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# PRESENT SITUATION ON THE UTILIZATION OF BY-PRODUCTS OF THE SUGAR INDUSTRY IN MAURITIUS*

by

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## INTRODUCTION

The sugar cane plant develops as a clump or stool made up of an underground portion or rhizome from which the roots normally develop and an aerial portion, constituted by a number of upright or recumbent stalks, each bearing about ten green leaves at its top and a variable number of dried leaves, adhering more or less strongly to the stem.

The sugars manufactured in the leaves are stored in the stems and it is this pórtion of the plant which is harvested at ground level, topped and sent to the mills. What is left in the field after harvest are : the underground portion of the plant from which the next, or ratoon, crop will grow, the dried leaves and the green tops made up of the leaves and immature portion of the cane, the sucrose content of which is too low to justify milling.

When the sugar cane is grown for the production of sugar, the by-products, which are available in the field, are the cane tops and the trash, and, in the factory, bagasse from the mills, filter muds from the juice filters and molasses from the centrifugals.

In Mauritius, the area under sugar cane reaped annually amounts to some 80 000 hectares. On the basis of an average sugar cane crop of 6 million tonnes cane (or 685 000 tonnes sugar), the amount of the various by-products available would be as follows :

| | Tonnes |
|---|---|
| Sugar cane tops | 1 800 000 |
| Bagasse (dry) | 840 000 |
| Molasses | 180 000 |
| Filter muds | 180 000 |

As it is felt that, in developing countries, when contemplating the establishment of a fermentation alcohol industry for use as fuel and chemical feedstock, the potential utilization of the other by-products of the sugar industry should be taken into account when assessing economic feasibility, the object of this paper is to discuss the utilization of these by-products under Mauritian conditions.

## ANIMAL FEED

The potential value of these by-products as animal feed is determined by their average nutrient composition, which is as follows :

| | Crude Protein | Crude Fibre | Ether Extract | Total Sugars |
|---|---|---|---|---|
| Cane tops % d.w. | 5.0 | 34.0 | 2.0 | 12 - 15 |
| Bagasse % d.w. | 1.7 | 49.0 | 0.7 | 2 |
| Filter muds % d.w. | 14.0 | 19.0 | 7.0 | 12 - 15 |
| Molasses % f.w. | 3.5 | 0 | 0 | 64 |

### (a) Cane tops

There is considerable interest in the utilization of cane tops as fodder for ruminants. In Mauritius, the crop season lasts 5-6 months of the year and, during that period, it has been estimated that just under 2 million tonnes of fresh cane tops are left in the field, while, during the inter-crop period, there is an acute shortage of fodder. This seasonal availability has led to studies on the storage properties of ensiled cane tops, as ensilage appears to be the most convenient method of conservation of this fodder. Laboratory experiments have shown that addition of molasses (5 or 10%) and ammonia (at 0.2% N) could contribute to the production of good quality silage (5). Feedlots trials then established that performance of animals was not affected whether they were given fresh or ensiled cane tops as fodder. Furthermore, the rumen fermentation process, as measured by volatile fatty acid production, were not greatly affected by ensiling (4).

The utilization, as cattle feed, of the considerable amount of cane tops left in the field at harvest should not be overlooked when planning alcohol production either directly from sugar cane or indirectly through the utilization of molasses from sugar factories. However, it should be borne in mind that, with the increased utilization of mechanical loading and harvesting of sugar cane, even in developing countries, this has led to more and more widespread burning of the cane fields before harvest. Experiments conducted so far have been on fresh cane tops from unburnt fields. It would be important to assess both the quantity and quality of cane tops, after burning, for direct utilization as fodder and after ensilage.

## (b) Bagasse

Bagasse, which is the fibrous mass obtained after extraction of the juice from the sugar cane stalks, has an average composition of 43-52% fibre, 46-52% moisture and 2-6% soluble solids (mostly sugars) (7). The fibre, which is the part insoluble in water is made up of cellulose, pentosans and lignin.

Of the 840 000 tonnes of dry bagasse produced on an average annually in Mauritius, 99% or 831 000 tonnes are burnt directly in the furnaces to produce the steam required to generate the energy needed to run the sugar mill; the surplus energy being supplied in the form of electricity to the public grid.

As early as 1904, Bonâme (3), in Mauritius, advocated the use of bagasse in animal feeding as a carrier for molasses. It was not considered, at the time, that the bagasse itself, being composed essentially of crude fibres with, as a result, a low palatability and digestibility, could be a possible source of nutrient. However, recently, after the finding that hardwood wastes when steamed under pressure could have an energetic value equivalent to a moderate quality hay, Bender (9) postulated that bagasse, with a similar structural carbohydrate arrangement, should respond to the treatment in the same way.

Bagasse was subjected to various steam treatments in Mauritius and digestibility experiments conducted *in vitro* and *in vivo* on the product obtained. It was found that steaming of bagasse at 14 bars for 10 minutes more than doubled palatability, while digestibility of the crude fibre fraction remained unchanged (11). Further work conducted by Preston (9) showed that steam-treated bagasse, supplemented with urea and a small amount of molasses could provide the necessary requirements of cattle for maintenance and pregnancy, but that for growth or milk production, a higher energy feed, e.g. molasses, should be supplemented or further processing of the bagasse was necessary to increase digestibility.

