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# CANE MOLASSES AS A REPLACEMENT FOR MAIZE MEAL IN BEEF FATTENING RATIONS

**B.D.H. Van Niekerk & D.J. Voges**
*Voermol Products Limited, P.O. Box 13, Maidstone*

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*OPSOMMING:* RIETMELASSE AS PLAASVERVANGER VIR MIELIEMEEL IN BEESVETMESTINGSRANTSOENE

Hoewel melasse op 'n uitgebreide skaal deur die veevoernywerheid in Suid-Afrika gebruik word, is daar uiteenlopende menings wat betref die waarde van hierdie grondstof as energiebron. Weens die lae koste van melasse in verhouding tot die prys van mielies en weens die toenemende aanvraag na energie-ryke graansoorte in die vetmestingsnywerheid, is dit gebiedend dat die waarde van melasse as 'n goedkoop plaasvervanger vir mielies ondersoek moet word.

Met hierdie doel in gedagte is twee proewe beplan waarin 0%, 7%, 14% en 21% melasse, uitgedruk in terme van die totale daaglikse rantsoen, gebruik is om mieliemeel in die rantsoen te vervang. In een proef is 4 groepe beeste 'n volledige rantsoen gevoer terwyl in 'n tweede proef 'n kragvoermengsel en ruvoer apart gevoer is. Daar is verder ondersoek ingestel na die invloed van vitamien A inspuitings op die tempo van massatoename.

Dit is gevind dat die aanwending van tot 21% melasse in die rantsoen geen uitwerking gehad het op die tempo van lewende-massa of karkasmassa toename nie. Melasse het egter die inname van die rantsoen bevorder sodat voeromsetting op die hoogste melasse-peil merkbaar swakker was. Daar is aanduidings dat melasse, teen 'n intermediêre peil, die tempo van massatoename en voeromsetting mag bevorder. Vitamien A inspuitings het geen betekenisvolle uitwerking op enige van die maatstawwe wat ondersoek is, gehad nie.

Met die huidige groot prysverskil in die koste van melasse en dié van mieliemeel, kan melasse of melassemeel met groot voordeel gebruik word om mieliemeel in vetmestingsrantsoene te vervang.

*SUMMARY:*

Although molasses is extensively used in the animal feed industry in South Africa, there are conflicting views on its value as an energy source. Because of its low cost in relation to that of maize and in view of the increasing demand for energy-rich grains in the feedlot industry, it is imperative that the value of molasses as an inexpensive substitute for maize meal should be investigated.

With this purpose in mind, two experiments were planned in which 0%, 7%, 14% and 21% molasses, expressed on a complete diet basis, was used to replace maize meal. In one experiment 4 groups of cattle were fed complete diets while in the second experiment a concentrate mixture and roughage were fed separately. In addition, the effect of vitamin A injections on mass gain was investigated.

The replacement of maize meal with up to 21% molasses did not influence rate of live mass or rate of carcass mass gain significantly. Molasses improved acceptability of the experimental rations so that the feed conversion rate on the highest molasses level was noticeably poorer. There is some evidence that molasses, at an intermediary level, may improve rate of gain and feed conversion rate. Vitamin A injections did not have a significant effect on any of the parameters investigated.

With the present wide price differential between molasses and maize meal, the use of molasses or molasses meal as an energy substitute in feedlot rations has considerable economic merit.

Cane molasses is routinely included in many types of livestock rations. Its widespread use in animal nutrition stems from its many advantages as a feed ingredient. It is highly palatable, it reduces dustiness of feed mixtures, it acts as a binding agent in pelleted feeds, stock licks or feed blocks, and it is a rich source of trace minerals as well as vitamins of the B-complex. Molasses is furthermore the ideal carrier for ingredients such as urea, phosphates, trace minerals and vitamins used in the liquid feed industry. However, its main advantage as a feed ingredient in South Africa is attributable to its low cost in relation to that of other energy sources such as maize meal.

