Assessment of Heavy Metals in Gallus and their Impacts on Human

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Abstract- Heavy metals are persistent in the environment and are subject to bioaccumulation in food chains. However exposure does not result only from the presence of a harmful agent in the environment. The present study was undertaken to investigate the concentrations of heavy metals in Broiler Chicken and to assess the extent of contamination due to intake of water, foodstuff, premixes by chicken and other sources like air, ground water, soil etc,. Samples of meat collected from poultry farms in Paladam were analyzed for seven heavy metals i.e. Chromium, Copper, Lead, Cadmium, Arsenic, Iron, and Zinc using Atomic Absorption Spectrophotometer after wet digestion of samples with HNO_3.From the results chromium is the maximum content of heavy metal accumulated in the body tissues of broilers and their feed. For all samples other heavy metals were under the limit of quantification. The levels of heavy metals were compared with standards of WHO/FAO. Precocious steps must be taken to avoid use of such health hazardous concentrations of heavy meals in poultry feed and chicken meat.

Index Terms- Atomic Absorption Spectrophotometer , Heavy metal , Lead ,Zinc , Copper , Cadmium , Arsenic , Chromum , Iron , Poultry Liver

I. INTRODUCTION

Tirupur is a developing city where the rate of urbanization and industrialization is increasing day by day. These developments are likely to produce certain changes in the environment. Besides many problems associated with such developments, the major one is pollution. Pollutions are of different types but the most hazardous type of pollution is the contamination of food. It occurs because of unhygienic condition, industrial effluents, domestic wastes and use of pesticides in crops.

Among the pollutants generated by various industrial, domestic and commercial sewerage effluents, heavy metals and various pathogenic bacteria are directly related to the health problems. Health safety is very important aspect of food quality. Hazardous substances enter the food chain and are the main sources of contamination for humans. Heavy metals are most dangerous contaminants.

Heavy metals poisoning results from contamination of drinking water (e.g. lead pipes) or intake through food chain. Heavy metals are dangerous because they tend to accumulate inside the living organisms.

These are found everywhere in nature. These contaminants pollute air, rivers, canals and underground water resources. These contaminants consist of a large variety of biological and chemical agents of diseases. The most dangerous heavy metals contaminants are lead, cadmium, and mercury and entrance of these toxic metals to human body results in various harmful diseases.

Extensive research is underway on the investigation on heavy metals and their ill effects. The relationship between dietary habit and environmental mercury exposure in Chinese children was studied. Concentration of three toxic metals (Cd, Pb, & Hg) and six essential heavy metals were determined in the muscle conserves consumed by individuals in Spain. The most important group of toxic compounds in food includes heavy metals and persistent organic pollutants.

The concept for healthy food is that it should be free from all types of health hazards and having good taste. From above discussion it is estimated that the main source of heavy metals toward human body is food and one of the important food item is Chicken meat.

Meat is one of nutritional diet necessary for human growth and development. It contains fats, protein and other important minerals. It should be clean and safe from all hazardous agents like Cd, Pb, Hg, Cu, Cr, Zn and Mg. Meat consumed by public is sold in open markets and even on road sides and thus various heavy metals get way to meat and other food products and finally enters to human body, resulting in harmful diseases.

There is growing evidences that micro nutrients intake has significant effect on the toxicity and carcinogenicity caused by various chemicals. Therefore people's diet, deficient in micro nutrients will be pre disposed to toxicity from non essential metals. There is a great interdependence exists between nutritional status of the organisms and the degree ofaccumulation and the toxicity of heavy metals.

Contamination of food with heavy metals is a serious problem which is recognized in most countries of the world. The study was conducted to determine selected heavy metals in Chicken meat as the most uptakes of these agents are by ingestion. Population exposure to toxic metals is of greatest concern due to their non biodegradable nature. This study is one of the efforts to asses the accumulation of heavy metals through food and will provide help to divert the attention of people for the safety of food products from all these hazardous agents.

II. MATERIALS AND METHODS

The analysis was carried out in the in paladam . The analysis was done in various tissues of chicken . The testing was carried out by using an Atomic Absorption Spectrometer. The analysis

done in muscle and liver of a chicken and Lead , Cadmium, Zinc, Copper, Arsenic, Chromium, Iron concentration were tested from each chicken parts.

