IOSR Journal of Applied Chemistry (IOSR-JAC)
e-ISSN: 2278-5736.Volume 15, Issue 5 Ser. I (May 2022), PP 50-58
www.iosrjournals.org

Nutritional Evaluation and Trace Metals Analysis of *Carcinus Maenas* (Crab) Found in Mairua Dam of Katsina State

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Abstract
Carcinus maenas (Crab) are important constituent of the human diet. Carcinus Maenas are rich source of vitamins, minerals, fibre, protein, lipid, energy and moisture. Crabs are commonly eaten and the area where the Mairua Dam is found is associated with farming activities and agro-allied industries (potential source of water contamination). The study is aimed at determining trace metals levels in Carcinus Maenas found in Mairua Dam. The study also obtained and compared results for both male and female Carcinus Maenas. From the obtained results; the concentration of Zinc (4.814 mg/L for male and 2.023 mg/L female) and Cadmium (0.099 mg/L for both male and female) were found to be below the permissible limits of WHO, while the concentration Lead (2.417 mg/L for both male and female) in Carcinus maenas was above the permissible limits. The proximate analysis also showed slight variation between the male and female Carcinus Maenas, with female Carcinus Maenas being more in terms of carbohydrate, crude fibre and crude protein while the male Carcinus Maenas was higher in terms of ash, lipid and moisture contents.

Keywords – *Carcinus maenas, Mairua Dam, Cadmium, Lead, Proximate, Trace metals, Zinc*

Date of Submission: 12-05-2022 Date of Acceptance: 27-05-2022

I. INTRODUCTION

Food is one of the essential aspect of life that most people do not care about (Samuel, 1970). Food is any substance usually composed of carbohydrates ,fats, proteins and water that can be eaten or drunk by an animals, including humans for nutrition or pleasure (Dutcher, 1951).The human body needs these special component of food known as nutrients for its energy supply, growth, maintenance, repair and production. Items considered as food may be source from plants, animals or other categories (Dutcher, 1951). The natural aquatic system may extensively be contaminated with heavy metal/trace metals release from domestic, Industrial and other man-made activities. *Carcinus maenas* are found throughout the world chiefly in marine waters but they also inhabit fresh water and land, where they dig or inhabit burrows. Several *CarcinusMaenus* are prize as food. *Carcinus Maenas are* decapod crustaceans of the Infra order brachyura, which typically have a very short projecting “tail” (abdomen) brachys = short, (Henry *et al.,* 2010) oura = tail, usually entirely hidden under the thorax (Henry *et al.,* 2010). They live in all the world’s oceans, in fresh water, and on land, and are generally covered with a thick exoskeleton and have a single pair of claws. Many other animals with similar names-such as hermit crabs, king crabs, porcelain crabs, horseshoe crabs and crab lice-are not true crabs (Richard *et al.,* 2001). *Carcinus Maenas* are generally covered with a thick exoskeleton, composed primarily of calcium carbonated armed with single pair of chelae (claws) (Bobelmann *et al.,* 2007). *Carcinus maenas* vary in size from the pea crab, a few millimeters wide, to the Japanese spider crab, with a leg span of up to 4 meters (13 ft). About 850 species of crab are freshwater, terrestrial or semi-terrestrial species; they are found throughout the world’s tropical and semi-tropical regions (Richard *et al.,* 2001). They were previously thought to be a monophyletic group, but are now believed to represent at least two distinct lineages, one in the Old World and the other in the New World.(Sternberg *et al.,* 1999). Heavy metals are metals with density greater than 5.00g/cm³ (chen*et al.,* 1999). Example includes Fe, Mn, Cu, Zn, Cd, Pb, Hg, Cr, Ni, e.g.when the heavy metals content in the environmental consequences. Therefore soil and water pollution caused by heavy metals is a phenomenon where the heavy metals content in the soil or water exceeds the natural background level and causes ecological and/or deterioration of environmental quality (Chen, 1996). In recent years there has been an increasing consumption of crab among the urban community. This is due to awareness of their nutritive value, as a result of exposure of people to proper education. However, *Carcinus maenas* contain both essential elements and also toxic elements (Trace Metals) that may have potential at varying degrees of contamination.

