



The 6<sup>th</sup> international- 20<sup>th</sup> Arabic conference for  
Home Economics  
Home Economics and Educational quality  
assurance December 23rd -24th, 2018

**Journal of Home  
Economics**

<http://homeEcon.menofia.edu.eg>

ISSN 1110-2578

## **Effect Of Cooking Methods( Boiling - Grilling) And Processing Using Some Natural Foods On The Concentrations Of Heavy Metals In Fresh Meats**

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### **Abstract**

The purpose of this study was to estimate some heavy metals such as Lead "Pb" ,Mercury "Hg" ,Cadmium "Cd" Nickel "Ni" ,Copper "Cu" and Cobalt "Co" in fresh meats (Btello "small veal" ,KndoZ "Beef" and Danni "sheep" ) also to investigate the effects of some cooking methods boiling and grilling on these selected heavy metals in fresh meats, finally to investigate the protective effect of soaking fresh meats precooking in natural foods (tomato juice ,lemon juice, onion juice and yogurt) on these heavy metals.

A total of 330 random samples were selected of fresh meats (Btello, KndoZ and Danni ) from the local markets in Damietta governorate 110 samples of each type of meats to evaluate their content of lead, mercury, cadmium, copper, nickel and cobalt. The samples of each kind of meats were divided as follows:

Group 1: contains 10 samples of fresh meats.

Group 2: contains 10 samples that were just boiled

Group 3: contains 10 samples that were just grilled

Group4: contains 10 samples soaked in 100% tomato juice for 2 hours before boiling

Group 5: contains 10 samples soaked in100% lemon juice for 2 hours before boiling

Group 6: contains 10 samples soaked in 100% onion juice for 2 hours before boiling

Group 7: contains 10 samples soaked in 100% yogurt for 2 hours before boiling

Group 8: contains 10 samples soaked in 100% tomato juice for 2 hours before grilling

Group 9: contains 10 samples soaked in 100% lemon juice for 2 hours before grilling

Group 10: contains 10 samples soaked in 100% onion juice for 2 hours before grilling

Group 11: contains 10 samples soaked in 100% yogurt for 2 hours before grilling

The main results declared that the concentrations of selected heavy metals were: Cd:  $0.81 \pm 0.01$ ,  $0.69 \pm 0.02$ ,  $0.37 \pm 0.01$  ppm, Cu :  $1.60 \pm 0.19$ ,  $1.20 \pm 0.10$ ,  $1.20 \pm 0.21$  ppm, Co:  $0.20 \pm 0.06$ ,  $0.15 \pm 0.02$ ,  $0.18 \pm 0.01$  ppm and Ni:  $0.40 \pm 0.08$ ,  $0.24 \pm 0.12$ ,  $0.47 \pm 0.01$  ppm in Btello, Kndo and Danni meats respectively and the concentrations of Pb, Hg in all samples were found negligible. This indicates that the investigated samples of fresh meats Btello, Kndo and Danni are safe from lead and mercury. The obtained results were concluded that mostly the values of heavy metals in fresh meats samples were lower than recommended maximum acceptable levels and the concentration of Pb and Hg were not detectable.

Results also showed that cooking methods had an important effect on these selected heavy metals concentrations. Boiling increased Cu concentrations ( $1.62 \pm 0.05$ ,  $1.68 \pm 0.08$ ,  $1.68 \pm 0.01$  ppm) but reduced Cd ( $0.26 \pm 0.02$ ,  $0.05 \pm 0.01$ ,  $0.06 \pm 0.02$  ppm), Co ( $0.16 \pm 0.02$ ,  $0.09 \pm 0.01$ ,  $0.17 \pm 0.01$  ppm) and Ni ( $0.21 \pm 0.01$ ,  $0.20 \pm 0.02$ ,  $0.26 \pm 0.02$  ppm) concentrations in Btello, Kndo and Danni meats respectively, as well Grilling increased Cu concentrations ( $2.53 \pm 0.20$ ,  $2.15 \pm 0.11$ ,  $1.83 \pm 0.02$  ppm) but reduced Cd ( $0.31 \pm 0.01$ ,  $0.08 \pm 0.01$ ,  $0.08 \pm 0.01$  ppm), Co ( $0.18 \pm 0.02$ ,  $0.09 \pm 0.01$ ,  $0.16 \pm 0.02$  ppm) and Ni ( $0.24 \pm 0.02$ ,  $0.22 \pm 0.02$ ,  $0.27 \pm 0.01$  ppm) concentrations in Btello, Kndo and Danni meats respectively.

In this study it was found that soaking fresh meats (Btello, Kndo and Danni) pre-cooking in natural foods (tomato juice, lemon juice, onion juice and yogurt) reduced selected heavy metals Cd, Cu, Co and Ni.

The present study recommends that fresh meats should be processed before cooking with the natural foods studied in order to reduce the contamination of heavy metals and overcome their health problems.