Atomic absorption spectrophotometer

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

Basic principle

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

III. METHODOLOGY

Sample Collection

Samples of chicken meat were collected from two different farms of Paladam. The feed which is the common brand used in selected poultry farm is collected from feed manufacture company. From each farm chicken liver and muscles were collected including excreta and water. Different types of meat samples i.e. poultry chicken muscle and liver were collected from different poultry farm of Paladam. For assessing heavy metals lead, cadmium, copper, zinc, chromium, arsenic and iron in collected samples, the samples were collected immediately after slaughtering and after specific exposure time.

The amount of samples collected was about 50g of each organ (muscles and liver), feed of 10gm and 100 ml farm water. Samples were transported to the lab by keeping under proper preservation (in glass container of volume 100 ml).

Analysis of water samples:

100 ml of water sample collected from the pipe line in poultry farm was analysed for following characteristics

Tab.1 Characteristics of farm water

S.No	Properties	concentrations
1	Ph	7.5
2	DO	6.4
3	Chlorides	82
4	Alkalinity	93.5
5	TDS	122.4

Analysis of feed samples

2g of feed was weighed into crucibles. 1ml of conc. nitric acid was added and then pre-ashed by placing the crucible on a heater until the contents charred. The cooled samples were dissolved using 5ml of 30% HCl and then filtered using Whatmann filter paper. The filtrates were individually poured into 50ml standard flask and made up to mark with distilled water. These were then transferred into prewashed sample bottles for analysis of the trace metals.

The sample solutions were then analyzed for zinc, iron, copper, lead, chromium, cadmium, arsenic and iron using atomic absorption spectrophotometer

Analysis of meat samples

The representative meat samples were chopped and 2g of each sample was treated with conc. Nitric acid. After treating samples with acid, samples were digested to get analyst metal in solutions till 1 ml of clear transparent sample solution was remained. The temperature was increased after every 30 minutes during digestion of samples. Then the solutions were filtered and volume of filtrate was made up to the mark in volumetric flask using distilled water and samples were stored in glass bottles. Filter paper No.4 was used for filtration of samples.

AAS Stock standard solution of 1000 ppm of respective elements (Pb,Cd,Cu,As,Cr,Zn and Fe) was used to prepare the working standard of 100 ppm. Then further dilution of 1, 2, 3, 4 and 5ppm were prepared as working standard of test elements.

Fig.1 Collected chicken meat

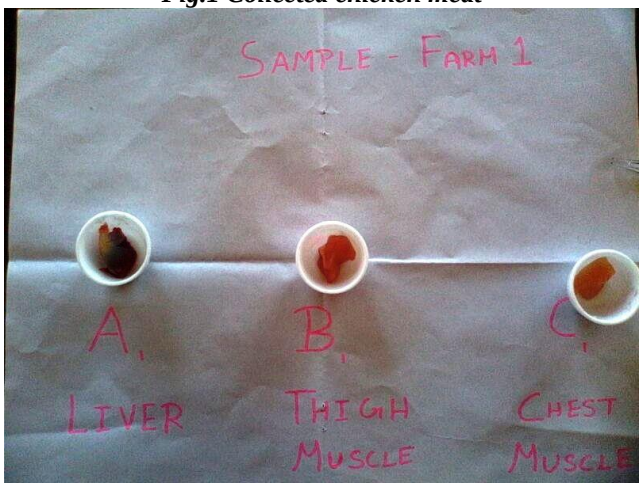
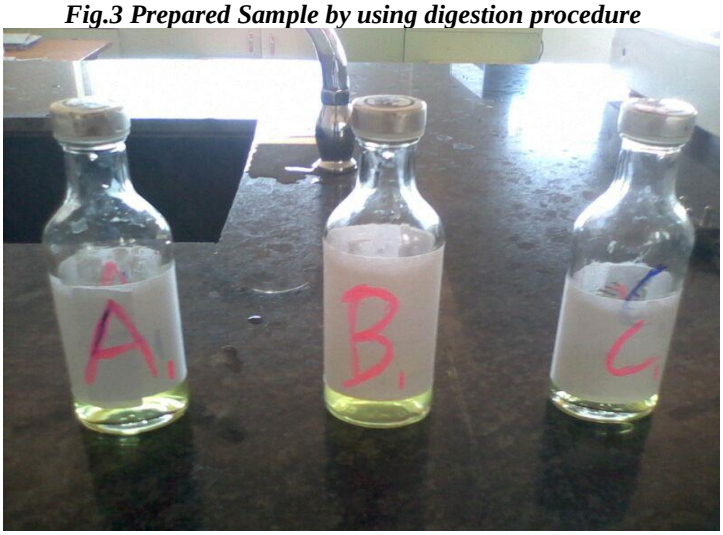


