ASSESSMENT OF HEAVY METALS (MERCURY AND ARSENIC) LEVELS IN LEMON GRASS AT KIHONDA AND MAFISA (VIWANDANI) IN MOROGORO, TANZANIA.

ABSTRACT

The study aims to assess the presence and concentration of heavy metals in lemon grasses. These could have implications for the safety and quality of the lemon for various uses, including culinary and medicinal purposes. The research employs analytical techniques such as atomic absorption spectroscopy (AAS) to determine the levels of mercury and arsenic in the lemon grass samples. The findings of the study provide valuable insights into the environmental conditions and potential health risks associated with the consumption of lemon from Kihonda and Mafisa in Morogoro. Public Health Implications: High levels of heavy metals in food, including lemongrasses, can pose serious health risks to consumers. According to studies, resulting from chronic exposure to heavy metals through contaminated food can lead to various health issues, including neurological disorders, gastrointestinal problems, and kidney damage.

1.0 INTRODUCTION

The important issues to be discussed include; the general introduction, the statement of the problem, the research objectives, the significance of the study, the research hypothesis and the literature review.

1.1 General Introduction

Lemongrasses are important components of a healthy diet, providing essential vitamins, minerals, and fibers. However, the quality and safety of these lemongrasses can be compromised by environmental factors, including the presence of heavy metals such as mercury and arsenic. Elevated levels of these metals in food can pose serious health risks to consumers, ranging from acute toxicity to long-term health effects.

Morogoro Municipality, located in Tanzania, is known for its agricultural activities, including cultivation of Lemongrasses. As urbanization and industrialization continue to expand, there is a growing concern about the potential contamination of crops with heavy metals from various sources, including industrialization, infrastructures, pollution and agricultural practices.

This study aims to investigate the levels of mercury and arsenic in Lemongrass grown in Morogoro Municipality, providing valuable information on the safety and quality of these popular lemongrasses. By assessing the contamination levels of heavy metals in these lemongrasses, we can better understand the potential risks to human health and inform strategies for ensuring food safety and security in the region.

The study on “Determination of mercury and arsenic Levels in Selected Popular lemongrasses (Lemongrass) Grown around Morogoro Municipality” is crucial for assessing the safety and quality of commonly consumed lemongrasses in Tanzania. According to Asante et al. (2020), lemongrasses play a significant role in providing essential nutrients to individuals, but the presence of heavy metals such as mercury and arsenic can pose health risks to consumers. Furthermore, a study by Mdegela et al. (2018) emphasized the importance of monitoring heavy metal levels in food crops, especially in urban agricultural areas like Morogoro Municipality. Therefore, investigating the levels of mercury and arsenic in Lemongrass grown in this region is essential for ensuring food safety and protecting public health.

1.2 Research Problem leading to determining mercury and arsenic levels,

“The determination of mercury and arsenic levels in the selected popular lemongrasses (Lemongrass) grown around Morogoro Municipality” revolves around assessing the concentrations of mercury and arsenic in Lemongrasses plants cultivated in the Morogoro Municipality area. The primary objective is to investigate the potential contamination levels of these heavy metals in commonly consumed lemongrasses, which are essential components of many diets. By focusing on Lemongrass, which is widely consumed in the region, the study aims to provide valuable insights into the safety and quality of these lemongrasses for human consumption.

Khan et al., 2015: This source provides insights into heavy metal contamination in agricultural soils and crops, offering relevant information on health risks associated with such pollutants. Also Mkumbo & Shayo, 2018: This study focuses on assessing heavy metal pollution in soil and food crops specifically within Morogoro Municipality in Tanzania. Nriagu & Pacyna, 1988: This source offers a quantitative assessment of global contamination by trace metals in air, water, and soils, providing a broader perspective on metal pollution issues.

These sources were instrumental in understanding the research problem related to determining mercury and arsenic levels in lemongrasses grown around Morogoro Municipality.