Heavy metals contamination in *Carcinus maenas* may pose a direct threat to human health, and it is one of a range of important types of contaminants that can be found on the surface and tissues of fresh *Carcinus maenas* (Chen *et al.,* 1999). Sources of heavy metals in soil and water include discharge from industrial waste water (effluent), sewage, solid waste disposal, pesticide and fertilizer application and atmospheric deposition. Large amount of these industrial and urban waste water are being discharged directly into environment with little or no treatment. These waste waters frequently contain metals that can have adverse effect on human health and the environment (Vivik *et al*., 2004). Animals growing on industrial effluent contaminated water accumulate potentially toxic element (PTE) from the water. Element like Fe, Zn, Mn, and Cu are essential trace elements to animal life while Pb, Cr, Ni and Cd are toxic even at a very low concentration (Kisku *et al.*, 2000). The accumulation of (PTE) may vary from animal to animal and water to water. The metals availability to plant depends on total concentration of metals in the soil and the forms in which they occur (Roberts and Johnson, 1978). The availability of water metals to animal is also a function of water properties like pH, Organic carbon, cation exchange capacity and stage of plants (Chambers and Guddle, 1991). Most of the metals are retained in top water and their concentration decreases with increases in depth (OlunaI *et al.*, 1991). The uptake of Trace metals in *Carcinus maenas* are influence by some factor such as climate, atmospheric depositions, the concentrations of Trace metals in soil, the nature of soil and water in which the *Carcinus maenas* are grown and the degree of maturity of the animals at the time of death or consumption (Jerup et al., 2003).Air pollution may pose a threat to post caught *Carcinus maenas* during transportation and marketing, causing elevated levels of Trace metals in crabs. Trace metals generally cause a decrease in total nutrient content hereby; alter the metabolic pathways of the animals. Trace metals obviously affects animals life and also reduces the birth rate likely to 10% (Kisku *et al*., 2000)

II. EXPERIMENTAL

Materials

All solutions were prepared with analar-grade chemicals and deionized water as diluents.
The glass wares and other apparatus used in this work were cleaned and dried before use.

Apparatus

In addition to routine laboratory apparatus and reagents, the following apparatus and reagents were also used.

- Digital weighing balance (JD400-3, ENGLAND)
- Oven (UNISCOPE SM9023, ENGLAND)
- Desiccator
- Soxhlet Set up apparatus
- Sterile blade
- Muffle Furnace (KAY MCB B/16, JAPAN)
- Protein Digestion set up apparatus

Reagents

- Nitric Acid (HNO_3)
- Hydrochloric Acid (HCI)
- Sulphuric Acid (H_2SO_4)
- Petroleum Ether
- Sodium hydroxide (NaOH)
- Boric Acid

Description of Study Area.

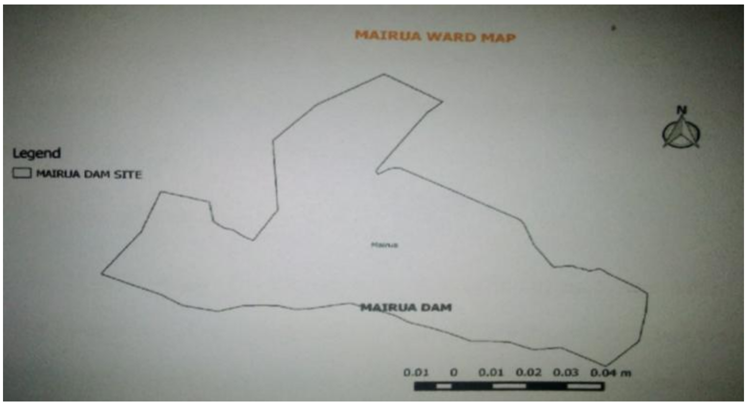

Fig. 1: Sketch of Mairua Dam

Mairua dam is situated in Funtua Local Government Water Board Treatment Plant at the eastern part of the Federal Government Road along Sokoto Road, 9 kM away from Funtua town. Mairua village is in Faskari Local Government of Katsina State of Nigeria.

