Sudan University of Science and Technology

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Study on Contamination of Meat with Some Metals in Tambol area- Aljazeera State – Sudan

دراسة عن تلوث اللحوم ببعض المعادن بمنطقة تمبول ـ ولاية الجزيرة – السودان

A thesis Submitted in Fulfillment of the Requirements for the degree Of Doctor of philosophy in Animal Production

(Quality of Meat and Meat Products)

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بسم الله الرحمن الرحيم

قَالَ تَعَالَىٰ:

﴿ وَفِي ٱلۡأَرۡضِ قِطَعٞ مُّتَجَٰوِرَٰتٞ وَجَنَّٰتٞ مِّنۡ أَعۡنَٰبٖ وَزَرۡعٞ وَنَخِيلٞ صِنۡوَانٞ وَغَيۡرُ صِنۡوَانٖ يُسۡقَىٰ بِمَآءٖ وَٰحِدٖ وَنُفَضِّلُ بَعۡضَهَا عَلَىٰ بَعۡضٖ فِي ٱلۡأُكُلِۚ إِنَّ فِي ذَٰلِكَ لَأٓيَٰتٖ لِّقَوۡمٖ يَعۡقِلُونَ ٤ ﴾

صدق الله العظيم

سورة الرعد الآية (4)

DEDICATION

To my Father

To my Mother

To my Brothers and sister

With everlasting love

Mohammed

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I would like to thanks Allah who gave me strength, health and patience to complete my study. First I would like to express my sincere gratitude to my major advisor Prof. Dr. Daoud Alzubair Ahmed Daoud Department of Meat Science and Technology- College of Animal Production Science and Technology Sudan University Of Science and Technology for his excellence supervision, considerable inspiration, invaluable input, encouragement advice, guidance, generous support and constructive comments rendered to thesis throughout all stages of my work. To build up this thesis to final version, I had encouragement and support from several people who are worth thanking. Special thanks to Deanship of Scientific Research Sudan University and German Academic Service (DAAD) for their financial support. My thanks also extend to members of Tambol Camels Research Centre as well as to Dean of Veterinary Medicine and Animal Production College – Butana University for logistic and unlimited help. My thanks express to Central Lab members of Environmental &Natural Resources & Desertification Research Institute (ENRDRI) for technical support.

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Abstract:

This study was conducted to evaluate the effect of polluted groundwater , soil, fodder with heavy metals and trace elements such as (Chromium (Cr), Nickel (Ni), Zinc (Zn), Iron (Fe), Lead (Pb) and Manganese(Mn) in safety of cattle, sheep, goat and camel meat raised at Tambol area. Samples of groundwater, soil, fodder, animals meat tissues, vital organs (liver, kidney and heart) and blood serum were randomly collected to detect heavy metals traces by using flame atomic absorption spectrophotometer (FAAS).The levels of heavy metals in the muscle, liver, kidney and heart of cattle ,sheep ,goat and camel was ranged as Chromium : (0.12 - 0.35 mg/kg) , Nickel: (0.09 - 0.21 mg/kg) , Zinc (3.84 - 11.74 mg/kg) Iron: (3.25 - 10.80 mg/kg) ,Lead: (0.44 – 1.36 mg/kg) and Manganese: (0.07 - 0.28mg/kg). Whereas the concentrations of heavy metals and trace element in blood serum were ranged as Chromium : (0.40 - 0.55 mg/kg) , Nickel: (0.11 - 0.14 mg/kg) , Zinc (0.57 – 0.87 mg/kg) Iron: (0.28 – 0.73 mg/kg) ,Lead: (0.04 – 0.37 mg/kg) and Manganese: (0.51 - 0.63 mg/kg) . While the means concentrations of heavy metals and trace element in groundwater , soil and fodder were as follows: Chromium : (0.003, 0.31 and 0.00 mg/kg) , Nickel: (0.002, 0.47 and 0.00 mg/kg) , Zinc (0.02, 1.24 and 4.32 mg/kg) Iron: (0.01, 41.26 and 13.51 mg/kg) ,Lead: (0.01, 1.23 and 0.00 mg/kg) and Manganese: (0.01, 12.5 and 1.22 mg/kg) in groundwater, soil and fodder respectively. The results revealed that there was significant different at ($p \leq 0.05$) between different animals species in muscle Iron content, liver chromium, nickel, iron and manganese. The statistical analysis showed significant different at ($p<0.05$) in iron and manganese content in heart of different animals species. Blood serum of different animals showed

significant different at ($p<0.05$) in chromium, zinc, iron and lead content .All elements under investigation were showed significant different at ($p<0.05$) in groundwater, soil and fodder.

Generally, livers and kidneys showed the highest metals content whereas heart showed the lowest content. Significant positive and negative correlation was observed in concentration of metals between meat tissues and soil. Regarding the meat safety and quality, chromium, zinc, iron and Lead concentrations in meat and vital organs were found to exceed the limits of EC (2008) and WHO&FAO (2011). While the concentrations of all metals under investigation in ground water, soil and fodder were below the recommended limits of WHO and FAO.

الخلاصة :

أجريت هذه الدراسة لتقييم أثر المياه والتربة والأعلاف الملوثة بالمعادن الثقيلة والعناصر النادرة مثل الكروم والنيكل والزنك والحديد والرصاص والمنجنيز على سلامة اللحوم والأعضاء الحيوية المنتجة من الأبقار والضأن والماعز والجمال التي تربى في منطقة تمبول. تم أخذ عينات من المياه الجوفية والتربة والأعلاف واللحوم والأعضاء الحيوية (الكبد والقلب والكلى) والسيرم وتم تحليلها لمعرفة تراكيز المعادن الثقيلة باستخدام جهاز اللإمتصاص الذري.مستويات المعادن الثقيلة في العضلات الكبد والقلب والكلى كانت كالآتي: الكروم (0.12- 0.35 ملجم/كجم) ، النيكل (0.09 – 0.21 ملجم/كجم) ، الزنك (3.84- 11.74 ملجم/كجم) ، الحديد (3.25- 10.80 ملجم/كجم)، الرصاص (0.44 – 1.36 ملجم/كجم) والمنجنيز (0.07 – 0.28 ملجم/كجم) . بينما تراوحت التراكيز في مصل الدم من (0.40 – 0.55ملجم/كجم) للكروم ، (0.11 – 0.14 ملجم/كجم) للنيكل ، (0.57 – 0.87 ملجم/كجم) للزنك ، (0.28 -0.73) للجديد ، (0.04 -0.37 ملجم/كجم) للرصاص و (0.51 -0.63 ملجم / كجم) للمنجنيز.في حين ان متوسطات تراكيز المعادن الثقيلة والعناصر النادرة في المياه الجوفية والتربة والأعلاف وجدت كالآتي:- الكروم (0.003 ، 0.31 و0.00ملجم/كجم) ،النيكل (0.002 – 0.47 و 0.00 ملجم/كجم) ، الزنك (0.002 – 1.24 و 4.32 ملجم / كجم) ، الجديد (0.01 – 41.26 و 13.15 ملجم / كجم) ، الرصاص (0.01 – 1.23 و 0.00 ملجم / كجم) والمنجنيز (0.01 – 12.5 و 1.22 ملجم / كجم) على التوالي . كشفت الدراسة عن وجود فروق معنوية عالية عند مستوى المعنوية ($p<0.05$) بين عضلات الحيوانات المختلفة في محتوى الحديد ومحتوى الكروم والنيكل والحديد والمنجنيز في الكبد . ايضا تمت ملاحظة فروق معنوية عند مستوى المعنوية ($p<0.05$) بين الحيوانات المختلفة في محتوى الحديد والمنجنيز في القلب.اما في مصل الدم للحيوانات المختلفة اوضحت الدراسة وجود فروق معنوية ذات دلالة إحصائية عند مستوى المعنوية ($p<0.05$) في محتوى الكروم والزنك والحديد والرصاص . كما اظهرت الدراسة وجود فروق معنوية ذات دلالة إحصائية عند مستوى المعنوية ($p<0.05$) لجميع العناصر بين المياه الجوفية والتربة والأعلاف .

خلصت الدراسة الى وجود أعلى تراكيز للمعادن الثقيلة في الكبد والكلية بينما أقل التراكيز وجدت في القلب .كما لوحظ وجود ارتباط معنوي سالب وموجب بين تراكيز العناصر في انسجة العضلات والتربة. فيما يخص سلامة اللحوم وجودتها وجد أن تراكيز عناصر

الكروم والزنك والرصاص قد تجاوزت الحدود المسموح بها من قبل المفوضية الأوربية ومنظمة الصحة العالمية والأغذية والزراعة بينما وجدت تراكيز كل العناصر تحت الدراسة في المياه الجوفية والتربة والأعلاف أقل من الحدود الموصى بها من قبل منظمة الصحة العالمية ومنظمة الأغذية والزراعة .

Chapter 1

Introduction

Heavy metals are called trace metals when these are present in low concentration and heavy metals are of two types, essential and non-essential heavy metals. When trace metals (Fe, Mn, Zn, and Cu) are found in body in small concentration, they are essential for the existence and survival of the living organisms. The trace metals can be found naturally in the rocks, water and soil bodies. Presence of heavy metals can cause vey toxic and harmful effects on the exposed plants, animals and human beings, Polia *et al*., (2009). The metals which has a relatively high density and toxic at low quantity are referred as 'heavy metal', e.g., arsenic (As), lead (Pb), mercury (Hg), cadmium (Cd), chromium (Cr), thallium (Tl), etc and some 'trace elements' are also known as heavy metals, e.g., copper (Cu), selenium (Se) and zinc (Zn) and heavy metals are generally referred to as those metals which possess a specific density of more than 5 g/cm3 and adversely affect the environment and living organisms , Jarup., (2003). Heavy metal is defined as a metal, which is neither essential nor has beneficial effect, on the contrary, it displays severe toxicological symptoms at low levels and as a metal with a specific weigh more than 5 g.cm3 , Gonzales, *et al*., (2006) , these metals get into human body by many manners, such as smelling, eating, and can be absorbed by skin, and have no beneficial effect to human body, however, they have direct physiological toxic effects at lower level to the body and their toxicity could be present in different ways depending on its route of ingestion, e.g. chemical form, dose, tissue affinity, age and sex, as well as whether exposure is acute or chronic , Johri and Unwin, (2010). Pollution of heavy metals is a global threat to the environment as they are widely the foremost factors for environmental pollution present

in the earth's crust, air, water and food Wang *et al*., (2004).The intensive animal production systems are on increase in many regions of the world, however increase animal production is not the only aspect in human food, the food safety is also important. Thus, one of the major aspects of food safety is toxic substances such as heavy metals. Today, the environmental pollution by heavy metals is considered as one of the most serious problems in the world over the last few decades and the increasing demand of food safety has stimulated research regarding the risk associated with consumption of meat contaminated by heavy metals, Maas *et al*., (2011). The sources of toxic metals in the environment are the fossil fuels, mining industries, waste disposals and municipal sewage. Farming and forestry also contribute to the metal content in the environment due to the uses of fertilizer, pesticide and herbicides as reported by Jayasekara *et al*., (1992) The main source of heavy metals in chicken meat arises from contamination of poultry feed and drinking water as reported by Baykov *et al*., (1996). Howver Munoz and Camara, (2001) reported other sources of contamination can be vehicle emission and dirty slaughter places. 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.The emissions of heavy metals to the environment occur via a wide range of pathways, including air, water, soil, natural and anthropogenic sources, rapid industrialization, and increase in road traffic, consumer habits and hectic life style Voutsaand and Samara., (2011). The environmental exposure through food is increasingly recognized as an important source of heavy metal exposure in developed countries, Johri and Unwin, (2010). The contamination with heavy metals is a serious threat because of their toxicity, bioaccumulation and biomagnifications in the food chain, Demirezen and Uruc, (2006). Contamination of animal feed by

toxic metals cannot be entirely avoided given the prevalence of these pollutants in the environment, so there is a clear need for such contamination to be minimized, with the aim of reducing both direct effects on animal health and indirect effects on human health, Scientific Committee on Animal Nutrition SCAN, (2003). The toxic effects of heavy metals have been described in animals under relatively low levels of metal exposure and one of the earliest effects is the disruption of trace element metabolism , Goyer., (1997); Lo'pez *et al.,(* 2002). The food items that constitute human diet and even animals are contaminated when they come in contact with polluted environmental media-air, soil and water and ingestion of these contaminants by animal's cause's deposition of residues in meat, Weldegebriel *et al*., (2012). The effect of heavy metal contamination in meat is a great concern for both food safety and human health because of the toxic nature of these metals even at low concentration when ingested over a long period of time, due to their ability to accumulate in human and animal body, Xue *et al.*, (2012). Patlolla and Tchounwou., (2005) reported that high levels of metals are found in beef and mutton as a result of contaminated soil and animal feeds and contamination of meat can also be from dirty slaughterhouses. Frequently harmful feature of human diets is the simultaneous presence of toxic substances in food stuffs. There is widespread concern about human health from risk of heavy metals that present in food product and processing technology in the food production increases the probabilities of food pollution with heavy metals. Eating of polluted feed by animals give rise to precipitation and deposit in meat. Similarly Sabir *et al*., (2003) reported high levels of heavy metals in mutton and beef, as cattle graze on contaminated soil. Contamination of meat with some heavy metals causes serious health problems because they cannot be naturally degraded like organic pollutants and they accumulate in different parts of

the food and /or feed chain and body tissues. Therefore the risk of heavy metals contamination in meat is of a great concern for both food safety and human health because of the toxic nature of these metals even at relatively minute concentrations. Johri and Unwin (2010) reported that the environmental pollution by heavy metals is considered as one of the most serious threat in the world over the last few decades. Meat as the flesh of animals used for food is a relevant dietary source of proteins, essential amino acids, chemical elements (e.g. iron, zinc) and vitamins (e.g. B12, D). Yet, the healthy image of meat is tarnished by its negative association with non-nutritional elements of various toxic contaminants. Although meat is a very important human food, there is need to monitor the level of heavy metal in animal tissues so as to assess the effect on animal health and the safety of animal products in human nutrition, since food consumption had been identified as the major pathway of human exposure to heavy metals and consuming such foodstuff threatens the health of the population. The increasing demand of safety food has accelerated researches regarding the risk associated with food consumption contaminated by heavy metals. Moreover, the use of large quantities of agro-chemicals such as metal-based pesticides and fertilizers plays an important role in the contamination of foodstuffs by heavy metals. Excessive amounts of heavy metals from anthropogenic sources that enter into the ecosystem may lead to geo-accumulation and bioaccumulation, which in turn pollute the environment and affect the food chain and ultimately pose serious human health risks. Therefore, the Food and Agricultural Organization (FAO), World Health Organization (WHO), United State Environmental Protection Agency (USEPA), and other regulatory bodies of various countries have established the maximum permitted concentrations of heavy metals in foodstuffs.

1.2 The Objectives of this Study are:

1- To determine the levels of heavy metals residues in water, soil, fodder, meat, liver, kidney, Heart and blood serum of (cattle, camel, sheep and goat) produced at slaughterhouse and retail butcher's shops in Tambul area.

2- Assessent and evaluation the safety of meat, animals feed, groundwater and soil polluted with some heavy metals at Tambul area.

3- To determine the possible sources of contamination of meat and some vital organs in meat animals.

4- To aware the local authorities and publics with the hazardousness of contamination of meat with heavy metals.

Chapter 2

Literature Review

2.1. Background information:

Heavy metals are included in the group of trace elements that have negative influence on human health, even at very low concentrations , therefore heavy metals are dangerous because they bioaccumulate in living tissue and decrease or even block the intracellular biochemical processes and the risk associated with the exposure to heavy metals present in foodstuffs represents a concern in human health especially improvements in the food production and processing technology increased the chances of contamination of food with various environmental pollutants; especially heavy metals, Akan *et al*., (2010). Heavy metals have recently come to the forefront dangerous substances and are considered as serious chemical health hazards for human and animals Lars. (2003); and Massadeh and Snook, (2002). The environmental pollution associated with heavy metals has been of global concern over many decades, these metals are natural components of the environment but high rate of industrialization has been responsible for their wider diffusion and dispersal in the environment, Rajaganapathy *et al*., (2011). Most of the countries of world are facing the heavy metal pollution. Nowadays, it is well known that damage to crops or livestock may be caused by trace metals present in, or added to soil, Wong. (1985). Soil is a long-term sink for heavy metals although; they have different mobility and bioavailability, Nicholson *et al*., (2006). Ihnat and Fernandes, (1996); Demirezen and Uruc,(2006); Toor *et al*.,(2007) reported that some metals may bio-accumulate in the food chain, causing human health and environmental concerns by nature, animal liver is a

natural source of Ferrous and other essential elements, such as Copper, Magnesium, Zinc and Manganese. However, liver might contain higher amounts of heavy metals and other contaminants, which tend to accumulate in liver tissues, Adei and Adaboh, (2008). Furthermore, heavy metals are not only found in soil and in water by human industrial activity but according to Sager (2007) and Moral *et al*., (2008) are artificially added in commercial feeds which are often enriched with essential elements such as Copper, Zinc, and Arsenic in order to promote optimum growth rate and to infuse antimicrobial properties. Feeds may also contain other nonessential elements such as Cadmium, lead, Chromium due to their presence in concentrates and supplements and pollutant environment, McBride and Spiers, (2001); Lin and Chen, (2005); Sager, (2007) . Heavy metal contents showed large variation among the feed samples, indicating the differences in the use of feed additives among farms as reported by Wang *et al*., (2013). European Commission EC, (2001); Moral *et al*., (2008) reported that the reducing heavy metal inputs in agricultural soils is an important strategic aim to protect farmland and ensure food safety, thus European develop the appropriate protection policies. Animals raised in industrial areas have higher concentrations of heavy metals in their internal organs, than animals reared in rural areas Abou-Arab, (2001). Combustion of fossil fuels, the utilization of antiseptics and disinfectants, the exhausted batteries, poor agricultural practices and disposing of industrial waste are the big sources for the entrance of heavy metals in the ecosystem and industrial evolution has played an important role in causing the heavy metal pollution. In general can be classified as toxic (cadmium, lead and mercury) and essential (cobalt, copper, zinc, iron). Toxic elements can be very harmful even at low concentration when ingested over a long time period due to their ability to accumulate in human and animal body, Ray,

