

# Stress and adaptation in beef heifers. 2. Influence of pen conditions on thyroid activity of Shorthorn, Afrikaner and Bonsmara heifers

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Eighteen beef heifers, representing the *Bos taurus* (Shorthorn), *Bos indicus* (Afrikaner) and intermediate (Bonsmara) types, were confined to a pen with 4,6 m<sup>2</sup> floor space per heifer. A similar number of heifers on veld grazing served as controls. Blood samples were taken at regular intervals during the winter and summer seasons from both groups for the determination of thyroxine concentrations. Pen conditions created a significant ( $P \leq 0,05$ ) rise in thyroxine values of the beef heifers. Breed effect was also significant ( $P \leq 0,01$ ). The thyroxine levels of Afrikaner heifers showed the greatest increase during penning ( $P \leq 0,01$ ), followed by those of the Bonsmara ( $P \leq 0,05$ ) and Shorthorn heifers. During the subsequent summer season the influence of penning was considerably reduced, with only the Afrikaner heifers having significantly ( $P \leq 0,05$ ) higher levels under pen than under veld conditions. Extending the penning period from 7 to 14 weeks did not result in any additional differences in thyroxine concentrations between groups.

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Agtien verse, teenwoordigend van *Bos taurus* (Korthoring), *Bos indicus* (Afrikaner) en intermediere (Bonsmara) tipes, is ingekraal teen 'n vloerspasie van 4,6 m<sup>2</sup> per vers. Dieselfde aantal loslopende verse het as kontrole gedien. Bloedmonsters vir die bepaling van tiroksienkonsentrasies is gereeld gedurende die winter en somerseisoene van albei groepe verse geneem. Gedurende die winter het ingekraalde toestande 'n betekenisvolle ( $P \leq 0,05$ ) verhoging in tiroksienwaardes veroorsaak. 'n Betekenisvolle ( $P \leq 0,01$ ) raseffek is ook verkry. Tiroksienwaardes van ingekraalde Afrikanerverse het die meeste toegeneem ( $P \leq 0,01$ ), gevolg deur dié van die Bonsmara ( $P \leq 0,05$ ) en Korthoringverse. Gedurende die daaropvolgende somerseisoen was die invloed van ingekraalde toestande op die verse heelwat minder; slegs die Afrikanerverse het 'n betekenisvolle ( $P \leq 0,05$ ) toename in tiroksienwaardes getoon. 'n Verlenging van die ingekraalde periode van 7 tot 14 weke het nie bykomende verskille in tiroksienpeile tussen behandelingsgroepe veroorsaak nie.

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## Introduction

Confining an animal to a given area demands a variety of adaptations. Among these are:

- (i) social adaptations in relation to species, breed, sex, etc. (Baxter, 1974);
- (ii) adaptations in relation to behaviour (Rasmussen, Banks, Berry & Becker, 1962; Bryant, 1970);
- (iii) adaptations in relation to increased animal density which cause hypertrophy of the adrenals (Siegel, 1959a; 1959b; 1960) or the occurrence of gastric ulcers (Selye, 1956; Kowalczyk, 1969);
- (iv) adaptations in relation to reproduction (Russel, 1968; Hafez, Schein & Ewbank, 1969) and
- (v) adaptation in relation to feeding (Gilchrist & Schwartz, 1972) and handling (Willet & Erb, 1972).

It is generally believed that *Bos taurus* types are better adapted to intensive conditions than *Bos indicus* types (Lombard & Retief, 1969). However, adaptation studies have been given little attention in the Republic of South Africa, in spite of the ideal opportunity offered by the availability of these types. Breeds such as the Shorthorn, Afrikaner and Bonsmara represent a large percentage of the beef herds and knowledge of the breeds and their adaptation to intensive conditions may lead to better utilization of their genetic potential. Differences in thyroid secretion rate have been suggested as a factor in adaptation differences between *Bos taurus* and *Bos indicus* beef species (Cowley, Gutierrez, Warnick, Hentges & Feaster, 1971). The aim of the study was to determine the influence of penning on thyroxine concentrations of Shorthorn, Afrikaner and Bonsmara heifers, and its relation to adaptation of the three beef breeds.

