STATISTICAL EVALUATION OF SOME MINERALS FOUND IN GARLIC (*Allium Sativum* Linn) SPECIES OF AFRICAN ORIGIN

Supported by tetfund TERTIARY EDUCATION TRUST FUND

E. S. Mohammed
Department of Chemistry, Federal University Dutse, Jigawa State, Nigeria
saadatueri@gmail.com

Received: November 29, 2018 **Accepted:** January 18, 2019

Abstract: The concentrations of some minerals (K, Ca, P, Mg, Mn and Cu) found in garlic species grown in Nigeria, Senegal and Chad were determined using Atomic Absorption Spectroscopy. The results showed that Nigerian garlic specie contained the highest concentration of phosphorus (1.29 mg/L) and Copper (0.017 mg/L). Calcium was found to be highest in Senegalese garlic specie (8.639 mg/L) with the Nigerian specie having the second-highest recorded value (6.930 mg/L). The highest values of potassium, magnesium and manganese content were recorded for Chadian garlic (68.26 mg/L), (51.60 mg/L) and (0.212 mg/L), respectively. Also from the results, there is notable variation in the concentration of the minerals, and this may be attributed to the types of soils on which the different garlic species were grown.

Keywords: Garlic species, mineral elements, *Allium sativum*, atomic absorption spectroscopy

Introduction

Allium sativum Linn commonly called garlic in English is a perennial plant belonging to the family *Liliaceae*. The plant is also referred to with some common names such as stinking rose, nectar of the Gods and camphor of the poor (Dobelis, 1986). Cultivated throughout the world, garlic belongs to the same group of plants as onions (*Allium cepa*) and is mostly planted between the months of February and March, or between September and November depending on the local climate in different countries (Almanac, 2019). The plant has a great healing power as it is used to treat ailments like hypertension, diarrhea, headache, dysentery, whooping cough, epilepsy (Murray, 1996). Garlic inhibits the growth of both bacteria and fungi (Orekhov *et al*., 1995). It provides protection against heart disease and strokes by lowering cholesterol and blood pressure (Murray, 1996).

Fresh garlic is a source of numerous vitamins like vitamins B_6 and C, minerals like copper, zinc, iron, tin, calcium, manganese, magnesium, aluminium, germanium and selenium although their quantities may vary depending on the type of soil on which they are cultivated (Marina *et al*; 2014; Odebunmi *et al*, 2009). Garlic contains the highest sulphur content than any member of the genus *Allium*. Alliin is a sulphur containing compound that makes up the essential oil of garlic. It is mainly responsible for the pungent odor of garlic. Other sulphur containing compounds that make up garlic'sessential oil include Diallyldisulphide (DADS) and Diallyltrisulphide (DATS) (Block, 1985). Trace minerals are important in plants and animal nutrition. Mineral deficiencies lead to arthritis and muscular dystrophy.

However, the number of trace minerals present in garlic is a direct function of the type of soil on which it is grown (Chartuvedil and Chartuvedil, 2011). This study is aimed at comparing the concentrations of some of these minerals in the commonest garlic species cultivated in Nigeria, Senegal and Chad.

Materials and Methods

Plant source and sample preparation

The garlic species were collected from Sokoto (Nigeria), Ndjamena (Chad) and Senegal. They were dried at room temperature to constant weight. The dried garlics were ground into powder using motar and pistil. A portion (2.5 g) of each sample was weighed and wet-digested using 25 cm^3 of concentrated nitric acid and perchloric acid in separate beakers. The mixtures were heated over heating mantle until all fumes of the perchloric acid were given off. The mixture was allowed to cool at room temperature and filtered to remove undissolved particles. The filtrate was placed in three separate 100 cm^3 standard flasks and made up to the marks with distilled water.

Analytical method

Atomic Absorption Spectrophotometer (AAS), Perkin Elmer instrument (Analyst 400) was used to determine the concentration of the minerals. AAS is an analytical technique which measures the concentrations of elements in gaseous state. The technique makes use of the wavelength of light specifically absorbed by an element which corresponds to the energies needed to promote electrons from ground state to excited state. Samples in aqueous media are aspirated into a high temperature flame. The amount of light absorbed by the element or metal atom is proportional to the concentration of the element, and this relationship is known as Beer-Lambert's Law (Elmer, 1993).

Results and Discussion

The results of the Atomic Absorption Spectroscopy of the minerals for the garlic samples collected in Nigeria, Senegal, and Chad are shown in Table 1. Descriptive statistics showing mean, standard deviation and coefficient of variance of the results is depicted in Table 2. A pictorial representation of the relationship among the concentration of the trace minerals is shown in Fig. 1.