(1994). The metal such as Fe, Cu, Mg, Co, Zn are essential for human body but chronic metabolic disturbances may occur due to the deficiency or excess of these metals and non-essential elements such as Pb, Cd, Cr, Ni and As are considered to be toxic and their presence in the body can cause profound biochemical and neurological changes in the body, Schroeder, (1991). Farooq Ahmad (2016) found cadmium is another toxic heavy metal which causes the high blood pressure, mutations and prostate cancer. Other metals like iron, copper, zinc and manganese are important in physiological functions and act as co-factor of enzymes but the presence of these metals in excessive amount can also have the toxic effects. Foods contain a wide range of metallic elements such as sodium (Na), potassium (K), iron (Fe), (Ca) calcium, (Cu) copper and (Zn) zinc , Many of these metals are essential in living organisms, nevertheless, a considerable number of them are harmful to plants, animals and man even at low concentration , this is particularly true of heavy metals such as mercury (Hg), arsenic (As), copper, cadmium (Cd) and lead (Pb), hence toxicological and environmental experts have shown concern for the increasing cases of food contamination with these heavy metals over the years as reported in several literatures , Ray, (1994); Oehlenschlager, (2002); Damek and Sawicka (2003); Yargholi *et al*., (2008) , Zahurul *et al*., (2011) reported the metals found in all living organisms where they play a variety of roles. Non-essential elements such as lead (Pb), cadmium (Cd), chromium (Cr), Nickel (Ni), and arsenic (As) are considered to be toxic and their presence in the body can cause profound biochemical and neurological changes in the body. Among the pollutants generated by industry and urbanization, heavy metals and various pathogenic bacteria are the most dangerous, because they can cause serious health problems to human population. Health implications from heavy metals lead to kidney damage, cardiovascular diseases, induction

of hypertension, growth inhibition, interference in haeme synthesis, irreversible changes in brain and nerve cells and also some of these residues are known to be carcinogenic in nature , the pulmonary and nervous systems and skin are main target organs of arsenic contamination .Cadmium associated with kidney damage and lead considered has been associated with learning deficits in children .Copper and zinc are essential micronutrients but in higher amount may impact metallic taste to the product resulting unacceptability of the product like other residues mycotoxin also mutagenic, carcinogenic , teratogenic or hepatotoxic to most experimental and domestic animals and man as reported by Sahoo and Chatli (2015). As a consequence of natural and anthropogenic activities, heavy metals are present in the environment, so that people come into contact with them especially through the consumption of foods Harmanescu *et., al*. (2011). The presence of Cu and Hg at significant concentrations in the meat and edible offal's is considered a potential health hazard to human and animals as reported by Abou-Arab, (2001) . Albu, (2010) found the main sources of heavy metal contamination are growing and are represented, especially, by pesticides, fertilizers, industrial processes and exhaust gases from automobiles. Heavy metal from man-made pollution continues to be released into aquatic and terrestrial ecosystems, and heavy metal contamination is a serious threat because of their toxicity, bioaccumulation and biomagnifications in the food chain One of the ways how heavy metals get in and interfere the human health is through the food consumption, either those are from raw materials or from contamination during processing, Demirezen and Uruc, (2006). (FAO, WHO 2001) reported that heavy metals have been in use in human societies in many different areas for thousands of years. Although adverse health effects of heavy metals have been known for a long time, exposure to heavy metals continues and in some countries is

even increasing. Unfortunately foods and food containers is one of the major routes of heavy metal contamination in general population. Prolong consumption of unsafe concentrations of heavy metals through foodstuffs may lead to the chronic accumulation of heavy metals in the kidney and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases. WHO, (2011) asserted that the main threats to human health are contamination with heavy metals, especially lead, cadmium and mercury, because they are not metabolized by the body and become toxic when they are accumulate in tissues. Heavy metals are given significant interest throughout the globe due to their toxic, mutagenic and teratogenic effects even at very low concentrations, Oluwole *et al*., (2013). With respect to human health impacts, lead, cadmium, copper and mercury are of primary concern because of their known toxicity to human being, Okoronkwo and Olasehinde, (2007). Cadmium has a long remanence in the human body (between 10-40 years), especially in the kidneys as reported by Rubio *et al*., (2006). Heavy metals are found naturally in the earth's crust and their compositions vary among different localities, resulting in spatial variations of surrounding concentrations, Khlifi and Chaffai, (2010). The metal distribution in the atmosphere is monitored by the properties of the given metal and by various environmental factors, and the main source of mineral for humans is food chain; hence one entry point to the mineral in the human body is through livestock, Lozak *et al*., (2002). Darmono., (2001) found that the metal that can cause poisoning is the kind of the heavy metal, these metals include the essential metal such as Cu, Zn, Fe, Cr, Ni, and Se and the non-essential ones such as Hg, Pb, Cd, and As. Owing to their toxicity persistence and tendency to accumulate, heavy metals when occurring in higher concentrations, become severe toxins for human being and all living organisms through alteration of physiological

activities and biochemical parameters in blood and tissues, through affecting nervous, cardiovascular, renal and reproductive systems and through defects in cellular uptake mechanisms in the mammalian liver and kidney, inhibiting hepatic and renal sulfate / bicarbonate transporter causing sulfaturia , Javed, *et al*., (2009) . Akan *et al*. (2010); Khalafalla *et al*.(2011); Ambushe *et al*., (2012); Bala, *et al*.(2013); AbdEl- Salam *et al*.(2013)., Badis *et al*.(2014) reported that all heavy metals are toxic at certain levels of intake, as lead and cadmium play no useful role and pose a risk for animal and human health. Heavy metals detected in muscle, liver and kidney of cattle. Many investigators detect the heavy metals in meat and edible offal's (liver and kidney) for example Eltahir *et al*., (2010) and Badis *et al*., (2014) detect the metals in camel tissues and Akan *et al*., (2010); Abd El-Salam *et al*.,(2013); Badis *et al*.,*(*2014), Akoto *et al*., (2014) detect the metals in sheep tissues and Abd El-Salam *et al*., (2013) ., Mehmood *et al*., (2014) detect the metals in buffalo tissues.

2-1-1 Chromium (Cr):

Chromium is the seventh most abundant element on earth which occurs in several oxidation states in the environment ranging from Cr2+ to Cr6+ Mohanty and Kumar (2013).Similarly Zhitkovich, (2005) ascertained that Chromium occur in many different states such as divalent, four-valent, five-valent and hexavalent state and added that Chromium (VI) and Chromium (III) are the most stable forms and only their relation to human exposure is of high interest , Chromium (VI) compounds, such as calcium chromate, zinc chromates, strontium chromate and lead chromates, are highly toxic and carcinogenic in nature. Chromium (III), on the other hand, is an essential nutritional supplement for animals and humans and has an important role in glucose metabolism

, while Rodriguez *et al.,* (2007) reported that the most commonly occurring forms of Chromium are trivalent- Cr+3 and hexavalent- Cr+6 , with both states being toxic to animals, humans and plants. Chromium is present in rocks, soil, animals and plants. It can be solid, liquid, and in the form of gas. Chromium compounds are very much persistent in water sediments. Ghani, (2011) found Chromium occurs naturally by the burning of oil and coal, petroleum from Ferro cromate refractory material, pigment oxidants, catalyst, chromium steel, fertilizers, oil well drilling and metal plating tanneries. Anthropogenically, chromium is released into the environment through sewage and fertilizers. Cr (III) is immobile in its reduced form and is insoluble in water whereas Cr (VI) in its oxidized state is highly soluble in water and thus mobile as reported by Wolińska *et al*., (2013). In order to determine the activities of the metal ions in the environment, metal speciation is very important where in case of chromium the oxidative form of Cr (III) is not an essential contaminant of the ground water but Cr (VI) has been found to be toxic for humans Gurkan *et al*., (2012). Chromium is extensively used in industries such as metallurgy, electroplating, production of paints and pigments, tanning, wood preservation, chemical production and pulp and paper production. Hence these industries play a major role in chromium pollution with an adverse effect on biological and ecological species, Ghani, (2011) and added the Chromium toxicity causes chlorosis and necrosis in plants. A wide range of industrial and agricultural practices increase the toxic level in the environment causing the pollution caused by chromium and pollution of the environment by chromium, particularly hexavalent chromium, has been the greatest concern in recent years. The presence of excess of chromium beyond the permissible limit is destructive to plants since it severely affects the biological factors of the plant and enters the food chain on consumption of these plant materials. Common features

due to Cr phytotoxicity are reduction in root growth, leaf chlorosis, inhibition of seed germination and depressed biomass. Chromium toxicity greatly affects the biological processes in various plants such as maize, wheat, barley, cauliflower, citrullus and vegetables, Zayed and Terry, (2003). Nath *et al*., (2008) reported that the enzymes like catalase, peroxidase and cytochrome oxidase with iron as their component are affected by chromium toxicity and the catalase activity stimulated with excess supply of chromium inducing toxicity has been studied with respect to photosynthesis, nitrate reductase activity, protein content in algae and photosynthetic pigments. Occupational sources of chromium include protective metal coatings, metal alloys, magnetic tapes, paint pigments, rubber, cement, paper, wood preservatives, leather tanning and metal plating, Martin and Griswold, (2009).

2-1-2 Nickel (Ni):

Nickel (Ni) is the 24th most abundant element in the Earth's crust and 28th element in the periodic table, comprising about 3% of the composition of the earth. It is the a silver-white hard metal found in several oxidation states (ranging from -1 to +4), Although it forms compounds in several oxidation states, the divalent ion seems to be the most important for both organic and inorganic substances, but the trivalent form may be generated by redox reactions in the cell, Denkhaus, Salnikow (2002) .Nickel is the 5th most abundant element by weight after iron, oxygen, magnesium and silicon. Nickel is one of many trace metals widely distributed in the environment, being released from both natural sources and anthropogenic activity, with input from both stationary and mobile sources. It is present in the air, water, soil and biological material. Natural sources of atmospheric nickel levels include wind-blown dust, derived from the weathering of rocks and soils, volcanic emissions, forest

fires and vegetation. Global input of nickel to the human environment is approximately 150 000 and 180 000 metric tons per year from natural and anthropogenic sources, respectively, including emissions from fossil fuel consumption, and the industrial production, use, and disposal of nickel compounds and alloys as reported by Kasprzak *et al*., (2003).

2-1-3. Zinc (Zn):

Zinc is a transition metal and its most common oxidation form is (Zn) +2. Zinc mostly occurs as single sulfides (ZnS) in nature and the primary use of zinc is to produce galvanized products for automobiles, and for structural components in the construction industry. Zinc is also used in brass and bronze production in plumbing as well as heating and cooling systems components, Canadian Council of Ministers of the Environment, CCME (1999b) and added in Canada, the major sources of anthropogenic zinc in the environment are: electroplaters, smelting and ore processors, mine drainage, domestic and industrial sewage, combustion of solid wastes and fossil fuels, road surface runoff, corrosion of zinc alloy and galvanized surfaces, and erosion of agricultural soils it is estimated that 1.18 million tons of zinc is released annually in the Canadian environment. While weathering and other natural sources are the most important pathways, anthropogenic sources are responsible for 35% of zinc released. McKeague and Wolynetz, (1980) found the background level of total zinc is 81 ppm in the Appalachian Region of Canada, higher than 64 ppm, the estimated mean zinc concentration for worldwide soils. In most soils, zinc accumulates in the surface horizons as a result of its bonding with organic matters, Kabata and Pendias, (2001). Harmful effects from too much zinc generally begin at levels from 10 to15 times higher than the recommended dietary allowances of 5, 12, and 15 mg per day for infants, women, and men, respectively and

consuming large amounts of zinc can cause stomach cramps, nausea, and vomiting, Agency for Toxic Substances and Disease Registry , ATSDR, (2004). Zinc is well known as an essential trace element for a variety of biological activities. In biological systems, Zn is present in protein-bound and ionic forms, and plays important roles in mediating the function and structure of proteins, and in maintaining physiological balance. In vertebrates, Zn accumulates in the testis at high levels which are comparable to those in liver and kidney, Sonoko. *et al*., (2009).Zinc concentrations were found to be highest in meat, liver, fish and eggs , Janet and Carl. (1994).

2-1-4. Iron (Fe):

Iron is the second most abundant metal on the earth's crust. Iron occupies the 26th elemental position in the periodic table and is the most crucial element for growth and survival of almost all living organisms, Valko *et al.*, (2005). It is one of the vital components of organisms like algae and of enzymes such as cytochromes and catalase, as well as of oxygen transporting proteins, such as hemoglobin and myoglobin, Vuori, (1995). Iron is an attractive transition metal for various biological redox processes due to its inter-conversion between ferrous (Fe2+) and ferric (Fe3+) ions as reported by Phippen *et al.*, (2008). The abundance of species such as periphyton, benthic invertebrates and fish diversity are greatly affected by the direct and indirect effects of iron contamination, Vuori, (1995). The iron precipitate will cause considerable damage by means of clogging action and hinder the respiration of fishes. A study of iron toxicity on aquatic plants, particularly rice, reported that the growth of species of aquatic reed was found to be inhibited by concentration of 1 mg/L total iron, Phippen *et al.*, (2008).

2-1-5. Lead (Pb):

Lead is a toxic metal that can be found everywhere in the environment whose widespread industrial use, but no known nutritional benefits and with unlike other metals, such as zinc, copper and manganese does not play any biological functions and disturbs various plant physiological processes, Najeeb *et al*.,(2014). Sharma and Dubey, (2005) defined lead as a bright silvery metal, slightly bluish in a dry atmosphere and predominantly exists in the nature in its stable plumbous ion (Pb2+). It alloys with other metals such as arsenic, zinc and copper and usually found in ore in association with zinc. It begins to tarnish on contact with air, thereby forming a complex mixture of compounds, depending on the given conditions. Lead is one of the most toxic elements, because it binds and inactivates essential enzymes, Baykov *et al.*, (1996). Renal, gastrointestinal, nervous and haemapoietic systems are affected by the lead intoxication and chronic exposure at relatively low levels can result to damage kidneys and liver and to immune, reproductive, cardiovascular, nervous and gastrointestinal systems, Nwude *et al*., (2010). Lead is a metabolic poison and neurotoxin heavy metal have capacity to make strong bonding with enzymes, having sulfhydryl groups and disturbs the normal function of enzymes, Mendil, *et al* (2008). Lead that binds to essential enzymes and several other cellular components and inactivates them and recognized as a toxic substance which accumulates in the body due to its low rate of elimination, Cunningham and Saigo, (1997). In the United State, more than 100000 to 200000 tons of lead per year is being released from vehicle exhausts, some is taken up by plants, fixation to soil and flow into water bodies, hence human exposure of lead in the general population is either due to food or drinking water, Goyer, (1990). Lead, bio-

accumulates in plants and animals and its concentration is generally magnified in the food chain, Halliwell *et al.*, (2000). Canadian Council of Ministers of the Environment,CCME, (1999c) reported that the uptake rate of lead vary among and within species and is highly related to soil pH and bioavailability of lead is higher in soils with lower pH, Kabata and Pendias, (2001) found that plants absorb lead from both soil and atmosphere by root hairs and stored mainly in cell walls, therefore the lead concentration in different organs of the plant is different and the translocation of lead from roots to tops is very limited and reported that only 3% of lead absorbed via the root will accumulate in the root and distribution of lead in different organs of corn plants grown in the soil with 300 ppm lead is as follows: Roots (over 100 ppm), leaves, stems, sheaths, and nodes (all around 5 ppm) and reported that the bio-Concentration Factor (BCF) (the concentration of a chemical in the sampled tissue per concentration of that chemical in the soil) of lead for most plants generally ranges from 0.001 to 0.03 ppm whereas the concentration of lead in plants grown on uncontaminated sites ranges between 0.1 to 10 ppm, with the mean value of 2 ppm (dry weight). Pan, et al., (2010) reported that the United Nations World Health Organization (WHO) has given recommendations for maximum lead content in food and water.The Joint FAO/WHO Expert Committee on Food Additives JECFA (2003) has established a provisional tolerable weekly intake (PTWI) of 25 μg/kg bw/ week for lead. PTWI is an estimate of the amount of a contaminant that can be ingested over a lifetime without appreciable risk. An intake above the PTWI does not automatically mean that health is at risk. Transient excursion above the (PTWI) would have no health consequences provided that the average intake over long period is not exceeded as the emphasis of (PTWI) is a lifetime exposure. After ingestion, the absorption rate of lead ranges from 3% to 80%, whereas the

typical absorption rates of dietary lead in adults and infants are 10% and 50%, respectively. After absorption, lead is initially distributed to soft tissues throughout the body via blood, and then deposited in bone. Lead is excreted through the kidney and to a lesser extent in the bile while non-absorbed dietary lead is excreted in the feces, hence the organic lead may be metabolized to inorganic lead. The concentration of lead in blood is commonly used as a biomarker of exposure.

2-1-6. Manganese (Mn):

Manganese is a silver-grey metal which occurs naturally in the earth's crust. It is found in water, soil and rocks as a compound combined with sulphur, oxygen and chlorine. Manganese is an essential element for all living organisms hence small amounts are needed in the body. Manganese is one of the most abundant elements in the earth's crust and naturally occurring found in rock, soil, water, and food. Thus, all humans are exposed to manganese, and it is a normal component of the human body. The behavior of manganese in soil is very complex and is controlled by different environmental factors, of which pH-Eh conditions are the most important, Kabata-Pendias (2001).

2-2. Sources and forms of heavy metal contamination:

Heavy metals are naturally-occurring components of the earth's crust that are, as a rule, neither created nor destroyed, but are simply redistributed. Distribution of heavy metals is not uniform, such that some soils may contain higher amounts of any of these chemicals, either due to natural processes or to pollution factors wherein heavy metals have been disbursed into the environment through human activities, such as mining, power generation, manufacturing, and the former use of leaded gasoline.

Each of the heavy metals can be absorbed into many plants as they grow. Human activities such as mining, manufacturing and fossil fuel burning has resulted in the accumulation of heavy metals and its compounds in the environment, including air, water and soil. Lead is used for the production of batteries, cosmetics, metal products such as ammunitions, solder and pipes, *etc.* Martin and Griswold, (2009). Lead may reach and contaminate plants, vegetables, fruits and canned food through air, water and soil during cultivation and also during industrial processing and packaging, Loopez *et al* (2002). Fruits and vegetables grown in polluted soils may become contaminated as a result of plant uptake of lead from soils or direct deposition of leaded dust on plant surfaces ,Westoo and Rydalv, (1972.) , Patlolla and Tchounwou (2005).Therefore, through these diverse mechanisms, lead deposited in soil becomes a persistent and long-term source of lead exposure for animals and humans. In other dietary exposures studies such as those conducted in the UK and China, cereals and vegetables were found to be the main dietary sources of lead, which contributed 31% to 40% of total dietary exposure for cereals, and 23% to 35% of total dietary exposure for vegetables , Andrée, *et al*., (2010) Mohamed, *et al*., (2009*),* Iwegbue, *et al.,* (2008) reported that people, especially those who consume rice as a staple food for daily energy, are inevitably exposed to significant amount of lead via rice. Rice crops, even from unpolluted areas, may be contaminated because of fertilizers that containing lead. Amongst other foods fish are constantly exposed to lead from polluted water. Lead accumulates in their bodies tissues in different amounts depending on the size and age of fish, Alturiqi et *al*., (2012), FAO, (1983).

2-3. Exposure to Heavy Metals:

Food consumption had been identified as the major pathway of human exposure to heavy metals, and consuming foodstuff threatens the

health of the population. The increasing demand of food safety has accelerated research regarding the risk associated with food consumption contaminated by heavy metals, Mansour, *et al*., (2009). Moreover, the use of large quantities of agrochemicals such as metal-based pesticides and fertilizers plays an important role in the contamination of foodstuffs by heavy metals, Loutfy, *et al*, (2012). Excess amounts of heavy metals from anthropogenic sources that enter into the ecosystem may lead to geo-accumulation and bioaccumulation, which in turn pollute the environment and also affect the food chain and ultimately pose serious human health risks, Weldegebriel, *et al*., (2012). Therefore, the Food and Agricultural Organization (FAO), World Health Organization (WHO), United State Environmental Protection Agency (USEPA), and other regulatory bodies of various countries have established the maximum permitted concentrations of heavy metals in foodstuffs , Xue, *et al*., (2012).Gerhardsson *et al.*, (2002), Thurmer *et al*., (2002) reported that the main sources of lead exposure are lead based paints, gasoline, cosmetics, household dust, contaminated soil, emissions of industrial processes, food and smoking, drinking water, and domestic wastes which has been extended to lead bullets, plumbing pipes, pewter pitchers, storage batteries, toys and faucets therefore Overexposure to lead continues to be an important worldwide problem.

2-4. Toxicity and Effects of Heavy Metals on human body:

There are 35 metals that are of concern for human because of residential or occupational exposure, out of which twenty three are heavy metals: antimony, arsenic, bismuth, cadmium, cerium, chromium, cobalt, copper, gallium, gold, iron, lead, manganese, mercury, nickel, platinum, silver, tellurium, thallium, tin, uranium, vanadium, and zinc, Mosby *et al*., (1996). The toxicity level of a few heavy metals can be just above the

background concentrations that are being present naturally in the environment. Hence thorough knowledge of heavy metals is rather important for allowing providing proper defensive measures against their excessive contact, Ferner, (2001).

The health implications from heavy metals lead to kidney damage, cardiovascular disease, and induction of hypertension, growth inhibition, interference in haeme synthesis irreversible change in brain and nerve cells and also some of these residues known to be carcinogenic in nature. The pulmonary and nervous systems and skin are the main target organs of arsenic contamination .Cadmium associated with kidney damage and lead considered has been associated with learning deficit in children. Copper and zinc are essential micronutrients but in higher amount may impact metallic taste to the product resulting unacceptability of the products, Jhari and Chatli (2015).

