Scientific Knowledge Group

Research Article

Journal of Modern Science and Scientific Methods

Determination of Some Mineral Elements in Some Vegetables from Dakasoye Farmlands Kano State, Nigeria

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ABSTRACT

Vegetables are the rich sources of mineral elements because of their ability to absorb essential nutrients from the soil through their roots. Consumption of Vegetables can increase nutrient requirement and reduce the risk of cardiovascular diseases, stroke and cancer. Additionally, it's high water content contributes to proper hydration. This study analysed some mineral elements (Calcium, Potassium, Magnesium and Sodium in 10 Vegetables from Kura-Dakasoye Agricultural area of Kano State.

Atomic Absorption Spectrophotometery (AAS) technique was used after wet digestion with 10 cm3 HNO3 and 8 cm3 HClO4 mixture.

The results obtained were in the following ranges, Ca (107-1025 mg/kg), K (225.8-1434.0 mg/kg), Mg(31.48-185.66mg/kg), Na(524.4-551mg/kg).

The results of statistical Analysis (ANOVA) between the concentrations of all the investigated mineral elements in all the analyzed vegetables indicated no significant difference (P>0.05).

The results of the analysis, indicated that calcium, Potassium, magnesium and sodium were present in adequate amount and do not pose any health risk to its consumers.

Keywords: Atomic Absorption Spectrometer, Analysis, Determination, Minerals, Vegetables.

Received: May 12, 2025;
Accepted: May 19, 2025;
Published: May 26, 2025

Introduction

Mineral elements are essential chemical elements required for numerous biological functions in plants, animals and humans. They are usually absorbed from the environment or water and play a vital in supporting health, growth and overall development. Among these mineral elements such as calcium, potassium, magnesium and sodium play crucial roles in biological processes such as nerve function, muscle contraction, fluid balance and bone development [1]. Mineral composition of vegetables can vary significantly depending on factors such as soil composition, farming practices, plant species and environmental conditions [2].

Vegetables acquires essential minerals mainly from the soil in which they are cultivated. These minerals are absorbed by plant roots from soil's water solution [3].

Soil is formed through weathering of rocks, which releases mineral nutrients such as potassium, calcium, magnesium and phosphorus and overtime, these minerals become available for plants uptake [3].

The decomposition of plant and animal residues contributes minerals like calcium, potassium, sodium and nitrogen to the soil [3].

Chemical fertilizers provide concentrated minerals such nitrogen, phosphorus and potassium directly to the soil [4].

Many African ethnic communities living in the bushes without access to modern health care facilities, clothing, and consistent food sources often maintain good health by relying on traditional diets rich in wild fruits and vegetable [5]. People who consume a lot of fruits

Citation: Huzaifa Garba Nataala, Aminu Mustapha, and Rabiah shehu Kura (2025) Determination of Some Mineral Elements in Some Vegetables from Dakasoye Farmlands Kano State, Nigeria. J Modr Sci Scient Res 1: 1-6.

and vegetables are much less likely to suffer from non-communicable health related diseases compared to those who consume less. Fruits and Vegetables are an important part of the diet of mankind as they are rich sources of macro and micro nutrients which help the body to fight against diseases [6].

Though, people generally believe that vegetable refers to the green leaves of some plants, but in the actual sense so many parts of a plant can be called or consumed as vegetable. Vegetables are therefore, categorized based on the part of plant consumed; they include flower bud, seeds (sweet corn (maize), peas, beans, corn), leaves (spinach, lettuce, garlic chives), stem (stems of leaves), stem shoots (ginger), tubers (potatoes, yams),roots (carrots) and bulbs (onions) as well as fruits in the botanical sense, but used as vegetables; tomatoes, cucumbers, pumpkins, peppers, okra [7]. Nutritionally, fruits and vegetables are energy-dense foods containing vitamins, minerals, fiber and other bioactive compounds [8]. According to a fruit is the edible and fleshy seed-associated structures of certain plants, which could be sweet (such as apples, oranges, grapes, strawberries, juniper berries and bananas) or non-sweet (such as lemon and olives) in their raw forms [9, 10].

Moreover, (FAO1990) revealed that "increasing fruit and vegetable consumption is a major public health challenge at the moment". The statement was made due to the micronutrient deficiencies being experienced worldwide which lead to nutritional disorders such as weakened immune systems, birth defects, mental and physical retardation, among others. These nutritional deficiencies occur as a result of low consumption of fruits and vegetables and also probably because of low knowledge of the nutritional values of fruits and vegetables [11]. In Nigeria, particularly in northern region, vegetables are cultivated and consumed. However, there is limited data on the mineral content of vegetables grown in some rural areas such as Dakasoye village in Kura local government area of Kano state. The aim of this study was to determine the concentration levels of some essential mineral elements (Calcium, Potassium, Magnesium and Sodium) in the selected vegetables cultivated in Dakasoye village using atomic absorption spectrometer, and to evaluate the potential health benefits or risks associated with the consumption of these vegetables based on their mineral composition.