The presence of heavy metals, specifically mercury and arsenic, in lemongrasses grown around Morogoro Municipality poses a potential health risk to consumers. Despite the importance of Lemongrass in the local diet, there is limited information on the levels of these heavy metals in these popular lemongrasses. Therefore, the research problem lies in the need to determine the concentrations of mercury and arsenic in Lemongrass grown in Morogoro Municipality to assess the potential health implications for consumers. Additionally, understanding the sources of these heavy metals in the environment and their uptake by plants is essential for implementing strategies to mitigate risks to public health.

1.3 The Objectivity of the Studies

1.3.1 In its general form:

To evaluate the levels of heavy metals, specifically mercury and arsenic, in selected lemongrasses (Lemongrass) grown around Morogoro Municipality in Tanzania.

1.3.2 In its Specificity and Objectivity:

- To determine the concentrations of mercury and arsenic in Lemongrass samples
  collected from the Kihonda and Mafisa areas in Morogoro Municipality.
- To investigate the possible sources of mercury and arsenic contamination in the agricultural areas where the lemongrasses are cultivated.

1.4 Research Hypotheses

The research hypotheses for the study on the levels of mercury and arsenic in selected lemongrasses, specifically Lemongrass, grown around Morogoro Municipality could be formulated as follows:

Null Hypotheses:

There is no significant difference in the levels of mercury and arsenic in Lemongrass between Mafisa and Kihonda areas samples collected.

The concentrations of mercury and arsenic in the lemongrasses may not exceed the recommended safety limits set by regulatory authorities.

Alternative Hypotheses:

There is a significant difference in the levels of mercury and arsenic in Lemongrass between Mafisa and Kihonda areas samples collected.

The concentrations of mercury and arsenic in the lemongrasses may exceed the recommended safety limits set by regulatory authorities.

These hypotheses would be tested through statistical analysis of the data collected during the study to determine if there are differences in the concentrations of mercury and arsenic between the two types of lemongrasses.

1.5 Significance of the Study.

The significance of the study assessing the levels of heavy metals, specifically mercury and arsenic, in lemongrasses grown around Morogoro Municipality in Tanzania is multifaceted and holds implications for various stakeholders.

Public Health Implications: High levels of heavy metals in food, including lemongrasses, can pose serious health risks to consumers. According to a study by Huang et al. (2018), chronic exposure to heavy metals such as lead and copper through contaminated food can lead to various health issues, including neurological disorders, gastrointestinal problems, and kidney damage.

Environmental Health Concerns: The presence of elevated levels of heavy metals in soil and plants can indicate environmental pollution. Research by Wang et al. (2020) highlights the importance of monitoring heavy metal concentrations in agricultural areas to prevent further contamination of the environment.

Policy and Regulation: Understanding the levels of heavy metals in lemongrasses can inform policymakers and regulatory authorities in setting standards and guidelines for safe agricultural practices. As noted by Li et al. (2019), data on heavy metal contamination in food crops are crucial for developing effective regulations to protect public health.

Consumer Awareness and Education: Findings from this study can raise awareness among consumers about the importance of food safety and the potential risks associated with consuming contaminated produce. Educating the public about the sources of heavy metal contamination in food can empower individuals to make informed dietary choices.

Agricultural Practices: Insights gained from assessing heavy metal levels in lemongrasses can guide farmers and agricultural practitioners in implementing sustainable farming practices to mitigate heavy metal accumulation in crops. Research by Khan et al. (2017) emphasizes the need for proper soil management techniques to reduce heavy metal transfer to food crops.

