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COMPARATIVE EVALUATION OF LYCOPENE AND HEAVY METAL CONTENTS OF TWO SPECIES OF TOMATOES WITHIN AWKA METROPOLIS.

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ABSTRACT: *Tomato Species belong to edible vegetable fruit obtained from tomato plant which serves as a food source to people irrespective of culture, religion and belief. Two species of the tomato samples were bought from five different local markets within Awka metropolis, Anambra State. The samples were washed with deionised water, and lycopene content extracted using solvent mixture of n-hexane, acetone and ethanol in the ratio of 2:1:1 respectively. The extract was subjected to Uv spectrophotometer for lycopene content at 503nm. The moisture content was examined via difference in weight in an oven at 105^0c. The washed samples were blended and digested with acid mixture of 10ml perchloric acid, 25ml concentrated nitric acid and 4ml sulphuric acid. The level of heavy metal in the digest was evaluated using atomic absorption spectrophotometer. The results showed lycopene range of 18.82mg/kg to 98.52mg/kg. The higher concentration of lycopene was associated with Beefsteak species with average value of 73.13mg/kg, while a lower average level of 40.76mg/kg was implicated in cherry specie. Lead was the metal with lowest average concentration of 0.083ppm. The metal with the highest average concentration in the tomato samples was chromium (0.520ppm). The observed trend in the metal concentration for all the samples was Cr (0.520ppm) > Cu (0.493ppm) > Fe (0.453ppm) > Zn (0.421ppm) > Cd (0.121ppm) > Pb (0.083ppm). Only Pb was within the permissible limit as stipulated by WHO (Pb-0.1mg/L), all other metals were above the permission limit as stated by FAO and WHO of 2011. Expectedly the tomato had high moisture content (95.7%). Statistical treatment of the data showed the existence of a strong inverse correlation between Fe and Pb concentration in the tomato sample ($r = -710$, $p = 0.020$). There was no statistical correlation between lycopene content and the total metal concentration ($r = -0.349$, $p = 0.324$).*

KEYWORDS: Tomato, lycopene, heavy metal, vegetable, fruits and spectrophotometer.

INTRODUCTION

Botanically, a tomato is a fruit and considered a vegetable for culinary purposes. Tomatoes are not the only food source with this ambiguity: green beans, eggplants, cucumbers and squashes of all kinds, (such as pumpkins) are all botanically fruits, yet cooked as vegetables (Etem et al.,2012).

Fig. 2: Cherry Tomato Species

Fig. 1: Beefsteak tomato species

Cultivated tomatoes vary in size from cherry tomatoes about 1-2cm up to beefsteak tomatoes 10cm. Beefsteak tomatoes are large tomatoes, their kidney bean shape makes commercial use impractical along with a thinner skin. Cherry tomato is a smaller garden variety of tomato. It is marketed at a premium to ordinary tomatoes. Cherry tomatoes range in size from a tumb tip up to the size of a golf ball, and can range from being spherical to slightly oblong in shape.The tomato is considered a healthy food due to its high content in lycopene and other health-promoting natural compounds (Etem et al.,2012; Baranska et al., 2006). Tomatoes have, undoubtedly, assumed the status of a food with functional properties, considering the epidemiological evidence of reducing the risk of certain types of cancers (Golia E, 2008). Consumption might be beneficial for reducing cardio vascular risk associated with type 2 diabetes (Shidfar et al, 2011). It contains many nutrients, anti-oxidants and secondary metabolites such as Vitamin c and E, B-Carotene, flavonoides, organic acids, phenolics and chlorophyl II which are important for human health (Giovanelli and Paradiso,2002), (Radwan and Salama, 2006; and Demirbas, 2010).

This work was set out in order to analyze cadmuim (Cd), Chromuim (Cr), Copper (Cu), Iron (Fe), Lead (Pb) and Zinc (Zn) concentrations by using atomic absorption Spectrophotometer (AAS) to compare and determine heavy metal levels in two major tomato species sold in five selected markets within Awka town in Anambra State and to evaluate the lycopene content of the tomato species. The research will highlight the contribution of tomato consumption to the recommended daily intakes and to evaluate the risk of dietary heavy metal exposure through tomato consumption.

MATERIALS AND METHODS

The fresh samples of beefsteak and cherry tomato species were collected from 5 different local markets within Awka Metropolis in Awka South L.G.A. of Anambra State. The samples were identified by Dr. E.I. Mbaekwe of the Department of Botany, Nnamdi Azikiwe University.