Sample Collection

Carcinus maenas sample were collected from Mairua Dam at Mairua dam, Faskari local Government, Katsina State, Nigeria, earlier wet season. Six pieces of matured fresh *Carcinus maenas* of different sex were selected from the *Carcinus maenas* caught in the Mairua Dam, meaning 2 samples were used for this study. The *Carcinus maenas* were caught at various time within one month.

Preparation and Treatment of Samples

The collected samples were cut to small pieces using clean knife. The samples of *Carcinus Maenas* were then air dried in an oven at 100°C for total dryness. After drying, the samples were grounded into a fine powder using a mortar and pestle and stored in polyethylene bags, until when needed.

Sample Digestion

About 2g of a sample was ashed in a muffle furnace, the ashed residue was transferred into a 250 cm^3 beaker. 50 cm^3HCI (1 part HCI + 3 parts deionized water) was added followed by several drops of Concentrated HNO. The mixture was set on a hot plate to boil under a fume cup board. The solution was allowed to cool and filtered into a 100 cm^3 sample bottle that had been rinsed with dilute acid. The filtrate was diluted to volume with distilled water. Trace metals such as Zn, Cd and Pb was found in the filtrate of male and female *Carcinus Maenas* and this was achieved by Atomic Absorption Spectrophotometer (AAS).

Proximate Analysis

Moisture Content:

The method described by AOAC (1984) was adopted. A clean crucible was dried to constant weight in an air oven at 105°C, cooled in a desiccator and weighed; the weight was then recorded as W1. Two grammes of sample was accurately weighed into the previously labeled crucible W1 and reweighed with the weight recorded as W2. The crucible was dried in an oven to a constant weight recorded as W3. The percentage moisture content was then calculated using the formula.

$$\% \text{ Moisture content} = \frac{W3-W1}{W2-W1} \times 100$$

Ash Content

The AOAC (1984) method was used. The porcelain crucible was dried in an oven at 100°C for 10 minutes, cooled in a desiccator and weighed the weight was recorded as W1. Two grams of the sample was placed into the previously weighed porcelain crucible and weighed with the weight recorded as W2. The sample was first ignited and transferred into a furnace, which was then set at 550°C. The sample was left in the furnace for eight hours to ensure proper ashing. The crucible containing the ash was then removed, cooled in the desiccator and weighed which was recorded as W_1 . The percentage ash content was calculated using the formula.

$$\% \text{ Ash content} = \frac{W3-W1}{W2-W1} \times 100$$

Crude Lipid Content

The lipid content was determined as is provided in the AOAC (1984) method.

A clean, dried 500 cm^3 round bottom flask, containing few anti-bumping granules was weighed, the weight was recorded as W_1. 300 cm^3 of Petroleum ether (40 - 60°C) for extraction was poured into the flask fitted with the Soxhlet extraction unit. The extractor thimble containing twenty grams of the sample was fixed into the Soxhlet extraction unit. The round bottom flask and a condenser were connected to the Soxhlet extractor and cold water circulation was put on. The heating mantle was switched on and the heating rate adjusted until the solvent was refluxing at a steady rate. Extraction was then carried out for six hours. The solvent was recovered and the oil was dried in the oven at 70°C for one hour. The round bottom flask containing the oil was cooled in the desiccator and then weighed, the weight recorded as W_2 . The lipid content was then calculated using the formula.

$$\% \text{ Crude Lipid Content} = \frac{W3-W1}{\text{Weight of Sample}} \times 100$$

Crude Fibre Content

The method described by AOAC (1980) was used. Two grams of sample was weighed out into a round bottom flask. 100cm^3 of 0.25M Sulphuric acid Solution was added and the mixture boiled under reflux for 30 mins. The hot solution was quickly filtered under suction machine. The insoluble matter was washed several times with hot water until it was acid free. It was then quantitatively transferred into the flask and 100 cm^3 of hot 0.31M Sodium hydroxide solution was added and the mixture boiled again under reflux for 30 minutes and quickly filtered under suction machine. The insoluble residue was washed with boiling water until it was based free. It was dried to constant weight in the oven at 100°C, cooled in a desiccator and weighed, with weight recorded as C_1. The weighed sample was then incinerated in a muffle furnace at 550°C for 2 hours, cooled in the desiccator and reweighed, with weight recorded as C_2. Formula for Calculating percentage crude fibre content.

