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Assessment of Chemical/phytotoxin and Microbial Contamination of Pasta Foods Marketed in Nigeria

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Abstract: The possible chemical/phytotoxin and microbial contamination of nine brands of pasta foods (macaroni, spaghetti and noodles) commonly consumed in Nigeria were investigated following identification of pesticide residues in Indomie noodles (a brand of pasta food) and contamination of baby foods (SMA) with some poisonous cassava materials. Enzymatic and spectrophotometric analysis of these foods for cyanide content indicate the presence of this compound ranging from 7.60-70.65 mg $CN^{-}kg^{-1}$. Chemical analysis of these foods showed the presence of alkaloids, tannins and saponins while microbial quality test indicated the presence of *Salmonella* sp., *Rhizopus* sp. and *Staphylococcus aureus* in three food samples. The implications of these findings are discussed from toxicological and food bioterrorism points of view.

Key words: Pasta foods, Nigeria, chemical/phytotoxin, microbial contamination

Introduction

The absolute necessity of nutrition for continuance of life points to food as critical substance that must be maintained free from dangerous levels of toxicants. Many common food plants contain significant amount of toxins and could also be easily contaminated with other chemical and biological toxins. With experience over a long period of time, the plants containing major toxins have been reorganized and eliminated from the diet or methods of detoxification found, but despite this accumulated knowledge, isolated cases of large outbreaks of poisoning from food plants still occur (Cooper and Johnson, 1984). Food poisoning some causing death raise alarm not only about food served in restaurants, but also about the food bought in the supermarkets. The September 11, 2000 terrorist attack on the Trade Center and Pentagon further heightened such concerns by exposing the vulnerability of food and water supplies to food bioterrorism (Marion, 2003).

The vulnerability of our foods and water supplies to contamination with toxic substances is exemplified by the event of 1977, where an evidently disgruntled US laboratory employee invited his co-workers to partake of doughnuts which he hard intentionally tampered with a particular virulent type of Shigella and 45 people feel ill (Kolavic *et al*., 1997). Also in the US, during the 2001 December holidays, nearly 300,000 pounds of ham products had to be recalled because an angry employee spiked them with nails, screws and other non-food materials (Kolavic *et al*., 2002). Furthermore, the poisoning of water supplies at German prisoner-of -war camps with arsenic, Israelis citrus with mercury and Chilean grapes with cyanide, suggest that no food or drink is invulnerable to such contamination (Khan *et al*., 2001).

In Nigeria, among many of the food poisoning reported in the recent past, is the contamination of Indomie noodles (a brand of pasta foods) with poisonous substances believed to be pesticide residues (The Punch, 2004) and baby foods (SMA) with toxic cassava flour probably containing high

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levels of cyanide (Daily Champion, 2004). On the basis of these findings, the present study Assessment of chemical/phytotoxin and microbial contamination of pasta foods marketed in Nigeria was carried out. Pasta foods form one of the major staples of majority of our students in Institutions of Higher Learning as well as that of many children. Pasta foods contain different components of plant origin at high ratio. Therefore occasional chemical/phytotoxin or microbial contamination of these foods may have serious consequences.

Materials and Methods

Sample Collection

Samples of nine brands of pasta foods commonly marketed and consumed in Nigeria were purchased from retail outlets in some major Nigerian markets and were brought for analysis. The pasta foods were macroni, spaghetti and various noodles. Three samples of each brand were obtained from ten different marketers. Samples of each brand were treated as one sample followed by triplicate analysis.

Sample Extraction

The samples of pasta foods were extracted for chemical/phytotoxin analysis using aqueous ethanol.

Chemical/phytotoxin Analysis

The main toxins present in plants used regularly for food include lectins, cyanogens, alkaloids, oxalates and polyphenols (mainly tannins) (Cooper and Johnson, 1984). The extracts were evaluated for the presence of alkaloids, tannins, saponins and carbohydrate (sugars) as recommended by Mohamoud *et al*. (1994). Molish test and Fehlings tests were used to identify the presence of carbohydrate and reducing sugars, respectively.

Alkaloids

Acidified solution of the test extract was used for the test. 1 cm^3 of 1% HCl was added to 3 cm^3 of test fraction in a test tube. These solutions were treated with few drops of Mayer, Wagner and Dragendroff reagents, respectively. A creamy white (Mayer), reddish brown (Wagner) and orange brown (Dragendroff) precipitates observed were positive observation for the tests.

