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Zn, Fe, Se, and I Concentrations Present in Tomato as Affected by Neem Extract Preservation in Sokoto, Nigeria

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ABSTRACT

Nowadays addition of chemicals to save tomatoes against early spoilage is rampant, but the chemicals are harmful; thus, bio-based alternative with novel features are needed. The aim of this study was to discover the effect of using neem leaves extract for preservation of two tomato cultivars collected from Sokoto, Nigeria. 5%, 10% and 25% (w/v) aqueous solutions of neem extract to be used to coat tomatoes were prepared and an experiment was done in a randomized control trial. Consequently, with the addition of neem extract for preservation of tomato; Zn, Fe, Se, and I were assessed in Daneka tomato variety using atomic absorption spectrometry. The Fe level increase from 13.0 ± 0.05 ppm to 16.1 ±0.01 ppm. Selenium increase from 2.0 ± 0.05 ppm to 5.2 ± 1.5 ppm, iodine increase from 6.2 ± 0.02 to 8.0 ± 0.02 ppm in Daneka, and zinc increase from 14.0 ± 0.5 to 18.0 ± 0.2 ppm. The ranges of the determined Fe, Se, Zn, and I micronutrients in UTC tomato variety are respectively as follows: 14.0± 0.03 to 18.0± 0.03 ppm, 3.1± 0.03 to 7.0± 0.01 ppm, 15.6± 0.04 to 18.0± 0.01 ppm, and 7.0± 0.02 to 9.1± 0.02 ppm. Therewith, the concentrations of micronutrients increase with an increase in neem extract concentrations ($p < 0.05$). more studies are needed to make neem extract as a cheap, safe, and accessible substance for tomato preservation.

Keywords: Tomato, Daneka, UTC, Zinc, iron, selenium, malnutrition, neem

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1. INTRODUCTION

More than 800 million people battle with hunger, and more than that suffer micronutrient malnutrition especially in developing countries (Gomathi et al., 2017; Jabin et al., 2020). Malnutrition due to insufficient daily intake of essential elements such as zinc, iron, selenium, and iodine is becoming a rampant and serious threat to public health. Albeit, iodine, zinc, selenium and iodine are pivotal and essential in normal growth, development and physiological functions of human body; developed and developing countries are battling with deficiency of micronutrients (Gomathi et al., 2017; Sahin et al., 2020; Buturi et al., 2022).

Iodine is versatile in both plants and animals, especially in the humans as it plays a huge role in thyroid hormones synthesis, brain functioning, and infant health (Islam et al., 2018; Umar etal., 2017). Selenium is valuable both in plants and animals. Particularly, it reduces uptake of heavy metals, and regulates reactive oxygen species, increases cell integrity, and regulates ion balance (Islam et al. 2018). Zinc is a structural component of thousands of entities in plants, animals and microbes. Therefore, insufficient zinc in the body leads to retarded growth, diarrhoea, low immunity, hypogonadism, delayed healing, and skeletal disorders (Buturi et al., 2022; Sahin et al., 2020). Iron functions in many aspects such as oxygen transport and needed for certain enzymes. anaemia, a single prominent deficiency due to iron is a public health threat worldwide and more especially in developing countries like Nigeria (Aliyu et al., 2018; Sahin, 2020; Aliyu et al., 2021; Ciudad-Mulero et al., 2021).

Moreover, these issues of deficiencies and malnutrition are aggravated because, the plants that are consumed by humans cannot get enough micronutrients from soil due to some factors; and on the other hand many plant food materials, such as the common stable cereals in Nigeria and Sokoto in particular contain antinutrients such as phytate (hinders zinc, and iron availability in crops) make nutrients composition of plants unavailable (Gomathi et al., 2017; Sahin, 2020). Fortunately, tomato is a good absorber of micronutrients from soil and contains low antinutrients that prevent nutrients bioavailability (Adekunle et al., 2020; Sahin, 2020). Therefore, tomato is a good plant that makes significant contribution in curtailing malnutrition and nutrients deficiency (Sahin, 2020; Buturi et al., 2022).

