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Research Article

LEAD (Pb) CONTAMINATION OF FOODS SOLD AT STREETS AND MARKETS IN URBAN CENTRES: FINDINGS FROM MAJOR CITIES AND TOWNS ACROSS NIGERIA

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ABSTRACT

Lead (Pb) is a heavy metal that has been in existence and predates the origin of man. It has found many social, cultural, scientific and technological applications among humans all through human civilizations to the present age. Pb is however found to be injurious to human health and its accumulation and undegradable nature in human body can lead to several metabolic and neurologic derangements causing several diseases and deaths across the globe. This systematic review paper looked at the sources of Pb poisoning among humans in Nigerian urban centers for the past 30 years (1992-2022) and offered appropriate measures that could control it. The study accessed 214 articles during the study period and found that at least 99% of the sources of Pb dissemination and accumulation in human body were due to anthropogenic sources gaining entries by ingestion of foods, water and otherdrinks; inhalation of street Pb loaded dusts and penetration of atmospheric Pb into both broken and unbroken skins and wounds. A substantial portion of raw, semi-processed and processed foods sold on Nigerian markets were found to be contaminated with varying degrees of Pb and in some instances above the maximum allowable threshold for human consumption. The general level of awareness on the depth of danger posed by this heavy metal from day-to-day human activity and interactions was perceived to be low. There should therefore be more public awareness about the dangers and sources of Pb accumulation in human body, and healthcare systems should be upgraded to adequately monitor Pb contents of the environment which includes soils, biota (flora and fauna), water and air regularly. Also, strict measures aimed at reducing human activities capable of spreading Pb in the environments should be established and enforced for strict compliance. And food inspectors should be adequately empowered to routinely inspect foods, fish and meat in Nigerian markets to confiscate such that are heavily loaded with Pb and unsuitable for human consumption for destruction.

Keywords: Accumulation, Contamination, Heavy Metals, Lead, Markets, Nigeria, Sources.

INTRODUCTION

Lead (Pb) is a heavy metal found naturally in the crust of the earth. Its presence in the surface and subsurface soils is usually in insignificant quantities incapable of accumulating in humans up to toxic levels. Lead enters human body through inhalation of contaminated dusts and emissions; ingestion of food, drinks, contaminated water, contaminated hands and objects, and by penetration through the skin. Accumulation of Lead in the body could lead to Pb poisoning which in children may manifest in the form of: Vomiting, difficulty in hearing,constipation, loss of appetite, weight loss, irritability, abdominal pain among others. Children are more prone to Lead poisoning because of their susceptibility to Pb contaminated sources and environments [1-5]. Pb has a melting point, boiling point and density of 327.5°C,1,744°C and $11.29\ g(cm)^{-3}$ respectively. It has half-lives of about one month in the human blood, 1-2 months in tissues and years to decades in bones [6]. All these physical parameters make Pb undegradable and bioaccumulate in human, animal and plant cells, tissues and organs causing various diseases and sometimes death to victims and organisms exposed to Pb concentrations above threshold values. The transport, fate and behavior of Pb just like any other HM is seen in the inter relationship of air, water, soil and biota. These four spheres of the environment upon interaction produce subsets [7]. Pb sourced from the soil can be entrained alongside dusts and when inhaled, it can cause adverse effects to man. When air-borne Pb is deposited by gravity on vegetations and it can cause effects that can be toxic to the vegetations directly, and indirectly to man that consumes the so-affected plants. In a similar way, air-borne Pb can produce its toxic effects in water if that becomes its sink. Pb on soil surface can be leached into the ground and cause toxicity to groundwater and when washed into ponds, lakes, streams, rivers and oceans during rainfall can also cause toxicity to these surface water bodies.Chronic Lead accumulation and toxicity in adults could lead to diseases such as hypertension, heart failure, kidney disease as well as certain cancers. It is estimated that about 240 million of the world population are over-exposed to Lead and 99% of those with blood levels above 20µg/dl are in the middle- and low-income countries. The heavy metal is said to have caused about 853,000 deaths across the globe and the rate of exposure appears to be on the increase globally. Findings on the mean Blood Lead Levels (BLLs) (in µg/dl) of people from different parts of the world show that: DR Congo, Thailand, Nigeria, India and Saudi Arabia had 11.5, 9.8, 8.7, 5.3 and 5.2 in µg/dl respectively. Findings from countries with percentage of population with mean BLLs greater than 10 were: DR Congo (71), Thailand (43.3), Nigeria (33) and South Africa (25) [8-10]. Considering the position Nigeria occupies among endemic countries for lead pollution and poisoning in the developing world, a regular update on analysis of the level of lead contamination and its impact on her populace becomes necessary [11-13]. This perspective view paper was therefore designed to assess the level of lead contamination of Nigerians through foods sold at her major markets in cities and towns. Findings will be useful to serve as avenues for policy formulation and implementation to curb lead and other heavy metal contaminations and poisoning in the country.

