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STUDIES ON HEAVY METALS CONTAMINATION OF VEGETABLES FROM URBAN AND SEMI URBAN AREAS OF BENGALURU

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ABSTRACT

Vegetables are one of the main foodstuffs of the diet sources which contain life building components [vitamins, minerals, fibresetc.] in it. Heavy metals which are toxic are present in daily intake vegetables and their presence pose threat to human lives. Vegetables [cabbage (Brassica oleracea L. var capitata L.), cauliflower (Brassicaoleracea L. var botrytis L.), turnip (Brassica Rapasubsp. Rapa)] collected from the market sites of Bengaluruie., both urban [KR Market, yeshawanthpur..] and semi-urban [kunigal, Doddaballapur...] were tested to identify whether they are polluted by the heavy metals like Cu, Fe, Cr, Pb, Mn. Heavy metals can accumulate in vegetables because their watering may be done using water from the rivers that are reputed to experience the pollution from the mineral origin [Shengo et al]. This project is on the study of effect of heavy and toxic metals present in various vegetables grown in Bengaluru rural and urban areas ranging from Fe (98-441mg kg^{-1}), Pb (16-32mg kg^{-1}), Mn, Cu, Cr were found to be less detectable. Samples were collected from seven market sites. The accumulated heavy metals were quantified and the levels compared to the FAO/WHO CODEX-STAN 179:2003.The methodology involved random sampling, extraction of the metals from the vegetables.

KEYWORDS: ***Heavy metal concentration, XRF, Quality of vegetable variables, market spots***.

INTRODUCTION

The term “heavy metals” refers to any metallic element that has a relative density greater than 4g/cm3 (Grant and Grant, 1987).Heavy metals are found naturally in the earth. They become concentrated as a result of human caused activities and can enter plants, animals, and human tissue via diet, inhalation and manual handling. In humans, heavy metal poisoning is generally treated by the administration of chelating agents. Vegetables are the important components of human diet, which contribute the vitamins, minerals, fibres and other micronutrients

which are in short supply. Plants may contain both essential as well as non-essential elements over a wide range of concentrations. Even a small traces of heavy metals results in contamination of vegetables either through soil, water, or any other sources. (Nogmaithem Rajendra Singh, Naorem Mohendro Singh 2014). Rapid unorganised urbanisation and industrial developments have contributed to the varied levels of heavy metal contamination in the urban environment (Wong et al., 2003; Sharma et al., 2008, b). Industrial inputs and the agronomic applications of fertilizers, pesticides and metal contaminated sewage continue to contribute the metal accumulation in the soil. Heavy metals come from a variety of sources but principally anthropogenic activities such as chemical manufacturing, electric power generation, coal and ore mining, smelting and metal refining, metal plating. When these heavy metals are retained in the soil by repeated and uncontrolled additions, they interfere with these key biochemical process. Heavy metal toxicity may affect all forms of life including micro-organisms, plants and animals. Heavy metals at concentration levels affect the soil microbial population this have impact on soil fertility, its toxicity affects on growth of microorganism results reduction in diversity, population size of microbial communities5-10 [Damera Vineeth et al.].

Heavy metals contamination in vegetables through the industrial waste and other pollutants may be deposited on the vegetables surfaces while transporting and marketing. Prolonged 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 , 1992; Jarup, 2003). Some heavy metals such as Cu, Zn, Mn, etc acts as micronutrients in animals and human beings when present in trace quantities, whereas others such as Cd, As, and Cr act as carcinogens (Feig et al., 1994; Trichopoulos, 1997), Hg and Pb are associated with the development of abnormalities in children, it is also reported that long term intake of Cd causes renal, prostrate, and ovarian cancers.

The present study provides data on the pollution of vegetables due to high heavy metal concentrations in vegetables such as Cauliflower (Brassica oleracea L. var botrytis L.), Cabbage (Brassica oleracea L. var capitata L), turnip (Brassica Rapasubsp. Rapa) fig 1.which are available locally in urban and semi-urban markets of Bengaluru. It is noticed that the atmospheric depositions in urban areas increase the levels of pollution of heavy metals in vegetables during transport and marketing leading to significant contamination of vegetables at the market sites than at the production sites. Environmental pollution due to heavy and toxic metals has become a health concern for all over the world. Biological accumulation of some metals such as lead (Pb) in human body

may disturb the proper functioning of the mitochondria i.e "power house of cell". There are some metals such as copper (Cu), iron (Fe), manganese (Mn), chromium (Cr) could serve as plant nutrients depending on particular concentration level. As far as analysis is concerned heavy metals such as Chromium (Cr), Copper (Cu), Iron (Fe), Manganese (Mn) and Lead (Pb) have been studied [Saikat Sinha Ray, Amsavel, J. John Joseph, D. Sangeetha].

MATERIALS AND METHODS

1. Study Area

Fresh samples of vegetables were (cauliflower, cabbage, turnip) collected simultaneously from 7 market sites of bengaluruie., urban and semi-urban areas. These vegetables being perishable are sold in open markets of the city fig 2.The market sites such as KR Market, Yeshawanthpur, KR market (Malur), Yelahanka were found to be exposed to traffic load, industrial activities, residential, commercial areas, heavy traffic, flyovers, highways(1000-1500 vehicles run per hour) and with a dense population. Whereas markets of semi urban-areas such as Doddaballapur, Hessarghatta, Kunigal were found in the areas having a small scale industries (fabric paintings, cements, small scale workshops, etc), narrow road with less residential influence.