Digestion of the tomato samples: Wet digestion method was employed in which 20g of the ground tomato samples was weighed into a 125ml Erlenmeyer flask. Acid mixture of perchloric acid, nitric acid and sulphuric acid in the ration of 1: 2.5 : 0.4 respectively was utilized in the digestion process. The sample and the acid mixture was heated on a hot plat under a perchloric acid fume hood (Baranska et al., 2006). The metal content of the digested solution was evaluated via AAS.

Lycopene Extraction from the Tomato Species (Baranska et al., 2006): Two fruits of washed tomatoes were homogenized and later sonicated to remove air bubbles. The Serum was removed by filtration through a No. 12.5cm watt man filter paper. A 0.1g aliquot amount of the pulp was weighed into a 10ml micro test tube. To this was added 4ml of the extractant solvent (Hexane 2ml, Acetone 1ml and Ethanol 1ml). The tube was capped and agitated on an orbital shaker for 3mins to obtain consistent slurry. The tube was transferred to a dark cupboard for 10mins for extraction to occur. A 1ml aliquot volume of deionized water was added to it after 10mins to effect separation of aqueous layer from organic layer. After further 10mins, the organic layer was separated with pipette and transferred into a 1cm cell/curvette and absorbance measure at 503nm. A blank was also performed and subsequently measured at 503nm.

RESULTS AND DISCUSSION:

The results of the percentage moisture Content of the tomato samples analysed showed that tomatoes have a high moisture content with average value of 95.7%.

The results of the metal analysis is presented in table 1 below.

Table 1: Metal content of ripe beefsteak tomato species

sample	**Fe (ppm)**	**Cu (ppm)**	**Zn (ppm)**	**Cr (ppm)**	**Cd (ppm)**	**Pb (ppm)**	**total**	**average**
A	0.426	0.376	0.488	0.118	0.062	0.074	1.544	**0.257**
B	0.217	0.710	0.183	1.418	0.038	0.089	2.655	**0.443**
C	0.598	0.640	0.183	1.180	0.007	0.074	2.682	**0.447**
D	0.460	0.560	0.549	0.236	0.025	0.089	1.919	**0.320**
E	0.435	0.500	0.731	0.118	0.069	0.074	1.927	**0.321**
sum	2.136	2.786	2.134	3.070	0.201	0.400		
mean	***0.427***	***0.557***	***0.427***	***0.614***	***0.040***	***0.080***		
FAO/WHO	**0.300**	**0.200**	**0.150**	**0.100**	**0.01**	**0.100**		

Sample A (Ifite ist Market); B (Ifite 2nd Market); C (Eke-Awka market); D (Tempsite market); E (Nkwo- Amenyi market).

FAO/WHO; Maximum allowable limits of elements in fruits and vegetables, Nutrition Meetings Report Series, 1978; Muhammed et al., 2011.

Iron concentration was highest in sample C with a value of 0.598ppm while the lowest level was implicated in sample B (0.217ppm). The mean concentration of Fe in the five samples was 0.427ppm which was higher than the Maximum allowable limit of Fe in fruits (0.3ppm, FAO/WHO). The high levels of Fe in the tomato species may be attributed to the irrigation water for their cultivation. Generally, Cr was implicated to have occurred highest in all the samples under investigation with a mean value of 0.614ppm far above the allowable limit as stipulated by FAO/WHO. The observed trend in the levels of metals was Cr (0.614ppm) > Cu (0.557ppm) > Fe (0.427ppm) ≈ Zn (0.427ppm) > Pb (0.080ppm) > Cd (0.040ppm). Cu, Cr and Pb had their highest level found in sample B (Ifite second market, Awka). Zn and Cd concentrations were found highest in sample E (Nkwo-Amenyi Market, Awka).