Although the role of molasses in the supplementary feeding of livestock has been extensively researched (Van Niekerk, 1975) and while a limited number of studies have been devoted to its value as a maize replacer in dairy feeds (Stewart, 1970, Hugo 1975) there appears to be little published information on its use in feedlot rations in South Africa. For this reason it is important to evaluate its role as an alternative energy source in South Africa's rapidly expanding feedlot industry. The object of this investigation was therefore to determine the effect of four levels of molasses, used as a direct replacement of maize meal, on rate of gain of fattening beef cattle.

## Procedure

Ninety yearling Hereford crossbred steers were restrictively randomized, according to body mass, into 9 groups of 10 animals each. One group was selected at random and slaughtered at the beginning of the experiment to serve as an index of the initial dressing percentage and carcass mass of the experimental animals.

Of the remaining 80 cattle, 4 groups of 10 animals each were fed complete rations containing 0%, 7%, 14% and 21% molasses. The composition of the rations fed to these 4 groups is given in Table 1. The remaining 4 groups op 10 animals each were used in a separate experiment in which cattle were fed veldgrass hay and a concentrate mixture separately, both being fed *ad libitum*. The concentrate part of the ration contained 0%, 7,8%, 15,6% and 23,4% molasses. Expressed on a complete diet basis, and assuming that they would consume 90% of the concentrate and 10% roughage, these 4 groups would therefore consume rations identical to those fed to the cattle in the first experiment. The composition of these 4 rations is summarised in Table 2.

In both experiments, the four diets were made as similar as possible as regards the percentages of crude protein, urea, calcium, phosphorus, bagasse, hay and salt. Molasses was used to replace maize meal in the ration. To compensate for the lower protein level of molasses, solvent-extracted peanut oilcake meal was used so as to equalize the protein levels of the four groups in each experiment. Urea was not used for this purpose as a variation in the level of non-protein nitrogen would have introduced another variable, thus confounding the results.

A further treatment was superimposed on both experiments by injecting half the animals in each treatment with 1,5 million I.U. vitamin A at the beginning of the experiment and a further 1,5 million I.U. 6 weeks later.

The molasses used in this experiment consisted of high-brix molasses containing only about 18% moisture. The molasses was first absorbed onto dried bagasse and incorporated into the rations as such. Bagasse levels were equalized by adding dry bagasse, where necessary, to the various treatments. The roughage used in the experiments consisted of veldgrass hay (mainly *Themeda triandra*) milled through a 12 mm screen.

Body mass was determined at fortnightly intervals throughout the trial. Only the initial and final body mass was determined after a 15 hour fast. In order to minimise differences in body composition, which could bias the results of the trial, animals of the various groups were fed to the same final body mass (Reid, Bensadoun, Paladines & Van Niekerk, 1963). Experimental groups, depending on their rate of gain, were thus fed for various periods of time. Feed was provided twice per day, care being taken that food was always available. The initial carcass mass of the experimental animals was estimated from the average dressing percentage of the initial slaughter group. Standard procedures were used in the statistical analysis of the experimental data (Steel & Torrie, 1960).

**Table 1**

*Composition of complete fattening meal fed ad libitum*

| | Experiment 1 | | | |
|---|---|---|---|---|
| Ingredients | Group 1 (%) | Group 2 (%) | Group 3 (%) | Group 4 (%) |
| Molasses | 0,00 | 7,00 | 14,00 | 21,00 |
| Yellow maize meal | 74,02 | 66,49 | 59,21 | 51,90 |
| Veldgrass hay | 13,00 | 13,00 | 13,00 | 13,00 |
| Dry bagasse | 7,00 | 7,00 | 7,00 | 7,00 |
| Urea | 1,40 | 1,40 | 1,40 | 1,40 |
| Peanut oil-cake meal | 2,62 | 3,34 | 3,84 | 4,30 |
| Dicalcium phosphate | 0,84 | 0,82 | 0,84 | 0,90 |
| Limestone | 0,88 | 0,71 | 0,47 | 0,26 |
| Salt | 0,24 | 0,24 | 0,24 | 0,24 |
| | 100,00 | 100,00 | 100,00 | 100,00 |
| Chemical composition | | | | |
| Crude protein | 12,0 | 12,0 | 12,0 | 12,0 |
| Calcium | 0,60 | 0,61 | 0,61 | 0,60 |
| Phosphorus | 0,31 | 0,30 | 0,30 | 0,30 |
| Dry matter | 90,00 | 89,44 | 88,88 | 88,32 |

