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Assessment of Concentration of some Heavy Metals in Sausage of Beef, Goat and Camel meat and Conformity with International Standards

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ABSTRACT

The aim of this study was to assess the concentration of lead, cadmium, mercury, arsenic, zinc, chromium, nickel, copper, manganese and iron in the sausage of beef, goat and camel meat and conformity with international standards. The meat samples were randomly collected from public market in Khartoum state and processed. The results of this study showed that, there was no significant difference between beef, goat and camel sausage in the level of lead, cadmium, mercury and arsenic, however the concentration in beef, goat and camel sausage were lower than detection limits (equipment reading 0.001), also the result showed, there was high significant difference ($p \leq 0.01$) in chromium, copper and iron between difference type of sausage and no significant difference between type of sausage in manganese, zinc and nickel. all the heavy metals in all type of sausage were conformed with FAO (2003), European Commission (EC 1881, 2006), Food Standards Australia New Zealand (FSANZ, 2015), China standard (2006) and gulf standards (2015).

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INTRODUCTION:

Toxic metal is defined as that metal, which is neither essential nor has beneficial effect, on the contrary, it displays severe toxicological symptoms even at low levels. With increasing industrialization, more and more metals are entering into the environment. These metals stay permanently because they cannot be degraded in the environment. They enter into the food material and from there they ultimately make their passage into the tissue (Munoz, 2001).

The term sausage is derived from the Latin word (salsus) meaning salt, or literally translated refers to chopped or minced meat preserved by salting and seasoned (Pearson and Tauber, 1984). Jihad et al (2009) define Sausage as prepared food, usually made of ground meat animal fat, salt, spices (sometimes with other ingredient such

as herbs) and typically packed in a casing.

Lead intoxication causes, Encephalopathy in the central nervous system, Disturbances in the kidney and liver functions progressing as far as necrosis, Damage to the reproductive organs, premature births, spontaneous abortion, Anemia and many metabolic deficiency symptoms (Janefrances, 2010). The concentration of lead in the beef products was 9.12 ppb (Gonzales-Waller et al., 2006). Demirezen and Uruc (2006) reported the concentrations of lead in sausage as 0.135 ppb.

Abedi (2011) reported cadmium content in sausages in Iran as 5.7μg kg−1. González et al (2007) found Concentrations of cadmium in meat product. Dora et al (2014) found the trace metals cadmium in sausage was (1.9) ug/kg. Also Amani and Lamia (2012) found the concentration of cadmium in sausage as (1.17–4.25) μg/g.

High levels of mercury exposure that occur through, inhalation of mercury vapors generated by thermal volatilization can lead to life threatening injuries to the lungs and neurologic system. Lower but more chronic levels of exposure can lead to erythrism which is characterized by tremor in hands, excitability, memory loss, insomnia, timidity, and sometimes delirium. This was seen in workers exposed to mercury in the felt-hat industry (mad as a hatter) (Hu, 2002). The level of mercury in sausage was1.053 ug/ (Dora et al, 2014). Also Amani and Lamia (2012) found the trace element mercury in sausage (0.014–0.055) μg/g. Hwang et al., (2011) found the mercury in sausage as (01.052) mg/kg.

Chronic arsenic exposure also causes a markedly elevated risk for developing a number of cancers, most notably skin, cancers of the liver, lung, bladder, and possibly the kidney and colon (Hu, 2002). The levels of arsenic in sausage was 18 ug/kg as reported by Dora et al (2014). Amani and Lamia (2012) found the arsenic in sausage as 0.125 mg/kg. Also Hwang et al., (2011) found the concentration of arsenic in sausage as18 mg/kg. Nickel can cause respiratory problems and is a carcinogen (ATSDR, 2004). Demirezen and uric et al. (2006) found nickel in meat products a ranged of 8.2- 24μg/g

Zinc is an essential element in animal and human diet. Too little Zinc can cause problems; however, too much Zinc is harmful to human health(nausea and vomiting, epigastric pain, abdominal cramps, and diarrhea) (Plum et al., 2010).Toxicity of zinc seems to be low; however, various toxic reactions such as the metal fume fever in which the victum suffering from pulmonary distress, fever and gastroenteritis following ingestion of zinc salts have been reported in man (Prasad, 1979). The concentration of zinc in sausage as (65.43) ppm as reported by Amani and Lamia, (2012). Also Dalia and Bassma, (2015) found Zinc concentration in sausage as (38.59) ppm.