Table 1: Mean concentration of mineral elements in garlic samples

Sample (2.5 g)	Country	Mineral element	Concentration (mg/L), n =3	%composition
Garlic	Nigeria	Ca	6.930	0.280
		P	0.280	0.010
		K	61.37	2.450
		Mg	26.89	1.080
		Mn	0.040	0.001
		Cu	0.017	6.8×10^{-4}
	Chad	Ca	6.227	0.249
		P	1.170	0.047
		K	68.260	2.730
		Mg	51.600	2.064
		Mn	0.212	0.008
		Cu	0.012	4.8×10^{-4}
	Senegal	Ca	8.639	0.346
		P	0.280	0.011
		K	61.560	2.462
		Mg	35.920	1.437
		Mn	0.068	0.003
		Cu	0.011	4.4×10^{-4}

Table 2: Descriptive statistics of mineral concentration in the garlic species

Mineral Element	Ca	P	K	Mg	Mn	Cu
Nigeria	6.930	0.280	61.37	26.890	0.040	0.017
Chad	6.227	1.170	68.260	51.600	0.212	0.012
Senegal	8.639	68.260	61.560	35.920	0.068	0.011
Mean	7.265	23.237	63.730	38.137	0.107	0.013
SD	1.240	38.994	3.924	12.503	0.092	0.003
CV	17.074	167.812	6.158	32.785	86.521	24.109

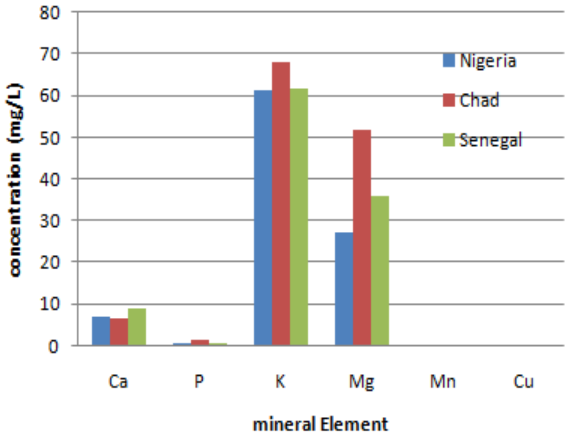

Fig. 1: Concentration of minerals in the three garlic species

A notable variation was observed in the concentration of the minerals (Ca, K, Mg, Mn, P and Cu) in the different samples of the garlic assessed which is in agreement with findings of Murat *et al*. (2017). From the results, phosphorus was found to have the highest concentration in Sokoto (Nigerian) garlic and the Senegalese garlic had the lowest. This outcome however disagrees with Murat *et al*. (2017) where phosphorus was found to be among the least present in the garlics they analysed. The Senegalese species of garlic was found to contain more of Calcium which was followed by the Nigerian and Chadian species respectively. In the same manner, Potassium, Magnesium and Manganese were found to be highest in the Chadian garlic species. Many researches though carried out on different mineral elements present in different garlic species also reported notable variations in the concentration of the chosen minerals which can be said to be consistent with the findings of this study bearing in mind the difference in geographical locations and climate. Reyhaneh (2017) for instance found the minerals analysed in garlic to be in the order: Mn>K>Ca>P>Mg. The results obtained in this study show that Senegalese garlic is richer in calcium which is an essential mineral required for bone and teeth development, and also in the regulation of nervous excitability. Nigerian garlic is richer in phosphorus which is a key component of the nucleic acids and also takes part in bone and teeth development; and copper which plays an important part in blood clotting. The garlic specie from Chad is richer in potassium, magnesium and manganese. Potassium plays an important role in maintaining pH balance and fluid distribution in the body; Magnesium serves in proper functioning of the muscles; Manganese is useful in proper bone formation.

Research showed that the amount of trace minerals contained in garlic is a direct function of their presence in the soil on which they were grown (Stephen and John, 2000). The amount of sunlight, air, and water are also factors among others which cause variation in the concentration of the respective minerals studied (Ekholm *et al*., 2007). The chemical composition of garlic is also affected by the pre and post harvest conditions. Also garlic grown with artificial fertilizer contains smaller amount of these trace minerals than those grown organically in soils that have had their minerals replenished by conscientious growers (Stephen and John, 2000). Trace minerals are an integral part for healthy growth of both plants and animals. Calcium is needed for the development and maintenance of bones and the regulation of nervous excitability and muscular contraction. Calcium's effectiveness is enhanced by the presence of vitamins A, C, and D, Magnesium, Manganese, Phosphorus and Copper. The presence of potassium in the body together with sodium and chloride ion helps in maintaining fluid distribution and pH balance. Phosphorus is the second most abundant essential mineral in the body after potassium. Phosphorus is a key component of DNA, RNA (nucleic acids), bones, teeth, and many other compounds required for life.

