noticeable with sorghum stalks (7 to 17 degrees more). The nature of the lost soluble material by the treatment might have a direct effect on the digestion coefficient of the remaining nitrogen free extractives. The alkali material seems also to have an effect. It was noticeable with sorghum stalks that although the losses in dry matter were greater with NaOH treatment, the digestion coefficient of the N.F.E. was noticablly higher than with Ca $(OH)_2$ methods. The subject needs further investigation because the plant materials seem to differ in their response.

TABLE I.—**Analysis and feeding value of the by-products**

| By-product | Dry matter as fed | Composition of dry matter | | | | |
|---|---|---|---|---|---|---|
| | | Crude protein | Ether extract | Crude fibre | N.F.E. | Ash |
| | % | % | % | % | % | % |
| *Maize stalks :* | | | | | | |
| Untreated . . . . | 81.50 | 3.85 | 1.43 | 36.20 | 47.30 | 11.22 |
| Ca $(OH)_2$ Method 1 | 22.55 | 4.16 | 1.45 | 38.61 | 39.58 | 16.26 |
| Ca $(OH)_2$ Method 2 | 93.00 | 4.59 | 1.08 | 39.62 | 40.58 | 14.13 |
| Na (OH), Method 3 | 17.45 | 3.68 | 0.97 | 42.57 | 40.15 | 12.63 |
| *Sorghum stalks :* | | | | | | |
| Untreated . . . . | 83.00 | 3.05 | 0.68 | 42.35 | 45.04 | 8.88 |
| Method 1 . . . . . | 20.62 | 2.79 | 0.57 | 43.12 | 42.57 | 10.95 |
| Method 2 . . . . . | 79.55 | 2.15 | 0.53 | 44.44 | 41.76 | 11.12 |
| Method 3 . . . . . | 14.88 | 2.24 | 0.58 | 45.87 | 41.61 | 9.70 |
| *Sweet potato vines :* | | | | | | |
| Untreated . . . . | 90.00 | 10.80 | 2.34 | 29.62 | 41.41 | 15.83 |
| Method 1 . . . . . | 24.00 | 9.76 | 2.06 | 30.54 | 37.07 | 20.57 |
| Method 2 . . . . . | 88.55 | 9.20 | 2.25 | 32.07 | 37.12 | 19.36 |
| Method 3 . . . . . | 20.17 | 6.37 | 1.78 | 38.17 | 37.32 | 16.36 |

**and their alkali treated materials.**

| Digestion coefficients | | | | Feeding value | | Losses in dry matter | Net S.V., kg/100 kg. original dry matter | |
|---|---|---|---|---|---|---|---|---|
| Crude protein | Ether extract | crude fibre | N.F. E. | as fed | of dry matter | | Animal 1 | Animal 2 |
| % | % | % | % | % | % | % | | |
| —30.81 | 26.86 | 51.55 | 59.19 | 19.86 | 24.36 | — | 24 | 24 |
| — 4.09 | 120.35 | 77.14 | 64.74 | 8.07 | 35.78 | 8.63 | 30 | 35 |
| 4.10 | 53.49 | 85.59 | 66.95 | 36.61 | 39.47 | 5.48 | 36 | 39 |
| 82.06 | 200.95 | 91.84 | 60.46 | 7.57 | 43.37 | 11.48 | 39 | 43 |
| —21.12 | —30.22 | 49.93 | 51.31 | 16.34 | 19.69 | — | 22 | 16 |
| 166.87 | 384.85 | 83.64 | 58.82 | 9.16 | 39.81 | 6.88 | 42 | 46 |
| 101.14 | 238.67 | 80.84 | 61.71 | 34.85 | 38.08 | 3.75 | 38 | 41 |
| 108.51 | 256.36 | 93.64 | 68.96 | 7.95 | 48.26 | 13.44 | 47 | 43 |
| 22.54 | 67.66 | 38.59 | 67.78 | 24.83 | 27.59 | — | 25 | 29 |
| 37.95 | 74.11 | 61.28 | 72.99 | 8.99 | 37.44 | 7.56 | 30 | 34 |
| 92.99 | 68.82 | 57.96 | 73.08 | 32.42 | 36.79 | 4.12 | 32 | 38 |
| 91.80 | 88.43 | 78.05 | 68.60 | 8.42 | 41.75 | 10.83 | 37 | 43 |

