# DIGESTIBILITY AND NITROGEN METABOLISM IN BRAHMAN, AFRICANDER AND SHORTHORN X HEREFORD CATTLE FED LUCERNE HAY

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*Summary*

Dry matter and apparent nitrogen digestibilities, and some constituents of urine and plasma, were measured in Brahman, Africander and Shorthorn x Hereford cattle fed three levels of lucerne hay.

No significant breed differences were found in dry matter digestibility, apparent nitrogen digestibility, urinary nitrogen, urinary urea or nitrogen balance, but there were significant differences in urinary ammonia and creatinine and in plasma urea and creatinine concentrations. Animals within a breed did not differ in their urinary ammonia excretion nor in their ability to digest dry matter or nitrogen. They did differ, however, in their urinary urea and creatinine excretions and in plasma urea and creatinine concentrations. Increasing the feeding level had no effect on dry matter digestibility or plasma urea concentration but increased urinary nitrogen, urea, ammonia and creatinine and decreased the apparent nitrogen digestibility and the plasma creatinine concentration. In apparent nitrogen digestibility and in plasma urea concentration, there were significant interactions between breed and feeding level.

## I. INTRODUCTION

Several comparative studies of the digestive efficiency of Zebu cross and British cattle have been made (French 1940; Phillips 1961; Ashton 1962; Vercoe 1966, 1967). However, few such comparisons of pure-bred Brahmans and British cattle have been reported (Ashton 1962; Howes, Hentges and Davis 1963). In addition, there is a lack of published information on the relative digestive efficiencies and nitrogen metabolism of Brahman, Africander and British cattle.

This paper compares the digestive efficiencies and some components of urine and plasma of Brahman, Africander and Shorthorn x Hereford cattle fed lucerne hay and indicates how these components were affected by feeding level.

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## II. EXPERIMENTAL

Nine Brahman, nine Africander and nine Shorthorn x Hereford (SH) male cattle were studied, three of each breed in each of the years 1966, 1967 and 1968. Details of the breeds and animals have been reported elsewhere (Frisch and Vercoe 1969). In any year, the ages of the breeds were similar and the mean weights of the Brahman, Africander and SH animals were 290, 254 and 243 kg respectively.

In each year, feed was offered at three levels in a Latin Square design so that, in each period, each animal within a breed received a different level of intake. Each period consisted of 11 days preliminary feeding and 10 days collection. During the collection period, the animals were housed in metabolism cages. The feed offered was hammermilled (1966, 1967) or chaffed (1968) lucerne hay fed daily in two equal portions at 7.30 a.m. and 3.30 p.m. The mean amounts of dry mater (DM) (kg/day) and nitrogen (N) (g/day) offered were 3.22 and 105.61, 4.19 and 137.91, and 5.17 and 170.20 for the low, medium and high levels respectively.

Daily faecal samples from each animal were bulked over the last eight days of the collection period and analysed for DM and N. Samples of similarly bulked urine (collected into a $CuSO_4/H_2SO_4$ preservative) were analysed for total nitrogen, urea, creatinine and ammonia. Blood was taken from the jugular vein on the final day of the collection period 2 h after the morning feed and analysed for urea and creatinine. The methods used were those of Vercoe ( 1967).

The effects of years and their interactions with feeding levels and breeds were partitioned in an analysis of variance, but the only components of variance which are considered in this paper are breeds, animals within breeds, feeding levels and the interaction between feeding levels and breeds.

## III. RESULTS

The breed means of DM digestibility, apparent N digestibility, urinary N and N balance at each feeding level are shown in Table 1. There were no significant differences between breeds or animals within breeds in DM or apparent N digestibilities, but there was a tendency for the apparent N digestibility to decrease as the feeding level increased ($P<0.10$). There was also a tendency for the breeds to respond differently to the three feeding levels in both DM ($P<0.10$) and apparent N digestibilities ($P<0.05$). DM and apparent N digestibilities decreased with increased feeding level in the Brahmans and Africanders but were not affected in the SH animals. There were no significant breed differences in urinary N or N balance but there were significant differences between animals within breeds ($P<0.001$). Urinary N and N balance increased significantly as the feeding level increased (urinary N, $P<0.001$; N balance, $P<0.05$).

