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Weight-Related Changes in Acetycholinestrase Activity and Total Protein Concetration in the Brain Regions and Hypophyses of Pigs in the Tropics

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Abstract: In an experiment to determine the effects of weight-related changes on Acetylcholinestrase (AChE) activity and total protein concentration in the brain regions and hypophyses of pigs reared commercially in the tropics, a number of randomly selected Yorkshire pigs were sorted into 8 body weight categories of 10 pigs each, giving a total of 80 pigs. The pigs were sacrificed and their brain regions and hypophyses assayed for AChE activity and for total protein concentration. The body weight categories were 21-30, 31-40, 41-50, 51-60, 61-70, 71-80, 81-90 and 91-100 kg. Both sexes were equally represented in each category. Acetylcholinestrase activity was highest in the amygdala, hippocampus and midbrain of 41-70kg pigs and lowest in the cerebral cortex of 31-40 kg pigs although the differences were not significant ($p>0.05$). Variations in mean specific AChE (SAChE) activity and in mean concentration of total proteins with pig body weight and brain regions/hypophyses were highly significant ($p<0.01$). Specific Acetylcholinestrase (SAChE) activity was highest in the amygdala, hippocampus and hypothalamus of 41-70 kg pigs and lowest in the cerebellum and cerebral cortex of 31-40 kg pigs. Total protein concentration was highest ($p<0.01$) in the pons and cerebellum of 31-40 kg and 91-100 kg pigs, lowest in the hypophyses of 41-50 kg pigs and did not vary in accordance with AChE activity. It was concluded that factors such as differences in age, nutrition and management of the pigs may have informed the non-specific variation patterns of the variables observed in this study.

Key words: Pigs, acetylcholinestrase, body weights, brain, hypophyses anygdala

INTRODUCTION

Food scarcity, especially of animal protein sources, still poses a great challenge to many countries in tropical Africa. In a country such as Nigeria with a large human population and an undeveloped livestock sub-sector, a wide gap still exists between demand and supply of livestock and poultry products. Consequently, meat, milk and eggs are in short supply, command high prices and remain out of the reach of a majority of the populace (Olayide *et al*., 1972).

The pig, though discriminated against on religious grounds in sections of Nigeria with high muslim populations, is accepted and widely reared in the southern part of country where the Yorkshire thrives. It therefore holds some potential in bridging the demand/supply gap for animal proteins in Nigeria. However, in order to ensure maximum productivity in farm animals including pigs, not only must the animals be well managed, the various physiological activities in the body must proceed optimally. By virtue of its prime position in the Central Nervous System (CNS), the brain plays a modulating role in all body functions and, through its control on the hypophyseal hormonal pathways, keeps the levels of hormonal production and metabolism of the other glands normal (Adewuyi, 2006). It is now known that the brain's neurotransmitters, particularly those of the cholinergic pathways, are of vital importance to the physiological integrity and, consequently, productivity of the animal (Ries *et al*., 1977; Ologhobo *et al*., 1986). These neurotransmitters are selectively concentrated in different regions of the brain depending on the functions of the region (Strazelle *et al*., 1988).

This study was carried out to ascertain the concentration and distribution of Acetylcholinestrase (AChE) and total protein and the specific AChE activity in the brain regions and hypophyses of pigs and how they vary with their body weights.

MATERIALS AND METHODS

Eighty samples of swine brains were collected from slaughtered Yorkshire pigs in Ibadan (7.38°N and 3.93°E) in southwest Nigeria. The pigs were slaughtered in line with internationally accepted standards. Before the pigs were slaughtered, they were randomly selected,

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weighed and classified into the following 8 body weight categories of 10 pigs each; 21-30, 31-40, 41-50, 51-60, 61-70, 71-80, 81-90 and 91-100 kg. Both sexes were equally represented. Immediately after slaughter, the pigs were decapitated, the heads quickly sawn open and samples taken from the hypothalamus, cerebellum, pons, cerebral cortex, amygdala, hippocampus, mid-brain and medulla oblongata as described by Egbunike (1981). The hypophyses were also removed and each was carefully dissected into the adeno- hypophysis neuro-hypophysis. Each brain or hypophyseal sample was then homogenized (1% w v^{-1}) in a 0.1 m o lar ice-cold phosphate buffer (pH 7.4) using a Potter-Elvengem glass homogenizer and immediately assayed for AChE activity and total protein content. Acetylcholinestrase (AChE) activity was determined according to the colorimetric method described by Egbunike (1981), which measures the rate of Hydrolysis of thiocholine and acetate using 5:5 Dithiobis-2-nitrobenzoate (DTNB) (Aldrich Chemical Company) as the colour reagent. AChE activity was expressed in mmole g^{-1}-wet tissue min^{-1}. Total protein was assayed by the biuret method as reported by Egbunike (1981) and expressed in g 100 mL^{-1}. All data collected were subjected to a two-way analysis of variance in a randomised complete block design. Means showing significant differences were separated using Duncan's Multiple Range Test (1955).