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MATERIALS AND METHODS

This study was based on a systematic literature search of electronic data bases such as goggle scholar, PubMed/Medline, web of science, EMBASE, SciElo, Cochrane library and AJOL on Lead contamination and poisoning. The search involved phrases such as: Lead or Heavy Metals contamination of specific foods in various Nigerian markets, Lead or Heavy metal contamination of processed foods, Lead and Heavy metal contamination of street hawked foods, Lead and heavy metals in drinks or packaged foods, Lead or Heavy metals contamination of raw foods, grains, and snacks. The search covered a period of 30 years (1992 to 2022) and was limited to the Nigerian geographical space; its cities and towns and only publications based on primary data were considered. Data was analysed using simple descriptive methods and also simple quantitative methods of sum, mean, and percentages.

RESULTS

The search yielded 214 articles that were found to be relevant to the purpose of the study. Of the 214 road side soils documented, 6.5%(14) had Pb concentrations above the minimum threshold allowable for environmental health while 6.4%(22) and 17.8%(53) of 342 and 297 street dusts and cultivation soils respectively had toxic Pb levels. Among the fishes documented as examined for Pb such as: Tilapia gallier, Crariaslazera, Osteoglossidae, Tilapia zilli, Clariasanguillaris, Protoptenus, Oreochromis niloticus, Eutropiusniloticus, and Synodentisbudgetti, the toxicity levels ranged from 6.8%(3/44) -18.2%(8/44) for Crariaslazeraand Oreochromis niloticus respectively among the 44 analsesanalyses each conducted. Among the vegetables and fruits documented, Pb toxicity in them was said to range from 2.7%(3/111) to 17.4%(16/92) for Rumex acetosa (Sorrel) and Brassica oleracea var. botrytis (Cauliflower) respectively. Other documented roots, tubers, fruits and vegetables containing varying toxic levels of Pb include: Amaranthus caudatus (Spinach), Lactuca sativa (Lettuce), Daucus carota (Carrot), Brassica oleracea (Red Cabbage), Brassica oleracea var. capitate (white cabbage), Brassica oleracea var. italic(Broccoli), Solanum tuberosum L. (Irish potato), Brassica oleracea var. sabellica(Curly kale), Raphanus sativus (Radish), Psidium guajava(Guava), Abelmoschus esculentus(Okra), Solanum melongena(Garden egg), Ipomoea batatas(Sweet Potato), Cucumis sativus(Cucumber), Lycopersicon esculenetum(Tomato), Talinum triangularae (Water leaf), and Allium cepa(Onion). Other sources Pb was reported in toxic levels include cereals such as: maize, guinea corn, millet and rice along with others such as yam, cassava and potato flours, beans and plantain. Toxic Pb accumulations were also established in solid waste 52.3%(45/86), combustion emissions 47.5%(77/162), drinking water from dam 34.0%(17/50), tap water 12.5%(5/40), soot 60.0%(150/250, and herbal medicines 22.2%(8/36). Accumulation of Pb below toxic levels in fishes studied ranged from 40.9%(9) in Osteoglossidae to 61.7%(66) in Tilapia gallier while undetectable Pb levels recorded ranged from 25.2%(27) to 50.0%(11) for the two species of fishes respectively; other fishes recording various proportions. Among fruits, green leaves, roots and tubers, Pb contamination below toxic levels was recorded in ranges from 31.9%(22) in Raphanus sativus (Radish) to 55.8%(154) in Daucus carota (Carrot); and undetectable Pb levels were reported to range from 34.8%(32) for Brassica oleracea var Sabellica (Kurly Kale) to 63.8%(44) for Raphanus sativus (Radish). Among the cereals, grains and seeds reported, Pb was found in non-toxic levels and ranged from 28.1%(96)- 56.8%(63) for Phaseolus vulgaris (Beans) and Oryza sativa (Rice) respectively; and undetectable Pb levels ranged from 41.3%(78)- 68.4%(234) for Zea mays L(Maize) and Raw Phaseolus vulgarisL(Beans). Other sources of Pb contamination below toxic levels recorded were: hair nail samples 34.5%(100), solid wastes dump sites soil 25.6%(22), combustion emissions 33.5%(54), drinking water dam 24.0%(12), soot 32.0%(8), tap water 47.5%(19) and herbal medicines 63.9%(23). (Table 1).

