Effects of some cooking methods and some treatments on the concentrations of heavy metals in meats

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INTRODUCTION

Meat is an essential part of the food we eat and consists mainly of protein and fats and some important basic elements (**Akan *et al*.,2010**). It is a very rich and an important source of nutrient, including micronutrients. The chemical composition of meat relies on both the type and degree of the feeding animal. Metals can be classified as toxic (cadmium, mercury) and essential (cobalt, copper, zinc, iron) (**Munoz –Olives *et al*.,2001**).

 Meat has the ability to accumulate toxic minerals and is an important source of heavy metals for human consumption that is dangerous to animal and human health. (**Aycicek *et al*., 2008**). Animal diet and contaminated environment in which animal respire is responsible for heavy metal pollution in meat (**Jalil, 2013**).Heavy metals are series of toxic 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 supply 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 chelating 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 . kndoz and danni), also to investigate the effects of cooking methods boiling and frying 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", Kndoz "beef" and Danni "sheep")were collected randomly from local markets of some villages in Damietta Governorate (El Sananya , El Basarta , EL Adlya, El Bustan and El Brashya) , 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 frying . 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)**.

The samples of fresh meats for frying were partially boiled for 5-8 minutes with water. No spices or food additives added. The meat was fried in a stainless steel frying pan containing cooking oil, fried for 3-5 minutes according to this size and the temperature obtained was 170 ° C after frying (**Joyce** *et al.*, **2016**).

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
A known weight of meat samples (50gm for each sample), placed in small Erienmeyer flasks ,dried in an oven at 105 C^0 for about 24 h, and acid digested by nitric acid and perchloric acid (2:1) on a hotplate until the solution turn into clear. Lead "Pb", Mercury "Hg", Copper "Cu" ,Cobalt "Co", Cadmium "Cd" and Nickel "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 . kndoz and danni) from the local markets in some villages of 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 fried
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
Group8: contains 10 samples soaked in 100% tomato juice for 2 hours before frying
Group 9: contains 10 samples soaked in100% lemon juice for 2 hours before frying
Group10: contains 10 samples soaked in 100% onion juice for 2 hours before frying
Group 11: contains 10 samples soaked in 100% yogurt for 2 hours before frying

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 . Cadmium are most commonly distributed ecological metal poisons and each of these constant contaminants has been blamed for large-scale poisoning agents **(Anonymous, 2003).** Concerning Cd concentration the results showed significant differences between fresh Btello samples and other samples (fresh kndoz and fresh danni) .The highest concentration of Cd was found in btello meat (0.82$\pm$ 0.02 ppm)and the lowest concentration of Cd was found in danni meat which was (0.38$\pm$0.03 ppm).It was found that these values appeared lower than the maximum Cd level allowed 2 ppm by **Choi (2011)**.Whereas the concentrations of Hg and Pb were non detectable .Cu is a primary component of various enzymes and it plays a key part in bone constructional, skeletal mineralization and in maintaining the safety of the connective tissues. Cu is fund a mental for good health, but very high intake can cause health problems such as liver and kidney injury **(Atsdr, 2004)**. For Cu concentrations the results in table (1) declared significant decrease in Cu concentrations in kndoz and danni meat samples comparing to Btello sampls. The Cu concentrations obtained from this study were (1.62$\pm$ 0.11, 1.22$\pm$ 0.08 and 1.22$\pm$ 0.10 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).** Concerning Co concentrations the results showed significant

differences between fresh btello meats and fresh kndoz meats while there were no significant differences between fresh btello meats and fresh danni meats. As well as the Co concentrations were high in btello meat(0.21 ± 0.05 ppm) while Co concentrations were low in kndoz meat(0.16 ± 0.04 ppm). Concerning Ni concentration the results showed significant differences between fresh btello samples and other samples (fresh kndoz and fresh danni meats). 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 0.26 ± 0.06 ppm and the highest Ni concentration was found in danni meat (0.49 ± 0.03 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).**

<p align="center">Table (1) heavy metals concentrations (ppm soft tissue) in fresh meats</p>

