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Concentration of Heavy Metals and Health Implication of Rice Husk Dust Inhalation

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Abstract: Concentrations of selected heavy metals and essential elements in Abakaliki rice and the rice husks samples and the effect of rice husks dust inhalation on the lung function of albino rats were assessed. Selected heavy metals and some essential elements were analyzed using Atomic Absorption Spectrophotometer. 100 albino rats were grouped into four with each group containing 25 rats. Group B, C and D were exposed to rice husk dust for a period of one week, two weeks and four weeks respectively. Group A served as control. The effects of rice husks dust inhalation on the lungs were assayed using standard histological procedure. Cholesterol, triglyceride and HDL-cholesterol analyses were performed on a Hitachi 704 Analyzer supplied by Roche Diagnostics. Result revealed that Hg, Cd and As have 0.00mg/g, 0.00mg/g, 0.00mg/g values for both samples respectively. Mg, K, Na, Zn, Cu, Se, Fe, Cr, Co and Ni contain 1.596mg/g, 0.304mg/g, 0.015mg/g, 0.745mg/g, 0.927mg/g, 0.00mg/g, 0.98mg/g, 0.00mg/g, 0.017mg/g and 0.00mg/g respectively for the rice sample and 1.71 Mg/g, 0.672 mg/g, 0.131 mg/g, 0.821 mg/g, 1.009 mg/g, 0.00 mg/g, 0.06 mg/g, 0.00 mg/g, 0.821 mg/g and 0.010 mg/g respectively for the husks samples. There were no significant changes in weight of the exposed rats. Total cholesterol levels varied insignificantly while the triglyceride increased insignificantly. HDL increased significantly in exposed groups. LDL also increased but not statistically significant. Photo micrographic result showed that group A normal lungs, exposed groups have edema of the alveoli sac, hemorrhage, lymphoid enlargement and focal areas of necrosis.

Key words: Rice Husk Dust · Heavy Metals · Toxicity · Inhalation and Lung Functions

INTRODUCTION

Rice is the seed of the monocot plant of the genus *Oryza* and of the grass family Poaceae (formally *Graminae*) which includes twenty wild species and two cultivated ones, *Oryza sativa* (Asian rice) and *Oryza glaberrima* (African rice). *Oryza sativa* is the most commonly grown species throughout the world today. Rice has been considered the best staple food among all cereals and is the staple food for over 3 billion people, constituting over half of the world's population [1]. Rice is grown in all ecological and dietary zones of Nigeria, with different processing adaptation trait for ecology [2]. Minerals like calcium, magnesium, phosphorus are present along with some traces of iron, copper, zinc and manganese [3]. A comparative nutritional studies on major staple foods in their raw form shows that rice contains Calcium (Ca), magnesium (Mg), potassium (K), phosphorus (P), sodium (Na), zinc (Zn), copper (Cu), selenium (Se), Iron (Fe) in various concentration [3].

With civilization, industrialization is increasing day by day. As a result, air pollution is increasing leading to various respiratory diseases. This is because organic dusts generated from such industries have high prevalence of lung diseases like chronic obstructive lung disease [4].

Many studies have shown that rice husks dust exposure could cause respiratory symptoms, associated with lung functions [5]. Rice husks dust is an allergen and is widely known to cause sensitization, allergic rhinitis and occupational asthma among millers and bakers [6]. Rice husks dust can be absorbed through the skin or swallowed, but most frequent route of exposure is through inhalation thus leading to various obstructive lung diseases [7].

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Research has also shown that albino rats exposed to varying degrees of rice husks dust may show any of these pathological signs via weight loss, lungs and thymus dysfunction, pathological modification of the respiratory tracts, increased respiratory rate, increased leucocytes count, granulomatous changes, focal intestinal fibrosis, necrosis, slight atrophy of the nasal mucous membrane and eventually death [8]. Toxicity studies of rice fiber showed a safety concern [9]. A test with and without metabolic activation as well as *in vivo* marrow micronucleus test in kuming mice showed that rice fibers lacks mutagenicity and genotoxicity. In view of the nutritional benefits of rice and the health threats of rice husk dust inhalation, this study was carried out to determine the concentrations of selected toxic (heavy) metals, some essential elements in Abakaliki rice and the rice husks samples respectively and to assess the resultant effects of the rice husks dust inhalation on the cardiovascular systems and lung function of albino rats exposed to rice husk dust.

