# BAGOMOLASSES AS THE BASIS OF A FATTENING RATION FOR CATTLE

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**SUMMARY**

**Three groups of five steers 21-27 months of age were fed individually for 17 weeks on rations containing up to 70 per cent. bagomolasses.**

**The bagomolasses, which contained 70 per cent. molasses and 30 per cent. bagasse, was combined in various proportions with meatmeal, urea, sorghum meal, lucerne chaff and salt. The ration for Group I contained 70 per cent. bagomolasses and 2.16 per cent. nitrogen. Group II received a similar level of bagomolasses but 1.5 per cent. nitrogen. The ration for Group III contained 2.11 per cent. nitrogen. Grain was incorporated in this ration to reduce the level of bagomolasses to 50 per cent.**

**A comparable group of five animals was slaughtered for carcass appraisal at the commencement of the experiment. The remainder were slaughtered at the conclusion of the 17 weeks' feeding. Response to the rations was measured by body-weight gains and changes in carcass weight and composition. The digestibility of bagomolasses was determined.**

**The mean daily air-dry feed intake in Group III of 22.4 lb per head per day was significantly higher ($P<0.05$) than that in either Group I or Group II (18.0 and 16.9 lb respectively). Mean respective body-weight gains for Groups I, II and III were 1.4, 1.5 and 2.3 lb per day on a non-shrunk basis and 1.1, 1.0 and 1.7 lb per day on a shrunk basis. Carcass weights in Group III were correspondingly higher than in the other two groups, over 66 per cent. of this difference being due to fat deposition.**

**Bagomolasses was shown to have an apparent dry-matter digestibility of approximately 52 per cent. Apparent digestibility of crude protein was 16.7 per cent. and crude fibre 21.3 per cent.**

**From these results it is considered that bagomolasses should not comprise more than 50 per cent. of a cattle fattening ration.**

## I. INTRODUCTION

In Queensland, from an annual production of approximately 9 million tons of sugar cane, over 220,000 tons of molasses are produced (Nicklin and Brain 1960). Although production of molasses has approximately doubled since 1947, the amount of molasses used as stock feed has not increased, the extra production being used in distilleries or as fertilizer. Another by-product, bagasse, is used mostly as a fuel for mills. A small amount is used in the production of an insulating material, but 190,000 tons, or approximately 10 per cent. of the total production, is not used commercially. Possible uses of this surplus are in the production of paper and hardboard (Nicklin 1957; Nicklin and Brain 1959) and as a carrier for molasses in stock feeds (Wood 1934).

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Much work has been done on the feeding value of molasses but very little on the utilization of bagasse-molasses mixtures (bagomolasses). Some of the more important results have come from the United States of America (Lamb 1938; Bray, Snell, Morrison, and Jackson 1945; Lathrop, Aronovsky, and Naffziger 1951; Anon. 1951; Wayman, Iwanaga, Morita, and Henke 1952), India (Ray and Talapatra 1945; Ayyar and Zubery 1945) and Trinidad and British Guiana (Scott 1950). Bagasse contains 40-50 per cent. fibre, 18-20 per cent. lignin and no digestible protein. Kamstra, Moxon, and Bentley (1958) have shown that lignin itself is virtually indigestible and by a process of encrustation can also reduce the digestibility of cellulose by 50-75 per cent. Because of the high fibre and lignin content of bagasse, the T.D.N. value of 46·5 (Morrison 1959) would tend to over-estimate its feeding value.

Freight costs are of major importance in the inland areas of Queensland. From this aspect alone, bagasse, being of low feeding value, would be uneconomical as a drought fodder when compared with grains. In this State, the best use of bagomolasses would be as the roughage portion of a topping-off ration for cattle fed in close proximity to the sugar mills.

This paper gives the results of a feeding experiment with cattle using rations containing high levels of bagomolasses. The concentrates used in the rations were selected on the basis of the cost and availability in Queensland. Bagomolasses containing 70 per cent. molasses and 30 per cent. bagasse was chosen, as this is the highest concentration of molasses which would permit transportation in jute bags. The digestibility of the bagomolasses was also determined.

## II. MATERIALS AND METHODS

(i) *Animals*.—The cattle used in the feeding experiment were Hereford steers 21-27 months of age, in store condition. They were bred and reared in south-eastern Queensland. Three mature dairy-type steers were used for the determination of the digestibility of bagomolasses.

