3. Barnes, R. H., Fiala, G., *J. Nutrit.*, 1959, v68, 603.
4. Porter, R. J., Rettger, L. F., *J. Inf. Dis.*, 1940, v66, 104.
5. Nath, H., Barki, V. H., Sarles, W. B., Elvehjem, C A., *J. Bact.*, 1948, v56, 783.
6. Rogosa, M., Mitchell, J. A., Wiseman, R. F., *J. Bact.*, 1951, v62, 132.
7. ———, *J. Dent. Res.*, 1951, v30, 682.

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Adrenal Gland Weights of Hereford and Brahman Cattle. (25822)

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Information about weights of organs may be helpful in estimating functional status of the organ. This concept has been widely used with endocrine glands since some methods of assaying hormone output have been based upon gland weight. Hartman and Brownell (1), Bachmann(2) and Chester Jones(3) have recently reviewed the scattered data concerning adrenal weights of the rat, man, dog, rabbit, cat and mouse, but little or no information is presented on cattle adrenals. Sisson and Grollman(4) merely describe the shape of the adrenal glands and their normal position in the bovine body, without mentioning size or internal anatomy. In view of the paucity of information concerning weight of adrenals of cattle, the following data are presented.

Methods. Adrenal glands were obtained from 119 Hereford (*Bos taurus*) and Brahman (*Bos indicus*) beef cattle, slaughtered by standard abattoir procedures. Fifty-eight were steers, 5 were bulls and the remainder females. All animals except bulls were slaughter cattle, selected at random from groups of known Herefords or Brahmans. All animals had carcass grade either U.S. Standard or Good. Animals were transported to slaughterhouse holding pens on day previous to killing and given access to water only. On day of slaughter animals were weighed, then stunned, bled, skinned and dressed. To avoid damage to adrenal glands, they were removed before the carcass was split. This removal occurred approximately 15 minutes after death. Adrenal glands were cleaned of excess fat and the gland from each side of animal weighed separately. One gland taken at random from each of 13 Hereford heifers was dissected into cortical and medullary regions under dissecting microscope, then weighed.

Results. Fresh adrenal and body weights for each group of animals are presented in Table I. Data of weight ratios for the 2 groups of steers and Hereford heifers were subjected to analysis of variance since each group was sufficiently large and comparable in size. The Hereford heifers had a significantly larger ($P<.05$) adrenal to body weight ratio than either group of steers, while there was no significant difference in weight ratios of the 2 steer groups. Weights of cortex and medulla for the 13 dissected glands are presented in Table II.

Discussion. Adrenals of beef cattle are much smaller in relation to body weight than those of most other mammals examined. Expressed in mg, adrenal weight/100 g of body weight (mg %) the male rat, according to Korenchevsky(5), has a ratio varying from 42 to 14 decreasing with age, and the human decreases from over 100 g/100 kg body weight at birth to 30 g at puberty and 25 g at 70 years of age. Other instances of higher ratios of adrenal weight to body weight are cited by Chester Jones(3). Published data on adrenal weights of cattle are summarized in Table III, and would appear to confirm the low gland to body weight ratios observed in cattle by the authors. The data for the Angus and Jersey cows(6) differ from the remainder possibly because of the very high

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TABLE I. Mean Adrenal Weights for the Various Groups of Cattle.

Cattle data			No. of animals	Mean live wt, kg	Mean adrenal wt, g			Adrenal, live wt ratio, g/100 kg
Breed	Sex	Age, yr			Pair	Left	Right	
Hereford	St.	1½	30	403	19.0	9.6	9.4	4.46 ± .66
Brahman	St.	1½	28	373	16.2	8.2	8.0	4.34 ± .80
Hereford	♀	3+	29	362	19.1	10.1	9.0	5.16 ± 1.36
Brahman	♀	3+	10	404	14.3	7.9	6.4	4.53 ± 1.84
"	♀	¾	17	156	6.8	3.4	3.4	4.36 ± 1.11
Hereford	♂	3+	3	581	29.6			5.13
Brahman	♂	3+	1	472	23.9	12.2	11.7	5.06
"	♂	¾	1	173	7.7	3.7	4.0	4.45

TABLE II. Weights of Adrenal Cortex and Medulla.

No. and group	Mean of single adrenal wt, g	Mean wt of adrenal, g		% of adrenal wt	
		Cortex	Medulla	Cortex	Medulla
13 Hereford heifers	6.6 ± 1.57	4.5 ± .79	2.1 ± .36	69.	31.

condition of these animals, both of which were show ring champions receiving special attention for many years.

In rats, adrenal weight to body weight ratio declines with age(5), as it does in children up to puberty(3). In this study with cattle an opposite effect is observed with adrenal weights slightly increasing with age. This trend is confirmed by the observations of others (Table III).

Adrenal weight in many mammals appears to vary with estrus, pregnancy, difference in strain and body weight(3). The females in this study were not in estrus on the day of slaughter nor were any pregnant, and since the animals slaughtered came at random from many strains, these variables cannot be discussed in relation to the presented data. In this study the adrenal weight to live weight ratio increased slightly with age and weight. This effect might have been even more marked if weight ratios were calculated on a true body weight (fat free) basis, since much of the weight increase in beef cattle is extracellular fat.

