
Full Length Research Article

Cortical Concentrations of Metals and Protein in the Brain of Two Breeds of Goats in Nigeria.

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ABSTRACT

Metal pollution and exposure is an increasing global problem. One of the best ways to assess the impact of this problem on the brain is by using animals raised in such environments. As a prelude to this, the goat was used in this study to determine its normal metal and protein level in the brain. Ten metals and total crude protein were each analysed in the brains of twenty adult goats belonging to Red Sokoto (RS) and West African Dwarf (WAD) breeds. The dry weight concentration of Fe, Cu, Mn, Zn, and I obtained in the brain using the Atomic Absorption Spectrophotometer were 189.10±42.99 ppm, 3.08±0.55ppm, 0.90±0.52ppm, 73.00±10.63ppm, 0.05±0.03ppm, and 188.91±61.13ppm 3.43±0.71ppm, 1.19±0.64ppm, 73.92±7.88ppm and 0.05±0.02ppm in West African Dwarf(WAD) and Red Sokoto(RS) goats respectively. The male RS goats had significantly higher levels (P<0.05) of Mn than the females. While the male WAD goats had higher levels of total crude protein, the concentration between the sexes of the RS goats was the same. This study has given information on metal and protein concentration in the brain of goat for use in comparative neurochemistry and toxicological studies.

Key Words: Metal, Protein, Brain, Goats, Nigeria

INTRODUCTION

Chronic low level exposure to toxic metals is an increasing global problem (Quing, 1998). It has been suggested that metal toxicity, study of which is apparently neglected may be exceedingly more potent in its effect in real life than all radioactive and organic pollutants combined (Meike et al., 1998) and is the least studied of all carcinogens (Waalkes et al, 1992). For instance, leaded gasoline in the nineteen-seventies in the United States of America was found to have affected Intelligence Quotient (I.Q) permanently reducing it by seven points in some children (Winneke and Kramer 1997).

While metals play vital roles like enzyme activation, are essential co-factors of metabolic reactions, carriers of proteins, regulator of digestion, regulation of nerve transmission, protect

against diseases (Haenlein, 2003), it remains to be generally agreed on by researchers that deficiency and/or toxicity of trace elements play a role in the pathogenesis of neuropathies. Not least in these intriguing findings are the roles Iron and Aluminium mismanagement play in the epidemiology of some brain diseases (Beard and Connor, 2003) and the indictment of the interplay of several metal in the incidence of brain pathologies both in humans and animals. For instance feeds high in molybdenum relative to copper are well known to induce copper deficiency in ruminants (McDowell, 1985). This interplay of metals seem to suggest the existence of location dependent environmental factors which may not cause disease conditions like Transmissible Spongiform Encephalomyelitis (TSE) but predispose individuals to infection.

The hypotheses of many researchers (Taylor, 1998, Wilesmith et al., 1992a, 1992c) are consistent with the suggestion that an environmental or nutritional factor is a predisposing and or causative factor of brain diseases like Bovine Spongiform Encephalomyelitis (mad cow). A striking support to such hypothesis is the known fact that uptake of metals in the brain can occur via the olfactory pathways (Tjalve and Henriksson, 1999).

Total brain protein undergo major changes during development (Tucek et al, 1990) and such changes have been found to be unaffected by genetic or specie effects amongst some ruminants (Adejumo et al., 2005). Protein in the brain is important for many functions amongst which is that it binds to some minerals to ensure bio-availability of the minerals. While normal metal profile of the brain has been documented in the pig in Nigeria (Adejumo and Okunlola, 2005), such work remains scanty in the goat. However, due to its (goat) high population and distribution (FAO, 1995) and its ubiquitous and hardy nature (Gall, 1996), we are postulating that the goat could be a better model to study the role of the environment on metal toxicity or deficiency in the brain.

The aim of this study is to examine the level of some metals and protein profile in the brain of goats from non-industrial areas using two breeds from two different environments (Sokoto and Ibadan) in Nigeria as part of a pilot study to determine a baseline level for this species.

MATERIALS AND METHODS

A total of twenty goats, ten each for the Red Sokoto and West African Dwarf breeds (4 males and 6 females in each breed) and all aged 1-2 years were used in this study. The Red Sokoto goat was obtained from Sokoto north western Nigeria while the West African Dwarf was obtained from Ibadan, south western Nigeria. The animals were obtained from the local slaughter slabs where they were slaughtered by restraint and

exsanguinations. The goats were subsequently decapitated and their heads were kept in the freezer at -20°C. The brain was later removed according to the technique of Olopade and Onwuka, (2002).

The brain samples were removed using plastic utensils from the lateral frontal cortex of the brain and dried in a laboratory oven (B and T®) at between 40-50°C for four days and later macerated. The level of metal and protein were determined using an atomic absorption spectrophotometer according to the procedures described by Benas (1968).