(ii) *Housing*.—The animals were housed in individual stalls with concrete flooring and troughing. Softwood shavings were supplied as bedding. Water was available *ad lib.* from automatic drinkers.

(iii) *Rations*.—The following rations were used:

| — | I | II | III |
|---|---|---|---|
| | % | % | % |
| Bagomolasses | 70 | 70 | 50 |
| Meat-and-bone meal | 10 | 8 | 5 |
| Urea | 1 | .. | 1 |
| Sorghum meal | 12 | 15 | 37 |
| Lucerne chaff | 5 | 5 | 5 |
| Sodium chloride (coarse) | 2 | 2 | 2 |

The bagomolasses was 70 per cent. molasses and 30 per cent. bagasse by weight and was prepared in a screw mixer. The urea was fertilizer grade (45·4 per cent. nitrogen on air-dry basis). The lucerne chaff, sorghum meal and meat-and-bone meal were uniform lines obtained prior to commencement of the experiment.

(iv) *Sampling and Analysis.*—Samples of ration components were taken prior to the experiment except in the case of bagomolasses, where each bag was sampled as used and the pooled sample analysed.

All analyses of feed, faeces and carcass were done by the official A.O.A.C. methods (Association of Official Agricultural Chemists 1955).

Carcass composition was estimated from analysis of the 9th, 10th and 11th rib cut, using the regressions of Hankins and Howe (1946) given below:

$$Y_1 = 2{\cdot}82 + 0{\cdot}77\,X_1 \quad \ldots \quad (1)$$
$$Y_2 = 5{\cdot}98 + 0{\cdot}66\,X_2 \quad \ldots \quad (2)$$
$$Y_3 = 14{\cdot}90 + 0{\cdot}78\,X_3 \quad \ldots \quad (3)$$
$$Y_4 = 4{\cdot}30 + 0{\cdot}61\,X_4$$

$Y_1$ = percentage ether extract in the edible portion* of the carcass ;
$X_1$ = percentage ether extract in the edible portion* of the rib cut ;
$Y_2$ = percentage protein in the edible portion* of the carcass ;
$X_2$ = percentage protein in the edible portion* of the rib cut.
$Y_3$ = percentage water in the edible portion* of the carcass ;
$X_3$ = percentage water in the edible portion* of the rib cut ;
$Y_4$ = percentage separable bone in the whole of the carcass ;
$X_4$ = percentage separable bone in the whole of the rib cut.

* Edible portion refers to the whole less the bone.

To correct equations (1), (2) and (3) to percentages in the whole carcass, the following formulae were used:

$$\text{Ether extract} = \frac{0{\cdot}99\,Y_1\,(100-Y_4)}{Y_1 + Y_2 + Y_3}$$

$$\text{Protein} = \frac{0{\cdot}99\,Y_2\,(100-Y_4)}{Y_1 + Y_2 + Y_3}$$

$$\text{Water} = \frac{0{\cdot}99\,Y_3\,(100-Y_4)}{Y_1 + Y_2 + Y_3}$$

The factor 0·99 is a correction for an allowance of 1 per cent. ash in the edible portion of the carcass.

(v) *Digestibility.*—In the digestibility trial, faeces were collected by using harness to the design by Ballinger and Dunlop (1946). Animals were individually housed in stalls. No bedding was used. The precollection period was 10 days and the collection period 7 days.

The digestibility of bagomolasses was determined by difference. In the first period each animal was fed slightly below its maximum intake on a ration of 50 per cent. lucerne chaff, 50 per cent. bagomolasses, mixed on an air-dry basis. In the second period each animal was fed lucerne chaff of air-dry weight similar to the total air-dry weight in the first period.

(vi) *Body-weight.*—Initial and final body-weights were obtained on a shrunk (18 hr without feed and water) basis. Non-shrunk body-weights were obtained at fortnighly intervals. All weighings were made on scales with an accuracy of ± 1 lb at 8.30 a.m. before the morning addition of feed.

## III. EXPERIMENTAL

Twenty steers were allotted by stratified random sampling on the basis of body-weight into four groups of five and placed on the following treatments:

Groups I, II and III were assigned to Rations I, II and III respectively.
Group IV was slaughtered at the commencement of the experiment.

The rations were fed *ad lib.* The duration of the feeding period was 17 weeks, this being determined by the time taken for the most rapidly gaining group to reach a degree of finish which was considered suitable for the local trade.

On being stalled, the animals were fed lucerne chaff; this was progressively changed to the experimental ration over the first 2 weeks of the 17-week feeding period.