Tomato fruits ranked the most secondly produced vegetable worldwide, and is the most important crop in the West African region. Tomato is a popular fruit known for its historic antecedents in the human diet worldwide. It contributes to a healthy, balanced, mineral-rich diet that contains sugars, minerals, vitamins and the likes (Emmanuel et al., 2019; Oves & Iqbal, 2019; Kabore et al., 2022). But, due to perishability of tomato, poor knowledge, poor basic amenities, and poor agricultural tactics producers tend to apply chemicals to preserve tomatoes for a longer period and to serve the public in the whole year round. However, the utilization of chemicals is basically affected by two concerns. firstly, the chemicals are harmful to biological system (Sharma, 2015; Udah et al., 2021). Secondly, the chemicals tend to reduce the quality parameters of tomatoes under preservation. Thus, the search for a bio-based material that is accessible, safe, and effective in preserving tomato begins. Neem, a versatile and rampant plant in Sokoto, can be appropriately used for this purpose because of its phytochemical compositions (Sarkar et al., 2015; Hosea et al., 2017; Zewdie et al., 2022). The aim of this study was to mainly discover the effect of using neem leaves extract for preservation of two tomato cultivars collected from Sokoto, Nigeria.

2. MATERIALS AND METHODS

Study location

The study was carried out in Sokoto state, Nigeria.

Preparation of Samples

Tomatoes varieties and turmeric were obtained from Sokoto Metropolis, Sokoto state, Nigeria. After identification of tomato, neem leaves were taken to the plant physiology laboratory and cleaned, air-dried and grounded into fine powder and kept for further analysis.

Preparation of turmeric extract

Powdered leaves of neem leaves were dissolved in distilled water to form 5%, 10% and 25% (w/v) aqueous solutions of neem extract to be used to coat tomatoes in this study. 5g, 10g and 25g neem powder was dissolved in 9.5, 9.0 and 7.5 litres of distilled water respectively (Hamza et al., 2023).

Experimental treatment

Ripe, firm, smooth and healthy tomato fruits of the two varieties (UTC and Daneka) were selected and washed under running tap water, distilled water, rinsed and air dried before treatment. The experimental treatment procedure was performed based on the methods described in Hosea etal (2017).

Elemental and data analysis

Iron, zinc, selenium, and iodine, micronutrients were determined according to standard methods described in Sanusi et al. (2020). And data analysis was done using analysis of variance (ANOVA) at 5% level of significance.

3. RESULTS AND DISCUSSION

Effects of neem utilization on preservation of Zn, Fe, Se, and I micronutrients in tomato collected from Sokoto, Nigeria were shown in Tables 1, and 2.

Table 1. Zn, Fe, Se, and I concentrations present in Daneka ntomato as affected by neem extract preservation in Sokoto, Nigeria

Treatment	Iron (ppm)	Selenium (ppm)	Zinc (ppm)	Iodine (ppm)
Control	2.5 ± 0.05	1.0 ± 0.05	12.0 ± 0.3	2.1 ± 0.05
5%	13.0 ± 0.05	2.0 ± 0.05	14.0 ± 0.5	6.2 ± 0.02
10%	15.0 ± 1.4	4.0 ± 0.01	16.0 ± 0.5	7.0 ± 0.01
25%	16.1 ±0.01	5.2 ± 1.5	18.0 ± 0.2	8.0 ± 0.02
4^{o}C	14.0 ±0.01	5.2 ± 1.05	16.0 ± 0.1	7.5 ± 0.03

Table 1 shows how preservation using neem extract affects the concentration of Zinc, iron, selenium, and iodine present in Daneka tomato fruits collected from Sokoto, Nigeria. The results unveiled that, the concentrations of all the assessed micronutrients increased with increasing extract concentrations, and low temperature (4^{o} C) used for tomato storage was able to preserve the concentrations of micronutrients (Fe, Zn, Se, and I) compared to the control (0% neem extract).