2-5. Heavy Metals and Trace elements in groundwater:

Water is the important resource which influences the human and animal's life. Generally water obtained from two types of natural sources surface water (lakes, ponds, rivers, streams etc.) and ground water (bore holes and well water). Water plays an important role domestic, industrial supply, irrigation in all over the world. Ground water is a resource found under the earth's surface as most ground water comes from rain and melting snow soaking into the ground and is considered the healthiest source of drinking water, but increase of population, industrialization and urbanization are causes contamination of ground water. The contamination ground water is not easy to restore. Hence it is necessary to protect quality of ground water. According to WHO 80% of diseases are arises due to contamination ground water, Smith, *et al* (2000). In the world industrial, agriculture, and municipal activities are results ground

water contamination especially the trace metal contamination in ground water shows serious health issues. Generally metals such as chromium, nickel, zinc, iron, lead and manganese are essential but increasing concentrations causes the severe health problems, Chen *et al*., (1999). Generally the deeper the well, the better the ground water. Even if no sources of anthropogenic contamination exists there is potential for natural levels of metals and other chemicals to be harmful to human health, Odukoya *et al*., (2010).

2-5-1. Chromium in water:

The concentration of Chromium in drinking water was found as (0.0291 mg/l) as reported by Leontopoulos *et al.,* (2015). Tanneries discharge numerous polluting heavy metals and compounds into the water streams, Nath *et al*., (2008). Due to presence of excess oxygen in the environment, Cr (III) is oxidized to Cr (VI), which is extremely toxic and highly soluble in water, Cervantes *et al*., (2001). Zayed and Terry, (2003) reported in Tokyo, the underground water containing Cr (VI) spoil masses had a 2,000 times higher limited than the permissible limit of chromium. In India, the chromium level in underground water has been witnessed to be more than 12 mg/L and 550–1,500 ppm/L. The mechanism of ultra structural organization, biochemical changes and metabolic regulations has not been clarified since the process of phytotoxicity in the aquatic environment by chromium has not been concentrated on in detail, Chandra and Kulshreshtha, (2004). Oladipo *et al.,* (2014) asserted the concentrations of chromium in drinking water Sources due to Illegal Gold Mining Activities in Zamfara State – Nigeria Ranges as (25-96 mg/l). Eshraga (2005) reported the concentration of Chromium in groundwater ranges as (0.0002-0.0008mg/l), whereas the concentration in drinking water ranged as (0.0006-0.0007 mg/l), and

added that the admissible concentration of that elements in drinking water according to WHO and Sudanese standard and Meteorology organization (SSMO) Standards was 0.05 mg/l . Kumar *et al.,* (2016) found the concentrations of Chromium in Groundwater of the West Bokaro in Post-monsoon and Pre- monsoon are (0.8 mg/l) and (2.8 mg/l) respectively and added that the permissible levels of that element stated by WHO (2006) and United State Environmental Protection Agency, USEPA, (2010) are (50 and 100 mg/l) respectively. Purnama *et al.,* (2014) found the concentration of Chromium in animal drinking water as 0.52 mg/l.

2-5-2. Nickel in water:

The concentrations of nickel in drinking water Sources due to Illegal Gold Mining Activities in Zamfara State – Nigeria Ranges as (3-15 mg/l) as reported by Oladipo *et al*., (2014). Eshraga (2005) found the concentration of nickel in groundwater ranges as (0.0048-0.0069 mg/l) and concentration in drinking water ranges as (0.0023-0.0051 mg/l) and added that the admissible concentration of Nickel in drinking water according to WHO and SSMO Standards was 0.02 mg/l. Tiwari *et al*., (2016) reported the concentrations of Nickel in Groundwater of the West Bokaro Post- monsoon, and Pre- monsoon as 9.4 mg/l and 21 mg/l) respectively and added that the permissible level of nickel stated by WHO (2006) and United State Environmental Protection Agency USEPA (2010) Standards was (20 mg/l) . The concentrations of nickel element in samples of water and flesh taken from three location represent (High, Medium and Low Pollution risk- area) were (3.035, 0.002, 0.002 mg/l) respectively as reported by Hamed .*et al.,* (2015). Leontopoulos *et al*., (2015) reported the concentration of Nickel in drinking water as 0.0155 mg/l. Purnama *et al*., (2014) found the concentration of Nickel in animal drinking water as (0.05 mg/l). Sulieman *et al.,* (2017) found that the

concentration of nickel in water sample in different sites of Sudan as (0.027 and 0.015 mg/l) for Khartoum City River Nile and Nubian Lake respectively.

2-5-3. Zinc in water:

In natural surface waters, the concentration of zinc is usually below 10 μg/litre, and in groundwaters, 10– 40 μg/litre, whereas in tap water, the concentration can be much higher as a result of the leaching of zinc from piping and fittings. In a Finnish survey of 67% of public water supplies, the median zinc content in water samples taken upstream and downstream of the waterworks was below 20 μg/litre; much higher concentrations were found in tap water, the highest being 1.1 mg/litre WHO, (1996). Oladipo *et al.*, (2014) found the concentrations of zinc in drinking water Sources due to Illegal Gold Mining Activities in Zamfara State – Nigeria Ranges (1-29 mg/l). Even higher zinc concentrations (up to 24 mg/litre) were reported in a Finnish survey of water from almost 6000 wells. Estimated total exposure and relative contribution of drinking-water Values of 5–22 mg have been reported in studies on the average daily intake of zinc in different areas. Drinking-water usually makes a negligible contribution to zinc intake unless high concentrations of zinc occur as a result of corrosion of piping's and fittings. Under certain circumstances, tap water can provide up to 10% of the daily intake. Concentration of zinc in groundwater ranges in mg/l (0.005-0.011), whereas the concentration in drinking water ranges in mg/l was (0.0024-0.1195), and added that the admissible concentration of zinc in drinking water according to WHO and SSMO Standards was 5.00mg/l as reported by Eshraga (2005). Tiwari *et al.*, (2016) reported that the concentration of Zinc in Groundwater of the West Bokaro Post- monsoon (14.3 mg/l), and Pre- monsoon (33 mg/l), and added that the permissible level of zinc stated by WHO (2006) and United State Environmental

Protection Agency USEPA, (2010) are (4000 and 5000 mg/l) respectively the concentration of Zinc in drinking water was found as 2.23 mg/l as reported by. Leontopoulos *et al.,* (2015). Purnama *et al.,* (2014) reported no traces of zinc in animal's drinking water while the concentration of Zinc in forages was (3.88mg/kg) and added the concentration of zinc in tissues and organs of cattle grazing in mine revegetation areas as Fe: (32.89 , 57.95 , 47.36 , 10.10and 91.9 mg/kg) Zn: (5.64 , 8.79 ,6.9 9.18 , 0.8 mm/kg) Cr: (No traces) Ni: (No traces, No traces , 0.08 No traces mg/kg) in heart , liver , kidney , muscle and blood) respectively .

2-5-4. Iron in water:

The source of iron in surface water is anthropogenic and is related to mining activities. The production of sulphuric acid and the discharge of ferrous (Fe^{2+}) takes place due oxidation of iron pyrites (FeS_2) which are common in coal seams , Valko *et al.,* (2005). The median iron concentration in rivers has been reported to be 0.7 mg/litre. In anaerobic groundwater where iron is in the form of iron (II), concentrations will usually be 0.5–10 mg/litre, but concentrations up to 50 mg/litre can sometimes be found. Concentrations of iron in drinking-water are normally less than 0.3 mg/litre but may be higher in countries where various iron salts are used as coagulating agents in water-treatment plants and where cast iron, steel, and galvanized iron pipes are used for water distribution. Oladipo *et al.,* (2014) reported the concentrations of Iron in drinking water Sources due to Illegal Gold Mining Activities in Zamfara State – Nigeria Ranges as (256-345 mg/l). Eshraga (2005) stated that the concentration of Iron in groundwater ranges as (0.018-0.079 mg/l) whereas the concentration in drinking water ranges as (0.002 – 2.006 mg/l) and added that the admissible concentration of Iron in drinking water according to WHO and SSMO Standards as Iron 300 mg/l . Tiwari *et al.,* (2016) found the concentration of Iron in Groundwater of the

West Bokaro (476 and 880 mg/l) in Post- monsoon and pre- monsoon respectively and added that the permissible level of Iron as stated by WHO (2006) and United State Environmental Protection Agency USEPA, (2010) was (300 mg/l). While Purnama *et al.,* (2014) reported the concentration of (Iron) in animal drinking water as (0.05 mg/l).

2-5-5. Lead in water:

Water used for irrigation is normally obtained from urban streams, wells and rivers which have often been reported to be polluted by heavy metals that as well are the source of heavy metals accumulations in agriculture products, Kihampa *et al,* (2011). The concentration of lead in drinking water Sources due to Illegal Gold Mining Activities in Zamfara State – Nigeria ranges in mg/l was (21-326) as reported by Oladipo *et al.*, (2014). Eshraga (2005) found the concentration of Lead in groundwater ranges in mg/l as (0.0015-0.0025) mg/ and added the admissible concentration of lead in drinking water according to WHO and SSMO Standards as 0.05 mg/l. Hamed *et al.,* (2015) reported the concentration of lead in sample of water and flesh taken from three location represent (High, Medium and Low Pollution risk- area) were (0.409, 0.160 and ND mg/l) respectively. Leontopoulos *et al.,* (2015) stated that the concentration of lead in drinking water as 0.0068 mg/l. Sulieman *et al*., (2017) found that the concentration of lead in water sample in different sites of Sudan as (0.056 and 0.042) for Khartoum City River Nile and Nubian Lake respectively.

2-5-6. Manganese in water:

Some manganese compounds are readily soluble in water, so significant exposures can also occur by ingestion of contaminated drinking-water. Manganese in surface water can oxidize or adsorb to sediment particles and settle to the bottom. Tiwari *et al.,* (2016) reported

the concentration of Manganese in Groundwater of the West Bokaro as (28.6 , 53 mg/l) in Post- monsoon and Pre- monsoon respectively and added the permissible level of Manganese stated by WHO (2006) and United State Environmental Protection Agency , USEPA, (2010) are (100 and 50 mg/l) respectively. While Oladipo *et al.*, (2014) found the concentrations of Manganese in drinking water Sources due to Illegal Gold Mining Activities in Zamfara State – Nigeria Ranged as (22-49 mg/l).

2-6. Heavy Metals and Trace elements in Food:

Distribution of heavy metals in liver, kidney, heart, pancreas and muscle tissues of various animals showed higher concentrations in the liver and kidneys and lower in muscle tissues as reported by Abd EI- Salam, (2013). Therefore, it is necessary to evaluate the level of heavy metals contamination and assess the risks that can arise if the human consumed the cattle meat, Khalafalla *et al.*, (2011). Meat is a very important human food; therefore, it may potentially accumulate toxic minerals and represents one of the sources of heavy metals for humans, Bendeddouche *et al.*, (2014). Contamination of meat and other edible tissues with heavy metals is a matter of great concern for food safety and human health due to progressive irreversible bioaccumulation in human body organs, especially kidney, liver and spleen. Furthermore, heat treatment of food for long period of time cannot destroy heavy metals. Thus, there is a great risk associated with the consumption of ready to eat edible offal's if they are manufactured from already contaminated raw edible offal, Chitmanat and Traichaiyaporn, (2010).

2-6-1.Chromium in food:

The level of Chromium in liver, kidney, and meat of Beef, mutton, goat and Chicken ranged as 0.23 to 1.22 mg/kg as reported by Akan *et al.,* (2010). Iwegbue (2008) found the concentration of Chromium ranged as (2.88 – 4.43, 2.51-4.92 mg/kg) in liver and kidney respectively while Lgene, *et al.,* (2015) reported the concentration levels of Chromium in tissues of grasscutter from different location ranged as (0.121 – 0.182), (0.157 – 0.301), and (0.074 – 0.306) in kidney, liver and muscle respectively. The concentration of Chromium in meat of Charolaise and Herford breed ranged as (0.074- 0.077 mg/kg) as reported by Pilarczy (2014). Shaheen, *et al.,* (2016) reported that the concentration of Chromium in beef as 2.02 mg/kg, while the concentration in mutton ranged as (1.20 – 7.08 mg/kg). Lopez *et al.,* (2004) found the concentrations of Chromium in tissue of cattle from North and West Spain were (24.3, 54.0, 75.9 mg/kg) in liver kidney and muscle respectively. The concentration of Chromium in meat of goat ranged as (0.2 -0.3 mg/kg) whereas the concentration in meat of beef was ranged as (0.3 -0.48 mg/kg) as reported by Out, *et al.,* (2014). The concentration level of Chromium in meat was found as (0.304, 0.957 and 0.632 mg/kg) in beef, mutton and chevon respectively as reported by Nkansah and Ansah (2014). Zahurul, *et al.,* (2011) found the concentration of Chromium in some tissue of cattle estimated as (0.86, 0.00, 1.22mg/kg) in heart, liver and meat respectively. Concentration of Chromium in corned beef ranged as (0.1 – 0.4 mg/kg) as reported by Hozan and Mohammed (2013) whereas Leontopoulos *et al.,* (2015) reported the concentrations of Chromium in cattle tissues as (2.01, 2.98, 0.0006 mg/kg) in liver, kidney and muscle respectively. While Purnama *et al.,* (2014) reported no traces of Chromium in tissues of cattle grazing in mine revegetation areas.

Zahran and Hendy (2015) found the concentration of chromium in meat and meat products sold in Egyptian Markets ranged as (0.37 – 2.04 mg/kg). Nnadozie, *et al.,* (2014) found that no traces of chromium in beef, sheep, goat and camel meat. Bratakos *et al.,* (2002) found chromium contents in lamb meat (0.08–0.16 mg/kg) and in chicken meat (0.11–0.21mg/kg). Ogundele *et al.,* (2015) reported that the concentrations of chromium in Plants along Heavy Traffic Roads in North Central Nigeria were ranged as (0.00 – 14.1 mg/kg).

2-6-2. Nickel in food:

The concentration of Nickel in liver, kidney, and meat of Beef, mutton, goat and Chicken ranged as (0.01to 1.09 mg/g) as reported by Akan *et al.,* (2010). Iwegbue (2008) found the concentration of Nickel in liver ranged as (0.03 to 0.30 mg/kg) whereas the concentration in kidney ranged as (0.06 to 0.3 mg/kg). The concentrations of Nickel in meat of Charolaise and Herford breed ranged as (0.205- 0.208mg/kg) Pilarczy (2014). Lgene, *et al.,* (2015) reported the concentration of Nickel of grasscutter tissues from different location ranged as (0.071 – 0.114, (0.097 – 0.180 and 0.045 -0.188 mg/kg) in kidney, liver, and muscle respectively. Shaheen, *et al.,* (2016) reported the concentrations of Nickel in beef as 1.34 mg/kg while the concentration in mutton ranged as (1.5 – 1.29 mg/kg). Hamed *et al.,* (2015) found the concentrations of nickel element in samples of flesh taken from three location represent High , Medium and Low Pollution risk- area as (0.055 , 0.044 , 0.031 mg/kg) respectively. The concentrations of Nickel in tissue of cattle as (1.15, 0.00 and 2.64 mg/kg) in heart, liver and meat respectively as reported by Zahurul, *et al.,* (2011). Hozan and Mohammed (2013) reported no traces of Nickel in corned beef. The concentrations of Nickel in cattle tissues was (0.63, 0.84, 0.06 mg/kg) in liver, kidney and muscle

respectively as reported by Leontopoulos *et al.,* (2015). Purnama *et al.,* (2014) reported no traces of Nickel in heart, liver and muscle of cattle grazing in mine revegetation areas while the concentration in kidney 0.08 mg/kg).The concentration of Nickel in meat and meat products sold in Egyptian Markets ranged as 0.54 – 7.45 mg/kg as reported by Zahran and Hendy (2015). Nnadozie, *et al.,* (2014) found that no traces of nickel and in beef, sheep, goat and camel meat. Demirezen and Uruc*e* (2006) conducted the study to analyze the meat and meat products and found the content of Nickel were present in a range of 8.2- 24mg/kg). Ogundele *et al.,* (2015) reported that the concentrations of nickel in Plants along Heavy Traffic Roads in North Central Nigeria were ranged as (1.65-11.85 mg/kg). Beata *et al.,* (2002) ascertained that the concentration of nickel in muscles and liver of cattle reared in the vicinity of a metallurgic industry as (0.156 – 0.176 mg/kg) respectively.

2-6-3. Zinc in food:

Zinc is found in meat, liver, kidney, fish, chicken and cereals, fats, Fish, fruits, cakes, Poultry, pork, dairy products and whole grains, cereals, lamb, beef, leafy grains, root vegetables, shell fish , Oysters, lobster and organ meats. Major plant sources of zinc include cooked dried beans, sea vegetables, fortified cereals, soy foods, nuts, peas, and seeds, Walsh, (1994). The recommended dietary allowance for adult men is set at 15 mg/day, for adult women 12 mg/day, for formula-fed infants 5 mg/day, and for preadolescent children 10 mg/day WHO, (1996). Akan *et al.,* (2010) reported the level of zinc in liver, kidney, and meat of Beef, mutton, Caprine and Chicken ranged from 1.1 to 6.23 mg/g. The concentration of Zinc in meat of Charolaise and Herford breed ranged as (33.1- 41.6 mg/kg) as reported by Pilarczy (2014). Fanlandysz (1991) found the concentration of zinc in sheep slaughtered in Poland ranged (12

– 54, 30 – 50, and 13 – 29 mg/kg) in muscle, liver and kidneys respectively. The concentrations of Zinc in cattle tissues from the North Poland were (34.00, 43.0 and 22 mg/kg) in muscle, liver and kidneys respectively as reported by Fanlandysz (1993). Sedki *et al.,* (2003) reported the concentration of Zinc in cattle slaughtered in Polluted area as (89.0, 126 and 123 mg/kg) in kidney, liver and muscle respectively. The concentrations of zinc in the tissue of cattle from North and West Spain were (49.4, 15.1, 50.4 mg/kg) in liver kidney and muscle respectively as reported by Lopez *et al.,* (2004). Miranda, *et al.,* (2005) reported the concentration of Zinc in tissue of cattle from Asturias (Northern Spain) as (38.5, 23.0, 47.0 mg/kg) in liver, kidney and muscle respectively. The concentrations of Zinc in meat ranged in mg/kg as (2.9 – 4.7 mg/kg) in goat, whereas the concentrations in beef were found to range as (0.48 – 6.36 mg/kg as reported by Out, *et al.,* (2014). Badis, *et al.,* (2014) reported the concentrations of Zinc in fresh meat as (36.99, 39.64, 23.51 mg/kg) in beef, sheep and camel respectively. Zahurul, *et al.,* (2011) found the concentration of Zinc in some tissue of cattle as (263.64, 20.09, 43.23mg/kg) in heart, liver and meat respectively. Concentration Zinc in corned beef ranged as (2.43 -3.81 mg/kg) as reported by Hozan and Mohammed (2013). Purnama *et al.,* (2014) found the concentration of Zinc in tissues and organs of cattle grazing in mine revegetation areas as (5.64 , 8.79 ,6.9 9.18 , 0.8 mm/kg) in heart , liver , kidney , muscle and blood respectively . The concentration of zinc in meat and meat products sold in Egyptian Markets ranged as (67.9 – 222.3, mg/kg) respectively Zahran and Hendy (2015). Nnadozie, *et al.,* (2014) reported the concentrations of zinc as (0.158, 0.146, 0.164 and 0.206 mg/kg) in beef, sheep, goat and camel meat respectively. Mustafa *et al.,* (2015) reported that the concentration of zinc (10.31. 5.99 and 7.24) for (liver, kidney and heart) respectively. Ogundele *et al.,* (2015) reported that the

concentrations of zinc in Plants along Heavy Traffic Roads in North Central Nigeria were ranged as (23.9 – 117.8 mg/kg). Beata *et al.*, (2002) ascertained that the concentration of zinc in muscles and livers of cattle reared in the vicinity of a metallurgic industry as (23.712 - 79.95 mg/kg) respectively.