2. Sampling and Pretreatments

Vegetables were collected from above mentioned respective market sites of Bengaluru and were brought to the laboratory in a hygienic condition in a polythene bags. The samples collected were of the same size and picked up in a random manner(1kg each for cauliflower, cabbage, turnip).The uneatable portions were removed and the eatable portions were washed with distilled water to remove the dust particles, then samples were cut into equal sized pieces in a hygienic condition using a clean knife. Such vegetables were dried by exposing the samples to the sun covered with thin sheets upto 2-3 days without any contamination. Then the samples were dried inside a hot air oven at a constant temperature of 75ºC-85ºC for 48 hours until a constant weight was obtained. Dried vegetables were turned into fine powder with a pestle and a mortar and commercial blender. The powdered samples were tested for their pH, conductivity and acidity fig 3. The vegetables in its powdered form were stored inside the cleanly labelled polythene covers fig 4.

ANALYSIS

Vegetables collected from different places were analysed for the concentrations of heavy metals using X-ray fluorescence spectro photometer (XRF a-4000) fig 5. Vegetable samples were collected from different market places [Hessarghatta, KR market (malur), Yelahanka, Doddaballapur, Kunigal, Yeshawanthapura, KR Market]. At each sample location, vegetable samples were collected from 7 different locations which includes cauliflower, cabbage, turnip. The samples were analysed for heavy metals such as Cu, Fe, Cr, Pb, Mn.

Effects of heavy metals:

1. **Cu:** Copper is one of theimportant nutrient required by the human body. But exceeding the safe limit given by NAFDAC and WHO may lead to gastrointestinal problem such as constipation (leads to diverticular disease where the intestine becomes damaged),Diarrhoea ,nausea and vomiting[Internet source www.nutricia.ie/articles]. Even it may cause dysfunction of metabolism of other nutrients. The safe limit proposed by NAFDAC and WHO is 2.5 mg/kg in vegetables.

2. **Cr:** Chromium may affect the respiratory tract, stomach and small intestine (it affects nose and cause cancer) if the concentration of Cr exceeds the safe limit of 5.0 mg/kg. Even it may affect the male reproductive system. It can easily change from one form to another in water and soil, depending on the conditions present.[ATSDR, Tox FAQs]

3. **Pb:** Lead is one of the prominent metals that are carcinogenic in nature. The accumulation of lead in human body may cause cancer as it will damage the mitochondria of the cell. Lead serves no useful purpose in the human body, but its presence in the body can lead to toxic effects, regardless of exposure pathway. Lead toxicity can affect every organ system. As far as the safe limit is concerned it is about 1.0mg/kg in vegetables.

4. **Fe:** Iron is used in the biochemical reactions that form chloro- phyll and is a part of one of the enzymes that is responsible for the reduction of nitrate-N to ammoniacal-N. The body normally absorbs less iron if its stores are full, but some individuals are poorly defended against iron toxicity. Iron overload is known as hemochromatosis and usually is caused by a gene that enhances iron absorption. Additionally, long-term overconsumption of iron may cause hemosiderosis, a condition characterized by large deposits of the iron

storage protein hemosiderin in the liver and other tissues. The safe limit proposed by NAFDAC and WHO is20–150 mg/kg

5. **Mn:** Excess manganese interferes with the absorption of dietary iron. Long-term exposure results in iron-deficiency anemia. Manganese overload is generally due to industrial pollution. Workers in the manganese processing industry are most at risk. Manganese poisoning has been found among workers in the battery manufacturing industry. Symptoms of toxicity mimic those of Parkinson's disease (tremors, stiff muscles) and excessive manganese intake can cause hypertension in patients older than 40. The human body contains approximately ten milligrams of manganese, most of which is found in the liver, bones, and kidneys. Manganese functions with vitamin K in the formation of prothrombin. Manganese functions in several enzymatic reactions that involve the energy compound adenosine triphosphate (ATP).