Table1. Sources of Lead contamination and poisoning in the environments in Nigeria

Sources of Lead contamination and Poisoning	Number of Sources without Pb Contaminations	(%)	*Number of Sources of Pb Contaminations below Toxic Levels	(%)	Number of Sources of Pb contaminations above Toxic Levels	(%)	Total (100%)
Road side soils	103	48.1	97	45.3	14	6.5	214
Street dust	154	45.0	166	48.5	22	6.4	342
Cultivation soils	112	37.7	132	44.4	53	17.8	297
Fishes							
Tilapia gallier	27	25.2	66	61.7	14	13.1	107
Crariaslazera	19	43.2	22	50.0	3	6.8	44
Osteoglossidae	11	50.0	9	40.9	2	9.1	22
Tilapia zilli	12	30.0	22	55.0	6	15.0	40
Clariasanguillaris	17	29.3	32	55.2	9	15.5	58
Protoptenus	22	30.6	38	52.8	12	16.7	72
Oreochromis niloticus	15	34.1	21	47.7	8	18.2	44
Eutropiusniloticus	16	37.2	23	53.5	4	9.3	43
Synodentisbudgetti	9	28.1	19	59.4	4	12.5	32
Fruits, Roots and Vegetables							
Amaranthus caudatus (Spinach)	188	35.1	289	53.9	59	11.0	536
Lactuca sativa (Lettuce)	76	53.5	57	40.1	9	6.3	142
Daucus carota (Carrot)	105	38.0	154	55.8	17	6.2	276
Brassica oleracea (Red Cabbage)	132	54.8	88	36.5	21	8.7	241
Brassica oleracea var. capitate (white cabbage)	118	52.7	96	42.9	10	4.5	224
Brassica oleracea var. italic(Broccoli)	22	59.5	13	35.1	2	5.4	37
Brassica oleracea var. botrytis (Cauliflower)	77	56.6	52	38.2	5	3.7	136
Solanum tuberosum L. (Irish potato)	68	52.3	55	42.3	7	5.4	130