MATERIALS AND METHODS

Sample Collection and Preparation: The rice and husks samples were collected randomly from different locations within the Abakaliki rice mill area, located at Onuebonyi in Abakaliki, Ebonyi State, Nigeria. These samples were sundried, thoroughly homogenized in a mortar using pestle. The homogenate were further ground to powder using a grinder and then put in a clean dry beaker for the analysis.

Determination of the Concentration [of Selected Toxic (Heavy) Metals and Some Essential Nutrients in Abakaliki Rice and Rice Husks

This was done using the method of AOAC [8]. 2.0g of each ash samples were at 520°C for 6h. The ash was dissolved in 25ml of 0.1M HCl, filtered into a 100ml volumetric flask and made up to the mark with distilled water. magnesium (Mg), potassium (K), sodium (Na), zinc (Zn), copper (Cu), selenium (Se), iron (Fe), chromium (Cr), cobalt (Co), nickel (Ni), mercury (Hg), cadmium (Cd), arsenic (As) and iodine (I) concentrations were analyzed using Atomic Absorption Spectrophotometer (AAS) (Perkin- Elmer model 372).

Experimental Animals: One hundred albino rats were obtained from the school of Veterinary Medicine, Nnamdi Azikiwe University Awka, Anambra State, Nigeria.

ll the animals were acclimatized for 7days before the commencement of the experiment. Food and deionized water were given to the rats *add libitium*. After the first week the animals were grouped into four; A, B, C and D groups. Each group contains 25rats, group A served as the control and was never exposed to the rice husks dust. Whereas, groups B, C, D and E were exposed for 7, 14 and 28days respectively from morning till evening before they are returned to the animal house located around the rice mill. Physical examinations such as posture activity, fur texture and weight were checked throughout the periods of exposure.

Histopathological Examination of the Rat's Lungs: At the end of the exposure period, the rats were anesthetized with chloroform and blood obtained by cardiac puncture and the serum were used for biochemical analysis. The animals were then sacrificed and the lungs were gently and carefully removed for histological studies. Histopathological examination of the lungs was carried out using standard histological procedure. The photomicrographs of the lungs collected from each groups were taken.

Determination of the Levels of LDL-C, HDL-C and Triglycerides in the Serum: Cholesterol, triglyceride and HDL-cholesterol analyses are performed on a Hitachi 704 Analyzer and this was supplied by Roche Diagnostics, Indianapolis. Cholesterol was measured enzymatically using the Cholesterol High Performance reagent (CAT.NO. 704036), Roche Diagnostics). Triglycerides were analyzed enzymatically concurrently with cholesterol by the use of reagents from the same manufacturer (Triglycerides/GPO, CAT.NO. 1488872). Triglyceride blanks were measured in CDC surveillance materials using the same reagent, however, without lipase. Direct HDL-cholesterol reagent was obtained from Roche Diagnostics (Direct HDL, CAT. NO. 1661442) and analyzed at same timed with cholesterol and triglycerides. triglycerides. LDL was obtained from [LDL-chol] = [total chol] - [HDL-chol]-[TG]/5 where [TG]/5 is an estimate of VLDL-cholesterol and all values are expressed in mg/dL.

RESULTS AND DISCUSSION

From the result in Table 3.1, concentrations of Hg, As, Cd, were 0.00mg/g, 0.00mg/g, 0.00mg/g respectively for both Abakaliki rice and the rice husks samples. These values were far below the permissible limit of heavy metals in food by the Joint FAO/WHO Expert Committee on Food Additives [10]. The value of 0.00mg/g analyzed for arsenic in both samples is in strong agreement with the assertionof [11] which says that ‘‘there is no safe limit of arsenic in foods’’ due to its extreme toxicity.

Table 1: Concentration of some heavy (toxic) metal and some essential elements in Abakaliki rice and the husks samples

Elements Identified	Rice Sample (Mg/g)	Husks Sample (Mg/g)
Mercury (Hg)	0.00	0.00
Cadmium (Cd)	0.00	0.00
Arsenic (As)	0.00	0.00
Iron (Fe)	0.98	0.06
Selenium (Se)	0.00	0.00
Chromium (Cr)	0.00	0.00
Cobalt (Co)	0.017	0.821
Zinc(Zn)	0.745	0.821
Manganese (Mn)	0.064	0.098
Magnesium (Mg)	1.596	1.715
Potassium (k)	0.304	0.672
Sodium (Na)	0.015	0.131
Copper(Cu)	0.927	1.009
Nickel (Ni)	0.00	0.010

Table 2: Effect of duration of rice husk dust inhalation on the body weight and plasma lipids level of rats exposed to rice husk dust