Feed was before the animals at all times and was added to twice daily. Residues were weighed daily and fed back.

Carcasses of Group IV at the commencement of the experiment and of Groups I, II and III at the conclusion were sampled for analysis to estimate the separable bone, protein, water and ether extract.

## IV. RESULTS

(i) *Feed Analyses.*—Proximate analyses of the ration components are given in Table 1. The composition, estimated starch equivalent and digestible protein percentage of the rations are shown in Table 2.

**TABLE 1**

PROXIMATE ANALYSES OF RATION COMPONENTS IN FATTENING EXPERIMENT

| Component | Moisture (%) | Crude Protein (%) | Ether Extract (%) | Crude Fibre (%) | Nitrogen-free Extract (%) | Ash (%) | Ca (%) | P (%) |
|---|---|---|---|---|---|---|---|---|
| Bagomolasses 70/30 | 16·5 | 3·9 | 0·2 | 13·0 | 55·5 | 11·0 | 1·04 | 0·11 |
| | . . | *4·7* | *0·26* | *15·6* | *66·2* | *13·2* | *1·24* | *0·15* |
| Meat-and-bone meal | 7·6 | 58·1 | 4·5 | . . | 9·0 | 20·8 | 6·8 | 3·26 |
| | . . | *62·9* | *4·9* | . . | *9·7* | *22·5* | *7·4* | *3·52* |
| Sorghum meal . . | 13·5 | 10·6 | 2·7 | 2·3 | 69·4 | 1·5 | 0·03 | 0·30 |
| | . . | *12·2* | *3·1* | *2·6* | *80·4* | *1·7* | *0·03* | *0·34* |
| Lucerne chaff . . | 13·2 | 16·9 | 1·2 | 20·5 | 41·6 | 6·6 | 0·79 | 0·28 |
| | . . | *19·4* | *1·3* | *23·6* | *48·1* | *7·6* | *0·86* | *0·32* |

*Italics* indicate composition on a dry-matter basis.

## TABLE 2

CHEMICAL COMPOSITION, ESTIMATED STARCH EQUIVALENT AND DIGESTIBLE PROTEIN OF RATIONS I, II AND III

| — | Moisture (%) | Crude Protein* (%) | Ether Extract (%) | Crude Fibre (%) | Nitrogen-free Extract (%) | Ash (%) | Ca (%) | P (%) | Digestible Crude Protein† (%) | Starch Equivalent ‡ (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Ration I .. .. .. .. | 14·6 | 13·5 | 1·0 | 10·4 | 49·8 | 12·3 | 1·4 | 0·5 | 9·3 | 39 |
| | .. | *15·8* | *1·2* | *12·2* | *58·4* | *14·4* | *1·6* | *0·6* | .. | .. |
| Ration II .. .. .. | 14·7 | 9·8 | 1·0 | 10·5 | 51·7 | 11·9 | 1·3 | 0·4 | 6·1 | 40 |
| | .. | *11·4* | *1·2* | *12·3* | *60·5* | *13·9* | *1·5* | *0·5* | .. | .. |
| Ration III .. .. .. | 14·2 | 13·2 | 1·4 | 8·4 | 55·8 | 9·4 | 0·9 | 0·3 | 8·9 | 49 |
| | .. | *15·4* | *1·6* | *9·8* | *65·0* | *10·9* | *1·0* | *0·4* | .. | .. |

*Italics* indicate composition on a dry-matter basis.

* (N x 6·25).

† Digestible protein percentage of bagomolasses taken from Table 5. Urea nitrogen is given a digestibility of 90 per cent. (Beames 1959). Values for other ration components taken from Morrison (1959).

‡ Starch equivalent by method described by Woodman (1957).

(ii) *Feed Consumption.*—The means of the total and daily air-dry feed consumptions over the whole experimental period are given in Table 3. The progressive mean daily consumptions calculated at weekly intervals are shown in Figure 1. In all groups, and particularly in Group I, intakes fluctuated but showed a general increase as the experiment progressed. At all times the consumption in Group III was greater than that in either Group I or Group II. The initial intakes in all groups were low, with Group III being the only one to achieve a satisfactory level for most of the experiment. The mean daily intake of 22·4 lb in Group III was significantly ($P < 0{\cdot}05$) higher than those in Groups I and II, which were 18·0 lb and 16·9 lb respectively. There was no significant difference between feed intakes of Groups I and II.