## Procedure

Thirty six heifers, 15 to 18 months old, representing the *Bos taurus* (Shorthorn), *Bos indicus* (Afrikaner) and intermediate (Bonsmara) types, were used in a switchback experimental design (Cochran & Cox, 1957). The latter included 2 treatments and 3 periods during a winter and a summer season. The treatments consisted of heifers that were either penned (4,6 m<sup>2</sup> per heifer) or kept under veld conditions. Half the number of heifers (18) were allocated to a penned-veld-penned situation, while the other half were allocated to a veld-penned-veld situation for a period

of seven weeks. Treatments were alternated during a 21 week period. The latter represented a winter period, from 2nd June to 26th October 1976. Animals were then re-allocated to treatments before the start of the summer season. The procedure was previously described by Erasmus & Krause (1982).

Blood samples were drawn from the jugular vein of the heifers just before commencement of the study. Samples were then collected on days 2, 21 and 49 of each period. The procedure was repeated after the heifers were changed from pen to veld conditions, and *vice versa*. Care was taken not to upset the heifers during sampling. Plasma thyroxine concentrations were determined by the competitive protein binding assay technique (Thyopac-4 kits – the Radiochemical Centre, Amersham, U.K.)

## Results

### Winter Season

Mean thyroxine concentrations in the plasma of all Shorthorn, Afrikaner and Bonsmara heifers were 52,5; 71,4 and 62,0 ng/ml respectively at the onset of the experiment. Shorthorn and Afrikaner heifers differed significantly ( $P \leq 0,05$ ). Body masses were 276, 235 and 290 kg respectively. The heifers lost 7% of their initial body mass on average, and were in a state of sub-maintenance nutrition for 87% of the 21-week trial period. At the termination of this period, Afrikaner heifers had lost 8,5 kg, whilst the Shorthorn and Bonsmara heifers gained 13,3 and 11,2 kg per heifer respectively.

Pen conditions created a significant ( $P \leq 0,05$ ) rise in thyroxine levels of the heifers, while breeds were also significantly ( $P \leq 0,01$ ) influenced. Plasma thyroxine concentrations of Shorthorn, Afrikaner and Bonsmara heifers confined to pen conditions of 4,6 m<sup>2</sup> per heifer, were respectively 8,5; 102,2 ( $P \leq 0,01$ ) and 42,3 ( $P \leq 0,05$ ) ng/ml higher than those under veld conditions. Mean thyroxine concentrations for each period are presented in Table 1. The variation in thyroid activity of penned and free-grazing heifers is shown in Figure 1. A comparison of

**Table 1** Comparison of mean thyroxine levels between heifers in the pen and on veld during the winter (ng/ml)

| Breed      | n            | Period 1      | Period 2      | Period 3      |
|------------|--------------|---------------|---------------|---------------|
| Short-horn | 6 penned     | 55,93 ± 8,86  | 40,65 ± 5,61  | 47,81 ± 10,04 |
|            | 6 Veld       | 44,28         | 40,70         | 46,56         |
|            | Significance | N.S.          | N.S.          | N.S.          |
| Afrikaner  | 6 Penned     | 68,73 ± 5,66  | 74,68 ± 6,01  | 53,65 ± 6,33  |
|            | 6 Veld       | 45,66         | 40,70         | 40,96         |
|            | Significance | $P \leq 0,05$ | $P \leq 0,01$ | N.S.          |
| Bonsmara   | 6 Penned     | 57,85 ± 7,51  | 71,40 ± 15,29 | 50,71 ± 7,14  |
|            | 6 Veld       | 54,21         | 50,81         | 53,18         |
|            | Significance | N.S.          | N.S.          | N.S.          |

