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Evidence of Heavy Metals Distribution in Placenta in Association with Residual Levels in Some Dams' Organs from Bodija abattoir, Oyo State, Nigeria

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Abstract
Heavy metals have been known to be causing serious detrimental effect on the health of livestock and human populace in general. However, little study had been carried out on the ability of heavy metal to cross placental barrier, which has already been bio-accumulated in the dam. Therefore, this study aimed at showing the evidence of placental barrier crossing by selected heavy metals. The study was carried out in Bodija abattoir, Ibadan, Oyo-state, Nigeria, located on latitude $70^0$20N, longitude $30^0$5E. A cross-sectional study design was adopted and lasted for 6 weeks. Samples were collected from kidney cortices, apical lobe of dam's liver and a portion of fetal placenta. 12 sample each from liver, kidney and the placenta which were analyzed using Atomic Absorption Spectrophotometer (AAS). Results were subjected to descriptive statistics, t-test and correlation using SPSS17.0 package.From this study cadmium (Cd) and lead (Pb) residues were not found in the samples, while chromium (Cr) was found in all the samples (100% prevalence) and the total prevalence for the heavy metals in the study was 33.4%. The mean chromium (Cr) residual values in placenta, kidney and liver were 0.89±0.66mg/kg, 1.32±0.94mg/kg and 1.00±0.87 mg/kg respectively. The correlation between chromium (Cr) in the dam's kidney and placenta was 0.3, while for the dam's liver and placenta was 0.6. In comparison with permissible limit, the residual level in kidney 1.32±0.94, liver 1.00±0.87 and placenta 0.89±0.66, were within the permissible limit. The study revealed that chromium (Cr) residue was a major challenge in the organs sampled. Liver of the dam had the highest level of bioaccumulation and stronger correlation in the distribution to the placenta. It is therefore recommended that attention should be paid on the disposal of chromium (Cr) residues on the grazing floor where the bulk of the residues were from.
Keywords: Heavy metals, Liver, Kidney, Placenta and cattle.

1. Introduction

Heavy metals are natural constituent of the earth's crust but indiscriminate human activities have drastically altered their geochemical cycle and biochemical balance which has led to the accumulation of heavy metals in different parts of plants which is the major source of food for both man and animals. Heavy metals includes lead (Pb), cadmium (Cd), mercury (Hg) arsenic (As), chromium (Cr), copper (Cu) selenium (Se) nickel (Ni), Silver (Ag) and zinc (Zn) other less common metallic contaminant includes aluminum (Al), Cesium (Cs) cobalt (Co), manganese (Mn), Molybdenum (Mo), strontium (Sr) and uranium (U) (Mcintryre, 2003). All metals are toxic at high concentration (Chronopoulos, 2002).

Long term exposure can result in slowly progressing physical, muscular and neurological degenerative processes that mimics Alzheimer's disease, Parkinson's disease, muscular dystrophy and multiple sclerosis, allergies are meet uncommon and repeated long term contact with some metals can cause cancer

Heavy metals especially lead, mercury, cadmium, arsenic and chromium are well known for causing birth defect although the mother maybe unaffected and unaware of the contamination. Infants exposed to such agent in-utero may have a number of side effects as these substances readily move across the placental barrier. (European review 2013)

Fetuses and neonates are especially vulnerable to toxic chemicals because of the immaturity of their detoxification system in fact, intake by children of heavy metals per unit of body weight is expected to be higher than in adults (Marti- cid *et al.,* 2007) lead is an established neuro-developmental toxicant while cadmium is a well known animal carcinogens (IARC 2012) Cadmium is also neuro-toxicants (Gouil *et al*., 2012; Hu *et al.,* 2007, Wasserman *et al;* 2004) it also act in endocrine disruption (Hanson and Chedrese, 2004) Cr is known to be mutagenic and carcinogenic (Zhitkovich, 2011).

Because some heavy metals may reach and cross the placental barrier (ATSDR 2006; Osman *et al.,* 2000) and interfere with placental transport systems (Wier *et al.,* 1990, Zhang *et al.,* 2004) pre natal exposure to these toxic compounds should be a matter of special concern the placental appears to be the optimal biological matrix to access environmental risk in material transfer to the fetus

The placental plays a central role for the fetus by providing nutrients and oxygen, but also by acting as a barrier to prevent passage of toxic sustain, but though researches, it has been discovered that some toxic materials such as bacteria and heavy metals cross the placenta barriers to accumulate in the fetal tissues.

Substances cross the placenta by one of the four methods; passive diffusion, facilitated diffusion, active transfer and receptor–mediated endocytosis (Brodner *et al*., 2004) .Passive diffusion is the most substantial transfer method and is limited by the molecular weight of a substance, facilitated diffusion is a mechanism by which specific transport proteins allow a substance to pass down its concentration gradients into the fetus. Active transport on the other hand uses energy to move substances against a concentration gradient (Nunley *et al*. 2009)

Receptor medicate endocytosis is a process by which certain substances are ingested using a specific receptor ligand interaction to transport across the placenta (Nunley *et al*., 2009). Placental passage of heavy metals varies for instance the passage of cadmium is limited suggesting a partial barrier for this metal; it is likely that metallothionein is responsible for placental storage of the metals especially of cadmium.

It is however unclear which proteins are involved in placental uptake where the transports are located at the placental barriers. Only certain aspects of placental metal toxico-kinetics are known so far.