Elements / Meat samples	Cd (Means±SD)	Hg (Means±SD)	Pb (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Fresh Btello	0.82 ± 0.02^a	ND	ND	1.62 ± 0.11^a	0.21 ± 0.05^a	0.42 ± 0.02^b
Fresh Kndoz	0.70 ± 0.03^b	ND	ND	1.22 ± 0.08^b	0.16 ± 0.04^b	0.26 ± 0.06^c
Fresh Danni	0.38 ± 0.03^c	ND	ND	1.22 ± 0.10^b	0.19 ± 0.05^{ab}	0.49 ± 0.03^a

 ND = non detectable , ppm = part per million
Different letters on same column represent statistically significant (P<0.05) difference between means.

Effect of cooking methods (boiling – frying) 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 table (2) demonstrated the effect of cooking methods boiling and frying on heavy metals concentrations in fresh meats.

Results showed   that boiling and frying   of fresh meats caused significant decrease (p<0.05) in Cd concentrations comparing Cd concentrations of fresh meats where boiling reduced Cd concentrations to 0.28 ± 0.04 , 0.05 ± 0.01 and 0.08 ± 0.01 ppm as well as frying   of fresh meat   reduced the Cd

concentrations to 0.42 $\pm$0.02 , 0.07 $\pm$ 0.02 and 0.18 $\pm$ 0.01 ppm comparing to the Cd concentrations in fresh meats (0.82 $\pm$0.02 , 0.70 $\pm$ 0.03 and 0.38 $\pm$0.03 ppm) in btello ,kndoz and danni meats respectively.

These results are in harmonization with **Okareh and Akande (2015)** who found that Cd were reduced in all boiled cooked samples while the increase in Cd concentrations may be associated with evaporation that happens during frying treatment **(Diaconescu *et al*., 2012)**.

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 cooking has the capacity to decrease the level of the most toxic heavy metal .

However , the results showed that frying declared significant decrease (p<0.05) in Co concentrations in btello , kndoz and danni meats comparing the concentrations of fresh meats while boiling showed significant decrease (p<0.05) in Co concentrations in btello and kndoz samples comparing the concentrations of fresh meats.

Co concentration in boiled samples were (0.15$\pm$ 0.03, 0.08$\pm$ 0.03 and 0.17 $\pm$ 0.01 ppm) and in fried samples were (0.14 $\pm$0.03 , 0.07$\pm$0.03 and 0.16 $\pm$ 0.01 ppm) these concentrations were lower than that of the fresh meats (0.21 $\pm$0.05 , 0.16 $\pm$ 0.04 and 0.19$\pm$ 0.05 ppm) in btello ,kndoz 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.

Moreover, the concentrations of Ni for all boiled and fried danni samples meats in table (2) showed significantly decrease compared to that of fresh meat samples while, fried btello and fried kndoz meat samples showed no significant differences in the Ni concentrations between these samples and that of fresh meats .

In this concern **Ersoy (2011)** reported that heavy metal level in meats can be affected by processing or cooking methods.

Therefore, the results showed significant increase in Cu concentrations after boiling to become 1.82 ± 0.02 , 1.48 ± 0.04 and 1.64 ± 0.03 ppm in boiled samples in btello , kndoz and danni meats respectively while, the results also declared that frying caused significant decrease in Cu concentrations in fried btello and fried danni meat samples . Frying decreased Cu concentrations to 1.50 ± 0.04 , 1.18 ± 0.03 and 1.16 ± 0.02 ppm in fried samples in btello ,kndoz and danni meats respectively. These results are in agreement with **Joyce *et al*.,(2016)** who declared that boiling increased Cu level but frying decreased 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. Many studies reported that some changes happened during cooking in the Cd, Ni, Co and Cu levels **Jorhem *et al*., (1994) .**

On the other hand , **Eboh *et al*.,(2006)** reported that some cooking procedures could be applied for the moderate lowering of heavy metals in meats. Also, **Ahmed *et al*.,(2011)** and **Ajani *et al*.,(2013)** attributed to the influence of heat on heavy metals and the possibility of converting the heavy metal into other compounds. It has also been mentioned that cooking methods (boiling, evaporation, frying, etc.) can change the levels of heavy metals through various ways , like water evaporation and volatile components, dissolving the element and also linking minerals to large nutrients present in food like as carbohydrates, fats and proteins.