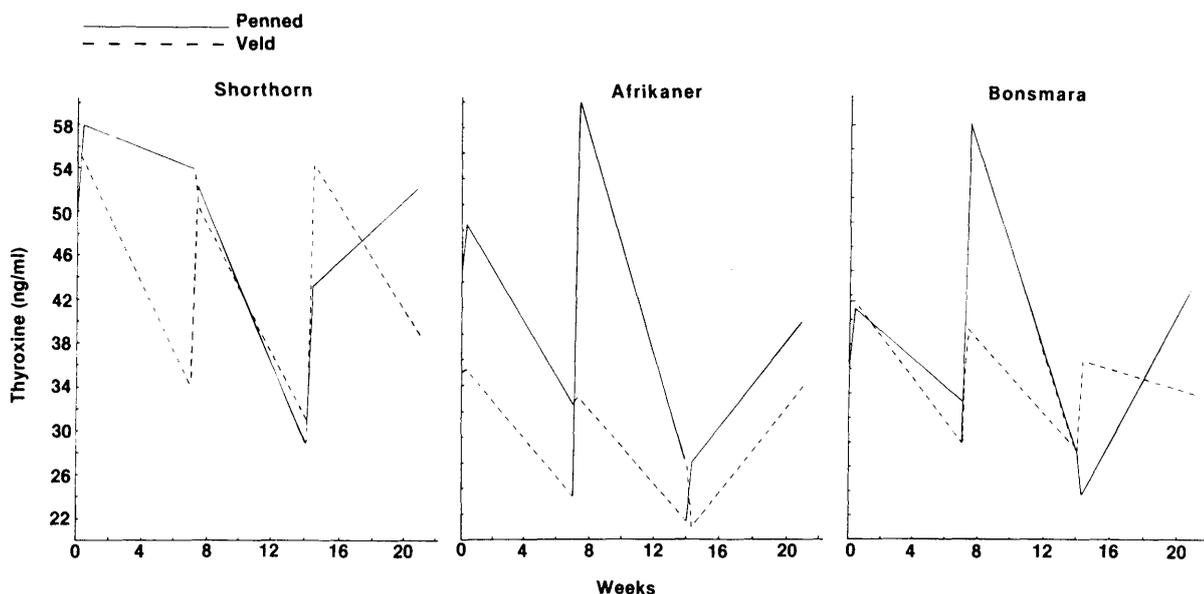
± = SD.

the breeds is presented in Figure 2. A strong influence of penning on thyroxine levels of Afrikaner and Bonsmara heifers is evident.

### Summer season

At the onset of the summer season, the body masses for Shorthorn, Afrikaner and Bonsmara heifers of both treatments were 289, 227 and 301 kg respectively. At termination, the heifers gained 26% in body mass, individual gains being 74; 67 and 73 kg respectively.

The influence of penning on thyroxine levels during this season was much less: No significant pen or breed effect was recorded. Thyroxine concentrations of penned Shorthorn, Afrikaner and Bonsmara heifers were 2,5; 61,6 ( $P \leq 0,05$ ) and 26,7 ng/ml higher than their free-grazing counterparts. Mean thyroxine concentrations for each period are presented in Table 2. The reduced influence of penning on thyroid activity of the heifers is evident from Figure 3. A comparison of thyroxine concentrations of the 3 breeds is presented in Figure 4. The prolonged effect of penning on the heifers is shown in Figure 5.



**Figure 1** Thyroxine concentrations of Shorthorn, Afrikaner and Bonsmara heifers under penned and veld conditions during the winter.