	Duration of exposure			
Biochemical parameters	Non-exposed A	7 days B	14 days C	28 days D
Weight (g)	198.9±41	168.1±48.1	198.9±8.4	201.1±13.0
Total cholesterol (mg/dl)	120.0±6.8	121.3±7.8	123.5±11.6	121.6±11.2
Triglyceride (mg/dl)	33.7±3.9	28.4±5.3[a]	28.1±9.0[a]	35.3±5.3[a]
HDL-C (mg/dl)	32.5±5.2	39.3±6.5[a]	37.3±6.7[a]	34.0±7.7[a]
LDL-C (mg/dl)	54.0±7.0	56.4±11.7	56.7±5.6	56.1±6.4

Values bearing the superscript a are significantly different from the Non-exposed group

According to the research by Maret and Moulis [12], the biochemical mechanisms of cadmium toxicity is that it acts as catalyst in the formation of reactive oxygen species and lipid peroxidation, in addition to its depletion action on antioxidants, glutathione and protein-bound sulfhydryl groups. Moreso, it promotes the production of inflammatory cytokines. Mercury poisoning can result in several diseases, including acrodynia (pink disease), Hunter-Russell syndrome and Minamatadisease [13]. Symptoms typically include sensory impairment (vision, hearing, speech), disturbed sensation and a lack of coordination. The findings from this study thus, suggest that Abakalikirice and the husks cannot be associated with the above health hazards since cadmium, arsenic and mercury occurred at zero concentration in both samples.Magnesium and potassium concentrations were 1.596mg/g and 0.304mg/g for the rice and 1.715mg/g and 0.672mg/g for the husks samples respectively. These values for the rice samples were slightly above the values obtained by Oko and Ugwu [14] on their comparative study of the mineral compositions of five varieties of rice grown in Abakalilki, Ebonyi State, Nigeria. This slight difference might be as a result of parboiling and the amounts of soil nutrients all of which affect the mineral contents of rice. Sukhjinder *et al*. [15] reported that as greater amount of rice bran are removed from grain during milling and polishing, more vitamins and minerals are lost.

Zinc was observed at the concentration of 0.745mg/g and 0.821mg/g for the rice and the rice husks respectively. The maximum permissible limit of 3.00mg/g for zinc was not exceeded by any of the values. Zinc at the limit as analyzed in this study does not pose any health and environmental hazards on the consumers or the local inhabitants. However, since the concentration of zinc is bellow the W.H.O permissible limit in grains; copper and iron absorption cannot be suppressed in the system of the consumers of Abakaliki rice due to the low concentration of zinc.

Selenium and chromium were both obtained at 0.00mg/g concentrations in the rice and the husks samples respectively. Copper was contained at the concentration of 0.927mg/g and 1.009mg/g for the rice and the rice husks samples respectively. The 0.927mg/g concentration obtained from the rice sample is lower than the permissible limit by Standard Organization of Nigeria. The concentration of 1.009mg/g obtained from the rice husks is slightly above the 1.00mg/g WHO permissible limit.

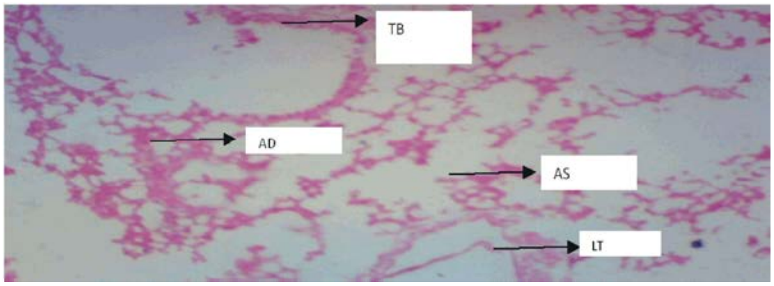

Fig. 1: The photomicrograph of lungs of control shows normal alveoli sac (AS), normal alveoli duct (AD), terminal bronchiole (TB) with visible alveoli lymphoid tissue (LT). Method of staining (Hematoxylin and Eosin x 10)

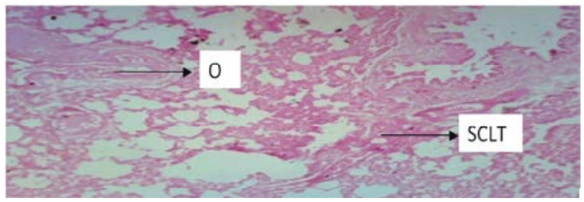

Fig. 2: The photomicrograph of exposed lungs of albino rat to rice husk dust for 14 days shows swelling (odema) of the alveoli sack, coalition of the alveoli sack and stratified ciliated lymphoid tissue. Method of staining (Hematoxylin and Eosin x10)

