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RELATIONSHIP OF THYROID AND ADRENAL FUNCTION TO GROWTH RATE IN *BOS INDICUS* AND *BOS TAURUS* CATTLE

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The efficiency of production of domestic animals under specific environmental conditions is dependent upon their ability to maintain physiological activities at levels which are optimal for growth and reproduction. Breeds differ in their ability to tolerate environmental stress (Bonsma, 1940). Under temperate conditions the productivity of *Bos taurus* breeds is higher than that of *Bos indicus* breeds. However, feed intake and growth rate of *Bos taurus* breeds decreases rapidly as temperature increases (Fuller, 1969). Differences in heat tolerance and thermal stability between breeds have been attributed to differences in anatomy, in metabolic conditions involving thyroid function (Fuller, 1969), and in rates of energy turnover. In addition, thyroid function has been related to growthrate (Post, 1963) and adaptation to tropical conditions. The adrenal cortex also influences growthrate (Hafs, Purchas & Pearson, 1971) and general tolerance to stressful conditions (Judge, Briskey, Cassens, Forrest & Meyer, 1968). The object of this investigation was to study thyroid and adrenal function in relation to growth rate in cattle breeds of temperate and tropical origin.

Ten Africander bulls and 9 Simmentaler bulls (age $8^1/2$ to 9 months) were included in the first experiment. All the bulls were maintained on a high nutritional plane for 30 weeks at the Irene Bull Testing Station, near Pretoria. Observations on growth rate and feed conversion were made over a period of 20 weeks following an adaptation period of 10 weeks. In the middle of this observational period, blood samples for hormone analyses were collected from the jugular vein. Although the bulls were used to being handled, care was taken not to upset them during this procedure.

In the second experiment 8 Mashona and 8 Aberdeen Angus steers (age 2 years) were fed high concentrate rations for 24 weeks at Henderson Research Station, Rhodesia. Jugular blood was sampled at the end of this feeding period.

Blood was always sampled between 09h00 and 11h00. Immediately following the collection of blood in heparinized bottles in ice, the plasma was recovered and stored at -20^oC. Analyses of plasma thyroxine and cortisol were done by competitive protein binding methods

Table 1

Mean gains in body mass, blood thyroxine and cortisol levels of Africander and Simmentaler bulls

	No.	Body Mass (kg) Initial Weight	Final Weight	Daily Gain	Feed/ Daily Gain	Age (days)	Weight/Age	Thyroxine ng	Cortisol ng/ml.
Africander	10	275,3±12,2	422,8±11,4	1,06±0,06	7,80±0,36	486,0±15,6	0,80±0,03	7,0±0,12	110,0±9,12
Simmentaler	9	358,8±17,4	581,2±10,2	1,60±0,02	6,98±0,17	460,0± 9,2	1,20±0,03	7,9±0,19	93,0±5,55
Significance		P < 0,01	P < 0,01	P < 0,01	P < 0,1	N.S.	P < 0,01	P< 0,25	P < 0,025
Correlations with:									
1. Thyroxine		–	0,346	0,235	–0,112	–	0,274	–	–
2. Cortisol		–	–0,547*	–0,674**	–0,528*	–	–0,700**	–	–

* = P < 0,05
** = P < 0,01

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Table 2

Body masses, plasma cortisol and blood cell counts of Aberdeen Angus and Mashona steers

		Body mass (kg)		Average	Cortisol	White cell	Haematocrit	Haemoglobin	Red blood
		Initial Weight	Final Weight	Daily Gain kg	ng/ml ng/ml	Count ($x10^3$)	%	gm/100 ml	cells ($x 10^6$)
Aberdeen Angus	8	239,8 ± 8,4	421,2 ±36.6	1,12 ±0,15	76.5 ±14,9	7,59±1,76	38,4 ±1,6	14,7 ±0,7	7,72 ±0,36
Mashona	8	244,6 ±14,7	385,4 ±25,2	0,85±0.11	154.2 ±43.1	11,36±2,82	46,8± 2.2	17,3 ±0.7	9,36 ±0,15
Significance		N.S	P < 0,025	P < 0,005	P < 0,025	P< 0,005	P < 0,005	P <0,005	P < 0,005
Correlation Coefficient with Cortisol		–	–0,25	–0,35	–	0,74**	–	–	–

** = P < 0,01

(Braveman, Vaginaris, Foster & Ingbar, 1971) using thyroxine I^{125}) Tetralute, Ames) and tritiated cortisol (Murphy, 1967) (CEA Sorin) (Experiment 1), and cortisol I^{125} (Experiment 2).

Simmentaler bulls grew more rapidly than Africander bulls (Table 1) and plasma thyroxine concentration in Simmentaler bulls was 11,3% higher (N.S.) and plasma cortisol concentration 11,9% lower (P < 0,01) than in Africander bulls. Rank order correlation tests (Snedecor & Cochran, 1967) of the combined data for the two breeds showed that thyroid function tended to be correlated with growth rate (average daily gain, body mass) per age in days). However, this correlation was not statistically significant. Conversely, significant negative correlations of average daily gain (r = 0,674), feed conversion (r = –0,528) and body mass per age (r = –0,700), with cortisol concentrations were found (Table 1).