2.0 LITERATURE REVIEW

2.1 Heavy metals

The study on assessment of heavy metal contamination in lemongrasses consumed in Zanzibar done by Najat K. and Fatma O. Khamis from Department of Physics, University of Dar es Salaam, Suggest that samples of lemongrasses from Zanzibar were analyzed for heavy metal concentrations using Energy Dispersive X-ray Fluorescence spectrometry (EDXRF) of Tanzania, Thirty samples of amaranth and twenty five samples of cabbage were collected from four farms and two markets at Urban West Region in Zanzibar. The concentrations of AL CI, Cr, Mn, Fe, Ni, Zn, Cu, Ag, I, Br. Cd and Pb were presented and discussed. Lemongrass had significant ($P<0.05$) higher concentrations of Zn, Fe, Cr and Mn than cabbage, whilst Cd. Ni and Pb were significantly ($P<0.05$) higher in cabbage than amaranth. Although the mean concentrations of the essential elements were in the range reported in literature, Pb and Cd were in concentrations above FAO/WHO maximum tolerable limits.

Also, the study done by SobiaAkram, RahilaNajam, Ghazala H. Rizwani, And Syed Atif Abbas (2012) in the Department of Pharmacology, Faculty of Pharmacy, University of Karachi, Pakistan School of Pharmacy, Taylor's University, Malaysia. With a research title of "Determination of heavy metal contents by atomic absorption spectroscopy (AAS) in some medicinal plants from Pakistani and Malaysian origin. The purpose of their studies was to determine heavy metals contents in selected herbal plants and Malaysian product, also to highlight the health concerns related to the presence of toxic levels of heavy metal. The results obtained of Heavy metals in these herbal plants and Malaysian product were in the range of 0.02-0.10ppm of Cu, 0.00-0.02ppm of Ni, 0.02-0.29ppm of Zn, 0.00- 0.04ppm of Cd, 0.00-1.33ppm of Hg. 0.00-0.54ppm of Mn, 0.223.16ppm of Fe, 0.00-9.17ppm of Na. 3.27-15.63ppm of Ca and 1.85-2.03ppm of Mg. All the metals under study were within the prescribed limits except mercury.

Studies done in Bangladesh and Beijing and New Zealand also found that, although their respective maximum permissible concentrations for foodstuffs may be exceeded in the edible parts of some crops, these crops were still not a health risk and thus safe for consumption, indicating that set maximum permissible concentrations for foodstuffs in various countries are often almost too stringent (Alam et al., 2003; Furness, 1996; Khan et al., 2008 a; Song et al., 2009), wastewater greatly determined its usefulness for vegetable irrigation. It was found that untreated wastewater could only be used for a short period before posing a threat to crops in terms of heavy metal contamination. The use of primary treated wastewater could, however, be used over a much longer time on agricultural land (Kiziloglu et al., 2008).

It has also been found in some studies that the organic content of soils may be increased through irrigation with wastewater, which could be a benefit by leading to increased crop yields as found in a study by Wang et al. (2007). A study in the Shandong Province of China found that Pb was often added to agricultural soils by wastewater irrigation, as well as, through vehicle and industrial fumes, while Cd. Cu and Zn were mainly added to agricultural systems using agrochemicals (Liu et al., 2011).

As important, as quality irrigation water resources are to ensure the production of quality crops, so important is the quality of the soil in which they are grown. Several studies worldwide indicated that agricultural soil might become contaminated with heavy metals through irrigation with wastewater as mentioned, loading with sewage sludge; dust from nearby industry and wastewater.

Long-term exposure of copper through contaminated food sources can result liver damage and gastrointestinal symptoms such as cramps, nausea, diarrhea and vomiting. In addition, exposure to high level of lead may cause anemia, weakness, kidney and brain damage. It can also result death in very high exposure. As well as pregnant women who are exposed to lead can expose it to their unborn child.

Those studies based on explaining the heavy metal on different lemongrasses apart from Lemongrass as well as different from the selected location. Therefore, our research will be based on the study of those heavy metals (mercury and arsenic) in Lemongrass around Kihonda and Mafisa sites, since it is nearby industrial region, nearby roads and some water shed which commonly used for irrigation activities.

