TOXIC LEVELS OF ARSENIC AND PHOSPHOROUS FOUND IN SOME COMMONLY CONSUMED FRUITS SOLD IN THE MARKET IN BENIN CITY

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ABSTRACT

Background: Fruits for commercial purposes are usually harvested unripe and transported to their site of retail in order to avoid spoilage. In most developing countries such as Nigeria, this practice has led to the use of several chemicals to ripen fruits without regard to its potential toxic effect on the health of the consumers.

Purpose: The present study was carried out to determine the levels of arsenic and phosphorus in fruits artificially ripened with these compounds in Benin City, Edo state Nigeria.

Method: Fruits were purchased from four randomly selected markets in the city namely; Uselu market, New Benin market, Oba market and Oregbeni markets. 2 sets of various fruits (mango, banana, plantain, and avocado pear) were used. A set of ripe fruits were purchased from the markets, while another set of unripe fruits were ripened artificially using calcium carbide. Levels of arsenic and phosphorus were measured in the peels and flesh of the fruits using atomic absorption spectrophotometer.

Results: The result of the analysis showed high levels of arsenic (0.021-0.097 mg/kg) and phosphorus (30.5 - 690.0 mg/kg) in the fruits marketed in Benin city. For mango, level of arsenic and phosphorus was greater on the peel (0.064 and 65.5 mg/kg respectively compared) on the flesh (0.021 and 36.0 mg/kg respectively). Same was observed in plantain with higher arsenic and phosphorus levels on the peel than on the flesh (0.037 and 0.023 mg/kg respectively). This was not so with the banana, where the level of arsenic and phosphorus on the peel (0.053 and 254.0 mg/kg respectively) was lower than that on the flesh (0.066 and 289.0 mg/kg respectively). Also, arsenic and phosphorus levels were found to be highest on the flesh of the avocado pear (0.097 and 302.0 mg/kg).

Conclusion: Many fruits sold in Benin City contain high levels of arsenic and phosphorus. There is therefore need for strong legislative frame work, public enlightenment and education to curtail the practice of using chemicals to ripen fruits, considering the harmful effects of these chemicals.

Keywords: Calcium carbide, ethylene, artificially ripened fruits, Arsenic, Phosphorus.

INTRODUCTION

Ripening is a chemical process in fruits that makes them more palatable, sweeter, less green, and softer. It is associated with changes in the composition of the carbohydrate present in the fruit from starch to sugar [1]. Chemicals commonly employed as ripening agents include: ethylene, ethephon/ethrel; (2-chloro ethyl phosphoric acid), Ethylene glycols and calcium carbide. The most commonly used chemical for artificial ripening is calcium carbide.

Calcium carbide once dissolved in water, produces acetylene which acts as an artificial ripening agent. Calcium carbide is indiscriminately used in preference to other recommended

practices of inducing ripening because it is readily available and also very much affordable. However, use of calcium carbide poses lots of potential health hazards to human health. The acute (short-term) health effects may include the irritation of the skin causing rashes, redness, and burning feeling on contact. Irritation of the mouth, nose and throat, irritation of the lungs causing cough and or/ shortness of breath. Higher exposures may cause a build-up of fluid in the lungs (pulmonary edema), a medical emergency, with severe shortness of breath. Other effects on acute exposure include headache, vertigo, dizziness, delirium, seizures and even coma. Immediately after consumption, there may be abdominal pain, vomiting and diarrhea. Prolonged and repeated exposure may cause dry, cracked skin; eyes lids irritation [2].

Consumption of carbide ripened fruits is extremely hazardous for health, mainly for the nervous system. This is because acetylene, generated from carbide reduces oxygen supply to the brain. In the long term, it may produce mood disturbance and loss of memory. Industrial grade Carbide is also known to contain a lot of other chemical impurities such as Arsenic and Phosphorous. Long term arsenic toxicity leads to multisystem disease and the most serious consequence is malignancy. Arsenic is a known carcinogen. It also affects the skin, respiratory, endocrine and cardiovascular systems.

Phosphate toxicity due to excessive retention of phosphate in the body can cause a wide range of cellular and tissue injuries.