Sources of Lead contamination and Poisoning	Number of Sources without Pb Contaminations	(%)	*Number of Sources of Pb Contaminations below Toxic Levels	(%)	Number of Sources of Pb contaminations above Toxic Levels	(%)	Total (100%)
Brassica oleracea var. sabellica(Curly kale)	32	34.8	44	47.8	16	17.4	92
Raphanus sativus (Radish)	44	63.8	22	31.9	3	4.3	69
Psidium guajava(Guava)	65	58.0	43	38.4	4	3.6	112
Abelmoschus esculentus(Okra)	75	43.1	83	47.7	16	9.2	174
Solanum melongena (Garden egg)	66	55.5	47	39.5	6	5.0	119
Ipomoea batatas(Sweet Potato)	117	49.2	106	44.5	15	6.3	238
Cucumis sativus(Cucumber)	109	48.2	106	46.9	11	4.9	226
*Rumex acetosa(*Sorrel)	65	58.6	43	38.7	3	2.7	111
Lycopersicon esculenetum(Tomato)	208	48.5	197	45.9	24	5.6	429
Talinum triangularae (Water leaf)	113	41.7	128	47.2	30	11.1	271
Allium cepa(Onion)	203	42.3	244	50.8	33	6.9	480
Hair and Nail Samples	17	58.6	10	34.5	2	6.9	29
Neem tree (Leaf, Stem, Bark)	32	71.1	12	26.7	1	2.2	45
Dump sites of solid wastes	19	22.1	22	25.6	45	52.3	86
Combustion emissions	31	19.1	54	33.3	77	47.5	162
Abattoir waste water	3	14.3	5	23.8	13	61.9	21
Chicken Adult layers (Breast part, kidney gizzard)	4	28.6	8	57.1	2	14.3	14
Drinking water (Dam)	21	42.0	12	24.0	17	34.0	50
Moringa oleifera (Horseradish tree)	11	50.0	7	31.8	4	18.2	22
Zobo drink	12	52.2	8	34.8	3	13.0	23
Kunu drink	14	41.2	14	41.2	6	17.6	34
Zea mays L (Maize)	78	41.3	92	48.7	19	10.1	189
Tap water	16	40.0	19	47.5	5	12.5	40
Soot	2	8.0	8	32.0	15	60.0	25
Carica papaya (Paw paw)	21	35.6	33	55.9	5	8.5	59
Used Engine oil	11	16.4	34	50.7	22	32.8	67
Liquid and powdered Herbal medicines	5	13.9	23	63.9	8	22.2	36
Dioscoreaalata(Yam) Powder	56	34.8	72	44.7	33	20.5	161
Dioscoreaalata (Yam) Fried	97	56.4	66	38.4	9	5.2	172
Manihot esculenta(Cassava) flour	119	44.1	135	50.0	16	5.9	270
Manihot esculenta (Cassava) flakes (Garri)	138	48.6	122	43.0	24	8.5	284
Fried *Phaseolus vulgaris L*(Beans) cake (Akara)	23	56.1	14	34.1	4	9.8	41
Raw *Phaseolus vulgaris L*(Beans)	234	68.4	96	28.1	12	3.5	342
Roasted *Musa x paradisiaca*(Plantain)	11	33.3	21	63.6	1	3.0	33
Roasted meat	34	54.0	18	28.6	11	17.5	63
Honey	4	21.1	12	63.2	3	15.8	19
Oryza sativa(Rice)	46	41.4	63	56.8	2	1.8	111
Zea mays subsp. Mays(Maize)	67	61.5	35	32.1	7	6.4	109
Sorghum bicolor(Guinea corn)	22	56.4	15	38.5	2	5.1	39

NB: * = Presence of trace amounts could also be dangerous to health

DISCUSSION

Common sources of Pb contamination in the Nigerian environment which were found to be from air dusts, soil, water, raw and processed foods, fish, vegetables, cereals, fruits tubers and root crops including herbal concoctions. The heavy metal enters the body through *inhalation* in the lungs, *ingestion* in foods, drinks and water and *absorption* through broken skin, surface wounds and prolonged contacts. As much as 99% of the documented modes of spread of Pb in the environment is caused by anthropogenic activities. Soils at refuse and solid waste dump sites surrounding Nigerian cities usually look fertile due to decomposition of organic matter; this attracts attention of small scale and subsistence farming to the sites. The supply of greens and vegetables, roots and tubers to the city centers constitute supplies from such agricultural lands and reclamations. Adequate sensitization and health education on dangers of cultivation and practice of agricultural activities of refuse and solid wastes dump sites from cities need to be carried out to restrain utilization of such toxic soils. Similar sensitization should equally be carried out to discourage farming activities within 20 meters from major and busy highways as such soils have equally been found to be high in Pb and other heavy metal concentrations [15-17]. The high level of Pb in fishes could be attributed to the Pb washed from soils due to human activity into the bodies of water harboring these fishes. Even though majority of the fishes just as other food items had trace or levels non-toxic to humans, prolonged ingestion of such and a sustained accumulation may progress to toxicity [18-20]. This therefore calls for need for a regular and periodic assessment of the fishes and other raw foods prone to Pb and other heavy metal contamination so as to timely withdraw from human consumption and also arrest the source(s) of contamination. The manifestations of Pb poisoning and toxicity in a community may go on for a considerable time unnoticed especially in children where there are no adequate knowledgeable health personnel, equipment and infrastructure to establish such diagnoses. Considering the proneness of Nigerian communities to Pb contamination and poisoning, capacity building in health care delivery involving both personnel, hardware and software including adequate infrastructure to diagnose Pb and other heavy metal pollution and contamination should be pursued and put in place [21, 22].Detection of Pb in herbal and medicinal concoctions as was documented in some researches could be traced to the source of soil and its Pb content from where those plants were harvested to prepare medicines. It could as well be from Pb contaminated sources of water or other additives in the preparations. This brings out the need for proper physicochemical analysis of traditional herbal medicines to rule out contaminations with heavy metals such as Pb and also other toxic chemicals injurious to health [23, 24]. Similar scenarios may also contribute to high and trace Pb levels in grains and cereals such as maize, guinea corn, millet, rice, and beans. This has probably contributed to the rejection of such grains from Nigeria at international markets, hence banning their export into Britain and European Union among others while heavy herbicides, pesticides and post-harvest preservatives have also been implicated in high Pb loads in food stuffs. A regular sampling of food stuffs at Nigerian markets by relevant agencies of Agriculture, Environmental and Healthministries to assess and monitor the levels of Pb and other heavy metal contaminations will be a useful guide towards formulation and implementation of strict policies to curb it [25,26].