Materials and Methods

In the preparation of reagents, chemicals of analytical grade purity and deionized water were used. All glass wares were washed with liquid detergent and rinsed with distilled water before drying in an oven at 1050C. All weightings were done using analytical weighing balance model FA due to its high precision, accuracy and sensitivity and analysis of metals was done using Agilent Atomic Absorption spectrophotometer (AAS) [12].

Sample Collection

Ten fresh Vegetable samples were collected from Kura-Dakasore Agricultural area. For a meaningful plant analysis. Plant sampling was carried out with highest level of caution. The samples of Vegetables were collected at maturity i.e. ripening. In case of Onion the whole plant was uprooted carefully using a wooden stick, so that the tuber does not receive any cut to avoid contamination due to soil. The vegetable samples were identified by an expert at the Department of Plant science, Bayero University, Kano. All the samples were washed with distilled water and rinsed with deionized water, then dried using good quality tissue paper. Each sample was cut into slices using stainless steel knife and spread on Polyethylene sheets to sun-dry taking care of any dust deposition by covering with a light veil. Later the fruits samples were dried in the oven at 60 0C, this was repeated until complete drying. The samples were grounded and sieved, using 0.5 mm sieve [13].

Sample Digestion

1.0g of the ground vegetable samples was placed in 100 cm3 volumetric flask. 10 cm3 of HNO3 was added and kept overnight for pre-digestion. 8 cm3 of HClO4 was added and swirled gently the flask was then place on low heat (at about 100 0C) on hot plate. Then heated at higher temperature (at about 260 0C) until the production of red fumes ceases, the content was then further evaporated until the volume is reduced to about 3 cm3. The completion of the digestion was confirmed when the liquid became colorless. Deionized water was added up to mark after cooling and filtered through What man number 1 filter paper [14].

Description of the Study Area

Dakasoye is a village located near the boundary between Kura and Garun malam local governments in Kano state, Nigeria. Geographically, Dakasoye village is located on latitude 11.70710'N of the equator and longitude 8.44060' E of Greenwich meridian with an elevation of about 473m above the sea level (Figure1). The village is situated close to localities such Turedasu, Takanawa, shifawa and yadakwari [15]. The area is well known for Rice farming and vegetables cultivation.

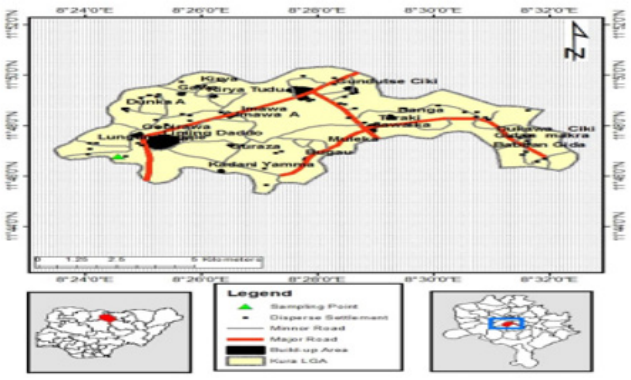

Figure 1: Map of Kura-Dakasoye indicating the Sampling sites
Source: GIS Unit, Department of Geography Bayero University Kano

Instrumentation

Minerals (Ca, Mg, Na, K,) were determined in some vegetables cultivated in Dakasoye village by Agilent Atomic Absorption spectrophotometer (AAS), after appropriate digestion of samples to extract the minerals. Standard solutions with known concentrations and blank are prepared. A calibration curve is created from the standards. The absorbance of the vegetable samples is measured and compared to the calibration curve to determine the concentration of the minerals. A blank is used to correct for background interference.

Preparation of Reagent Solutions

All the reagents used were of analytical grade. Glass wares were washed with liquid detergent solution, rinsed with deionized water and oven dried at 1500C.

Results

The results of the analysis of mineral elements concentration in selected Vegetables from Kura-Dakasoye Agricultural area are presented in Tables 1 below. While Pearson correlation for macro elements are depicted in table2.

Table 1: The mean Concentrations of some mineral elements (Ca, K, Mg and Na) in the analyzed Vegetable samples from Dakasoye village in Kano state.

Samples (mg/kg)	Ca	K	Mg	Na
Spinach- Amaranthus Hybridus (Alaiyahu)	722.80	763.20	83.86	539.2
Cabbage-Brassica Oleracea	107.66	450.60	57.14	541.40
Sesame Leaves (Karkashi)	495.0	506.40	42.36	524.20
Baobab leaves- Adansonia digitata (Kuka)	1025.0	225.80	44.76	530.80
Lettuce Lactuca Sativa (Salak)	216.40	961.20	36.42	543.60
Onion- Allium Cepa (Albasa)	478.20	556.20	68.62	531.60
Kenaf- Hibiscus Cannabinus (Rama)	321.20	337.80	29.04	541.60
Bitter leaf- Vernonia Amygdalina (Shuwaka)	254.80	713.80	31.48	535.60
Senna- Cassia Senna (Tafasa)	685.80	632.40	36.88	528.80
Moringa Oleifera (Zogale)	986.40	393.60	59.80	545.00
FAO	3000	3500.0	350.0	2500

Table 2: Pearson correlation coefficients for mineral elements in some vegetables from Dakasoye village in Kano state.