**Table 2**

*Composition of concentrate fed ad libitum together with veldgrass hay fed separately*

| | Experiment 2 | | | |
|---|---|---|---|---|
| Ingredients | Group 1 (%) | Group 2 (%) | Group 3 (%) | Group 4 (%) |
| Molasses | 0,00 | 7,78 | 15,56 | 23,34 |
| Yellow maize meal | 85,97 | 77,79 | 69,60 | 61,29 |
| Dry bagasse | 7,77 | 7,78 | 7,77 | 7,77 |
| Urea | 1,55 | 1,55 | 1,55 | 1,55 |
| Peanut oil-cake meal | 2,50 | 3,10 | 3,74 | 4,48 |
| Dicalcium phosphate | 0,89 | 0,92 | 0,92 | 0,96 |
| Limestone | 1,06 | 0,82 | 0,60 | 0,35 |
| Salt | 0,26 | 0,26 | 0,26 | 0,26 |
| | 100,00 | 100,00 | 100,00 | 100,00 |
| Chemical composition | | | | |
| Crude protein | 13,0 | 13,0 | 13,0 | 13,0 |
| Calcium | 0,63 | 0,63 | 0,63 | 0,63 |
| Phosphorus | 0,33 | 0,33 | 0,33 | 0,33 |
| Dry matter | 90,00 | 89,38 | 88,76 | 88,13 |

## Results

*Initial slaughter group:* The average dressing percentage of the cattle slaughtered at the start of the experiment amounted to 52,4% . This value was used to estimate the initial carcass mass of the experimental animals.

*Feed intake and live mass gain:* Shortly after the experiments were started, two cattle in Experiment 1 died due to Red Water disease. The results of Groups 1 and 2 are thus based on only 9 animals per group. Two further animals in Groups 2 and 4 of Experiment 1 gained exceptionally poorly and were slaughtered at lower final masses than had been planned for. The initial goal of feeding animals to a fixed live mass was therefore not fully realised.

It will be seen from Tables 3 and 4 that the inclusion of molasses at 3 different levels stimulated progressively greater feed intakes in both feeding systems tested. This effect was particularly noticeable during the initial stages of the experiment, but tended to diminish as the experiments progressed. This higher feed intake was at first also associated with faster rates of gain. The final results, however, show no statistically significant (P> 0,05) improvement in rate of gain due to molasses inclusion.

### Table 3

*Live mass gain, carcass data and feed conversion rates*

| | Experiment 1 | | | |
|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 |
| *Average live mass data* | | | | |
| Number of animals | 9 | 9 | 10 | 1C |
| Feeding period, days | 168,1 | 171,4 | 160,0 | 163,1 |
| Initial mass, kg | 201,1 | 202,6 | 204,3 | 202,7 |
| Final mass, kg | 375,9 | 362,3 | 372,9 | 363,5 |
| Total mass gain, kg | 174,8 | 159,7 | 168,6 | 160,8 |
| Mass gain/ day, kg | 1,04 | 0,93 | 1,05 | 0,99 |
| Feed intake, kg | 8,58 | 8,96 | 9,17 | 9,66 |
| Feed conversion ratio | 8,25 | 9,63 | 8,73 | 9,76 |
| *Average carcass data* | | | | |
| Initial carcass mass, kg | 105,4 | 106,1 | 107,1 | 106,2 |
| Final carcass mass, kg | 214,2 | 209,1 | 216,1 | 210,2 |
| Total mass gain, kg | 108,8 | 103,0 | 109,0 | 104,0 |
| Mass gain per day, kg | 0,65 | 0,60 | 0,68 | 0,64 |
| Feed conversion ratio | 13,2 | 14,8 | 13,5 | 15,1 |
| Dressing percentage | 57,0 | 57,7 | 58,0 | 57,8 |

