

The Impact of Using the Scratched Utensil on Food Contamination with Heavy Metals

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Abstract: Heavy metals with adverse health effects in human metabolism. The objectives of this study are monitor the heavy metal concentrations in food samples are cooked in different common normal and scratched cooking utensil as (Aluminum, Stainless steel, Tefal, lead, Copper, Glass, and enamel cookware). The samples of cooked were fresh tomato juice cooked in normal and scratched utensil, samples cooled then kept in clean polyethylene bottles with code number, samples digested then analyzed by atomic absorption spectrophotometer [AAS], for six heavy metals (Cd, Ni, Pb, Zn, Cu, and Fe). They have negative effects on food safety and quality, the results showed significant differences in elemental concentrations among the cooked tomato juice samples analyzed which cooked in different type of utensils. The results revealed that there were wide variations in the contents of the heavy metals in samples. Crushed Tefal was found to contain the highest concentrations of the previously mentioned elements, In conclusion we should avoid using crushed utensil because it considered harmful on food and health.

Keywords: Heavy metals; utensil; Aluminum; Stainless steel; Tefal ; Atomic absorption spectrophotometer ; food ; health .

I. Introduction

Environmental pollution is a major cause of the elevated levels of micro and macro elements in food chain (Nnorom et al., 2007). Studies have shown that the nature of cook wares, cooking process, storage and processing can increase trace metal levels in foods (Anderson et al., 1992; Ebong et al. 2006). Heavy metals are potential environmental contaminants with the capabilities of causing human health problems if present in foods at high concentrations (Cabrera et al. 2003). Emmanuel and Godwin., (2013) reported that, the type of cooking utensil used may contribute some considerable amounts of trace metals into foods by way of leaching in addition to the ingredients. Studies have shown that the nature of cook wares, cooking process, storage and processing methods can increase trace metal levels in foods (Anderson et al., 1992; Ebong et al. 2010).

Heavy metals disrupt basic metabolic functions in two ways. On the one hand, they disrupt the functioning of vital organs and glands such as the heart, brain, kidney, bone or liver and secondly they move nutrients that are essential minerals and they prevent them from fulfilling their biological function. For example, aluminum as a chelator has the ability to capture and prevent the uptake of essential elements and thereby disrupt the proper use of many of them such as calcium, zinc or copper (Couzy and Mareschi, 1988). This metal is heavily involved in the onset of Alzheimer's disease (Harrington, 1994; Dabonne et al., 2010). Aluminum cookware is especially dangerous when used to prepare acid foods such as tomatoes, which causes the metal to be leached out. Besides Alzheimer's, toxic levels of aluminum has also been associated with Parkinson's disease, various dementias and bone diseases. In general, Metals are particularly toxic to the sensitive, rapidly developing systems of fetuses, infants, and young children. Some metals, such as lead and mercury, easily cross the placenta and damage the fetal brain. Childhood exposure to some metals can result in learning difficulties, memory impairment, damage to the nervous system, and behavioral problems such as aggressiveness and hyperactivity. At higher doses, heavy metals can cause irreversible brain damage. Children may receive higher doses of metals from food than adults, since they consume more food for their body weight than adults (Thirulogachandar et al., 2014). Guerardi, (1999) Indicated that, developing countries, much of the urban population and almost all rural population still use traditional cooking utensils. Examples are the clay and aluminum pots. Unlike modern utensils, traditional one does not have a protective layer of inert material to prevent contamination of food. The present study was designed with the aim of determining the concentration of Cu, Zn, Pb, Ni, Cd and Fe in six samples of juice tomato cooked in different normal and crush utensils.

II. Materials And Methods

Utensil used:

Different type of utensil prepared from traditional common material in Egypt home, utensil was (normal & crushed Tefal, Fold Iron, Aluminum, Stainless steel and Pyrex).