**Key words:** cadmium, copper, cobalt, nickel, tomato juice ,lemon juice, onion juice ,yogurt.

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### **Introduction**

Meat is considered the top sources of protein, it serves to get better the overall health and welfare of the body through the reform and constructing of body tissues as well as the production of antibodies (**Mann and Truswell, 2007 and Bender and Zia ,2006**).It is a very rich and comfortable source of nutrient, including micronutrients. The chemical composition of meat relies on both the type and degree of the feeding animal. Metals in publican be classified as toxic (cadmium, mercury) and essential (cobalt, copper, zinc, iron) (**Munoz –Olives et al.,2001**). Food safety and human worry the heavy metal pollutants in meat is of great concern due to the toxic nature of these contaminants even in minute quantity. Animal diet and contaminated environment in which animal respire is responsible for heavy metal pollution in meat. (**Jalil, 2013**).Heavy metals are series of Stoxic chemicals, constant in the environment, bio-accumulative and non biodegradable in food series(**Uysal et al., 2008**).Not only do heavy metals have serious positive roles in human life, but also there are negative roles too. Some of the heavy metals are considered essential, and these inclusive iron, zinc, and copper, whereas some other metals such as mercury, cadmium, lead, and arsenic have toxic roles in biochemical response of our body (**Divrikli et al., 2006**).One of the main mechanisms backwards heavy metal toxicity has been attributed to oxidative stress. Toxic metals excess production of free radicals and decrease availability of antioxidant reserves to reply to the resultant damage. A growing amount of data supplys evidence that metals are capable of interacting with nuclear proteins and DNA causing oxidative of biological devolution macromolecules (**Leonard et al., 2004**).It is well known that heavy metals induce toxic effects on various systems and apparatuses. Moreover, because of their long half-life,

heavy metals also induce collection phenomena, which in turn make an experimental excess of their concentration in blood and tissues. Besides their effects and their inclusion in chronic respiratory disease, there is a danger that heavy metals intoxication may lead to damage of the nervous system (**Mameli et al., 2001**). The meat is often sold each as fresh (whole undressed) carcasses, or dressed and smoked. Most people use diverse cooking methods to treat these meats and these methods contain barbequing, boiling, grilling, pan frying, stir frying and roasting which is done to excess its flavor, taste, palatability and to turn out it tender (**Barnes ,1994 and Omojola et al.,2015**). The cooking experiments showed that heat treatment had diverse effects on the different nutrients. The determining agents for the changes were the meat cut itself as well as the parameters related to the identical cooking methods applied (time, medium and temperature) (**Gerber, 2007**). However, with the different cooking methods and their effects on palatability, there is a poverty of information on the impact on different cooking methods on heavy metals concentration in animal meat ( **Joyce et al.,2016**). Dietary supplements have been reported to play significant roles in the reduction or prevention of Cd and Pb toxicity. Dietary strategies are helpful , as nutritional ingredients can easily and affordably be added to the daily food and can beat the negative side effects of the chelation therapy (**Zhai et al.,2015**). Therefore, the purpose of this study was to estimate some heavy metals such as Pb, Hg, Cd , Ni , Cu and Co in fresh meats (Btello . Kndoiz and Danni), also to investigate the effects of cooking methods boiling and grilling on these heavy metals and to study the protective effect of soaking fresh meats precooking in natural foods (tomato juice , lemon juice ,onion juice and yogurt) on these heavy metals concentration.

## **Materials And Methods**

### **Sample Collection and Preparation**

This study was conducted in Faculty of Science, Damietta University. A total of (330 ) samples of fresh meats (Btello " Small veal", Kndoiz "Beef" and Danni "Sheep") were collected randomly from local markets in Damietta Governorate, Egypt. Meat samples

were collected from ten different local markets to supply replicate samples of every meat. According to their kinds, all collected samples were stored in clean polythene bags and brought to the laboratory for preparation and processing. All samples were stored at -10°C until analysis (**Parekhan et al., 2014**).

### **Samples cooking**

Fresh meat samples were ready for cooking and served as the standard. Meat samples were distributed carefully to two different cooking conditions of boiling and grilling. The meat was washed and boiled in a cooking pan with enough water to cover meat using gas stove as described by **Omojola et al., (2015)**. Grilling of meat was done using home grill. No spices or food additives were added.

Prior being analyzed, samples of meat were placed outside to melt at a room's temperature. All samples were washed with distilled water to take off any polluted particles. Then samples were chopped to small pieces using a ceramic knife completely, mixed; weight 1-gram of meat was placed in a test tube for the analysis.

### **Soaking samples precooking**

Fresh meat samples were soaked in (100%tomato juice, 100%lemon juice, 100%onion juice and 100%yogurt each separately) for two hours at room temperature and washed well precooking.

### **Samples analysis for heavy metals**

The weight of a known weight of meat samples, placed in small Erlenmeyer flasks, dried in an oven at 105 C<sup>0</sup> for about 24 h, and acid digested by nitric acid and perchloric acid (2:1) on a hotplate until the solution turn into clear. Pb, Hg, Cu, Co, Cd and Ni concentration in the meat samples were prepared for heavy metal analysis according to the method described by **Kalay et al., (1999)** using an atomic absorption spectrophotometer (Pin AAcie 500, Perkin Elmer).

A total of 330 random samples were selected of fresh meats (Btello, Kndoza and Danni) from the local markets in

Damietta governorate (110 samples ) of each type of meats to evaluate their content of Pb, Hg, Cd, Cu, Ni and Co. The samples of each kind of meats were divided as follows:

Group 1: contains 10 samples of fresh meats.

Group 2: contains 10 samples that were just boiled

Group 3: contains 10 samples that were just grilled

Group4: contains 10 samples soaked in 100% tomato juice for 2 hours before boiling

Group 5: contains 10 samples soaked in 100% lemon juice for 2 hours before boiling

Group 6: contains 10 samples soaked in 100% onion juice for 2 hours before boiling

Group 7: contains 10 samples soaked in 100% yogurt for 2 hours before boiling

Group8: contains 10 samples soaked in 100% tomato juice for 2 hours before grilling

Group 9: contains 10 samples soaked in 100% lemon juice for 2 hours before grilling

Group10: contains 10 samples soaked in 100% onion juice for 2 hours before grilling

Group 11: contains 10 samples soaked in 100% yogurt for 2 hours before grilling

#### **Statistical Analysis:**

Statistical analysis were performed by using computer of statistical package for social science (SPSS version 11.0 ). The results are presented as means $\pm$  SD (SPSS,1999).