Fig .2 Sample digestion by heating mantle

Fig.3 Prepared Sample by using digestion procedure



IV. HEALTH HAZARDS ASSOCIATED WITH HEAVY METAL EXPOSURE AND THEIER PROPERTIES

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. Examples of heavy metals that are harmful to humans include mercury, lead, and arsenic. Chronic exposure to these metals can have serious health consequences. Humans are exposed to heavy metals through inhalation of air pollutants, consumption of contaminated drinking water, exposure to contaminated soils or industrial waste, or consumption of contaminated food. Food sources such as vegetables, grains, fruits, fish and shellfish can become contaminated by accumulating metals from surrounding soil and water. Heavy metal exposure causes serious health effects, including reduced growth and development, cancer, organ damage, nervous system damage, and in extreme cases, death. Exposure to some metals, such as mercury and lead, may also cause development of autoimmunity, in which a person's immune system attacks its own cells. This can lead to joint diseases such as rheumatoid arthritis, and diseases of the kidneys, circulatory system, and nervous system.

Metals are particularly toxic to the sensitive, rapidlydeveloping systems of fetuses, infants, and young children. Some metals, such as lead and mercury, easily cross the placenta and damage the fetal brain. Childhood exposure to some metals can result in learning difficulties, memory impairment, damage to the nervous system, and behavioral problems such as aggressiveness and hyperactivity. At higher doses, heavy metals can cause irreversible brain damage. Children may receive higher doses of metals from food than adults, since they consume more food for their body weight than adults.

1)Mercury

Mercury is a toxic heavy metal and a persistent environmental pollutant. Exposure to mercury is associated with serious adverse health and developmental effects, especially in pregnant women, developing fetuses, and young children. The health risks associated with mercury are damage to the nervous system and deformities in infants exposed to mercury in the womb. At levels well below World Health Organization limits, it has been shown to affect unborn fetuses and their embryonic nervous systems, leading to learning difficulties, poor memory and shortened attention spans. Low-level exposures also adversely affect male fertility.

2)Lead

Lead affects almost every organ system in the human body. The central nervous system is particularly vulnerable in infants and children under age six. The effects are the same whether it is breathed or swallowed. Large amounts of lead exposure may lead to blood anemia, severe stomachache, muscle weakness, and brain damage. Lower levels of exposure, may affect a child's mental and physical growth leading to learning disabilities and seizures. Children can be exposed to lead by drinking contaminated water, eating lead-based paint chips, chewing on objects painted with lead-based paint or swallowing house dust or soil containing lead.

3)Arsenic

Arsenic is a steely grey metal that is widely distributed in the Earth's crust and found naturally in the environment. It cannot be destroyed or eradicated. Because it occurs naturally in the environment it is possible to be exposed to it through air, water and soil contact. There are two different types of arsenic, organic and inorganic. Organic arsenic compounds consist of arsenic combined with oxygen and hydrogen. There is very little information available on the effects of organic arsenic compounds in humans. Inorganic arsenic compounds consist of arsenic combined with oxygen, chlorine and sulfur. Several studies have shown that inorganic arsenic can cause
lung, bladder, liver, kidney, prostate and skin cancer. Emerging science also shows that inorganic arsenic may harm pregnant women and their fetuses. Arsenic has been shown to cross the placenta to the fetus and has been found in breast milk. Chronic exposure to arsenic has been shown to affect child development, lowering their IQ scores.

4)Cadmium

Cadmium is biopersistent and, once absorbed by an organism, remains resident for many years (over decades for humans) although it is eventually excreted.In the general, non-smoking population the major exposure pathway is through food, via the addition of cadmium to agricultural soil from

various sources (atmospheric deposition and fertilizer application) and uptake by food and fodder crops. Additional exposure to humans arises through cadmium in ambient air and drinking water.

5)Chromium

Chromium is used in metal alloys and pigments and other materials. Low-level exposure can irritate the skin and cause ulceration. Long-term exposure can cause kidney and liver damage, and damage too circulatory and nerve tissue.