### Table 4

*Live mass gain, carcass data and feed conversion rates*

| | Experiment 2 | | | |
|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 |
| *Average live mass data* | | | | |
| Number of animals | 10 | 10 | 10 | 10 |
| Feeding period days | 171,2 | 167,4 | 168,8 | 171,6 |
| Initial mass, kg | 199,7 | 201,2 | 201,2 | 203,3 |
| Final mass, kg | 364,2 | 369,3 | 361,9 | 364,5 |
| Total mass gain, kg | 164,5 | 168,1 | 160,7 | 161,2 |
| Mass gain/ day, kg | 0,96 | 1,00 | 0,95 | 0,94 |
| Concentrate intake/day, kg | 7,46 | 7,37 | 7,76 | 7,89 |
| Hay intake/ day, kg | 0,58 | 0,59 | 0,81 | 0,74 |
| Total feed intake/day, kg | 8,04 | 7,96 | 8,57 | 8,63 |
| Feed conversion rate | 8,37 | 7,96 | 9,02 | 9,18 |
| *Average carcass data* | | | | |
| Initial carcass mass, kg | 104,6 | 105,4 | 105,4 | 106,5 |
| Final carcass mass, kg | 212,1 | 217,3 | 211,9 | 214,3 |
| Total mass gain, kg | 107,5 | 111,9 | 106,5 | 107,8 |
| Mass gain/ day, kg | 0,63 | 0,67 | 0,63 | 0,63 |
| Feed conversion ratio | 12,8 | 11,9 | 13,6 | 13,7 |
| Dressing percentage | 58,2 | 58,8 | 58,6 | 58,8 |

Rations containing molasses tended to result in poorer feed conversion rates. This was particularly evident in the group, of each experiment, receiving the highest molasses level. The best feed conversion rate was, however, recorded in Group 2 of Experiment 2, receiving approximately 7% molasses expressed on a complete diet basis.

*Carcass data:* Because animals in the various treatments were slaughtered at approximately the same final live mass, the differences in carcass mass between treatments were relatively small. It can thus be assumed that the results are not biased by differences in final body composition. Although the best rates of gain were recorded in Groups 3 and 2 of Experiments 1 and 2, respectively, the differences between various treatment groups were small and insignificant (P> 0,05). The inclusion of molasses, irrespective of the levels used or the method of feeding, thus did not appear to influence rate of carcass gain. It is interesting to note that the molasses-fed groups had consistently higher dressing percentages in both experiments, although the differences were once again not significant.

Feed requirements per unit carcass gain followed the same trend as feed requirements per unit live mass gain, the highest molasses level in each experiment giving the poorest conversion rate, but with 7% molasses group in Experiment 2 giving the best conversion rate. Of interest is the fact that the cattle fed concentrate and hay separately required less feed per unit carcass gain than the animals fed the complete diet. This can be attributed to lower total intake of hay by the animals in Experiment 2 and their slightly higher dressing percentages.

*Vitamin A:* The effect of vitamin A on live mass gain and carcass gain is recorded in Table 5 and 6. From these results it is evident that vitamin A had no effect on any of the parameters measured.