#### **Results And Discussion**

##### **Heavy metals concentrations in fresh meats :**

Data in table (1) demonstrated the heavy metals concentration in fresh meats Btello, Kndoz and Danni . Cd are most commonly distributed ecological metal poisons and each of these constant contaminants has been blamed for large-scale poisoning agents (Anonymous, 2003).The highest concentration of Cd was found in Btello meat ( $0.81\pm 0.01$  ppm )and the lowest concentration of Cd was found in Danni meat which was ( $0.37\pm 0.01$  ppm).It was found that these values appeared lower than the maximum Cd level allowed 2 ppm by Choi (2011).Whereas the concentrations of Hg

and Pb were non detectable .Cu is an primary component of various enzymes and it plays a key part in bone constructional, skeletal mineralization and in maintaining the safety of the connective tissues. Cu is fund a mental for good health, but very high intake can cause health problems such as liver and kidney injury (**Atsdr, 2004**).The Cu concentrations obtained from this study were (1.60±0.19,1.20±0.10,1.20±0.21 ppm) for Btello, KndoZ and Danni meats respectively ,these results were lower than those recorded by **Canli and Atli (2003)**.In this concern, the provisional tolerable weekly intakes (PTWI) Cu for fresh meat has been proposed as 14mg/week/ person.(**Food and Nutrition Board, 2001**).As well as the Co concentrations were high in Btello meat( 0.20± 0.06ppm) while Co concentrations were low in KndoZ meat( 0.15±0.02ppm).Although Ni is considered an essential element, Ni can cause respiratory problems and is carcinogenic (**Atsdr , 2004**), it was observed that the lowest Ni concentration was found in kndoZ meat at (0.24±0.12 ppm) and the highest Ni concentration was found in Danni meat (0.47±0.01) ppm .These results were far below the permissible limit of 0.500 mg/kg, as recorded by **USDA( 2006 )**.

On the other hand, the concentration of heavy metals in meat from various animals relies on factors like environmental conditions, type of grassland and industrialization development ( **Kadim et al., 2013**).

**Table (1) heavy metals concentrations (ppm soft tissue ) in fresh meats**

<b>Elements</b>	<b>Cd</b>	<b>Hg</b>	<b>Pb</b>	<b>Cu</b>	<b>Co</b>	<b>Ni</b>
<b>Meat</b>	<b>(Means+SD)</b>	<b>(Means+SD)</b>	<b>(Means+SD)</b>	<b>(Means+SD)</b>	<b>(Means+SD)</b>	<b>(Means+SD)</b>
<b>Btello</b>	<b>0.81+ 0.01</b>	<b>ND</b>	<b>ND</b>	<b>1.60+ 0.19</b>	<b>0.20+ 0.06</b>	<b>0.40+ 0.08</b>
<b>KndoZ</b>	<b>0.69+0.02</b>	<b>ND</b>	<b>ND</b>	<b>1.20+ 0.10</b>	<b>0.15+ 0.02</b>	<b>0.24+ 0.12</b>
<b>Danni</b>	<b>0.37+0.01</b>	<b>ND</b>	<b>ND</b>	<b>1.20+0.21</b>	<b>0.18+ 0.01</b>	<b>0.47+ 0.01</b>

ND = non detectable , ppm = part per million

**Effect of cooking methods (boiling – grilling) on heavy metals concentrations in fresh meats :**

Cooking may lower metal content although some foods can absorb metals if the cooking water is polluted . Metals used in food processing equipment or food packaging material may contribute to

food pollution. Pollution may also happen during kitchen preparation and storage( **Morgan ,1999**).

Results presented in tables (2) demonstrated the effect of cooking methods boiling and grilling on heavy metals concentrations in fresh meats.

Result revealed that cooking methods affect the concentrations of heavy metals in fresh meats. Results showed that boiling of fresh meats reduced the Cd concentrations to (0.26±0.02, 0.05±0.01 and 0.06±0.02 ppm) as well as grilling of fresh meat reduced the Cd concentrations to( 0.31±0.01, 0.08±0.01, 0.08±0.01 ppm) comparing to the Cd concentrations in fresh meats (0.81±0.01, 0.69±0.02 and 0.37±0.01 ppm) in Btello ,Kndoiz and Danni meats respectively.

These results are in harmonization with **Okareh and Akande (2015)** who found that Cd were reduced in all cooked samples boiled and grilled samples.

In this respect **Ersoy (2011)** declared that cooking methods reduced heavy metal concentration in African catfish. and the effect of cooking methods on the level of heavy metals in fish is relies on the specific heavy metal and cooking medium. Boiling of fish prior consumption is defend for the lowering of Cd and Pb concentration in *Clariasgariepinus*. fish, In addition , **Joyce et al.,(2016)** found that grilling which has the capacity to decrease the level of the most toxic heavy metal .