The coefficients of minor nutrients increased greatly, being over 100 in most cases. This might be attributed to the fact that any slight decrease in the digestion coefficients of such nutrients in the basal ration due to the associative effect would be exagerated, indicating as very high apparent digestion. This could possibly happen particularly if the basal ration contains much higher contents of crude protein and crude fat. This could be seen from the relatively moderate increase of such coefficients with sweet potato vines which contain relatively high content of crude protein and crude fat. Nevertheless, the high apparent digestion with such minor nutrients would not materially affect the calculated feeding value of the product.

*Feeding value :*

The products fed wet were close in feeding values being ca. 8–9% starch value (S.V.) with the three alkali treatments and among the three plant materials On dry matter basis, it was clear that NaOH was more effective than the two Ca $(OH)_2$ methods which have practically the same effect. The difference between both chemicals was greater in case of sorghum scalks, being ca. 9 degrees of S.V. The feeding value of the dry alkali products varied between 36 and 48% S.V. being similar to good quality clover hay or even better for providing the energy requirements.

The net effect of the alkali treatment was studied from net starch value obtained from 100 kg. dry matter of the untreated material considering the losses in dry matter. The Overall interpretation : from the analysis of varience were as follows :

(1) Treatments clearly increased S.V. in Alkali plant residuce tested.

(2) NaOH method was superior to the other two.

(3) There was no interaction with effectiveness of (OH) method and plant residue *i.e.* no one method was more effective than another with any specific residue. The interaction suggested in the first analysis was due to the fact that sorghum stalks responded more to (OH) treatments than the other plant residues.

There was no interaction when increases in S.V. were tested against methods used.

(4) It can be concluded that the type of plant residue had no influence on the effectiveness of the (OH) methods. Na (OH) method was superior to either of those involving Ca (OH) and both of the latter were equally effective. It seems that the selection of the method to be used, then, rests upon factors such as availability of (OH), cost of process, convenience in practice, etc. It is suggested in this study that the NaOH method may increase the S.V. of plant residues about 1.3 as much as the $Ca(OH)_2$ methods. This, of course, would need to be investigated more critically, (Mean increase due to NaOH 18.66 S.V., due to Ca (OH), 13.42). How does cost and convenience compare ?.

The Ca $(OH)_2$ methods appeared to be more applicable in practice in meantime, being less costly and more available allover the country. The ordinary farmer is familiar with handling the lime using simple appliences. In the

near future, drying plants could be used at suitable centres when the electricity and fuel become cheaper for economical preparation of the product. Moreover, the cheap fuel would encourage the farmer to avoid burning the stalks as customarily done.

*The replacement value of the products* :

For practical application of the products, their equivalent to a standard feed is very useful. Taking one kilogram of air dried local wheat straw having a feeding value of 25% S.V., the following equivalents of the different products (To the nearest 0.25 kg.) was summarised in the following table :—

| Feeding-stuffs | Untreated | Ca $(OH)_2$ wet | Ca $(OH)_2$ dry | Na OH wet |
|---|---|---|---|---|
| Maize stalks . . . . | 1.25 | 3.0 | 0.75 | 3.25 |
| Sorghum stalks . . . | 1.5 | 2.75 | 0.75 | 3.0 |
| Sween potato vines . | 1.0 | 2.75 | 0.75 | 3.0 |

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# تأثير ايدروكسيد الكالسيوم والصوديوم على القيمة الغذائية

## الملخص

لقد عوملت ثلاث متخلفات زراعية وهى حطب الذرة الشامى ، وحطب الذرة الرفيعة ، وعرش البطاطا الجاف ، بالقلويات بثلاث طرق :

( أ ) المعاملة بالجير ٥ر١ ٪ ثم الفسيل والتغذية عليه رطبا .

