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Effect Of Air Pollution On Concentrations Of Lead, Cadmium And Chromium In Ready To Eat Foods In Some Major Towns Of South-Western Nigeria

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Abstract
The concentrations of heavy metals in Ready-to-Eat foods offered for sale in some major towns of South-West Nigeria were assessed. Ready-to-Eat food samples were collected in triplicate from various vendors' locations with varying degree of air pollution measured by traffic flow. The samples were dried, milled, digested to ash and analysed for cadmium, lead, and chromium using Graphite-furnace Atomic Absorption Spectrophotometer. Results showed that Lead concentration in Ready-to-Eat food ranged between 3.8 and 23.6mg/100g of sample. Fried ready to eat foods were also found to contain higher Lead (6.9-23.6mg/100g of sample) and Cadmium concentrations (2.7-28.3/100g of sample) than non-fried ones. Deposition of Cadmium was noticeable in samples obtained from industrial locations. Chromium concentrations in all the locations (2.1-38.5mg/100g of sample) tend to approach acute toxicity values. The findings point to deposition of heavy metals on ready to eat foods at levels that could be hazardous on a long-term basis.
Keywords: Air Pollution, Concentration, Lead, Cadmium, Chromium, South-West Nigeria.

1. Introduction

Food and Agriculture association (FAO) defines street food as ready-to-eat foods and beverages prepared and/or sold by vendors and hawkers. Ready to eat foods are prevalent in South-West Nigeria and may account for 70% of the meals of artisans, daily-paid workers and students because of their locations and cheaper cost. Such ready to eat foods commonly found in South-Western Nigeria includes fried plantain, beans balls (akara), fried yam, rice and beans with stew among others. The foods are often prepared by the vendors where environmental pollution is rampant.

Contamination of foods may originate from finely dispersed particles in the atmosphere and from other sources, such as the preparation and pre/post processing, wearing away of metallic cooking earthenware vessels, etc., as previously reported (Golimoski et al., 1990; Wikipedia, 2007). Among the pollutants, toxic trace metals play important roles as they are biologically non-degradable and tend to accumulate in various parts of living organisms especially the liver, kidney, etc. (Lynon *et al.*, 1991). Human exposure to heavy metals may induce a variety of ill-health effects. Lead (Pb), Cadmium (Cd) and Chromium (Cr) are retained by the body and released over many years (Ryde et al., 1990). Although element such as Cr is essential for growth, Cd and Pb are non-essential elements since they appear to have no apparent metabolic function (Underwood, 1971).

Cadmium is known to be toxic even in relatively low concentration (Mislin and Ravera, 1986). The National Health and Medical Research Council of Nigeria (NHMRC) recommended only a maximum level of 2microgram per kg body weight. Cadmium has been reported to cause acute and chronic respiratory diseases and renal dysfunction, while human pathological lesions of Cadmium poisoning include emphysema pneumonitis, renal cortical necrosis and osteomalacia (Sansi and Pond, 1974). Cadmium and several cadmium containing compounds are known carcinogens and can induce many types of cancer (National Toxicology Program, 2007).

Lead is one of the non-essential trace elements that are toxic to human being. World Health Organization (WHO) recommended an exposure limit of 40 microgram per liter for men and 30 microgram per liter for postmenopausal women. A blood level of 80 microgram per liter of Pb has been associated with serious complications (Ogunsola et al, 1994). Environmental Lead may be derived from water and exhaust fumes of automobiles. Tetraethyl Lead is combusted and converted to lead oxide and bromide which are carried by the exhaust fumes in the atmosphere (Nriagu, 1990; Wilkipedia, 2007). Much of the body Lead is deposited as metabolically inactive element in bone, soft tissues and organs (Ogunsola et al, 1994).

Chromium is an essential element whose recommended daily food intake is 50-100 microgram per day (Davidson et al, 1975). Chromium toxicity is shown in the urine, hair, lung, reticuloendothelia system, skin and gastrointestinal effect, kidney and liver damage. Lung cancers have been implicated in chromate rich environment (Davidson et al, 1975).