As well as Co concentration in boiled samples were (0.16±0.02, 0.09±0.01, 0.17±0.01 ppm )and in grilled samples were (0.18±0.02, 0.09±0.01, 0.16±0.02 ppm ) these concentrations were lower than that of the fresh meat (0.20±0.06, 0.15±0.02, 0.18±0.01 ppm) in Btello ,Kndoiz and Danni meats respectively . In this concern **Ajani et al.,(2013)** attributed to heat effect on heavy metals and a potential of the heavy metal being turn into other compounds. It was also reported that cooking methods (boiling, steaming, frying and others) can change the concentration of toxic metals through different means, including the evaporation of water and volatile components, solublization of the element and also by metal binding to other macronutrients existing in the food items like carbohydrates, lipids and proteins.



The concentrations of Ni for all boiled and grilled samples in table 2 were obviously reduced compared to that of fresh samples. In this concern **Ersoy (2011)** reported that Heavy metal level in meats can be affected by processing or cooking methods. Ni contents lowered in grilled fish thus, it can be recommended that grilling are suitable method.

While Cu concentrations were increased after boiling and grilling to become (1.62±0.05, 1.68±0.08, 1.68±0.01 ppm) in boiled samples and (2.53±0.20, 2.15±0.11, 1.83±0.02 ppm) in grilled samples in Btello, Kndoz and Danni meats respectively. These results are in agreement with **Joyce et al.,(2016)** who found that boiling and grilling increased Cu level in meats.

In this respect, **Gerber (2007)** cooking heat affects meats, it will lose some water due to evaporation and drip loss, also affects the minerals concentration. The amount of the losses will rely on the temperature and length of time the meats is cooked.

On the other hand, **Eboh et al.,(2006)**, **Ahmed et al.,(2011)** and **Ajani et al.,(2013)** studied the drop in concentration of heavy metals in the grilled samples in fish meat by attributed to heat effect on heavy metals and a potential of the heavy metal being changed to other compounds. From the results of this research follows, that some cooking procedures could be applied for the moderate lowering of heavy metals in meats.

**Table (2)The effect of boiling and grilling on the heavy metals concentrations (ppm soft tissue) in fresh meats.**

Meat samples	Elements			
	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Fresh Btello	0.81±0.01	1.60±0.19	0.20±0.06	0.40±0.08
Boiled Btello	0.26±0.02	1.62±0.05	0.16±0.02	0.21±0.01
Grilled Btello	0.31±0.01	2.53±0.20	0.18±0.02	0.24±0.02
Fresh Kndoz	0.69±0.02	1.20±0.10	0.15±0.02	0.24±0.12
Boiled kndoz	0.05±0.01	1.68±0.08	0.09±0.01	0.20±0.02
Grilled Kndoz	0.08±0.01	2.15±0.11	0.09±0.01	0.22±0.02
Fresh Danni	0.37±0.01	1.20±0.21	0.18±0.01	0.47±0.01
Boiled Danni	0.06±0.02	1.68±0.01	0.17±0.01	0.26±0.02
Grilled Danni	0.08±0.01	1.83±0.02	0.16±0.02	0.27±0.01

ppm = part per million

## **Effect of some natural foods on the heavy metals concentrations in meats:**

### **The effect of soaking fresh meats in tomato juice on the heavy metals concentrations in boiled meats**

Data in table (3) demonstrated the effect of soaking fresh meats in tomato juice on the heavy metals concentrations (ppm soft tissue) in boiled meats

Results in table (3) showed that boiled meats soaked in tomato juice reduced the Cd concentrations to ( $0.25 \pm 0.01$ ,  $0.04 \pm 0.01$  and  $0.05 \pm 0.02$  ppm) comparing to the boiled meats ( $0.26 \pm 0.02$ ,  $0.05 \pm 0.01$  and  $0.06 \pm 0.02$  ppm) in Btello, Kndo and Danni meats respectively.

On the other hand, boiled meats soaked in tomato juice reduced each of Cu concentrations to ( $1.61 \pm 0.06$ ,  $1.67 \pm 0.07$  and  $1.66 \pm 0.02$  ppm), Co concentration to ( $0.09 \pm 0.14$ ,  $0.05 \pm 0.02$ , ND ppm) and Ni concentration to ( $0.17 \pm 0.02$ ,  $0.15 \pm 0.02$ ,  $0.05 \pm 0.01$  ppm) comparing to the boiled meat samples in Btello, Kndo and Danni meats respectively.

In this concern, **Ilić et al.,(2014)** reported that tomato as a fruit vegetable is not distinguished by high accumulation of heavy metals. We found important greater concentrations of Cu, and Ni in conventional tomatoes, but we found the growing method to have no influence on Cd and Cu concentrations in all cultivars.

In this respect, **Monachese et al.,(2012)** stated that tomatoes are rich in (iron, calcium, selenium, zinc, vitamins B and C, quercetin and naringenin), as well as particularly important as natural antagonists to Cd and Pb toxicity and should be consumed regularly.

Moreover, **Shi and Maguer(2000)** declared that tomato is considered as one of the most potent natural antioxidants. Also, tomato has been reported to make metal chelating proteins and phytochelatin when exposed to heavy metal ions (**Tito et al., 2011**).

