HEALTH RISK ASSESSMENT OF SOME FREQUENTLY CONSUMED YOGHURT IN MALUMFASHI LOCAL GOVERNMENT AREA, KATSINA STATE

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ABSTRACT

For a lot of people, diet is the main route of exposure to trace metals, so the assessment risk of these elements to human via diary intake is important. The non-carcinogenic health risk of Pb, Cd, Cr and Cu to men, women and children via some frequently consumed Yoghurt marketed in Malumfashi local government area of Katsina state was estimated. The mean concentrations of the heavy metals obtain in the Yoghurt samples were below the WHO and FAO permissible limits with the exception of Cd in Hamdala Yoghurt which shows concentration higher than the WHO/FAO permissible limits (0.012±0.11 against 0.05). The target hazard quotients (THQs) and hazard index (HI) were calculated to evaluate the non-carcinogenic health risk from individual heavy metal and combined heavy metals due to Yoghurt intake. THQs for individual heavy metal from consuming individual analyzed Yoghurt in Malumfashi were all less than one, indicating that health risk associated with the intake of a single heavy metal through consumption of only one kind of Yoghurt was relatively absent. Also health risk from consuming all the analyzed Yoghurt i.e. combined heavy metals (HIs) was also found to be less than one, indicating that the health risk associated with the intake of combined heavy metals from all the analyzed samples was also relatively absent.

Key words: Yoghurt, heavy metals, target hazard quotient, hazard index

INTRODUCTION

Heavy metals are persistent contaminants in the environment that can cause serious environmental and health hazards (Ayar *et al.*, 2009). They are released into the environment from natural as well as man-made activities. Some heavy metals (such as Cu and Fe) are essential to maintain proper metabolic activity in living organisms while others (such as Pb and Cd) are non-essential and have no biological role (Ayar *et al.*, 2009; Qin *et al.*, 2009). However, at high concentrations, they are toxic to living organisms (Li *et al.*, 2005).

Dairy products

Dairy products are considered to be a great source of nutrients, such as: proteins, fat, vitamins, minerals and probiotic bacteria. Thus, they are included in the human diets and consumed by all age groups (Enb *et al.*, 2009). Yogurts are dairy products obtained by fermentation of milk with bacterial cultures, which contributes to colon health, improve the bioavailability of other nutrients. They are also a rich source of calcium preventing the occurrence of osteoporosis, an ideal source of macro- and microelements, in cosmetics the micro and macronutrients help in cleaning and hydrating

the skin, reducing sun burns, fighting acne and aging process. Thus, they are beneficial for human health (Buldini *et al.*, 2002; Enb *et al.*, 2009). The presence of heavy metals is caused by different agricultural activities like irrigation with heavy metal-contaminated water, use of pesticides, also by treating the cows with different drugs; all of these resulting in toxic metal contamination of feeds, meat, and milk (Anastasio *et al.*, 2006; Mohammad et al 2012). Other sources of heavy metals are the manufacturing and packaging processes and also the packaging material. The exposure of the organism at levels higher than those admitted by food legislation, even for essential microelements, can cause different adverse effects, including cancer and mutations (Enb *et al.,* 2009).

MATERIAL AND METHODS

Quality assurance

All reagents that would be used are of analytical grade, deionized water would also be used. All the glass wares and polyethene sample bottles will be washed with liquid soap rinsed with water and soaked in 10% nitric acid for 24 hours, cleaned thoroughly with deionized water and then dry up (Todorovi *et al.,* 2005)

Description of study area

Malumfashi is one of the 34 Local Government Areas of Katsina State, Nigeria. Its headquarters are in the town of Malumfashi. It has an area of 674 km² and a population of 182,920 as at 2006 census. and the current chairman of the local government is Alhaji Muktar Ammani and the Emir (sarki) of the district is Dr Mamman Nasir (Galadiman Katsina), it has a postal code of the area is 822

Sample collection

Nafsi, Salam, City, San, Maidabino, Wafa, Aljazeera, Basako, Hamdalla Yoghurt drinks would be procured from different selling points at Malumfashi local government area of Katsina State.

Sample pretreatment

The collected samples of yoghurt would be stored in a refrigerator prior to the analysis (Anastasio *et al.*, 2006)

Sample digestion

Each yoghurt sample was thoroughly shaked, 5ml was transferred into a conical flask followed by addition of 5ml of conc HNO_3. The digestion was carried out on a hot plate until an optically clear solution was obtained. (Abolfazl *et al.*, 2012). The volume of the digest was filtered in 100ml volumetric flask and then top up to mark with deionized water (Abolfazl *et al.*, 2012)

SAMPLE ANALYSIS

The digested samples were analyzed for lead, cadmium, chromium and mercury using Atomic Absorption Spectrophotometer (AAS650FS) in the multi user science laboratory of chemistry department, ABU Zaria.

