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Research Article

A Study on Heavy Metals Comparison in Processed Tomato Paste and Fresh Tomatoes Sold in a Market in Umuahia Metropolis of Abia State Nigeria

Kelechi E Onwuka*, Aghalibe U Christopher, Igwe JC, Achulonu C Victor

Department of pure and Industrial Chemistry, Abia state University Uturu, Nigeria

***Corresponding Author:** Kelechi E Onwuka, Department of pure and Industrial Chemistry, Abia state University Uturu, Nigeria, E-mail: mailkelechi25@gmail.com

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Abstract

Heavy metals are among the largest contaminants of food products. Once metals are present in vegetables, their concentrations are rarely modified by industrial processing techniques, although in some cases washing may decrease the metal content. In this study, levels of heavy metals in tinned, sachets, tomato pastes and fresh tomatoes sold in markets in Umuahia, Nigeria were evaluated by Atomic Absorption Spectrophotometry. The result obtained for tinned tomatoes were: iron, 0.03 -2.78 µg/g; lead, 0.01-0.18 µg/g; chromium, 0.03-0.05 µg/g; copper, 0.01-0.04 µg/g; nickel, 0.03-0.1 µg/g; zinc, 0.06 0.11 µg/g; calcium, 0.04 -0.8 µg/g and cadmium, 0.00-0.01 µg/g. The mean values for sachet tomatoes were: iron, 0.38-0.84 µg/g; lead, 0.03-0.18 µg/g; chromium, 0.03-0.04 µg/g; copper, 0.02-0.04 µg/g; nickel, 0.03-0.08 µg/g; zinc, 0.049-0.14 µg/g; calcium, 0.4-1.02 µg/g, while cadmium was not detected. The mean concentration values in fresh tomatoes sold in markets and farm land were: iron, 0.025-0.075 µg/g; lead ranges between 0.03-0.19 µg/g; chromium, 0.00-0.27 µg/g; copper, 0.002-0.10 µg/g; nickel, 0.00-0.15 µg/g; zinc, 0.05-013 µg/g; calcium, 0.24-0.74 µg/g; while cadmium was not detected in all fresh and farm land samples. These values indicate that levels of investigated metals in the analyzed tomatoes were below the permissible levels of metals recommended as dietary intake in tomato.

Keywords: Atomic Absorption Spectrophotometry; Heavy metal and Tomato

1. Introduction

The metal contamination in food has raised public and scientific interest due to their dangerous effects on human health. This has led researchers all over the world to study the pollution with heavy metals in air, water, and foods to avoid their harmful effects and to determine their permissibility for human consumption [1]. Tomato is one of the most widely cultivated crops in the world. Tomatoes contribute to a healthy, well-balanced diet. They are rich in minerals, vitamins, essential amino acids, sugars and dietary fibres. Tomato contains much vitamin B and C, iron and phosphorus. Tomato fruits are consumed fresh in salads or cooked in sauces, soup and meat or fish dishes. They can be processed into purées, juices and ketchup. Canned and dried tomatoes are economically important processed products [2]. Tomato sauce and similar products are widely used for coloring and taste enhancement of various food products. Apart from their taste properties they also have a high nutritive value due to the content of easily retainable sugars, vitamin C, carotenoids and mineral salts [3], in traditional way for preparing tomato paste, the tomatoes are washed and chopped. After a while they squeeze the tomatoes to drain water. Then pour it in a strainer to separate the juice from the pulp. Then the filtered water is boiled until thick and kept in ceramic or glass container (Parisa and Fatemehsadat 2014). Tomato Paste is prepared from sound, ripe red tomatoes (Lycopersicon/Lycopersicum esculentum P. Mill) and packed in tin cans. The determination of heavy metals in foods allows for the evaluation of risk, and this is part of every food safety program. Regulation (EC) 1881/2006 of the European Commission has set maximum levels for certain contaminants in vegetables establishing a maximum level of 0.05 mg/kg for Cd and 0.10 mg/kg for Pb.9 The EFSA's Panel on Contaminants in the Food Chain (CONTAM Panel) concluded that for cadmium the current Tolerable Weekly Intake (TWI) of 2.5 μg/kg body weight (b.w.) established in 2009 should be maintained in order to ensure a high level of consumer protection, including subgroups of the population such as children, vegetarians or people living in highly contaminated areas. 10 Provisional Tolerable Weekly Intakes (PTWI) are set for substances, such as heavy metals, that are contaminants in food and are known to accumulate in animals and humans. PTWIs have been set for cadmium, lead, mercury and tin. The PTWI recommended by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) was previously 7 μg Cd/kg b.w.11,12 In 2010 the JECFA reviewed the evaluation on cadmium and established a new provisional tolerable monthly intake (PTMI) of 25 μg/kg b.w. which corresponds to a weekly intake of 5.8 μg/kg b.w.11. For Pb, the PTWI set by JECFA is 25 μg Pb/kg b.w. (FAO/WHO 2011) [4]. Combining data on metal levels with information on food consumption allows for the estimation of metal intakes from a food group in population groups [5]. The dietary intake of each element was calculated by multiplying the concentration of the element in tomatoes by the mean consumption for this food group established in the most recent Spanish diet survey [6]. Some studies highlight the fact that vegetables are an important route of metal transfer from the soil to the human consumer [7]. Other factors such as climate, agricultural practices (for example the addition of fertilizers and metal-based pesticides), transportation, harvesting processes, and storage and commercialization conditions could explain differences in the concentrations of trace and heavy elements in vegetables [8].