CONCLUSION

This study has shown that almost all the raw foods and semi-processed ones as well such as green vegetables, fruits, tubers, grains, cereals and medicinal herbal concoctions could have varying levels of Pb contamination from trace to amounts above the maximum threshold regarded safe for human consumption. Anthropogenic activities constitute the most important single cause of Pb dissemination in the environments and contamination of foods, and Pb can also enter the body through inhalation, broken and unbroken skin in addition to ingestion of food, drinks and water. And the general level of awareness on the depth of danger posed by this heavy metal from day-to-day human activities and interactions appears low.

RECOMMENDATIONS

There is need for more public awareness on the sources and also the dangers of Pb poisoning and on how to avoid it such as farming close to major busy highways, farming on solid wastes dump sites from cities, and regulated use of herbicides, pesticides and preservatives of food stuffs. Also, there should be a policy in place to monitor the Pb contents of all raw and semi-processed foods sold at Nigerian markets by relevant Agricultural and Health agencies on a regular basis. And strict measures should be put in place and compliance enforced to limit contamination of foods with Pb as well as control of automobile emissions to the environment. Furthermore, health facilities should be upgraded and properly equipped to monitor Pb contamination of the environments and foods, and food inspectors be properly empowered to rid the markets of foods and items heavily contaminated with Pb.

REFERENCES

1. Gottesfeld P. The Environmental AndHealth Impacts OfLead Battery RecyclingOccupational knowledge international. https://wedocs.unep.org/bitstream/handle/20.500.11822/13943/1_ECOWAS%20lead%20background%202016.pdf. Accessed 19th March 2022.
2. Bazié BSR, Compaoré MKA, Bandé M, et al. Evaluation of metallic trace elements contents in some major raw foodstuffs in Burkina Faso and health risk assessment. Sci Rep. 2022;12(1):4460. doi:10.1038/s41598-022-08470-z.
3. Shokri S, Abdoli N, Sadighara P, et al. Risk assessment of heavy metals consumption through onion on human health in Iran. Food Chem X. 2022;14:100283. doi:10.1016/j.fochx.2022.100283.
4. Ahmed S, Fatema-Tuj-Zohra, Mahdi MM, Nurnabi M, Alam MZ, Choudhury TR. Health risk assessment for heavy metal accumulation in leafy vegetables grown on tannery effluent contaminated soil. Toxicol Rep.2022;9:346-355.doi:10.1016/j.toxrep.2022.03.009.
5. Rezapour S, Siavash Moghaddam S, Nouri A, KhosraviAqdam K. Urbanization influences the distribution, enrichment, and ecological health risk of heavy metals in croplands. Sci Rep. 2022;12(1):3868. Published 2022 Mar 9. doi:10.1038/s41598-022-07789-x.
6. Britanica. Lead (Pb) element. https://britanica.com/science/lead-chemical-element.
7. Pachana K, Wattanakornsiri A, Nanuam J. Heavy metal transport and fate in the environment compartments. NU Science Journal 2010, 7(1): 1-11
8. Matthews D. Nearly half the world's kids are exposed to dangerous levels of lead. Vox.https://www.vox.com/future-perfect/22834666/lead-exposure-poisoningdeveloping-countries. Accessed 19th March 2022.
9. UNICEF. A third of the world's children poisoned by lead, new groundbreaking analysis says. UNICEF and Pure Earth call for urgent action to abolish dangerous practices including the informal recycling of lead acid batteries. UNICEF.https://www.unicef.org/press-releases/third-worlds-children-poisoned-lead-new-groundbreaking-analysis-says. Accessed 19th March 2022.
10. Knollmann-Ritschel BEC, Markowitz M. Lead Poisoning. AcadPathol. 2017;4:2374289517700160. doi: 10.1177/2374289517700160.
11. Emoyan OO, Ogban FE, Akarah E. Evaluation of heavy metals loading of River Ijana in Ekpan–Warri, Nigeria. Journal of Applied Sciences and Environmental Management. 2006;10(2):121-127.
12. Essoka PA, Ubogu AE, Uzu L. An overview of oil pollution and heavy metal concentration in Warri area, Nigeria. Management of Environmental Quality: An International Journal. 2006;17(2):209-215.
13. Uwah EI, Ndahi NP, Abdulrahman FI, Ogugbuaja VO. Heavy metal levels in spinach (Amaranthus caudatus) and lettuce (Lactuca sativa) grown in Maiduguri, Nigeria. Journal of Environmental Chemistry and Ecotoxicology. 2011;3(10):264-271.
14. Lanre-Iyanda TY, Adekunle IM. Assessment of heavy metals and their estimated daily intakes from two commonly consumed foods (Kulikuli and Robo) found in Nigeria. African Journal of

