THE FEEDING VALUE OF MOLASSES

By T. G. CLEASBY

Molasses is the most valuable by-product from the Sugar Industry. The molasses referred to in this article is blackstrap molasses, that is the molasses from the production of raw sugar from sugar cane. It is similar to, but should not be confused with, beet molasses, refinery molasses, corn molasses or high-test molasses, all of which have slightly different analyses. Molasses has been used to manufacture a number of industrially important compounds by fermentation reactions. Ethyl alchohol is the best known of these, although its production from molasses has been largely superseded by more economical methods. Citric and Glutamic acids are other products which are made from molasses. Today, however, the bulk of the world's molasses, for example 85% of that imported into the United States of America, finds its way into animal feeds. Its value is therefore determined by its feeding value and is obviously related to the price of other animal feeds, such as barley, oats, maize, etc. The London price of molasses has varied between R14 and R28 per long ton over the last five years, not due to the variations in the price of the other feeds, but mainly due to the relation between the supply and demand. The New Orleans price for molasses has varied similarly, which shows that in Europe and in America, even at the lowest price, the value of molasses as a feed is high, particularly as these landed prices, and additional distribution costs, must be incurred.

The reason for publishing this paper is that facts relating to the feeding value of molasses are not generally appreciated. There is, however, a growing interest in the value of molasses in South Africa, which in the past has been content to export the bulk of it to other countries where it has been chiefly used in animal feeds. This paper is not an original one, but a survey of facts relating to the use of molasses as an animal feed supported by some work which has been done at Tongaat.

The growing appreciation of the feeding value of molasses in South Africa is evident by the number of new products reaching the farmer, based on molasses or molasses residues. These include products marketed under the following trade names:—Rumevite, Fermavite, Morea, Molameal, Voermol Meal, and a high molasses ruminant feed X-16. In addition to this, there are many blocks on the market which contain molasses and serious attempts have been made to dehydrate molasses in order to convert it into a more easily handled form.

Molasses is also a constituent of the majority of compounded animal feeds, excluding poultry and pig feeds where it is used up to 12½% because of its palatability, nutrient value and its physical properties which reduces the dustiness of feed and helps in the manufacture of pellets.

The feeding value of molasses is based on the fact that it contains approximately 50% sugars in the form of sucrose and invert sugar. It is therefore a source of readily available energy. Molasses contains 4% protein based on its nitrogen content multiplied by 6.25. It also contains mineral and trace elements and vitamins of the B complex. It is a good source of pantothemic acid but is deficient in riboflavin-thiamine.

It is interesting to compare its analysis with maize or yellow meal as shown below:

	Molasses	*Yellow Meal*
	%	%
Crude Protein	4.00	8.25
Nitrogen-free extract	62.00	68.00
Fat	—	3.80
Water	22.00	15.00
Calcium	0.60	0.02
Phosphorus	0.02	0.25
Total digestible nutrients	55.00	80.00

Work in America has established that when molasses is fed correctly, its feeding value is at least 70% that of maize and some experiments show it as high as 85%. Experiments have also shown that the maximum feeding value of molasses occurs when it is fed at approximately 10% of ruminant rations. Above this level, the feeding value tends to decrease. This does not, however, mean that 10 per cent is necessarily the most optimum economical level to feed as the price difference between molasses and other sources of carbohydrate is obviously important.

It is proposed to discuss the feeding value of molasses under the following headings:—its palatability factor, use in silage, use of molasses for feeding ruminants including the use of urea, uses of molasses for feeding pigs and the use of molasses with sugar cane bagasse or pith.

Palatability Factor

This is the feeding value "plus" with molasses. It is universally liked by stock; cattle, sheep and pigs being immediately attracted to it. A very important part of the feeding value of molasses is therefore its ability to enable stock, particularly ruminants, to eat unpalatable feeds, such as mealie cobs, poor quality damaged hay or pastures, sweet veld in winter, chaff and stover. This is particularly important in times of drought or shortage of food during winter. If urea is added to the molasses, the mixture can serve as a source of protein, which together with one or other of the unpalatable roughages mentioned above can mean the difference between losing or saving animals during difficult times. The usual practice is to dilute the molasses with water and then spray it on the material to be eaten. It is tragic to think of the number of cattle and sheep which could have been saved by such a simple procedure during times of drought.