6)Copper

Copper is an essential substance to human life, but in high doses it can cause anemia, liver and kidney damage, and stomach and intestinal irritation. People with Wilson's disease are at greater risk for health effects from overexposure to copper.

7)Nickel

Small amounts of Nickel are needed by the human body to produce red blood cells, however, in excessive amounts, can become mildly toxic. Short-term overexposure to nickel is not known to cause any health problems, but long-term exposure can cause decreased body weight, heart and liver damage, and skin irritation.

8)Iron

Your body has the ability to naturally store iron, however, too much iron in the body may be linked to heart disease, cancer, diabetes and other diseases. Dietary factors, including consuming iron-containing supplements, were significant risk factors. Fruit were also associated with a risk of high iron stores. Iron can be found in meat, whole meal products, potatoes and vegetables. The human body absorbs iron in animal products faster than iron in plant product.

Iron may cause conjunctivitis, choroiditis, and retinitis if it contacts and remains in the tissues. Chronic inhalation of excessive concentrations of iron oxide fumes or dusts may result in development of a benign pneumoconiosis, called siderosis, which is observable as an x-ray change. No physical impairment of lung function has been associated with siderosis. Inhalation of excessive concentrations of iron oxide may enhance the risk of lung cancer development in workers exposed to pulmonary carcinogens. LD50 (oral, rat) =30 gm/kg. (LD50: Lethal dose 50. Single dose of a substance that causes the death of 50% of an animal population from exposure to the substance by any route other than inhalation.Usually expressed as milligrams or grams of material per kilogram of animal weight (mg/kg or g/kg).) A more common problem for humans is iron deficency, which leads to anaemia. A man needs an average daily intake pf 7 mg of iron and a woman 11 mg; a normal diet will generally provided all that is needed.

9) Cobalt

As cobalt is widely dispersed in the environment humans may be exposed to it by breathing air, drinking water and eating food that contains cobalt. Skin contact with soil or water that contains cobalt may also enhance exposure.Cobalt is not often freely available in the environment, but when cobalt particles are not bound to soil or sediment particles the uptake by plants and animals is higher and accumulation in plants and animals may occur. Cobalt is beneficial for humans because it is a part of vitamin B_{12}, which is essential for human health. Cobalt is used to treat anaemia with pregnant women, because it stimulates the production of red blood cells. The total daily intake of cobalt is variable and may be as much as 1 mg, but almost all will pass through the

However, too high concentrations of cobalt may damage human health. When we breathe in too high concentrations of cobalt through air we experience lung effects, such as asthma and pneumonia. This mainly occurs with people that work with cobalt. When plants grow on contaminated soils they will accumulate very small particles of cobalt, especially in the parts of the plant we eat, such as fruits and seeds. Soils near mining and melting facilities may contain very high amounts of cobalt, so that the uptake by humans through eating plants can cause effects.

Health effects that are a result of the uptake of high concentrations of cobalt are:

- Vomitting
- Vision
- Nausea
- Thyroidproblem

Health effects may also be caused by radiation of radioactive cobalt isotopes. This can cause sterility, hair loss, vomiting, bleeding, diarrhoea, coma and even death. This radiation is sometimes used with cancer-patients to destroy tumors. These patients also suffer from hair loss, diarrhea and vomiting.

Cobalt dust may cause an asthma-like disease with symptoms ranging from cough, shortness of breath and dyspnea to decreased pulmonary function, nodular fibrosis, permanent disability, and death. Exposure to cobalt may cause weight loss, dermatitis, and respiratory hypersensitivity. LD 50 (oral, rat)-6171 mg/kg. (LD50 = Lethal dose 50 = Single dose of a substance that causes the death of 50% of an animal population from exposure to the substance by any route other than inhalation. LD50 is usually expressed as milligrams or grams of material per kilogram of animal weight (mg/kg or g/kg).)

10)Manganese

Manganese is a very common compound that can be found everywhere on earth. Manganese is one out of three toxic essential trace elements, which means that it is not only necessary for humans to survive, but it is also toxic when too high concentrations are present in a human body. When people do not live up to the recommended daily allowances their health will decrease. But when the uptake is too high health problems will also occur.The uptake of manganese by humans mainly takes place through food, such as spinach, tea and herbs. The foodstuffs that contain the highest concentrations are grains and rice, soya beans, eggs, nuts, olive oil, green beans and oysters. After absorption in the human body manganese will be transported through the blood to the liver, the kidneys, the pancreas and the endocrine.