Table 1: Analysis of variance on variation of AchE activity and total protein concentration with body weight and brain region/hypophysis of pigs

		Mean squares		
Source of Variation	Degree of freedom	AchE	SAChE	Total
Total	79			
Body weight	7	2.197ns	997.702**	0.140**
Brain region/ Hypophysis	9	18.230**	821.479**	0.122**
Residual	63	2.195	217.637	0.033

AChE = acetylcholinestrase; SAChE = specific acetylcholinestrase: ns=not significant (p>0.05) ** highly significant (p<0.01)

RESULTS AND DISCUSSION

The result of the analysis of variance on the effects of pig body weight and brain/hypophyseal region on Acetycholinestrase (AChE) activity and total protein concentration is presented in Table 1. Variations in mean AChE activity with pig body weight were not significant (p>0.05) while highly significant (p<0.01) differences in AChE activity were observed in the different brain regions and hypophyses of the pigs. Total protein concentration showed highly significant (p<0.01) differences with pig body weights and in the different brain regions/hypophyses of the pigs.

The mean AChE activity, Specific AChE (SAChE) activity and total protein concentration for the pigs at the different body weight categories and in the brain regions and hypophyses of the pigs are presented in Table 2 and 3. Pigs in the 41-70kg weight categories had the highest mean AChE (3.797-4.250 mmole g^{-1}-wet tissue min^{-1}.) and SAChE (25.099 - 32.241 mmole g^{-1}-wet tissue min^{-1}.) values while pigs which weighted 31 - 40 kg had the lowest values (2.745 and 5.993 mmole g^{-1}-wet tissue min^{-1} for AChE and SAChE respectively) Total protein concentration was significantly (p<0.01) higher in the 31-40 and 91-100 kg pigs than in any of the other body

Table 2: Variations in AChE activity and total protein concentration with body weight of pigs

	Pig body weight categories (kg)								
Parameters	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	SEM
AchE*	3.100^{a}	2.745^{a}	3.797^{a}	3.866^{a}	4.250^{a}	3.360^{a}	3.753^{a}	3.617^{a}	0.168
SAChE*	18.336^{c}	5.993^{d}	32.241^{a}	30.063^{a}	25.099^{b}	28.092^{ab}	16.070^{c}	8.599^{d}	3.493
Total protein**	0.285^{bc}	0.516^{a}	0.208^{c}	0.365^{b}	0.315^{bc}	0.288^{bc}	0.304^{bc}	0.493^{a}	0.038

AChE = acetylcholinestrase; SAChE = specific acetylcholinestrase: * mmole g^{-1} wet tissue min^{-1} **g 100mL^{-1}
Within each row, means with different superscripts differ significantly (p<0.01)

Table 3: Variation in AChE activity and total protein concentration with brain regions/hypophyses of the pigs

	Brain region/Hypophysis									
Parameters	Pons	Cerebellum	Amygdala	Hippocampus	Hippothalamus cortex	Cerebral oblongata	Mid-brain	Medulla hypophysis	Adeno-hypophysis	Neuro-	SEM
AchE*	3.309^{d}	3.532^{d}	5.563^{a}	4.713^{b}	4.461^{bc}	1.914^{e}	4.897^{b}	4.132^{c}	0.726^{f}	2.362^{e}	0.477
SAChE*	12.491^{cd}	9.351^{d}	40.392^{a}	27.018^{b}	26.343^{b}	10.229^{cd}	23.191^{b}	15.591^{c}	12.546^{cd}	28.462^{b}	3.205
Total protein**	0.528^{a}	0.514^{a}	0.351^{bc}	0.290^{cd}	0.364^{bc}	0.298^{cd}	0.255^{cd}	0.474^{ab}	0.194^{d}	0.196^{d}	0.039

AChE = acetylcholinestrase; SAChE = specific acetylchlinestrase *mmole g^{-1} wet tissue min^{-1} **g 100mL^{-1} With each row, means with different superscripts differ significantly (p<0.0)

weight categories. The concentrations were 0.516 g 100 mL^{-1} and 0.493 g 100 mL^{-1} respectively. Pigs, which weighed 41-50 kg, had the lowest mean total protein concentration (0.208 g 100 mL^{-1}). The amygdala was the most active region of the brain in terms of AChE activity and has AChE and SAChE values of 5.563 and 40.392 mmole g^{-1}-wet tissue min^{-1} respectively. The cerebral cortex had the lowest AChE activity (1.914 mmole g^{-1}-wet tissue min^{-1}) while the cerebellum recorded the lowest SAChE activity (9.351 mmole g^{-1} of wet tissue min^{-1}). Mean total protein concentration was highest in the pons and cerebellum 0.528 and 0.514 g 100 mL^{-1}, respectively and lowest in the hypophyses.

These results demonstrate the existence of a bodyweight-related differential distribution of total protein and AChE activity in the brain and hypophyses of the pig. Generally, AChE activity was highest in the amygdala, hippocampus and midbrain (mesencephalon) of pigs that weighted between 41 and 70 kg and least in the cerebral cortex of 31-40 kg pigs. These regional differences are in agreement with the findings of Moudgil and Kanungo (1973), Egbunike (1981), Adejumo and Egbunike (1984) and Adejumo and Egbunike (2002). Although low AChE activity was generally accompanied by low SaChE activity and vice versa as observed by Adejumo and Egbunike (1984), total protein concentration did not vary in the same way contrary to reports by the same authors. Other factors such as age, nutritional status and environmental factors to which the pigs may have been exposed, which are known to influence cholinergic activity in pigs (Adewuyi, 2006) but which could not be kept constant in this study may have accounted for this disparity.

CONCLUSION

Significant variations in Acetylcholinestrase activity and in protein concentrations with body weight and in different brain regions of tropical pigs were established. However, the variations followed no specific pattern probably because of the influence of other factors such as differences in age, nutrition and management of the pigs, which could not be kept constant in this study.

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