Data in Table I show that Hereford cattle in all groups had a slightly larger adrenal to live weight ratio than the Brahmans. The species differences were examined statistically and found to be not significant, however. A similar trend was demonstrated in other data(8) where the Santa Gertrudis and

TABLE III. Adrenal Weight (g) to Live Weight (100 kg) Ratio for Cattle as Calculated from Data from Other Sources.

Data source	Breed	Management	No.	Mean live wt, kg	Mean adr. wt, g	Adr. wt/Live wt
Swett *et al.*(6)	Angus	Beef	1	720	57.5	7.99
(7)	Hereford	"	3	374	19.9	5.32
Adult ♀ (7)	"	Dairy	4	370	17.4	4.70
(7)	Holstein	"	2	627	30.3	4.83
(6)	Jersey	"	1	421	37.0	8.79
Black(8)	Angus	Beef	2	393	16.47	4.19
1-yr-old steers	Hereford	"	6	374	16.08	4.30 ± .17
	Santa Gertrudis	"	7	431	15.90	3.69 ± .30
	Brangus	"	9	394	15.01	3.81 ± .65
Tucker(9) 1-yr-old steers	Crossbred	Beef	21	297	12.40	4.18 ± .76
Bedrak(10) 2-yr-old heifers	Hereford	Beef	18	325	13.57	4.18 ± .64
Brody & Kibler(11) Adult ♀	Mixed	Dairy		488	31.00	6.35

Brangus, 2 breeds with some Brahman blood, had relatively smaller adrenals per unit of live weight.

In most mammals examined to date, weight of the left adrenal exceeds weight of the right (2,3). The data on bovine adrenal gland weights presented here agree for the most part with this finding. The significance of these differences is probably limited to differences in anatomical makeup of each species.

Although there is evidence that the adrenals of women, female mice and female rats are larger than those of the males, many species do not exhibit this sex difference(3). Beef cattle apparently are in the latter category. In species which exhibit a sex difference in adrenal weight, castration results in an increase in adrenal cortex, particularly the zona fasciculata(3). This cortical change is brought about by a change in the balance of gonadotrophins and steroids. Although the gonads had been removed from the steers several months prior to slaughter, no increase in adrenal weight was detected, but rather there was a slight decline in the adrenal body weight ratio. Data from other sources(8,9) would tend to confirm the ratio decline following castration, which may be real or could be apparent due to increase in extracellular fat which is not an increase in true body weight.

Adrenal medulla in adults of higher mammals does not change in size very much or very quickly, while the cortex is prone to rapid changes in size(3). In female mice the cortex represents approximately 82% of the whole gland whereas in the male mouse the cortex makes up about 70% of the whole adrenal. In rats and humans the cortex accounts for about 90% and in dogs some 82% of the entire gland. Although limited, data in this study suggest that female Herefords possess an adrenal gland with a much smaller cortex than is reported for other species. The cortex of some of the adrenals taken from Hereford heifers were histologically examined by Bedrak(10). The mean width in millimeters of the various cortical zones for 20 Hereford heifers as determined microscopically were capsule, 0.217; glomerulosa, 0.501; fasciculata, 1.269; and reticularis 0.701. The zona fasciculata represented about half the cortex in these cattle, which is much less than that for man(3).

Summary. Weights of individual and paired adrenals together with adrenal-body weight ratio for male, female and castrated Hereford and Brahman cattle are presented. There was no significant difference between weight ratios for the 2 species although adrenal-body weight ratio was consistently smaller for Brahman cattle. Unlike most other mammalian species examined, adrenal-body weight ratio tends to increase slightly with age. Adrenal weights of cattle are apparently not affected by sex. Castration decreased adrenal-body weight ratio, which is the reverse of that observed in other species. While the left adrenal was consistently larger than the right, total adrenal weight was much smaller in relation to unit body weight than any other mammalian species for which data are available. The bovine adrenal cortex appears to be smaller in relation to the whole gland than for most other mammals as does the zona fasciculata.

1. Hartman, F. A., Brownell, K. A., *The Adrenal Gland,* 1949, Lea and Febiger, Philadelphia.

2. Bachmann, R., *Hndb. mikrosk. Anat. Mensch.,* 1954, v6, 1, Springer-Verlag, Berlin.

3. Chester Jones, I., *The Adrenal Cortex,* 1957, Cambridge Univ. Press.

4. Sisson, S., Grossman, J. D., *The Anatomy of Domestic Animals,* 1953, W. B. Saunders Co., Philadelphia.

5. Korenchevsky, V., *J. Path. Bact.,* 1942, v54, 13.

6. Swett, W. W., Graves, R. R., Miller, F. W., *J. Agric. Res.,* 1928, v37, 685.

7. Swett, W. W., Miller, F. W., Graves, R. R., Black, W. H., Creech, G. T., *ibid.,* 1937, v55, 239.

8. Black, J. A., M.S.A. Thesis, Jan. 1956, Univ. of Florida.

9. Tucker, C. A., *ibid.,* June 1954.

10. Bedrak, E., Ph.D. Dissertation, June 1958, Univ. of Florida.

11. Brody, S., Kibler, H. H., *Missouri Agric. Exp. Sta. Res. Bull.* 328, p16.

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