The present study evaluated and compared the level of heavy metals in processed tinned and sachet tomatoes and fresh tomatoes popularly sold in markets in Umuahia, Nigeria.

2. Materials and Method

2.1 Sampling

A total of thirteen different brands of tinned tomatoes and four of the brands that are packaged in sachets were randomly purchased from three popular markets (Orie-ugba, Ugbani and Eke-nta) in Umuahia, South Eastern, Nigeria. Fresh tomatoes were also procured from four different markets in Umuahia (Orie-ugba, Ugbani, Ahia-gate and Eke-nta) and a farm in Umudike. The farm samples served as control. Fresh tomatoes were cleansed with soap and rinsed thoroughly, sliced and oven dried at 105°C for 24 hours prior digestion.

2.2 Sample digestion and heavy metal analysis

1g of oven-dried, ground sample of each type of brand was weighed into a 50 cm^3 beaker. This was followed by the addition of 10 cm^3 mixtures of analytical grade acids HNO_3 and $HClO_4$ in the ratio 3:1. The beaker was covered with watch glasses and left overnight. Digestion was done on a hot plate at 90^oC in a fume cupboard until about 4 cm^3 of the mixture was left in the beaker. A further 10 cm^3 of acid mixture was then added and evaporated to a volume of about 4 cm^3 while still on a hot plate, giving a clear solution. The mixture was cooled to room temperature and the solution filtered using filter paper and made up to a final volume of 50 cm^3 with distilled water in a volumetric flask. These were stored in polythene bottles till analysis [9]. Eight heavy metals (Fe, Pb, Cr, Cu, Ni, Zn, Ca, and Cd) were analysed in the samples using Buck Scientific Model version (210/211) VGP Atomic Absorption Spectrophotometer. Determinations were done in triplicates. The result was subjected to statistically analysis using One-way ANOVA.

3. Results and Discussion

Sample	NI	Ca	Cd	Cu	Fe	Zn	Pb	Cr
TP1	0.03	0.71	AB	0.02	1.45	0.07	0.02	0.04
TP2	0.07	0.53	AB	0.03	1.32	0.07	0.04	0.03
TP3	0.08	0.64	AB	0.02	0.81	0.06	0.01	0.04
TP4	0.08	0.41	AB	0.02	0.24	0.11	0.01	0.04
TP5	0.08	0.48	AB	0.02	0.94	0.07	0.17	0.04
TP6	0.06	0.38	AB	0.02	0.03	0.09	0.02	0.05
TP7	0.06	0.05	AB	0.02	0.19	0.06	0.02	0.05
TP8	0.08	0.05	0.01	0.02	0.64	0.08	0.06	0.05

TP9	0.06	0.59	AB	0.04	1.11	0.08	0.18	0.04
TPX1	0.09	0.83	AB	0.02	2.79	0.09	0.04	0.04
TPX2	0.08	0.04	AB	0.01	0.85	0.05	0.04	0.04
TPX3	0.08	0.41	AB	0.02	0.74	0.11	0.18	0.03
TXP4	0.1	0.23	0.01	0.02	1.03	0.07	0.05	0.05

Key: TXP1, TXP 2, TXP3, TXP 4 were codes for tinned tomato paste that have sachet paste while TP 1 to TP9 were codes for tinned tomato paste that do not have sachet paste. Values are means of triplicate determinations. AB means absent.

Table 1: Heavy Metals Concentration (µg/g) in Tinned Tomatoes from Three Popular Markets in Umuahia Metropolis.

Table 1 shows the heavy metals concentration (µg/g) in tinned tomatoes from three popular markets in Umuahia Metropolis. The results indicated that Iron ranged from 0.03-2.78; lead ranged between 0.01-0.18; chromium, 0.03-0.05; copper, 0.01-0.04; nickel, 0.03-0.1; zinc 0.05-0.11; calcium 0.05-0.83; cadmium was detected only in samples TP 8 and TXP4 at 0.01. In all the samples iron and calcium have the highest concentration in sample TPX1.