Statistical treatment of the data

The data were expressed as mean ± standard deviation. To show whether there is significant difference between the mean concentrations of the metals among the samples collected, one way analysis of variance (ANOVA) was used and the Pearsons moment correlation (r) was used to establish the degree of relationship among the fractions of the analyzed metal ions across the samples using statistical software package for social science (SPSS version Exposure calculations. In accordance with the standard EPA methods, the risk of non-carcinogenic effects is expressed as the ratio of the dose resulting from the exposure to the site media compared to a dose that is believed to be without risk of effects, even in sensitive individuals. This ratio was called the Hazard Quotient

(HQ). If the value of HQ is less than one, it is believed there is no significant risk of non-carcinogenic effects. If the HQ exceeds one, then there is a chance that non-carcinogenic effects may occur, with a probability which tend to increase as the value of HQ increases (USEPA 2001).

The health risk for adult and children are separately considered since the contact pathway with each exposure medium (e.g. food) changes with age. Therefore, there would be a certain amount of discrepancy in health risk between age groups and locality of the inhabitants (Wang *et al.*, 2005). Therefore, dose resulting from exposure to ingestion could be calculated as follows:

$$D_{ingestion} = C \times (E_F E_D F_{IR}) / (W_{AB} T_A) \times 10^{-3}$$

Where D ($\mu g.g^{-1}.day^{-1}$) is the dose contacted through ingestion ($D_{ingestion}$); E_F is exposure frequency (365 day/year); E_D is exposure duration (70 years), equivalent to the average lifetime (Bennett *et al.*, 1999); F_{IR} is the food ingestion rate (g/person/day); C is the metal concentration in food (µg/g); W_{AB} is the average body weight (55.9kg for adults and 32.7kg for children, Ge, 1992), and T_A is the average exposure time for non-carcinogens (365days/year number of exposure years, assuming 70years in this study).

The Target Hazard Quotient (THQ) is determined based on HQ as described by the following equation (Wang *et al.*, 2005; Chien *et al.*, 2002)

$$THQ = C \times (E_F E_D F_{IR}) / (W_{AB} T_A RfD) \times 10^{-3}$$

Where RfD is the oral reference dose (mg/kg/day)

Harrison and Chirgawi (1989) reported that exposure to two or more pollutant may result in additive and or interactive effects. Assuming the additive effect, THQs can be summed across constituents to generate a Hazard Index (HI) for a specific receptor/pathway combination. The hazard index is a measure of the potential risk of adverse health effects from a mixture of chemical constituents. Whether or not a particular chemical mixture pose an additive risk depends on the targets (tissue, organ or organ system) and the mechanisms of action of the individual chemicals (USEPA 1999). The oral reference dose were based on 4µg/kg/d, 1µg/kg/d, 300 µg/kg/d, 40 µg/kg/d for Pb, Cd, Zn and Cu, respectively (USEPA, 2000, 1992).

RESULTS

Heavy Metals Concentrations

The concentrations of heavy metals in some brands of Yoghurt marketed in Malumfashi local government area of Katsina state are presented in Table 4.1. Lead and chromium were not detected (BDL) in all the analyzed samples. However, the concentrations of cadmium and copper ranges from BDL to 0.012± 0.011 and BDL to 0.005±0.008, respectively.

The results for the analysis of variance of the analyzed heavy metals are presented in Table 4.2 with the P-values ranging from 0 (Pb) to 0.716 (Cu). Similarly, the result of the correlation coefficients of the metals across the sampling points range from -0.987 (Cu6 Vs Cu5) to 1.0 (Cd1 Vs Cu5) as presented in Table 4.3; Target hazard quotient (THQ).

The target hazard quotient for men, women and children are calculated and presented in Table 4.4, 4.5 and 4.6 respectively. The THQ for men ranges from 0 (San, Maidabino and Jibson) to 0.005265 (Hamdala), 0 (San, Maidabino and Jibson) to 0.00361 (Hamdala) for women and 0 (San, Maidabino and Jibson) to 0.009 (Hamdala) for children, respectively

Table 4.1: Concentrations (mg/l) of heavy metals in some brands of Yoghurts Marketed in Malumfashi

	Metal			
Sample	Pb	Cr	Cd	Cu
Hamdala	BDL	BDL	0.012±0.011	0.005±0.008
Nafsi	BDL	BDL	0.004±0.000	0.002±0.003
Basako	BDL	BDL	0.002±0.002	0.003±0.003
San	BDL	BDL	BDL	BDL
City	BDL	BDL	BDL	0.004±0.004
Aljazeera	BDL	BDL	BDL	0.004±0.004
Wafa	BDL	BDL	BDL	0.002±0.004
Salam	BDL	BDL	BDL	0.003±0.003
Maidabino	BDL	BDL	BDL	BDL
Jibson	BDL	BDL	BDL	BDL
WHO/MCLG	0.01	0.05	0.005	1.3

