Effect of Age and Season on the Growth of some Endocrine and Lympho-Epithelioid Glands in Nigerian and White Leghorn Pullets

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SUMMARY

THE endocrine glands (pituitary, adrenal, thyroid), and thymus and bursa of Fabricius of Nigerian and White Leghorn pullets were studied from 2 weeks to 32 weeks of age in the wet and dry seasons of Nigeria. Pituitary weights were significantly ($P < 0.005$) greater in the wet season—reared than in the dry season—reared birds. Adrenal weight differences due to breed were significant, but had no significant influence on this parameter. Nigerian pullets had significantly ($P < 0.005$) greater thyroid weights (absolute and relative) than the Leghorns, and the absolute weights were also significantly ($P < 0.005$) higher in the wet than in the dry season. The differences in thymus weights between breeds and seasons were not significant, but the interaction between season and age, and between breed and age were highly significant ($P < 0.005$). The relative thymus weights were generally and significantly greater ($P < 0.005$) in the Nigerian than in the Leghorn pullets. The interaction between age and season and between breed and age were also highly significant [$P < 0.005$] in respect to the bursa. The effect of season and breed on the growth of the bursa was also highly significant ($P < 0.005$).

The possible significance of these findings in relation to the general physiology of the two breeds of chicken were discussed.

INTRODUCTION

THE weight of the gland is not always an accurate criterion of its activity, even though it is generally conceded that gland weight and function are necessarily associated in the normal bird (Hoffmann, Shaffner and Comstock, 1953).

The secretions of the pituitary gland are essential to normal metabolism and it also acts as a co-ordinator of other endocrine glands (Hartree and Cunningham, 1971). Oakberg (1951) observed that species characteristics of pituitary weights existed and that discrepancies in results of investigations on the same species depended upon genetic differences in the stock used.

Seasonal variation in thyroid weight has been observed by Riddle and Fisher (1925), Riddle (1927), Miller (1939) and Cruickshank (1929) in birds. Cruickshank (1929), Miller (1939) and Hoffmann and Shaffner (1950) have shown that there is a positive correlation between thyroid weight and function in the chicken.

According to Kamar and Rasek (1963) thymus weight in proportion to constant body weight may be considered as an approximate measure of the thymus activity. The bursa of Fabricius is the 'executive headquarters' of chick antibody-producing system (Good, 1972). The development of the bursa seems to vary considerably between breeds and strains of chicken.

The purpose of this investigation was to monitor the growth characteristics of the endocrine glands in the Nigerian and White Leghorn pullets in the two prevalent seasons of Nigeria.

MATERIALS AND METHODS

The chickens were hatched from the eggs laid by the stock of Nigerian and White Leghorn fowl kept at the University of Ibadan Teaching and Research Farm. The Nigerian stock of fowl was established with chickens bought in villages where they were unlikely to be confused with exotic breeds of fowl in 1968 (Oluyemi, 1974). The White Leghorn breed was imported from Israel in 1969, and established as the breeding stock.

The chickens for Experiment I (wet season) were hatched in May and June 1972; and those for Experiment II (dry season) in November and December, 1972. All the chicks were reared in a tier, electric brooder from day-old till 6 weeks of age. They were then transferred to deep litter. The

TABLE I

Formulation of Feeds [as supplied by Pfizer Company, Lagos.]

SPECIFICATION	MASH		
	CHICK	GROWER'S	LAYER'S
PROTEIN	20% min.	16.0% min.	16.5%
FAT	3.5% min.	3.5% min.	3.7%
FIBRE	5.0% max	7.5% max	6.5%
CALCIUM	1.0-1.1%	1.0%	3.5%
Available			
PHOSPHORUS	0.45-0.5%	0.35%	0.45%
ENERGY	1270 ME/Cal/Ib	1125 ME/Cal/Ib	1150 ME/Cal/Ib
INGREDIENTS USED			
	Maize/Guinea corn	Maize/Guinea corn	Guinea corn/maize
	Wheat middlings	Wheat middlings	Wheat middlings
	Fish meal	Groundnut cake	Fish meal
	Groundnut cake	Brewer's Grains	Groundnut cake
	Brewer's Grain	Fish meal	Brewer's Grains
	Brewer's Yeast	Salt	Oyster shell
	Bone meal	Bone meal	Bone meal
	Oyster shell	Oyster shell	Palm oil
	Salt	Methionine	Methionine
	Molasses	Vitamin Premix	Vitamin Premix
	Vitamin mix	Mineral Premix	Mineral Premix
	Methionine		
ANTIBIOTIC AND COCCIDIOSTATS			
Terramycin (R)	32 g per ton	10 g per ton	10 g per ton
AMPROLIUM	170 g per ton	170 g per ton	-