**Table (3)The effect of soaking fresh meats in tomato juice on the heavy metals concentrations (ppm soft tissue ) in boiled meats**

Elements	Cd	Cu	Co	Ni
Meat samples	(Means+SD)	(Means+SD)	(Means+SD)	(Means+SD)
Boiled Btello	0.26±0.02	1.62±0.05	0.16±0.02	0.21±0.01
Boiled Btelo processed with tomato juice	0.25±0.01	1.61±0.06	0.09±0.14	0.17±0.02
Boiled Kndo	0.05±0.01	1.68±0.08	0.09±0.01	0.20±0.02
Boiled kndo processed with tomato juice	0.04±0.01	1.67±0.07	0.05±0.02	0.15±0.02
Boiled Danni	0.06±0.02	1.68±0.01	0.17±0.01	0.26±0.02
Boiled Danni meat processed with tomato juice	0.05±0.02	1.66±0.02	ND	0.05±0.01

ND = non detectable , ppm = part per million

**The effect of soaking fresh meats in tomato juice on the heavy metals concentrations (ppm soft tissue ) in grilled meats**

Data in table (4) demonstrated the effect of soaking fresh meats in tomato juice on the heavy metals concentrations (ppm soft tissue ) in grilled meats

According to the results in table (4) the mean concentrations of Cd ,Cu, Co and Ni decreased in grilled meat samples processed with tomato juice to become (0.09±0.01, 0.02±0.01,ND ppm for Cd ) ,(2.50±0.16, 2.10±0.11, 1.06±0.01 ppm for Cu) ,(0.17±0.01, 0.03±0.01,ND ppm for Co) and (0.19±0.02 ,0.11±0.01, ND ppm for Ni ) comparing to the mean concentrations of Cd ,Cu, Co and Ni in grilled meats in Btello ,Kndo and Danni meats respectively.

These results are in concordance with that obtained by **Nwokocho et al., (2012)** who indicated that tomato has been shown to significantly decrease the accumulation of heavy metals in the tissues.

**Table (4)The effect of soaking fresh meats in tomato juice on the heavy metals level (ppm soft tissue ) in grilled meats**

Elements	Cd	Cu	Co	Ni
Meat samples	(Means+SD)	(Means+SD)	(Means+SD)	(Means+SD)
Grilled Btello	0.31±0.01	2.53±0.20	0.18±0.02	0.24±0.02
Grilled Btelo processed with tomato juice	0.09±0.01	2.50±0.16	0.17±0.01	0.19±0.02
Grilled Kndo	0.08±0.01	2.15±0.11	0.09±0.01	0.22±0.02
Grilled Kndo processed with tomato juice	0.02±0.01	2.10±0.11	0.03±0.01	0.11±0.01
Grilled Danni	0.08±0.01	1.83±0.02	0.16±0.02	0.27±0.01
Grilled Danni processed with tomato juice	ND	1.06±0.01	ND	ND

ND = non detectable , ppm = part per million

**Effect of soaking fresh meats in lemon juice on the heavy metals concentration (ppm soft tissue ) in boiled meats**

Data in table (5) showed that mean concentrations of heavy metals Cd , Cu, Co and Ni in boiled meats processed with lemon juice in Btello ,Kndo and Danni meats respectively ,were reduced compared to mean concentrations of these heavy metals in boiled meats in Btello ,Kndo and Danni meats respectively. Cd concentrations of meat samples soaked in lemon juice were(0.19±0.01, 0.02±0.01, 0.04±0.02 ppm),whereas Cu concentrations of meat samples soaked in lemon juice were (1.51±0.05, 1.67±0.01, 1.24±0.04ppm) also Co concentrations of meat samples soaked in lemon juice were (0.07±0.01, 0.06±0.01,ND ppm ) and Ni concentrations of meat samples soaked in lemon juice were (0.18±0.02, 0.15±0.02, 0.15±0.03 ppm) in Btello ,Kndo and Danni meats respectively.

**Table (5)The effect of soaking fresh meats in lemon juice on the heavy metals concentrations (ppm soft tissue) in boiled meats**

Elements	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Meat samples				
Boiled Btello	0.26±0.02	1.62±0.05	0.16±0.02	0.21±0.01
Boiled Btello processed with lemon juice	0.19±0.01	1.51±0.05	0.07±0.01	0.18±0.02
Boiled Kndo	0.05±0.01	1.68±0.08	0.09±0.01	0.20±0.02
Boiled Kndo processed with lemon juice	0.02±0.01	1.67±0.01	0.06±0.01	0.15±0.02
Boiled Danni	0.06±0.02	1.68±0.01	0.17±0.01	0.26±0.02
Boiled Danni processed with lemon juice	0.04±0.02	1.24±0.04	ND	0.15±0.03

ND = non detectable , ppm = part per million

**The effect of soaking fresh meats in lemon juice on the heavy metals concentrations (ppm soft tissue ) in grilled meats**

Results presented in table (6) demonstrated the effect of soaking fresh meats in lemon juice on the heavy metals level (ppm soft tissue ) in grilled meats

According to the results in table (6) the mean concentrations of Cd , Cu, Co and Ni decreased in grilled meat samples processed with lemon juice to become (0.16±0.02, 0.03±0.01,ND ppm for Cd )

,(2.37±0.02, 2.15±0.10, 0.78±0.02 ppm for Cu) ,(0.18±0.02, 0.05±0.02,ND ppm for Co) and (0.20±0.08, 0.20±0.17, ND ppm for Ni ) when compared to the mean concentrations of Cd ,Cu, Co and Ni concentrations in grilled meat samples in Btello ,Kndoz and Danni meats respectively.

Results from tables (5,6)are in a concordance with that obtained by **Shalan *et al.*,(2005)** who found that lemon contains vitamin C (ascorbic acid) which reduce the toxic effect of heavy metals.