(c) Molasses

Molasses can play an important role as animal feed in cane sugar producing countries. For several years, final or blackstrap molasses have been utilised in small amounts mainly as an additive to increase palatability or as an aid to pelletizing in conventional dry mixed rations. It was feared that higher levels of molasses needed for fattening cattle would lead to digestive disturbances. However, dry feeds have been formulated with high levels of molasses, but have not found widespread application, mainly in developing countries, on account of their poor handling qualities, but even more so on account of the high cost of the equipment needed and the difficulties experienced in the mixing operation. However, further to the work carried out in Cuba, the incorporation of high levels of molasses in cattle rations is now widely practised, the underlying concept being that the molasses had to be mixed, transported and fed as a liquid. Owing to their high content of total sugars (more than 50%), molasses are an excellent source of energy and an ideal substrate for introduction of non-protein nitrogen (such as urea) in the feed. Its stimulation of microbial activity in the rumen increases the digestibility of low grade roughages such as cane tops, straw and even bagasse. However, when high levels of molasses are used, in order to obtain optimum performance, roughage input, such as sugar cane tops, fresh or ensiled (another by-product) has to be critically assessed, and supplementary nitrogen and protein are necessary (9).

Unfortunately, in Mauritius, as in many developing countries, molasses is exported as such to industrialised countries, where it is used as animal feed. Mauritius thus exports 87% of its production annually on long-term trading arrangements.

(d) Filter muds

Filter muds, although they contain some 14% protein on a dry matter basis, have so far been utilized in Mauritius as a low grade fertilizer (about 2% $P_2O_5$). Annual production can represent about 5 000 tonnes of crude protein. Studies have shown, however, that this protein is digestible to only 17% (2). It follows, therefore, that the total annual production of filter muds would yield only 850 tonnes of digestible crude protein. It would, nevertheless, be interesting to investigate ways and means of increasing the digestibility of the protein in scums.

Animal production based on sugar cane and sugar by-products diets is limited by the lack of protein to supply amino-acids for protein synthesis, and of glucose precursors which are essential for optimum animal performance. Adequate supplementation must necessarily be an important consideration in the elaboration of any project concerning the use of sugar cane by-products as animal feed.

## FERMENTATION PRODUCTS

The utilization of molasses in the production of rum in Mauritius goes back to the middle of the 18th century and of denatured spirit for burning to the very beginning of the 19th. These remained for a long time the only two by-products of the sugar industry, derived from the fermentation of molasses.

It is only round about 1930 that a real interest was focussed on the possible utilization of alcohol as motor fuel. A product known as "Cernite", made up of a mixture of 64% hydrated alcohol, 30% ether and 6% petrol, was patented and became so popular for some time, petrol being rather expensive at the time, that supply could not meet demand. But, as soon as the price of petrol went down again, "Cernite" production was abandoned (6).

In 1932, attention had been drawn to the production of anhydrous alcohol and its utilization as fuel for motor cars (10). However, the idea was not taken up and it is only the outbreak of the second world war and the difficulties experienced in our petrol supply that led to the production of alcohol to be used in partial replacement of petrol as motor fuel. However, as the required distillation plant for the production of anhydrous alcohol could not be installed during war time, alcohol (96° GL) was produced, and denatured with 10-20% petrol. This alcohol, after admixture with more petrol so as to obtain a 20 : 80 mixture, supplied the requirements in motor fuel during the war years. In 1949, a Power Alcohol Committee strongly recommended that anhydrous alcohol should be produced in Mauritius to be used as fuel for motor cars. The sale was contemplated of a natural fuel containing 25% anhydrous alcohol and 75% petrol. However, as the price at which molasses was being sold to distillers was not controlled, coupled with the sudden rise in the price of that product in 1951, the project was abandoned. As a last blow, in that same year, the exportation of molasses in bulk on a large scale became organized (6).

The whole situation was reviewed in 1955 and the general conclusions were that the high world price of molasses constituted an inducement to export and, with the considerable increase in the cost of materials and equipment, production of anhydrous alcohol would prove uneconomical (1).

At present, the industrial utilization of molasses in Mauritius is fairly low, about 11% of total production; some 160 000 tonnes being exported annually.

Local production of fermentation products, derived from molasses as substrate, expressed in litres at 100° GL, is as follows :

| | Litres |
|---|---|
| Rum | 2 300 000 |
| Denaturated alcohol | 350 000 |
| Refined alcohol | 220 000 |
| Industrial alcohol | 140 000 |
| Vinegar | 25 000 |
| Perfumery, pharmaceuticals, etc. | 95 000 |
| Alcohol for export | 18 000 |
| **Total:** | 3 148 000 |

It will be noted that rum production is the major component, 73%.

The total installed capacity of the three distilleries operating in Mauritius is 4.5 million litres per annum. Baker's Yeast production, which had started on a small scale, has been abandoned.

The annual consumption of petroleum products is as follows :

| | Tonnes |
|---|---|
| Petrol | 50 000 |
| Diesel oil | 60 000 |
| Paraffin oil | 25 000 |
| Fuel oil | 55 000 |

Mean annual increase in consumption is of the order of 12% (8).

Although there are no plans at the moment for the production of power alcohol or for using ethanol as a feedstock for chemical industries, it should be borne in mind that, should a decision along those lines be taken, a valuable asset is the experience acquired in Mauritius over half a century in the distillation industry. However, the constraints are of a different nature for, if on the one hand, the production of power alcohol needed as an admixture to imported petrol as motor fuel should, in itself, set no problem; on the other hand, as long as the domestic price of molasses is kept at par with the price obtainable in the export market, it will not be economical for Mauritius to produce power alcohol. Thus, the current price of petrol in Mauritius is 2.44 rupees (41 cents) per litre whereas the cost of producing 1 litre of alcohol (96° GL) is, at present, 1.70 rupees (28 cents). However, without excise duty, the price of petrol falls to only 1.20 rupees (20 cents) per litre. It follows, therefore, that the price of molasses on the one hand, will have to be substantially reduced and the efficiency of the distilleries increased if power alcohol produced locally is to become competitive with imported petrol.

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