The metals analysed in this study were Iron (Fe), Iodine (I), Copper (Cu), Manganese (Mn), Zinc (Zn), Silicon (Si), Molybdenum (Mo), Magnesium (Mg), Lead (Pb) and Selenium (Se).

The results were statistically analysed using Analysis of Variance (ANOVA), and means tested by student t test at 5% level of significance using SPSS® (2000) as the statistical package of analysis.

RESULTS

The mean level of Mg in this study was 0.53% and 0.63% in the WAD and RS respectively. There was no statistical significant difference (P>0.05) in the values of all the metals (Table 1) and crude protein (Table 3) examined in this study between both breeds of goats.

The percentage value of crude protein in the RS (17.35%) was higher than that obtained in the WAD which was 16.28 %. The WAD male had a higher level of percentage crude protein than the female while the value was the same for both sexes in the RS goat (Table 3).

The RS male goats had significantly (P<0.05) higher values for Mn in the brain than the female counterparts. The latter however had higher values for I and Se but none were significant (Table II). WAD males had higher values of Mg and Mn than the females which on the contrary had higher levels of Pb and Zn though none was significant (Table 2).

Table I: Mean values (\pm SD) of metals in the brain (dry weight) of WAD and RS goats in Nigeria.

	Mg%	Mn	Fe	Cu	Zn	Mo	Pb	I	Si	Se
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
WAD	0.53	0.90	189.10	3.08	73.00	0.16	0.18	0.05	0.15	0.09
N=10	\pm 0.16	\pm 0.52	\pm 42.99	\pm 0.55	\pm 10.63	\pm 0.03	\pm 0.05	\pm 0.03	\pm 0.05	\pm 0.03
RS	0.63	1.19	188.81	3.43	73.92	0.16	0.17	0.05	0.16	1.00
N=10	\pm 0.16	\pm 0.64	\pm 61.13	\pm 0.71	\pm 7.88	\pm 0.07	\pm 0.05	\pm 0.02	\pm 0.05	\pm 0.06

N= Number of Animals

Table 2
Mean values (\pm SD) of metals in the brain (dry weight) of WAD and RS goats in Nigeria, according to sex.

	Mg%	Mn ppm	Fe ppm	Cu ppm	Zn ppm	Mo ppm	Pb ppm	I ppm	Si ppm	Se ppm
WAD Male	0.62 \pm 0.08	1.22 \pm 0.61	184.19 \pm 56.04	2.99 \pm 0.73	70.04 \pm 8.73	0.17 \pm 0.04	0.22 \pm 0.06	0.04 \pm 0.02	0.18 \pm 0.02	0.08 \pm 0.03
Female	0.48 \pm 0.18	0.68 \pm 0.34	192.31 \pm 37.57	3.13 \pm 0.48	74.99 \pm 12.08	0.15 \pm 0.02	0.17 \pm 0.05	0.06 \pm 0.03	0.14 \pm 0.04	0.10 \pm 0.03
RS	0.69 \pm 0.04	1.68 \pm 0.19	220.99 \pm 30.07	3.63 \pm 0.44	78.13 \pm 6.29	0.21 \pm 0.05	0.20 \pm 0.04	0.04 \pm 0.01	0.19 \pm 0.04	0.06 \pm 0.01
Female	0.60 \pm 0.21	0.86 \pm 0.63	167.36 \pm 69.31	2.97 \pm 0.75	71.07 \pm 7.98	0.13 \pm 0.06	0.15 \pm 0.05	0.06 \pm 0.02	0.15 \pm 0.05	0.12 \pm 0.07

*N= Number of Animals; * Significant between sexes at $p < 0.05$*

TABLE 3
Mean values (\pm SD) of % crude protein (dry weight) of the brain of WAD and RS goats in Nigeria and the effect of sex.

	Crude Protein%		Crude Protein %
WAD (Both Sexes) n=10	16.28 \pm 3.74	RS (Both Sexes) n=10	17.35 \pm 2.66
Male	17.42 \pm 3.24	Male n=4	17.35 \pm 1.47
Female	15.52 \pm 4.14	Female n=6	17.35 \pm 3.39

N= Number of Animals

DISCUSSION

The available data in brain metal level in goats generally, and in goat breeds in Nigeria in particular is scanty. This is a disadvantage when one takes into cognizance our proposal that the goat could be a model from brain metal toxicity especially in environmentally polluted areas where goats thrive.

Deficiency of Zn is known to increase Cu content in the brain of female and male goats (Gruen et al. 1986). Zinc is one of the most abundant metals in the brain and an important component of the presynaptic vesicle of certain terminals. Accumulation of Zn can lead to selective neuronal death (Koh, 2001). The value in the brain of the WAD and RS goats was high and fairly constant but there was disparity between sexes.

The value of silicon in this study was the same in both WAD and RS goats. Silicon prevents accumulation of aluminium in the brain (Carlisle and Curran, 1987). It has been found that high level of aluminium in the brain had a deleterious effect on cognitive function when silicon concentration was low but these effects were reversed when concentration of silicon was high. Male goats had higher level of silicon in the brain in both breeds of goats in this study.