Use of Molasses in Silage

Another important use for molasses is in making silage, which is the preservation of fresh fodder by packing and compacting it in a pit, bunker or silo. Under these conditions, the living cells rapidly use up the oxygen in the air, trapped in the mass, and give off carbon dioxide. This prevents the development of moulds which are unable to grow in the absence of oxygen. Acid forming bacteria multiply enormously in silage by attacking the sugars in the forage and forming chiefly lactic acid with some acetic acid. The production of acids is the most important change in the process, the acidity preventing the growth of undesirable bacteria which cause rotting and putrifaction.

The value of silage can generally be improved by the addition of molasses which provides a ready source of sugar for the acid forming bacteria. The drier and less succulent the material ensiled, the more important the addition of molasses becomes. Morrison recommends the addition of 50 to 100 lb. of molasses per ton of material being ensiled and states that 75% of the nutritive value of the molasses is retained in the silage. In addition, it improves the quality, palatability and carotene content. It is fact that the bulk of silage made in South Africa could be improved economically by the addition of molasses.

Use of Molasses for Feeding Ruminants

Molasses can be fed to ruminants, cattle and sheep in many different ways. In the case of cattle it can be used with advantage for both dairy and beef animals—either (1) as a lick to stimulate the appetite and condition of the animals in addition to providing carbohydrate; (2) as an ingredient of mixed rations for dairy, maintenance, or fattening (as already mentioned commercial rations contain up to 12½% molasses) for its carbohydrate and palatability; (3) as a winter maintenance feed or a drought relief ration.

The main uses of molasses with sheep is as a constituent of a winter maintenance ration which will improve the condition of ewes and lambs and also the quality of the wool. The improvement in wool quality has been attributed to molasses feeding, but it is probably only a direct means of better nutrition.

Before going on to discuss these uses, it is appropriate to say something on the subject of urea as a source of animal protein. A great deal of work has been published on this, and the main factors can be summarised as follows:

(1) Urea contains 46% nitrogen and if this is converted into crude protein, it represents 287.5%.

(2) Excess urea is toxic to cattle and sheep and the generally recommended rates of feeding for adult animals are 3 ounces a day for cattle and ½ oz. for sheep. Although the animals can take over twice these quantities without any serious effect, there is definitely a point where urea becomes dangerous and deaths result.

(3) Urea can definitely be converted to protein by ruminants. The efficiency of this conversion has occupied research workers for a long time. One thing, however, must be remembered, in that urea is a cheap source of protein in which the cost per lb. of protein is 26 cents compared with R1.25 per lb. of protein from ground nut oil cake. The efficiency of urea as a protein source is apparently effected by two factors.

(*a*) The total amount of other proteins available to the animal. In general, the efficiency of urea protein decreases with an increasing amount of other proteins. In other words urea is of greatest value as a supplement to poor quality grazing or roughages in the form of a maintenance or drought relief ration.

(*b*) The carrier used with urea is also important. It is essential that the carrier provides the ruminant with energy, in order to enable it to convert the urea into protein. Two main carriers have been used — molasses and maize or yellow meal. The results of the work done indicates without any doubt that molasses is the most efficient carrier for urea. It is certainly the cheapest.

With regard to the use of molasses as a lick for cattle, the main point is that the intake has to be limited to an economical amount, depending on the price of molasses delivered on the farm. If *ad lib.* feeding is practiced, then cattle will take up to 1 gallon of molasses per head per day. The Natal Estates and Wewe Sugar Planting Co. dairies, situated adjacent to sugar industries, allow their cows half to three-quarters of a gallon of molasses per head per day. Also a beef breeding herd, run by The Tongaat Sugar Company on Cranbrook Estates, receives *ad lib.* molasses when it is available and the cattle consume a similar amount. In none of these instances do the cattle suffer from being over laxative. As a matter of interest, the United States Sugar Corporation Factory at Clewiston, Florida, disposes of the whole of its molasses from a crop of 60,000 tons of sugar by feeding it to its beef cattle on an adjacent ranch.

There is no doubt that feeding molasses to cattle on the veld, particularly in winter, can be advantageous, but where the molasses has to be transported over large distances, the amount fed has to be limited to 1 to 2 lb. per head per day. In order to be economical, the amount actually fed will depend primarily upon the price of molasses on the farm. In spite of high railage charges due to the large distances of the main cattle areas from the sugar belt, molasses is still by far the cheapest feed supplement available to farmers.