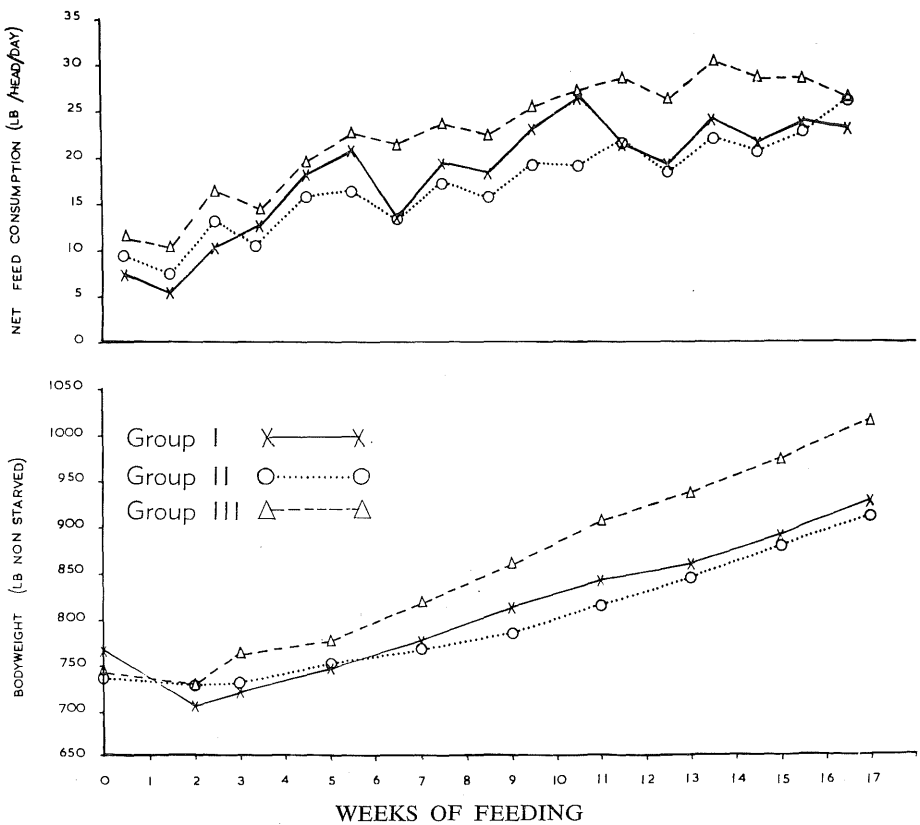


Fig. 1.—Net feed consumptions and bodyweight changes of Groups I, II and III over the 17-week feeding period.

(iii) *Body-weight.*—Initial and final body-weights are given in Table 3, with fortnightly changes shown in Figure 1. On the non-shrunk basis, Group III performed significantly ($P < 0{\cdot}01$) better than Groups I and II, between which there was no significant difference. On the shrunk basis, Group III made greater weight gains than Group II ($P < 0{\cdot}01$) and Group I ($P < 0{\cdot}05$). The weight increases in all groups on a shrunk basis were much smaller than on a non-shrunk basis, being 0·3–0·6 lb per day less. Dressing percentages on a shrunk basis were correspondingly higher, being 1·8 per cent. units in the group slaughtered initially and 3·8–4·5 per cent. units in the groups slaughtered at the conclusion.

TABLE 3

BODY-WEIGHT CHANGES AND FEED CONSUMPTION OVER THE 17-WEEK EXPERIMENTAL PERIOD

| —— | Group I | Group II | Group III | Group IV | Necessary Difference | |
|---|---|---|---|---|---|---|
| | | | | | $P < 0{\cdot}05$ | $P < 0{\cdot}01$ |
| Non-shrunk body-weight (lb)— | | | | | | |
| Initial | 763 | 738 | 745 | 751 | .. | .. |
| Final | 926 | 912 | 1,012 | .. | .. | .. |
| Total gain | 163 | 174 | 267 | .. | 65 | 91 |
| Mean gain/day | 1·4 | 1·5 | 2·3 | .. | 0·55 | 0·77 |
| Shrunk body-weight (lb)— | | | | | | |
| Initial | 733 | 722 | 728 | 726 | .. | .. |
| Final | 862 | 843 | 930 | .. | .. | .. |
| Total gain | 129 | 121 | 202 | .. | 54 | 76 |
| Mean gain/day | 1·1 | 1·0 | 1·7 | .. | 0·45 | 0·63 |
| Dressing percentage*— | | | | | | |
| (*a*) Non-shrunk basis | 52·3 | 53·6 | 55·1 | 49·3 | .. | .. |
| (*b*) Shrunk basis | 56·1 | 58·1 | 59·4 | 51·1 | .. | .. |
| Difference (b−a) | 3·8 | 4·5 | 4·3 | 1·8 | .. | .. |
| Air-dry feed consumption (lb)— | | | | | | |
| Total | 2,120 | 1,996 | 2,638 | .. | 490 | 686 |
| Mean/day | 18·0 | 16·9 | 22·4 | .. | 4·1 | 5·7 |

* Based on hot dressed weight.