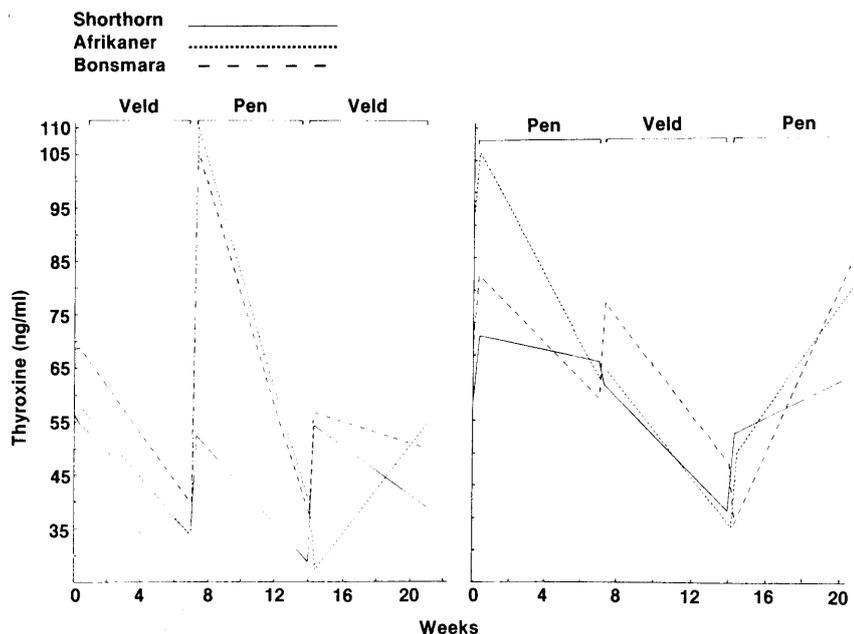


Figure 2 Comparison of thyroxine levels of 3 beef breeds under penned and veld conditions during the winter.

Table 2 Comparison of mean thyroxine levels between heifers in the pen and on veld during the summer (ng/ml)

| Breed      | n            | Period 1     | Period 2      | Period 3     |
|------------|--------------|--------------|---------------|--------------|
| Short-horn | 6 penned     | 62,16 ± 8,82 | 51,21 ± 13,06 | 69,26 ± 5,40 |
|            | 6 Veld       | 50,43        | 58,65         | 63,71        |
|            | Significance | N.S.         | N.S.          | N.S.         |
| Afrikaner  | 6 Penned     | 68,91 ± 7,43 | 75,78 ± 8,83  | 63,98 ± 4,97 |
|            | 6 Veld       | 56,68        | 52,21         | 61,76        |
|            | Significance | N.S.         | N.S.          | N.S.         |
| Bonsmara   | 6 Penned     | 70,03 ± 9,09 | 64,15 ± 7,84  | 63,76 ± 7,36 |
|            | 6 Veld       | 51,68        | 61,51         | 63,98        |
|            | Significance | N.S.         | N.S.          | N.S.         |

± = SD.

Discussion

In a previous paper, the influence of penning on the adrenal cortex activity of the same beef heifers was discussed independently from thyroid activity (Erasmus & Krause, 1982).

At the onset of this study, Afrikaner heifers had significantly ( $P \leq 0,05$ ) higher thyroxine concentrations than Shorthorn heifers. Howes, Feaster & Hentges (1962) found that Brahman heifers had less active thyroids than Herefords. Similarly, it was reported that Simmentaler bulls had higher thyroxine values than Afrikaner bulls (Van der Westhuysen, 1973a), while thyroid activity was found to be higher in Hereford than in Afrikaner cows (Van der Westhuysen, 1973b). Thus the present results are not in accordance with the general concept that *Bos indicus* beef types have less active thyroids than *Bos taurus* types.