This research work seeks to examine the levels of arsenic and phosphorus, which are impurities present in industrial grade calcium carbide, in fruits collected from the markets in Benin City, Edo State, Nigeria and also the levels of these elements in fruits artificially ripened in the laboratory. Considering the health hazards of these elements and the poor legislative framework in Nigeria in respect of the use of chemicals and pesticides in agricultural practices including post harvest preservation of food and fruits, there is the need to examine the extent to which these chemicals are used in our society.

MATERIALS AND METHOD

Materials

All reagents were of analytical grades. They were purchased from local suppliers and were used without further purification.

Sampling and ripening of the fruits:

Fruits were purchased from four randomly selected markets in the city namely; Uselu market, New Benin market, Oba market and Oregbeni markets. 2 sets of various fruits (mango, banana, plantain, and avocado pear) were used. A set of ripe fruits were purchased from the markets and the levels of arsenic and phosphorus in these ripe fruits were then determined, while another set of unripe fruits were ripened artificially in our laboratory using calcium carbide. The fruits were ripen by wrapping them with cellophane before placing them in drums containing calcium carbide. Extreme care was taken to prevent contact between the fruits and calcium carbide.

Determination of Arsenic and Phosphorus

This was done using the method of Miroslav and Vladimir 1999 [3]. About 5 g of the peel and flesh of each fruit (except avocado pear, where only the flesh was used) was dried at 105° C for 1 hour. 1 g of the material was then weighed into a 50 ml Pyrex beaker. The beaker was placed in a muffle furnace set at 500°C and the material was allowed to ash for 3 hours. The ash formed was then dissolved in a 10% HNO₃ and heated gently on a hot plate for 20

minutes. It was cooled and filtered into a 250 ml flask, and then diluted to mark with water. Determination of heavy metals (arsenic and phosphorus) was carried out using Atomic Absorption Spectrophotometer (Buck Scientific, USA).

Statistical Analysis: The result of this study was obtained three independent experiments. One way analysis of variance (ANOVA) was used to analyze the difference among the groups using graph Pad Prism 5.0 software.

RESULTS

The results showing the levels of arsenic and phosphorus in the fruits are presented in Table 1.

Fruit Sample	Levels of chemicals in ripe fruits purchased from the markets		Levels of chemicals in fruits ripened in the laboratory	
	Arsenic (mg/kg)	Phosphorus (mg/kg)	Arsenic (mg/kg)	Phosphorus (mg/kg)
Mango peel	0.064 ± 0.16	141.5 ± 0.22	ND	65.5 ± 0.11
Mango flesh	0.021 ± 0.04	$55.5\ \pm 0.16$	ND	36.0 ± 0.18
Banana peel	0.053 ± 0.17	254.0 ± 0.25	ND	161.0 ± 0.09
Banana flesh	0.066 ± 0.26	289.0 ± 0.18	ND	174.5 ± 0.02
Plantain peel	0.037 ± 0.32	263.0 ± 0.27	ND	142.0 ± 0.03
Plantain flesh	0.023 ± 0.22	12.5 ± 0.15	ND	30.5 ± 0.24
Avocado pear	0.097 ± 0.25	302.0 ± 0.23	ND	690.0 ± 0.19

Triplicate determination was used.

DISCUSSION

There were no detectable Arsenic levels in fruits ripened in the laboratory and the levels of phosphate in the fruits ripened in the laboratory were consistently lower than those purchased from the market. The fruits ripened with calcium carbide in the laboratory were ripened within three days rather than 6-7 days required for normal fruit ripening. This agrees with most research work in literature that ripening agents do accelerate ripening faster than when done naturally [4-5].

The absence of arsenic in fruits ripened in the laboratory could be as a result of limited exposure of the fruits to direct contact with calcium carbide or the quantity of calcium carbide used. The ripe fruits purchased from the market had high levels of arsenic and phosphorus. Also the elements were found in both peel and flesh of the fruits, which may suggest that direct contact and high level of calcium carbide may have been used in ripening these fruits in order to achieve quick ripening. Also, the hydrides of these elements are fat soluble, which dissolves in the wax layer of fruits and can diffuse from peel to flesh of fruits [6].