birds were fed mash bought from Ladokun Livestock Feeds, an agent of the Pfizer Company. The chicks were fed chick mash from day-old till 6 weeks of age, then grower's mash till 18 weeks of age, and layer's mash thereafter. The formulation of feeds, as supplied by Pfizer Company, Lagos, is in Table I.

Birds were slaughtered at 2, 4, 6, 8, 10, 12, 16, 20, 24, 28 and 32 weeks of age. Adult birds of about 18 months of age were similarly treated. Ten birds of each breed of the appropriate age were weighed alive just before they were killed by cutting through the jugular veins and disarticulating the atlanto-occipital joint. The glands were removed soon thereafter and weighed in an analytical balance.

A three factorial analysis of variance was performed on the data.

RESULTS

Fig. 1. shows the development of body weight of the birds in both seasons.

Pituitary glands

The growth of the pituitary was progressive from two weeks to 32 weeks of age (Fig. 2). The period of the most rapid growth coincided with the first 10 weeks in both breeds and seasons. The absolute gland weights were significantly ($P < 0.005$) higher in the Leghorns than in the Nigerian birds (Table 2). Gland weights of pullets of the wet season were also significantly ($P < 0.005$) greater than those of the dry season (Fig. 2). The relative gland weights followed a similar trend in both breeds and seasons (Fig. 3 and Table 3). There were no significant differences in the parameter between seasons and breeds (Table 3).

TABLE 2

Summary of the analysis of variance for the season, breed and age changes in pituitary gland weight

Sources of variation	df	ms	F	P
Due to season (A) factor	1	0.00001	8.62535	0.005
Due to Breed (B) factor	1	0.00004	29.59392	0.005
Due to AB factor	1	0.00001	8.18740	0.005
Due to Age (C) factor	10	0.00010	86.87624	0.005
Due to AC interaction	10	0.00001	4.57917	0.005
Due to BC interaction	10	0.00000	1.60487	NS
Due to ABC interaction	10	0.00000	1.59244	NS
Residual	382	0.00000		

TABLE 3

Summary of analysis of variance for the season, breed and age changes in the relative weights of the pituitary glands

Sources of variation	df	ms	F	P
Due to season (A)	1	0.00000	0.16220	NS
Due to Breed (A)	1	0.00000	0.13903	NS
Due to AB factor	1	0.00000	0.47445	NS
Due to Age (C)	10	0.00002	83.48132	0.005
Due to AC interaction	10	0.00000	0.98113	NS
Due to BC interaction	10	0.00000	4.32746	0.005
Due to ABC interaction	10	0.00000	2.46749	0.005
Residual	380	0.00000

FIG. 1. LIVE BODY WEIGHT VERSUS AGE.

FIG. 3 PITUITARY WEIGHT RELATIVE TO BODY WEIGHT OF PULLETS.

FIG 2 PITUITARY WEIGHT VERSUS AGE.

TABLE 4

Summary of the analysis of variance for the season breed and age changes, in adrenal gland weight

Sources of variation	df	ms	F	P
Due to season (A) factor	1	0.00025	0.85102	NS
Due to breed (B) factor	1	0.00139	4.73582	0.005
Due to AB factor	1	0.00519	17.69273	0.005
Due to age (C) factor	10	0.07374	251.16652	0.005
Due to AC interaction	10	0.00137	4.66826	0.005
Due to BC interaction	10	0.00049	1.66858	NS
Due to ABC interaction	10	0.00183	6.24167	0.005
Residual	390	0.00029		

Adrenal glands

Fig. 4 shows the growth of the adrenal glands. The absolute gland weights were generally higher in the Leghorn than in the Nigerian pullets reared in both seasons. These differences due to breed were highly significant (Table 4), but the differences due to season were not significant.