Food, Agriculture, Nutrition and Development. 2012;12(3):6156-169.
15. Olayinka OO, Akande OO, Bamgbose K, Adetunji MT. Physicochemical characteristics and heavy metal levels in soil samples obtained from selected anthropogenic sites in Abeokuta, Nigeria. Journal of Applied Sciences and Environmental Management. 2017 Nov 29;21(5):883-891.
16. Azeez JO, Hassan OA, Egunjobi PO. Soil contamination at dumpsites: implication of soil heavy metals distribution in municipal solid waste disposal system: a case study of Abeokuta, Southwestern Nigeria. Soil and Sediment Contamination. 2011;20(4):370-386.
17. Abdullahi N, Igwe EC, Dandago MA. Heavy metals contamination sources in Kano, Nigeria and their concentrations along Jakara River and its agricultural produce: A review. Moroccan Journal of Agricultural Sciences. 2021;2(2).
18. Bala M, Shehu RA, Lawal M. Determination of the level of some heavy metals in water collected from two pollution-Prone irrigation areas around Kano Metropolis. BayeroJournal of Pure and Applied Sciences. 2008:36-38.
19. Ibrahim S, Sa'id H. Heavy metals load in tilapia species: a case study of Jakara River and Kusalla dam, Kano state, Nigeria. Bayero Journal of Pure and Applied Sciences. 2010;3(1).
20. Mohammed AI, Kolo B, Geidam YA. Heavy metals in selected tissues of adult chicken layers (Gallus spp). ARPN Journal of Science and Technology. 2013;3(5):518-22.
21. Milam C, One MB, Dogara RK, Yila EY. Assessment of heavy metals (As, Cd, Cr, Cu, Ni, Pb and Zn) in blood samples of sheep and rabbits from Jimeta-yola, Adamawa State, Nigeria. Int J Adv Pharm Biol Chem. 2017;6(3):160-166.
22. Maigari AU, Sulaiman MB, Maigari IA. Heavy metals contamination in two popular local drinks consumed in northern Nigeria. Int J Inno Res Sci Engr Technol. 2016;3:441-446.
23. Adekola FA, Eletta OA. A study of heavy metal pollution of Asa River, Ilorin. Nigeria; trace metal monitoring and geochemistry. Environmental Monitoring and Assessment. 2007 Feb;125(1):157-63.
24. Orosun MM, Adewuyi AD, Salawu NB, Isinkaye MO, Orosun OR, Oniku AS. Monte Carlo approach to risks assessment of heavy metals at automobile spare part and recycling market in Ilorin, Nigeria. Scientific Reports. 2020 Dec 16;10(1):1-6.
25. Akawu B, Junaidu AU, Salihu MD, Agaie BM. Determination of some heavy metals' residues in slaughtered cattle at Sokoto and Gusau modern abattoirs, Nigeria. Journal of Veterinary Medicine and Animal Health. 2020 May 31;12(2):48-54.
26. Bala A, Junaidu AU, Salihu MD, Agaie BM, Abdulahi M. Survey of Some Heavy Metals in Tissues and Organs of Goats Slaughtered at Sokoto and Gusau Modern Abattoirs.EAS J Vet Med Sci. 2021;3(3):29-33.

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