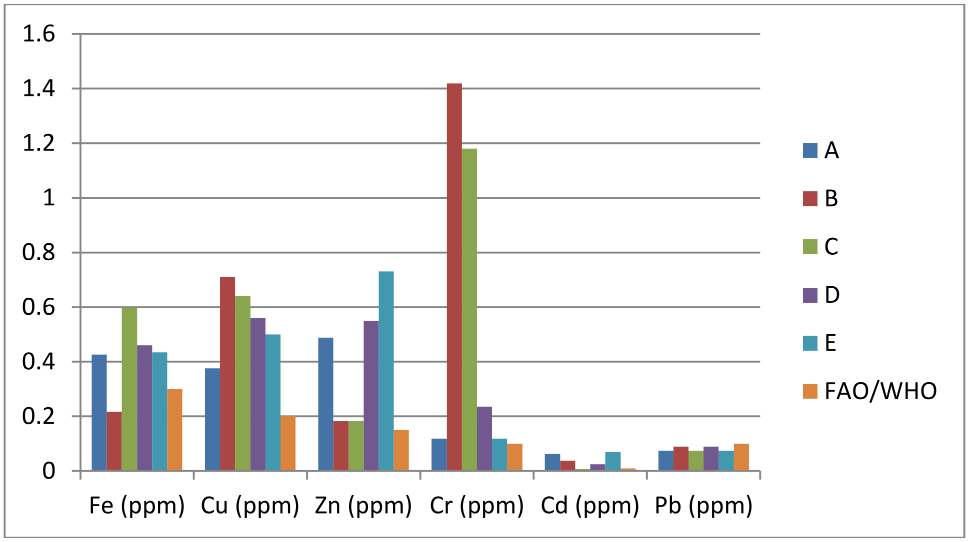

Fig 1: Bar chart for the metal concentration in beefsteak tomato species.

Figure 1 gave a good picture of the metals levels in the beefsteak tomato species with Cr highest mean concentration. The observed trend in the total metal concentrations for all the samples was samples C > B > E > D > A. The chart shows relative low concentration of Cd in all the samples under study for the beefsteak tomato species.

Table 2: Level of metals in the ripe Cherry tomato species

sample	**Fe (ppm)**	**Cu (ppm)**	**Zn (ppm)**	**Cr (ppm)**	**Cd (ppm)**	**Pb (ppm)**	**total**	**average**
A	0.326	0.338	0.183	0.709	0.069	0.089	1.140	**0.190**
B	0.598	0.451	0.305	0.118	0.075	0.074	1.621	**0.270**
C	0.710	0.226	0.305	0.236	0.092	0.074	1.643	**0.274**
D	0.190	0.600	0.670	0.118	0.385	0.104	2.067	**0.345**
E	0.570	0.526	0.610	0.944	0.385	0.089	3.124	**0.521**
sum	2.394	2.141	2.073	2.125	1.006	0.430		
mean	***0.479***	***0.428***	***0.415***	***0.425***	***0.201***	***0.086***		
FAO/WHO	**0.300**	**0.200**	**0.150**	**0.100**	**0.01**	**0.100**		

Sample A (Ifite ist Market); B (Ifite 2nd Market); C (Eke-Awka market); D (Tempsite market); E (Nkwo- Amenyi market).

FAO/WHO; Maximum allowable limits of elements in fruits and vegetables, Nutrition Meetings Report Series, 1978; Muhammed et al., 2011.

Similarly, the highest Fe level was observed in Sample C with a value of 0.710ppm in the Cherry tomato species just like that of Beefsteak samples. The metal with highest mean concentration was Fe with a value of 0.479ppm. The observable trend in the metals levels was Fe (0.479ppm) > Cu (0.428ppm) > Cr (0.425ppm) > Zn (0.415ppm) > Cd (0.201ppm) > Pb (0.086ppm). Cu, Zn, Cr and Pb had their highest levels found in sample D (Tempsite market, Awka) for the Cherry tomato species. This may be attributed the the source of water for the irrigation in the cultivation of the tomatoes within the Tempsite market environs. The trend in the average metal concentrations for all the samples of the Cherry tomato species was samples E > D > C > B > A. Noticeably, sample

A had the least metal concentrations for both the beefsteak and cherry tomato species with a value of 0.257ppm and 0.190ppm for the beefsteak and cherry tomato species respectively.