Farmers mixing their own cattle rations, either for dairy, maintenance or fattening, can certainly improve them, and generally cheapen them by including molasses. The difficulty in this is the problem of incorporating the molasses in the ration. It can be mixed easily if it is diluted with its own volume of water and mixed by hand. Alternatively, it can be

done by feeding the molasses portion of the ration separately in a small trough or simply by pouring the required amount of molasses over dry mix ration, when it is in the manger. The recommended level of feeding in these rations is between 10 and 20 per cent, replacing other carbohydrate sources, such as maize or yellow meal and ground corn and cob meal. If as much as 20 per cent is used in the ration then the protein level should be insreased to compensate for the protein difference between molasses and the material it is replacing. As already mentioned, this can be done cheaply by using urea.

A typical cattle fattening ration which has been fed at Tongaat with cane tops and which has produced weights gains of over 2 lb. per head per day on an *ad lib.* basis, has been made up of the following:

40% molasses
35% Corn and Cob meal or yellow meal
12% bagasse pith
8% nut oil cake
2% urea
3% minerals, vitamins and trace elements.

The crude protein content of this ration is about 12% but it has been kept low on purpose because of the *ad lib.* basis of feeding. The animals consumed about 15 lbs. per head per day, together with approximately 40 lb. of freshly chaffed cane tops.

The value of molasses in mixed rations can be summarised easily and accurately as follows. If its price, delivered on the farm, is less than three-quarters of that of yellow meal, then it can be used economically by replacing yellow meal by something between 10 and 20% of the total ration. It will also improve the palatability of the ration.

The use of molasses as a drought relief ration has already been dealt with under the heading of molasses and urea mixtures. However, to appreciate the importance of molasses as a maintenance or drought relief ration, it is necessary to consider the rumen. This is the vital part of the ruminant's complicated stomach which has been likened to a vat, where the micro-organisms break down the fibrous tissue of roughages into carbohydrates which can be utilised for energy. The winter feeding of cattle in South Africa is based on hay and silage, reaped and stored during the summer months. In the majority of cases it consists mainly of hay or dry grass on the veld. In order to work efficiently, the micro-organisms themselves have to be fed carbohydrates and protein, both of which are deficient in the normal winter feed. Molasses can supply the carbohydrate in a very readily available form and in combination with urea, can provide the protein as well.

There is no doubt that molasses/urea mixtures do have a very important part to play in minimising the effect of droughts and winters and that they have been recommended by the Department of Agriculture for this purpose. The fact that they have not been used to a much greater extent already can only be due to ignorance of their value on the part of the farmer; also handling and feeding difficulties, aggravated by the toxic nature of urea.

The Use of Molasses for Feeding Pigs

Very little molasses is used at the present time for feeding pigs; practically none is used by the farmer who is mixing his own rations. Experiments which were started in Hawaii and which have been continued by The Tongaat Sugar Company over the last two years, suggest that molasses has a very important part to play in feeding pigs and that it can lead to more palatable and cheaper rations. The reason for its neglect is probably the fact that molasses is believed to cause scouring in pigs, and scouring is well known to be the worst enemy of the efficient pig man. Again the work done at Tongaat shows that this danger has been over-emphasised and that with proper feeding it can be overcome.

The work done in Hawaii showed that economically as much as 20% of weaner rations, that is the ration fed from weaning to 70 lb., could be molasses and as much as 40% of pig fattening rations. In these experiments, the molasses was costed at approximately one-third the price of rolled barley.

As mentioned above, this work has been repeated at Tongaat. The rations that have been fed are shown below together with the results of one experiment, in which these high molasses rations were used. The high molasses rations had some laxative effect on the pigs, which horrified pig experts, but as the rations gave results recorded below, the overall effect could not have been serious. As a matter of interest, it might be mentioned that new experiments are now under way at Tongaat, utilising a mixture of molasses and bagasse pith and even in cases where this mixture has constituted 50% of the ration, no marked scouring has been observed.

PIG RATIONS used by THE TONGAAT SUGAR CO. LTD.