Commercial grade calcium carbide is impure, they contain impurities such as arsenic and phosphorus in the form of Calcium phosphide (Ca₃P₂) and calcium arsenide (Ca₃As₂), which may reacts with water to form phosphene (PH₃) and arsine (AsH₃) respectively. These hydrides are fat soluble, and may dissolve in the wax layer of fruits and can diffuse from peel to flesh of fruits, which cause health hazards [6]. Arsenic is one of the most toxic metals derived from the natural environment [7]. After acute poisoning electro-thermal atomic absorption spectrometry studies show that the highest concentration of arsenic is in the kidneys and liver [8]. In chronic arsenic ingestion, arsenic accumulates in the liver, kidneys, heart, and lungs and smaller amounts in the muscles, nervous system, gastrointestinal tract, and spleen [8].

Phosphate toxicity due to excessive retention of phosphate in the body can cause a wide range of cellular and tissue injuries. Phosphate toxicity can exert cytotoxic effects to compromise the functional ability of various organ systems. Phosphate toxicity can induce an increased rate of apoptosis in various tissues that can be suppressed by reducing the phosphate burden [9]. Recently, dietary phosphate has been shown to stimulate the Aktmediated signaling network and provoke an increase in lung tumorigenesis [10].

The result from this study agrees with the work of Hakim *et al* (2012); where they reported that chemically ripened pineapples and bananas have higher sugar content than non treated samples. Other fruit nutrition values like vitamin C and β -carotene were higher in naturally ripened fruits. More importantly, they also reported the presence of lead (Pb) in chemically ripened (market and laboratory treated) pineapples and bananas and Arsenic (As) in pineapples collected from the market [11].

The maximum tolerable intake of arsenic is $3.0 \ \mu g/kg$ body weights per day [12], and from the result obtained, toxic level of arsenic is being consumed daily from fruits ripened artificially with calcium carbide. Also, the tolerable upper intake level of phosphorus is 4000 mg/day [13], thus daily intake from these fruits coupled with other sources of phosphorus such as flour product and other foods containing phosphorus, can lead to gradual increase and thus toxic levels of phosphorus in the body. Above these levels, arsenic and phosphorus has carcinogenic effects, amidst other numerous health hazards to man.

Considering the health hazards of chemically ripened fruits, several countries have began to take measures against the use of chemical agents for ripening fruits. In Bangladesh, home grown and imported fruits are regulated by the pesticide law 2007 and the pure food rules and act 1967 and 2005. These laws prohibits the use of any chemical to ripen fruits and penalize any person who is mixing, selling and/or using illegally ripened fruits [14-15]. In Sri Lanka, under the Food Act No 26 1980, no person can manufacture, sell or distribute any food that contains any added detrimental substance, which turns out to be injurious to human health [16]. In India, the use of calcium carbide for fruit ripening is prohibited under rule 44 AA of

the prevention of Food Adulteration rules 1955 [17]. In Nepal, the Nepal Food regulation 2007 (part 7, rule No19 (d) has strongly prohibited the use of calcium carbide in ripening of fruits [17]. In the United States of America (USA), the United States National Organic Standard Board (NOSB) recommends the use of ethylene for post harvest ripening of tropical fruits and de-greening of citrus [18]. The United Kingdom Soil Association allows the use of ethylene to ripen bananas [19].

It is interesting to note that the developed countries like USA and UK allows using ethylene for post harvest ripening of selective fruits following specific dosing protocols. In contrast most of the developing countries including India demonstrate zero tolerance in preparing, selling or distributing artificially ripened fruits. In Nigeria, the National Agency for Food, Drugs Administration and control is the agency saddled with the responsibility of ensuring the safety of all foods and drugs manufactured and imported into the country. While the agency has been busy in its crusade against fake and counterfeit drugs, there is no known regulation from the agency against the use of chemicals and pesticides for preservation of fruits and food. A lot need to be done by this agency in this regard. The governments need to educate the citizens on the health hazards associated with the use of chemically ripened fruits, provide storage facilities and cold store to fruit sellers and teach the fruit sellers on the dosing protocol and proper handling of these chemicals. Also consumers need to learn how to select the right fruit by keenly observing the variation of colour and buying seasonal fruits.

CONCLUSION

Arsenic and phosphorus are impurities found in calcium carbide and were detected in fruits marketed in Benin City, Edo state and in fruits artificially ripened with calcium carbide. High levels of these elements in fruits were as a result of direct contact with the carbide which poses serious potential health challenges to man. These elements diffuse from the peel to the flesh of fruits, and thus, washing the fruits is not enough measure to reduce the toxic effects of this practice.

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