In Experiment 2 (Table 2) Aberdeen Angus steers grew significantly more rapidly (P < 0,005) and had a significantly lower plasma cortisol level (P 0,025) than Mashona steers. Although not significant, rank order correlation tests again showed negative correlations between plasma cortisol and growth rates (Table 2). In addition, highly significant differences in the haematocrit, red cell count, haemoglobin content and white cell counts of the two breeds emphasized the physiological differences between them.

Although these results indicate that the thyroid plays a subsidiary role in the regulation of growth rate they agree with other results (Cowley, Gutierrex, Warnick, Hentiges & Feaster, 1971) where Herefords were found to have higher levels of thyroxine than Brahmans. The lower thyroid function and possible lower metabolic rate is in agreement with the concept that metabolic acclimatization to high temperatures is associated with a lowering of thyroid function, lower energy turnover and therefore thermal stability of *B. indicus* breeds (Fuller, 1969).

The significant negative correlations between growth rates and plasma cortisol levels agree with the finding that cattle with low levels of glucocorticoid activity tend to grow more rapidly (Purchas, 1970; Hafs *et al.* 1971). Moreover, the results stress the significance of adrenal function in the regulation of growth (Hafs *et al.* 1971) and in the adaptation syndrome (Selye, 1956). It is noteworthy that adrenocortical activity was significantly higher in the slower growing Africander and Mashona than in the faster growing Hereford and Aberdeen Angus.

In general, tropically adapted cattle have slower growth rates than European breeds. In the present studies the low thyroid and increased adrenocortical functions in tropically adapted breeds suggest that metabolic factors associated with tolerance of stressful conditions (high temperatures) are related to low growth rates and vice versa. It has also been shown that intensive selection of pigs for growth rate led to the development of animals which were highly susceptible to stress (Judge, Briskey, Cassens, Forrest & Meyer, 1968). Judge *et al.* (1968), demonstrated that strains of pigs susceptible to environmental stressors ("stress-susceptible") had lower mean values of 17-ketosteroids and 17-hydroxycorticosteroids and higher protein bound iodine values than "stress resistant" pigs. These workers suggested that susceptibility of pigs to stress results partially from adrenal insufficiency accompanied by failure of the thyroid hormone to stimulate oxidative metabolism in striated musculature. This is supported by the findings of the present study that stress-resistant cattle breeds have high adrenocortical function and low thyroid function. In addition, it is suggested that metabolic factors involved in the manifestation of growth of the animal are, to some extent, inversely related to metabolic factors involved in tolerance of stressful conditions. Consequently, selection for high growth rate may eventually lead to a decrease in heat tolerance making the animal more stress susceptible.

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References

BONSMA, J.C., 1940. The influence of climatological factors on cattle. *Pamphlet No. 223, Dept. of Agric. S. Afr.*

BRAVERMAN, L.E., VAGINAKIS, A.C., FOSTER, A.E., & INGBAR, S.H., 1971. Evaluation of a simplified technique for specific measurement of serum thyroxine concentration. *J. clin. Endocr. 37, 497.*

COWLEY, J.J., GUTIERREX, J.H., WARNICK, A.C., HENTIGES, Jr. J.F., FEASTER, J.P., 1971. Comparison of thyroid hormone levels in Hereford and Brahman cattle. *J. Anim. Sci. 32,* 981.

FULLER, M.F., 1969. *Climate and growth.* In: Animal Growth and Nutrition, ed. E.S.E. Hafez & J.A. Dyer. Philadelphia: Lea and Febiger.

HAFS, H.D., PURCHAS, R.W. & PEARSON, A.M., 1971. A Review: Relationships of some hormones to growth and carcass quality of ruminants. *J. Anim. Sci. 33,* 64.

JUDGE, M.D., BRISLEY, E.J., CASSENS, R.G., FORREST, J.C., & MEYER, R.K., 1968. Adrenal and thyroid function in stress susceptible pigs(*Sus domesticus*). *Am. J. Phys. 214,* 146.

POST, T.B., 1963. Plasma protein bound iodine and growth rates of beef cattle. *Aust. J. agric. Res. 14,* 572.

PURCHAS, R.W., 1970. *Some relationships of growth hormone levels to bovine growth and carcass quality.* Ph.D.thesis. Michigan State University, East Lansing.

SELYE, H., 1956. *Stress.* Montreal: Acta Inc.

YOUSEF, M.K., HAHN, L., & JOHNSON, H.D., 1968. *Adaptation of cattle.* In Adaptation of Domestic Animals, ed. E.S.E. Hafez. Philadelphia. Lea and Febiger.