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ANALYSIS OF SOME INDUSTRIAL METALS AND IONS IN THE CEREBRAL CORTEX OF GOATS IN NIGERIA

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SUMMARY

A total of twenty goats, ten each belonging to the West African Dwarf (WAD) and Red Sokoto (RS) breeds from their natural environments had their brains analysed for five metals and ions namely F^-, Ni, Hg, As and Co using the Atomic Absorption Spectrophotometer. The result revealed that these metals and ions are kept in low concentrations in the cortex of both breeds. The level of As was significantly higher in the WAD than that of RS. These metals and ions showed no significant differences between sexes except. There was a significant negative correlation between the levels of Ni and As in RS males. With a recent upsurge in the search for solid minerals in virtually all states in Nigeria, the goat may prove a valuable indicator in future assessment of metal and ion toxicity in the brain of humans in such environments.

KEYWORDS: industrial metals, brain cortex, goats, Nigeria

INTRODUCTION

Heavy metal ions are known to be toxic to the central nervous system (CNS) (Zheng *et al.*, 1991) and are known to have neurological and behavioural effects of which the pathologies include interference with neurotransmitters, interruption of brain development through inhibition of cell division and cell migration and production of focal damages in specific areas in the brain (Clarkson, 1987). While some metals cause silent neurotoxicity i.e. persistent morphological and/or biochemical injury that remains clinically inapparent until later in life (Costa *et al.*, 2004) others are suspected to exert negative effects not solely by the individual metals but due to interactions within metals which have been known to predispose the brain to disease (McDowell, 1985).

Nigeria has had a monolithic economy (Adesopo and Asaju, 2004). One major way through which the government has started addressing this trend is through solid mineral exploitation. It is expected that the exploitation like it occurs in the petroleum industry will lead to environmental degradation and pollution. A subtle and often neglected negative effect of such pollution is the impact on the brain. Such fears have been substantiated by the fact that metal toxicity is known to occur via the olfactory pathways (Henriksson *et al.*, 1997; Persson *et al.*, 2003).

Goats are found in large numbers in Nigeria (FAO, 1995) and found in every climatic zone. We are proposing that the goat may prove a good indicator for future assessment of metal and ion toxicity in the brain. The aim of this work is to assess the baseline level of some industrial metals in the cortex of the brain of goats.

MATERIALS AND METHODS

Ten RS and ten WAD goats were obtained from abattoirs in Sokoto and Bodinga towns; and from Ibadan respectively. The animals' heads after slaughter were kept in the freezer at –20°C. The brain was exposed using the methods of Olopade and Onwuka (2002) and plastic utensils which were constantly washed in deionized water were used to remove brain samples from the lateral part of the frontal cortex. The samples were dried in B and T® laboratory oven if you at between 40 – 50°C for four days and then grounded. The samples were then prepared for the Atomic. Absorption Spectrophotometer (AAS) according to the methods of Benas (1968) for the determination of the concentrations of Fluoride, F^-; Nickel, Ni; Mercury, Hg; Arsenic, As and Cobalt, Co.

The results obtained are expressed as mean ±S.D and statistical analysis done using Pearson correlation, and student "t" test at 5% level of significance.

RESULTS

The level of F^- in the brain was 0.14ppm and 0.15ppm in WAD and RS goats, respectively while the level of Ni was similar at 0.13ppm in both breeds. The concentrations of Hg, As and Co were 0.02ppm, 0.03ppm; 0.06ppm, 0.04ppm; and 0.10, 0.11ppm in WAD and RS goats, respectively.

The level of Arsenic was significantly higher in the WAD than the RS goat. There were no significant differences ($P > 0.05$) between the sexes in each breed examined except for fluoride, which was significantly higher in RS males. There was a significant negative correlation at the 0.05 level between the concentration of Ni and As on the RS males.