Examined Samples:

Samples of tomato juice with equal amount cooked in different normal and Scratched utensils, samples was used for determining the rate of transfer of heavy metals during cooking, samples could then kept in clean polyethylene bottles, according to **Demirezen and Akosoy, (2006)**, with coed number, The testing was carried out by using an Atomic Absorption Spectrometer (AAS). The analysis done in cooked tomato samples of Lead, Cadmium, Zinc, Copper, Iron, Nikhil, concentration.

Atomic absorption spectrophotometer:

Flame atomic absorption spectrophotometer is very common technique for detecting metals and metalloids in environmental samples. It is very reliable and simple to use. The technique is based on the principle of ground state metals absorbing light at specific wave length. Metal ions in a solution are converted to atomic state by means of a flame. Light of the appropriate wave length is supplied and the amount of light absorbed can be measured against a standard curve according to the methods of (**Sobukola et al ., 2009 ; Thirulogachandar et al ., 2014**).

Basic principle:

The technique of flame absorption spectroscopy requires a liquid sample to be aspirated, aerosolized and mixed with combustible gases such as acetylene and air or acetylene and nitrous oxide. The mixture is ignited in a flame whose temperature ranges from 2100 to 2800°C. During combustion, atoms of the element of interest in the sample are reduced to free, unexcited ground state atoms, which absorb light at characteristic wave lengths. The characteristic wave lengths are element specific and accurate to 0.01-0.1 nm. To provide element specific wave length, a light beam from a lamp whose cathode is made of the element being determined is passed through the flame. A device such as photon multiplier can detect the amount of reduction of the light intensity due to absorption by the analyst and this can directly related to the amount of the element in the samples (Sobukola et al ., 2009); Thirulogachandar et al ., 2014).

Analysis of cooked tomatojuicesamples:

The representative tomatojuice samples werecooked and 2g of each sample was treated with conc. Nitric acid. After treating samples with acid, samples were digested to get analyst metal in solutions till 1 ml of clear transparent sample solution was remained. The temperature was increased after every 30 minutes during digestion of samples. Then the solutions were filtered and volume of filtrate was made up to the mark in volumetric flask using distilled water and samples were stored in glass bottles. Filter paper No.4 was used for filtration of samples. AAS Stock standard solution of 1000 ppm of respective elements (Cu,Zn,Pb, Cd, Ni and Fe) was used to prepare the working standard of 100 ppm. Then further dilution of 1, 2, 3 and 4 ppm were prepared as working standard of test elements according to the methods of (Sobukola et al ., 2009 ; Thirulogachandar et al ., 2014).

Statistical Analyses:

Statistical analysis was performed by the program of statistical package for the social sciences (SPSS) to calculate(means \pm SD). Data were analyzed using one way classification, analysis of variance (ANOVA) test. The differences between means were tested for significance using t leas significancedifference(LSD) test a t $P < 0.05$.

III. Results And Discussions

Some of heavy metals are required by most living organisms for normally healthy growth but excess concentration causes toxicity. The six samples of tomato juice cooked in different type of crushed utensil in order to determine the heavy metals leaching concentration (Cu , Zn, Pb , Ni ,Cd and Fi) in these, all the analytical data are given in table (1 , 2, 3).

Results in table(1): obtainedthat, the different crushed utensils studied recorded variable levels of heavy metals. Zinc recording the lowest metal level in the most oftomato samples analyzedso it appears that the concentration were within the permissible limit, but it recorded high significant (%0.05) level only in crushed aluminum utensil with mean (5.6 ± 0.07) ppm. Zinc is an intestinal irritant present in environment; the first sign of zinc poisoning is usually intestinal distress which includes vomiting, stomach cramps, diarrhea and nausea as indicated by (Thirulogachandar et al., 2014). Copper according to Codex (1995) is naturally present in most foodstuffs in the form of copper ions or copper salts. It is among the most effective of metal biochemical oxidizing agents. Copper though needed in our body can be harmful if present in excess amount as it acts as a hemolytic agent (Aaseth and Norseth, 1986).