The loss of weight on incineration => $\frac{C_1-C_2}{\text{Weight of original Sample}} \times 100$

Nitrogen and Crude Protein

Protein Digestion

Exactly 1.5g of the defatted sample in an ashless filter paper was transferred into 300cm Kjeldahl flask. Twenty five milliliters of H2SO4, and 3g of digesting mixed catalyst (weighed separately into an ashless filter paper) was equally transferred into the Kjeldahl flask. The flask was then fitted to the Kjeldahl digestion apparatus, and sample digested until a clear green colour was obtained. The digest was cooled and diluted to 100 cm^3 with distilled water in 100cm^3 volumetric flask. The method of Onyeike and Osuji (2003) was used.

Distillation of the Digest

20cm^3 of the diluted digest was measured into a 500 cm^3 Kjeldahl flask containing antibumping chips and 40 cm^3 of 40% NaOH was slowly added by the side of the flask. A 250cm' conical flask containing a mixture of 50cm^3 of 2% Boric acid and 4 drops of mixed indicator was used to trap the ammonia liberated. The conical flask and the Kjeldahl flask were then placed on the Kjedahl distillation apparatus, with the tubes inserted into the conical flask and the Kjedahl flask. The flask was heated to distill out the NH, evolved. The distillate was collected into the boric acid solution. From the point when the boric acid turned green, 10 minutes were allowed for complete distillation of the ammonia present in the digest. The distillate was then titrated with 0.IM HCL

Calculation for the percentage crude protein content;

The formula for calculating percentage crude Nitrogen.

$$\% N = \frac{14 \times M \times Vt \times Tv \times 100}{\text{weight of sample (mg)} \times Va}$$

The formula for calculating crude protein content.

% Crude protein =% Nitrogen (N2) x 6.25

Where M=Actual molarity of acid

Tv=Titre volume of HCI used

Vt= Total volume of diluted digest

Va-Aliquot volume distilled

Carbohydrate (by difference)

The total carbohydrate content was determined by difference. The sum of the percentage moisture, ash, crude lipid, crude protein and crude fibre was subtracted from 100 (Muller and Tobin, 1980).

Calculation of % Total Carbohydrate= 100-(% Moisture + % Ash +% Fat + % Protein + % Fiber)

Energy Value of Samples

The energy value was calculated using the factors reported by (Onyeike et al 2000). The value of protein content was multiplied by 4, that of Lipid by 9 and that of Total Carbohydrate by 4. The sum of these values was expressed in Kcal/100g sample.

III. RESULTS AND DISCUSSION

Results

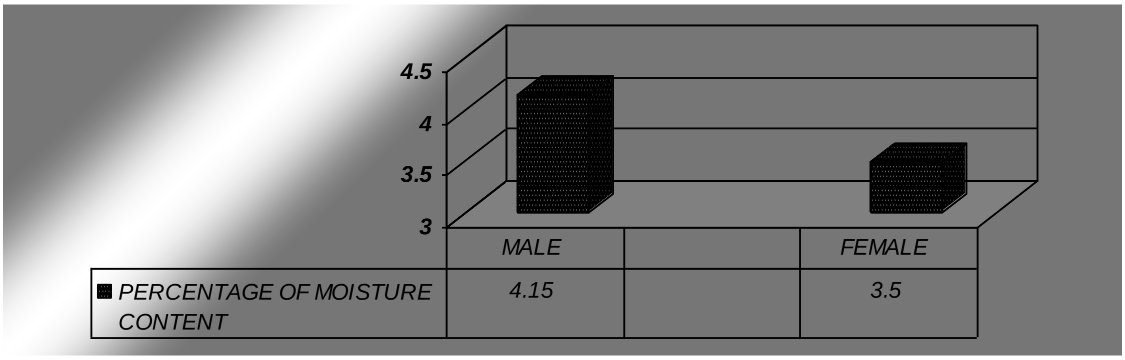

Figure 1: Percentage Moisture Content

Figure 1 above chart showing the moisture content of *Carcinus Maenas* samples which was found to be 4.15% for male and 3.5% for female which may be advantageous in terms of the shelf life of the *Carcinus Maenas* and the trend is, Male *Carcinus Maenas* moisture > Female Carcinus Moenas moisture. The moisture content of both the female and female *Carcinus maenas* are relatively low. The low moisture content signifies that Carcinus Maenas are less susceptible to deterioration by microbial contamination and enzymatic activity. Also the low moisture content signifies the higher dry matter yield.