Tannins

Two drops of 5% $Fe\ Cl_3$ was added to 1 cm^3 of test extract. A dirty-green precipitate indicated the presence of tannins in the extracts.

Saponins

Frothing test and Emulsion test were used to confirm the presence of saponins.

Cyanogens

The cyanogens content of the foods, which could be in the form of plant toxin (cyanogenic glycosides), or contaminant (in the form of cyanide compound) were determined using the picrate paper kits for determination of total cyanogens (Bradbury *et al*., 1999).

Microbial Quality of the Pasta Foods

Microbial analysis was carried out on the nine different pasta foods labelled A, B, C, D, E, F, G, H and I. The analysis was carried out in triplicates.

Sample Preparation

Handful amount of the food items were asceptically introduced into universal bottles containing sterile peptone water and incubated over night. The samples were then sub-cultured into nutrient agar, blood agar, chocolate agar, MacConkey agar, *Salmonella* Shigella agar, moult agar and Sabourond agar.

Results

The results indicated the presence of plant food toxins like alkaloids, tannins, saponins and cyanogens as shown the Table 1.

All the foods contain alkaloids at varying concentrations. The highest levels of alkaloids were measured in samples D and E, while samples A and C has the lowest level. Tannins were detected in three of the pasta foods namely E, F and G with the least amount occurring in E, while samples A, B, C, D and H contained no detectable amount of tannins. Saponins were also detected in all the samples except A. The highest concentration was measured in samples G and F followed by samples B and E. The cyanide levels measured in these foods ranged from 7.29-70.65 mg HCN equivalent kg^{-1} of food. All the foods except brands F and H has cyanide level above the 10 ppm (10 mg kg^{-1}) stipulated by Codex Alimentarius Commission of WHO/FAO (1988) as safe limit for human food.

Three of these foods contained microorganisms that could cause ill health in man. Food sample D contained *Salmonella* sp. while E and H contained *Rhizopus* sp. and *Staphylococcus aureus* respectively (Table 2).

Table 1: Result of the chemical/phytotoxin analysis of the pasta foods

Sample	Alkaloids	Tannins	Saponins	Cyanogens (mg kg^{-1})	$(CH_2O)_n$
A	+	-	-	11.09	+
B	++	-	++	21.86	+
C	+	-	+++	30.42	+
D	+++	-	+	29.14	+
E	++	+	++	70.65	+
F	++	++	+++	7.60	+
G	++	++	+	14.26	+
H	+++	-	+	7.29	+
I	++	-	+	55.75	+

*+→+++ indicates the intensity of the colour observed and corresponds to the concentration of the compound in the sample

Table 2: Result of microbial test of the pasta foods

	Microorganism identified		
Sample	*Salmonella* sp.	*Rhizopus* sp.	*Staphylococcus aureus*
A	-ve	-ve	-ve
B	-ve	-ve	-ve
C	-ve	-ve	-ve
D	+ve	-ve	-ve
E	-ve	+ve	-ve
F	-ve	-ve	-ve
G	-ve	-ve	-ve
H	-ve	-ve	+ve
I	-ve	-ve	-ve

Discussion

The total cyanide measured in more than 70% of these pasta foods was above the 10 mg kg^{-1} HCN equivalent recommended by Codex Alimentarius Commission of WHO/FAO (1988) to be the safe level in human foods. The possible sources of cyanide in these food could be cassava, since cassava flour forms part of the components of some of them as exemplified by Idomie noodles.

Moreover, cyanide is a primary nitrile that occurs in abundance in many plants including cereals (Baskin and Brewer, 1997), which form essential component of these foods. The cyanide content of these pasta foods could also be as a result of intentional or unintentional contamination along the production line. Intentional or unintentional contamination of foods with chemical or biological agents could occur anywhere during the production, processing, storage, transport and retail distribution or at the final foods service sector. Intentional food contamination of baby foods (SMA) with cassava flour probably containing high levels of cyanide was reported in Nigeria in 2004 (Daily Champion, 2004). Again, hydrogen cyanide has been used for fumigating dry foodstuffs including cereals and cereal products as well as for disinfections of buildings such as flour mills and warehouses.