Results obtained also indicated that, Copper recorded high mean leaching metal concentration with rang 4.25 – 22.34 ppm , the lowest copper level was recorded in sample cooked with crushed stainless steel utensil with mean 4.25 ± 0.03 ppm, and the highest copper level was recorded in sample cooked with crushed tefal with mean 22.34 ± 0.14 ppm. While, level of Cu in tomato cooked with crushed aluminum utensil was higher than their corresponding levels in tomato cooked in crushed fold iron utensil with mean 8.0 ± 0.07 , 5.08 ± 0.19 ppm, respectively. In addition, Results were observed that a Cu concentration in all cooked tomato was higher than the standard required by the human body. This revealed that, copper level in unprocessed foods can be as high as 2mg/kg or less as reported by Aaseth and Norseth (1986). It was also inferred from the results that, consumption of foods cooked with crushed utensil contains high level of copper can cause Cu toxicity and its implications such as migraine headaches, hypotension, anxiety, premenstrual syndrome, nausea, vomiting, renal and liver damage, increased respiratory rates etc. (Flemming and Trevors, (1989). Thus, this practice should be discouraged and discontinued to avoid a devastating effects associated with it.

As shown in this table , it could be observed that , Lead recorded higher mean metal concentrations than copper with rang 5.54 – 26.44 ppm , the mean value of lead revealed a high significantly increased $p < 0.05$ with tomato cooked in crushed stainless steel , tefal and aluminum utensils with mean 26.44 ± 0.09 , 15.48 ± 0.17 , 10.0 ± 0.07 ppm , respectively, while lead level was non-significant with the sample cooked in crushed fold iron. This result in agreement with the findings by **Weidenhamer et al., (2014)** who reported in his study that ,lead, aluminum and cadmium can migrate from this aluminum and stainless steels cookware during cooking and enter food at levels exceeding recommended public health guidelines. And so his results support the need to regulate lead content of materials used to manufacture these pots. Aluminum and stainless steels cook wares may be a major contributor to lead poisoning throughout the developing world. Testing of these cook wares in other developing countries is warranted. Lead affects almost every organ system in the human body. The central nervous system is particularly vulnerable in infants and children under age six. The effects are the same whether it is breathed or swallowed. Large amounts of lead exposure may lead to blood anemia, severe stomachache, muscle weakness, and brain damage (Thirulogachandar et al., 2014). Nickel is known to be essential to the health of some organisms; but it has not been proven to be essential to the health of humans (Barceloux, 1999; ATSDR, 1995). In this present study , Ni indicated the highest mean migration metal concentration with rang 14.54 – 30.3 ppm, these mean value recorded a high significantly increased $p < 0.05$ with tomato cooked in crushed fold iron , stainless steels , aluminum and tefal utensils with mean values 30.3 ± 0.56 , 28.98 ± 0.09 , 21.56 ± 0.12 , 14.54 ± 0.15 , respectively. This high Ni content in cooked sample may be attributed to the leaching of the metal from stainless steel pot into the sample. This is consistent with the findings by several researchers that, some quantity of Ni is always transferred into food cooked with stainless steel utensils (**Agarwal et al., 1997; Berg et al., 2000; Kumar et al., 1994**). However, the obtained results is not consistent with the report by **NiDI (1994)** that, the release of nickel ions from stainless steel. The cooking tomato sauces resulted in an average of 88 µg of Ni leached per 126 g serving of tomato sauce. Stainless steel cookware can be an overlooked source of nickel, where the contribution is dependent on stainless steel grade, and cookware usage (**Kamerud et al., 2013**). Even though, the use of stainless steel utensils by nickel sensitized persons does not bring forth an allergic reaction, some patients with certain types of nickel dermatitis may have eczema when exposed to high levels of Ni through foodstuffs rich in nickel (**Veien, 1989; Veien and Menné, 1990**). As shown in this table , it could be observed that , Iron recorded high mean metal concentrations with rang 2.22 – 9.5 ppm , the mean value of Fe revealed a high significantly increased $p < 0.05$ with tomato cooked in crushed tefal more than iron fold higher than aluminum follow stainless steel with mean 9.5 ± 0.13 , 5.67 ± 0.02 , 2.78 ± 0.02 , 2.22 ± 0.01 ppm . Some amounts of Fe have been leached from the cooking utensil into the food items cooked. Thus, a periodic assessment of the level of this metal in human body is recommended to avoid bioaccumulation and its attendant's effects in future.