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

Elements Meat samples	Cd (Means+SD)	Cu (Means+SD)	Co (Means+SD)	Ni (Means+SD)
Fresh Btello	0.82 ± 0.02^a	1.62 ± 0.11^b	0.21 ± 0.05^a	0.42 ± 0.02^a
Boiled Btello	0.28 ± 0.04^c	1.82 ± 0.02^a	0.15 ± 0.03^b	0.24 ± 0.03^b
Fried Btello	0.42 ± 0.02^b	1.50 ± 0.04^c	0.14 ± 0.03^b	0.44 ± 0.03^a
Fresh Kndoz	0.70 ± 0.03^a	1.22 ± 0.08^b	0.16 ± 0.04^a	0.26 ± 0.06^a
Boiled kndoz	0.05 ± 0.01^c	1.48 ± 0.04^a	0.08 ± 0.03^b	0.21 ± 0.03^b
Fried Kndoz	0.07 ± 0.02^b	1.18 ± 0.03^b	0.07 ± 0.03^b	0.27 ± 0.02^a
Fresh Danni	0.38 ± 0.03^a	1.22 ± 0.10^b	0.19 ± 0.05^a	0.49 ± 0.03^a
Boiled Danni	$0.08\pm0 .01^c$	1.64 ± 0.03^a	0.17 ± 0.01^{ba}	0.25 ± 0.03^c
Fried Danni	0.18 ± 0.01^b	1.16 ± 0.02^c	0.16 ± 0.01^b	0.28 ± 0.03^b

ppm = part per million

Different letters on same column represent statistically significant (P<0.05) difference between means.

Effect of some treatments on the heavy metals concentrations in meats

The effect of soaking fresh meats before boiling in tomato juice on the heavy metals concentrations

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 this table showed that boiled meats soaked in tomato juice reduced the Cd concentrations to 0.09 ± 0.03 , ND and ND ppm comparing to the boiled meats (0.28 ± 0.04, 0.05 ± 0.01 and 0.08 ± 0.01 ppm) in btello ,kndoz and danni meats respectively.

On the other hand, boiled meats soaked in tomato juice reduced each of Cu concentrations to 1.50 ± 0.03, 1.17 ± 0.02 and 1.36 ± 0.04ppm , Co concentration to 0.08 ± 0.03, ND and 0.03 ± 0.01 ppm and Ni concentration to 0.13 ± 0.02 , 0.11 ± 0.03 and 0.08 ± 0.02 ppm comparing to the boiled meat samples in btello ,kndoz 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. The authors 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 phytochelatins when exposed to heavy metal ions **(Tito *et al*., 2011)**.

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

Elements / Meat samples	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Boiled Btello	0.28±0.04	1.82±0.02	0.15±0.03	0.24±0.03
Boiled Btelo processed with tomato juice	0.09±0.03	1.50±0.03	0.08±0.03	0.13±0.02
Boiled Kndoz	0.05±0.01	1.48±0.04	0.08±0.03	0.21±0.03
Boiled kndoz processed with tomato juice	ND	1.17±0.02	ND	0.11±0.03
Boiled Danni	0.08±0 .01	1.64±0.03	0.17±0.01	0.25±0.03
Boiled Danni meat processed with tomato juice	ND	1.36±0.04	0.03±0.01	0.08±0.02

ND = non detectable , ppm = part per million

The effect of soaking fresh meats before frying in tomato juice on the heavy metals concentrations

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

According to the results in table (4) the mean concentrations of Cd ,Cu, Co and Ni were decreased in fried   meat samples processed with tomato juice to become (0.12±0.02 , ND and 0.05±0.01 ppm for Cd) ,(1.28±0.06 , 1.05±0.03 and 0.95±0.01   ppm for Cu) ,(ND , ND   and ND   ppm for Co) and (0.15±0.04   , ND and ND ppm for Ni) comparing to the mean concentrations of Cd ,Cu, Co and Ni in fried   meats in btello , kndoz and danni meats respectively.