(ب ) المعاملة بالجير ٥ر١ ٪ والتصفية والتجفيف هوائيا .

(جـ) المعاملة بالصودا الكاوية ٢٥ر١ ٪ والفسيل والتغذية عليه رطبا .

ولقد أجريت اثنتا عشرة تجربة هضم على خروفين تامى النمو واستخدام الدريس كعليقة أساسية وذلك لمقارنة القيمة الغذائية للمادة المعاملة بالطرق المختلفة بتلك الغير معاملة ، ولقد وجد أن المعاملة بالقلويات قد رفعت القيمة الغذائية لحطب الذرة الشامى من ٣٦ر٢٥ كجم معادل نشا لكل ١٠٠ كجم مادة جافة الى ٧٨ر٣٥ ، ٤٧ر٣٩ و ٣٧ر٤٣ عند المعاملة بالطرق ( أ ) ، ( ب ) ، ( جـ ) على الترتيب . ولقد بلغ الفقد فى المادة الجافة عند المعاملة بالقلويات ٥٣ر٩ ، ٤٨ر٥ ، ٤٨ر١١ ٪ فى هذه المعاملات على الترتيب وبذلك أصبح الصافى من القيمة الغذائية هو ٦٩ر٣٢ ، ٣١ر٣٧ ، ٣٩ر٣٨ كجم نشا مهضوم ناتجة عن ١٠٠ كجم مادة جافة قبل المعاملة بالترتيب . وفى حالة الذرة الرفيعة زادت القيمة الغذائية بالمعاملة من ٦٩ر١٩ ( كجم نشا/١٠٠ كجم مادة غير معاملة ) الى ٨١ر٣٩ ، ٠٨ر٣٨ ، ٢٦ر٤٨ فى المعاملات ( أ ) ، (ب) ، (جـ) على الترتيب مع فقد مقابل فى المادة الجافة بلغ ٣٨ر٦ ، ٧٥ر٣ ، ٤٤ر١٣ ٪ على الترتيب وبذلك نتجت قيمة غذائية صافية تبلغ ٠٣ر٣٧ ، ٦٥ر٣٦ ، ٧٧ر٤١ كجم قيمة نشوية من كل ١٠٠ كجم مادة جافة قبل المعاملة بالترتيب . ولقد كانت النتائج متشابهة فى حطب الذرة الشامى والعويجة من الناحية العملية وذلك بعد المعاملة بالطرق الثلاثة رغم أن حطب الذرة العويجة الغير معامل أقل فى القيمة الغذائية من حطب الذرة الشامى الغير معامل . وفى حالة عرش البطاطا الجاف فان قيمته الغذائية قبل المعاملة بلغت ٥٩ر٢٧ كجم معادل للنشا فى المادة الجافة تماما وبعد المعاملة ارتفعت القيمة الغذائية الى ٤٤ر٣٧ ، ٧٩ر٣٦ ، ٧٥ر٤١ فى المادة الجافة باستخدام الطرق ( أ ) ، ( ب ) ، ( جـ ) على الترتيب وكان الفقد المقابل فى المادة الجافة هو ٥٦ر٧ ، ١٢ر٤ ، ٨٣ر١٠ ٪ على الترتيب مما جعل القيمة الغذائية

الصافية ( من معـــاملة ١٠٠ كجم مادة جافة تمـــاما من المادة الخشـــنة بالقلويات ) تبلغ ٣٤٫٦١ ، ٣٥٫٢٢ ، ٣٧٫٢٣ كجم معادل نشـــا على الترتيب وهذه النتائج تشابه كذلك ما حدث فى حالة حطب الذرة الشـــامى والعويجة ، كما أن تأثير المعاملة بالجير بعد خصم الفقد فى المـــادة الجافة يشابه من الناحية العملية تأثير المعاملة بالصودا الكاوية ولذلك يفضل استخدام الجير لرخصه وسهولة الحصول عليه كما درس تأثير المعـــاملة واختلاف المـــادة المستخدمة احصائيا باستخدام معادل النشا الصافى من كل معاملة .