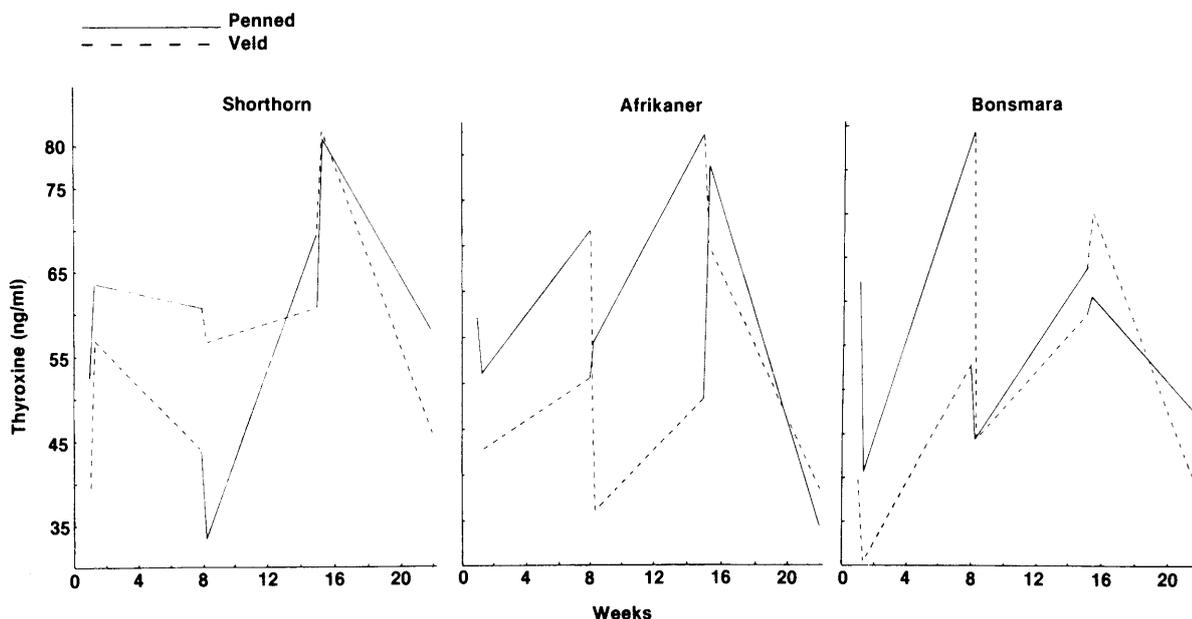


Figure 3 Thyroxine concentrations of Shorthorn, Afrikaner and Bonsmara Heifers under penned and veld conditions during the summer.

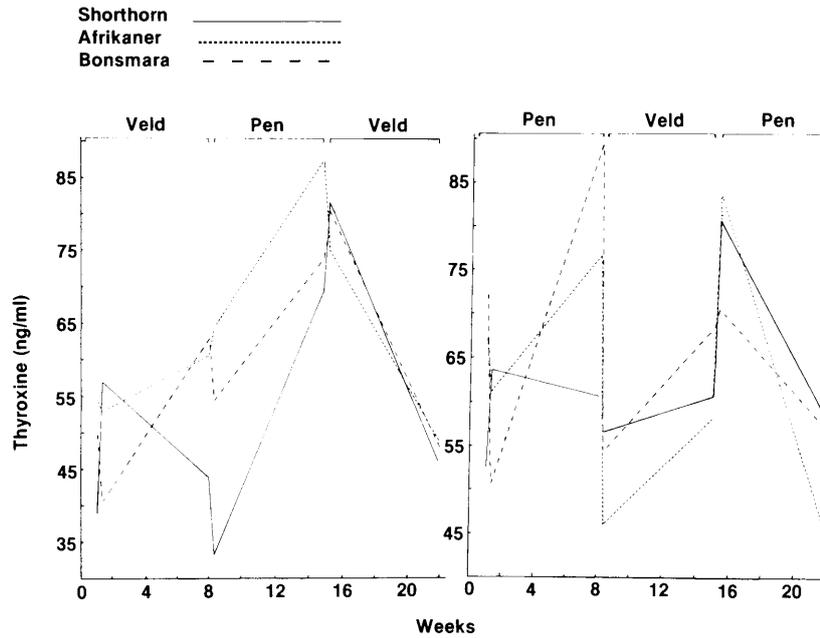


Figure 4 Comparison of thyroxine concentrations of 3 beef breeds under penned and veld conditions during the summer.

During the winter season, penned conditions initially caused significantly elevated thyroxine concentrations in Afrikaner ( $P \leq 0,01$ ) and Bonsmara ( $P \leq 0,05$ ) heifers, in spite of differences within breeds. After the heifers had been moved from veld to pen conditions, levels rose from 33,9 to 52,4 ng/ml in the Shorthorn, 33,3 to 109,9 ng/ml in the Afrikaner and 39,7 to 105,3 ng/ml in the Bonsmara heifers (Figure 1). During this season, mass gain was limited to 13,3 and 11,2 kg per heifer for the Shorthorn and Bonsmara heifers respectively, while the Afrikaner heifers lost 8,5 kg per animal. During the summer season, when the influence of penning on thyroxine concentrations was much less (Figure 3), mass gains were 74; 67 and 73 kg per animal for Shorthorn, Afrikaner and Bonsmara heifers respectively.