2-6-4. Iron in food:

Iron occurs as a natural constituent in plants and animals. Liver, kidney, fish, and green vegetables contain 20–150 mg/kg, whereas red meats and egg yolks contain 10–20 mg/kg. Rice and many fruits and vegetables have low iron contents (1–10 mg/kg).The level of Iron in liver, kidney, and meat of cattle, sheep, goat and Chicken ranged as 0.98 to 4.65 mg/kg as reported by Akan *et al.*, (2010). The concentration of Iron in cattle from Southern Nigeria ranged as (22.89 – 57.86, 20.37 – 46.59 mg/kg) in liver and kidney respectively as reported by Iwegbue (2008). Fanlandysz (1993) found the concentrations of Iron in tissues of cattle from North Poland were found as (23.0, 44.0 and 72.0 mg/kg) in muscle, liver and kidneys respectively. The concentration of Iron in meat of Charolaise and Herford breed ranged as (13.3- 15.3 mg/kg) as reported by Pilarczy (2014). The concentration of iron of sheep slaughtered in Poland ranged as (5.1 -30, 13- 63, and 24 – 75 mg/kg) in in muscle, liver and kidneys respectively as reported by Fanlandysz (1991). Lopez *et al.*, (2004) reported the concentration of Iron in tissues of cattle from North and West Spain as (70.3, 51.3, 38.7 mg/kg) in liver kidney and muscle respectively. While Miranda, *et al.,* (2005) reported the concentration of Iron in tissues of cattle from Asturias (Northern Spain) as (96.2, 105 and 56 mg/kg) in liver, kidney and muscle respectively. The concentration of (Iron) in meat ranged as (9.4 – 19 and 9.59 – 15.63 mg/kg) in goat and beef respectively as reported by Out, *et al.*, (2014). Badis, *et al.*, (2014)

reported the concentration of (Iron) in fresh meat from as (84.22, 70.36, 75.03 mg/kg) in beef, sheep and camel respectively. The concentration of (Iron) in tissues of cattle estimated to be (33.54, 99.29 and 131.69 mg/kg) in heart, liver and meat respectively as reported by Zahurul, *et al.*, (2011). While Hozan and Mohammed (2013) reported the concentration of (Iron) in corned beef ranged as (1.43 -5.4 mg/kg). Purnama *et al.*, (2014) found the concentration of (Iron) in tissues of cattle grazing in mine revegetation areas as (32.89 , 57.95 , 47.36 and 10.10 mg/kg) in heart , liver , kidney , muscle respectively .whereas Zahran and Hendy (2015) reported the concentration of (Iron) in meat and meat products sold in Egyptian Markets ranged as (82.95 – 352.9 mg/kg) respectively as reported by Nnadozie, *et al.*, (2014) found that the concentrations of iron were found as (0.121, 0.326, 0.416 and 0.868 mg/kg) in beef, sheep, goat and camel meat respectively. Beata *et al.*, (2002) ascertained that the concentration of iron in muscles and livers of cattle reared in the vicinity of a metallurgic industry as (36.85 -103.8 mg/kg) respectively.

2-6-5. Lead in food:

Consumers eating diets rich in these foods may therefore be exposed to an unacceptable level of lead. A further source of lead in the diet is from food containers containing lead, e.g. storage in lead-soldered cans, ceramic vessels with lead glazes and leaded crystal glass. Lead accumulates in the plants and animals, while its concentration is magnified in the food chain, Halliwell *et al.*, (2000). Food is an important source of lead and determination of lead in food can be used for the estimation of lead exposure and the level of lead in the Earth's crust is about 20 μg/g and reported that the industrial revolution gave rise to an increase in the amount of lead in the environment and an even bigger increase occurred around 1920 when leaded gasoline was

introduced. Leaded gasoline is still not banned everywhere in the World, and it still used in the developed countries, Wang and Zhou (2004). Concentration of lead ranges as (0.99 – 2.79 ppm), (0.09 – 3.16 ppm) in cow and Buffalo tissue respectively and in different organs of cow ranges as Neck (0.11- 6.75 ppm), Chest (0.34- 8.26 ppm) and Leg (0.7-20.05 ppm) as reported by Nawaz et *al.,* (2015). The level of lead in liver, kidney, and meat of beef, mutton, goat and Chicken ranged from, 0.1 to 1.34 mg/kg as reported by Akan *et al.,* (2010).The concentration of lead in liver as reported by Iwegbue (2008) was ranged as (0.00-0 .26 mg/kg). The concentration of lead in different organs of local sheep in Jordan estimated as 3.15 mg/kg in muscle 4.52mg/kg in liver 3.87 mg/kg in kidney, and the concentration of lead in different organs of Australian sheep estimated to be 4.38 mg/kg in muscle 5.69 mg/kg in liver 4.59 mg/kg in kidney while the concentration in Chinese sheep muscle 2.71 mg/kg as reported by Massadeh, and Dalaleh (2006). The concentration of Lead in meat of Charolaise and Herford breed ranged as (0.204-0.208mg/kg) as reported by Pilarczy (2014). Shaheen, *et al.,* (2016) reported that the concentrations of lead in beef as 0.48 mg/kg, while the concentration in mutton ranged as (0.15 – 4.25mg/kg). Concentrations of Lead in of Sheep slaughtered in Netherlands were (0.05, 0.96 and 0.42mg/kg) in (meat, liver, and kidneys) respectively as reported by Vos, *et al.*, (1988). Swaileh *et al.*, (2009) reported the concentrations of lead of local cattle in Palestein as (3.28 , 4.7 , 0.27 , and 0.51mg/kg in liver, kidney, heart , and muscle respectively , while the concentrations in sheep were (2.42 , 3.02 , 0.20 , and 0.25 mg/kg) in liver, kidney, heart , and muscle respectively and added the concentrations in goat were (2.17 , 3.49 , 0.20 , and 0.37 mg/kg) in liver, kidney, heart , and muscle respectively. Miranda *et al.*, (2003) reported the concentrations of lead in calves tissues slaughtered in Asturias –Spain estimated as (34.5, 34.6, and

11.1 mg/kg) in liver, kidney and muscle respectively. The concentration of lead in sheep tissues slaughtered in Poland ranged as (< 20 - < 30, 80 – 120 and 90 – 200 mg/kg) in muscle, liver and kidneys respectively as reported by Fanlandysz (1991).The concentrations of Lead in cattle from the North Poland were (40.0, 160 and 210 mg/kg) in muscle, liver and kidneys respectively as found by Fanlandysz, (1993). Concentrations of lead in samples of flesh taken from three location represent (High, Medium and Low Pollution risk- area) were (0.083, 0.029, 0.064 mg/kg respectively as reported by Hamed *et al.*, (2015). Lopez *et al.*, (2004) found the concentrations of lead in tissue of cattle from NW Spain were (28.0, 20.0, 14.5 mg/kg) in (liver kidney and muscle) respectively. The concentrations of Lead in meat of goat and beef ranged as (0.001 -0.5 mg/kg) in goat, whereas the concentration in beef was range as (0.001 - 0.1 mg/kg) as reported by Out *et al.*, (2014) whereas Badis, *et al.*, (2014) found the concentration of Lead in fresh meat as (7.76, 3.49, 2.01 mg/kg) in beef, sheep and camel respectively. The concentrations level of Lead in meat types as reported by Nkansah and Ansah (2014) were (1.154, 0.377 and 0.377 mg/kg) in beef, mutton and chevon respectively. Hassan *et al.*, (2013) reported the concentrations of Lead in fresh and ready to eat offal's of cattle as (0.98, 0.72 and 0.57 mg/kg) in kidney, liver and spleen respectively. Concentrations of Lead in some tissue of cattle were found as (0.67, 0.72, 0.81 mg/kg) in heart, liver and meat respectively Zahurul, et al (2011). Hozan and Mohammed (2013) found the concentration of Lead in corned beef ranged as (0.53 -2.07 mg/kg). Leontopoulos *et al.*, (2015) reported the concentration of lead in cattle tissues as (0.02, 0.02, 0.02 mg/kg) in liver, kidney and muscle respectively. The concentration of lead in meat and meat products sold in Egyptian Markets ranged as (0.45 – 2.81 mg/kg) as reported by Zahran and Hendy (2015). Nnadozie, *et al.*, (2014) found that no traces of lead in beef, sheep, goat and camel

meat. Sanaa, *et al.*, (2015) reported that the concentration of heavy metals in camel muscle ranged as (0.11 and 16.94 mg/kg) for lead and zinc respectively and added that the concentration of lead and zinc in Egyptian camel vital organ ranged as lead (0.00-1.18, 0.00-0.97 mg/kg), zinc(10.15-39.89 mg/kg) in liver and kidney respectively. Mustafa *et al.*, (2015) reported that the concentration of lead in cattle tissues from Zagazig city as lead: (0.83, 1.04 and 0.65 mg/kg) for liver, kidney and heart respectively. Ogundele *et al.*, (2015) found that the concentrations of lead in Plants along Heavy Traffic Roads in North Central Nigeria were ranged as (24 – 39.7 mg/kg). Beata *et al.*, (2002) ascertained that the concentration of lead in tissues of cattle reared in the vicinity of a metallurgic industry as (0.671 - 1.072 mg/kg) in muscles and liver respectively. Sulieman *et al*., (2017) found that the concentration of lead in flesh samples in different sites of Sudan ranged as (0.001- 0.028 mg/kg).

2-6-6. Manganese in food:

Food is usually the most important route of exposure for humans. Estimated Safe and Adequate Daily Intakes of 1–5 mg manganese have been established for children 1 year of age and older through to adults; these levels generally parallel amounts of the compound delivered via the diet as reported by WHO, (1999). Akan *et al.*, (2010) reported the level of Manganese in liver, kidney, and meat of cattle, sheep, goat and Chicken ranged as (0.45 to 4.11 mg/kg),while Iwegbue (2008) found the concentration of Manganese in tissues of cattle from south Nigeria ranged as (6.86 – 17.35 , 6.11 – 13.97 mg/kg) in liver and kidney respectively. The concentration of Manganese in meat of Charolaise and Herford breed ranged as (0.062- 0.073 mg/kg) as reported by Pilarczy (2014) while Lopez *et al.*, (2004) reported the concentration of

manganese in the tissue of cattle from North and West Spain as (2.37, 0.694, 0.191 mg/kg) in liver kidney and muscle respectively. The concentrations of Manganese in tissues of cattle from Asturias (Northern Spain) were found as (3.11, 1.19 mg/kg) in liver and kidney respectively as reported by Miranda, *et al.,* (2005), whereas Hozan and Mohammed (2013) reported no traces of Manganese in corned beef, while Zahran and Hendy (2015) found the concentration of manganese in meat and meat products sold in Egyptian Markets ranged as (0.8 – 3.27 mg/kg). Nnadozie, *et al.,* (2014) found that the concentrations of manganese were found as (0.06, 0.05, 0.04 and 0.15 mg/kg) in beef, sheep, goat and camel meat respectively. Cabrera *et al.,* (2010) analyzed the meat samples and found the Manganese contents ranged as (0.05-0.17mg/kg). WHO (2011) reported that manganese content in meat was ranged as (0.10-3.99 mg/kg).

2-7. **Heavy metals in Blood serum:**

Environmental pollution has become a global issue and the results are implied in high level of contaminants reported for soil, water, air, plants and animals. Food items that constitute human diet are contaminated when they get in contact with polluted environmental media. Studies on the impacts of pollutant metals and metalloids on livestock have largely focused on animals with relatively high levels of exposure, Ogabiela *et al.,* (2011). In polluted areas with rust scrub metals in Nigeria where dairy cows were raised, concentration of Pb in blood, milk and animal wastes, increased significantly compared with cows raised in uncontaminated areas of the country, Ogundiran *et al.,* (2012). Tomza, *et al.,* (2010) reported that the concentration of heavy metals in serum of cattle from Organic and Conventional Farms as (0.021, 0.012, 0.159, 0.863 and 0.007 mg/l) for chromium, nickel, zinc, iron and lead

respectively, whereas in another study Tomza, *et al.,* (2011) found that the concentration of lead and zinc in cattle serum as (0.018 and 0.629 mg/l) respectively. Charles *et al*., (2017) stated that the concentration of heavy metals in blood samples of Sheep and Rabbits from Jimeta-yola, adamawa State, Nigeria was ranged as Cr: (0.014-0.041 mg/l), Ni:(0.013-0.035 mg/l), Zn:(0.575-1.603 mg/l) and Pb:(0.024-0.036 mg/l). Sanaa, *et al* (2015) reported the concentration Lead and zinc in the examined samples of camel blood serum from Banha abattoir in Kalubia as (0.014, 1.96 mg/l) respectively. Leonidis *et al.,* (2010) reported that the concentration of lead in blood serum of cattle farmed Near Polluting Industries in the Province of Thessaloniki was 0.082mg/l). Whereas Husamettin *et al.,* (2015) found that the concentration of heavy metal in blood serum of cows raised near and away from highways in Korea ranged as (3.1-7.4, 0.57-2.88, 0.004-0.63, 61.22-164.3, 0.00-0.012 and 0.29-1.05 mg/l) for chromium, nickel, zinc, iron, lead and manganese respectively. The concentration of heavy metal in serum of camel, cattle and sheep in Saudi Arabia was distributed as zinc (103.4, 98.5, 110.7 mg/l), manganese (30.0, 8.3, 7.5 mg/l) and iron (80.2, 168.4, 178.6 mg/l) for camel, cattle and sheep respectively, as reported by Al-Busadah (2003) while Ogabiela *et al.,* (2011) reported that the concentrations of heavy metals in Cow Blood from Cow's Grazed around Zango, Zaria and Challawa Industrial Estate were ranged as Cr:(0.53-5.36mg/l), Ni: (0.04-5.05 mg/l), Zn:(0.17-15.81 mg/l), Fe: (25.16-55.87 mg/l), Pb: (0.001-1.37 mg/l) and Mn: (0.01-0.49 mg/l).

2-8. Heavy Metals and Trace elements in Soil:

Soil is a very important natural resource to man as it is a source of his life on this planet Misra and Mani, (2009). Despite its importance, soil is often contaminated by human activities this is reflected in the high

horizontal and vertical variability brought about by the anthropogenic influence on soil formation and development, Fong *et al.,* (2008). Materials that find their entry into the soil system persist and accumulate in toxic concentrations becoming sources of pollution in the soil, Misra and Mani, (2009). Agricultural soil contamination with heavy metals through the repeated use of Untreated or poorly treated wastewater from industrial establishments and application of chemical fertilizers and pesticides which emitted into atmosphere as aerosols and distributed in soil is one of the most severe ecological problems around the world. Fodder cultivated in soils polluted with toxic and heavy metals take up such metals and accumulate them in their edible and non-edible parts in quantities high enough to cause clinical problems both to animals and human beings consuming these metal-rich plants, Bhuiyan *et al.,* (2011), Odoh and Adebayo ;(2011). Trace heavy metals like chromium, nickel, zinc and lead are omnipresent in industrialized sites and they do have potential of contaminating soils which can be transported to plants, animals and humans causing their health effects: carcinogenicity, mutagenicity, disruption of DNA, etc, Kenneth and Stein (2009). Uptake and release of trace heavy metals from soil particles depends not only on total element concentrations but more importantly on the amounts and types of soil minerals and organic matter and on soil chemical properties such as pH and oxidation -reduction potential, Yuanan *et al.,* (2013). The concentration of heavy metals in agricultural soils is mainly related with the parental material of the area. Similarly Antolín *et al.,* (2005) reported that there was no traces of chromium and nickel concentration in soils treated with sewage sludge under semiarid Mediterranean conditions whereas the concentrations of lead and zinc in the same soil were found as (1.34, 0.77 mg/kg respectively. furthermore Massas *et al.,* (2009) find that the concentrations of heavy metal in top soils of an Aegean island

town (Greece) as (1.5, 1.3, 5.8 and 7.8 mg/kg) for chromium , nickel , lead and zinc respectively . Buccolieri *et al.*, (2010) stated that the concentration of heavy metals in agricultural soils was found as (0.00, 0.41, 2.09 and 3.67 mg/kg) for chromium, nickel, lead and zinc respectively.

2-8-1.Chromium in Soil:

Chromium (III) residues in the organic matter of soil and aquatic environment in the form of oxides, hydroxides and sulphates, Cervantes *et al.*, (2001). Bielicka *et al.*, (2005) reported the discharge of industrial wastes and ground water contamination has drastically increased the concentration of chromium in soil. During manufacturing of chromate, the deposit of the chromium residues and waste water irrigation posed a serious chromium pollution to farmland and with the implementation of modern agriculture there is continuous release of chromium into the environment by means of chromium residues, chromium dust and chromium waste water irrigation, resulting in soil pollution affecting the soil-vegetable system and also disturbing the vegetable yield and its quality to humans, Duan *et al.*, (2010). José et *al*., (2014) reported that the concentration of chromium in Mediterranean Agricultural Soils as (0.85mg/kg). Ramos (2006) found that there were no traces of chromium in vineyard soils of the Penedès area. Concentration level of Chromium in soil particle from Northern China ranged as (27.68 – 100.88mg/kg) as reported by Yutong and Shenggao (2016). Chon, *et al.*, (1998) reported the concentration of Chromium in soil and dusts from koyang (Korea) ranged as (23- 85 mg/kg). José *et al.*, (2014) found the concentration of chromium in soil samples from Caia area ranged as (, 5.2-48.6 mg/kg dry soil). Mohammed and Folorunsho (2015) found that the concentration of chromium in soil ranged as (21.35-27.772 mg/kg). Ogundele et al (2015)

reported that the concentrations of chromium in Plants and Soil along Heavy Traffic Roads in North Central Nigeria were ranged as (10.57 – 77.10 mg/kg).

2-8-2. Nickel in Soil:

Nickel is generally distributed uniformly through the soil profile but typically accumulates at the surface from deposition by industrial and agricultural activities. Nickel may present a major problem in land near towns, in industrial areas, or even in agricultural land receiving wastes such as sewage sludge. Its content in soil varies in a wide range from 3 to 1000 mg/kg as reported by Bencko (1983), Scott (1997), Von, (1997). Nickel can exist in soils in several forms: inorganic crystalline minerals or precipitates, complexed or adsorbed on organic cation surfaces or on inorganic cation exchange surfaces, watersoluble, free-ion or chelated metal complexes in soil solution, Scott (1997), WHO, (1991), Bennett, (1982). Overall, significantly higher metal values occur in the inner city and lower values occur in outlying areas. In Poland, the level of nickel in 60 samples of the soil collected from the Stalowa Wola area, which is affected by industrial emissions, was higher (average 17.20 mg/kg) than that in the reference samples (average 9.72 mg/kg). All the values, however, were below the highest allowable concentration, Kocjan, *et al.*, (2002). Chon *et al.,* (1998) found the concentration of Nickel in soil and dusts from koyang (Korea) ranged as (24 – 81 mg/kg). Norbaya *et al.*, (2014) reported the concentration of nickel in samples of soils ranged as (0.69-2.22 mg/kg). José *et al.*, (2014) found the concentration of nickel in soil samples from Caia area ranged as (10.8-89 mg/kg dry soil). José et *al* (2014) reported that the concentration of nickel in Mediterranean Agricultural Soils was (1.95 mg/kg). Ramos (2006) found that there were no traces of nickel in vineyard soils of the Penedès area. Ogundele *et al.*,

(2015) reported that the concentrations of nickel in Plants and Soil along Heavy Traffic Roads in North Central Nigeria were ranged as (1.83 - 14.87 mg/kg).

2-8-3. Zinc in Soil:

Zinc content in soil depends on the nature of parent rocks, texture, organic matter and pH, and ranges from 10 to 300 mg kg-1 with an estimated global average of 64 mg kg-1as reported by Kabata and Pendias (2001). Since Zinc is easily absorbed by mineral and organic components in most soil types; it normally accumulates in the surface horizons and the median total Zn content is 47 mg/ kg in subsoil and 52 mg/ kg in topsoil; the range of values varies from <3 to 3060 in subsoil and from <3 to 2900 mg/ kg in topsoil, Kabata and Pendias (2001). Yutong and Shenggao (2016) reported that the concentration level of Zinc in soil particle from Northern China ranged as: (38.11 -464.89 mg/kg). The concentration of zinc in soil and dusts from koyang (Korea) ranged as (87- 1400 mg/kg), Chon, *et al.,* (1998). José *et al.,* (2014) found the concentration of zinc in soil samples from Caia area ranged as (10.1-65.6 mg/kg dry soil). José et *al*., (2014) reported that the concentration of zinc in Mediterranean Agricultural Soils was (0.64 mg/kg). Ramos (2006) reported the concentration of zinc in vineyard soils of the Penedès area as (2.2 mg/kg). Mohammed and Folorunsho (2015) stated that the concentration of zinc in soil ranged as (10.10-22.38 mg/kg). Ogundele *et al.,* (2015) reported that the concentrations of zinc in Plants and Soil along Heavy Traffic Roads in North Central Nigeria were ranged as (30.8 – 144.7mg/kg).