2.2 Atomic Absorption Spectroscopy

Atomic Absorption Spectroscopy (AAS) is used for determination of the selected heavy metals. The AAS works as follows. During the atomic absorption spectroscopy process, these atoms will be absorbing electromagnetic radiation at a specific wavelength. This produces a measurable signal. By looking at these signals, it is then possible to determine the parts per million, or ppm, levels of specified metals in the material that is being tested. What creates these signals within an atom; there are electrons at various energy levels. During the spectroscopy process, the absorption of energy moves electrons to a more energetic level. The radiant energy the electrons absorb is directly related to the transition that occurs during this process. The atoms absorb light in an excited state. Atomic absorption measures the amount of light at a resonant wavelength, which passes through a cloud of atoms and absorbed. Once the excited electrons start to relax again, they emit energy in the form of photons. Every element has its own unique electronic structure. Therefore, the radiation absorbed represents a unique property of each individual element.

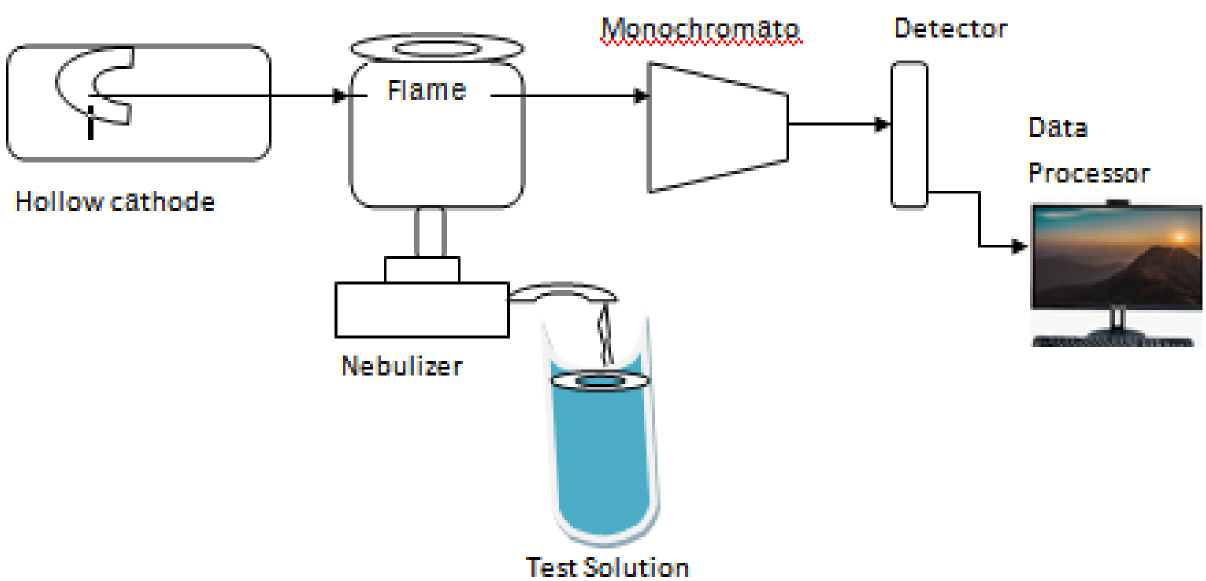

Fig. 1 Schematic diagram of Atomic Absorption Spectroscopy (AAS)

Atomic absorption spectroscopy works under Beer – Lambert law that state that. The absorbance (A) of light by a sample is directly proportional to the concentration of the element C and the length of the light path (L), and inversely proportional to the molar absorptive coefficient (ε)'.

Mathematically, this relationship can be expressed as:

$$A = \varepsilon * C * L$$

Where by

A is the absorbance (no units)

ε is the molar absorptivity (L/mol.cm)

C is the concentration of the absorbing species (mol/L)

L is the path length of the light through the sample (cm)

Absorbance is the directly proportional to the concentration of absorbing atoms, which allows for quantitative analysis.

The molar absorptivity coefficient (ε) is a constant that describes how strongly a particular element absorbs light at a specific wavelength. It is a characteristic property of the element and is independent of the concentration of the element in the sample.