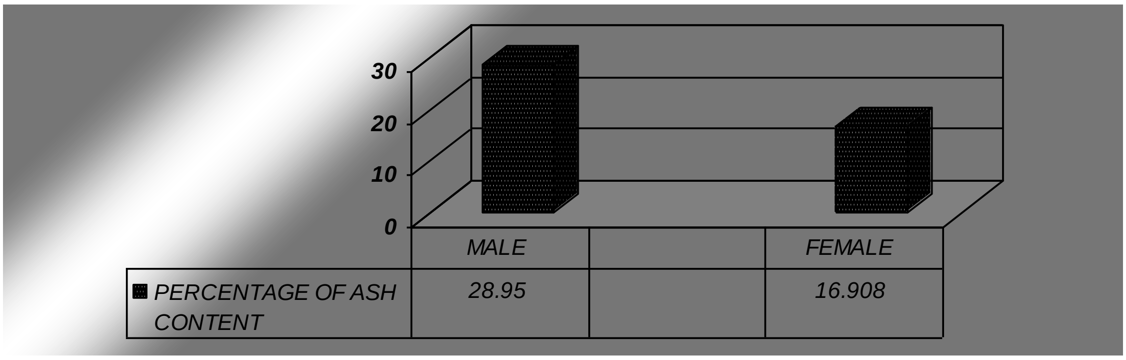

Figure 2: Percentage Ash Content

Figure 2 above showing the Ash content of *Carcinus Maenas* samples which was found to be 28.95%for male and 16.908% for female which may be advantageous in terms of shelf life of the Carcinus Marnas and the trend is, Male *Carcinus Maenas* Ash content >Female *Carcinus Marnas* Ash content. The Ash content of the male Carcinus *Maenas*(28.95%) is appreciably higher than that of the female *Carcinus Maenas*(16.908%). This suggests that the male *Carcinus Maenas* has a large amount of inorganic matter than the female *Carcinus Maenas*. Therefore the male *Carcinus Maenas* will be a better source of inorganic elements often in the form of salts in the body.

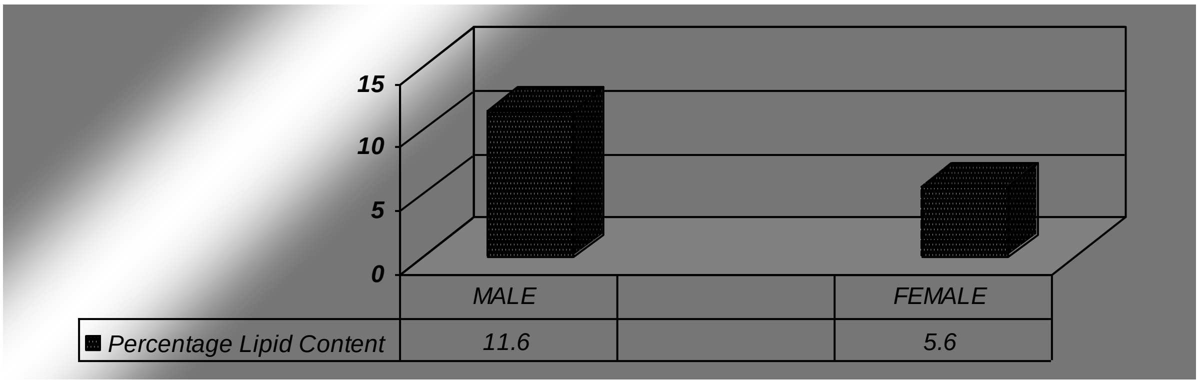

Figure 3: Percentage Lipid Content

Figure 3 showing the percentage Lipid content of *Carcinus Maenas* samples which was found to be 11.6%for male and 5.6% for female which may be advantageous in terms of the shelf life of the *Carcinus Maenas* and the trend is, Male *Carcinus maenas* Lipid content>Female *Carcinus maenas* Lipid content. The percentage (%) lipids content of male *Carcinus Maenas* differs appreciably from that of the female *Carcinus Maenas*. The high percentage (%) lipid comment of the male *Carcinus Maenas* suggest that it is a better source of energy than the female *Carcinus Maenas* since lipids are important as source of energy.