2-8-4. Iron in Soil:

Iron is a major element in soil with a median value of 2.1%. The mobility of Fe in soil is largely controlled by the solubility of Fe3+ and Fe2+ amorphous hydrous oxides, although the formation of other Fe compounds, such as phosphates, sulphides and carbonates, may greatly modify Fe solubility's, Rose *et al.,* (1979). Mohammed and Folorunsho (2015) reported that the concentration of iron in soil ranged as (1425-1981.6 mg/kg).

2-8-5. Lead in Soil:

Lead often occurs naturally in the soil in concentrations ranging from (10 to 50 mg/kg). Low-level lead contamination is common in urban areas because of the widespread use of lead in man-made products and industrial processes. The concentration level of Lead in soil particle from Northern China ranged as (14.98 – 179.84 mg/kg). Chon *et al.,* (1998) reported the concentration of lead in soil and dusts from koyang (Korea) ranged as (36 – 956 mg/kg) as reported by Yutong, and Shenggao (2016). José *et al.,* (2014) found the concentration of lead in soil samples from Caia area ranged as (7.7-41.9 mg/kg dry soil). José et *al* (2014) reported that the concentration of lead in Mediterranean Agricultural Soils was found as (3.16 mg/kg). Ramos (2006) find that there were no traces of lead in vineyard soils of the Penedès area.while Mohammed and Folorunsho(2015)find that the concentration of lead in soil ranged as (087-1.10mg/kg). Ogundele *et al.,* (2015) reported that the concentrations of lead in Plants and Soil along Heavy Traffic Roads in North Central Nigeria were ranged as (24 – 157.67 mg/kg).

2-8-6. Manganese in Soil:

There was a wide range of Mn in world soils (7- 9200 ppm) with a calculated grand mean of 437 ppm as reported by Kabata and Pendias, (1992). Manganese occurs in soils and minerals mainly in the forms of Mn^{2+}, Mn^{3+}, and Mn^{4+}, McBride, (1994); Kabata and Pendias, 1992). The geographic distribution of Manganese in soils is influenced by lithologic characteristics and origin of the soil parent material as well as by local soil conditions such as pH, drainage and oxidation - reduction status. Manganese in soil can migrate as particulate matter to air or water, or soluble manganese compounds can be leached from the soil. The average concentrations of Manganese in soils range between 500 and 900 mg.kg-1, as reported by WHO (1981).

2-9. Heavy metals and trace elements in Air:

Itoh *et al*., (2006); Kalantari and Ghaffari, (2008); Vinodhini and Narayanan, (2009) reported that industrial processes, fossil fuel combustion, mining, waste incineration, motor vehicles and other human activities emit large amounts of atmospheric pollutants.Chromium is released into the atmosphere mainly by anthropogenic stationary point sources, including industrial, commercial, and residential fuel combustion, *via* the combustion of natural gas, oil, and coal. Other important anthropogenic stationary point sources of chromium emission to the atmosphere are metal industries, such as chrome plating and steel production. Nickel concentrations in ambient air vary considerably and the highest values have been reported from highly industrialized areas. Typical average levels of airborne nickel are: 0.00001-0.003 μg/m3 in remote areas; 0.003- 0.03 μg/m3 in urban areas having no metallurgical industry; 0.07-0.77 μg/m3 in nickel processing areas. In Poland the

recommended nickel concentration in the atmospheric air is set as 0.025 μg/m3 Polia, *et al.*, (2009), American Public Health Association APHA ,(1998), Cabrera, *et al.*, (2010). In rural areas, atmospheric zinc concentrations are typically between 10 and 100 ng/m3, whereas levels in urban areas commonly fall within the range 100–500 ng/m3 and mean concentrations of zinc associated with particulate matter in ambient air in Canada were 85 ng/m3 and in Finland, 170 ng/m3 WHO,(1996).

Manganese is released to air mainly as particulate matter, and the fate and transport of the particles depend on their size and density and on wind speed and direction. Above-average exposures to manganese are most likely to occur in people who work at or live near a factory or other site where significant amounts of manganese dust are released into the air. In some regions, the general population can be exposed to manganese released into air by the combustion of unleaded gasoline containing the organ manganese compound. In chronic inhalation exposure to manganese, the main organ systems affected are the lungs, nervous system, and reproductive system, although effects on other organ systems have also been observed.

2-10. Recommended Heavy Metals Limits:

Virtually, all metals can produce toxicity when ingested in sufficient quantities but the heavy metals are especially important because either they are so pervasive or they produce toxicity at such low concentrations, Vaishnavi and Gupta (2015). In order to ensure that the maximum permissible limits are not exceeded, routine surveillance of levels of these toxic metals in food is a necessity and meat as the flesh of animals used for food is a relevant dietary source of proteins, essential amino acids, chemical elements (e.g. iron, zinc) and vitamins (e.g. B12, D). Yet, the healthy image of meat is tarnished by its negative association

with non-nutritional issues like the presence of various toxic contaminants, Doneley, (2004).

2.10.1. Recommended Heavy Metals limits in food:

Food contains a wide range of metallic elements (metals) such as sodium, potassium, iron, calcium, boron, magnesium, selenium, copper and zinc. These elements are essential in trace quantities for maintenance of cellular processes.The metals of particular concern in relation to harmful effects on health are: mercury (Hg), lead (Pb), cadmium (Cd), tin (Sn) and arsenic (As). Other potentially toxic metals such as chromium and uranium have been also reported to be present as contaminants in food, while a number of metals have been associated with health effects in individuals exposed to them in the workplace, for example beryllium and nickel, Toxicology Factsheet Series T.F.S, (2009). According to Food and Agriculture Organization FAO (2000) the standard of nickel for food items is 5 mg/kg, while the standard value of chromium in meat was 2.3 mg/ kg. FAO has given the standard value of cadmium and copper in food items as 0.2 mg/kg and 40 mg/kg for cadmium and copper respectively as reported by Bratakos, (2002). WHO and FAO (2011) stated the permissible limits of heavy metals and trace elements in meat as (0.05, 0.3-1.0, 0.01and 0.1 mg/kg) for Chromium, zinc, iron and lead respectively. While Eurpean Commission, EC, (2008) reported the maximum levels of lead in meat (excluding offal) of bovine animals, sheep, pig and poultry and muscle meat of fish reported as (0.1-0.3mg/kg) respectively , whereas the permissible level of lead in Edible offal of bovine animals, sheep, pig and poultry reported as 0.5mg/kg.The permissible limit of heavy metals and trace elements recommended by WHO was Chromium (1.30 mg/kg), Nickel(10mg/kg), zinc (50 mg/kg), iron (20 mg/kg), lead(2mg/kg) as reported by Afzal Shah *et al.*, (2011).

While Hassan *et al.,* (2012) reported the permissible limit of chromium in plants according to level recommended by World Health Organization (WHO) as 2mg/kg, while the recommended level of copper and Cadmium was (10 and 0.02mg/kg) respectively.

2-10.2. Recommended limits in water:

The contamination of water is directly related to the degree of contamination of our environment. Rainwater collects impurities while passing through the air. Streams and rivers accumulate impurities from surface runoff and through the discharge of sewage and industrial effluents; these are carried further to lakes or reservoirs that supply our drinking water. All of the chemicals generated by man will eventually end up in our water supplies. These dangerous products from industry, agriculture and other human activities enter the rivers, lakes and underground water, and can contaminate water. Luc *et al.,* (2015) found that the concentration of heavy metals and trace elements in irrigation water in selected farms at Loumbila and Paspanga, Burkina Faso as Cr :(0.116 mg/l), Ni: (0.451 mg/l) , Zn : (0.036 mg/l), Fe: (1.286 mg/l) , Pb : (0.272 mg/l) and Mn : (0.462 mg/l) and added the permissible limits of these metal in irrigation water as (0.1, 0.2, 2, 5,5 and 0.2 mg/l) for Cr Ni , Zn , Fe, Pb and Mn respectively. Hussein *et al.,* (2013) reported that the Permissible limits of heavy metals in water according to WHO standards ranged as Cr: (0.00-1.2 mg/l), Ni :(0.00-1.12mg/l), Zn :(1.02-2.99 mg/l), Pb :(0.00-0.5mg/l) and Mn (0.00-1.05 mg/l).

The maximum permissible limit for Chromium in drinking water is 0.1 mg/l , while the maximum permissible limit for Ni in water is 0.2 mg/l Hassan *et al.,* (2012). Maximum recommended limits of Heavy metal in the irrigation waters of vegetable farms was (0.1, 0.2,2,5,5 and 0.2 mg/l) for Chromium, Nickel, Zinc Iron, Lead and Manganese respectively as

reported by Afshin *et al.,* (2014). According to WHO standards permissible limit of lead in water is 0.05mg/l, whereas the permissible limit of zinc in water according to WHO standards is 5mg/l. Chennaiah *et al.,* (2014). Reported permissible limits of trace elements and heavy metals in ground water according to WHO (2004) as (0.05, 0.02, 3, 0.3, 0.01and 0.1mg/l) for Chromium, Nickel, Zinc Iron, Lead and Manganese respectively. Vaishnavi and Gupta (2015) reported the permissible limits concentration of heavy metals in water according to WHO standards as (0.05, 0.01-0.05, 0.02 and 3-5 mg/l) for Chromium Lead Nickel and Zinc respectively. Due to the excess health effects associated with exposure to mercury, the present standard for drinking water has been set at lower levels of 0.002 mg/L and 0.001 mg/L as stated by the Environmental Protection Act and World Health Organization, WHO, (2004).SSMO (2008) reported the maximum permissible limits of heavy metals in drinking water and compatible for most available water sources as (0.033, 0.05, 0.007 and 0.27 mg/l) for chromium, nickel, lead and manganese respectively, whereas the permissible limit of zinc in water according to WHO standards is 5mg/l. According to WHO standards permissible limit of lead in water is 0.05mg/l the maximum permissible limit for Cu in water is 2 mg/l the maximum permissible limit for Cd in water is 0.01 mg/l.

2-10.3. Recommended Heavy Metals limits in soil:

Metals are present in soils in different chemical and physical forms, which influence their mobility and bioavailability, Zauyah *et al*, (2004). Heavy metals in soils have been considered as powerful tracers for monitoring impact of anthropogenic activity such as industrial emission (cement plant, fossil fuel and coal combustion chemical plants), vehicular emission, and atmospheric deposited. These lead to emission of heavy

metals into the air and their subsequent deposition into soils Wang *et al.*, (2012). Heavy metal is the most dangerous pollutant of anthropogenic environmental pollutants due to their toxicity and persistence in the environment Guo, *et al.*, (2012). Therefore heavy metals contamination of soils becomes a severe issue around the world as a result of anthropogenic activities that been emitted into atmosphere as aerosols and distributed in soil, Zhao *et al.*, (2012). They are distributed by atmosphere within a distance and transported up to several kilometers away from their sources and transferred to the soil through wet or dry deposition Soriano *et al.*, (2012). The maximum permissible limit (MPL) values of the trace heavy metals in agricultural soil set by different standards as Food and Agriculture Organization and World Health Organization reported a maximum permissible limit (MPL) values of the trace heavy metals in agricultural soil as (0.1and 90-400 mg/kg) for copper and Cadmium Chromium and lead respectively , whereas EC: (2002) reported the limits as (0.15 and 0.30 mg/kg) for Chromium and lead respectively different limits set by United States as(1500 and 50-300 mg/kg) for Chromium and lead respectively, while Germany reported a limits as (100 mg/kg) for Chromium and lead.as reported by Tamene and Letab (2015).

Table 2.1 : Comparison of average metals levels in ground water (mg/l) with some international water quality standards

Element	Present study	WHO (2011)	SSMO (2008)	US.EPA (2009)	EU (2010)	Japan (2015)
Cr	0.003	0.05	0.033	0.1	0.05	0.05
Ni	0.002	0.02	0.05	0.1	0.05	0.01
Zn	0.02	3	3	5	0.1	-
Fe	0.01	0.3	0.3	0.3	0.2	0.3
Pb	0.01	0.01	0.007	0.015	0.05	0.05
Mn	0.01	0.1-0.5	0.27	0.05	0.05	0.1-0.05

2-11. Elemental analysis:

Elemental analysis is the qualitative detection and quantitative determination of chemical elements in a sample. It is carried out by different physical, chemical and biological methods, Senaratne and Shooter, (2004). Spectroscopic, luminescence, mass-spectrometric as well as radioactive methods, which based on measuring the radioactivity of natural radionuclides, are the most typical methods used for qualitative and quantitative analysis of elements in different environmental samples, Choppin *et al*., (2002). As a branch of analytical chemistry, methods of elemental analysis is governed by some characteristics, among which, the detection limits, sensitivity, selectively, precision, accuracy, rapidity and price of analysis are highly significant , Hoenig, (2001). On the other hands, elemental analysis depends also on the physical state of the samples under analysis. Elemental analysis methods consist of several steps including; sampling, sample preparation, analysis, calculations and statistical evaluation of the results. Each step has a direct impact on accuracy, precision and sensitivity of the method, Hoenig, (2001).

2-11-1.Sample preparation techniques in elemental analysis:

In general, aqueous samples can be introduced to analysis directly and without any previous special pre-treatment, i.e. total or partial decomposition, as long as measured concentrations using spectrometric methods are reliable and satisfactory while possible interferences are under control. In most cases only very little sample preparation is required and the easiest way is simple sample dilution. Compared to liquids, preparation of solid samples is more complex. In general, unless the analytical method involves direct analysis of solid samples, they need to be in solution before analysis. Major concerns in selection of a solid sample preparation method for elemental analysis are requirements of the

analytical technique used for detection, the concentration range of analyses and the type of matrix in which analyses exist depending on as-received state of the samples, the target preparation technique to be applied and the analytical results required, pretreatment of the samples may be necessary in order to obtain suitable targets, Rauf and Hanan, (2009).Availability of a variety of analytical techniques and instrumentation in addition to a great assortment of samples and preparation procedures make that selection of the right analytical approach is critical for method development , Little, (2012).

2-11-2. Dry ashing:

The purpose of the ashing is to destruct the organic matrix, there by concentrating the trace elements in the sample. In dry ashing, the organic matter is decomposed at high temperature in the presence of atmospheric oxygen, Friedlingstein *et al*., (2006). Wall retention has been found to be a problem, especially with cobalt, copper, iron, silver, aluminium, and manganese, when using silica dished.

2-11-3.Wet ashing:

It is also known as wet digestion; this process is usually used for oxidation of the organic part of samples or to extract elements from inorganic matrices, using concentrated acids or their mixtures. This process is usually carried out both in open containers (such as tubes, beakers, or on a hot plate) or in closed systems at high pressure using different forms of energy , Hoenig, (2001); Sneddon *et al*., (2006). As compared to dry ashing, wet ashing could be carried out by different means, regarding the choice of reagents and devices used, also wet digestion is fast and has much less problems of volatilization losses, because of its low temperature (100-200^{o}C) , Rumpel, *et al*., (2001). Wet

ashing in open system (Teflon or glass beakers or glass tubes on hot plates, in a heating devices) which has been practiced for many decades, is suitable for the relatively “simple” samples, such as food or agricultural products sample and materials, however, this method is unsuitable for samples need more than 24 hours, Demirel *et al.*, (2008).

2-11-4. Microwave-assisted digestion:

This technique is usually applied to decompose many inorganic and organic materials. In microwave assisted digestion HNO_3 or its mixtures with HCl or H_2SO_4, with or without added H_2O_2, is used as extracting material. In this technique the interaction of microwave radiation accelerate the interaction between samples and reagents leading to fast and efficient decomposition. The most significant advantages of this technique over the other conventional methods such as dry or wet ashing procedures are that this techniques can be applied very broad, and it need much shorter reaction time (minutes), also, in this technique direct heating of samples and reagents is applied, and reduced need for aggressive reagents, as well as minimal contamination and lack of loss of volatile elements, Aydin, (2008).

Chapter 3

Materials and methods

This study was carried out in the period of May 2016 to July 2017 at Tambol area - Algazera State Sudan .The samples analysis was done in the laboratories of Environment and Natural Resource and Desertification Research Institute - National Center for Research- Ministry of Higher Education and Scientific Research using Atomic Absorption Spectrophotometer.

3.1. Muscles Tissues:

3.1.1. Samples collection:

Forty samples of beef, sheep, goat and camel muscle were collected from slaughterhouse and butchers shops in Tambol public market. A slice of muscle sample of approximately 200 g was taken with a clean stainless steel knife from each carcass and placed in a plastic bag. All samples were placed in a cooler box at 4 °C and transported to the laboratory and stored at –20 °C for further analysis.

3.1.2. Sample Preparation:

The samples were thawed, cut into small pieces using a stainless steel knife and about 50.0 gm was taken into crucible then dried in drying oven at 105 °C for 24 hour and then put in desiccators to absorb residual moisture to a fixed weight, 5 gm of dried samples were put in crucible .The crucible was placed in muffle furnace and ashed at 550 °C for 6-8 hour, then cooled in muffle and transferred to 50 ml volumetric flask and taken up in 5-ml of 20% HCl, then the obtained solution was filtered through a 0.45μm cellulose membrane filter paper, and the mixture was diluted with de-ionized water to 50 ml. for analysis.

3.2. Vital Organs:

3.2.1. Samples collection:

120 samples of liver, heart and kidney of beef, sheep, goat and camel (40sample for each organ) were collected from slaughterhouse and butcher´s shops in Tambol public market. Approximately 100 g was taken from each organ with a clean stainless steel knife in a plastic bag. All samples were placed in a cooler box at 4 °C transported to the laboratory and stored at –20 °C for analysis.

3.2.2. Samples Preparation:

The samples were thawed, cut into small pieces using a stainless steel knife and about 50.0 gm was taken into crucible then dried in drying oven at 105 °C for 24 hour then put in a desiccators to absorb residual of moisture to a fixed weight, 5 gm of dried samples were put in crucible. .The crucible was placed in muffle furnace and ashed at 550 °C for 6-8 hour, and then cooled in muffle. The ash was transferred to 50 ml volumetric flask and taken up in 5-ml of 20% HCl, and the obtained solution was filtered through a 0.45µm cellulose membrane filter paper, then the mixture was diluted with de-ionized water to 50 ml. for analysis.

3.3. Blood:

3.3.1. Samples Collection and preparation:

A total of 40 blood samples (10) sample from each animal (cattle, sheep, goat and camel) in Tambul were collected randomly. The blood samples were collected from jagular vein using plan vacutainer tubes, and kept under frozen condition. The samples placed in centrifuge under 1500 rotations for 10 minutes for more accurate separation of serum. Carefully shift pure serum to sterile Eppendorf tubes and then stored at -20 °C until subsequent analysis.

3.4. Water samples Collection and preparation:

Ten samples of ground water were collected randomly from farms at Tambol. Cleaned polyethylene bottles with de-ionised water were used for collecting water samples. Water sampling was conducted as described by Miller and Baker (2001). Samples were transported to laboratory filtered and stored at -20 °C for further analysis.

3.5. Fodder: Dry Ashing

3.5.1. Samples Collection:

Ten samples of fodder were randomly collected from farms at Tambol. The samples were transported to the laboratory for detection of heavy metals (namely, Chromium (Cr), Nickel (Ni), Zinc (Zn), Iron (Fe), lead (Pb) and Manganese (Mn).

3.5.2. Samples preparation:

Dry ashing was done according to Parker (1963). Dried ground fodder plant weighing 5 gm was taken in a porcelain crucible and Placed in a cool muffle furnace and ashed at 500 ºC for 4 to 12 hours, then cool and dissolved in 5-mL of 20% HCl. Then the solution was Filtered through an acid washed filter paper into a volumetric flask and dilute the solution to volume of 50-mL with deionized water and mix well. The samples were stored for analysis.