**Table (6)The effect of soaking fresh meats in lemon juice on the heavy metals concentrations (ppm soft tissue ) in grilled meats**

Elements	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
<b>Meat samples</b>				
Grilled Btello	0.31±0.01	2.53±0.20	0.18±0.02	0.24±0.02
Grilled Btelol processed with lemon juice	0.16±0.02	2.37±0.02	0.18±0.02	0.20±0.08
Grilled Kndoz	0.08±0.01	2.15±0.11	0.09±0.01	0.22±0.02
Grilled Kndoz processed with lemon juice	0.03±0.01	2.15±0.10	0.05±0.02	0.20±0.17
Grilled Danni	0.08±0.01	1.83±0.02	0.16±0.02	0.27±0.01
Grilled Danni processed with lemon juice	ND	0.78±0.02	ND	ND

ND = non detectable , ppm = part per million

**The effect of soaking fresh meats in onion juice on the heavy metals concentrations (ppm soft tissue ) in boiled meats**

Results presented in tables (7) revealed the effect of soaking fresh meats in onion juice on the heavy metals concentrations (ppm soft tissue ) in boiled meats

From table (7) it was observed that the mean concentrations of heavy metals Cd ,Cu, Co and Ni decreased in boiled meats samples processed with onion juice to become (0.24±0.01, 0.04±0.01, 0.03±0.01 ppm) for Cd ,(1.61±0.21, 1.67±0.21, 1.31±0.20 ppm) for Cu ,(0.15±0.04, 0.06±0.05,ND ppm) for Co and (0.19±0.10, 0.09±0.02, 0.09±0.01ppm) for Ni comparing to the mean concentrations of Cd ,Cu, Co and Ni in boiled meats in Btello ,Kndoz and Danni meats respectively.

In this respect, onion have comparable antioxidant capacities to garlic, and supplementation with these food ingredients gave

protection against developmental toxicity of heavy metals (Ola-Mudathir *et al.*, 2008).

**Table (7) The effect of soaking fresh meats in onion juice on the heavy metals concentrations (ppm soft tissue) in boiled meats**

Elements	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Meat samples				
Boiled Btello	0.26±0.02	1.62±0.05	0.16±0.02	0.21±0.01
Boiled Btelo processed with onion juice	0.24±0.01	1.61±0.21	0.15±0.04	0.19±0.10
Boiled kndoz	0.05±0.01	1.68±0.08	0.09±0.01	0.20±0.02
Boiled kndoz processed with onion juice	0.04±0.01	1.67±0.21	0.06±0.05	0.09±0.02
Boiled Danni	0.06±0.02	1.68±0.01	0.17±0.01	0.26±0.02
Boiled Danni processed with onion juice	0.03±0.01	1.31±0.20	ND	0.09±0.01

ND = non detectable , ppm = part per million

**The effect of soaking fresh meats in onion juice on the heavy metals concentrations (ppm soft tissue ) in grilled meats**

Results presented in tables (8) demonstrated the effect of soaking fresh meats in onion juice on the heavy metals concentrations (ppm soft tissue ) in grilled meats.

According to the results in table (8) it was found that the mean concentrations of Cd , Cu, Co and Ni decreased in grilled meat samples processed with onion juice to (0.21±0.01, 0.05±0.01, ND ppm) for Cd ,(2.53±0.03, 2.15±0.14,1.34±0.05 ppm) for Cu ,(0.16±0.02, 0.05±0.05, ND ppm) for Co and (0.21±0.02, 0.20±0.01, 0.21±0.02 ppm) for Ni when compared to the mean concentrations of Cd ,Cu, Co and Ni concentrations in grilled meat samples in Btello ,Kndoz and Danni meats respectively.

In this concern, **Monachese *et al.*,(2012)** reported that some edible plants like onions are good source of selenium, quercetin , vitamins B and C. Also, particularly important as natural antagonists to Cd and Pb toxicity and should be consumed regularly.

**Table (8) The effect of soaking fresh meats in onion juice on the heavy metals concentrations (ppm soft tissue) in grilled meats**

Elements	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
<b>Meat samples</b>				
Grilled Btello	0.31±0.01	2.53±0.20	0.18±0.02	0.24±0.02
Grilled Btelo with onion juice	0.21±0.01	2.53±0.03	0.16±0.02	0.21±0.02
Grilled Kndoz	0.08±0.01	2.15±0.11	0.09±0.01	0.22±0.02
Grilled Kndoz processed with onion juice	0.05±0.01	2.15±0.14	0.05±0.05	0.20±0.01
Grilled Danni	0.08±0.01	1.83±0.02	0.16±0.02	0.27±0.01
Grilled Danni processed with onion juice	ND	1.34±0.05	ND	0.21±0.02

ND = non detectable, ppm , part per million

**The effect of soaking fresh meats in yogurt on the heavy metals concentrations (ppm soft tissue ) in boiled meats**

Data in table (9) declared that mean concentrations of heavy metals Cd, Cu, Co and Ni in boiled meats processed with yogurt in Btello ,Kndoz and Danni meats, were reduced compared to mean concentrations of these heavy metals in boiled meats in Btello ,Kndoz and Danni meats respectively.

Cd concentrations of samples processed with yogurt were ( 0.25±0.03, 0.01±0.01, 0.05±0.01ppm ) ,whereas Cu concentrations of samples processed with yogurt were (1.61±0.15, 1.65±0.21, 1.13±0.11ppm ) also, Co concentrations of samples processed with yogurt were (0.15±0.04, 0.06±0.02,ND ppm ) and Ni concentrations of samples processed with yogurt were (0.19±0.01, 0.19±0.01, 0.03±0.01 ppm) in Btello ,Kndoz and Danni meats respectively.