The breed means for urinary constituents at each feeding level are shown in 'Table 2. There were significant breed differences in urinary ammonia and creatinine ($P<0.05$) but, in the case of creatinine, analysis of covariance showed that the breed effect was accounted for by differences in liveweight. Animals within breeds differed significantly in urinary urea ($P<0.001$) and slightly in creatinine ($P<0.10$). All three urinary constituents increased significantly with increased feeding level (urea, $P<0.001$; ammonia and creatinine, $P<0.05$).

TABLE 1

*Breed means at each level of intake for dry matter digestibility, apparent nitrogen digestibility, urinary nitrogen and nitrogen balance*

| Breed | Level | Dry matter digestibility (%) | Apparent nitrogen digestibility (%) | Urinary nitrogen (g/day) | Nitrogen balance (g/day) |
|---|---|---|---|---|---|
| Brahman | Low | 65.49 | 73.81 | 73.84 | 4.15 |
| | Medium | 64.49 | 73.46 | 86.48 | 15.01 |
| | High | 63.32 | 71.62 | 98.54 | 23.52 |
| | Mean | 64.43 | 72.96 | 86.29 | 14.23 |
| Africander | Low | 66.23 | 73.97 | 71.80 | 6.44 |
| | Medium | 64.27 | 73.20 | 86.50 | 14.75 |
| | High | 64.27 | 71.94 | 94.98 | 27.58 |
| | Mean | 64.92 | 73.04 | 84.43 | 16.26 |
| Shorthorn x Hereford | Low | 64.91 | 72.83 | 72.87 | 4.22 |
| | Medium | 63.94 | 72.24 | 86.36 | 13.64 |
| | High | 64.33 | 72.75 | 94.47 | 29.57 |
| | Mean | 64.39 | 72.61 | 84.57 | 15.81 |
| Standard errors for differences between means | | | | | |
| Breed | | 0.56 | 0.64 | 4.18 | 4.17 |
| Level | | 1.55 | 0.80 | 3.97 | 6 56 |
| Breed x Level | | 0.47 | 0.50 | 2.21 | 2.13 |

The breed means of plasma urea and creatinine concentrations at each feeding level are also shown in Table 2. There were significant differences between breeds ($P<0.05$) and between animals within breeds ($P<0.001$) in both. The Africanders had a significantly lower mean plasma urea concentration than the SH animals but the differences between the Brahmans and Africanders and between Brahmans and SH animals were not significant. Brahmans had a significantly higher mean plasma creatinine concentration than the other two breeds. In an analysis of covariance, this breed effect was not accounted for by difference in liveweight. Plasma urea concentration was not affected by feeding level but there was a significant interaction between breeds and feeding levels ($P<0.05$); in the Brahmans and Africanders it increased, if anything, with feeding level whereas in the SH animals it decreased. Plasma creatinine decreased significantly with increased feeding levels ($P<0.01$) but the interaction between breeds and feeding levels was not significant.

## IV. DISCUSSION

Ashton (1962) found consistently higher DM and N digestibilities in grade Brahman than in Hereford steers fed spear grass and spear grass/lucerne mixtures. Howes, Hentges and Davis ( 1963 ) also reported higher N digestibilities in Brahman than in Hereford heifers, mainly when they were fed low N diets. On an alfalfa (lucerne) hay diet, however, Hereford heifers had a slightly higher N digestibility than Brahmans (Hentges and Howes 1963). The present results indicate that on a lucerne diet the differences in DM and N digestibility between Brahmans, Africanders and SH are small. The small interaction between breeds and

TABLE 2

*Breeds means at each level of intake for urinary urea-nitrogen, creatinine and ammonia, and plasma urea-nitrogen and creatinine*