The result also revealed that food cooked with tefal and iron fold utensil recorded more of the Fe than those cooked with aluminum and stainless steel pots. However, the range of Fe obtained in this study is within the recommended safe limit for the metal in food (0.8mg/kg) by **JECFA (1983)**. Result in this study agreement with the findings by (**MENG Xian and KANG Yong ,2004**) who reported in them study that ,through experiments it has been found in non-acidic condition iron element in food cannot be increased by using any kinds of cooking utensils and there's not so much difference between iron cooking ware, stainless steel and aluminum utensils . In alkaline condition the iron element in food will be reduced, but in acidic condition (as tomato sauce) the amount of iron element migration in food by using iron cooking utensils can be 74 times greater than in nearly condition and 146 times greater than alkaline condition.

With regard to table (2) , which showed the mean concentration of metals (Cu , Zn , Fe) in tomato cooked in normal utensils (tefal , fold iron , aluminum and stainless steel compared with control sample cooked in (Pyrex glass). Results indicated that the mean of copper recorded the highest significantly increase $p < 0.05$ in normal aluminum's sample compared with Pyrex glass (control sample) or with stainless steel sample, while the mean copper value with tefal and fold iron wear no significant compared with control sample. The results

also indicated that, levels of Cu in tomato cooked in aluminum pot was higher than their corresponding levels samples cooked in stainless steel pot (5.11 ± 0.01) ppm. This confirmed that, aluminum cook wares may contain alloying elements such as magnesium, silicone, iron, manganese, copper and zinc (European Standard EN 601; European Standard EN 602). Greger et al., (1985) reported that, the longer the cooking time, the greater the accumulation of aluminum and about 3.5 mg/day quantity of Al is added to the daily diet through the use of aluminum for food processing. Studies have also shown that, acidic foodstuffs and soft fruits most frequently take up more Al from the containers than their basic counterparts (Hughes, 1992). Several complications have been reported on toxicity of aluminum in human like Alzheimer's disease (Harrington, 1994; Martyn et al., 1989), Neurons alteration diseases (Crappier et al., 1976; Bharathi et al., 2008). The high and low Cu levels reported for different utensils in this study was in agreement with results obtained by Onianwa et al., (1999) in aluminum sample (7.50 ± 0.10) and fold iron sample (0.147 ± 0.001) ppm.

Data in table (2) revealed that, a high significantly increased $p < 0.05$ in mean value of tomato cooked in aluminum utensils compared with control sample, while zinc level was non-significant with the sample cooked in tefal, fold iron and stainless steel utensils. As shown in this table, it could be observed that, iron recorded a high significantly increased $p < 0.05$ in mean value of tomato samples cooked in stainless steel and aluminum utensils compared to control sample with mean (4.45 ± 0.02 , 2.69 ± 0.02) ppm respectively. The result also revealed that tomato sample cooked in stainless steel utensil recorded more of the Fe than those cooked with aluminum utensil. This may be attributed to the fact that stainless steel is a metal alloy that contain more than fifty percent (50%) Fe be it ferrites or martensitic which are the most common constituent in almost all stainless steel cooking utensils found in homes and industries among other factors (Elinder, 1986). Also, there was a significantly increase $p < 0.05$ in mean value of fold iron sample (2.40 ± 0.01) ppm compared with control sample. This result is in agreement with the findings by Accominotti et al., (1998) who reported in their study that the amount of metals released into food during cooking or processing were still less than the tolerable daily intake (TDI) recommended. Comparison between the mean metals concentrations in researched and normal utensil's samples are presented in table (3).