These results are in concordance with that obtained by **Nwokocha *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 before frying in tomato juice on the heavy metals concentrations (ppm soft tissue)

Elements / Meat samples	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Fried Btello	0.42±0.02	1.50±0.04	0.14±0.03	0.44±0.03
Fried Btelo processed with tomato juice	0.12±0.02	1.28±0.06	ND	0.15±0.04
Fried Kndoz	0.07±0.02	1.18±0.03	0.07±0.03	0.27±0.02
Fried Kndoz processed with tomato juice	ND	1.05±0.03	ND	ND
Fried Danni	0.18±0.01	1.16±0.02	0.16±0.01	0.28±0.03
Fried Danni processed with tomato juice	0.05±0.01	0.95±0.01	ND	ND

ND = non detectable , ppm = part per million

The effect of soaking fresh meats before boiling in lemon juice on the heavy metals concentrations

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 ,kndoz and danni meats respectively ,were reduced compared to mean concentrations of these heavy metals in boiled meats in btello ,kndoz and danni meats respectively. Cd concentrations of meat samples soaked in lemon juice were 0.11+0.03 , ND and ND ppm ,whereas Cu concentrations of meat samples soaked in lemon juice were 1.27+0.04 , 1.15+0.03 and 1.12+0.03 ppm, also Co concentrations of meat samples soaked in lemon juice were ND, ND, ND ppm and Ni concentrations of meat samples soaked in lemon juice were 0.05+0.03 , ND and ND ppm in btello ,kndoz and danni meats respectively.

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

Elements / Meat samples	Cd (Means+SD)	Cu (Means+SD)	Co (Means+SD)	Ni (Means+SD)
Boiled Btello	0.28+0.04	1.82+0.02	0.15+0.03	0.24+0.03
Boiled Btelo processed with lemon juice	0.11+0.03	1.27+0.04	ND	0.05+0.03
Boiled Kndoz	0.05+0.01	1.48+0.04	0.08+0.03	0.21+0.03
Boiled Kndoz processed with lemon juice	ND	1.15+0.03	ND	ND
Boiled Danni	0.08+0.01	1.64+0.03	0.17+0.01	0.25+0.03
Boiled Danni processed with lemon juice	ND	1.12+0.03	ND	ND

ND = non detectable , ppm = part per million

The effect of soaking fresh meats before frying in lemon juice on the heavy metals concentrations

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

According to the results in table (6) the mean concentrations of Cd , Cu, Co and Ni decreased in fried meat samples processed with lemon juice to become 0.17+0.02, ND and ND ppm for Cd , 1.22+0.03 , 0.87+0.03 and 0.69+0.03 ppm for Cu , 0.06+0.02 , ND and ND ppm for Co and 0.20+0.04, ND and ND ppm for Ni when compared to the mean concentrations of Cd ,Cu, Co and Ni concentrations in fried 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. In this regard dietary vitamin C supplementation can be considered as effective antioxidant against toxic effects of heavy metals Sahiti **et al.,(2018)**.

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

Elements / Meat samples	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Fried Btello	0.42±0.02	1.50±0.04	0.14±0.03	0.44±0.03
Fried Btelol processed with lemon juice	0.17±0.02	1.22±0.03	0.06±0.02	0.20±0.04
Fried Kndoz	0.07±0.02	1.18±0.03	0.07±0.03	0.27±0.02
Fried Kndoz processed with lemon juice	ND	0.87±0.03	ND	ND
Fried Danni	0.18±0.01	1.16±0.02	0.16±0.01	0.28±0.03
Fried Danni processed with lemon juice	ND	0.69±0.03	ND	ND

ND = non detectable , ppm = part per million

The effect of soaking fresh meats before boiling in onion juice on the heavy metals concentrations