The main sources of chromium in the diet are cereals, meat, vegetables, unrefined sugar, whale fish, vegetable oil (Codex, 1995). According to USDA (2006), the limit of chromium in meat as 1.0 mg/kg. Zahurul et al (2011) found the concentration of chromium in meat products are in the range of 2.89-4.33 mg/ kg.

Toxic intake of Manganese may result in sever pathological changes particularly in the CNS, neural damage, reproductive and immune system dysfunction, nephritis, testicular damage, pancreatitis and hepatic damage (; Keen and Leach,

1987). The concentration of manganese in sausage as (18.33) ppm (Amani and Lamia, 2012). González et al (2014) reported manganese in sausage as (0.56) mg|kg. Dalia and Bassma, (2015) reported the manganese in sausage as (8.4) ppm

ASTDR (2004) reported copper is an essential component of various enzymes and it plays a key role in bone formation, skeletal mineralization and in maintaining the integrity of the connective tissues. copper concentration in sausage as (3.45) ppm (Dalia and Bassma, 2015) , Amani and Lamia(2012) found the levels of copper in sausage as (2.3–12.05) µg/g.

MATERIALS AND METHODS:

Area of study and collection samples: This study was conducted from January - 2016 to February - 2017. Fresh samples of meat (beef, goat and camel) were randomly collected from the public Market in Khartoum state and processed at Meat Science Laboratory- Collage of Animal Production Science and Technology – SUST, samples were collected in polyethylene bags and marked according to type of sausage, then the samples were stored at ⁻18˚c for analysis.

Preparation and treatment of samples: Samples were dried in an oven at 100 °C for 2hrs. After drying the samples were grained into a fine powder using a ceramic mortar and stored in polyethylene bags until used for acid digestion. The samples were decomposed by wet digestion method for the determination of various metals. A known quantity of 10 g of As shown in Table (1) there was no significant different between different samples of sausage. All heavy metals (lead, cadmium, mercury and arsenic) in sausage were lower than the detection limits (0.001).

and González et al (2014) reported copper in sausage as (1.13)mg|kg

The level of iron in sausage as 12.54 mg|kg (González *et al* ,2014). Dalia and Bassma, (2015) found iron concentration in sausage as (135) ppm. Also Amani and Lamia(2012) found the levels of iron in sausage as (44.87–250.23) µg/g.

The aim of this study was to investigate safety, identify possible toxicants present, quantitatively measure the Lead, Cadmium, Mercury, Arsine, Zinc, Nickel, Manganese, Iron, Copper, and Chromium in the fresh meat of beef, goat and camel sausage with international standards.

each sample was introduced into the digestion flask. and 20 mL of sulphuric acid was added. The digestion flask was heated for 30 min. After digestion, hydrogen peroxide was added drop wise until a clear solution obtained. Then the content of the flask was filtered into a 50 mL volumetric flash and made up to the mark with distilled water. Determination of Cd, As, Hg, Cr, Mn, Zn, Ni and Pb in samples were made directly on each of the final solutions using Perkin-Elmer Analyst 300 Atomic Absorption Spectroscopy (AxAS).

Statistical analyses:The results were subjected to one way analysis of variance (ANOVA) ($p<0.05$) to assess whether heavy metals and essential metals varied significantly between samples. All statistical calculations were performed with SPSS 17 (SPSS, 2007).