Table 3: ANOVA for the analysed garlic species from Nigeria, Chad and Senegal

Source of variation	Sum of Square	Number of groups	Df	Mean Square	F	F,critical	p value
Between groups	9549.349	6	5	1909.870	6.765	3.106	0.0032
Within groups	3387.603		12	282.300			
Total	**12936.953**		**17**				

Statistical inference

From the result, the highest coefficient of variation value (167.812) was noticed in the phosphorus content of the garlic species. This shows that there is difference in the concentration of minerals in all three sample locations of study. The lowest standard deviation value was recorded for copper (0.003) which indicates the proximity of the result to the actual value compared to other minerals (Table 2). ANOVA result also revealed a significant p value of 0.0032 at 95% confidence interval. This result further corroborates the fact that there is difference in concentration of the respective minerals in all three geographical locations as evident in the observed values for coefficient of variation, hence null hypothesis is rejected (Table 3). Logically put, the results show that variation in geographical location could mean higher variability around the mean of observed values (concentration of the metals). The standard deviation values are in agreement with those of coefficient of variation as they depict considerably closer values to the mean in the respective geographical locations.

Table 4: Spearman correlation coefficients for the garlic samples analysed

Garlic sample	Correlation coefficient (r)	p value
Nigerian garlic	0.990	0.0001
Chadian garlic	0.986	0.0001
Senegal garlic	0.894	0.0001

Spearman correlation results revealed strong, positive correlation coefficients (r) = 0.99, 0.986, 0.894 for the respective Nigeria/Chad, Nigeria/Senegal and Chad/Senegal garlic species. This implies that a strong relationship exists among the concentrations of the minerals as they exist in the three different garlic samples even though they were grown in different countries. This may be due to similarities in environmental and edaphic factors especially when viewed from the point that all three countries are West African countries (Table 4).

Conclusion

The concentrations of the trace minerals under study in garlic species obtained from Nigeria, Senegal and Chad have been analyzed and reported. The results obtained are in agreement with the WHO guideline (1996) for allowed elemental concentrations in human nutrition. The low phosphorus content in the garlics is of great concern; this may be related to the fact that some of these soils are treated with artificial fertilizer which resulted in minute quantities available for absorption by the plants, and this is dependable on the amount of water present in the soil. The garlics grown in the three African Countries showed good nutritional values as the minerals studied compliment their respective roles in the body leading to a healthy nutritional balance.

Acknowledgement

The author is grateful to Dr. S. Garba of Chemistry Department, Nigerian Defense Academy Kaduna, Kaduna State, Nigeria for his valuable input throughout the composition of this paper.

Conflict of Interest

The author declares that there is no conflict of interest related to this study.

References

Block, E. (1985). The Chemistry of Garlic and Onions. *Sci. Am.*, 252(3): 114-119. http://dx.doi.org/10.1038/scientificamerican0385-114

Chartuvedil R & Chartuvedil S 2011. A review on different therapeutic uses and antimicrobial potential of garlic. *South Asian Journal of Experimental Biology*, 1: 20-25.

Dobelis IN 1986. *Magic and Medicine of Plants*. The Reader's Digest Association; Pleasantville, New York.

Ekholm, P., Reinivuo, H., Mattila, P., Pakkala, H., Koponen, J., Happonen, A., Hellstro¨m, J. and Ovaskainen, M. (2007). Changes in the mineral and minor element contents of cereals, fruits and vegetables in Finland. *J. Food Composition and Analysis*, 20: 487-495.

Elmer P 1993. User's Guide for Atomic Absorption Spectroscopy.

Gourmet Garlic Gardens 1997. A Primer on the Chemistry of Garlic. http://dx.doi.org/10.2135/cropsci1997.0011183X003700050003x

Marina S, Masood S, Butt AS & Saira T 2014. Chemical and mineral analysis of garlic: a golden herb. *Pak. J. Food Sci.*, 24(1): 108-110.

Murray MT 1996. The Healing Power of Herbs. Rocklin, *CA: Prima Publishing*, pp. 121-131.

Odebunmi EO, Oluwaniyi OO & Bashiru MO 2009. Comparative proximate analysis of some food condiments. *J. App. Sci. Res*. 2(1): 1-3.

Orekhov, A. N., Tertov, V. V., Sobenin, I. A. & Pivovarova, E. M. (1995). Direct anti-atherosclerosis-related effects of garlic. *Annals of Medicine*, 27(1): 63-65. http://dx.doi.org/10.3109/07853899509031938

Reyhaneh M 2017. Determining the chemical composition of garlic plant and its exixting active elements. *IOSR Journal of Applied Chemistry*, 10(1): 63-66.

Stephen F & John B 2000. Garlic: Nature's Original Remedy. *Published by Healing Arts Press of Rochester.*

WHO 1996. Trace Elements in Human Nutrition and Health. World Health Organization (WHO), Geneva.