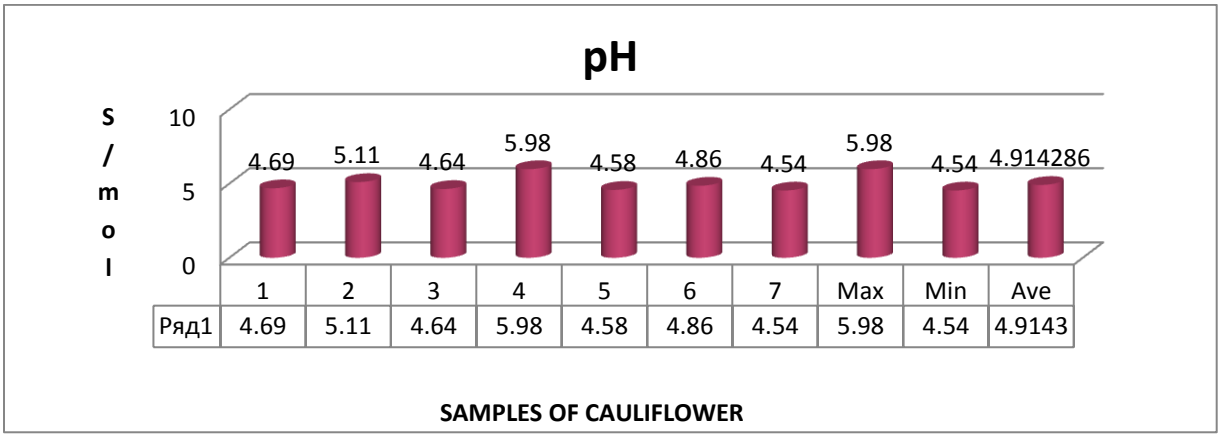
RESULTS AND DISCUSSION

The mean concentrations of Cu, Cr, Fe, Pb and Mn in different parts (as a whole) of vegetables studied are given in graphs. The concentrations of heavy metals in these samples are quite variable such as Fe (98-441mg kg^{-1}), Pb (16-32mg kg^{-1}). The extent of heavy metals detected in different kinds of vegetables was Cr < Cu < Mn<Pb<Fe. The cabbage (279.5mg kg-1) exhibited higher levels of Fe than the other vegetables. In contrast, cabbage (25mg kg-1) contained the highest levels of Pb, while turnip (22mg kg-1) contained the lesser Pb concentration than the other vegetables.

GRAPHS AND FIGURES

GRAPH 1:

GRAPH 1: A



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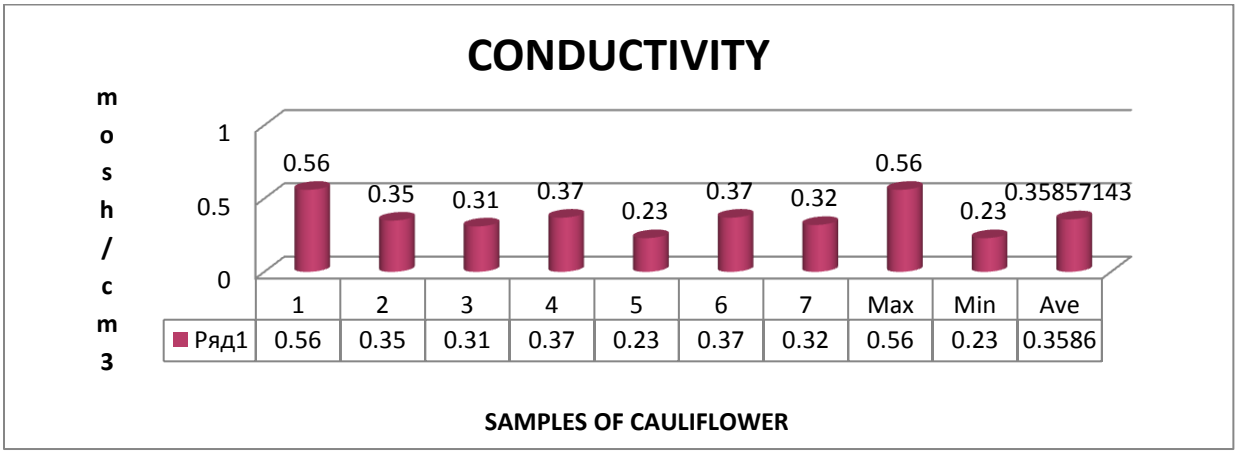

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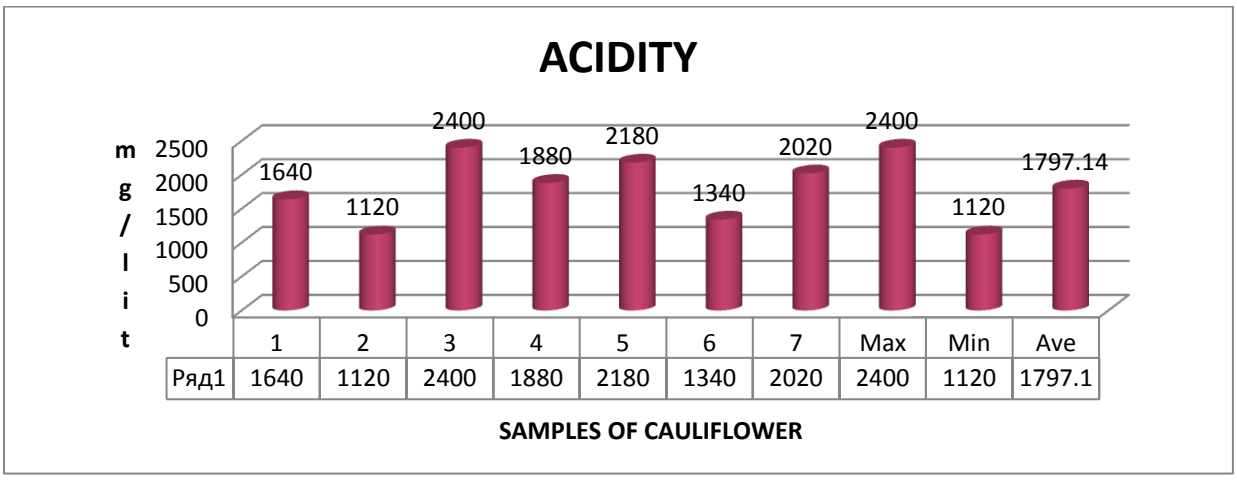