The relative weights of the gland in both seasons were similar (Fig. 5). The parameter was significantly ($P < 0.005$) higher in the Nigerian than in the Leghorn in both seasons (Table 5). The effect of age on the parameter was highly significant ($P < 0.005$) (Table 5) and the interaction between season and age was significant ($P < 0.01$).

FIG. 4 ADRENAL WEIGHT VERSUS AGE OF BIRDS.

TABLE 5

Summary of analysis of variance for the season, breed and age changes in the relative weight of the adrenal glands

Sources of variation	df	ms	F	P
Due to Season (A)	1	0.00004	2.67576	NS
Due to Breed (B)	1	0.00028	17.80710	0.005
Due to AB factor	1	0.00001	0.32274	NS
Due to Age (C)	10	0.00101	63.66089	0.005
Due to AC interaction	10	0.00004	2.35114	0.01
Due to BC interaction	10	0.00007	4.61859	0.005
Due to ABC interaction	10	0.00005	3.13135	0.005
Residual	390	0.00002

FIG. 5 ADRENAL WEIGHT RELATIVE TO BODY WEIGHT OF PULLETS.

The thyroid glands

The absolute gland weights were generally higher in the Nigerian than in the Leghorn pullets in both seasons (Fig. 6). The weights were also generally higher in the wet than in the dry season (Fig. 6).

These differences between breeds and seasons were highly significant ($P < 0.005$) (Table 6). The interaction between season and age and between breed and age were also highly significant ($P < 0.005$) (Table 6) because of the differences in the growth of

TABLE 6

Summary of the analysis of variance for the season, breed and age changes in thyroid glandweight

<i>Sources of variation</i>	<i>df</i>	<i>ms</i>	<i>F</i>	<i>P</i>
Due to Season (A) factor	1	0.01321	44.18008	0.005
Due to Breed (B) factor	1	0.00298	9.96668	0.005
Due to AB factor	1	0.00012	0.38603	NS
Due to Age (C) factor	10	0.06055	202.56355	0.005
Due to AC interaction	10	0.00128	4.27476	0.005
Due to BC interaction	10	0.00108	3.60415	0.005
Due to ABC interaction	10	0.00059	1.98791	0.005
Residual	387	0.00030		

the glands between the two seasons and also between the two breeds of similar ages in both seasons.

The relative gland weights were significantly higher ($P < 0.005$) (Table 7) (Fig. 7) in the Nigerian than in the Leghorn pullets. Relative weights did not change significantly from one season to the other; and the interaction between breed and age was not significant, probably because the pattern of development of the relative weights did not vary between the two breeds and because the differences between actual gland weights were a function of the actual body weights of the birds, which were generally lower in the dry season.

The thymus glands

Three phases of thymus growth were observed in the wet season and two in the dry season. The first phase was that of rapid growth, followed by decelerative growth and finally involution (Fig. 8). In the dry season-reared birds, the phase of involu-

tion was evident. Thus, the glands remained active throughout the investigation. The differences in thymus weights between breeds and seasons were not significant. The interaction between season and age, and between breed and age were highly significant ($P < 0.005$) (Table 8). The former is probably due to the dissimilar patterns of growth between the two seasons, and the latter due to differences in growth pattern exhibited by the two breeds, especially in the phase of involution.

The relative thymus weights of the Nigerian birds were generally greater than those of the Leghorn during the growth phases, especially in the dry season-reared birds (Fig. 9). These differences were highly significant ($P < 0.005$) (Table 9). Season did not play any significant role in the relative growth of the thymus, but the interaction between season and age, and between age and breed were highly significant ($P < 0.005$) (Table 9). These are related to absolute gland weight.