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 0.13±0.03, ND and ND ppm for Cd , 1.57±0.05, 1.15±0.04 and 1.23±0.02 ppm for Cu , 0.07±0.03, ND and ND ppm for Co and 0.15±0.05, 0.09±0.04 and 0.09±0.03 ppm 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 before boiling in onion juice on the heavy metals concentrations (ppm soft tissue)

Elements / Meat samples	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Boiled Btello	0.28±0.04	1.82±0.02	0.15±0.03	0.24±0.03
Boiled Btelo processed with onion juice	0.13±0.03	1.57±0.05	0.07±0.03	0.15±0.05
Boiled kndoz	0.05±0.01	1.48±0.04	0.08±0.03	0.21±0.03
Boiled kndoz processed with onion juice	ND	1.15±0.04	ND	0.09±0.04
Boiled Danni	0.08±0 .01	1.64±0.03	0.17±0.01	0.25±0.03
Boiled Danni processed with onion juice	ND	1.23±0.02	ND	0.09±0.03

ND = non detectable , ppm = part per million

The effect of soaking fresh meats before frying in onion juice on the heavy metals concentrations

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

According to the results in table (8) it was found that the mean concentrations of Cd , Cu, Co and Ni decreased in fried meat samples processed with onion juice to 0.17±0.01 , ND   and 0.03±0.01 ppm for Cd   , 1.23±0.02 , 0.87±0.05 and 0.74±0.05 ppm for Cu , 0.05±0.02 , ND and 0.03±0.01ppm for Co and 0.29±0.02   , 0.08±0.06 and 0.10±0.03 ppm for Ni when compared to the mean concentrations of Cd ,Cu, Co and Ni concentrations in fried   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 before frying in onion juice on the heavy metals concentrations (ppm soft tissue)

Elements / Meat samples	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Fried Btello	0.42±0.02	1.50±0.04	0.14±0.03	0.44±0.03
Fried Btelo processed with onion juice	0.17±0.01	1.23±0.02	0.05±0.02	0.29±0.02
Fried Kndoz	0.07±0.02	1.18±0.03	0.07±0.03	0.27±0.02
Fried Kndoz processed with onion juice	ND	0.87±0.05	ND	0.08±0.06
Fried Danni	0.18±0.01	1.16±0.02	0.16±0.01	0.28±0.03
Fried Danni processed with onion juice	0.03±0.01	0.74±0.05	0.03±0.01	0.10±0.03

ND = non detectable, ppm , part per million

The effect of soaking fresh meats before boiling in yogurt on the heavy metals concentrations

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 0.11±0.01 , ND and ND ppm ,whereas Cu concentrations of samples processed with yogurt were 1.44±0.03, 1.23±0.04 and 1.15±0.04 ppm also, Co concentrations of samples processed with yogurt were 0.03 ±0.01 , ND and ND ppm and Ni concentrations of samples processed with yogurt were 0.05±0.01, ND and 0.05±0.03 ppm in btello , kndoz and danni meats respectively.

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

Elements / Meat samples	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Boiled Btello	0.28±0.04	1.82±0.02	0.15±0.03	0.24±0.03
Boiled Btelo processed with yogurt	0.11±0.01	1.44±0.03	0.03 ±0.01	0.05±0.01
Boiled Kndoz	0.05±0.01	1.48±0.04	0.08±0.03	0.21±0.03
BoiledKndoz processed with yogurt	ND	1.23±0.04	ND	ND
Boiled Danni	0.08±0.01	1.64±0.03	0.17±0.01	0.25±0.03
Boiled Danni processed with yogurt	ND	1.15±0.04	ND	0.05±0.03

ND = non detectable , ppm = part per million

The effect of soaking fresh meats before frying in yogurt on the heavy metals concentrations

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

From table (10) it was observed that the mean concentrations of heavy metals Cd ,Cu, Co and Ni decreased in fried meat samples processed with yogurt to 0.15±0.06 , ND and ND ppm for Cd , 1.19 ±0.03 , 0.75 ±0.04 and 0.64 ± 0.05 ppm for Cu , ND, ND and ND ppm for Co and 0.17 ±0.03 , ND and ND ppm for Ni comparing to the mean concentrations of Cd ,Cu, Co and Ni in fried meats in btello , kndoz and danni meats respectively.