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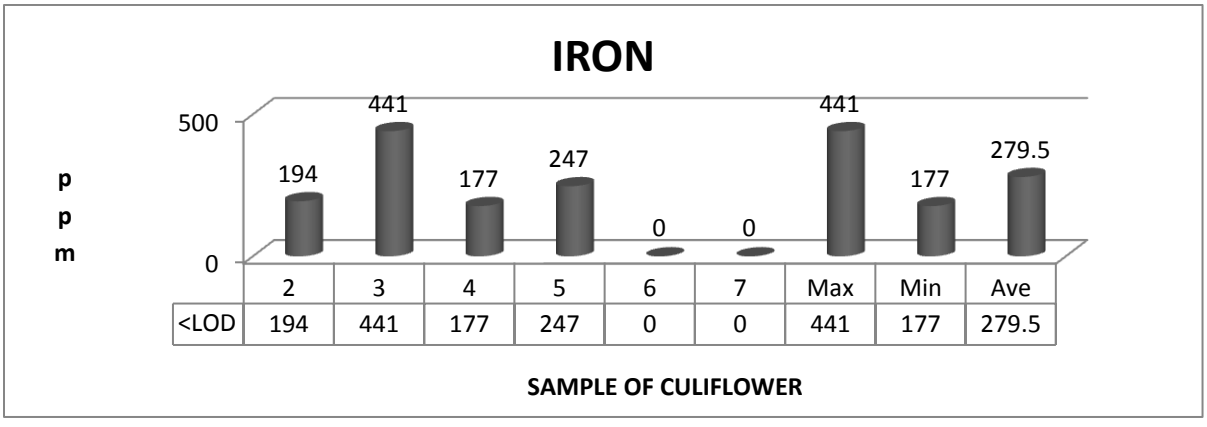
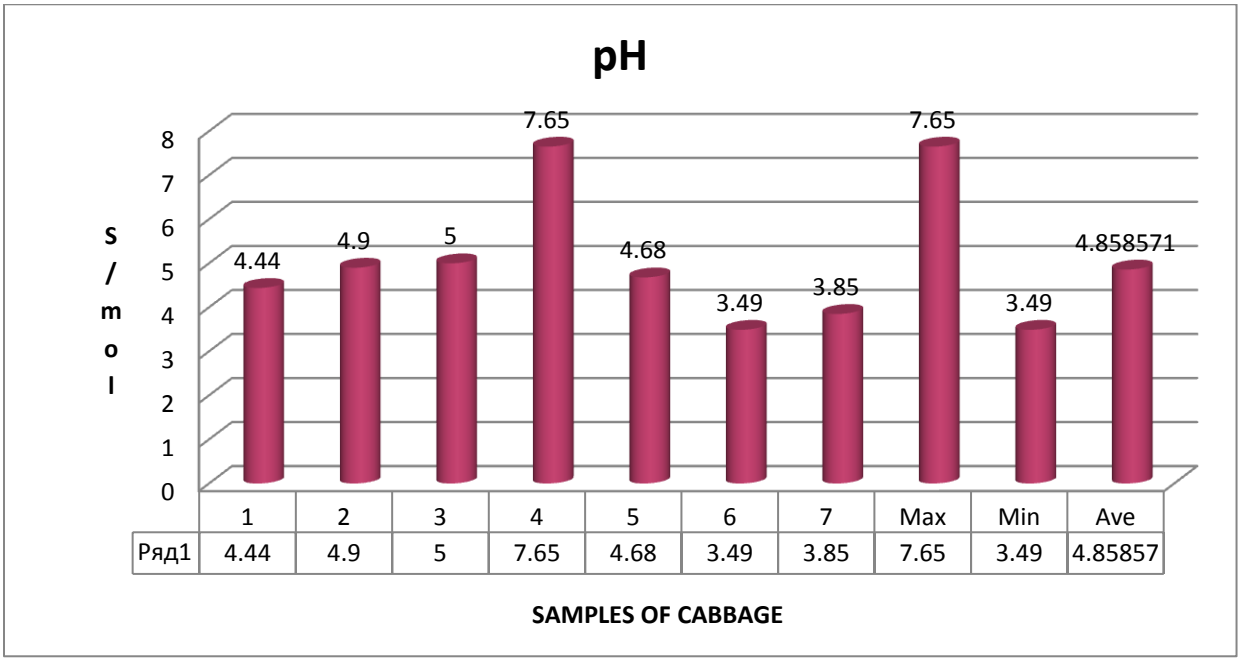


GRAPH 2:

GRAPH 2: A



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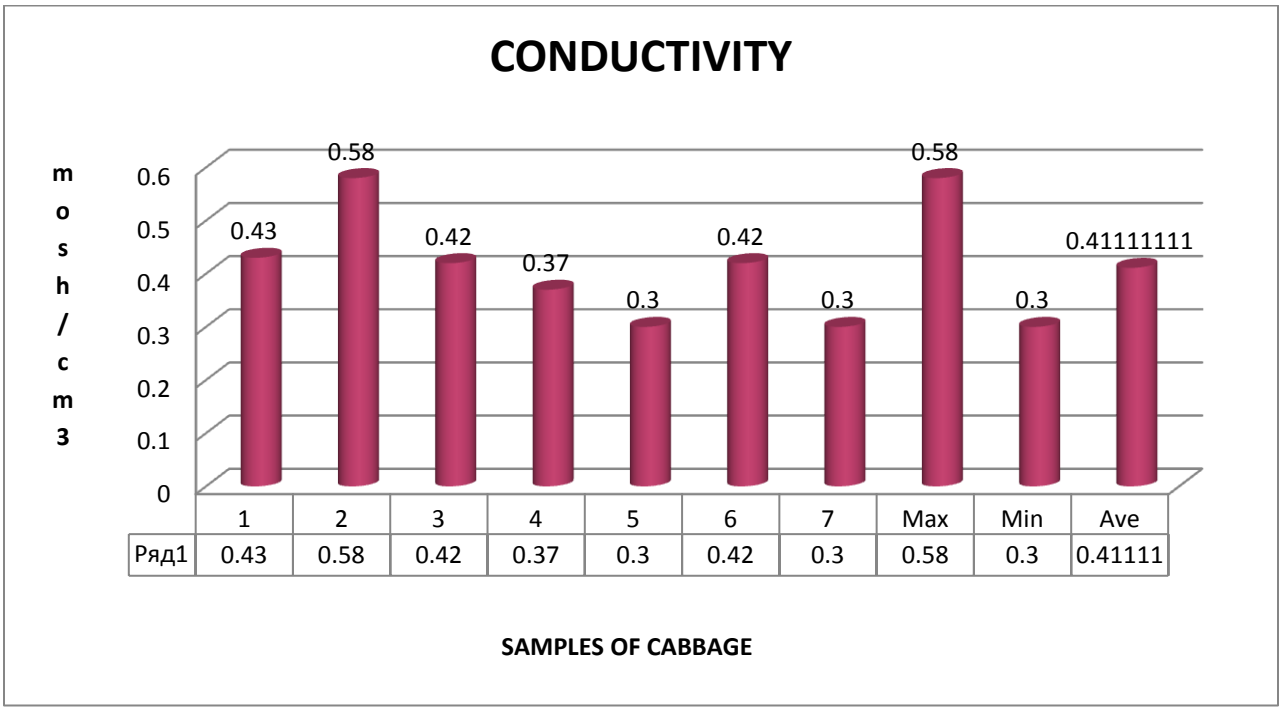

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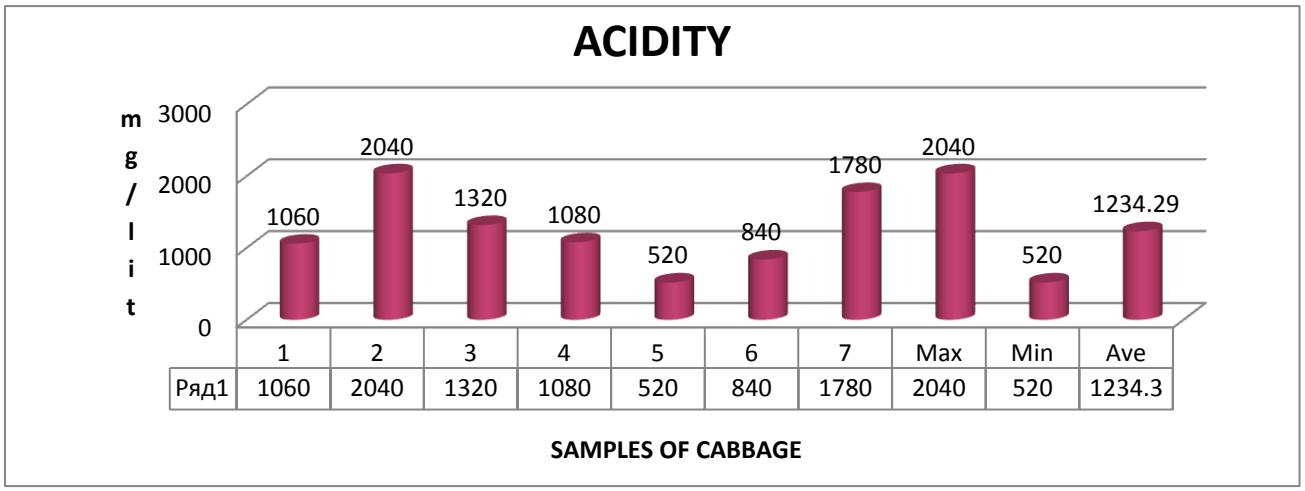