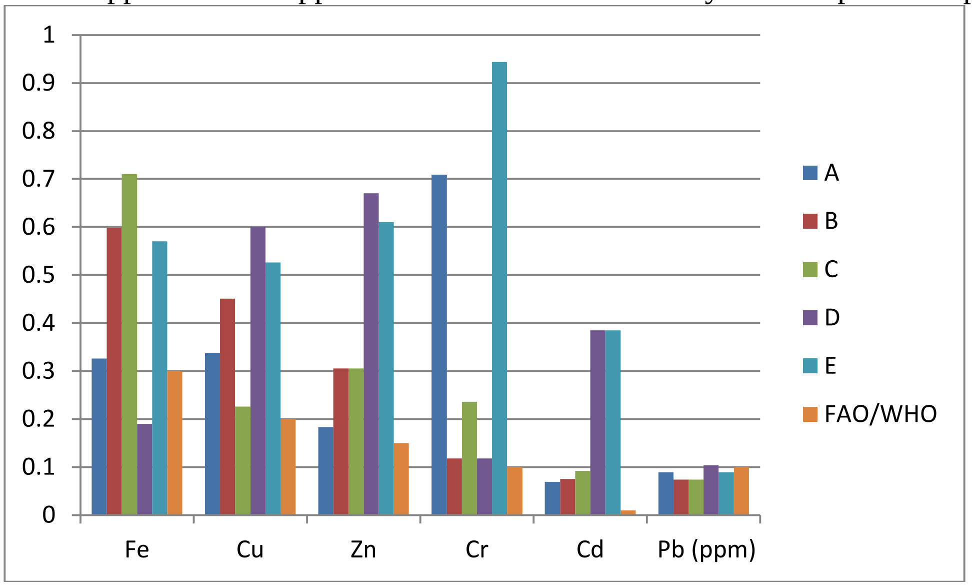

Fig 2: Level of metals in the ripe Cherry tomato species

Figure 2 shows the distributions of metal concentrations in the various samples of the cherry tomato species as investigated. It was observed from the chart that Cr occurred highest in sample E, while Pb relatively occurred lowest in all the samples of the cherry tomato species. The levels of Cd and Cr found were comparable to those reported by Etem et al., 2012 while Zn and Pb values were lower than the values reported by Etem et al., 2011.

Table 3: levels of Lycopene content of beefsteak tomato species:

Sample	**Absorbance at 503nm**	**Corrected Absobance**	**Concentration (mg /Kg)**
A	2.157	2.026	69.57
B	1.485	1.354	46.50
C	1.661	1.530	52.54
D	3.000	2.869	98.52
E	3.000	2.869	98.52

Sample A (Ifite ist Market); B (Ifite 2nd Market); C (Eke-Awka market); D (Tempsite market); E (Nkwo- Amenyi market).

The lycopene contents of the beefsteak tomato species were found at relatively high amount with a range of 46.50 to 98.52mg/Kg. The trend observed was sample E (98.52mg/Kg) ≈ D (98.52mg/Kg) > A (69.57mg/Kg) > C (52.54mg/Kg) > B (46.50mg/Kg). The values of the lycopene contents in the beefsteak tomato species were within the range (74.34 to 91.19mg/Kg) as reported by Baranska et al., 2006.

Table 4: Concentration of Lycopene in Cherry tomato species

Sample	**Absorbance at 503nm**	**Corrected Absobance**	**Concentration (mg /Kg)**
A	0.679	0.548	18.82
B	1.513	1.382	47.46
C	1.314	1.183	40.62
D	0.679	0.548	18.82
E	2.305	2.174	74.66

Sample A (Ifite ist Market); B (Ifite 2nd Market); C (Eke-Awka market); D (Tempsite market); E (Nkwo- Amenyi market).

The lycopene contents of the cherry tomato species found in the samples were relatively lower than observed in the beefsteak tomato species. The lowest value was implicated in sample A and D (18.82mg/Kg) while the highest value was associated with sample E with a value of 74.66mg/Kg giving a range of 18.82 to 74.66mg/Kg. The values obtained in the cherry tomato species were relatively lower than recorded by Baranska et al., 2006. The average lycopene content as observed in the beefsteak and cherry tomato species were 73.13mg/Kg and 40.08mg/Kg respectively.

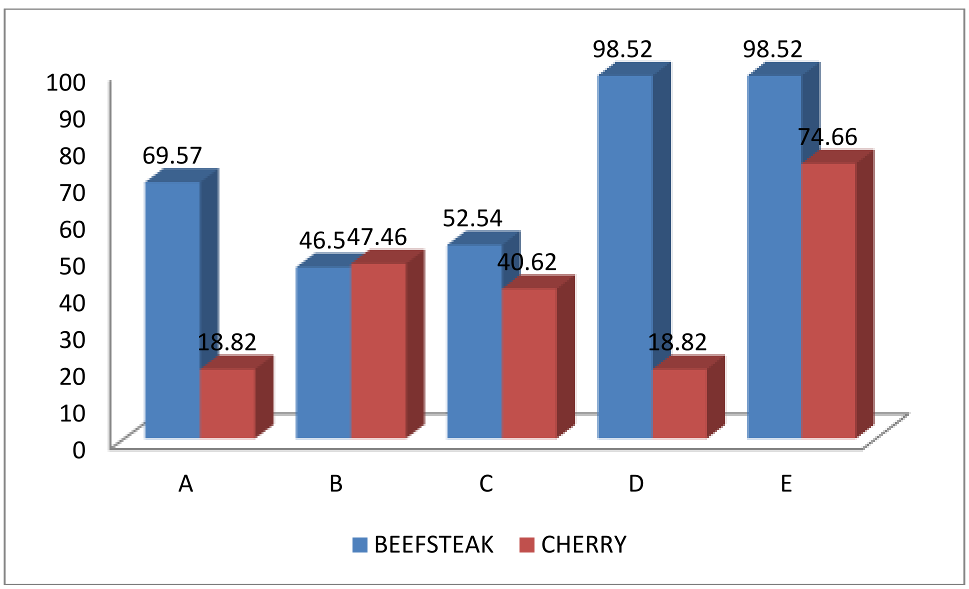

Fig 3: Bar chart of the levels of Lycopenes in beefsteak and Cherry tomato species.