Presently, it is expected that, food materials provide nutrients needed by the body for energy, body building, regulation of metabolic activities and other related activities (Hassan et al., 2018). However, in Nigeria, there are economic crises, food insecurity, and related concerns that pose greater threat and risk to growth and development of human body especially in children and women (Gafar & Itodo, 2011). Particularly, tomato fruits are important sources of various nutrients required by the body for growth and development, that is why in almost all parts of the world tomatoes are cultivated and applied in various food preparations (Mohammed et al., 2017; Malick et al., 2021). In tomato production and utilization, the perishability of the fruit makes it difficult to stay for a longer period. Therefore, the fruit is lost easily and many people are prevented from the benefits of tomato (Morakinyo et al., 2016; Emmanuel et al., 2018). In the region of Nigeria, let alone in rural regions of Sokoto where tomatoes are cultivated, there are issues of malnutrition, scarce social amenities for the proper storage of tomatoes. In turn, people are deprived of the micronutrients contents of tomato and farmers incurred a lot of losses. To alleviate the consequences of poor tomato storage capacity, people turned to the use of chemical preservatives that are on the other hand harmful to human biological system (Hosea et al., 2017; Hamza et al., 2023). Thus, the need to seek for bio-based materials such as neem for preservation of tomato is imminent to provide cheap, healthy and effective extract for tomato preservation (Hamza et al., 2023).

Consequently, with the addition of neem extract for preservation of tomato; then Zn, Fe, Se, and I were assessed in Daneka tomato variety. The Fe level was recorded to increase from 13.0 ± 0.05 ppm to 16.1 ±0.01 ppm. This level of Fe albeit is lower than the level obtained from garden cress by Hassan et al., (2011) and higher than average Fe in fortified tomato reported by Buturu etal., (2021), it is important in human nutrition. It mainly functions in haemoglobin and myoglobin that are essential in oxygen transport, DNA synthesis, energy metabolism, and electron transport chain. The Fe presence in fruits is because plants absorbed Fe from soil for the metabolic needs of plants (Hassan et al., 2011; Buturi et al., 2021). Selenium determined increases from 2.0 ± 0.05 ppm to 5.2 ± 1.5 ppm, a range that is higher than the levels determined in a fortified tomato (Buturu etal., 2021). Selenium is indeed an essential element in human metabolism, a micronutrient that remain a constituent of selenoproteins that are essential for enzymatic functions. Selenium also functions in reproduction and fertility, brain function, mood, thyroid health, and cancer (Islam et al., 2018; Buturu et al., 2021). An increase in iodine from 6.2 ± 0.02 to 8.0 ± 0.02 ppm was noticed in Daneka fruit collected and the values are lower compared to values reported in fortified tomato by Buturi et al., (2021). Therewith, iodine values contribute the iodine need of the body in the synthesis of thyroid hormone responsible for growth and development, and basal metabolic rate of the human body (Sager, 2017; Adekunle et al., 2020; Buturi et al., 2021; Vaselina & Diney, 2021). And zinc was found in Daneka increase from 14.0 ± 0.5 to 18.0 ± 0.2 ppm and could help in alleviating the prevalence of malnutrition in the area. It acts in several enzymes that participate in energy metabolism of the body (Gafar & Itodo, 2011; Sahin, 2020).

Table 2. Zn, Fe, Se, and I concentrations present in UTC tomato as affected by neem extract preservation in Sokoto, Nigeria

Treatment	Iron (ppm)	Selenium (ppm)	Zinc (ppm)	Iodine (ppm)
Control	1.50± 0.01	0.2± 0.02	6.0± 0.05	1.1± 0.01
5%	14.0± 0.03	3.1± 0.03	15.6± 0.04	7.0± 0.02
10%	16.0± 0.02	6.0± 0.02	16.1± 0.02	7.1± 0.02
25%	18.0± 0.03	7.0± 0.01	18.0± 0.01	9.1± 0.02
4^{o}C	14.0± 0.03	3.0± 0.02	15.0± 0.01	4.5± 0.02

Table 2 shows how preservation using neem extract affects the concentration of Zinc, iron, selenium, and iodine present in UTC tomato fruits collected from Sokoto, Nigeria. The results revealed that, the concentrations of all the assed micronutrients increased with increasing extract concentrations, and low temperature (4^{o}C) used for tomato storage was able to preserved the concentrations of micronutrients (Fe, Zn, Se, and I) compared to the control (0% neem extract).