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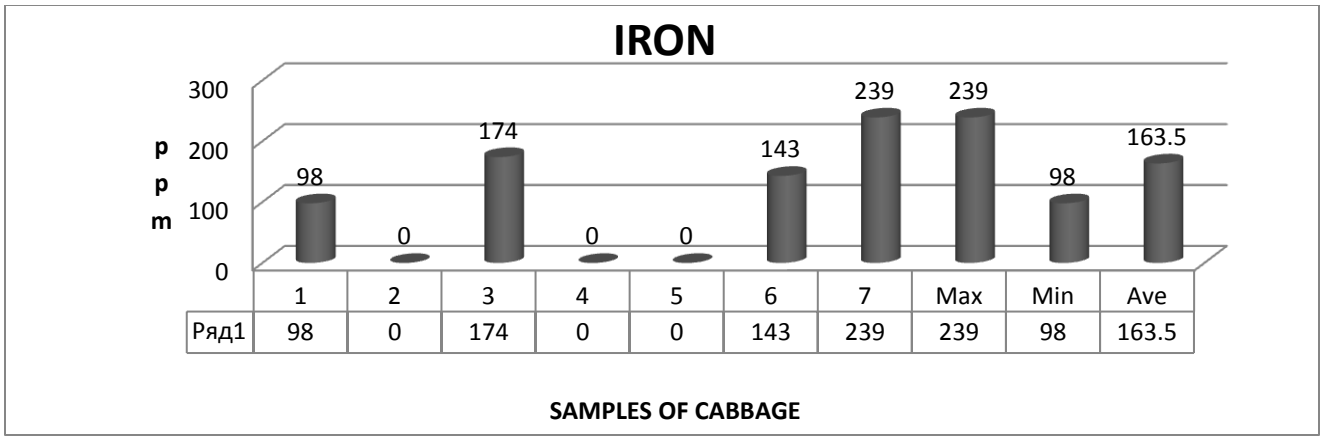

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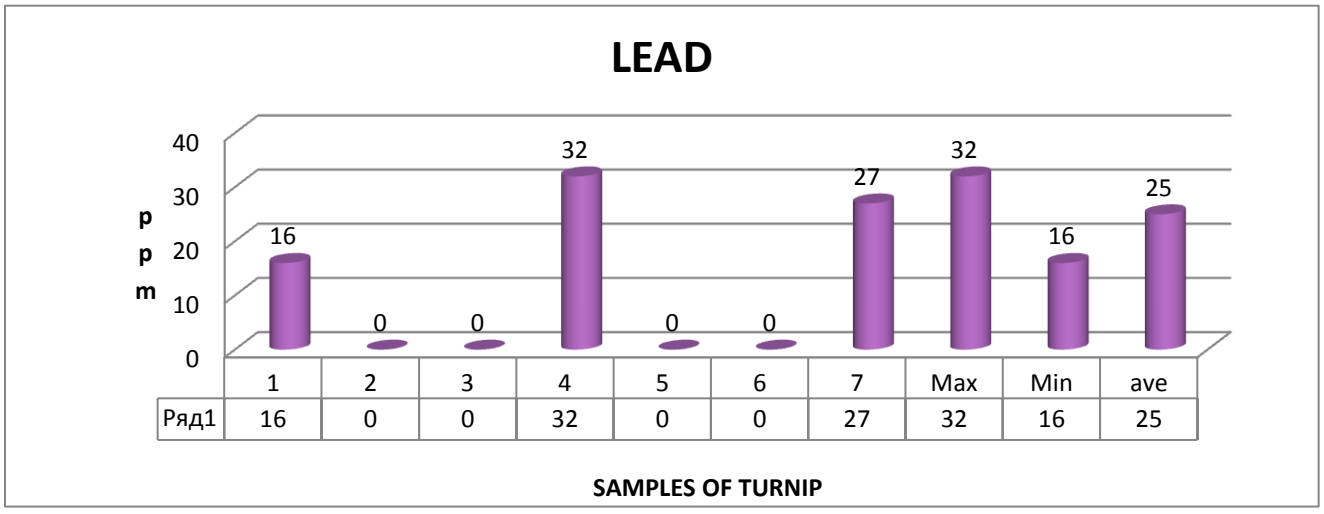
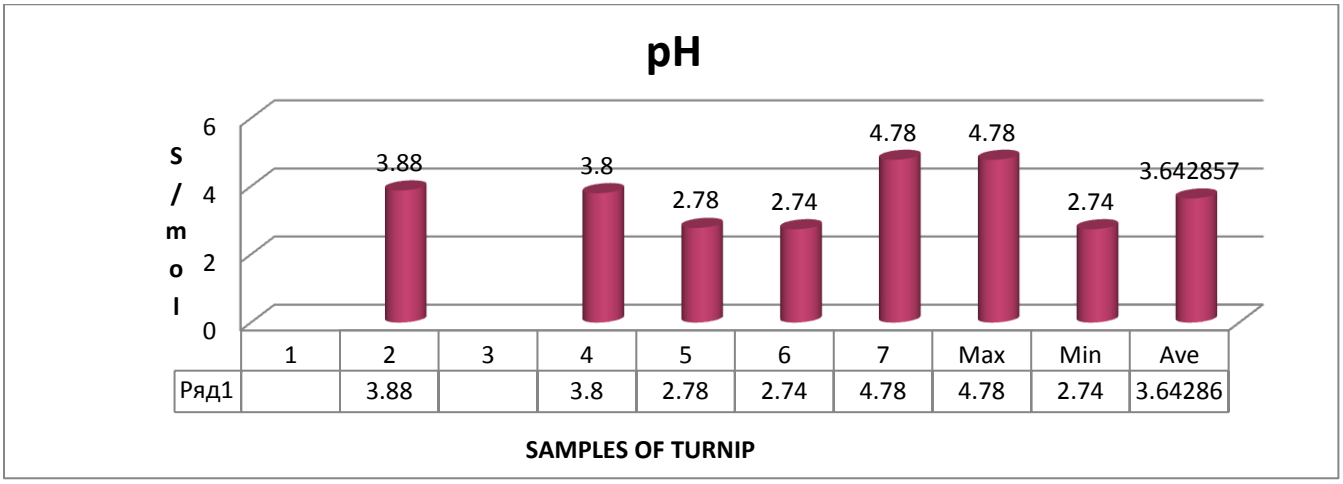