Table 4.2: ANOVA of heavy metals in some brands of Yoghurts Marketed in Malumfashi Town

		Sum of Squares	df	Mean Square	F	Sig.
Pb	Between Groups	0.000	9	0.000	0.000	0.000
	Within Groups	0.000	20	0.000		
	Total	0.000	29			
Cr	Between Groups	0.000	9	0.000	1.000	0.471
	Within Groups	0.000	20	0.000		
	Total	0.000	29			
Cd	Between Groups	0.000	9	0.000	3.096	0.017
	Within Groups	0.000	20	0.000		
	Total	0.001	29			
Cu	Between Groups	0.000	9	0.000	0.682	0.716
	Within Groups	0.000	20	0.000		
	Total	0.000	29			

Table 4.3: Correlation matrix of some brands of yoghurt drinks sold in Malumfashi

Sample	Cr10	Cd1	Cd3	Cd6	Cd8	Cd10	Cu1	Cu2	Cu3	Cu5	Cu6	Cu7	Cu8
Cr10	1												
Cd1	-.711	1											
Cd3	.225	-.845	1										
Cd6	-.500	.965	-.956	1									
Cd8	-.500	.965	-.956	1.000**	1								
Cd10	-.693	-.014	.546	-.277	-.277	1							
Cu1	-.500	.965	-.956	1.000**	1.000**	-.277	1						
Cu2	1.000**	-.711	.225	-.500	-.500	-.693	-.500	1					
Cu3	-.866	.264	.292	0.000	0.000	.961	0.000	-.866	1				
Cu5	-.721	1.000**	-.838	.961	.961	.000	.961	-.721	.277	1			
Cu6	.822	-.985	.740	-.904	-.904	-.160	-.904	.822	-.427	-.987	1		
Cu7	-.500	.965	-.956	1.000**	1.000**	-.277	1.000**	-.500	0.000	.961	-.904	1	
Cu8	-.500	-.254	.731	-.500	-.500	.971	-.500	-.500	.866	-.240	.082	-.500	1

**. Correlation is significant at the 0.01 level (2-tailed).

a. Cannot be computed because at least one of the variables is constant.

Table 4.4: Target hazard quotient of heavy metals in some brands of yoghurt drinks sold in Malumfashi town.

	THQ MEN				
Sample	Pb	Cr	Cd	Cu	TTHQ
Hamdala	0	0	0.00526	5.50E-06	0.005265
Nafsi	0	0	0.00018	2.20E-06	0.000178
Basako	0	0	8.80E-05	3.30E-06	9.09E-05
San	0	0	0	0	0
City	0	0	0	4.40E-06	4.38E-06
Aljazeera	0	0	0	4.40E-06	4.38E-06
Wafa	0	0	0	2.20E-06	2.19E-06
Salam	0	0	0	3.30E-06	3.29E-06
Maidabino	0	0	0	0	0
Jibson	0	0	0	0	0
THI	0	0	0.005522	2.50E-05	0.005548
Standard	1	1	1	1	1

Table 4.5: Target hazard quotient of heavy metals in some brands of yoghurt drinks sold in Malumfashi

	THQ WOMEN				
Sample	Pb	Cr	Cd	Cu	TTHQ
Hamdala	0	0	0.00361	3.80E-06	0.00361
Nafsi	0	0	0.00012	1.50E-06	0.000122
Basako	0	0	6.00E-05	2.30E-06	6.24E-05
San	0	0	0	0	0
City	0	0	0	3.00E-06	3.01E-06
Aljazeera	0	0	0	3.00E-06	3.01E-06
Wafa	0	0	0	1.50E-06	1.50E-06
Salam	0	0	0	2.30E-06	2.25E-06
Maidabino	0	0	0	0	0
Jibson	0	0	0	0	0
THI	0	0	0.003787	1.73E-05	0.003804
Standard	1	1	1	1	1

Table 4.6: Target hazard quotient of heavy metals in some brands of yoghurt drinks sold in Malumfashi

	THQ CHILDREN				
Sample	Pb	Cr	Cd	Cu	TTHQ
Hamdala	0	0	0.00899	9.40E-06	0.009
Nafsi	0	0	0.0003	3.70E-06	0.000303
Basako	0	0	0.00015	5.60E-06	0.000155
San	0	0	0	0	0
City	0	0	0	7.50E-06	7.49E-06
Aljazeera	0	0	0	7.50E-06	7.49E-06
Wafa	0	0	0	3.70E-06	3.75E-06
Salam	0	0	0	5.60E-06	5.62E-06
Maidabino	0	0	0	0	0
Jibson	0	0	0	0	0
THI	0	0	0.00944	4.30E-05	0.009483
Standard	1	1	1	1	1