Feeds high in molybdenum relative to copper are known to induce copper deficiency in ruminants (McDowell, 1985) and the increase of molybdenum in feed has been shown to have a linear increase with brain concentration (Wang, 1992). The concentration of molybdenum in RS goats in this study was equal to that found in the WAD with males having higher values.

Iron is important in the brain as impaired acquisition leads to neurological problems (Connor et al, 2003). It is a pro-oxidant of the nigrostriatal system (Sziraki et al, 1998). Iron is abundant in the brain cortex of goats as shown in this study with lack of uniformity in disparity between sexes.

Copper imbalance in the brain has been associated with a lot of neuropathies. Copper deficiency leads to several loss of abiotrophy of cerebellum characterized by a severe loss in Purkinje cells (Rehbinder and Peterson, 1994) while increased levels caused up to 80% reduction in brain acetylcholine in a study (Salanki et al, 1993). Interestingly copper level in the cerebrum like the one done in this study has been found to be a more reliable indication of copper deficiency than that of the liver (Arnold et al, 1998). The concentration in RS goats in this study was found to be higher than WAD goat and also higher in males in the former compared to females.

Magnesium is important in the brain; its concentration has effect on serotonin receptors, nitric oxide synthesis and release, and effects on migraine receptors in humans (Mauskop and Altura, 1998). Magnesium deficiency at the onset of the rainy season has long been linked to grass tetany in cattle (Merck, 2005). Its role and importance in the brain of goats are scarcely studied. It was higher in RS than WAD in this study and higher in males of both breeds.

Manganese mediates an opposite action to iron in the nigrostriatal system (Sziraki et al, 1998). It had a higher concentration in RS compared to WAD and with males having a higher value in both

breeds than females. This sex difference was significant in the RS breed. This occurrence suggests a greater requirement for manganese in males than females; this is supported by the recommendation of higher doses of intake of manganese in males amongst humans (University of Maryland, 2005)

Selenium plays a key role in brain development (Watanabe, 2001). There is a dearth of literature on this metal in the brain of goats. Significant increases have been seen in selenium in brain regions of rat offsprings whose mothers were supplemented with selenium (Bou-Reshi et al, 2002) indicating that supplementation in feed can augment deficiencies in the brain or may cause toxicity. This has however been disproved in sheep where feed supplementation had no significant effect on brain levels of the metal (Yeh et al, 1997). The values were fairly similar in both breeds in this study but higher in females.

Lead poisoning had always elicited neurological manifestations. Lead is involved in Intelligent Quotient depression (Winneke et al, 1997), breakdown of blood brain barrier by damaging capillaries and injury to glial cells (Human Brain, 2005), and is a differential diagnosis for polioencephalomalacia in sheep (Merck, 2005). The baseline level of lead in the brain is thus important for assessment of the impact of environmental pollution of this metal in the brain. The RS goats had level of 0.19ppm lower than the WAD goats in this study with higher levels found in males than females in both breeds.

Iodine deficiency is known to hamper brain development (Hatzel and Dunn, 1989, Delange, 2000) though the study of iodine levels in the brain remains scarce (Adrasi et al, 2004). The level in the brain of goats in this study suggests that it is kept at low levels with the lower limits being that of the female. Total brain protein level in animals in Nigeria has been studied by Adejumo et al (2005) in goats and Adejumo and Egbunike (2004) in pigs. Protein and metal interaction could be avenues for metal toxicity in the brain (Erikson and Aschner, 2003)

The total protein concentration in RS bucks in all the brain regions were very similar (Adejumo et al, 2005). There was no significant difference in the crude protein concentration of the brain between the WAD and RS goats. There was however a higher value in WAD male compared to the female. Total protein concentration is actually a combination of protein synthesis, protein breakdown, amino acids turnover rate (Dekosky and Bass, 1985) and hormonal status (Adejumo and Egbunike, 2001) amongst other factors. The difference between sexes in WAD goat may be

because the female experience a decrease in turnover of protein with age compared to the males. It should be noted that the WAD goat is raised mainly through semi-intensive system with uncontrolled mating and in comparison to the RS, the WAD matures early and is highly fecund thus making the female WAD to undergo a prolonged time of reproductive burden which in addition to low protein diet could have affected the protein profile. In addition, it has been reported that the brain turnover undergo major changes during development (Tucek et al, 1990) and such changes may show genetic variation (Adejumo et al, 2005) as reflected in the sex difference in the WAD. Also, of importance is the recent fact that some studies have indicated the expression of some proteins in the brain to be higher in males than females (Olesen and Auger, 2005)

This study has shed light into the metal and total protein level in the brain of two goat breeds in Nigeria and may play a relevant role in future analysis of these values in the brain particularly as it affect the interplay between these metals and proteins and the environment.

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