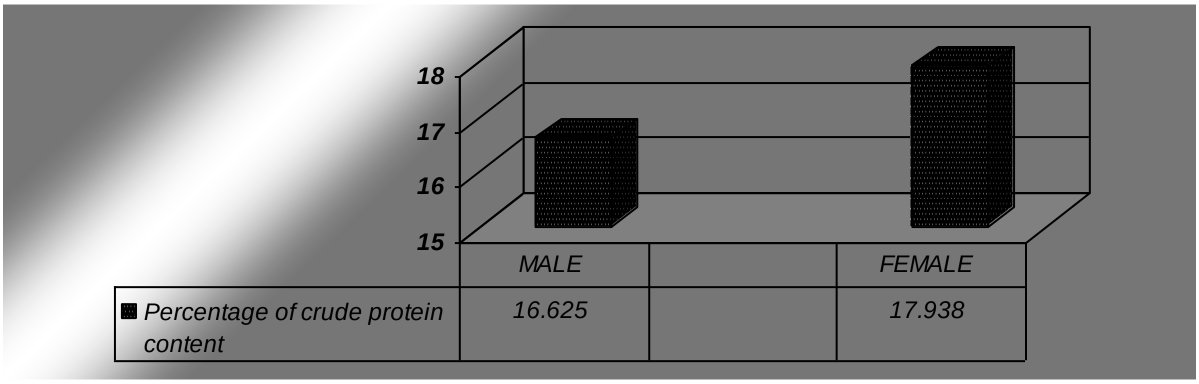

Figure 4: Percentage Crude Protein Content

Figure 4 above showing the percentage crude protien content of *Carcinus Maenas* samples which was found to be 16.625%for male and 17.938% for female which may be advantageous in terms of the shelf life of the *Carcinus Marnas* and the trend is, Male *Carcinus maenas* crude protein <Female Carcinus maenas crude protein. The percentage (%) protein content of both the male and female Carcinus Marnus are virtually the same. The percentage (%) of protein content in both is appreciable. Therefore both the two can serve as source of protein considering the level of protein defeating in society and can be a good food supplement.

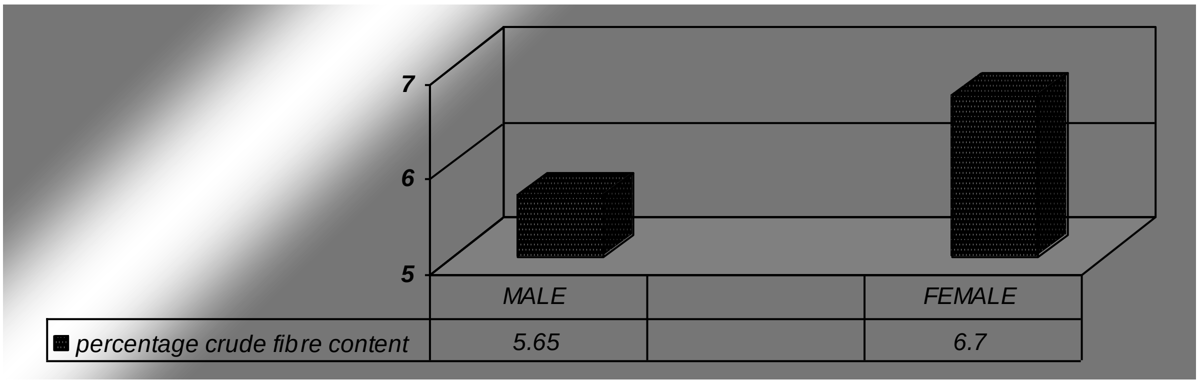

Figure 5: Percentage Crude Fibre

Figure 5 above showing the percentage crude fibre content of *Carcinus Maenas* samples which was found to be 5.65%for male and 6.7% for female which may be advantageous in terms of the shelf life of the *Carcinus maenas* and the trend is: Male *Carcinus Maenas* crude fibre< Female *Carcinus Maenas* crude fibre. The fibre content of female and male Carcinus Maenas is 6.7% and 5.65% respectively. These suggest that they have a reasonable amount of indigestible matter. This indigestible matter is of no nutritional value but help in peristaltic movement and excretion.