GRAPH 3:

GRAPH 3: A



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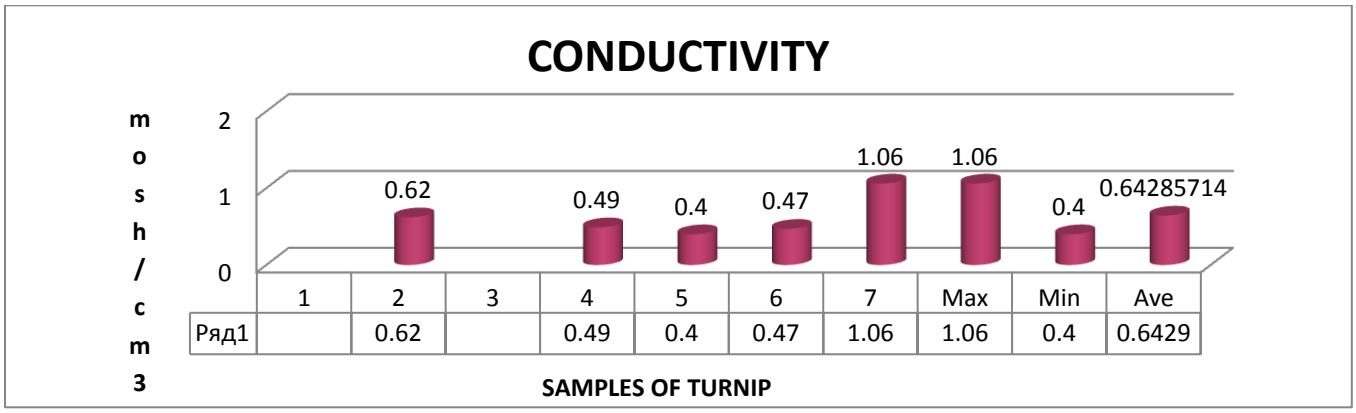

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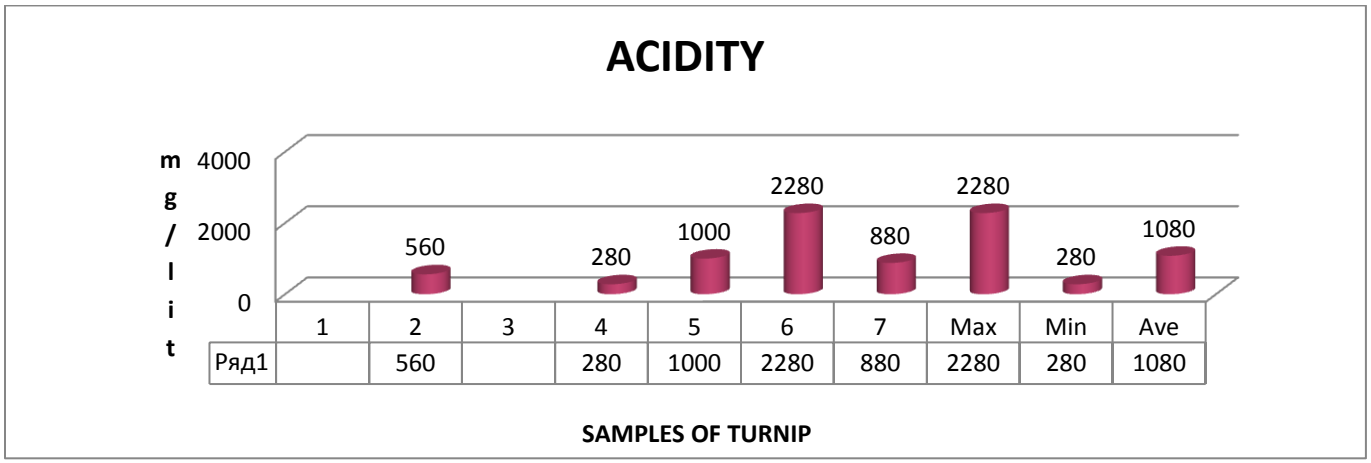