The ranges of the determined Fe, Se, Zn, and I micronutrients in UTC tomato variety collected from Sokoto are respectively as follows: 14.0 ± 0.03 to 18.0± 0.03 ppm, 3.1 ± 0.03 to 7.0± 0.01 ppm, 15.6± 0.04 to 18.0± 0.01 ppm, and 7.0 ± 0.02 to 9.1 ± 0.02 ppm. Therewith, the concentrations of micronutrients increase with an increase in neem extract concentrations. Likewise, the low temperature (4^{o}C) was able to show higher micronutrients compared to the control (0% extract). Certainly, the values of selenium and iodine determined in Table 2 (the vital nutrients in thyroid functioning, and metabolism) are lower than the recommended dietary allowances of 90-250ug and 60-70ug respectively, but can precisely help in meeting the demand (Duborska et al., 2022).

Nevertheless, the concerns that arise in terms of food security in the region are many (Alfartuise & Mohsan, 2017; Sarkingobir etal., 2019; Sarkingobir et al., 2020; Gada & Ismaila, 2021). There is plain food insecurity, malnutrition, scarce basic social amenities; that in turn elicit many losses to the producers. The consumers are affected because they are deprived of the useful food nutrients required to curb hunger, food insecurity, malnutrition, and deficiency. Thus, the producers tend to apply preservatives that aimed to remove air, water, and microbes (that cause spoilage), and prevent early spoilage (Olaniran et al., 2013; Sharma, 2015; Abdullahi et al., 2016). However, most of the rural producers do not have the technological know-how and materials to perpetuate storage of tomato/ food using chemicals. Even if the chemicals are utilized, the nutritional value/ constituents of the tomato become diminished, and the chemicals are toxic or harmful too human body (Sharma, 2014; Hosea et al., 2017; Rao et al., 2018). Therefore, the search for cheap, accessible, material with proven efficiency and effectiveness needs to be intensified (Hosea et al., 2017). The results shown in Tables 1 and 2 have displayed that, the use of neem extract for preservation of Daneka and UTC tomato types is able to increase quality of stored tomato, particularly the levels of Zn, Fe, Se, and I. This is similar to some pockets of studies that show the ability of bio-based materials in preserving the quality parameters of tomato (Garcia et al., 2014; Hosea et al., 2017; Rao et al., 2018; Hamza et al., 2023).

The most suggestive reason behind the ability of neem (or other plant-based) material to improve quality of tomato during storage is due its ability to contain phytochemicals (Hosea et al., 2017; Zewdie et al., 2022). In most of the cases, the presence of phytochemicals impedes microbial enzymes activity (especially in DNA synthesis and

membrane/wall synthesis enzymes). In the other hand, the phytochemicals cause growth inhibition, alleviate virulent factors of the microbes (Sarkingobir et al., 2022; Zewdie et al., 2022). Therefore, it is imperative to carry out more studies and make the plant-based substances more intensive, and biologically friendly. Additionally, the tomato obtained micronutrients (Zn, Fe, Se, and I) from soil for growth, structure, and other metabolic events. Thus, the levels of micronutrients in the environment determine the levels in the plant or plant products (such as tomato fruits). Poor levels of micronutrients in plants indicates poor soil, and excess level of micronutrients in plant indicate pollution. This has made monitoring of micronutrients in plants or soils imperative (Hassan et al., 2018; Kaoje et al., 2019; Vaselina, & Dinev, 2021; Duborska et al., 2022).

4. CONCLUSION

Nowadays addition of chemicals to save the nutrients of tomatoes against early spoilage, but the chemicals are harmful, thus, bio-based alternative with novel features most be sought for. The aim of this study is to mainly discover the effect of using neem leaves extract for preservation of two tomato cultivars collected from Sokoto, Nigeria. Therewith, this study shows concentrations of micronutrients in tomatoes increase with an increase in neem extract concentrations.

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