**Table 5**

*Effect of vitamin A injection on rate of live mass gain, rate of carcass mass gain on dressing percentages*

| | Experiment 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Group 1 | | Group 2 | | Group 3 | | Group 4 | |
| | Control | Vit A | Control | Vit A | Control | Vit A | Control | Vit A |
| Live mass gain/day, kg | 1,04 | 1,04 | 0,95 | 0,91 | 1,08 | 1,02 | 0,90 | 1,07 |
| Dressing percentage | 57,1 | 56,9 | 57,8 | 57,6 | 58,5 | 57,3 | 57,9 | 57,7 |
| Carcass mass gain/dat, kg | 0,64 | 0,65 | 0,61 | 0,59 | 0,70 | 0,66 | 0,59 | 0,69 |

**Table 6**

*Effect of vitamin A injection on rate of live mass gain, rate of carcass gain and on dressing percentage*

| | Experiment 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Group 1 | | Group 2 | | Group 3 | | Group 4 | |
| | Control | Vit A | Control | Vit A | Control | Vit A | Control | Vit A |
| Live mass gain/day, kg | 1,00 | 0,92 | 0,98 | 1,02 | 1,05 | 0,86 | 0,90 | 0,98 |
| Dressing percentage | 58,3 | 58,2 | 57,4 | 60,2 | 58,4 | 58,7 | 58,4 | 59,1 |
| Carcass mass gain/day, kg | 0,65 | 0,60 | 0,63 | 0,71 | 0,68 | 0,58 | 0,59 | 0,67 |

## Discussion

According to the literature there appears to be no agreement on the value or optimum use of molasses in various feeding programmes. There is similarly a general lack of agreement concerning the energy value of molasses under various feeding conditions. Many earlier studies showed that molasses, added to the diet of dairy cows or fattening animals, depressed feed intake and digestibility of cellulose and energy. Morrison (1956) attributes to molasses a net energy value equivalent to 66% – 70% of that of maize meal if used in cattle and sheep fattening rations and a value of 89% of that of maize when used at a level not exceeding 10% in dairy concentrate mixtures. More recent work with modern balanced diets which do not cause a depression of feed intake have resulted in a drastic revision of the energy value of molasses for use in fattening and dairy rations. This fact is reflected by the National Research Council (1970; 1971) publications for both beef and dairy cattle which list molasses as having the same TDN and NE value as maize meal when expressed on a dry matter basis. This is also evident from the work of Lofgreen (1965) who found that finishing beef cattle, if fed molasses at levels of 5%, 10%, 15% and 20% of the ration, performed similarly, although those receiving the 20% molasses level required more feed when adjusted to an equal energy gain. Lofgreen (1965) concluded that the net energy values of rations containing 5%, 10% and 15% molasses were similar, while at 20% molasses net energy was only slightly depressed. Preston, Willis & Martin (1969), in a comparative slaughter experiment with molasses supplying up to 72% of the ME intake, could not demonstrate any decrease in the efficiency of molasses utilization due to an increased intake of molasses. Hatch & Beeson (1972), using 5%, 10% and 15% molasses to replace maize meal in high-energy feedlot-type rations, found that at the 10% and 15% levels, molasses improved nitrogen retention and apparent digestibility of dry matter and energy. They attribute this response to the establishment of superior microbial environment. These workers come to the conclusion that cane molasses need not be assigned an energy value lower than that of maize meal when used in the type of ration investigated.