DISCUSSION

The mean concentrations of heavy metals obtained as presented in Table 4.1, it was observed that the concentrations of lead (Pb) and chromium(Cr) were below the detection limits (BDL) for all the samples, however cadmium (Cd) and copper(Cu) were detected in three(3) and seven(7) samples respectively. Hamdala, Nafsi and Basako Yoghurt, with Hamdala Yoghurt having the highest concentration of Cd followed by Nafsi then Basako Yoghurt while in the other samples the concentration of Cd was below detection limit (BDL). Copper was detected in Hamdala, Nafsi, Basako, City, Aljazeera, Wafa and Salam Yoghurt with Hamdala Yoghurt having the highest concentration followed by City, Aljazeera, Salam, Basako, Wafa and Nafsi Yoghurt, respectively. All the mean concentrations of heavy metals obtained in the Yoghurt samples were below the WHO and FAO permissible limits with the exception of cadmium (Cd) in Hamdala Yoghurt which shows concentration higher than the WHO/FAO permissible limits.

Since P-values was found to be less than 0.05 for lead (Pb) and cadmium (Cd), it indicate that there were significant differences in the concentrations of these heavy metals among the analyzed brands of the Yoghurt marketed in the town of Malumfashi. The difference in the concentrations of these metals may be attributed to water, milk, packaging or the processing method used during the processing. Conversely, the P-values for chromium (Cr) and copper (Cu) were found to be greater than 0.05 indicating that there was no significant difference in the concentrations of these heavy metals across the samples. This further suggests that the source of Cr and Cu might be the same in all the Yoghurt brands.

The results of the correlation analysis further suggest that Cu6 was strongly negatively correlated with Cu5 which indicates an inverse relationship of Cu in these samples. However, Cd1 and Cu5 were strongly positively correlated indicating a direct relationship of these metals in sample 1 and 5 this indicates that the source of the metals in the samples might be attributed to processing or packaging processes in the industry

Effects of the Individual Heavy Metals

The target hazard quotients (THQs) of individual heavy metal through Yoghurt consumption for the residents (Men, women and children) in Malumfashi are listed in Tables 4.4, 4.5 and 4.6, respectively. The average heavy metal concentrations in ten (10) samples of Yoghurt are used for calculation of the THQ for Malumfashi residents. No THQ value greater than one (1) was recorded among the analyzed samples. This indicates that health risk associated with heavy metals exposure for men, women and children is insignificant if the residents only ingest individual heavy metal from one brand of Yoghurt. Furthermore, Hamdala Yoghurt has the highest THQ value for Cd followed by Nafsi and Basako Yoghurts respectively. Also for Cu, Hamdala has the highest value followed by City, Aljazeera, Salam, Basako, Wafa, Nafsi, San, Maidabino and Jibson Yoghurt respectively for Men. For Women and Children the grading from the Yoghurt with the highest value to the lowest is same with that of the Men with little variation in the values. All the values recorded are below one as earlier stated.

Potential health risk of combined heavy metals

Comparing the TTHQ of the different brands of Yoghurts, the potential health risk was assessed as follows; for men, women and children, the TTHQ through the consumption of any of the ten brands of yoghurt marketed in Malumfashi was found to be less than one, indicating that there was no significant potential health risk for men, women and children by consuming any of the analyzed sample. Hamdala has the highest value of TTHQ followed by City, Aljazeera, Salam, Basako, Wafa, Nafsi, San, Maidabino and Jibson Yoghurt respectively for Men. For Women and Children the grading from the Yoghurt with the highest value of TTHQ to the lowest is same with that of the Men with little variation in the values. All the values calculated are below one as earlier stated.

Hazard index (HI)

HI values through the ten brands of Yoghurt consumption for men, women and children in Malumfashi indicates that there was no significant health risk from the consumption of the ten brands of Yoghurt marketed at Malumfashi since all the values for men, women and children was less than one (1). Hamdala has the highest value of HI followed by City, Aljazeera, Salam, Basako, Wafa, Nafsi, San, Maidabino and Jibson Yoghurts respectively for Men. For Women and Children the grading from the Yoghurt with the highest value of HI to the lowest was same with that of the Men with little variation in the values. All the values calculated were less than one indicating that there is no significant potential health risk for Men, Women and Children resident in Malumfashi as a result of the consumption of all the analyzed Yoghurt.

CONCLUSION

Food consumption has been identified as the major pathway of human exposure to heavy metals. The dairy products might get contaminated from the source of milk; the cattle might feed on contaminated grass and water and pass it on through the milk thereby contaminating any product from that milk. The THQs and HIs obtained in this work are all less than one, indicating that there is no health risk for men, women and children in Malumfashi town due to the intake of the analyzed samples of Yoghurts.

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