Chronic Manganese poisoning may result from prolonged inhalation of dust and fume. The central nervous system is the chief site of damage from the disease, which may result in permanent disability. Symptoms include languor, sleepiness, weakness, emotional disturbances, spastic gait, recurring legcramps, and paralysis. A high incidence of pneumonia and other upper respiratory infections has been found in workers exposed to dust or fume of Manganese compounds. Manganese compounds are experimental equivocal tumorigenic agents.

V. RESULTS AND DISCUSSIONS

Some of heavy metals are required by most living organisms for normally healthy growth but excess concentration causes toxicity. The samples of chicken meat, water and feed collected from different farms of Paladam in order to determine the heavy metals concentration in these, all the analytical data are given in table.

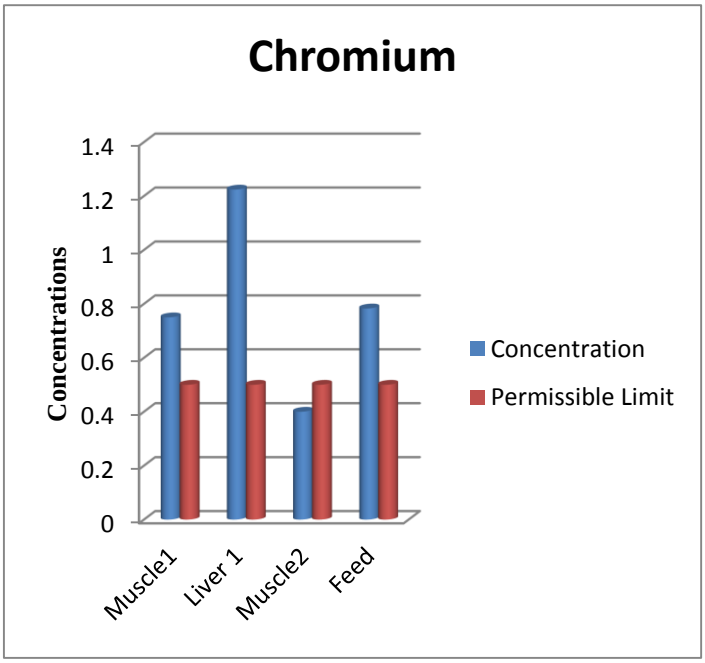
Tab.2 Heavy metal I chicken feed sample and farm water

Heavy Metals	Concentrations	
	Feed(mg/kg)	Water(mg/l)
Cr	0.783	0.007
Cu	3.116	0.004
Zn	5.356	0.269
Cd	-	-
Fe	22.688	2.321
Pb	0.004	-
As	-	-

Tab.3 Heavy metals in muscle and liver of chicken.

Organ	Heavy Metals	Concentrations in (mg/kg)	
		Farm 1	Farm 2
Muscles	Cr	0.750	0.400
	Cu	3.536	0.007
	Zn	5.324	1.570
	Cd	0.009	-
	Fe	19.321	16.32
	Pb	0.001	-
	As	-	0.004
Liver	Cr	1.224	0.004
	Cu	2.029	1.141
	Zn	5.535	2.300
	Cd	-	-
	Fe	14.788	11.204
	Pb	0.006	-
	As	0.002	-