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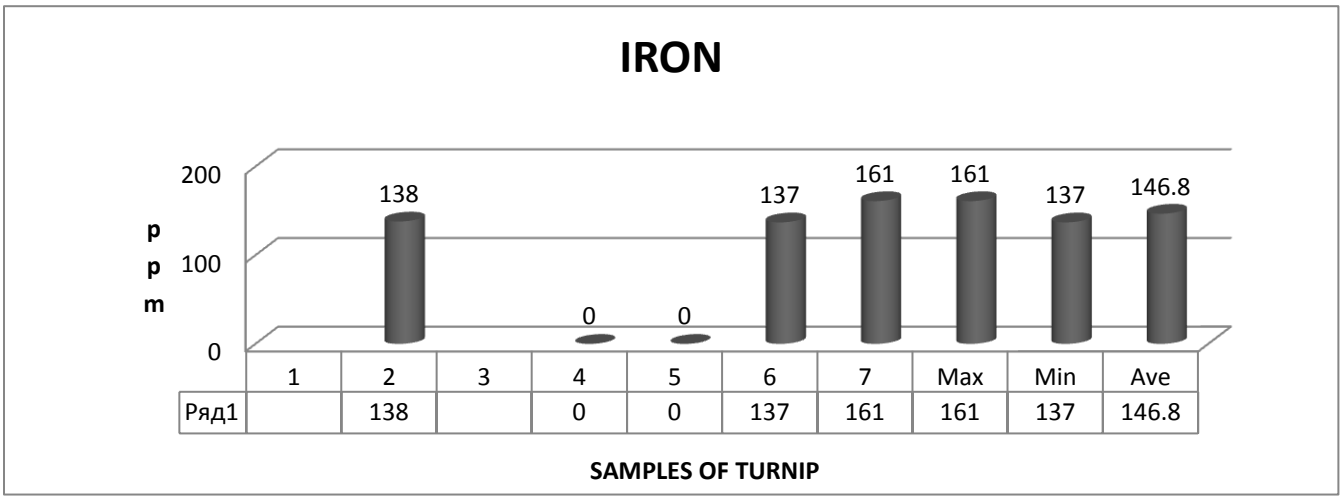

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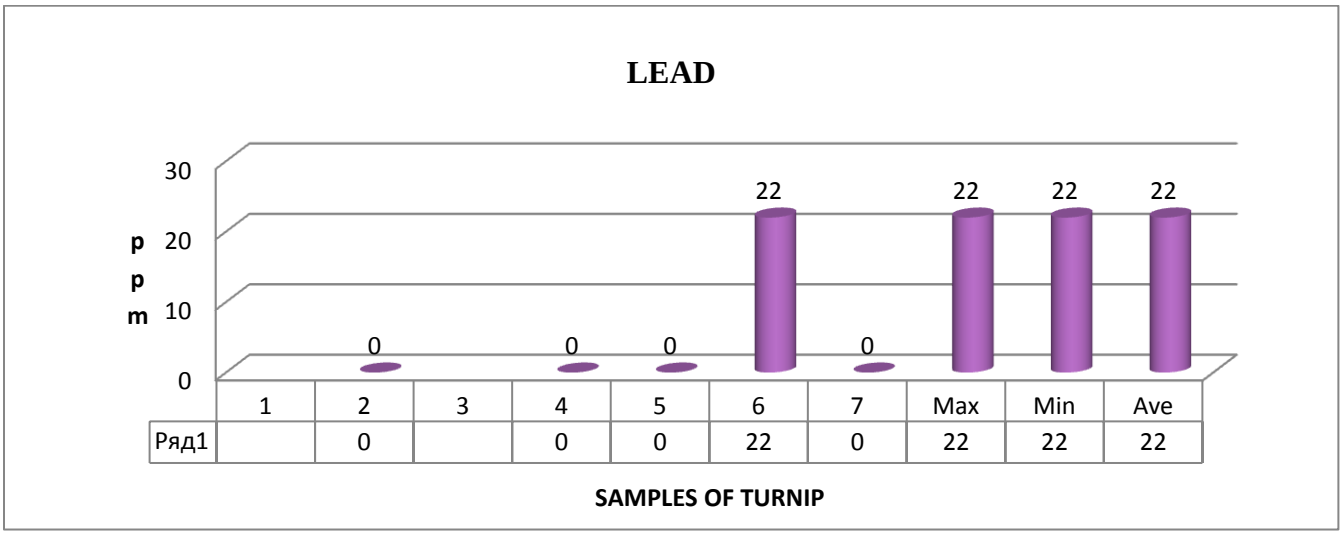

FIGURES

FIGURE 1:

Cauliflower **Cabbage** **Turnip**

FIGURE 2:

LOCAL MARKETS

FIGURE 3:

SAMPLES

FIGURE 4:

SAMPLES IN POLYTHENE COVERS

FIGURE 5:

X-ray fluorescence spectro photometer (XRF a-4000)

CONCLUSION

The results from this study suggested that significant differences existed in the elemental concentrations among the vegetables analyzed that might be in due part to the geological status of the area under investigation and the ability of plants and their specific parts to accumulate metals as well. The present study revealed that Pb and Fe were above the toxicity level in leafy vegetables collected in the markets of urban and semi-urban of Bengaluru, whereas other heavy metals (Mn, Cu and Cr) were within the permissible limits and some are less than detectable. From the results of present investigations, it could be concluded that in the semi-urban of Bengaluru, the uptake of certain heavy metals like Pb and Fe is due to the sewage water utilization for the agricultural purpose and this shows the environmental pollution and that risks the life of semi-urban and urban people by the consumption of such vegetables.

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