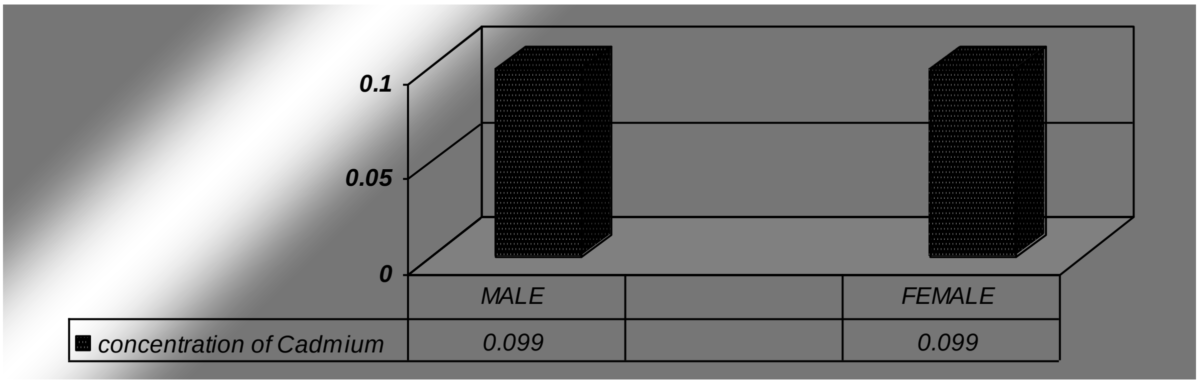

Figure 6: Concentration of Cadmium in *Carcinus maenas* Sample

Figure 6 shows the concentration of Cadmium in sample of *Carcinus Maenas* gender (male and female). According to FAO/WHO the permissible limit of Cadmium is 1.0mg/L, from the chart above it shows that the concentration of Cadmium in sample of crab gender is within the permissible limit and the trend of Carcinus Maenas sample was given as: Concentration of cadmium in MALE *Carcinus maenas* and FEMALE Carcinus *Maenas* is the same. From above result we can conclude that the male and female Carcinus Maenas caught from Mairua Dam are safe to consume but not in large quantity to avoid rapid accumulation of cadmium metal which may affect normal health condition.