(iv) *Carcass Analysis.*—The carcass analyses of Group IV slaughtered at the commencement of the feeding period and Groups I, II and III slaughtered at the conclusion of the feeding period are given in Table 4. In all these analyses Group III was markedly different from Groups I and II, which, on the whole, had comparable performance throughout. In the whole carcass, Group III had a greater percentage of ether extract than Groups I and II ($P < 0{\cdot}01$) and a lower percentage of carcass water than either Groups I ($P < 0{\cdot}05$) or II ($P < 0{\cdot}01$). Each group made an average increase of 16·1–18·9 lb in skeletal growth (i.e. separable bone), with no significant difference between groups.

(v) *Carcass Quality.*—In the commercial assessment of carcass quality of Groups I, II and III by visual appraisal, all carcasses were classed as 1st quality, except one in Group I, which was classed as 2nd quality. Of the group slaughtered at the commencement of the trial, four were classed as 2nd quality and one as 3rd quality.

(vi) *Digestibility.*—Results of the digestibility trial are given in Table 5. Apparent digestibility of both crude protein (16·7 per cent.) and crude fibre (21·3 per cent.) was low, while that of nitrogen-free extract was comparatively high (65·1 per cent.).

**TABLE 4**

Percentage and Total Weights of Carcass Components at Slaughter, Calculated from Percentages in the 9th, 10th and 11th Rib Cut

| Carcass Component | Group Means | | | | Necessary Difference | |
|---|---|---|---|---|---|---|
| | I | II | III | IV | $P < 0·05$ | $P < 0·01$ |
| Percentage in separable portion— | | | | | | |
| Ether extract .. .. | 20·3 | 20·0 | 27·2 | 13·7 | 4·4 | 6·2 |
| Protein .. .. .. | 17·0 | 16·4 | 15·7 | 18·0 | 1·1 | 1·6 |
| Water .. .. .. | 61·4 | 61·5 | 55·8 | 64·4 | 3·3 | 4·7 |
| Total .. .. .. .. | 98·5 | 97·9 | 98·8 | 96·1 | 1·0 | 1·5 |
| Percentage in whole carcass— | | | | | | |
| Ether extract .. .. | 16·9 | 17·1 | 23·2 | 11·8 | 3·9 | 5·5 |
| Protein .. .. .. | 14·2 | 14·0 | 13·5 | 15·3 | 1·0 | 1·4 |
| Water .. .. .. | 51·5 | 52·2 | 47·7 | 55·1 | 3·2 | 4·4 |
| Separable bone .. .. | 16·5 | 16·1 | 14·7 | 17·0 | 1·2 | 1·7 |
| Weight in whole carcass (lb)— | | | | | | |
| Total .. .. .. .. | 484 | 490 | 557 | 370 | 32 | 44 |
| Ether extract .. .. | 81·8 | 83·8 | 129·2 | 43·6 | 24·5 | 34·3 |
| Protein .. .. .. | 68·7 | 68·6 | 75·2 | 56·6 | 4·1 | 5·7 |
| Water .. .. .. | 249·3 | 255·8 | 265·7 | 203·9 | 12·8 | 17·9 |
| Separable bone .. .. | 79·7 | 78·8 | 81·6 | 62·7 | 7·1 | 9·9 |

**TABLE 5**

Apparent Digestibility of Bagomolasses Determined by Difference

| Animal No. | Mean Body-weight (lb) | Average Dry-matter Intake/Day (lb) | | Digestibility (%) | | | |
|---|---|---|---|---|---|---|---|
| | | Period 1 | Period 2 | Dry Matter | Crude Protein | Fibre | Nitrogen-free Extract |
| 36 | 718 | 12·4 | 13·5 | 51·2 | 7·0 | 21·4 | 64·9 |
| 37 | 700 | 12·5 | 13·5 | 50·0 | 20·4 | 18·6 | 65·1 |
| 38 | 1,418 | 16·7 | 18·0 | 53·9 | 22·8 | 24·0 | 65·3 |
| Mean | .. | .. | .. | 51·7 | 16·7 | 21·3 | 65·1 |