TABLE 7

Summary of analysis of variance for the season, breed and age changes in the relative weights of the thyroid glands

<i>Sources of variation</i>	<i>df</i>	<i>ms</i>	<i>F</i>	<i>P</i>
Due to Season (A)	1	0.00001	0.46688	NS
Due to Breed (B)	1	0.00074	49.71742	0.005
Due to AB factor	1	0.00001	0.73160	NS
Due to Age (C)	10	0.00005	3.05864	0.005
Due to AC interaction	10	0.00002	1.59571	NS
Due to BC interaction	10	0.00001	0.94338	NS
Due to ABC interaction	10	0.00002	1.52709	NS
Residual	384	0.00001

FIG. 6 THYROID WEIGHT VERSUS AGE.

FIG. 7 THYROID WEIGHT RELATIVE TO BODY WEIGHT OF PULLETS.

TABLE 8

Summary of the analysis of variance for the season, breed and age changes in thymus gland weight

Sources of variation	df	ms	F	P
Due to Season (A) factor	1	3.31372	3.13874	NS
Due to Breed (B) factor	1	3.01416	2.85499	NS
Due to AB factor	1	0.02441	0.02312	0.005
Due to Age (C) factor	10	29.13123	27.59291	0.005
Due to AC interaction	10	8.03052	7.60646	0.005
Due to BC interaction	10	4.26638	4.04109	0.005
Due to ABC interaction	10	2.04214	1.93430	0.005
Residual	394	1.05575		

TABLE 9

Summary of analysis of variance for the season, breed and age changes in the relative weight of the thymus glands

Sources of variation	df	ms	F	P
Due to Season (A)	1	0.02748	1.41186	NS
Due to Breed (B)	1	0.19684	10.11269	0.005
Due to AB factor	1	0.09089	0.04547	NS
Due to Age (C)	10	0.33175	17.04388	0.005
Due to AC interaction	10	0.08257	4.24216	0.005
Due to BC interaction	10	0.08041	4.13099	0.005
Due to ABC interaction	10	0.02459	1.26330	
Residual	394	0.01946

FIG. 8 THYMUS WEIGHT VERSUS AGE.

TABLE 10

Summary of the analysis of variance for the season breed and age changes in bursa of Fabricius weight

Sources of variation	df	ms	F	P
Due to Season (A) factor	1	2630.38281	1.54309	NS
Due to Breed (B) factor	1	3022.87891	1.77334	NS
Due to AB factor	1	3262.33984	1.91382	NS
Due to Age (C) factor	10	3730.44873	2.18843	0.25
Due to AC interaction	10	5654.01953	3.31688	0.005
Due to BC interaction	10	5598.22266	3.28414	0.005
Due to ABC interaction	10	44142.85938	25.89598	0.005
Residual	355	1704.62109		

The bursa of Fabricius

Two phases of growth were observed in the growth of the bursa—a phase of rapid growth followed by involution. Peak weights were observed at 12 and 20 weeks of age in the Nigerian and Leghorn respectively in the wet season—reared birds (Fig. 10). In the dry season, both breeds recorded peak weights at 20 weeks

of age. The phase of involution was more rapid in the Nigerian pullets in both seasons. The Bursae were present in the dry season-reared birds of 30 and 32 weeks of age, whereas no wet season-reared birds of these ages possessed any bursae. The interaction between age and season and between breed and age were therefore highly significant ($P < 0.005$) (Table 10).

FIG. 9 THYMUS WEIGHT RELATIVE TO BODY WEIGHT OF PULLETS.

TABLE 11

Summary of analysis of variance for the season, breed and age changes in the relative weights of the bursa of Fabricius

Sources of variation	df	ms	F	P
Due to Season (A)	1	0.14530	11.84243	0.005
Due to Breed (B)	1	0.14095	11.48775	0.005
Due to AB factor	1	0.00267	0.21725	NS
Due to Age (C)	10	0.14484	11.80517	0.005
Due to AC interaction	10	0.03391	2.76365	0.005
Due to BC interaction	10	0.02644	2.15465	0.005
Due to ABC interaction	10	0.00534	0.43490	NS
Residual	366	0.01227

The relative bursae weights followed a similar pattern as the actual weights, though the effect of season and breed on the organ growth were highly significant ($P < 0.005$) (Table 11). This is because of

the generally higher relative weight of the organ in the Nigerian than in the Leghorn, especially during the rapid growth phases, and the generally lower relative weights in the dry season-reared birds (Fig. 11).