The results which obtained from tables (9 and 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 tissue**s(Tian *et al*., 2012).**

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

Elements Meat samples	Cd (Means±SD)	Cu (Means±SD)	Co (Means±SD)	Ni (Means±SD)
Fried Btello Fried Btello processed with yogurt	0.42±0.02 0.15±0.06	1.50±0.04 1.19±0.03	0.14±0.03 ND	0.44±0.03 0.17 ±0.03
Fried Kndoz Fried Kndoz processed with yogurt	0.07±0.02 ND	1.18±0.03 0.75±0.04	0.07±0.03 ND	0.27±0.02 ND
Fried Danni Fried Danni processed with yogurt	0.18±0.01 ND	1.16±0.02 0.64±0.05	0.16±0.01 ND	0.28±0.03 ND

ND = non detectable , ppm = part per million

CONCLUSION

Samples of fresh meats btello ,kndoz and danni which obtained from local markets from some villages in Damietta Governorate, Egypt were investigated from hevy metals.   The levels of lead (Pb) and mercury(Hg) were non detectable .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 of fresh meats caused significant decrease ($p<0.05$) in Cd and Ni concentrations while it caused significant increase in Cu concentrations. On the other hand, frying of fresh meats caused significant decrease ($p<0.05$) in Cd and Co concentrations comparing to the concentrations of fresh meats while frying caused significant decrease in Cu concentrations in btello and danni meat samples .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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ABSTRACT
Effects of some cooking methods and some treatments on the concentrations of heavy metals in meats

The aim of current   study was to estimate some heavy metals like 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 frying   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 of some villages in Damietta governorate(El Sananya , El Basarta , EL Adlya, El Bustan and El Brashya) , 110 samples of each type of meats to evaluate their content of lead, mercury, cadmium, copper, nickel and cobalt. Where samples of each type were divided into eleven groups of equal numbers (10 samples) as follows: group 1 includes fresh samples without any treatment , groups 2 and 3 include samples treated by cooking methods (boiling and frying respectively). Groups 4,5,6 and 7 include samples which boiled and treated by soaking in 100% natural foods (tomato juice, lemon juice, onion juice and yogurt respectively) for two hours before boiling. Groups 8,9,10 and11 include samples which fried and treated by soaking in 100% natural foods (tomato juice, lemon juice, onion juice and yogurt respectively) for two hours before frying . The main results showed significant differences between fresh btello samples and other samples fresh kndoz and fresh danni in the concentrations of heavy metals Cd, Cu, Ni and the concentrations of pb, Hg in all samples were found negligible. This indicates that the investigated samples of fresh meats btello ,kndoz 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 declared that cooking methods had an important effect on these selected heavy metals concentrations. Boiling and frying of fresh meats caused significant decrease (p<0.05) in Cd concentrations comparing to the concentrations of fresh meats. However **,** frying   of fresh meats declared

significant decrease ($p<0.05$) in Co concentrations comparing the concentrations of fresh meats .

Moreover, the concentrations of Ni for all boiled meat samples and fried danni meat samples showed significantly decrease($p<0.05$) compared to that of fresh meat samples while, fried btello and fried kndoz meat samples showed no significant differences in the Ni concentrations between these samples and that of fresh meats . Therefore, the results showed significant increase in Cu concentrations after boiling in btello ,kndoz and danni meats respectively while, the results also declared significant decrease($p<0.05$) in Cu concentrations in fried btello and fried danni meat samples. In this study 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.

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: meats**,** cooking ,cadmium, copper, cobalt, nickel, soaking ,tomato juice, lemon juice, onion juice ,yogurt.