The present study indicates that molasses, up to a 21% level of inclusion in complete fattening rations for cattle, has an energy value very similar to that of maize meal. The results of Experiment 2 suggest that at a 7% level of inclusion molasses may even improve the value of the ration. These results are thus not only in general agreement with the findings cited above, but also lend support to the experiments reported by other South African workers. Stewart (1970), replacing maize meal with molasses meal (25% bagasse and 75% high-brix molasses) at levels of 0%, 11%, 22% and 33% in the concentrate portion of the diet of dairy cows, found no significant differences in milk production or milk composition between groups. Hugo (1975), reported in his trials, in which 0%, 10%, 15% and 20% molasses meal was included at the expense of maize meal in complete diets for dairy cattle, that no differences in milk production or milk composition could be measured although the molasses-fed groups were found to consume more total feed. Lishman (1967) reported the results of two experiments in which molasses was used to supply 0%, 10%, 20% and 30% of the TDN of the ration. Molasses was assumed to have a TDN value of 53,3% and maize meal, which it replaced in the ration, was assumed to have a TDN value of 80,1%. Lishman concluded that molasses feeding did not significantly influence live mass gain or any of the carcass parameters investigated. It is of considerable significance to point out, however, that Lishman allowed for a 17 day preliminary period and based his conclusion only on the last 8 weeks of the fattening period. If the entire experimental period is viewed then it is obvious that the molasses-fed groups gained considerably more live mass than the control groups. It is also of interest to note that the molasses-fed groups had markedly heavier carcasses. The groups in which 10%, 20% and 30% TDN was supplied by molasses produced carcasses which were 15,8 kg, 5,0 kg and 1,9 kg heavier in Experiment 1 and 10,4 kg, 10,2 kg and 10,7 kg heavier in Experiment 2. These results strongly suggest that molasses has an energy value considerably higher than that assumed by Lishman (1967).

The present study furthermore illustrates that molasses improves the acceptability of rations as is reflected by the small but consistent increases in feed intake as the molasses level increased. This finding is in agreement with results published by Lishman (1965), Lishman (1967), Grey & Franck (1970) and Hugo (1975).

Because of the large price differential between molasses and maize meal in South Africa, the results of the present experiment clearly indicate that molasses can be used to considerable economic advantage as an alternative energy source in beef fattening rations.

## References


GREY, J.H. & FRANCK, F., 1970. Die effek van melasse en stikstofbron op die voerinname van lae kwaliteit ruvoer deur skape. *Proc. S. Afr. Soc. Anim. Prod.* 9, 145.

HATCH, C.F. & BEESON, W.M., 1972. Effect of different levels of cane molasses on nitrogen and energy utilization in urea rations for steers. *J. Animal Sci.* 35, 854.

HUGO, W.C., 1975. *Die benutting van melasse deur produserende melkkoeie.* M.Sc. Tesis, Universiteit van die Oranje-Vrystaat.

LISHMAN, A.W., 1965. The wintering of ruminants on the veld: Role of protein and energy supplements. *Proc. S. Afr. Soc. Anim. Prod.* 4, 107.

LISHMAN, A.W., 1967. Cane molasses as a substitute for maize in beef-finishing rations. *S. Afr. J. Agric. Sci.* 10, 51.

LOFGREEN, G.P., 1965. Net energy of fat and molasses for beef heifers with observations on the method of net energy determination. *J. Animal Sci.* 24, 480.

MORRISON, F.B., 1956. *Feeds and Feeding.* 22nd ed. Clinton, Iowa: Morrison Publ. Co.

NATIONAL RESEARCH COUNCIL, 1970. *Nutrient requirements of beef cattle.* Washington, D.C: National Academy of Sciences.

NATIONAL RESEARCH COUNCIL, 1971. *Nutrient requirements of dairy cattle.* Washington, D.C. : National Academy of Sciences.

PRESTON, T.R., WILLIS, M.B. & MARTIN, J.L., 1969. Efficiency of utilization for fattening of the metabolizable energy of molasses-based diets. *J. Animal Sci.* 28. 796.

REID, J.T., BENSADOUN, A., PALADINES, O.L. & VAN NIEKERK, B.D.H., 1963. Body water estimations in relation to body composition and indirect calorimetry in ruminants. *Ann. N.Y. Acad. Sci.* 110, 327.

STEEL, R.G.D. & Torrie, J.H., 1960. *Principles and procedures of Statistics.* New York: McGraw-Hill.

STEWART, M.J., 1970. *Molasses meal as an alternative energy source in rations of dairy cows.* M.Sc. Thesis, Stellenbosch University.

VAN NIEKERK, B.D.H., 1975. Role of molasses as a supplement for grazing ruminants. The Pure Cane Molasses Co., Molasses Technical Seminar, Durban.