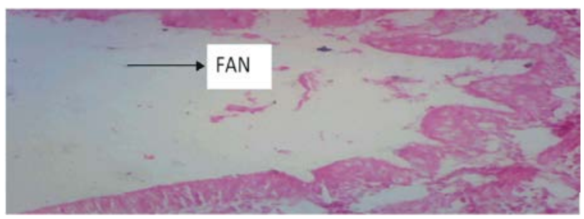

Fig. 3: The photomicrograph of lungs of albino rats exposed to rice husk dust for 28 days showing focal area of necrosis (FAN). (Hematoxylin and Eosin x 10)

The higher value of copper in the husks sample also suggests that copper could be a natural resource in Abakaliki parts where the rice is grown.

The results shown in Figures 1, 2 and 3 showed that rice husks dust has histopathological changes on the lungs function of albino rats. The result of the photomicrographs showed that rats of group A have normal lungs, group B have edema of the alveoli sac, group C have hemorrhage and lymphoid enlargement. Group D showed focal areas of necrosis [16-18]. This findings is consistent with the findings of Fan *et al*. [18] who reported that rice mill and flour mill workers working in these industries suffer from various types of air way diseases like Pneumoconiosis, Farmer's Lung, Chronic bronchitis, pulmonary fibrosis and Asthma. Bulat *et al*. [5] also reported in their studies respectively that flour dust and rice husk dust could cause chronic bronchial irritation which is responsible for the impairment of lungs functions. According to Artiss and Zak [16], in their study reported that rice husk dust could also result to damage of bronchial passage, with resultant damage to the elastic component of alveolar walls; this finding is consistent and comparable with our findings which show histopathological changes on the lungs of the albino rats.

Olencheck [19] in their study on airborne endotoxin in a rice production community in the people's republic of China showed that rice husk dusts contain some air borne endotoxins which cause inflammatory reactions in broncho-pulmonary system. This is comparable to our findings in this research showing inflammation of the alveoli sac as evidenced by the photomicrograph of group B.

The changes in the body weight of the exposed rats were not statistically significant when compared to the control. The level of total cholesterol in the serum of the exposed increased insignificantly as compared with the control while triglyceride decreased in the exposed group at the 7days and 14days group but increased in the 28 days group. However both the decrease and the increase were not statistically significant. Also HDL increased significantly in the exposed group and LDL also increased but not statistically significant. High levels of serum triglycerides help mark conditions that are associated with increased risk for coronary heart disease and peripheral atherosclerosis. High triglycerides are associated with increased risk for CAD in patients with other risk factors, such as low HDL-cholesterol, some patient groups with elevated apolipoprotein B concentrations and patients with forms of LDL that may be particularly atherogenic. LDL carries most of the circulating cholesterol in man and when elevated contributes to the development of coronary atherosclerosis Artiss and Zak [16]. Therefore, artherogenicity develops when LDL cholesterol, triacylglycerol and total cholesterol increases relative to plasma HDL cholesterol. Increase in the level of HDL cholesterol therefore improves the transportation of cholesterol from plasma to liver for biotransformation and excretion thereby preventing atheroma. Therefore, our result shows that atheroma is unlikely to be associated with rice husk dust inhalation. However, the lungs were negatively affected by the rice husk dust inhalation as revealed by our histological studies.

CONCLUSION

The high concentration of Magnesium, potassium, sodium and iron in the rice sample obtained from our study suggest that Abakaliki rice can serve as a good dietary source of these essential minerals to the consumers.The concentrations of the various trace elements which were below the WHO/FAO permissible limits, however, speak well of the safety and other important biochemical roles of the rice in the system of the consumers since these trace elements perform important functions in the body at low concentration. Whereas, zero concentrations of heavy metals (mercury, cadmium and arsenic) asserts that Abakaliki rice and its husks cannot be associated with any health hazards traceable to these toxic metals.

We, hereby assert that the various histopathological changes observed in the lungs of the albino rats were not caused by the toxic heavy metals analyzed but might be due to prolonged inhalation/over exposure to the husks dust. We, further advice that the workers and the local inhabitants of the rice mill area should protect themselves properly from over exposure to the husks dust to avoid health hazards associated with over inhalation of the husks dust as reported in this study.

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