It has been found that stressful agents and adrenocortical hormones have a depressing effect on the activity of the thyroid gland (Blincoe & Brody, 1955; Robertson, Len-

non, Bailey & Mixner, 1957; Guyton, 1971; Turner & Bagnara, 1971). Cows however, under acute stress conditions lasting for short periods, had higher levels of plasma 17-hydroxycorticosteroids than normal cows, but the level of protein-bound iodine in cows under stress was not significantly lower (Robertson, Lennon, Bailey & Mixner, 1958). According to Guyton (1971), most clinicians believe that prolonged emotional states cause an effect exactly opposite to the acute effect, namely, increased rather than decreased secretion of thyrotropin.

Although the present high thyroxine levels of penned heifers may be in accordance with the view of Guyton (1971), penning did not cause significantly higher cortisol levels in the beef heifers (Erasmus & Krause, 1982), indicating that no significant stress resulted from penning. However, this study reveals that penning activates the thyroid gland to such an extent that excessive levels of thyroxine are produced in the Afrikaner and Bonsmara

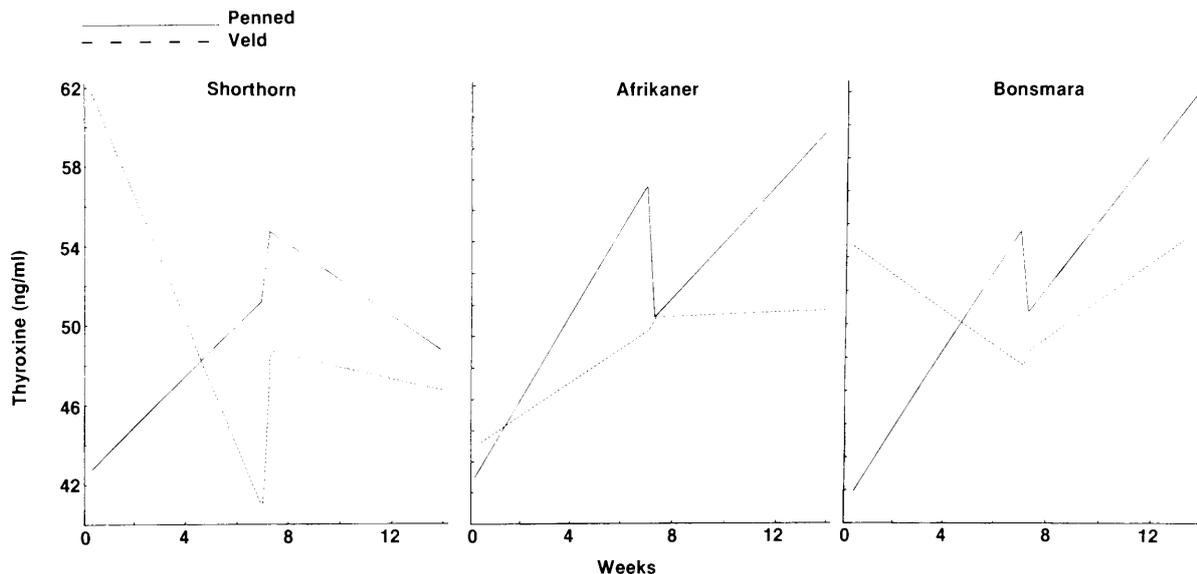


Figure 5 Thyroxine concentrations of Shorthorn, Afrikaner and Bonsmara heifers under penned and veld conditions for 14 weeks.

heifers. An environmental stimulus or influence of feeding should largely be excluded as possible causes of this reaction, since heifers on the veld were kept in a camp adjoining the penned heifers, while the maintenance of similar masses for both groups was attempted (Erasmus & Krause, 1982).

### Conclusions

Penning of beef heifers at 4,6 m<sup>2</sup> caused significantly ( $P \leq 0,05$ ) elevated thyroxine concentrations in Afrikaner and Bonsmara heifers during the winter. This was accompanied by low mass gains or mass losses. During the subsequent summer season, a much reduced influence of penning on thyroxine levels was recorded, while mass gain was enhanced. It is therefore suggested that thyroxine concentrations are an indicator of adaptation to pen conditions, with low or normal concentrations indicating adaptability. However, further studies are required to substantiate this view. It is evident that the Shorthorn heifers are most suited to pen conditions, showing the highest mass gains during both seasons, while thyroxine concentrations were virtually unaffected by pen conditions.

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