**Table (9)The effect of soaking fresh meats in yogurt on the heavy metals concentrations (ppm soft tissue ) in boiled meats.**

Elements	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
<b>Meat samples</b>				
Boiled Btello	0.26±0.02	1.62±0.05	0.16±0.02	0.21±0.01
Boiled Btelo processed with yogurt	0.25±0.03	1.61±0.15	0.15±0.04	0.19±0.01
Boiled Kndoz	0.05±0.01	1.68±0.08	0.09±0.01	0.20±0.02
BoiledKndoz processed with yogurt	0.01±0.01	1.65±0.21	0.06±0.02	0.19±0.01
Boiled Danni	0.06±0.02	1.68±0.01	0.17±0.01	0.26±0.02
Boiled Danni processed with yogurt	0.05±0.01	1.13±0.11	ND	0.03±0.01

ND = non detectable , ppm = part per million

**The effect of soaking fresh meats in yogurt on the heavy metals concentrations (ppm soft tissue ) in grilled meats**

Results presented in table (10) demonstrated the effect of yogurt on the heavy metals concentrations (ppm soft tissue ) in grilled meats.

From table (10) it was observed that the mean concentrations of heavy metals Cd ,Cu, Co and Ni decreased in grilled meat samples processed with yogurt to (0.12±0.03, 0.03±0.02,ND ppm) for Cd ,(2.50±0.40, 2.11±0.18,1.12±0.01 ppm) for Cu ,(0.12±0.02, 0.04±0.01,ND ppm) for Co and (0.18±0.01, 0.19±0.01,ND ppm) for Ni comparing to the mean concentrations of Cd ,Cu, Co and Ni in grilled meats in Btello ,Kndo and Danni meats respectively.

The results which obtained from tables (9,10) are in harmonization with another study investigated the yogurt has lower effect on heavy metals concentration (Galati and O'Brien 2004).In this concern lactobacilli strain which found in yogurt has protective effect against Cd toxic in tissues( Tian *et al.*, 2012).

**Table (10) The effect of soaking fresh meats in yogurt on the heavy metals concentrations (ppm soft tissue ) in grilled meats**

Meat samples \ Elements	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Grilled Btello	0.31±0.01	2.53±0.20	0.18±0.02	0.24±0.02
Grilled Btello processed with yogurt	0.12±0.03	2.50±0.40	0.12±0.02	0.18±0.01
Grilled Kndo	0.08±0.01	2.15±0.11	0.09±0.01	0.22±0.02
Grilled Kndo processed with yogurt	0.03±0.02	2.11±0.18	0.04±0.01	0.19±0.01
Grilled Danni	0.08±0.01	1.83±0.02	0.16±0.02	0.27±0.01
Grilled Danni processed with yogurt	ND	1.12±0.01	ND	ND

ND = non detectable , ppm = part per million

### Conclusion

Samples of fresh meats Btello ,Kndo and Danni which obtained from local markets in Damietta Governorate, Egypt were safe from lead (Pb) and mercury(Hg).The obtained results were concluded that mostly the values of heavy metals Cadmium (Cd), Nickel (Ni), Copper (Cu) and Cobalt (Co ) in fresh meats samples were lower than recommended maximum acceptable levels and the concentration of lead and mercury were not detectable. Cooking methods had an important effect on selected heavy metals



concentrations. Boiling and grilling increased Cu concentrations but reduced Cd, Co and Ni concentrations in Btello ,Kndoz and Danni meats, also it was found that soaking fresh meats (Btello . Kndoz and Danni ) precooking in natural foods (tomato juice ,lemon juice, onion juice and yogurt) reduced selected heavy metals (Cd, Cu, Co and Ni),so the present study recommends that fresh meats should be processed before cooking with the natural foods studied in order to reduce the contamination of heavy metals and overcome their health problems.

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## تأثير طرق الطهي ( السلق – الشى ) والمعالجة ببعض الأغذية الطبيعية على محتوى اللحوم الطازجة من المعادن الثقيلة

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### الملخص

يهدف البحث الحالى إلى تقدير نسب بعض المعادن الثقيلة ( الرصاص ، الزئبق ، الكاديوم ، النيكل ، النحاس والكوبلت ) فى اللحوم الطازجة ( البتلو ، الكندوز والضانى ) الموجودة فى السوق المحلى ، بالإضافة إلى دراسة تأثير طرق الطهي ( السلق والشى ) والمعالجة ببعض الأغذية الطبيعية ( عصير الطماطم ، عصير الليمون ، عصير البصل و الزبادي ) على تلك النسب .