Graph.1 Conc of chromium in each sample and with their permissible limit

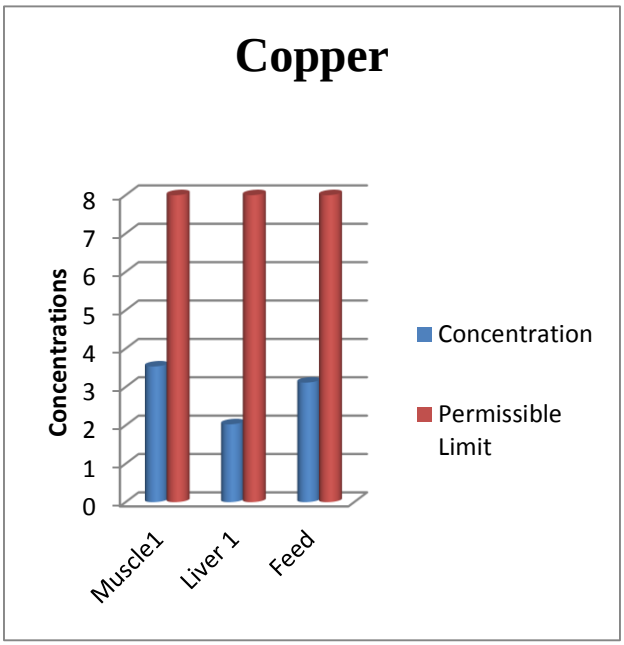


Inference

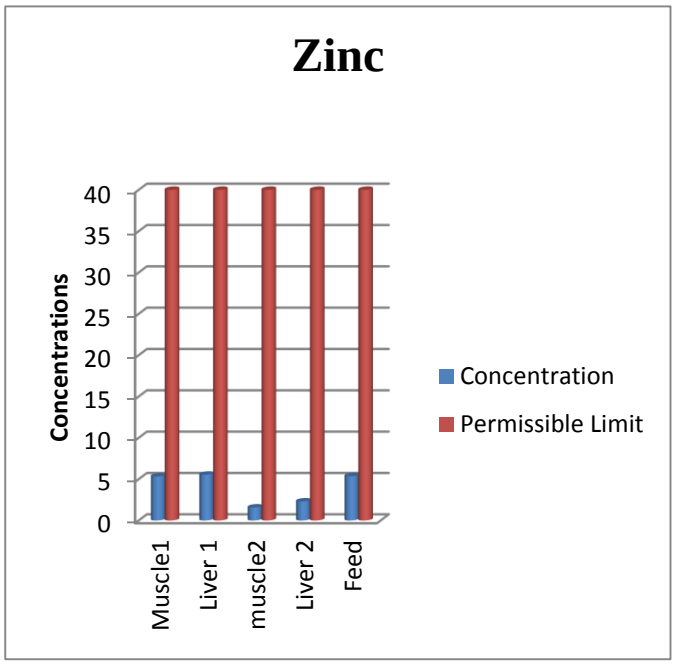
It is carcinogenic in nature present in environment. The main sources of chromium are jewellary, cosmetics, cigarette smoke, utensils, fertilizers etc. In human body highest concentration of chromium is found in lungs,kidneys and some hormones producing tissue. Small amount of chromium is also hazardous to human body.however in excessive amounts can become midely toxic and can cause decreased body weight, heart liver damages, skin diseases, cancer, headache and respiratory illness.

In current study the concentration of chromium is higher than the permissible level. Maximum level found in chicken meat sample of liver sample of farm1 while minimum level found in muscle sample.The difference in the concentration of chromium in meat samples may be due to the level of pollution, fodder of animals, slaughtering places.

Graph.2 Conc of copper in each sample and with their permissible limit



Graph.3 Conc of zinc in each sample and with their permissible limit



Inference

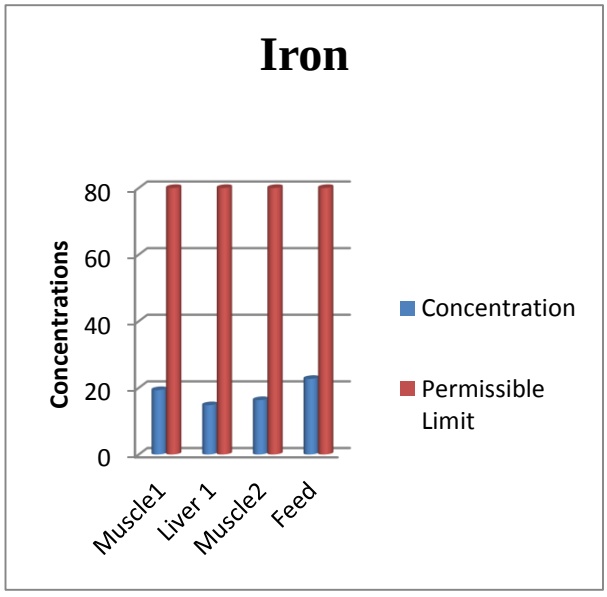
Copper is an essential trace element for human body and is an indispensable component of many enzyme systems; however a number of pathogenic characteristics are attributed to this element. Copper is an essential substance to human life as it is involved in absorption, storage and metabolism of iron but in high doses it can cause anemia, liver and kidney damages and stomach and intestinal irritation. The sources of copper entrance into human body are drinking water from copper pipes as well as the use of brass cooking utensils.