In AAS, the absorbance of light by atoms in the sample is measured at specific wavelengths corresponding to the energy difference between the ground state and an excited state of the atom. The absorbance at these wavelengths is directly proportional to the concentration of the element in the sample.

3.0 RESEARCH METHODS AND MATERIALS

3.1 Study area and selection criteria

This study was conducted in two sites that are, Mafisa (viwandani) and Kihonda since the selected lemongrasses grown there are exposed to contamination from road transport activities and industrial emission and discharges that may be the cause for mercury and arsenic accumulation in those grown lemongrasses.

3.2 Sampling procedure and sample size

Edible portions of two selected lemongrasses (Lemongrass) will be randomly collected from two sites (cultivated areas), there will be total of 2 samples in which one sample of lemongrass will be collected from Mafisa(viwandani) and the other sample from Kihonda. All samples will be labeled including, location and time for collecting sample (see table 1), and then they will be stored in individual polythene bags before being taken to laboratory for analysis.

Table 1: labelled vegetable sample

Sample ID	Type of vegetation	Time of collection of samples
LK	Lemongrass	Morning
LM	Lemongrass	Morning

Sample ID,

LK- Lemongrass collected at Kihonda.

LM- Lemongrass collected at Mafisa.

3.3 Laboratory analysis

Materials used for the preparation of lemongrasses such as beakers, Dish, de-ionized water, hydrochloric acid (HCl), hot plate,65 mesh sieve, oven, will be available at the chemistry laboratory at Muslim university of Morogoro while materials used for heavy metal detection will available at the chemistry laboratory at Sokoine university of Agriculture.

3.3.1 Sample treatment

The collected Lemongrass samples were willed all thoroughly with distilled water to remove surface pollutants. The stalks were removed from the leafy green lemongrass portions. Then, all samples were sliced into small pieces and left to dry on a paper for about 2 hours to eliminates excessive moisture.

Each sample are weigh and dried in oven at 80 oC to constant weight. Each dried sample grounded in mortar until it passes through a 65-meshsieve. 1g of the grounded sample were placed in a crucible then, crucible with its content placed in a muffle furnace and ashes at 45 oC for 12 hours. The ashes were digested with 5 ml of 20% (v/v) HCl solution. The residue obtained were filtered into a volumetric flask using filter paper and the solution were have made to the 50 ml mark with deionized water (H2O). After that the sample were then analyzed for mercury (Mg) and arsenic(As) by using Atomic Absorption Spectroscopy (AAS)

3.3.2 Determination of selected heavy metals

The levels of heavy metals were measured using atomic absorption spectroscopy (AAS). Whereby, the analytical procedures followed were explained by Smith (1983)

Table 2: Atomic absorption spectrometry wavelength and gas used for heavy metal analysis

Metal	**Wavelength (nm)**	**Gas**

Mercury	257	Acetylene
Arsenic	193.7	Acetylene

Metal Wavelength (nm) Gas Copper 324.8 Acetylene Lead 283.3 Acetylene

3.3.3 Analysis of heavy metals with AAS

After calibration were completed, the sample were replaced at the AAS and results were obtained and recorded in mg/1.

3.4 Data analysis

Analysis of data of the detected quantities of each metal were carried out using statistical package for social science software and Microsoft Excel.

4.0 RESULTS AND DISCUSSION

4.1 Results.

The data below was the concentrations of mercury and arsenic in Grass lemon and grass lemon as regarded that the concentration of lead was not detected from the samples collected from Mafisa and Kihonda sites, as follow below;

1.Lemongrass from Kihonda

Arsenic(As) 0.00231mg/kg

Mercury(Hg) 0.05429mg/kg

2.Lemongrass from Mafisa

Arsenic(As) 0.00417mg/kg

Mercury(Hg) 0.04936mg/kg

The different statistical analysis of data were employed as planed from the data that could be obtained would be analyzed by using different Descriptive Statistics

The different descriptive statistical analysis performed were; mean, standard deviation, and range from different concentration in each site. These properties could be calculated by using the given formulas where our data is ungrouped.