RESULTS AND DISCUSSION:

The concentration of lead was lower than detection limits, which is conformed to European Commission (EC 1881, 2006) Chain standard (2015); Gulf standards (2015); Food Standards Australia New Zealand (FSANZ, 2015) and Ireland standards

(2009). However, this result disagrees with Gonzales-Waller et al., (2006) who reported the mean concentration of lead in the pork meat products as 6.72 ppb and in the beef products as 9.12 ppb. Also disagrees with Demirezen and Uruc (2006) who found the average lead concentrations was obtained from sausage as 0.135 ppb respectively, also disagrees with Abedi (2011) who reported the lead concentration in beef sausage from Iran as 53.5ppb. Also disagrees with Dora et al (2014) who found lead in beef sausage as 9.0 ug/kg. In this study absence of lead may be due to that fresh meat and sausage additives were free of lead contamination.

The concentration of cadmium in this study was lower than detection limits, which is conformed with European Commission (EC 1881, 2006) Chain standard (2015); Gulf standard (2015); Food Standards Australia New Zealand (FSANZ, 2015) and Ireland standard (2009). However, this result disagrees with Amani and Lamia (2012) who reported the cadmium in sausage as (3.33)ppm. And disagrees with Abedi (2011) who found the concentration of cadmium in sausages in Iran as 5.7 $\mu g\, kg^{-1}$. Also disagrees with González et al (2007) who found concentration of cadmium in meat product (4.76) µg kg−1. Also disagrees with Dora et al (2014) who found the cadmium in and sausage as 1.9 ug/kg . In this study may absence of cadmium may be due to that fresh meat and sausage additives were free of cadmium contamination.

The level of mercury concentration in sausage of this study was less than detection limits, which is similar to European Commission (EC 1881, 2006) Chain standard (2015); Gulf standard (2015); Food Standards Australia New Zealand (FSANZ, 2015) and Ireland standard (2009). This result disagrees with Dora *et al* (2014) who found the mercury in beef sausage 1.053ug/kg. Also disagrees with Amani and Lamia (2012) who found the mercury in beef sausage (0.014–0.055 µg/g. In this study may absence of mercury may be due to that fresh meat and sausage additives were free of mercury contamination.

The concentration of arsenic in this study was lower than detection limit, which is conformed with European Commission (EC 1881, 2006) Chain standard (2015); Gulf standard (2015); Food Standards Australia New Zealand (FSANZ, 2015) and Ireland standards (2009). This result disagrees with Dora *et al* (2014) who found the arsenic sausage as 18ug/kg, also disagrees with Amani and Lamia (2012) who found the arsenic in sausage beef as 0.125 mg/kg. In this study May absence of arsenic may be due to that fresh meat and sausage additives were free of arsenic contamination.

Table 1: The heavy metals in beef, goat and camel sausage (mg|kg):

Element Type of sausage	Pb	Cd	Hg	As
Beef sausage	ND	ND	ND	ND
Goat sausage	ND	ND	ND	ND
Camel sausage	DL	ND	ND	ND
Sig	NS	NS	NS	NS

*ND: Not detected
DL: Detection limits (at equipment reading 0.001).
NS: No Significance different.

As shown in Table (2) there was high significant difference ($P \leq 0.05$) between different sausage samples in Iron, chromium and copper but there was no significant difference (NS) in nickel, manganese and zinc. Beef sausage recorded the highest level of nickel (0.11) compared with goat and

camel sausage as (0.01) and (0.01) mg/kg respectively, which disagrees with Ijaz et al,(2013) who found Concentration of nickel in goat meat as (2.335 -13.271) mg|kg. Also disagrees with Sathyamoorthy et al., (2016) who found Nickel in meat as (22.1) mg|kg, And also disagrees with Demirezen and Uric. (2006) who found nickel in meat products in the range of 8.2-24µg/g. In this study the lower presence of nickel may be due to lower content of nickel in grazing fodders.