The concentration of copper obtained in the present study showed positive value and were found to be in lower concentration than the permissible limit WHO/FAO in both chicken and feed. Copper concentration show negative value in water sample

Inference

The results revealed the concentration of Zinc ranged more in liver of chicken . Maximum value observed in farm 1 while the lowest concentration found in feed .zinc concentration within the permissible limit . So it appears that the concentration of zinc in present study of meat samples were within the permissible limit. Zinc is an intestinal irritant present in environment. The first sign of zinc poisoning is usually intestinal distress which includes vomiting, stomach cramps, diarrhea and nausea.

Graph.4 Conc of Iron in each sample and with their permissible limit



Inference

Your body has the ability to naturally store iron, however, too much iron in the body may be linked to heart disease, cancer, diabetes and other diseases. Dietary factors, including consuming iron-containing supplements, were significant risk factors.In this assessement iron concentration is positive and higher in meat sample. The present heavy metal is lesser than permissible limit but regular exposure to such concentration will cause tremendous effect to human being.

Lead

The results of lead in meat samples of present study showed negative concentration ranged. The lead concentration in all meat samples were negative values which indicate that the concentration of lead in these samples is very low from safe level. The lead concentration in feed is positive where it is lower than the permissible limit.Lead is a toxic element and can cause severe health risks such as abdominal pain, allergies, cardiovascular disease, depression and kidney disorder etc.

Cadmium

Cadmium occurs through out the body with highest concentrations in the liver, kidney, spleen and bone. The exposure to cadmium causes kidney and liver damage, skin irritation and also causes ulceration as well as it is an activator for several enzymes which are needed to drive numerous chemical reactions necessary to life. In this study cadmium concentration show negative ,which mean the cadmium presence lower than the safer level.

Arsenic

Arsenic is a steely grey metal that is widely distributed in the Earth's crust and found naturally in the environment. It cannot be destroyed or eradicated. Because it occurs naturally in the environment it is possible to be exposed to it through air, water and soil contact. Several studies have shown that inorganic arsenic can cause lung, bladder, liver, kidney, prostate and skin cancer. Emerging science also shows that inorganic arsenic may harm pregnant women and their fetuses. Arsenic has been shown to cross the placenta to the fetus and has been found in breast milk. This paper thus not show any positive value in concentration level because the farm we selected is not exposed to arsenic by any mean source.Various paper shown in our literature review consist of arsenic concentration and here we conclude that small amount of any toxic metals will become lethal to human body when there get accumulated in human body.

VI. Recommendation

- Keep yourself informed on the impacts of heavy metals and products containing them and act responsibly in their use and disposal.
- Always read the labels of products that may contain heavy metals e.g. paints that may contain lead and follow usage and disposal instructions carefully.
- Protect children from exposure to all heavy metals since babies and young children are more sensitive to such toxic substances.
- Avoid mercury-silver dental amalgams.
- Only drink clean water and if possible use a high quality water filtration unit that removes heavy metal impurities.
- Avoid regular consumption of chicken and seafood especially the largest fish (shark, swordfish, tuna) that may have been exposed to industrial discharges especially those containing heavy metals This is particularly important for pregnant women and children.
- Reduce your exposure to harmful chemicals by eating organically grown food crops and using natural cleaning products.
- Wash all fruits and vegetables carefully with fresh water to remove traces of pesticides and fertilizers which may contain heavy metals.
- Buy environmental friendly products whenever possible.
- Support companies that use less toxic materials in their production processes and demonstrate good corporate environmental stewardship.
- Support industrial recycling activities such as those for used batteries, used paint, used pesticides, used oil, and electronic wastes such as used computers and cell phones.

Large numbers of people in the world today suffer from heavy metals contamination caused largely by the discharge of effluents of industries and increasing trends. Although people in all population groups in the globe affected, the most wide spread and severe problems are usually encountered amongst resource poor, food insecure and vulnerable household in most developing countries. Lack of knowledge of hazards associated with contaminated food products is the key factor of many harmful diseases.

Keeping in view the results of present study it is recommended that;

- Meat having large nutrition value and less toxicity should be used.
- Animals should be fed on uncontaminated food and water.
- The slaughtering places must be clean and meat should be covered properly.
- A consumer is suggested to buy fresh and covered meat.
- As common man does not know about the harmful presence of heavy metals in meat therefore public should be made aware through print and electronic media and health education.
- Meat must be safe and suitable for human consumption and all parties including government, industries and consumers have a role in achieving this outcome.

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