Cyanide because of its rapid, profound toxicity at adequate concentration has been employed as a chemical threat agent. Although CN may not be efficient large-scale offensive persistent chemical weapon; it has been used in military and terrorist operations (Baskin and Rockwood, 2002). In this context, Moroccans were arrested for possession of large quantities of cyanide, which may have been intended for use in bioterrorist attack in Romes water supply and the US embassy in 2002 (Robert, 2005). Thus, cyanide remains a reorganized chemical warfare threat (Khan *et al*., 2000; Daily News, 2001) and historical use of CN as military or terrorist weapon has been reviewed (Baskin and Brewer, 1997; De Lorenzo, 1999). The need for proper processing and handling of these pasta foods cannot be over emphasized as some of them contain high levels of cyanide up to 50 ppm as examplified by brands E and I (Table 1).

Apart from food samples A and C all others contain high levels of alkaloids indicated by the intensity (concentration) of the resultant colours developed when tested for alkaloids. Dangerously high quantities of alkaloids may develop in some plants, e.g., potato tubers that have sprouted or been stored in the light and become green (Cooper and Johnson, 1984). Alkaloids are known to have effects on the nervous system, generally disrupting electrochemical transmission at the nerve junction (synapse) either by preventing transmission (as in the case of plant toxin curare) or enhancing it inappropriately (as for example physostigmine). Food samples E, F and G contained tanning as part of their component (Table 1). It has been suggested that polyphenols are possible cause of upper digestive tract cancer that develop after eating sorghum, or drinking teas or alcoholic drinks containing high concentrations of tannins (Cooper and Johnson, 1984). Tannins are known to cause binding and precipitation of dietary proteins and digestive enzymes (Butler *et al*., 1984). Saponins were also detected in all the food samples except for food sample A. Saponins influence the nutritive value of some foods or diets. The mechanisms of action of saponins are not entirety known but they are thought to inhibit the function of digestive enzymes and so lower the absorption of amino acids, sugars and other nutrients (Krogdahl, 1980). These results are in agreement with the report of Cooper and Johnson (1984) that the main toxins present in plants used frequently for food include lectins, cyanogens, alkaloids, oxalates and polyphenols (mainly tannins). When inadequately processed or stored, plant parts that contain toxins are eaten, serious poisoning can result. Most toxins impair protein synthesis and can cause damage to specific organs or systems.

Detection of *Salmonella* sp. in food sample D, *Rhizopus* sp. in sample E and *Staphylococcus aureus* in sample H (Table 2) is also another significant finding in the present study. Food born diseases due to microbial contamination have been divided into two categories; those in which cell growth and toxin contamination occur in food primarily prior to its ingestion and those contamination which grow in food and bring about intestinal infection or colonization with toxin elaboration within the host. The toxin forming bacterial organism can also proliferate in the intestinal tract or in fact other tissue and thus disseminate their toxin from sites within the host. *Salmonella* sp. is a representative of those in which considerable proliferation of the biological agent apparently take place within the intestinal tract with concomitant release of endotoxins and exotoxins. Commenting on *Salmonella* sp. and the possible use of this organism in food bioterrorism, Fee and Brown (2001) wrote: if accidental contamination of ice cream with *Salmonella* can make hundreds of thousands of people sick, it is easy to imagine the damage that could be caused by deliberate tampering. In this context also, Henderson (1999) reported that weapons mass destruction (nuclear, chemical and biological) the biological ones are the most greatly feared. On the other hand *Staphylococcus* food poisoning is due to protein exotoxin, which are distinct entities among, several toxic metabolite of enterotoxin positive strain of *Staphylococcus aurens*. It is worth mentioning that moulds occur mainly in cereal grains, rice, or nuts stored under damp, inadequately ventilated conditions and that toxins may be present in the absence of visible signs of mould and are not necessarily associated with any alteration (Cooper and Johnson, 1984). From 1988 through 1992 food born disease outbreaks cursed an annual average of more than 15,000 cases of illnesses in United States (CDC, 1996). The actual illness rate may be higher because a count is taken only when microorganism that caused the illness is identified by a laboratory and reported by a physician. When unreported cases are taken into account, an estimated 76 million illnesses, 325,000 hospitalizations and 5,000 deaths each year may be associated with microorganisms in food (Mead *et al*., 1999). The situation in Nigeria may be more serious than the reports suggest.

In conclusion, the findings in the present study further demonstrate the vulnerability of our foods to chemical/phytotoxin and microbial contamination and the need to minimize such.

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