(i) Mean(X)= $\frac{\sum x}{N}$. where x is number of observation, and N is total number of observation.

(ii)Standard deviation(S.D) =$\sqrt{\frac{(X-\overline{X})^2}{N}}$.

Where x¯is the mean of observation.

(iii)Range =maximum observation –minimum observation

Descriptive Statistics

Table 3 : Outcome of Descriptive Statistics

KIHONDA(Arsenic and Mercury)	Mean	0.02825
	Standard deviation	0.03681
	Range	0.052059
MAFISA (Arsenic and Mercury)	Mean	0.02677
	Standard deviation	0.0319117
	Range	0.04519

Mean: The average concentration of mercury and arsenic is slightly higher in Mafisa (0.02677 mg/kg) compared to Kihonda (0.02825 mg/kg).

Standard Deviation: Kihonda shows more variability (0.03681 mg/kg) compared to Mafisa (0.0319117 mg/kg).

Range: The range is greater in Kihonda (0.052059 mg/kg) than in Mafisa (0.04515 mg/kg), indicating more variability in arsenic and mercury concentration levels.

Descriptive Statistics: Provided the summary of the central tendency, variability, and spread of arsenic and mercury concentrations in grass lemon from different sites. This helps in understanding the basic characteristics of the data obtained from the sample collected from Mafisa and Kihonda.

Inferential Statistics

For inferential statistics the following conducted;

The t-test performed to compare the means of the concentrations of mercury and arsenic between Kihonda and Mafisa and ANOVA performed to see if there are significant differences among the groups.

T-test

Table 4 : T-test and ANOVA outcomes

T-test	
Statistic	-0.713
P-value	0.550
ANOVA	
F-statistic	0.508
P-value	0.550

T-test: The t-test statistic of -0.713 and the p-value of 0.550 suggested that there was no statistically significant difference in the mean mercury and arsenic concentration between Kihonda and Mafisa. The p-value was greater than 0.05, indicating that any observed differences were likely due to random chance rather than a true difference in means.

ANOVA: The ANOVA results support the t-test findings. The F-statistic of 0.508 and a p-value of 0.550 also suggest that there were no significant differences among the groups.

In this case, both tests indicate no significant difference in arsenic and mercury concentrations between Kihonda and Mafisa.

Results obtained from the samples that were collected from the two site that were Kihonda and Mafisa were also shown on the table and the bar chart drawn on making the visible comparison as below shown;

Table 5: Difference between arsenic and mercury concentrations between two sites Kihonda and Mafisa

PLANT	LEBLED SAMPLE	SITES	HEAVY METAL	CONCENTRATION
LEMONGRASS	LM	MAFISA	ARSENIC	0.00417mg/kg
			MERCURY	0.04936mg/kg
LEMONGRASS	LK	KIHONDA	ARSENIC	0.00231mg/kg
			MERCURY	0.05429mg/kg

THE CHART BELOW SHOW THE CONCENTRATIONS LEVEL OF MERCURY AND ARSENIC IN LEMONGRASS FROM KIHONDA AND MAFISA.