3.6. Analysis of Soils:

3.6.1. Samples Collection:

A total 10 samples weight 200 g of agricultural soil were collected in depth of 0-15cm at Tambol area using hand auger, stored in polyethylene bags transported to laboratory for further analysis.

3.6.2. Samples Preparation:

The soil samples preparation was carried out starting with removal of sands, small stones and any other non soil ingredients; air dried at room temperature for several days over pre-cleaned Pyrex petry dishes. Air dried samples was crushed to pass a 2mm mesh sieve. Then acid digestion was done. The samples were next placed in a 100 mL Pyrex glass beaker and diluted with distilled water up to 50 mL. The solution was filtered and the filtrates were analyzed by Atomic Absorption Spectrophotometer, 210VGP Buck Scientific double beam AAS, (1994). The working standard solutions for each metal were prepared before analysis. Concentrations of Cr, Ni, Zn, Fe, Pb and Mn were then measured.

3.7. Flame Atomic Absorption Spectroscopy:

Atomic absorption spectrometry (AAS) is an analytical technique that measures the concentrations of elements. It so sensitive that it can measure down to parts per billion of a gram in a sample. The technique makes use of the wavelengths of light specifically absorbed by an element. The instrument was considered as an analytical procedure for the quantitative determination of chemical elements using the absorption of optical radiation (light) by free atoms in the gaseous state. In analytical chemistry the technique is used for determining the concentration of a particular element in a sample to be analyzed, Dafalla (2016). AAS can be used to determine over 70 different elements in solution or directly in solid samples used in pharmacology, biophysics and toxicology research.

3.7.1. Analytical Methods for Atomic absorption:

The analysis of meat, vital organs, serum, water, soil and fodder samples for measuring Cr, Ni, Zn, Fe, Pb and Mn, concentrations was done by calibrated atomic absorption spectrometer instrument (210VGP

Buck Scientific double beam , AAS.(1994) on wet weight basis using the hollow cathode lamps for each elements with known stock standard solutions prepared in ratio 1:3:6 mg/l to perform the linear curves within the linear ranges (5, 5, 2.5 and 2.5mg/l) at the proper wave length and other (AAS) conditions for the mentioned element respectively, beside the reference sample materials (certified samples for the same elements) according to certain condition listed shown in table (3.1).

3.7.2. Standard Conditions of atomic absorption spectrometer:

The recommended Standard Conditions of atomic absorption spectrometer for the determination of individual elements are: wavelengths; the optimum slit width at each wavelength, the relative noise, the characteristic concentration, the characteristic concentration check value, and the approximate linear range.

3.7.2. 1. Wavelengths:

Several possible wavelengths are listed for each element. The most commonly used primary wavelength is always listed first. Select the best wavelength for your analysis based on the concentration range of the samples. If the samples are at a very low concentration, the most sensitive wavelength should be selected; if the samples are very concentrated, a less sensitive wavelength should be used.

3.7.2. 2.Slit Width:

The slit width listed for each element is the one found to be optimum for that element at the particular wavelength. Other slits can be used, but the signal to noise ratio and characteristic concentration will vary. For wavelengths in the UV range, a single recommended slit setting (0.2 nm, 0.7 nm, or 2.0 nm) is listed. Two recommended slit positions (e.g., 0.2/0.4 nm) are listed for wavelengths in the visible region. The 0.2 nm,

0.7 nm, and 2.0 nm positions are for those spectrometer models utilizing a single grating, while the 0.4 nm and 1.4 nm positions are for spectrometer models that have dual gratings.

3.7.2. 3.Relative Noise:

The relative noise is used to judge the stability of a particular line. Values are compared relative to the noise measured at the primary wavelength, which is always listed first. The relative noise is based on the standard deviation values measured at 50× expansion under the specified conditions with the flame on.

3.7.2. 4.Characteristic Concentration:

The characteristic concentration is the concentration of the element (mg/L) required to produce a signal of 1.0% absorption (0.0044 Abs. units). The characteristic concentration values listed are approximate values that should be used only as a guideline. Variables that affect characteristic concentration (and linearity) include the performance of the specific nebulizer being used and the type, age, and condition of the light source. Generally, the characteristic concentration values measured should agree within ±15% relative to the guideline values listed.

3.7.2. 5.Characteristic Concentration Check Value:

The characteristic concentration check value is the standard concentration that gives a reading of approximately 0.2 Absorbance units at the wavelength and slit width listed using optimum conditions. This is useful in setting up your instrument for a particular element. It allows you to adjust your burner position, nebulizer, and gas flows by knowing approximately what absorbance you should be getting for a particular solution concentration.

3.7.2. 6.Linear Range:

The approximate linear range values are listed for the most sensitive atomic absorption lines. They tell you the approximate concentration you can read before the absorbance/concentration plot starts to curve and curvature correction becomes necessary. These are listed to give you an estimate of the linear range and should be used only as a guideline.

Table3.1: Analytical Conditions for Atomic Absorption Spectrometry (Flame Atomic Absorption Ranges)

Metal	Wavelength (nm)	Slit Width (nm)	Detection limit (mgl^{-1})	Sense Check (mgl^{-1})	Linear Range (mgl^{-1})	Flame Type Color
Cr	357.9	0.7	0.04	2	5.00	A-A rich/yellow
Ni	232.0	0.2	0.05	3.5	4.00	A-A, lean/blue
Zn	213.9	0.7	0.005	0.50	2.50	A-A, lean/blue
Fe	248.3	0.2	0.050	2.50	5.0	A-A, lean/blue
Pb	283.3	0.7	0.08	10	20.00	A-A, lean/blue
Mn	279.5	0.7	0.03	1.25	2.50	A-A, lean/blue

Sourse: Dafalla (2016).

3.8. Preparation of Standard Solution:

Instructions for the preparation of stock standards are given for each element. It is also possible to purchase standards directly from Perkin-Elmer Make sure all standards are made up properly. Standard solutions will degrade with time. It is recommended that all calibrated standards be dated and replaced when necessary.

3.8.1. Chromium Standard Solution:

Stock of 1000 mg/L Chromium Standard Solution was prepared by dissolving 3.735 g of potassium chromate, K2CrO4, in deionized water and diluted to 1 liter with deionized water.

3.8.2. Nickel Standard Solution:

Stock of 1000 mg/L Nickel Standard Solution was prepared by dissolving 1.000 g of nickel metal in a minimum volume of (1+1) HNO_3 and diluted to 1 liter with 1% (v/v) HNO_3.

3.8.3. Zinc Standard Solution:

Stock of 500 mg/L Zinc Standard Solution was prepared by dissolving 0.500 g of zinc metal in a minimum volume of (1+1) HC1 and diluted to 1 liter with 1% (v/v) HCl.

3.8.4. Iron Standard Solution:

Stock of 1000 mg/L Iron Standard Solution was prepared by dissolving 1.000 g of iron wire in 50 mL of (1+1) HNO_3 and diluted to 1 liter with deionized water.

3.8.5. Lead Standard Solution:

Stock of 1000 mg/L Lead Standard Solution was prepared by dissolving 1.598 g of lead nitrate, $Pb(NO_3)_2$, in 1% (v/v) HNO_3 and dilute to 1 liter with 1% (v/v) HNO_3.

3.8.6. Manganese Standard Solution:

Stock of 1000 mg/L Manganese Standard Solution was prepared by dissolving 1.000 g of manganese metal in a minimum volume of (1+1) HNO_3 and diluted to 1 liter with 1% (v/v) HCl.

The techniques of instrument operation performed in several steps, the desired lamp of each element was installed this operating position to align the wavelength and slit width selector knob was turned to the position specified by the library and the specific wavelength was selected and the air valve and fuel valve at the instrument turned on. Then stock

standards solutions were run from lower Concentration to the highest one respectively and their absorbance must be differs according to their concentrations, the average of the three readings noticed must be taken to fit the linear curve wanted according to the linear range shown in above table , after the linear curve was fitted the reference sample material readings was run to check the accuracy of readings, then the samples was run last, the samples readings must lay between the standard concentration ranges, the standard concentration reading repeated after running every 10 samples reading to check the stability of instrument beside the reading of the reference sample, these steps repeated for each element individually.

3.9. Statistical analyses:

The data presented as mean ± standard deviation was subjected to one way analysis of variance (ANOVA) ($p<0.05$) to assess whether heavy metals varied significantly between samples. All statistical calculations were performed with SPSS 17, Gomez and Gomez (1984).

Chapter4

Results

The mean values ± standard deviation of Chromium, Nickel, Zinc, iron, Lead and manganese, concentrations in groundwater samples, soil, fodder, serum, muscle, liver, heart and kidney of cattle , sheep , goat and Camel from Tambol area presented in (Table1 to Table7) and correlation coefficient presented in (Table 8 and Table 9). The results of this study showed highly significant different at ($p \leq 0.05$) in the concentration of (Iron in muscle), (Chromium, Nickel, Iron and Manganese in liver)**, (**Iron and Manganese in heart), **(**Chromium, Nickel, Manganese in kidney), (Chromium, Zinc, Iron and Lead in blood serum) and all metals under investigation in water, soil and fodder.

4.1. Concentration of selected heavy metals and some Trace elements in groundwater, soil and fodder samples from Tambul area (mg/kg).

Table 4-1: levels of selected heavy metals and some Trace elements in Water , soil and fodder samples from Tambul (mg/kg)

	Cr	Ni	Zn	Fe	Pb	Mn
Water	0.003^{b} ± 0.001	0.002^{b} ± 0.001	0.02c ± 0.002	0.01^{c} ± 0.001	0.01^{b} ± 0.001	0.01 ± 0.001
Soil	0.31^{a} ± 0.09	$.0.47^{a}$ ± 0.09	1.24^{b} ± 0.82	41.26^{a} ± 11.83	1.23^{a} ± 0.60	12.5^{a} ± 2.48
Fodder	0.00^{b} ± 0.00	0.00^{c} ± 0.00	4.32^{a} ± 1.31	13.51^{b} ± 3.26	0.00^{b} ± 0.00	1.22^{b} ± 0.68

a, b, c: - means within the same column followed by different superscripts are significantly ($p < 0.05$) different

The concentrations of metals were determined by using atomic absorption spectrophotometer (AAS) device. From (Table1) the obtained results showed significant different at ($p \leq 0.05$) between water soil and fodder from Tambol area in the concentrations of all elements under investigation and concentrations of chromium (Cr) varied in distribution from (0.00 – 0.31mg/kg) for fodder and soil respectively. Nickel (Ni) content in water, soil and fodder ranged from (0.00 – 0.47mg/kg) whereby soil recorded a high value (0.47mg/kg) whereas no traces of nickel in fodder. Zinc concentration varied in distribution and ranged from 0.02 - 1.24 - 4.32 mg/kg in water, soil and fodder respectively.

A high value of iron recorded by soil (41.26 mg/kg) followed by fodder (13.51mg/kg) and water (0.01 mg/kg).Lead observed to distributed as 0.01 mg/ml in water, (1.23mg/kg) in soil whereas no traces in fodder. Similarly high value of manganese (Mn) content recorded by soil (12.5mg/kg) followed by fodder (1.22 mg/kg) and (0.01 mg/ml) in water.

4.2. Concentration of Heavy Metals and trace elements in different meat types:

Table 4-2: levels of some heavy metals and Trace elements in various meat samples from Tambul area, in (mg/kg)

	Chromium	Nickel	Zinc	Iron	Lead	Manganese
Beef	0.14 ± 0.08	0.12 ± 0.10	8.04 ± 1.94	5.54[a] ± 2.14	1.17 ± 0.52	0.08 ± 0.04
Mutton	0.26 ± 0.19	0.15 ± 0.13	6.47 ± 2.4	3.25[b] ± 1.61	1.24 ± 1.02	0.13 ± 0.15
Goat meat	0.17 ± 0.12	0.13 ± 0.1	7.8 ± 0.7	3.26[b] ± 0.70	1.25 ± 0.60	0.10 ± 0.05
Camel meat	0.16 ± 0.14	0.12 ± 0.11	7.67 ± 1.9	3.56[b] ± 0.71	1.36 ± 0.54	0.07 ± 0.04

a, b, c: - means within the same column followed by different superscripts are significantly ($p < 0.05$) different

The mean values ± standard deviation of Chromium, Nickel, Zinc, iron, Lead and manganese, concentrations in meat samples of cattle, Sheep, Goat and Camel from Tambol area are given in Table 2. The concentrations of metals were determined by using atomic absorption spectrophotometer (AAS) device. However, the statistical analysis of variance indicated that there was no significant difference ($p<0.05$) in chromium content of different meat samples it observed to recorded a highest value in mutton (0.26 mg/kg) followed by goat (0.17mg/kg) , camel (0.16 mg/kg) , while the lowest value recorded in beef (0.14 mg/kg) and ranged as 0.14 - 0.26 mg/kg .Similarly Nickel (Ni) recorded high value in mutton (0.15 mg/kg) whereas the lower value recorded in beef and camel meat (0.12 mg/kg) and was range from 0.12 – 0.15 mg/kg. A highest concentration of Zinc (Zn) was recorded in beef meat

(8.04 mg/kg) while the minimum value was recorded in mutton (6.47mg/kg). Iron (Fe) concentration ranged from 3.25 to 5.54 mg/kg and the highest value recorded in beef while the lower value recorded in mutton and obtained results of this study showed highly significant different at ($p \leq 0.05$) in the concentration of Iron in muscle. Lead (Pb) concentration ranged from 1.17 to 1.36 mg/kg and high value recorded in camel meat while the lower value recorded in beef. Manganese (Mn) recorded high value in mutton (0.13 mg/kg) whereas the lower value recorded in camel meat (0.07 mg/kg).

4.3. Levels of some heavy metals and Trace elements in liver of cattle, sheep, goat and camel from Tambol

Table 4-3: levels of some heavy metals and Trace elements in liver of cattle ,sheep, goat and camel from Tambol area, in (mg/kg)

	Cr	Ni	Zn	Fe	Pb	Mn
Cattle	0.29^{ab} ± 0.15	0.14^{c} ± 0.02	7.92 ± 5.78	10.80^{a} ± 0.08	0.76^{b} ± 0.35	0.20^{b} ± 0.03
Sheep	0.29^{ab} ± 0.15	0.21^{a} ± 0.05	8.49 ± 5.21	9.79^{b} ± 1.20	0.75^{b} ± 0.53	0.24^{a} ± 0.02
Goat	0.35^{a} ± 0.23	0.20^{ab} ± 0.04	11.74 ± 5.55	9.89^{b} ± 0.92	0.95 ± 0.51	0.28^{a} ± 0.07
Camel	0.17^{b} ± 0.06	0.17^{b} ± 0.04	8.52 ± 4.33	10.39^{ab} ± 0.59	0.71 ± 0.52	0.21^{b} ± 0.04

a, b, c: - means within the same column followed by different superscripts are significantly ($p < 0.05$) different

The mean values ± standard deviation of Chromium, Nickel, Zinc, iron, Lead and manganese, concentrations in livers samples of cattle, Sheep, Goat and Camel from Tambol area are given in (Table3). The concentrations of metals were determined by using atomic absorption spectrophotometer (AAS) device. The results revealed high significant difference at ($p < 0.05$) in concentration of Chromium, Nickel, Iron and Manganese in liver, whereas there was no significant difference in zinc and lead content. From results Chromium (Cr) concentration in liver

ranged as (0.17 to 0.35 mg/kg) goat liver recorded high value 0.35 followed by beef and sheep(0.29mg/kg) while the camel recorded lower value 0.17mg/kg).Liver Nickel (Ni) content varied in distribution (0.14 - 0.21 mg/kg) high value recorded by sheep (021mg/kg) followed by goat (0.20mg/kg) and camel (0.17mg/kg) whereas beef recorded lower value (0.14mg/kg). However, the statistical analysis of variance indicated that there was no significant difference ($p<0.05$) in zinc content. It was observed that Zinc (Zn) in liver of different animals ranged from (7.92 to 11.74 mg/kg) and observed to recorded the highest value in goat (11.74mg/kg) followed by camel (8.52mg/kg), sheep (8.49mg/kg) while beef record lower value (7.92mg/kg). Liver Iron (Fe) content of different animals ranged from 9.79 to 10.80 (mg/kg) the highest values recorded by beef (10.80mg/kg) followed by camel (10.39mg/kg), goat (9.89mg/kg) while the lowest value recorded by sheep (9.79mg/kg). Although, the statistical analysis of variance indicated that there was no significant difference ($p<0.05$) in Lead concentration in livers of animals from Tambol area, it was observed that lead (Pb) varied in distribution from 0.71 to 0.95 mg/kg as presented in (Table3) and the highest value (0.95mg/kg) recorded by goat liver followed by beef liver (0.76mg/kg) and sheep liver (0.75mg/kg) while the lower value (0.71mg/kg) recorded by camel liver. Manganese (Mn) concentration in liver of different animals from Tambol area ranged as (0.20-0.28 mg/kg) goat liver recorded high value (0.28mg/kg) followed by sheep liver (0.24mg/kg) and camel liver (0.21mg/kg) whereas the lower value (0.20mg/kg) recorded by beef liver .

4.4. Levels of some heavy metal and Trace elements concentration in Heart of cattle, sheep, goat and camel from Tambol.

Table 4-4.levels of some heavy metal and Trace elements concentration in Heart of cattle, sheep, goat and camel from Tambol area , (mg/kg)

	Chromium	Nickel	Zinc	Iron	Lead	Manganese
Cattle	0.19 ± 0.08	0.18 ± 0.06	5.01 ± 1.92	5.16[a] ± 1.23	0.44 ± 0.22	0.11[a] ± 0.03
Sheep	0.29 ± 0.20	0.17 ± 0.05	5.18 ± 1.96	3.89[b] ± 0.45	0.55 ± 0.42	0.09[ab] ± 0.03
Goat	0.26 ± 0.16	0.19 ± 0.06	5.04 ± 2.26	4.17[ab] ± 1.57	0.69 ± 0.33	0.08[b] ± 0.01
Camel	0.18 ± 0.09	0.17 ± 0.09	5.54 ± 1.71	5.16[a] ± 1.29	0.55 ± 0.23	0.09[ab] ± 0.04

a, b, c: - means within the same column followed by different superscripts are significantly ($p < 0.05$) different.

The mean values ± standard deviation of Chromium, Nickel, Zinc, iron, Lead and manganese, concentrations in heart samples of cattle, Sheep, Goat and Camel from Tambol area are given in (Table 4). The concentrations of metals were determined by using atomic absorption spectrophotometer (AAS) device. The results also showed high significant difference at ($p < 0.05$) in concentration of Iron and Manganese in heart**.** Chromium (Cr) concentration in Heart ranged from (0.18 to 0.29 mg/kg) sheep recorded high value (0.29mg/kg) followed by goat (0.26mg/kg) and beef (0.19mg/kg) whereas camel record the lower value (0.18mg/kg). Heart Nickel (Ni) of different animal's species from Tambol ranged from (0.17 to0.18mg/kg) high value recorded by goat (0.19mg/kg) followed by beef (0.18mg/kg) while the lower value (0.17mg/kg) recorded by sheep and camel. Zinc (Zn) content in heart of

animals varied in ranged from (5.01 to 5.54 mg/kg) camel heart record a high value (5.54mg/kg) followed by sheep (5.18mg/kg) and goat 5.04mg/kg) while the lower value (5.01mg/kg) recorded by beef. Iron (Fe) concentration in heart varied in distribution from (3.89 – 5.16 mg/kg) beef and camel record a high value (5.16mg/kg) followed by goat (4.17mg/kg).While the lower value (3.89 mg/kg) recorded by sheep. Lead (Pb) concentration in heart varied in distribution from (0.44-0.69 mg/kg) high value recorded by goat (0.69mg/kg) followed by sheep and camel (0.55mg/kg) whereas beef record a lower value (0.44mg/kg).Heart manganese (Mn) varied in distribution and ranged from (0.08 - 0.11mg/kg) high value recorded by beef (0.11mg/kg) followed by sheep and camel (0.09mg/kg) while goat record a lower value (0.08mg/kg).