TABLE 1: Concentration of some industrial metals in the cortex of the brain of goats in Nigeria (dry weight/ppm)

Breed	F^-	Ni	Hg	As	Co
WAD	0.14 ±0.03	0.13 ±0.12	0.02 ±0.01	0.06* ±0.01	0.10 ±0.02
RS	0.15 ±0.04	0.13 ±0.02	0.03 ±0.01	0.04 ±0.02	0.11 ±0.02

TABLE II: Effect of sex on the concentration of some industrial metals and ions in the context of the brain of goats in Nigeria (dry weight/ppm)

Breed and Sex	F^-	Ni	Hg	As	Co
WAD (Male)	0.15 ±0.04	0.13 ±0.02	0.02±0.0.01	0.06 ±0.01	0.10 ±0.02
(Female)	0.13 ±0.03	0.13 ±0.02	0.03 ±0.01	0.07 ±0.01	0.10 ±0.02
RS (Male)	0.18*±0.02	0.15** ±0.02	0.02 ±0.00	0.03 ±0.02	0.12 ±0.01
(Female)	0.14 ±0.03	0.12 ±0.02	0.03 ±0.02	0.04 ±0.02	0.10 ±0.02

* $P < 0.05$

** Negative correlation with As at 0.05 level of significance

DISCUSSION

There is currently a dearth of information on the levels of industrial metals and ions in the brains of goat breeds in Nigeria. The animals in this study were however from non-industrial sites.

Fluoride toxicity has been known to affect children's intelligence (Xiang *et al.*, 2003), and alter neuronal and cerebrovascular integrity in animals (Varner *et al.*, 1998) and may have adverse effect on developing brain (Schettler *et al.*, 2000). Levels as low as 1ppm in water given through prolonged administration can be neurotoxic (Varner *et al.*, 1998). The brain usually has the lowest concentration of fluoride amongst body tissues (Jenkins, 1991) and was found to be 0.5 ±0.4mg/kg wet weight in human pineal gland (Luke, 2001). The value in this study ranged from 0.14 – 0.15ppm without significant differences between sexes.

Nickel as part of a soluble salt (Nickel chloride) is used in nickel plating, ink industry as a adsorbent for ammonia in gas masks (Merck 1996) and occupational poisoning has been reported (Sunderman *et al.*, 1988). The metal has been known to be taken into the brain via the olfactory nerves (Henriksson *et al.*, 1997). Similar levels were seen in both breeds and no significant differences were found between sexes of goats in this study.

Mercury is a known neurotoxicant (Berlin, 1986) and has been known to accumulate more in gray than the white matter of the cortex during toxicity (Eggleston and Nylander, 1987). The values in this study show that mercury in the cortex of the goat brain is kept at low concentrations with a mean range of 0.02 - 0.03ppm dry weight.

Arsenic is released into the environment through copper, zinc and lead smelters amongst others (Intoxication, 2005). At toxic levels, it produces a variety of neural and behaviour changes in laboratory animals, which is time and not dose dependent (Rodriguez *et al.*, 2001). It is not certain why a significantly higher level ($P<0.05$) was found in the WAD goats. More studies may help ascertain if this was a transient occurrence due to an exposure, a breed difference or a real toxicity.

Cobalt is used in chemical industry and can be taken into the brain through the nasal pathways (Persson *et al.*, 2003).The effect of the deficiency of the metal is well documented in goats (Evans, 2005). It is an essential element necessary for formation of vitamin B12 (hydroxocobalamin) and also an important constituent of brain enzymes in the metabolism of amino acids and protein with concentration highest in the pineal gland (Demmel *et al.*, 1982). The metal is known to delay the onset of ryegrass toxicity in sheep (Davies *et al.*, 1995). The toxicity of cobalt leads to goiter and reduced thyroid activity (Barceloux, 1999). The levels found in the cerebral cortex in this study were fairly constant between breeds and sexes.

This study has highlighted the level of some industrial metals and ions in the cerebral cortex of the brain of two goat breeds in Nigeria and will be useful in establishing a baseline, which will aid neurotoxicological studies of heavy metal pollution of the brain of Nigerians.

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