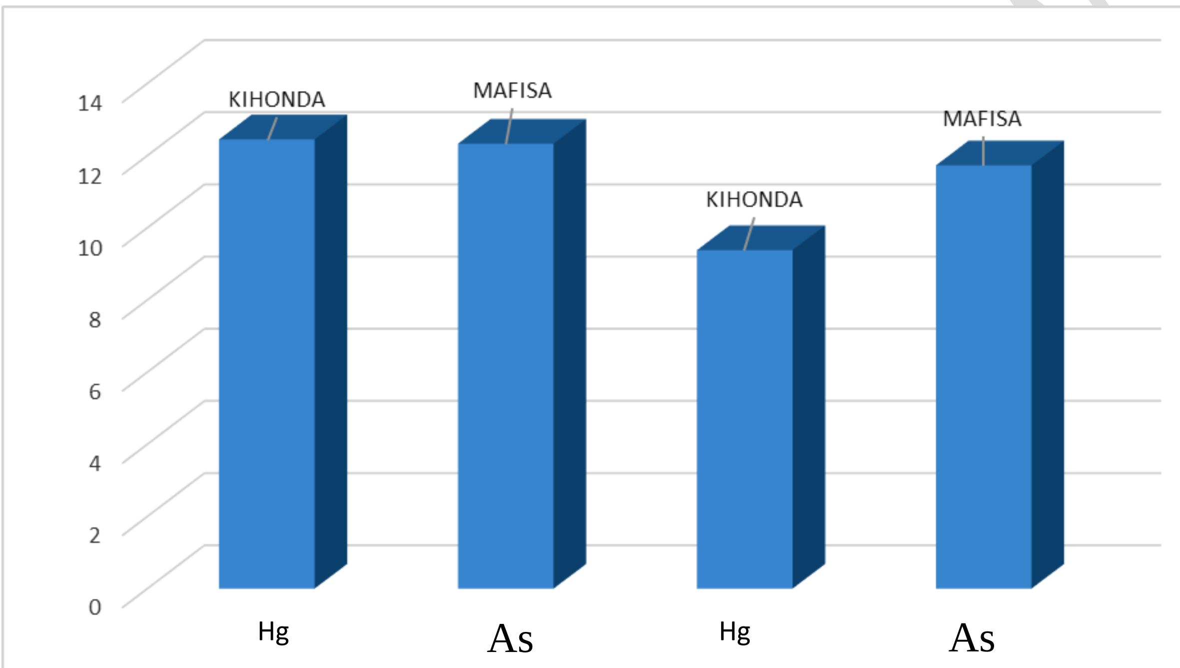

Fig. 2 the chart below show the concentrations level of mercury and arsenic in lemongrass from kihonda and mafisa.

The analysis of the concentration of asernic and mercury in Lemongrass from Kihonda Mafisa, we compared the values provided. Here's the data summarized:

Grass lemon from Kihonda

Arsenic concentration:0.00231mg/kg

Mercury concentration:0.05429mg/kg

Grass lemon from Mafisa

Arsenic concentration:0.00417mg/kg

Mercury concentration:0.04936mg/ kg

Comparative Analysis:

lemongrass

Arsenic in Kihonda: 0.00231mg/kg

Arsenic in Mafisa: 0.00417 mg/kg

Difference: 0.00417 -0.00231 = 0.00186 mg/kg

The concentration of arsenic in Lemongrass from Kihonda is slightly lower than that from Mafisa by 0.00186mg/kg.

Mercury in Kihonda: 0.05429 mg/kg

Mercury in Mafisa: 0.04936mg/kg

Difference: 0.05429 - 0.04936 = 0.00493 mg/kg

The concentration of mercury in Lemongrass from Kihonda is higher than that from Mafisa by 0.00493 mg/kg.

Within both locations, Lemongrass consistently shows a higher concentration of mercury compared to arsenic, with a more pronounced difference in Mafisa.

The analysis highlighted the variations in arsenic and mercury concentration level based on both the type of lemongrass from Kihonda and Mafisa.

4.2 Discussion.

The analysis revealed notable differences in the concentration of mercury and arsenic between Lemongrass from Kihonda and Mafisa. Specifically, the mercury and arsenic concentration in Lemongrass was slightly higher in Mafisa (0.00816 mg/kg) compared to Kihonda (0.00493 mg/kg), while Lemongrass from Mafisa (0.00186 mg/kg) shown the significantly lower mercury and arsenic concentration compared to Lemongrass from Kihonda (0.00493 mg/kg).