It could be observed that, the researched tefal sample showed a significantly increase $p < 0.05$ in the mean value of Cu, Zn and Fe, metals compared with normal tefal sample. Results introduced in table (3) is noticed, cooking tomato in fold and normal paint iron recorded lower significantly increase in the mean value of Cu, Zn and Fe metals than tefal sample. Data in table (3) indicated that, the researched aluminum sample showed a highly significantly increase in the mean value of Cu, Zn and Fe metals compared with normal aluminum sample. These findings are supported by Xian and Yong, (2004) who reported that, the content of iron and other elements in different cooking utensils in different condition has been determined with flame atomic absorption spectrophotometry. Through experiments it has been found in non-acidic condition iron element in food cannot be increased by using any kinds of cooking utensils and there's not so much difference between iron cooking utensils and stainless steel and aluminium utensils. In alkaline condition the iron element in food will be reduced. but in acidic condition the amount of iron element in food by using iron cooking utensils can be 74 times greater than in nearly condition and 146 times greater than in acidic condition. Also, Accominotti et al., (1998) said that, the amount of metals released into food during cooking or processing was still less than the tolerable daily intake (TDI) recommended.

Table (1): Effect of using Scratched utensil on some metals contaminated cooking food products (Mean ± S. D)

Kind of utensil	Metals mg/100gm				
	Cu	Zn	Pb	Ni	Fe
Tefal	$22.34^{**} \pm 0.14$	1.9 ± 0.01	$15.4^{**} \pm 0.17$	14.54 ± 0.15	$9.5^{**} \pm 0.13$
Fold Iron	5.08 ± 0.19	1.81 ± 0.02	5.54 ± 0.13	$30.34^{**} \pm 0.56$	$5.67^{**} \pm 0.02$
Brilliant Aluminum	$8.0^{**} \pm 0.07$	5.6 ± 0.07	$10.0^{**} \pm 0.07$	$21.56^{**} \pm 0.12$	$2.72^{**} \pm 0.02$
Stainless steel	4.25 ± 0.03	1.85 ± 0.05	$26.44^{**} \pm 0.09$	$28.98^{**} \pm 0.09$	$2.22^{**} \pm 0.01$

Values are expressed as mean ± SD.

Significance is expressed at $P < 0.05$ using one way ANOVA test and LSD.

Table (2): Effect of using utensil on some metals contaminated cooking food products (Mean ± S.D)

Kind of utensil	Metals mg/100gm		
	Cu	Zn	Pb
Tefal	0.151±0.001	0.159**±0.01	2.01±0.01
Fold Iron (paint)	0.147±0.001	0.137±0.001	2.40**±0.01
Aluminum	7.50**±0.10	6.02**±0.00	2.69**±0.02
Pyrex glass	6.52±0.09	0.81±0.00	Zero
Stainless steel	5.11±0.01	0.81±0.07	4.45±0.02

Values are expressed as mean± SD

Significance is expressed at P< 0.05 using one way ANOVA test and LSD0

Table (3): Comparative between Scratched and normal utensil on some metals contaminated cooking food products (Mean ± S.D)

Metals Mg/100gm	Tefal		Paint Iron		Aluminum	
	Scrached	Normal	Scrached	Normal	Scrached	Normal
Cu	22.34**±0.14	0.151±0.001	5.08**±0.19	0.147±0.001	7.50±0.10	8.0±0.07
Zn	1.9±0.01	0.159±0.01	1.81±0.02	0.137±0.01	6.02**±0.00	5.6±0.07
Fe	9.5**±0.13	2.01±0.01	5.67**±0.02	2.4±0.01	2.69±0.02	2.78±0.02

Values are expressed as mean± SD

Significance is expressed at P< 0.05 using one way ANOVA test and LSD.

IV. Recommendations

It has shown that different cooking utensils like aluminum and stainless steel pot which are commonly utilize in food processing have different impact on the metal levels of different foodstuffs processed .Cooking acidic foods (tomatosauce) in recreated cooking wares (utensils)cause releasing large amount of heavy metals into food during cooking, further studies should be done on other food items not assessed in this study to avoid metal toxicity in human. And so we should avoid using scratched utensils because it considered harmful on food and our health.

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