4.5. Concentrations of some heavy metals and Trace elements in Kidney of beef, Sheep, Goat and Camel from Tambol.

Table 4-5: Concentrations of some heavy metals and Trace elements in Kidney of beef, Sheep, Goat and Camel from Tambol area, in(mg/kg)

	Chromium	Nickel	Zinc	Iron	Lead	Manganese
Cattle	0.34^{a} ± 0.21	0.09^{b} ± 0.03	4.53 ± 2.12	5.64 ± 1.51	0.74 ± 0.15	0.17^{a} ± 0.04
Sheep	0.21^{b} ± 0.08	0.11^{ab} ± 0.04	5.03 ± 1.18	4.59 ± 1.32	0.72 ± 0.62	0.13^{b} ± 0.02
Goat	0.14^{b} ± 0.02	0.15^{a} ± 0.08	4.89 ± 1.45	4.62 ± 1.25	0.54 ± 0.26	0.15^{ab} ± 0.02
Camel	0.18^{b} ± 0.07	0.11^{ab} ± 0.05	3.84 ± 1.74	4.97 ± 0.99	0.63 ± 0.43	0.14^{b} ± 0.02

a, b, c: - means within the same column followed by different superscripts are significantly ($p < 0.05$) different.

The mean values ± standard deviation of Chromium, Nickel, Zinc, iron, Lead and manganese, concentrations in kidneys samples of cattle, Sheep, Goat and Camel from Tambol area are given in (Table 5). The concentrations of metals were determined by using atomic absorption spectrophotometer (AAS) device. Similarly result showed high significant difference at ($p < 0.05$) in concentration of chromium, nickel and manganese in kidney. Chromium (Cr) concentrations in kidney ranged from (0.14 to 0.34 mg/kg) high value (0.34mg/kg) recorded by beef followed by sheep (0.21mg/kg) and camel (0.18mg/kg) while goat record a lower value (0.14mg/kg). Kidney Nickel (Ni) content varied in distribution from (0.09-0.15 mg/kg) goat record a high value (0.15mg/kg) followed by sheep and camel (0.11mg/kg) while the lower value

(0.09mg/kg) recorded by beef. Zinc (Zn) concentration in kidney ranged from (3.84- 5.03mg/kg) a highest value (5.03mg/kg) recorded by sheep followed by goat (4.89mg/kg) and beef (4.53mg/kg) whereas the lower value (3.84mg/kg) recorded by camel. Iron (Fe) concentration in kidney ranged from (4.59-5.64mg/kg) a highest value (5.64 mg/kg) recorded by beef followed by camel (4.97mg/kg) and goat (4.62mg/kg) whereas sheep record a lower value (4.59mg/kg).Lead (Pb) concentration in Kidney varied from (0.54-0.74mg/kg) beef record a high value (0.74mg/kg) followed by sheep (0.72mg/kg) and camel (0.63mg/kg) while the lower value (0.54mg/kg) recorded by goat. Manganese (Mn) concentration in Kidney varied from (0.13-0.17mg/kg) beef record a high value (0.17mg/kg) followed by goat (0.15mg/kg) and camel (0.14mg/kg) while the lower value (0.13mg/kg) recorded by sheep.

4.6. Concentrations of selected heavy metals and some Trace elements in Blood Serum of beef, sheep, goat and camel from Tambool

Table 4- 6: Concentrations of selected heavy metals and some Trace elements in Blood Serum of beef ,sheep, goat and Camel from Tambool in (mg/l)

	Chromium	Nickel	Zinc	Iron	Lead	Manganese
Cattle	0.40^{b} ± 0.03	0.14 ± 0.02	0.76^{a} ± 0.21	0.41^{c} ± 0.16	0.33^{ab} ± 0.24	0.63 ± 0.08
Sheep	0.54^{a} ± 0.08	0.13 ± 0.05	0.87^{a} ± 0.09	0.73^{a} ± 0.02	0.37^{a} ± 0.21	0.52 ± 0.22
Goat	0.55^{a} ± 0.07	0.11 ± 0.04	0.57^{b} ± 0.23	0.53^{b} ± 0.25	0.05^{c} ± 0.01	0.61 ± 0.03
Camel	0.43^{b} ± 0.01	0.13 ± 0.02	0.68^{b} ± 0.20	0.28^{c} ± 0.11	0.04^{bc} ± 0.01	0.51 ± 0.10

a, b, c: - means within the same column followed by different superscripts are significantly ($p < 0.05$) different

From (Table 6) the results revealed high significant difference at ($p < 0.05$) in concentration of Chromium, Zinc, Iron and Lead in blood serum of beef, sheep, goat and camel whereas there was no significant difference in Nickel and Manganese content. Chromium (Cr) concentration varied in distribution from (0.40 - 0.55mg/l) high value recorded by goat (0.55mg/l) followed by sheep (0.54mg/l) and camel 0.43mg/l) while the lower value (0.40mg/l) was recorded by beef. Serum content of nickel (Ni) ranged from (0.11 – 0.14 mg/l) beef record a highest value (0.14mg/l) followed by sheep and camel (0.13mg/l) while goat record a lower value (0.11mg/l).Zinc (Zn) concentrations in blood serum of different animals species varied in distribution from (0.57 – 0.87 mg/l) high value recorded by sheep (0.87mg/l) followed by beef (

0.76mg/l) and camel (0.68mg/l) whereas the lower value (0.57mg/l) was recorded by goat. Iron (Fe) content in blood serum ranged from (0.28 – 0.73 mg/l) and similarly high value recorded by sheep (0.73mg/l) followed by goat (0.53 mg/l) and beef (0.41 mg/l) while the lower value (0.28 mg/l) recorded by camel. Lead (Pb) concentration distributed in range from (0.04 – 0.37 mg/l) and sheep record a high value (0.37 mg/l) followed by beef (0.33mg/l) and goat (0.05mg/l) whereas a lower value (0.04mg/l) recorded by camel.

Blood serum manganese (Mn) content varied in distribution from (0.51-0.63 mg/l) and beef record a high value (0.63mg/l) followed by goat (0.61mg.l) and sheep (0.52mg/l) while camel record a lower value (0.51mg/l).

Table 4 - 7: Metal – to - Metal correlation coefficient matrix for Selected metals in muscle samples (n= 40)

Parameters	Muscle Cr	Muscle Ni	Muscle Zn	Muscle Fe	Muscle Pb	Muscle Mn
Muscle Chromium	1					
Muscle Nickel	**0.906**	1				
Muscle Zinc	**- 0.505 -**	-0.281-	1			
Muscle Iron	**- 0560 -**	**- 0.549 -**	**0.325**	1		
Muscle Lead	**0.659**	**- 0658 -**	0.218	**0.361**	1	
Muscle Manganese	0.167	0.211	0.123	-0.060	-0.143	1

Bold values are significant at ($p<0.05$)**.**

The results of this study showed significant positive correlation between muscle Cr and Muscle Ni r= (0.906) and between Muscle Pb and Muscle Fe r = (0 .361) Table 8. Significant negative correlation between Muscle Cr and Muscle Zn r = (- 0.505) and between muscle Cr and muscle Fe r = (- 0.560) and showed negative correlation between muscle Cr and muscle Pb r = (- 0.659).

Table 4-8: Muscle Metal – to - Water metal correlation coefficient matrix for some heavy metals and trace elements in muscle and ground water samples

Table 4 - 8:Muscle Metal– to - Water metal correlation coefficient matrix for some metals in muscle and ground water samples (n= 40)

Parameters	Water Cr	Water Ni	Water Zn	Water Fe	Water Pb	Water Mn
Muscle Chromium	0.146					
Muscle Nickel	-0.073-	-0.177-				
Muscle Zinc	0.171	-0.013-	-0.073-			
Muscle Iron	-0.142	0.116	-0.065-	-0.064-		
Muscle Lead	-0.177-	0.079	-0.197	0.01	-0.133-	
Muscle Manganese	-0.094	0.212	0.205	0.004	0.254	-0.240-

Also results showed significant negative correlation between muscle Ni and muscle Fe r = (- 0.549) and between muscle Ni and muscle Zn r = (- 0.658) and showed also significant negative correlation between muscle Zn and muscle Fe r = (- 0.325) .Whereas the study did not indicate any correlation between metals concentration in groundwater and muscle tissues (Table 7 and Table8).

Chapter5

Discussion

The results of the present study will be discussed in this chapter.

5.1. Heavy metals in groundwater:

The results of this study revealed that the concentrations of heavy metals and trace elements in ground water in Tambol were (0.003 ± 0.001 , 0.002 ± 0.001, 0.02 ± 0.002 , 0.01 ± 0.001,0.01 ± 0.001 and 0.01 ± 0.001 mg/l) for (chromium , Nickel, Zinc, Iron, Lead and Manganese) respectively. This results were in-line with that reported by, Sirajudeen and Vahith (2012), Olafisoyel *et al* (2013), Luc T *et al* (2015), Tadiboyinaa and Ptsrkb (2016), Elumalai et al (2017) but was in contrast with results of Sulieman *et al* (2017). Regarding water quality standards the results were matching with the permissible limits recommended by international agencies such as WHO (2006), USEPA (2010), EU (2010), SSMO (2008) and Japan standards (2015).

5.2. Heavy Metals and trace elements in different meat types in Tambol:

From the results of this study it was observed that chromium (Cr) concentrations in different types of meat were ranged from (0.14-0.26 mg/kg) this result was within the range reported by Hozan and Mohammed (2013) as (0.10 - 0.40 mg/kg) but differ to that reported by Rashed (2002) as (3.3 - 4.2 mg/kg) and Akan (2010) as (0.23-1.22 mg/kg).

Nickel (Ni) concentration in meat of beef, sheep, goat and camel ranged as (0.12-0.15 mg/kg) this result was within the range reported by Akan (2010) as (0.01-1.09 mg/kg) but less than that range reported by

Rashed (2002) as (1 – 4 mg/kg) , Beata *et al* (2002) as (0.156-0.176 mg/kg), Shaheen *et al* (2016) as (1.34 mg/kg) , (Zahran and Hendy (2015) as (0.54-7.45 mg/kg) and higher to that reported by Ubong and Woluchem, A. (2016) as (0.001 mg/kg) and in contrast to the findings of Hozan and Mohammed (2013) who found no traces of nickel in meat tissues.

Content of zinc (Zn) in different type of meat ranged as (6.47- 8.04 mg/kg) this result was higher to that reported by Akan (2010) as (1.1-6.23 mg/kg) , Rashed (2002) as (0.06 -0.10 mg/kg) and Hozan and Mohammed (2013) as (2.43 -3.81 mg/kg) and less than the findings reported by Beata *et al* (2002) as (23.71 mg/kg), Badis *et al* (2014) as (23.51- 39.64 mg/kg) .

The concentration of iron (Fe) in this study ranged as (3.25-5.54 mg/kg) which was higher than that reported by Akan (2010) as (0.98-4.65 mg/kg), Rashed (2002) as (0.47 -0.55 mg/kg) and Nnadozie, *et al.*, (2014) (0.121, - 0.868 mg/kg), but less than that reported by Purnama *et al.*, (2014) as (10.10 mg/kg), and Beata *et al* (2002) as (36.85 mg/kg) .The finding of Hozan and Mohammed (2013) as (1.43 -5.41 mg/kg) was within the range of this study.

The result of lead (Pb) concentration in different type of meat was (1.17-1.36 mg/kg). This result was within the range reported by Akan (2010) as (0.1- 1.34 mg/kg), Nkansah and Ansah (2014) as (0.377- 1.154 mg/kg), Shaheen, et al (2016) as (0.15- 4.24 mg/kg) , Hozan and Mohammed (2013) as (0.53 – 2.07 mg/kg) .But higher than the results reported by Out, *et al* (2014) as (0.001 -0.1 mg/kg) , Sulieman *et al* (2017) as (0.001 – 0.028 mg/kg), Beata *et al* (2002) as (0.671 - 1.072

mg/kg), Sanaa, *et al* (2015) as (0.11 mg/kg) and less than the findings of Badis, *et al* (2014) as (2.01- 7.76 mg/kg).

Although, the statistical analysis of variance indicated no significant difference in manganese content in different types of meat at ($p<0.05$). The manganese content in four meat types ranged as (0.07-0.13 mg/kg). This results was within the range with the results reported by Nnadozie, *et al.*, (2014) as (0.04-0.15 mg/kg) and Cabrera *et al.*, (2010) as (0.05-0.17) , but less than the findings of Pilarczy (2014) as (0.204- 0.208 mg/kg) , Zahran and Hendy (2015) as (0.8 – 3.27 mg/kg), Akan *et al.*, (2010) as (0.45 - 4.11mg/kg) and WHO (2011) as (0.10-3.99 mg/kg).

5.3. Levels of some heavy metals and Trace elements in liver of cattle, sheep, goat and camel.

The chromium (Cr) concentration in liver of different animals revealed significant difference at ($p<0.05$) and ranged as (0.17-0.35 mg/kg) which was in-line with that obtained by Osei *et al* (2014) as (0.34 mg/kg), but less than the result reported by Maxwell (2008) as (2.88 – 4.43 mg/kg).

The nickel concentration in livers of different animals revealed significant difference at ($p<0.05$) and ranged as (0.14-0.21 mg/kg) which matched with the findings of Osei *et al* (2014) as (0.15-0.19 mg/kg) but differ to the result obtained by Akan (2010) as (0.01 - 1.09 mg/kg).

Although the zinc concentration in the liver showed no significant difference at ($p<0.05$) and ranged as (7.92-11.74 mg/kg) which was similar to the findings of, Mustafa *et al* (2015) as (10.31 mg/kg), but higher than the result reported by Akan (2010) as (1.1-6.23 mg/kg). The results reported by Osei *et al*., (2014) as (77.34-97.06 mg/kg) , Maxwell (2008) as (22.89 – 57.86 mg/kg, Beata *et al*., (2002) as (79.95 mg/kg) and

Sanaa *et al.,* (2015) as (16.94 mg/kg) was higher than the zinc concentration in this study.

Regarding, iron concentration in liver of different animals which ranged as (9.79-10.80 mg/kg). This finding was higher to the result obtained by Akan (2010) as (0.98 -4.65mg/kg) and lower to that reported by Beata *et al* (2002) as (103.8 mg/kg).

The lead concentration in liver of different animals in the present result showed no significant difference at ($p<0.05$) and ranged as (0.71-0.95 mg/kg) which was similar to that reported by Vos, *et al* (1988) as (0.96 mg/kg) , (Zahurul, et al 2011, Hassan, et al 2013 as (0.72 mg/kg) and Mustafa *et al* (2015) who found lead concentration as (0.83 mg/kg) but higher than the result reported by Osei *et al* (2014) as (0.04-0.14mg/kg) , Maxwell (2008) as (0.00-0 .26 mg/kg), Sanaa, et al (2015) as (0.11 mg/kg) and lower than the result reported by Swaileh et al (2009) as (2.17 -3.28 mg/kg) and Beata *et al*., (2002) as (1.072 mg/kg).

Manganese concentration in liver of different animals in this study was in the range of (0.20-0.28 mg/kg) this result was lower than the results reported by Akan (2010) as (0.45 -4.11 mg/kg), Iwegbue (2008) as (6.86 – 17.35 mg/kg), Lopez *et al.*, (2004) as (2.37 mg/kg), Purnama *et al.*, (2014) as (57.95 mg/kg) and Miranda, *et al.*, (2005) as (3.11 mg/kg).

5.4 Levels of some heavy metals and Trace elements concentration in Heart of cattle, sheep, goat and camel.

The result of statistical analysis of variance showed that there was no significant difference at ($p<0.05$) in chromium concentration in heart of different animals which was ranged as (0.18-0.29 mg/kg) which was similar to that reported by Osei et al (2014) as (0.25-0.33mg/kg).

The result of nickel concentrations in heart of different animals was ranged as (0.17-0.19 mg/kg). This result was within the range reported by Osei *et al* (2014) as (0.08-0.32 mg/kg) but lower than the result of Zahurul, *et al* (2011) as (1.15 mg/kg).

Since that there was no significant difference in zinc concentration in heart of different animals species which ranged as (5.01-5.54 mg/kg) this result was lower than the result reported by Osei et al (2014) as (44.87-57.58 mg/kg) and Mustafa *et al* (2015) as (7.24 mg/kg).

The concentration of iron in the heart of different animals ranged as (3.89 – 5.16 mg/kg), which was higher than the values reported by Zahurul, *et al* (2011) as (0.67mg/kg), Osei *et al* (2014) as (0.17-0.23) and Swaileh *et al* (2009) as (0.20-0.27mg/kg) but lower than the results reported by Purnama *et al.,* (2014) as (32.89 mg/kg) .

The lead content in heart of different animal which was in range of (0.44-0.69 mg/kg) was similar to that reported by Mustafa *et al* (2015) as (0.65 mg/kg).

Result of statistical analysis of variance showed significant difference at ($p<0.05$) in manganese content in heart of different animals which was ranged as (0.08-0.11 mg/kg).

5.5. Concentrations of some heavy metals and Trace elements in Kidney of Cattle, Sheep, Goat and Camel.

The result of chromium concentration in kidney of different species of animals showed significant difference at ($p<0.05$) which was ranged as (0.14-0.34 mg/kg) was lower than the results reported by Osei et al (2014) as (0.59-0.74mg/kg) and Maxwell (2008) as (2.51- 4.92 mg/kg).

The nickel concentration in the kidney of different animals which was ranged as (0.09-0.15 mg/kg).This result was in the range that reported by Maxwell (2008) as (0.06 to 0.3 mg/kg) but lower than the values reported by Ubong *et al* (2016) as (2.72 mg/kg), Osei *et al* (2014) as (0.29-0.63 mg/kg).

The result of zinc concentration in kidneys of different animals species which was in range of (3.84-5.03 mg/kg) was in the range reported by Mustafa *et al* (2015) as (5.99 mg/kg) and Sanaa, *et al* (2015) as (1.96-18.33mg/kg) but lower than that reported by Osei *et al* (2014) as (74.91-86.21mg/kg).

The iron concentration in the kidneys of different animal species which range as (4.59-5.64mg/kg) was not statistically significant at ($p<0.05$) which was lower than that reported by Purnama *et al.*, (2014) as (47.36 mg/kg).

The lead concentration in kidneys of different animal species which ranged as (0.54-0.74mg/kg) was not statistically significant at ($p<0.05$) was in the range of result reported by Vos. *et al* (1988) as (0.42 mg/kg) and Sanaa, *et al* (2015) who found lead concentration in kidney ranged as (0.00-0.97 mg/kg), but higher than the result reported by Osei *et al* (2014) as (0.13-0.18 mg/kg), Swaileh et al (2009) as (3.02- 4.7mg/kg) and Mustafa *et al* (2015) as (1.04 mg/kg).

The manganese content in kidneys of different animal species which was in the range of (0.13-0.17 mg/kg). This result was lower than the result reported by Akan *et al*., (2010) as (0.45 to 4.11 mg/kg), Iwegbue (2008) as (6.11 – 13.97 mg/kg), Lopez *et al*., (2004) as (0.694 mg/kg) and Miranda, *et al*., (2005) as (1.19 mg/kg).

5.6. Concentrations of selected heavy metals and some Trace elements in Blood Serum of beef, sheep, goat and camel.

The chromium (Cr) concentration in blood serum was ranged as (0.40 - 0.55mg/l) which was within the range reported by Ogabiela *et al* (2011) as (0.53-5.36 mg/l) but higher than the results reported by Tomza, et al (2010) as (0.021 mg/l), Charles *et al* (2017) as (0.014-0.041 mg/l) and lower than the result reported by Husamettin *et al* (2015) as (3.1-7.4 mg/l).

The nickel content in the blood serum of different animals was ranged as (0.11 – 0.14 mg/l) which was in the range reported by Ogabiela *et al* (2011) as (0.04-5.05 mg/l) but higher than the values reported by Charles *et al* (2017) as (0.013-0.035 mg/l) and Tomza, *et al* (2010) as (0.012 mg/l) and lower than the result reported by Husamettin *et al* (2015) as (0.57-2.88) .