Ingredient	*Sow and Boar Ration*	*Growth 1 Weaning -70 lbs.*	*Growth 2 70-100 lbs.*	*Fattening 1 100-150 lbs.*	*Fattening 2 150-220 lbs.*	*Creep Ration*
Molasses	% 40	% 14	% 20	% 30	% 40	% 7
Yellow Meal	23	60	50	37	27	63
Lucerne Meal	20	5	10	15	15	5
Nut Oil Cake	10	8	12	12	12	10
Fish Meal	3	6	4	—	—	14
Carcass Meal	4	7	4	6	6	—
Mineral Supplement (No. 3)	20 lbs/Ton	20 lbs/Ton	20 lbs/Ton	20 lbs/Ton	20 lbs/Ton	40 lbs/Ton
Vitamin Supplement	1 lb/Ton	1 lb/Ton	1 lb/Ton	1 lb/Ton	1 lb/Ton	2 lbs/Ton
Anti-Biotic (Rx444)	—	4 lbs/Ton	1 lb/Ton	—	—	8 lbs/Ton
Ferrous Sulphate	1 lb/Ton	2 lbs/Ton	1 lb/Ton	—	—	4 lbs/Ton
Copper Sulphate	—	2 lbs/Ton	2 lbs/Ton	2 lbs/Ton	2 lbs/Ton	—

RESULTS OF PIG FATTENING EXPERIMENT WITH THE ABOVE RATIONS FROM WEANING TO BACON WEIGHT AT 220 LBS.

No. of Pigs tested	10
No. of days from weaning to bacon weight	130
Mean daily weight gain in lbs.	1.38
Feed conversion ratios:	
Growth 1	4.4
Growth 2	3.2
Fattening 1	4.5
Fattening 2	4.0
Mean	3.95
*Mean cost per lb. gain in cents	8.3
Grades of pig marketed:	
Grade 1	7
Grade 2	3
Grade 3	1

*Molasses costed at R4.00 per ton.

As the price of molasses at Tongaat is obviously very different from its price when it has been transported to a farm away from the sugar belt, the above rations are not recommended for general use. However, as the price of molasses delivered on the farm is cheaper everywhere in South Africa than yellow meal, it has really a place in the rations, not only for its feeding value but also for its ability to make dry rations more palatable. The problem of getting pigs to eat dry and sometimes dusty home-mixed rations can readily be overcome by incorporating some molasses, either by diluting it and mixing it in or simply by pouring it over the dry ration. It is suggested that pig rations could be improved by including up to 10% molasses in the growth ration and 20% in the fattening rations. It can also be used up to 7½% in the creep feed where it definitely encourages the young pigs to eat. Pigs universally like molasses and will always pick our molasses lumps first in any home-mixed rations.

Use of Molasses with Bagasse Pith

A paper on the feeding of molasses would not be complete without mentioning the amount of work which has been done on the combination of molasses and bagasse pith. It is significant that many sugar beet companies dispose of the whole of their molasses production in the form of a molasses meal made by absorbing molasses on the dried beet pulp. Unfortunately, bagasse pith does not have the feed value of best pulp but it does have the ability to absorb large quantities of molasses, which enables the molasses to be bagged. A solid mixture can be made with 10% dry bagasse pith and 90% molasses, but it is sticky and not easily handled. A mixture of 30% dry bagasse pith and 70% molasses is, however, relatively friable. It is interesting to note that in a paper presented to the recent meeting of the International Society of Sugar Cane Technologists in Mautitius on "Sugar Cane Bagasse and Molasses Rations for Beef Cattle" showed that bagasse from sugar cane is an excellent roughage carrier for feeding blackstrap molasses to cattle, also that optimum results were obtained when the rations contained 20% bagasse and 50% molasses which corresponds roughly to the 30% bagasse pith and 70% molasses mixture mentioned above. This mixture can be packed in paper pockets and stored without any seepage of molasses through the paper. There appears to be no reason why, in time, molasses meals with bagasse pith should not be as popular as their counter-parts in America, and Europe, molasses-beet pulp mixtures from the sugar beet industry.

Mr. Wilson (in the Chair) said the paper was of great interest especially as many cane growers were going for diversification in their farming.

Mr. Coignet remarked upon the sulphur content of molasses, especially from sulphitation factories.

In the case of sheep, sulphur apparently improved the quality of wool whilst in the feeding of cattle and pigs sulphitation molasses caused galls.

Mr. Main stated that his experience with the manufacture of Molameal, which was a mixture of bagasse and molasses, showed that the scouring particularly in the case of pigs could be avoided if the bagasse were sifted before mixing to get rid of sand. The keeping quality of molasses mixtures deteriorated after a time causing them to become hard and decomposing eventually into a charred mass. This was a great handicap in the transportation of Molameal from the coast to up-country. Mr. Ritter's patent for the preparation of paper from bagasse might be to some extent applicable to bagasse/molasses mixtures provided that the product did not become toxic. Some sort of preservative added to the bagasse before mixing might result in a long lasting cattle feed which would fetch a better price.