ملخص البحث

تأثير بعض طرق الطهي وبعض المعالجات على تركيزات المعادن الثقيلة في اللحوم

يهدف البحث الحالى إلى تقدير نسب بعض المعادن الثقيلة (الرصاص ،الزئبق ، الكادميوم ،النيكل،
النحاس والكوبلت) فى اللحوم الطازجة (البتلو ، الكندوز والضانى) الموجودة في السوق المحلى فى
بعض قرى محافظة دمياط ، بالإضافة إلي دراسة تأثير طرق الطهى (السلق والتحمير) 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 ،الكندوز والضانى) من
الأسواق المحلية في بعض قري محافظة دمياط (السنانية ، البصارطة ، العدلية ، البساتين و البراشية)
بواقع ١١٠عينة من كل نوع لحم حيث قسمت عينات كل نوع إلي إحدى عشر مجموعة متساوية الأعداد
(١٠ عينات) كالتالي :المجموعة الأولى تشمل عينات طازجة دون أي معالجة، المجموعة الثانية
والثالثة وتشمل العينات المعالجة بطرق الطهي (السلق و التحمير علي التوالي) ، المجموعة الرابعة
والخامسة والسادسة والسابعة تشمل عينات مسلوقة ومعالجة بالنقع في ١٠٠% أغذية طبيعية (عصير
طماطم، عصير ليمون، عصير بصل و زبادي علي التوالي) لمدة ساعتين قبل السلق ، المجموعة
الثامنة والتاسعة والعاشرة والحادية عشره تشمل عينات محمرة ومعالجة بالنقع في ١٠٠% أغذية طبيعية
(عصير طماطم، عصير ليمون، عصير بصل و زبادي علي التوالي) لمدة ساعتين قبل التحمير.وقد
أظهرت نتائج الدراسة أن معظم تركيزات المعادن الثقيلة المدروسة في اللحوم الطازجة (البتلو ، الكندوز
والضانى) كانت أقل من الحدود المسموح بها ، كما أظهرت النتائج وجود فروق معنوية($P< 0.05$) بين
عينات البتلو الطازجة وعينات اللحوم الأخرى الطازجة (الكندوز والضانى) فى تركيزات الكادميوم
والنحاس والنيكل أما عنصرى الرصاص والزئبق فكانت نسبهم غير ملحوظه. كما أشارت نتائج الدراسة
إلى التأثير الهام لطرق الطهى (السلق و التحمير) على تركيزات المعادن الثقيلة في اللحوم الطازجة (
البتلو ، الكندوز والضانى) ، فبالمقارنة باللحوم الطازجة أظهر كل من السلق والتحمير انخفاض معنوى
فى تركيزات الكادميوم عند مستوى معنوية ($P< 0.05$)، كما أظهر التحمير انخفاض معنوي($P< 0.05$) فى تركيزات الكوبلت ،بالاضافة الي ظهور انخفاض معنوى ($P< 0.05$) في تركيزات النيكل
لعينات اللحوم المسلوقة وعينات الضانى المحمرة وذلك بالمقارنـــــــة بتركيزات النيكل فى اللحوم
الطازجـة،أيضا أظهرت النتائج أن السلق أدى إلى زيادة معنويه ($P<0.05$) فى تركيزات النحاس فى
عينات اللحوم (البتلو ، الكندوز والضانى) ، بينما أدى التحمير إلى انخفاض معنوى ($P< 0.05$) فى
تركيزات النحاس فى عينات البتلو والضانى ٠ كما أظهرت النتائج أيضاً تأثير معالجة اللحوم الطازجة

(البتلو ، الكندوز والضاني) قبل الطهي (السلق ، التحمير) بالنقع في بعض الأغذية الطبيعية (عصير الطماطم ، عصير الليمون ، عصير البصل ، الزبادي) حيث أدي ذلك إلي انخفاض تركيزات المعادن الثقيلة (الكادميوم ، النحاس ، الكوبلت والنيكل) الأمر الذي جعل الدراسة توصي بمعالجة اللحوم الطازجة قبل طهيها بالأغذية الطبيعية محل الدراسة وذلك في محاولة للتخلص من التلوث بالمعادن الثقيلة والقضاء علي المشكلات الصحية التي تنجم عنها .

الكلمات المفتاحية: اللحوم ، الطهي ، الكادميوم ، النحاس ، الكوبلت ، النيكل ، النقع ، عصير الطماطم ،عصير الليمون ،عصير البصل ،الزبادى.