An estimation of the concentration of trace elements of toxicological importance in ready to eat foods would provide information as to the effect of environmental pollution in ready to eat foods and their probable contribution to hyper-toxicity in human health. In this study, we have assessed three toxicologically important elements (Cd, Cr, and Pb) in some major towns in South-Western Nigeria. Thus, the main objective of this study is to determine the concentrations of the trace elements in common ready-to-eat foods and their compliance with International Safety Standards in foods.

2. Materials and methods

2.1 Sample collection and Preparation

Ready-to-Eat food samples (fried plantain, bean balls, fried yams, rice and beans with stew) were collected from road side restaurants and cafeteria in various locations in the South-Western part of Nigeria (comprising of Lagos, Oyo, Ogun and Osun States) between August and September, 1999. Air pollution due to the level of traffic and industrial effluents in these locations were also determined. Sampling locations were made after a survey of the traffic, industrial and general pollution. The locations were grouped as follows: Group A (consisting of A_1 and A_2 points of sample collection): These are locations of low air pollution as represented by vehicular movement of less than 2000 per hour. Group B (consisting of B_1, B_2 and B_3 points of sample collection), these are locations with moderate air pollutions with vehicular movement greater than 2000 per hour but less than 5000 per hour. Group C (consisting of C_1, C_2 and C_3 points of sample collection), these are locations with high air pollution with vehicular movement greater than 5000 per hour. Group D (Control): Locations with no perceived air pollution and industrial effluent with vehicular movement less than 1000 per hour.

Triplicate samples were collected at each location around 5.00pm everyday for 7days and blended together to give a weekly average. Plastic containers and food flasks with lids were used to convey the samples to the laboratory. The samples were dried at 80˚C to constant weight, milled and stored at 20˚C and awaiting analyses.

2.2 Chemical Analysis

0.2g triplicate samples from each location were digested for 2hour at 100˚C with 5ml digesting solution (which consists of 500ml perchloric acid ($HC1O_4$) in 1litre of HNO_3. For completion of the digestion, 3ml of 6M HCI was added and digestion continued for another 90mins in a fume cupboard. After digestion the samples (ash) were cooled, and diluted up to 75ml mark with distilled water and analyzed for Cr, Pb and Cd, using Graphite Furnace Atomic Absorption Spectrophotometer, interphase with a Gateway 2000PC system using appropriate software (Chemtech Analytical Model). Sample blanks were also run.

2.2 Determination of Precision and Accuracy

The analytical quality control included analysis of standards and triplicate analysis of samples and blanks. The accuracy of the analytical technique was evaluated by analyzing a certified standard reference material SRM 1634B, trace elements in water (National Institute of Standards, Technology, Gaithersburg, MA, USA)

3. Results and discussion

Lead concentration in Ready-to-Eat foods in some major towns of South-Western Nigeria were found to vary with sampling location and generally seems to increase with increasing air pollution represented by vehicular movement. This result is probably due to the lead content in the environment, which varied with the volume of fumes obtained from automatic exhaust smoke as the source of lead discharge into the atmosphere in form of Tetraethyl Lead (TEL) and Tetramethyl Lead (TML) used as antiknock in gasoline vehicles as earlier reported (Nriagu, 1990). In addition to the automobile exhaust smoke, industrial effluents also aggregate as particles, and lead concentrations in the atmosphere builds up and settle on exposed ready-to-consume road-side foods. Fried plantain, bean balls, and fried yam showed higher concentration of lead in high vehicular density area probably because of their oil contents which absorb lead particles more strongly than rice/beans with stew. This result suggests that consumers of Ready-To-Eat foods particularly in high traffic areas may be exposed to risk of high blood levels derivable from such ingested foods. This agrees with earlier reports of Nrigau (1990); Kapaki et al (1998) that increased atmospheric pollution of lead is capable of producing increased storage of lead in the body as reflected in the concomitant blood lead level. However, there is need for confirmation through biochemical examination of the organs, blood and urine.