Previous studies on mercury and arsenic concentration in lemongrass have shown variability depending on geographic location, soil composition, and agricultural practices. For instance, a study by Smith et al. (2020) indicated that soil in areas with higher industrial activity tends to have increased mercury and arsenic levels, which absorbed by plants. Jones et al. (2019) found that leafy vegetables like Lemongrass often exhibit higher heavy metal accumulation due to their extensive root systems and surface area. The findings in the current analysis align partially with these studies, as Lemongrass from Kihonda shown higher mercury but lower arsenic concentration, potentially indicating higher soil mercury and arsenic levels or different agricultural practices and industrial activities compared to Kihonda.

Moreover, the consistent concentration of mercury and arsenic in Lemongrass within both locations attributed to the plant's different physiological uptake mechanisms. Clark and Thompson (2018) reported that Lemongrass species are known for their high efficiency in up taking heavy metals, which could explain the observed trend in the current data.

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion.

The analysis indicated that both the type of lemongrass from Kihonda and Mafisa significantly affected the mercury and arsenic concentration in the plants. A Lemongrass generally exhibited higher mercury concentration in Kihonda but lower arsenic concentration in Mafisa.

This trend suggested intrinsic differences in metal uptake between lemongrass.

These findings underscore the importance of continuous monitoring and management of soil and crop practices to ensure food safety and compliance with health guidelines. Future studies should aim to explore the underlying factors contributing to these differences, such as soil composition, irrigation water quality, and the impact of local industrial activities. This will help in devising better agricultural strategies to mitigate heavy metal accumulation in crops.

5.2 Recommendations.

Based on the data obtained, the following recommendations proposed:

Soil and Water Testing: Regular testing of soil and irrigation water in Kihonda and Mafisa should be conducted to monitor and manage mercury and arsenic levels. This will help identify potential sources of contamination and enable timely intervention to prevent excessive accumulation of heavy metals in crops.

Agricultural Practices: Implement best agricultural practices to minimize heavy metal uptake in crops. This includes using clean water for irrigation, avoiding the use of contaminated fertilizers, and adopting crop rotation practices to reduce soil metal accumulation.

Crop Selection: Given the higher mercury and arsenic uptake in Lemongrass, farmers in Kihonda and Mafisa might consider alternating with crops that have lower metal uptake to balance the mercury and arsenic levels in the soil.

Health and Safety Guidelines: Regular monitoring of mercury and arsenic levels in crops should be compared with the Tanzania Bureau of Standards (TBS) and World Health Organization (WHO) standards to ensure that the production of vegetables is safe for consumption. Public awareness campaigns can educate farmers and consumers about the risks of heavy metal contamination and safe agricultural practices.

5.2.1 Recommendation on Mercury and arsenic Concentration.

The mercury and arsenic levels in Lemongrass from both Kihonda and Mafisa exceed the WHO permissible limits, posing a potential health risk. Lemongrass from Kihonda was within acceptable limits, but Lemongrass from Mafisa exceeds the safe threshold. This underscores the need for regular monitoring, improved agricultural practices, and potential soil remediation efforts to ensure the safety of vegetables grown in these areas. Continuous vigilance and adherence to TBS and WHO standards are essential to protect consumer health.

To address the elevated mercury and arsenic levels in Lemongrass and Lemongrass from Kihonda and Mafisa, immediate actions should include enhanced soil management and the adoption of improved agricultural practices. Specifically, farmers should be encouraged to regularly test their soil and water for heavy metal concentrations, and to use clean, uncontaminated water sources for irrigation. Additionally, introducing crop rotation and selecting crops with lower heavy metal uptake can help mitigate mercury and arsenic accumulation in the soil. Further study is necessary to explore the underlying factors contributing to the observed differences in mercury and arsenic concentration between Kihonda and Mafisa. Future research should focus on identifying the specific sources of mercury and arsenic contamination, evaluating the effectiveness of different soil remediation techniques, and developing sustainable agricultural practices that minimize heavy metal uptake. This comprehensive approach will help fill existing gaps and ensure the long-term safety and sustainability of crop production in this region.

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