Sample	NI	Ca	Cd	Cu	Fe	Zn	Pb	Cr
A1	0.06	0.8	AB	0.03	0.84	0.049	0.03	0.04
A2	0.08	0.4	AB	0.02	0.74	0.11	0.18	0.03
A3	0.03	0.71	AB	0.02	0.72	0.07	0.03	0.04
A4	0.06	1.02	AB	0.04	0.38	0.14	0.05	0.04

Key: A1, A2, A3, A4 were codes for a sachet tomato paste that have tinned paste. AB means Absent.

Table 2: Heavy Metals Concentration (µg/g) in Sachet Tomatoes from Three Popular Markets in Umuahia Metropolis.

Table 2 shows the heavy metals concentration (µg/g) in sachet tomato from three popular markets in Umuahia Metropolis. The level of concentration of metals in sachet tomato pastes in µg/g was: Iron, 0.38-0.84; lead, 0.03-0.18; chromium, 0.03-0.04; copper, 0.02-0.04; nickel, 0.03-0.08; zinc, 0.049-0.14; calcium, 0.4-1.02; cadmium was not detected in all the samples. Calcium has the highest concentration in sample A4. All the samples have concentrations that were below the permissible levels of metals recommended by W.H.O. in tomato.

Sample	Ca	Cd	Cu	Fe	Zn	Pb	Cr	Ni
FT Orie-ugba M	0.35	AB	0.1	0.025	0.08	0.05	0.27	0.15
FT Ugbani M	0.24	AB	0.04	0.05	0.07	0.03	0.05	0.09
FT Ahia-gate M	0.31	AB	0.06	0.05	0.08	0.05	0.02	0.08
FT Eke-nta M	0.32	AB	0.06	0.075	0.13	0.19	0.04	0.07
FT Ugbani F	0.74	AB	0.002	0.04	0.05	0.04	0	0

Key: FT stands for fresh tomato fruits: M indicates market while F indicates Farm AB means absent.

Table 3: Heavy Metals Concentration (µg/g) in Fresh Tomatoes Sold in Popular Markets and a Farm in Umuahia Metropolis.

Table 3 shows the heavy metals concentration (µg/g) in fresh tomato sold in different markets and a farm. Iron ranges from 0.025-0.075; lead ranges between 0.03-0.19; chromium, 0.00-0.27; copper, 0.002-0.10; nickel, 0.00-0.15; zinc, 0.05-013; calcium, 0.24-0.74; cadmium was not detected in all the samples. Calcium has the highest concentration in sample from Ugbani Farm but lowest concentrations of lead, copper and zinc, while chromium, nickel and cadmium were not detected in the farm sample. Lead, chromium, nickel in the samples may be due to the presence of the metals in soils of the farms on which they were planted and also the transportation system since the level in the sample obtained from Ugbani Farm is lower, compared to other samples.

All the samples have concentrations that were below the permissible levels of metals recommended as dietary intake of tomato: iron 30 mg/kg day, lead 1.0 mg/kg/day, cadmium 0.03 mg/kg/day, nickel 25/35 ug/kg/day, zinc 20 mg/kg/day. From the statistical analysis of both the tinned, sachet and fresh tomatoes the result showed significant difference ($P<0.05$) in the concentration of the following metals calcium, zinc, copper, chromium and iron; while cadmium, nickel and lead showed no significant difference ($P<0.05$).

The result of this study is in agreement with results obtained by Harmanescu et al. [8] in tomato sauce where cadmium and chromium were not detected, but iron showed higher concentrations in two samples (14.81 and 16.44 µg/g respectively) while other metals have close range to the ones obtained in this study. The work of David et al. [3] on canned tomato paste showed high values in iron (17.53-219.58 ppm), it was reported that though iron is beneficial to the human body, it may become an energetic catalyst for some chemical or biochemical processes at very high concentration. However, Jacob and Kakulu [9] was at variance reporting very high concentration of lead, cadmium, nickel and chromium in all samples including the control samples.

4. Conclusion

From This study, it is seen that maximum limit set by legislation is not exceeded either in the case of tinned, sachet tomato pastes and fresh tomatoes. Tomatoes are a good source of essential elements in the diet, mainly iron and zinc. A daily tomato consumption pattern contributes to the recommended dietary intakes of trace elements. Tomato consumption does not significantly affect the intake of heavy metals. Fresh tomatoes from the farm should be on the preferred scale and therefore all the populace is advised to go back to the era of backyard farming to sustain food security. To reduce the pollutant in fresh tomatoes there should be improvement in our transportation system and handling of farm produce to reduce the introduction of heavy metals. Industries should employ the use sachet packaging for processing tomato paste instead of using tins.

5. Acknowledgement

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6. Competing Interest

No conflict interest exists.

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