Figure 3 shows the variation in the lycopene contents of all the samples of beefsteak and cherry tomato species under study. Apart from sample B where the level of lycopene content was higher in cherry tomato, all the other samples had higher lycopene content in beefsteak tomato species. The chart showed a great disparity in the lyconpene contents with a difference of 98.52mg/Kg for the beefsteak tomato compared to that of 18.82mg/Kg for the cherry tomato species.

CONCLUSION

The lycopene contents of the beefsteak tomato species occurred at relatively higher amount compared to the amount found in the cherry tomato species for the five markets survey. Similarly, the amounts of metals observed in the cherry samples were relatively lower than the values obtained from the beefsteak tomato species. The study revealed that care should be taken to avoid further increase in the metal contents of both beefsteak and cherry tomato species to prevent health risk.

REFERENCES

Baranska, M., Schutze, W. and schutze, H. (2006).Determination of Lycopene and Beta-carotene content of Tomato Fruits and Related Products. Anal. Chem., 78(24):8456-8461.

Chiraz C, Houda G., Habib GM; (2003). Nitrogen Metabolism in tomatoes plants under Cadmium stress. Journal of Plant nutribution 26, 1617-1634.

Demirbas A., (2010). Micronutient and heavy Metal Contents of Tomatoes. Food Chem., 118, 504-507

Djebali W, Zarrouk M; Brow quisse R; El Kahoui S., Limam F; Ghorbel MH; Chaibi W., (2005). Ultrastructure and Lipid Alterations Induced by Cadmium in Tomao (Lycopersicon esculentum) chloroplast membranes. Plant Biology7, 358-368.

Etem, O., Ibrahim, I.O., Zeliha. L., Goksel, D and Memduh, S (2012). Determination of heavy metal concentration in tomato grown in different Station types. Romanian Biotechnological Letters 17(1):6962-6971

FAO/WHO, (1978). Evaluation of Certain Food Additives (Twenty-first report on the Joint FAO/WHO Expert Committee on Food Additives). Geneva, World Health Organization (WHO Technical Report Series, No. 617).

Giovanelli, G and Paradiso, A (2002). Stability of dried and Intermediate moisture tomato pulp during storage. J. Agr Food Chem., 50, 7277-7281

Golia E.E.; Damirkou A; Mitsios Ik. (2008) Influence of some soil parameters on heavy metals accumulation by vegetables grown in agricultural soils of different soil orders. Bull Environ. Contain Toxicol: 81: 80-4

Isildak O, Turkekul I, Elmastas M, Tuzen M. (2004) Analysis of heavy metal in some wild-grow mushrooms from the middle black sea region, Turkey. Food Chem; 86: 547-552.

Kalac P, Burda J, Staskova I. (1991). Concentrations of Lead, Cadmium, Mercury and Copper in Mushrooms in the Vicinity of a lead Smelter. Sci. Total Environment 105: 109 – 199.

Muhammad A. I, Muhammed N. C, Shujah Z, Muhammed I, Khuram A, Asma I (2011).Journal of Environmental Technology and Management Vol. 2, No. 1.

Namlk Aras and O. Yavuz Ataman, (2006). Trace element analysis of food and diet. RSC Publication, PP: 344-349.

Parnel, Tracy L., Suslow, Trevor V, Harris, Linda J., (2004). "Tomatoes: Safe Methods to store, preserve, and Enjoy". ANR Cataalog. University of Califonia: Division of Agriculture and Natural Resources. Retrieved 18 February, 2013.

Radwan M.A., Salama A.K., (2006). Market Basket Survey for some heavy metals in Egyptian fruits and Vegetables. Food and Chemical Toxicology 44: 1273 – 1278.

Sharma O., Bangar P., Rajesh K., Sharma P.K., (2004). Heavy metals accumulation in soils Irrigated by Municipal and Industrial effluent. Environ. Sci. Engine, 46(1), 65-73.

Shidfar S., Gobari M., (2011). "The Effects of Tomato Consumption on Serum Gilucos, Apolipoprotein B, Apoliporotein A-I, Homocysteine and Blood Pressure in type 2 Diabetiic Patients". International Journal of Food Sciences and Nutrition 62(3); 289-294.