There was a world-wide competition for molasses because of its shortage and prices were very high and the whole question of the most lucrarive disposal of molasses was ripe for reconsideration. With the possibility of the construction of a pipe line to convey fuel to the hinterland it was likely that many tank-cars would become available in the near future and these could be used for distribution of molasses throughout the country. In the past the transport facilities had proved to be a bottle-neck.

Dr. Cleasby said that the storage quality of molasses/bagasse mixture was very largely a function of the amount of molasses in the mixture. Mixtures with a high proportion of molasses, say 90 or 80 per cent did not store well, but if the bagasse pith content was increased to about 30 per cent the mixture kept well under dry conditions and after several months no deterioration was detected.

The Ritter process has been tried on cane tops to see if the feeding value would be enhanced but unfortunately only good compost was produced. The use of the process on bagasse met with the difficulty of putting it into suitable heaps which would enable the fungus to do its work properly. His opinion was that it was criminal to export molasses at all and the Industry should see that all of this product was used in this country.

Mr. Boyes said that in 1957 Dr. Douwes Dekker had presented a paper to our Congress in which he showed that there was no difference in the sulphur content of sulphitation molasses as compared with that produced by the defecation process. When 80-90 parts of molasses to 20-10 parts of bagasse pith was made into the mixture the moisture content was about 19 to 20 per cent which was sufficient for bacterial activity to take place. By decreasing to a mixture of 70 molasses and 30 parts of pith and making sure the moisture content of the pith was reduced to about 6 per cent the resulting mixture had a moisture content of only about 16 per cent and this preserved extremely well. He had found that quicklime added to the extent of about 1 per cent acted well as a preservative as the high pH thus produced destroyed all bacterial activity. However this was unnecessary as a 70/30 mixture was quite stable.

Mr. A. C. Barnes referred to his experience in the West Indies where he found that the use of molasses as a supplementary feed increased the yield of milk from dairy cattle and the herd itself improved in health. The molasses was used in silage as described in the paper, the other components being chopped young cane and Guinea corn. The silage was readily taken by the animals and it was a standard feed during the Winter season when other feeds of that type were not available.

The feeds were supplemented by high protein substances such as oil seed residues.

There was a great field for the use of molasses for dairy cattle and this subject was worthy of further investigation.

Dr. Cleasby agreed with Mr. Barnes that molasses was useful for dairy cattle. He had mentioned only the use as a lick in the case where it did not have to be transported and where it could be supplied *ad lib.*

Another important point in the use of molasses apart from its nutrient value for dairy cattle was the fact of its palatability. Often the dairyman when he prepared his own feed ration produced a very dry one and the problem of inducing the animals to take it could be solved by adding molasses.

Mr. Grice asked if the author had any information on the use of molasses in conjunction with pineapple residues from the canning factories. He had been told in Hawaii that the excellence of beef there was due to the use of pineapple residues together with molasses as feed.

Dr. Cleasby replied that this type of feed had been used at Empangeni for fattening cattle with success. This raised the controversial point of the value of alcohol in the ration. One feed on the market for addition to molasses contained urea and in addition to all the trace elements had 6 per cent alcohol, which was said to improve the absorption of the urea by the animal and the quality of marbling of the meat. In Japan a certain farm, renowned for the steaks it supplied, was said to give its animals a bottle of beer daily.

The whole point was still an unsolved problem.

Mr. de Robillard said there was a mortar prepared from quicklime and molasses which set very hard and he asked if Mr. Boyes could enlarge on the use of quicklime as a preservative.

Mr. Boyes said when only 1 per cent of quicklime was added the mixture became very hot, pointing to the formation of calcium hydroxide before calcium saccharate was formed, but in his opinion the preserving action of the lime was due to the high pH produced. The product did not become hard with the addition of the small amount of lime used.

Mr. Main said if it could be proved that alcohol was of value in cattle feed this suggested that a small distillery could be with advantage attached to the sugar factory as was done in other countries and feed consisting of molasses, alcohol and roughage could thus be produced.

Mr. Coignet asked if the use of lime as a preservative might prevent the digestion of the proteins and roughage by the animal.

Dr. Cleasby thought this unlikely as the sugars present would enhance the activity of the digestive process.

Mr. Boyes asked if the use of a preservative to kill off the bacteria would affect the value of molasses in silage.

Dr. Cleasby replied that the molasses so treated would be quite suitable for silage production.