ولهذا الغرض تم اختيار ٣٣٠ عينة عشوائية من اللحوم الطازجة ( البتلو والكندوز والضانى ) من الأسواق المحلية فى محافظة دمياط بواقع ١١٠ عينة من كل نوع لحم حيث قسمت عينات كل نوع إلى إحدى عشر مجموعة كالتالى : المجموعة الأولى تشمل ١٠ عينات طازجة دون أي معالجة، المجموعة الثانية تشمل ١٠ عينات تم معالجتها بالسلق، المجموعة الثالثة تشمل ١٠ عينات تم معالجتها بالشى، المجموعة الرابعة تشمل ١٠ عينات تم معالجتها بالنقع فى ١٠٠% عصير طماطم لمدة ساعتين قبل السلق، المجموعة الخامسة تشمل ١٠ عينات تم معالجتها بالنقع فى ١٠٠% عصير ليمون لمدة ساعتين قبل السلق ، المجموعة السادسة تشمل ١٠ عينات تم معالجتها بالنقع فى ١٠٠% عصير بصل لمدة ساعتين قبل السلق، المجموعة السابعة تشمل ١٠ عينات تم معالجتها بالنقع فى ١٠٠% زبادي لمدة ساعتين قبل السلق، المجموعة الثامنة تشمل ١٠ عينات تم معالجتها بالنقع فى ١٠٠% عصير طماطم لمدة ساعتين قبل الشى، المجموعة التاسعة تشمل ١٠ عينات تم معالجتها بالنقع فى ١٠٠% عصير ليمون لمدة ساعتين قبل الشى ، المجموعة العاشرة تشمل ١٠ عينات تم معالجتها بالنقع فى ١٠٠% عصير بصل لمدة ساعتين قبل الشى، والمجموعة الحادية عشرة تشمل ١٠ عينات تم معالجتها بالنقع فى ١٠٠% زبادي لمدة ساعتين قبل الشى.

وقد أظهرت نتائج الدراسة أن معظم تركيزات المعادن الثقيلة المدروسة فى اللحوم الطازجة ( البتلو ، الكندوز والضانى ) كانت أقل من الحدود المسموح بها ، وقد جاءت كالتالى: بالنسبة للكاديوم ( ٠,٨١ ± ٠,٠١ ، ٠,٦٩ ± ٠,٠٢ ، ٠,٣٧ ± ٠,٠١ جزء فى المليون علي التوالي )، وبالنسبة للنحاس ( ١,٦٠ ± ٠,١٩ ، ١,٢٠ ± ٠,١٠ ، ١,٢٠ ± ٠,٢١ جزء فى المليون علي التوالي )، أما الكوبلت فكانت ( ٠,٢٠ ± ٠,٠٦ ، ٠,١٥ ± ٠,٠٢ ، ٠,١٨ ± ٠,٠١ جزء فى المليون علي التوالي ) ، وبالنسبة للنيكل ( ٠,٤٠ ± ٠,٠٨ ، ٠,٢٤ ± ٠,١٢ ، ٠,٤٧ ± ٠,٠١ جزء فى المليون علي التوالي ) ، أما عنصرى الرصاص والزئبق فكانت نسبهم غير ملحوظة. كما أشارت نتائج الدراسة إلى التأثير الهام لطرق الطهي ( السلق و الشى ) على تركيزات المعادن الثقيلة فى اللحوم

الطازجة ( البتلو ، الكندوز والضاني) حيث أدى السلق إلي زيادة تركيزات عنصر النحاس فكانت (  $1,62 \pm 0,05$  ،  $1,68 \pm 0,08$  ،  $1,68 \pm 0,01$  جزء في المليون علي التوالي ) ، بينما أدى إلي انخفاض تركيزات الكاديوم فكانت (  $0,26 \pm 0,02$  ،  $0,05 \pm 0,01$  ،  $0,06 \pm 0,02$  جزء في المليون علي التوالي ) ، كما أدى السلق أيضاً إلي انخفاض تركيزات الكوبلت فسجلت (  $0,16 \pm 0,02$  ،  $0,09 \pm 0,01$  ،  $0,17 \pm 0,01$  جزء في المليون علي التوالي ) وكذلك الحال بالنسبة للنیکل حيث انخفضت تركيزاته وسجلت (  $0,21 \pm 0,01$  ،  $0,20 \pm 0,02$  ،  $0,26 \pm 0,02$  جزء في المليون علي التوالي ) ، كما أدت طريقة الشى إلي زيادة تركيزات عنصر النحاس أيضاً حيث سجلت (  $2,53 \pm 0,20$  ،  $2,15 \pm 0,11$  ،  $1,83 \pm 0,02$  جزء في المليون علي التوالي) وتقليل تركيزات كلا من الكاديوم ، الكوبلت والنیکل فسجل الكاديوم تركيزات (  $0,31 \pm 0,01$  ،  $0,08$  ،  $0,01 \pm 0,08$  ،  $0,08 \pm 0,01$  جزء في المليون علي التوالي ) ، بينما سجل الكوبلت (  $0,18 \pm 0,02$  ،  $0,09 \pm 0,01$  ،  $0,16 \pm 0,02$  جزء في المليون علي التوالي ) ، أما النیکل فسجل (  $0,24 \pm 0,02$  ،  $0,22 \pm 0,02$  ،  $0,27 \pm 0,01$  جزء في المليون علي التوالي ) . كما أظهرت النتائج أيضاً تأثير معالجة اللحوم الطازجة ( البتلو ، الكندوز والضاني ) قبل الطهي ( السلق ، الشى ) بالنقع في بعض الأغذية الطبيعية ( عصير الطماطم ، عصير الليمون ، عصير البصل ، الزبادي ) حيث أدى ذلك إلي انخفاض تركيزات المعادن الثقيلة ( الكاديوم ، النحاس ، الكوبلت والنیکل) الأمر الذي جعل الدراسة توصي بمعالجة اللحوم الطازجة قبل طهيها بالأغذية الطبيعية محل الدراسة وذلك في محاولة لتخلص من التلوث بالمعادن الثقيلة والقضاء علي المشكلات الصحية التي تنجم عنها .

**الكلمات المفتاحية:** الكاديوم ، النحاس ، الكوبلت ، النیکل ، عصير الطماطم ، عصير الليمون ، عصير البصل ، الزبادي.