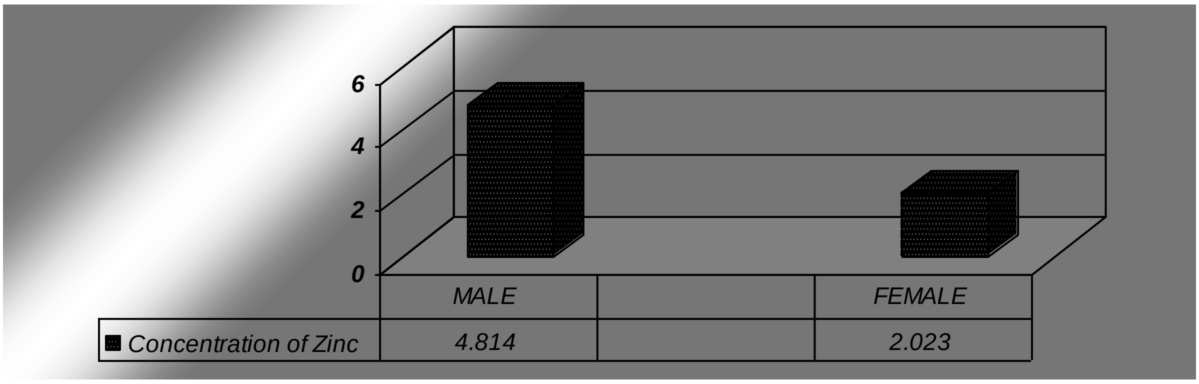

Figure 7: Concentration of Zinc in *Carcinus maenas* Samples

Figure 7 shows the concentration of Zinc in sample of *Carcinus Maenas* gender (male and female). According to FAO/WHO the permissible limit of Zinc is 55.0mg/L, from the chart above it shows that the concentration of Zinc in sample of *Carcinus Maenas* gender is within the permissible limit though is very low and the trend of *Carcinus Maenas* sample was given as: Concentration of Zinc in MALE *Carcinus maenas* is greater than Concentration of Zinc in FEMALE *Carcinus Maenas.* This implies that the level of contamination of Zinc is very low in the *Carcinus maenas* caught in Mairua Dam, and is within the permissible limit though the concentration of zinc in male *Carcinus Maenas* is higher than that of female Carcinus maenas. Zinc is the most prevalent trace metal in tissue. Therefore by consuming male and female, Carcinus Maenas caught from Mairua Dam will affect the level of zinc metal concentration in man and animals positively.

There is a wide range before reaching the maximum limit of zinc concentration approve by WHO.

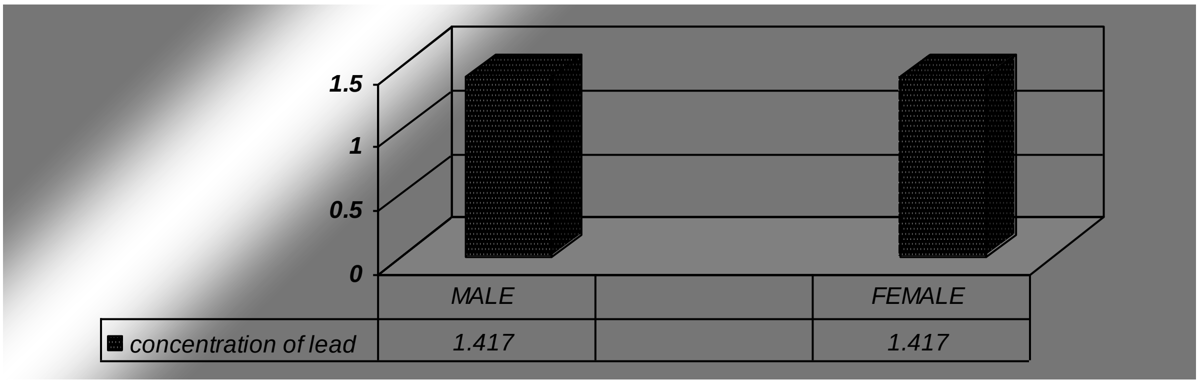

Figure 8: Concentration of Lead in *Carcinus maenas* Samples

Figure 8 shows the concentration of lead in sample of *Carcinus Maenas* gender (male and female). According to FAO/WHO the permissible limit of lead is 1.0mg/L, from the chart above it shows that the concentration of lead in sample of *Carcinus Maenas* gender is above the permissible limit in all samples and the trend of *Carcinus Maenas* sample was given as, Concentration of Lead in MALE *Carcinus Maenas* and FEMALE Carcinus maenas is the same. This implies that the level of contamination of Lead in the Carcinus Maenas samples caught in Mairua Dam is the same and is above the permissible limit. From the above result's shows that large consumption of male and female. Carcinus Maenas caught from Mairua Dam will lead to high accumulation of Lead in the body system, and is not recommended by health organizations.

IV. CONCLUSION:

The results shows that the concentration of cadmium (Cd) and Zinc (Zn) in *Carcinus Maenas* were below the permissible limits of WHO while the concentration of Lead (Pb) in *Carcinus Maenas* was above the permissible limits. The consumption of most of these trace metals at high concentration may lead to adverse health hazardous effects. However, these studies show that both male and female *Carcinus Maenas* are nutritionally valuable. They contain low moisture, appreciable lipid, fibre, Ash, protein and carbohydrates. Therefore Carcinus maenas comprised a good diet combination for Human being and higher aquatic animals.

ACKNOWLEDGEMENT

The research team wish to acknowledge and appreciates the Department of Pure and Applied Chemistry, Usmanu Danfodiyo University, Sokoto, Nigeria for the support extended to the Research team.

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Muhammad Gidado Liman, et. al. "Nutritional Evaluation and Trace Metals Analysis of Carcinus Maenas (Crab) Found in Mairua Dam of Katsina State." *IOSR Journal of Applied Chemistry (IOSR-JAC)*, 15(05), (2022): pp 50-58.