## V. DISCUSSION

The high bagomolasses content of Rations I and II resulted in a low estimated starch equivalent (approximately 40 per cent. for each ration). It was anticipated that on these two rations a high feed intake would partly compensate for the low energy level. However, only towards the conclusion of the experiment were the intakes of these two rations considered satisfactory. The main difference between Ration I and Ration II was in the level of nitrogen (Table 2), this difference being provided mainly in the form of urea. For there to be no difference between the results achieved by these rations one would assume that some factor other than nitrogen was limiting in both rations, or that urea was ineffective in a production ration. This latter explanation would tend to be discounted by the findings of several workers using sheep (Harris and Mitchell 1941; Johnson, Hamilton, Mitchell, and Robinson 1942; Hamilton, Robinson, and Johnson 1948). These findings should apply to cattle, as they have been reported to respond as well as, if not better than, sheep to urea feeding (Gallup, Pope, and Whitehair 1953; Morris 1958). Dinning, Briggs, and Gallup (1949) showed urea to be well utilized in a fattening ration for both cattle and sheep when it provided approximately 20 per cent. of the total nitrogen intake.

The body-weight changes in Group III could be considered satisfactory for fattening cattle, i.e. 2·3 lb per day on a non-shrunk basis and 1·7 lb per day on a shrunk basis. The marked difference between the data calculated on a shrunk and non-shrunk basis emphasizes the importance of standardizing the weighing technique as shown by Hughes and Harker (1950) and Taylor (1954).

An important factor in the rate of gain in all groups was the length of time taken for feed intakes to rise to a somewhat steady level (Figure 1). Over the final 10 weeks of the 17-week period the mean daily weight increases (on a non-shrunk basis) of 2·1, 2·1 and 2·9 lb for Groups I, II and III respectively, as compared with those over the total period of 1·4, 1·5 and 2·3 lb respectively, are perhaps a better measure of the capabilities of the rations.

The quantitative type of carcass analysis of Hankins and Howe (1946) was used in this experiment in preference to the system of either McMeekan and Walker (1950) or Yeates (1952), in which no statistical analyses can be made on the results, and to the more exact but more time-consuming dissection techniques of Callow (1947) and Watson, Kennedy, Davidson, Robinson, and Muir (1949). Hopper (1944) found that the analysis of the 9th, 10th and 11th rib cut had a high degree of correlation ($r = 0 \cdot 95$) with total carcass analysis, although his regressions differed from those of Hankins and Howe (1946). More recently, Kraybill, Bitter, and Hankins (1952) showed that the specific gravity of the 9th, 10th, 11th rib cut was highly correlated ($r = 0 \cdot 95$) with that of the whole carcass.

The equal amount of bone growth in all groups (Table 3) is understandable, as the mean calcium and phosphorus intake in each was above the National Research Council (1958) requirements for fattening yearling cattle. The low energy value of the rations and low feed intakes in both Group I and Group II could explain the low fat and protein deposition in these groups. When these carcass analysis figures are compared with those calculated by Callow (1950) for young steers, it is seen that the weight of bone in Group III and Group IV was comparable with Callow's figures but was high in Groups I and II. Weight of protein was higher than Callow's figures in all groups, whereas ether extract (fat) was similar in Group III, less in Groups I and II and much less in Group IV. Thus, taking the data of Callow as being representative of normal well-grown young steers, the steers used in this experiment at the commencement of feeding had made normal skeletal and muscular growth. On the experimental rations, normal growth continued, but only in Group III was the deposition of fat brought to an adequate level.

The high apparent digestibility of nitrogen-free extract of bagomolasses could be explained by the high molasses content. The variability in apparent digestibility of the crude protein of bagomolasses could have been caused by small variations in the percentage of metabolic faecal nitrogen, especially in a determination such as this where the method of difference was used on a low-nitrogen feedstuff. The low average apparent digestibility of fibre (21·3 per cent.) of bagomolasses could have been a result of the high lignin content of bagomolasses, aggravated by a high carbohydrate level in the feed (Hoflund, Quin, and Clark 1948).

Essentially, the findings from these data are that a ration containing 50 per cent. bagomolasses is suitable for topping-off beef cattle, whereas a ration containing 70 per cent. bagomolasses appears to be limiting in energy.

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