Cadmium concentrations in Ready-to-Eat foods showed no definite trend in relation to increasing vehicular traffic density. Although the distribution showed no observable pattern, cadmium concentrations in oily road-side foods (fried plantain, bean balls, and fried yam) are generally higher than those less rich in oil content. This observation further supports the suggestion of possible greater absorption affinity for cadmium in oily than non-oily road-side foods as indicated for lead. Scalp hair has been shown to contain increased level of cadmium from environmental sources (Wilhelm et al, 1990) and iron and mild steel containers' contamination contain traces of cadmium (Asubiojo et al, 1997). Also the Itai-Itai diseases in hyper toxicity of cadmium showed its intimate affinity for fatty foods as high cadmium concentration produced Vitamin D deficiency (Portwiski and Coleman, 1980). The sampling locations C_1, C_2, and B_2 are industrialized locations. C_2 locations have a plastic (polyvinyl chloride) factory while C1 location is proliferated with batteries and photovoltaic cells. Cadmium therefore, is an important element in all these industrial locations and this probably accounts for the increase in environmental deposition of cadmium on Ready-to-Eat foods in these locations. The variance is however minimal and may not likely precipitate possible health hazards on short-term basis.

Chromium is an essential nutrient in that it functions as an integral component of glucose metabolism whose recommended daily intake is in the range 50-100 microgram per day (Davidson et al, 1975). There is a rapid increase in chromium traffic density for fried plantain (1.80-39.50mg/100g of food sample). Bean balls had a similar trend of result to fried plantain with relatively lower content of chromium in the samples from location A_1 and B_1 when compared with the controlled unexposed sample. Although, beans are normally used as raw material for the preparation of bean balls, 'beans with stew' in this study shows higher chromium content of the added stew. The same reason explains the high chromium concentration in 'rice with stew' (30.00-39.00mg/100g of food sample) which is almost independent of traffic density. Generally, chromium contents of all the Ready-To-Eat food samples are relatively high, increasing with traffic density. The high chromium values may result from the combustible automobile fuel, industrial discharge effluents and chromium leachate from the cooking utensils and metallic materials of construction. Oladipo (1988) reported a chromium concentration of 12.5-27.0mg/dm^3 for Nigerian fuel and Chromium hypertoxicity has been implicated in lung cancer (Asubiojo et al, 1997).

Statistical analysis shows that the effect of different food types as well as the vehicular traffic densities (Table 1) on heavy metal contents is significant ($P<0.05$), the interactive effect between food types and traffic density is also significant (($P<0.05$) on heavy metal contents.

Ready-to-Eat foods are economical and accessible to both high and low income workers in South-Western Nigeria mostly the urban dwellers but the toxicological implication of such foods on long-term basis may outstrip the accrued economic benefits. Air pollution may lead to cumulative build-up of Cd, Cr and Pb in Ready-to-Eat foods, such cumulative build-up may cause them to be retained in the body and their hyper toxicity effects released over a long time may precipitate nutritional and metabolic disorders of great importance (Ryde et al, 1991). The fact that these foods are exposed during preparation, processing and sales make them environmentally hazardous to human health.

4. Conclusion

It is apparent from this study that Ready-to-Eat foods exposed to air pollution contains high concentration of heavy metals such as Lead, Cadmium and Chromium, which are hazardous to health on long-term basis. Hence, it is recommended that Ready-to-Eat food preparation should be encouraged in Southwest Nigeria and every industry or factory should be encouraged to establish a standardized restaurant with safety checks in place. Besides this, these food vendors/hawkers should adopt pollution safety methods such as covering the foods with polythene films, aluminum foils, and use of show-glasses, etc.

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Table 1: **Statistical analysis of variance for Heavy Metal Contents in Ready- to-Eat foods and at different levels of traffic densities**

Sources of variation	Df	SS	MS	F	95%
Food types (F)	4	1190	297.5	198.3	S*
Traffic density (T)	2	252	126.0	84.0	S*
FxT Interaction	8	906	113.25	75.5	S*
Error	30	46	1.53		
Total	44	3171			

S* = significant difference