Beef sausage recorded the highest concentration of zinc (0.75) compared with goat and camel sausage which is (0.58), and (0.66) mg/kg respectively, which was similar to FAO, (2002) who stated the Zinc concentration in meat product was below the allowed limit as 50 mg/kg. However, this result disagrees with Amani and Lamia (2012) who reported the zinc in sausage as 16.79–49.43ppm. Also disagrees with Dalia and Bassma, (2015) who found Zinc concentration in sausage as 38.59ppm. In this study the lower presence of zinc may be due to lower content of zinc in grazing fodders.

Beef sausage recorded the highest level of chromium (0.606) compared with goat and camel sausage which were (0.27) and (0.36) mg/kg respectively, which is similar to china standard (2015) and USDA (2006). This results also Agrees with Zahurul *et al* (2011) who found the concentration of chromium in meat products is the ranged 2.89-4.33 mg/ kg^{-1}. In this study the lower presence of chromium may be due to lower content of chromium in grazing fodders.

Beef sausage recorded the highest level of manganese as (0.03) compared with goat was (Not Detection limits) and camel sausage (0.03) mg/kg respectively, which disagrees with González et al., (2014) who reported manganese in sausage as 0.56 mg|kg. Also disagrees with Amani and Lamia (2012) who found manganese in sausage as 7.72–13.99µg/g. Also disagrees Dalia and Bassma, (2015) who found manganese in sausage as (8.4)ppm. And also disagrees Zahran and Hendy (2015) who reported the concentration of manganese in sausages ranged from 3.32–18.38 ppm. In this study the lower presence of manganese may be due to lower content of manganese in grazing fodders.

Beef sausage also recorded the highest level of copper (1.08) compared with goat and camel meat which were (0.50) and (0.43) mg/kg respectively, but was lower than Dalia and Bassma, (2015) who found copper concentration in sausage as 3.45 ppm, also lower than Amani and Lamia (2012) who found the levels of copper in sausage as 2.3–12.05 µg/g. However, this result is similarly near to González et al., (2014) who reported copper in sausage as (1.13)mg|kg. In this study the lower presence of nickel may be due to lower content of nickel in grazing fodders. In this study the lower presence of copper may be due to lower content of copper in grazing fodders.

Beef sausage samples recorded the highest level of iron as (76.14) compared with goat and camel sausage (38.32) and (37.81) mg/kg respectively, which agrees with that reported by Amani and Lamia (2012) as 44.87–250.23 µg/g. this result also agrees with Zahran and Hendy reported (2015) who found the concentration of Fe in sausages as ranged from 82.9 to 270 mg. However, this result disagrees with Dalia and Bassma, (2015) who found iron concentration in sausage as 135 ppm. Also disagrees with González et al (2014) who found the level of iron in

sausage as (12.54) mg|kg. In this study the lower presence of iron may be due to lower content of iron in grazing fodders.

Table 2: Essential metals in beef, goat and camel meat sausage (mg|kg):

Element Type of sausage	Cr	Cu	Mn	Zn	Ni	Fe
Beef sausage	0.6[a]±0.028	1.07 [a]±0.329	0.33±0.030	0.72±0.16	0.10±0.09	76.14[a]±0.76
Goat sausage	0.27[b]±0.624	0.5[b]±0.036	DL	0.31±0.13	0.01±0	38.32[b]±0.18
Camel sausage	0.36 c±0.083	0.02[b]±0.050	0.04±0.046	0.16±0.04	0.01±0.01	37.81[b]±0.35
Sig	**	**	NS	NS	NS	**

[a], [b], c mean with different superscript in the same column are significantly different at ($p \leq 0.05$)
**: Significance different $p \leq 0.05$
DL: at detection limits (0.001)
NS: No Significance different.

This study concluded all samples of sausage were free of heavy metals contamination, which is similar to international standards. The essential element of sausage in this study were also less than the standards levels.Further studies should carried out in this field to produced meat and meat product that matches with international standards .

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