FIG. 11 BURSA WEIGHT RELATIVE TO BODY WEIGHT OF PULLETS.

DISCUSSION

Pituitary weight relative to body weight fell precipitously from 2 weeks of age till the 8th week, and thereafter changed very little. Latimer (1924) and Aire (1974) also made similar observations. There were no marked differences in the relative weights of the pituitary between the different ages in the male chickens studied from 4 weeks to 52 weeks of age by Kamar (1960); indeed there were slight increases in this parameter between 16 and 28 weeks of age. These observations are at variance with those made in this study and those by Latimer (1924) and Aire (1974). However, Oakberg (1951) has cautioned that variation in weight of the pituitary obtained by various investigators arises in part from errors in dissecting and weighing such a small gland. He also observed that species characteristics exist and that discrepancies in results of investigations on the same species may depend upon genetic differences in the stock used.

Latimer (1924) and Kamar and Rasek (1963) showed that there are no sex differences in respect of pituitary weight relative to body weight. The results in this investigation and in the study using Nigerian and White Leghorn cockerels (Aire, 1974) confirm these findings. This, therefore, shows that the heavier pituitary weight in the male is a direct function of the higher body weight in this sex.

Considerable variation in adrenal weight is due to breed, age, health and environmental factors (Kar, 1947; Garren and Shaffner, 1956). In this investigation, there was no significant influence of environment (season) on the adrenal weights, but there were highly significant differences in the gland weight due to breed and age. It is not known if the higher relative gland weight in the Nigerian pullet necessarily indicates a higher level of adrenal secretions in the blood of this breed. It is generally known that the Nigerian chicken is more excitable than the White Leghorn

breed of chicken. Adrenal function needs to be studied in this breed of chicken.

The highly significantly greater actual and relative thyroid gland weight in the Nigerian pullets as shown in this investigation is similar to that observed in the Nigerian and White Leghorn cockerels (Aire, 1974). Cruickshank (1929) and Hoffman and Shaffner (1950) have shown that there is a positive relationship between thyroid weight and function in the chicken. That is why, from the results obtained in this study and in an earlier one on the cockerels of the same breeds (Aire, 1974), it may be assumed that the thyroid gland is far more active in the Nigerian than in the White Leghorn breed of fowl. These differences may be genetical or may be due to adjustment on the part of the White Leghorn to an environment different from its native environment since high temperature cause a decrease in thyroid weight and function and low temperatures cause an increase in thyroid weight and function (Cruickshank, 1929; Dempsey and Astwood, 1943; Hurst and Turner, 1947, cited by Turner, 1948). Thyroid function studies in the Nigerian and White Leghorn fowl have been planned.

The thymus gland, unlike the bursa, does not completely involute and according to Siegler (1962) the thymus size continually changes, depending on the equilibrium between lymphocyte production and release. Kamar and Rasek (1963) apparently supporting this view, stated that thymus weight in proportion to constant body or eviscerated weight may be considered an approximate measure of the thymus activity. Thus, it can be said that the thymus glands in the pullets reared in the dry season remained in a state of activity throughout the duration of the investigation.

The prolonged growth and slower involution of the bursa in both breeds of fowl, especially in the dry season-reared birds, as compared with the White Leghorns investigated by Glick (1956) may have an explanation. Glick (1956) comparing the development of the bursa in battery-reared and litter-reared birds, showed that

maximal bursa size was attained later in litter-reared birds than in battery-reared birds in both the White Leghorns and Rhode Island Reds. He attributed this to external stress factors, such as micro-organisms, which stimulate the bursa to extend its growth and continue in its role as a defensive organ. To these may be added the harsh climatic conditions in Nigeria which might be expected to increase the stress factors. Furthermore, the strains of the breeds used by various investigators are unlikely to be identical.

From the data collected in this and in earlier investigation (Aire, 1973), the higher relative weights and earlier growth of the bursa and thymus glands in the Nigerian than in the Leghorn breed may be of special significance to the former breed which is more resistant to diseases than the improved breeds of fowl (Hill and Modebe, 1960; and Aire and Ojo, 1974).

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