2. Materials and Method

The samples were collected from Bodija abattoir Ibadan in Oyo State Nigeria. 36 samples comprising of dams' liver apical lobe, kidney cortices, and placenta (12 kidneys, 12 livers and 12 placentas) were collected. Samples were taken over a period of 6 weeks in conformity with FAO guidelines. Samples were coded appropriately to eliminate bias from the laboratory

Samples were analyzed using Conc. HNo_3, Conc. $HClO_4$, digestion flasks, Digestion block, distilled water, 50ml volumetric flasks, and atomic absorption spectrophotometer. (All reagents were of ANA LAR grade) and the reagents includes perchloric acid and nitric acid at ratio of 1:2. Perchloric acid was to slow down the rate of evaporation of the nitric acid

2.1 Digestion

Known weight of each sample material was weighed into digestion flask. 10ml of nitric acid was added. This was digested at low temperature (between 70^0 and 100^0C). The temperature was increased to 150^0C and 2ml concentrated $HClO_4$ was added until clear fume was attained. The digest was allowed to cool and washed into 50ml standard volumetric flask and made up to the mark with distilled water. The digest was filtered to remove any particulate matter prior to analysis.

2.2 Analysis

The digest above was analyzed, on an AAS Elmer Perkin model after calibrating the equipment for each element, and a specific hollow cathode lamp for each metal at specific wavelength was used. Wavelength for chromium, lead and cadmium were 357.6nm, 283.7nm and 228.5nm respectively.

3. Results and Discussion

Table 1 revealed that cadmium and lead were not detected in all the samples taken while chromium was detected in all the samples (100% prevalence), and this line with Amaya *et al.,* 2012 which showed that Cr was detected in almost all the placenta tested. Exposure to Cr may occur from natural or industrial sources and from hazardous waste sites (US-EPA, 2012b). The general population is exposed to Cr by eating food, drinking water and inhaling air

Table 2 showed the distribution of the selected heavy metals in the placenta. As in table 1 above, it showed that chromium passes through placenta barriers and in all placentas tested. This showed that Cr can be transferred from the dam to the fetus by any of the mechanism identified by Brodner *et al*., 2004.

Table 3 showed the level of chromium in the dam's kidney, liver and placenta and the values were statistically significant. This supports the work on chromium (relevance to public health) that says that absorbed chromium distributes to nearly all tissues, with the highest concentrations found in kidney and liver. Level of kidney was higher and this is in respect to the work José *et. al*. (2013) that showed that kidney plays an important role in elimination of xeno-biotics, including drugs and toxic environmental agents. Kidney is the target of heavy metals and the proximal tubule has been recognized as the main site of accumulation and damage.

Table 4 showed the association between levels of selected heavy metals in dams' organs and placenta. The association was necessary because heavy metals found in the placenta were mainly from the dam's organs and blood, but for this study the organs were used. The correlation showed that, when there was increase in heavy metals in the liver, there must be corresponding increase in heavy metals in the placenta. The correlation of heavy metals in the kidney in relation to the placenta was weak. The study revealed that the bulk of heavy metals found in the placenta were the products of the dam's liver.

Table 5 showed the comparison between results obtained with international standard. The values were within the permissible limit except in dams' kidney which was slightly higher.

4. CONCLUSION

It could be concluded from the study that chromium could pass through placental barrier and majority of the heavy metals found in the placenta from this study were from the dam's liver.

5. Recommendation

Since heavy metals has the ability to cross the placenta barriers, care must be taken to reduce the exposure of the dams to these metals as those found in the placenta originated from the dam. Attention should be paid on the disposal of chromium (Cr) residues on the grazing floor where bulk of the residues were found. Also, screening of meat and meat products for heavy metals should be made compulsory at the abattoir during inspections.

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Table 1: Detection of Selected Heavy Metals in Placenta of Cattle Sampled

Animals	Cadmium (Cd)	Chromium (Cr)	Lead (Pb)
1	ND	D	ND
2	ND	D	ND
3	ND	D	ND
4	ND	D	ND
5	ND	D	ND
6	ND	D	ND
7	ND	D	ND
8	ND	D	ND
9	ND	D	ND
10	ND	D	ND
11	ND	D	ND
12	ND	D	ND

Detection Limit: Cr: 0.003, Cd: 0.002, Pb: 0.05
ND- Not detected
D- Detected
Percentage of heavy metal detected = 33.33%

Table 2: Descriptive statistics of distribution of the selected heavy metals in Placenta (mg/kg)

Heavy metals	Number of animals	Minimum	Maximum	Mean	Std. Dev.
Lead in placenta(mg/kg)	12	0.00	0.00	0.00	0.00
Cadmium in placenta(mg/kg)	12	0.00	0.00	0.00	0.00
Chromium in placenta(mg/kg)	12	0.32	2.70	0.89	0.66

Table 3 - Level of significance of chromium residues in each organ sampled

Organs	Number of animals	Mean	S. D	SEM	T	df	p-value
chromium in dam's kidney(mg/kg)	12	1.32	0.94	0.27	4.891	11	0.000
chromium in dam's liver(mg/kg)	12	1.00	0.87	0.25	3.979	11	0.002
chromium in placenta(mg/kg)	12	0.89	0.66	0.19	4.635	11	0.001

Table 4: Association between levels of selected heavy metal in dams' organs and placenta Correlations

		Chromium in Placenta(mg/kg)
chromium in dam's liver(mg/kg)	Pearson Correlation	0.637(*)
	N	12
chromium in dam's kidney(mg/kg)	Pearson Correlation	0.297
	N	12

* Correlation is significant at the 0.05 level

Table 5: Comparison of residual level of chromium (mg/kg) in dam's kidney, liver and placenta with standard levels

Organs	Mean ± S.D	Internationally accepted standard
Dam's kidney(mg/kg)	1.32±0.94	1.00*
Dam's Liver (mg/kg)	1.00±0.87	1.00*
Placenta (mg/kg)	0.89±0.66	1.00*

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