The zinc concentrations in blood serum of different animals species was ranged as (0.57 – 0.87 mg/l) which was within the range reported by Tomza, et al (2011) as (0.629 mg/l), Ogabiela *et al* (2011) as (0.17-15.81 mg/l) , but lower than the result of Al-Busadah (2003) as (103.4, 98.5, 110.7 mg/l) , (Sanaa et al 2015) as (1.96 mg/l) and higher than the results reported by Husamettin *et al* (2015) as (0.004-0.63 mg/l) and Tomza, *et al* (2010) as (0.159 mg/l) .

Iron (Fe) concentration in blood serum in different animals species which was ranged as (0.28 – 0.73 mg/l) which matched with the result of Tomza, *et al* (2010) as (0.863 mg/l) but higher than the result of Tomza, *et al* (2011) as (0.018 mg/l), and far lower than the result of Husamettin *et al* (2015) as (61.22-164.3 mg/l) , Al-Busadah (2003) as (80.2, 168.4, 178.6 mg/l) and Ogabiela *et al* (2011) as (25.16-55.87 mg/l) .

The concentration of lead (Pb) in blood samples of different animals species which was in the range of (0.04 – 0.37 mg/l) was in the range

reported by Leonidis *et al* (2010) as (0.082 mg/l) but higher than the results of Ogabiela *et al* (2011) as (0.001-1.37 mg/l), Charles *et al* (2017) as (0.024 - 0.036 mg/l), Tomza, et al (2010) as (0.007 mg/l) , Husamettin *et al* (2015) as (0.00-0.012 mg/l) and Sanaa *et al* (2015) (0.014 mg/l). The concentration of manganese in blood serum of different animal's species was ranged as (0.51-0.63 mg/l) which was in the range reported by Ogabiela *et al* (2011) as (0.01-0.49mg/l) but lower than the results reported by Husamettin *et al* (2015) as (0.29-1.05 mg/l) and Al-Busadah (2003) as (7.5 – 30.0 mg/l).

5.7. Concentrations of some heavy metals and Trace elements in Soil and Fodder sample from Tambol.

The concentration of chromium in soil samples of this study was ranged as (0.31 mg/kg) which was lower than the results reported by Jose *et al* (2014) as (0.85mg/kg), Ogundele *et al* (2015) as (10.57- 77.10 mg/kg), and Masas *et al* (2009) as (1.5 mg/kg) however Bucolieri *et al* (2010) , Ramos (2006) and Antolin *et al* (2005) reported no traces of chromium in soil samples.

The concentration of nickel in soil samples were found as (0.47mg/kg) this result was within the range reported by Bucolieri *et al* (2010) as (0.41mg/kg) but lower than the result of Jose *et al* (2014) as (1.95mg/kg) , Ogundele *et al* (2015) as (1.83- 14.87 mg/kg) and Masas *et al* (2009) as (1.3mg/kg) however, Ramos (2006) and Antolin *et al* (2005) found no traces of nickel in the soil samples .

The concentration of zinc in soil samples was found as (1.24mg/kg) this result was higher than the results reported by Jose *et al* (2014) as (0.64mg/kg) and Antolin et al (2005) as (0.77 mg/kg) but lower than the results reported by Masas *et al* (2009) as (7.8 mg/kg), Bucolieri *et al*

(2010) as (3.67 mg/kg), Ogundele *et al* (2015) as (30.8- 144.7 mg/kg) and Ramos (2006) as (2.2mg/kg).

The lead concentration in soil was found as (1.23mg/kg) this result was almost in-line with that reported by Antolin *et al* (2005) as (1.34mg/kg),.but lower than the result of Masas *et al* (2009) as (5.8mg/kg), Jose *et al* (2014) as (3.16 mg/kg) Bucolieri *et al* (2010) as (2.09 mg/kg) and Ogundele *et al* (2015) as (24.0 – 157.67 mg/kg)however, Ramos (2006) reported that no traces of lead in soil samples.

CONCLUSION AND RECOMMENDATION

CONCLUSION:

The concentrations of chromium, nickel and lead in groundwater were found to exceed the recommended limits of WHO / FAO 2000 whereas concentration of zinc, iron and manganese were less than WHO/FAO (2011), SSMO (2008), UEPA (2009), EU (2010) and Japan (2015). Concentrations of Chromium, Zinc, Iron and Lead in fresh meat and vital organs were found to exceed the recommended limits of WHO (2011) while the concentrations of Nickel in fresh meat and vital organs were found within the limits of WHO and FAO (2000). Concentrations of all metals under investigation in fodder were found to be below the recommended limits of FAO and WHO (2000). There was a close positive and negative Correlation between heavy metals concentrations in soil and concentration in fresh meat and vital organs.

RECOMMENDATIONS:

For the importance of heavy metals pollution in the human and animal's health. We recommend continuation of the study in this field to provide additional data on heavy metals pollution to help in risk assessment of consumer exposure to hazardness of heavy metals.

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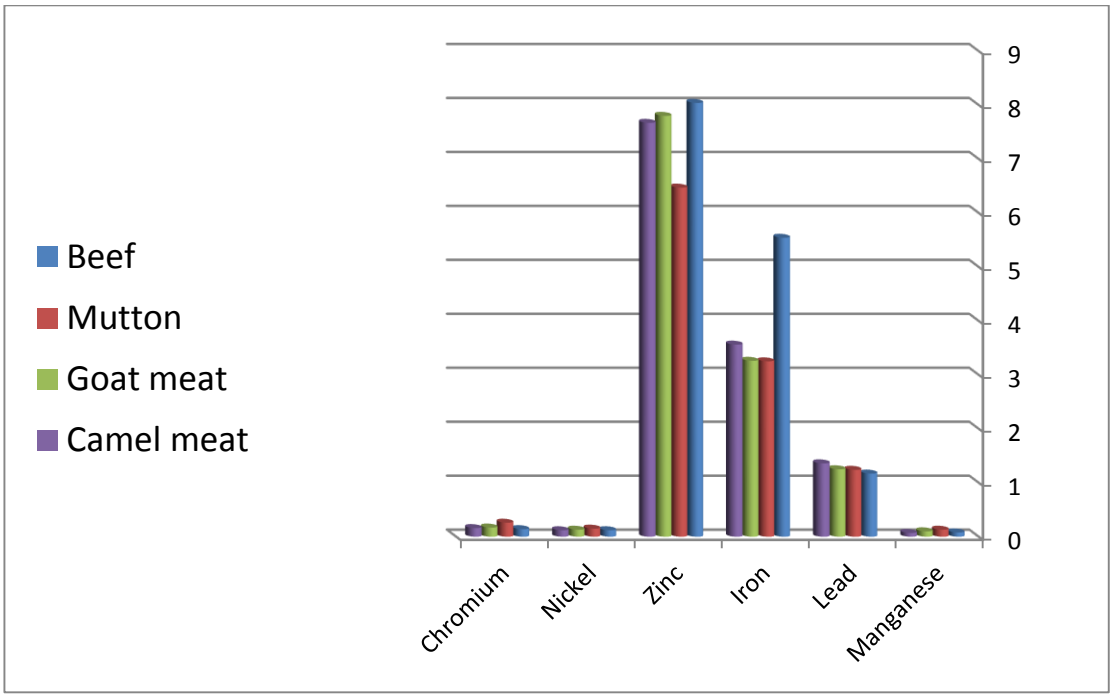
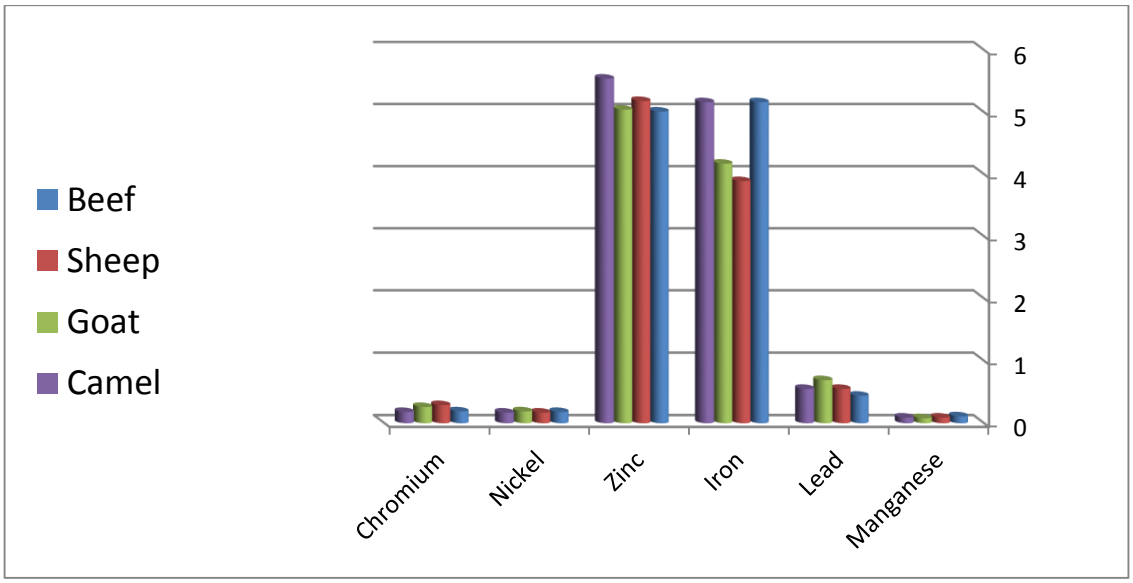
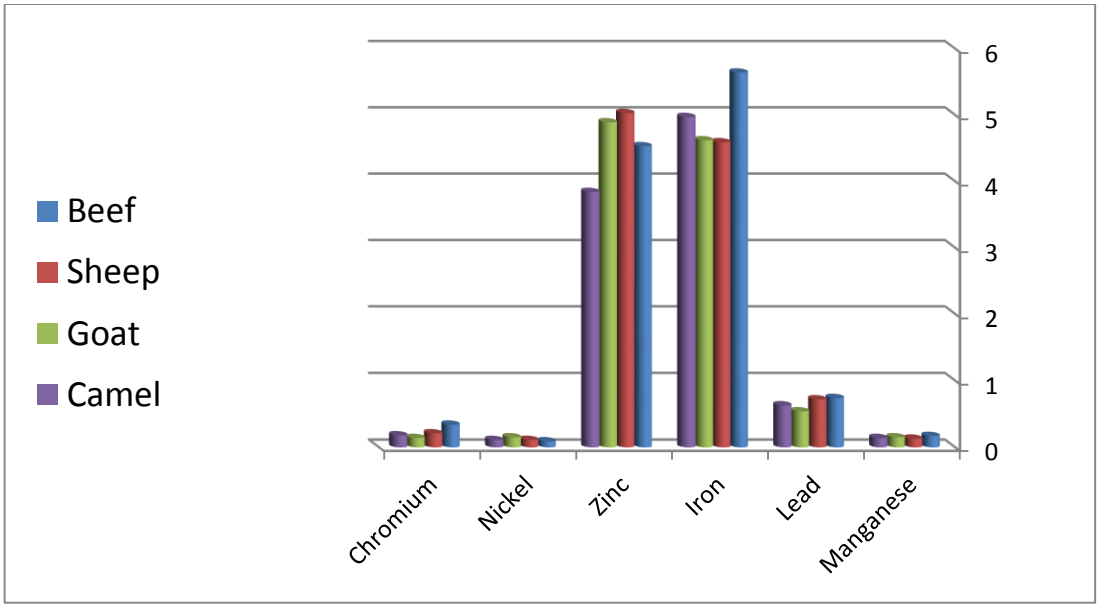
Appendices



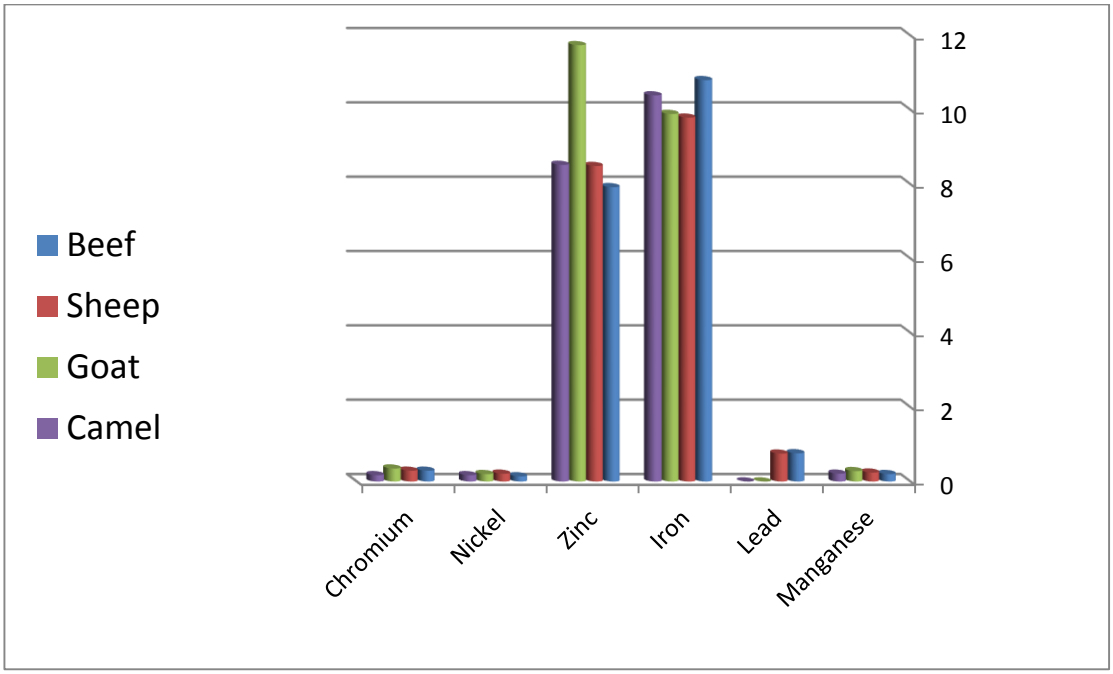
App. (1): levels of some heavy metals and Trace elements in various meat samples from Tambul area, in (mg/kg)



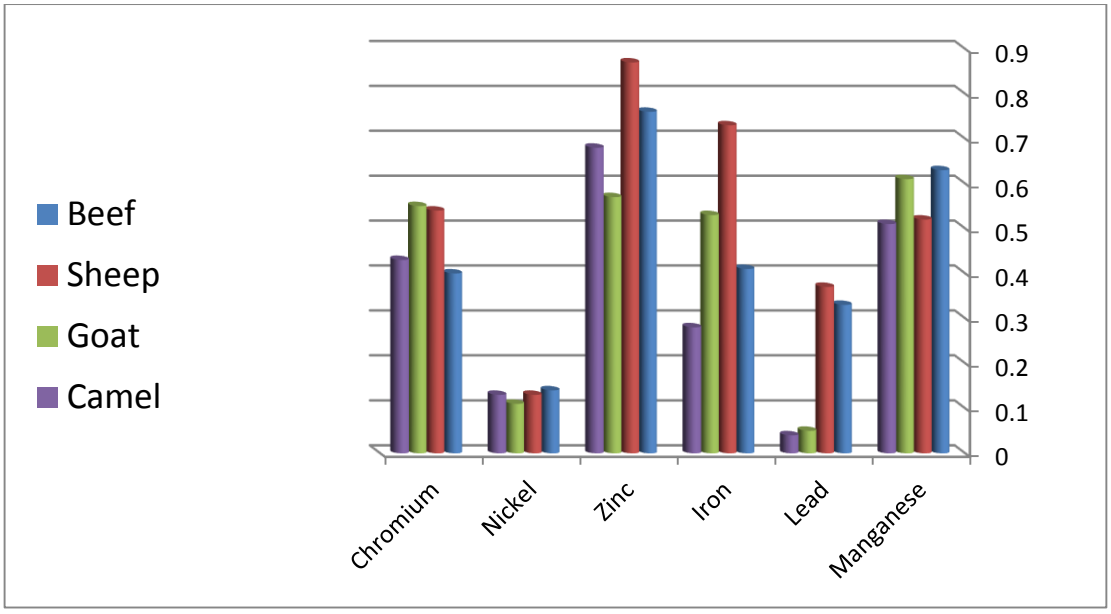
App. (2): levels of some heavy metal and Trace elements concentration in Heart of cattle, sheep, goat and camel from Tambol area, in mg/kg



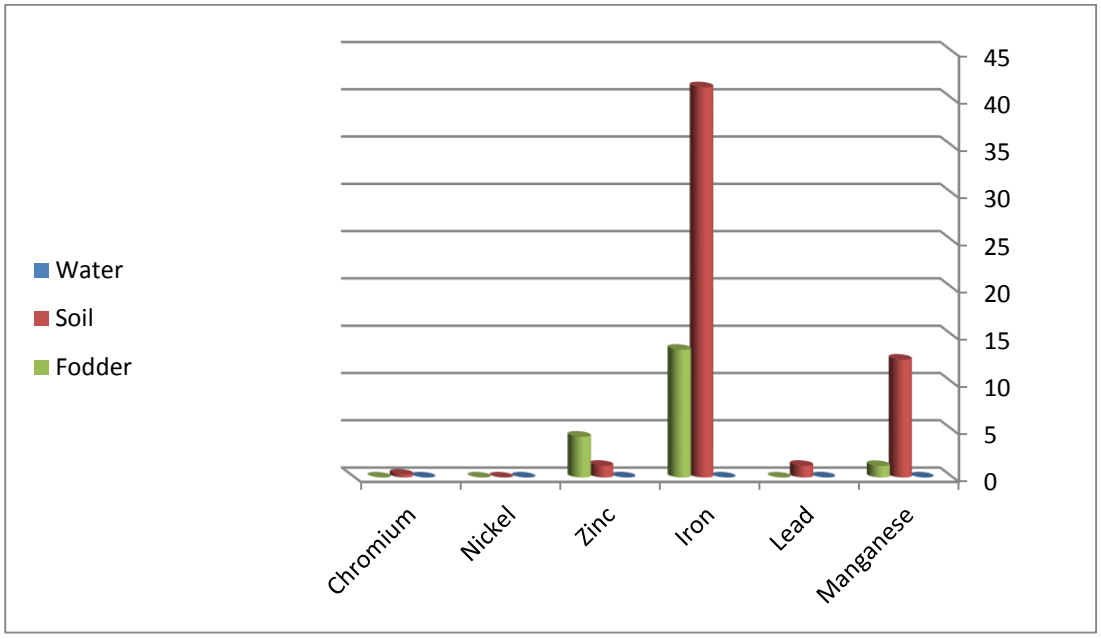
App. (3): Concentrations of some heavy metals and Trace elements in Kidney ofbeef, Sheep, Goat and Camel from Tambol area, in (mg/kg)



App. (4): levels of some heavy metals and Trace elements in liver of cattle, sheep, goat and camel from Tambol area, in (mg/kg)



App.(5) : Concentrations of selected heavy metals and some Trace elements in Blood Serum of beef, sheep, goat and Camel from Tambool area in (mg/l)



App. (6): Levels of selected heavy metals and some Trace elements in water, soil and fodder samples from Tambol area (mg/kg)

App. (7): Kidney Metal – to - soil metal correlation coefficient matrix for some heavy metals and trace elements in Kidney and soil samples

Parameters	Heart Cr	Heart Ni	Heart Zn	Heart Fe	Heart Pb	Heart Mn
soil Cr	**0.417**					
Soil Ni	0.253	0.178				
Soil Zn	0.007	0.060	- 0.010			
Soil Fe	- **0.555**	- **0.555**	- 0.010	**0.353**		
Soil Pb	- 0.026	- 0.029	**0.591**	0.127	0.093	
Soil Mn	- **0.790**	**0.743**	0.036	**0.535**	**0.628**	- **0.609**

Bold values are significant at $p<0.05$

App. (8): Heart Metal – to - soil metal correlation coefficient matrix for some heavy metals and trace elements in Heart and soil samples

Parameters	kidney Cr	kidney Ni	kidney Zn	kidney Fe	kidney Pb	kidney Mn
soil Cr	0.294					
Soil Ni	0.129	0.250				
Soil Zn	0.015	0.008	-0.023			
Soil Fe	- **0.334**	- **0.473**	-0.009	0.201		
Soil Pb	0.014	-0.005	**0.760**	0.010	-0.104	
Soil Mn	**-0.496**	**-0.729**	**-0.523**	**0.316**	**0.386**	**-0.790**

Bold values are significant at $p<0.05$