| Breed | Level | Urinary urea-nitrogen (g/day) | Urinary creat-inine (g/day) | Urinary ammonia-nitrogen (g/day) | Plasma urea-nitrogen mg/100 ml) | Plasma creat-inine |
|---|---|---|---|---|---|---|
| Brahman | Low | 64.36 | 6.14 | 1.19 | 20.7 | 1.69 |
| | Medium | 72.58 | 6 25 | 1.78 | 21.8 | 1.56 |
| | High | 82.01 | 8.00 | 2.01 | 21.6 | 1.45 |
| | Mean | 72.98 | 6.80 | 1.66 | 21.4 | 1.57 |
| Africander | Low | 61.62 | 5.35 | 1.64 | 19.2 | 1.30 |
| | Medium | 71.03 | 5.85 | 3.78 | 19.4 | 1.17 |
| | High | 76.91 | 6.28 | 4.08 | 20.8 | 1.18 |
| | Mean | 69.85 | 5.83 | 3.17 | 19.8 | 1.22 |
| Shorthorn x Hereford | Low | 61.99 | 4.57 | 1.67 | 23.2 | 1.51 |
| | Medium | 73.35 | 6.29 | 3.04 | 23.1 | 1.39 |
| | High | 77.73 | 6.47 | 5.63 | 22.3 | 1.27 |
| | Mean | 71.02 | 5.78 | 3.45 | 22.8 | 1.39 |
| Standard errors for differences between means | | | | | | |
| Breed | | 4.27 | 0.68 | 1.21 | 1.7 | 0.15 |
| Level | | 1.72 | 0.69 | 0 93 | 1.2 | 0.05 |
| Breed x Level | | 2.22 | 0.51 | 1.03 | 0.6 | 0.05 |

feeding levels for N digestibility suggests that comparisons of digestive efficiency of breeds should be made at the same or, preferably, over a range of feed intakes.

The N balances of the three breeds were not significantly different under the conditions of this experiment. It should. be noted, however, that the differences in N balance between the breeds necessary to account for the differences in growth rate reported by Frisch and Vercoe ( 1969) are only of the order of 2 g N/day, assuming that 50 per cent of the difference in gain was due to protein. Differences of this order of magnitude would not be detected in this short-term balance experiment. In addition, it has been shown that, at ambient temperatures which produce a differential rise in rectal temperature of Zebu cross and SH cattle, substantial breed differences in urinary N and N balance exist (Vercoe 1969; Vercoe and Frisch, unpublished data; O'Kelly, unpublished data).

The breed differences in urinary creatinine were accounted for by differences in liveweight. However, between animals within a breed, the correlation between urinary creatinine and liveweight was small ($r = +0.35$) and not significant.

The significantly lower amounts of urinary ammonia in the Brahmans is consistent with a previous report for Brahman x Hereford and Hereford steers (Vercoe 1967). Some of the estimated urinary ammonia would have been formed on the urine collection tray post-urination, but there is no reason why this should bias a particular breed. Further study on the significance of this appears desirable.

The fact that the Brahmans and SH animals had similar plasma urea concentrations is consistent with the finding on Brahman x Hereford and Hereford steers fed lucerne hay (Vercoe 1967). However, in that experiment, both breeds showed a decrease in plasma urea concentration with increased feeding level whereas, in the present experiment, only the SH animals declined. This may be related to the fact that in this experiment the range of feeding levels was from 3.22 to 5.17 kg DM/day but in the earlier work they ranged from 2.53 to 5.90 kg DM/day. The lower plasma urea concentration in the Africanders than in the SH animals is currently under study with crossbreds.

The higher plasma creatinine in the Brahmans and the decline of all breeds as feeding level increased is similar to the finding on Brahman x Hereford steers fed a low quality diet (Vercoe 1967).

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## VI. REFERENCES

ASHTON, G. C. (1962). *J. agric. Sci., Camb. 58: 333.*

FRENCH, M. H. ( 1940) *J. agric. Sci., Camb. 30: 503.*

FRISCH, J. E., and VERCOE, J. E. ( 1969). Aust. *J. agric. Res. 20:* 1189.

HENTGES, Jr., J. F., and HOWES, J. R. (1963). In "Crossbreeding Beef Cattle." (Univ. of Florida Press : Gainsville. )

HOWES, J. R., HENTGES, Jr., J. F., and DAVIS, G. K. (1963). *J. Anim. Sci. 22: 22.*

PHILLIPS, G. D. ( 1961). *Res. vet. Sci. 2: 202.*

VERCOE, J. E. ( 1966). *Proc. Aust. Soc. Anim. Prod. 6: 370.*

VERCOE, J. E. (1967). *Aust. J. agric. Res.* **18:** 1003.

VERCOE, J. E. (1969). *Aust. J. agric. Res. 20: 607.*