	Ca	*K*	*Mg*	*Na*
Ca	1			
K	-0.20633	1		
Mg	0.08187	0.108863	1	
Na	-0.07069	0.270238	0.01211	1

Table 3: ANOVA Result for Calcium in the analyzed vegetables from Dakasoye village in Kano state.

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
490.8	19	4865.07	256.0563	19760.72		
388.9	19	4523.61	238.0847	16653.22		
204.5	19	4199.11	221.0058	13940.7		
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	11673.65	2	5836.824	0.347743	0.70785	3.168246
Within Groups	906383.6	54	16784.88			
Total	918057.2	56				

SS= Sum of the Squares, df= degree of freedom, MS= Mean Squares, F= Fisher Statistics, P- Value= Probability Value, Fcrit= Fisher Critical.

Table 4: ANOVA Result for Potassium in the analyzed vegetables from Dakasoye village in Kano state.

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
103.9	19	4130.25	217.3816	17940.69		
101.1	19	4053.59	213.3468	19044.69		
98.29	19	3912.41	205.9163	17527.63		
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1285.313	2	642.6563	0.035367	0.965273	3.168246
Within Groups	981234.1	54	18171			
Total	982519.4	56				

SS= Sum of the Squares, df= degree of freedom, MS= Mean Squares, F= Fisher Statistics, P- Value= Probability Value, Fcrit= Fisher Critical.

Table 5: ANOVA Result for Magnesium in the analyzed vegetables from Dakasoye village, Kano state.

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
118.7	19	716.867	37.72984	398.6761		
115	19	693.358	36.49253	396.7497		
111.1	19	672.298	35.38411	388.3693		
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	52.32618	2	26.16309	0.066303	0.935923	3.168246
Within Groups	21308.31	54	394.5984			
Total	21360.64	56				

SS= Sum of the Squares, df= degree of freedom, MS= Mean Squares, F= Fisher Statistics, P- Value= Probability Value, Fcrit= Fisher Critical.

Table 6: ANOVA Result for Sodium in the analyzed vegetables from Dakasoye village in Kano state.

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
44.92	19	916.08	48.21474	274.8548		
43.88	19	893.11	47.00579	268.5394		
42.58	19	870.43	45.81211	260.9203		
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	54.8408	2	27.4204	0.102275	0.902956	3.168246
Within Groups	14477.66	54	268.1048			
Total	14532.5	56				

SS= Sum of the Squares, df= degree of freedom, MS= Mean Squares, F= Fisher Statistics, P- Value= Probability Value, Fcrit= Fisher Critical

Discussion

A total of ten vegetable samples obtained from Kura Dakasoye Agricultural area were analyzed for calcium, potassium, magnesium and sodium (Ca, K, Mg, Na).

The mean concentration of calcium in all the samples analyzed ranged from 107 mg/kg to 1025 mg/kg as shown in (Table1). The accumulation of calcium appeared to be higher in Baobab leaves (Adansonia digitata).This could be attributed to the fact that baobab leaves stores more nutrients including calcium as survival mechanism in harsh condition while Cabbage (Brassica Oleracea) has the least concentration. Cabbage is more water dense and nutrients diluent hence less accumulation in cabbage [16]. Statistical analysis of variance (ANOVA) (Table 3) showed that there was no significant difference at (P>0.05) between the concentrations of calcium in the samples analyzed. Calcium was moderately correlated with magnesium as shown by the Pearson correlation presented in Table2.This reveals that calcium and magnesium might come similar source. On the other hand, Table2.showed negative correlation between calcium, sodium and potassium, indicating dissimilar source.

The results obtained in this study also indicated that the concentrations of all the samples analyzed were within the recommended permissible limit of 3000mg/Kg calcium levels in all the samples analyzed in this study were found to be lower than what was reported by in Basella alba (98652 mg/kg), Spinacia oleracea (95213 mg/kg), Lactuca sativa (86606 mg/kg), Lablab niger (84615 mg/kg) and Brassica Oleracea (80743 mg/kg) [17-19]. Reported a range (2951to 1510 mg/kg) of calcium in Moringa Olefera from different locations in Thailand.

However, the concentrations of calcium obtained in this study were higher than what was reported by in Sesanum indium leaf (30.79 mg/kg), Lactuca capensis (2.53 mg/kg), Amaranthus hybridus (83.37 mg/kg), Adasonia digitata (77.21 g/kg) and Brassica oleracea (77.29 mg/kg) [20].

The Mean levels of potassium were significantly higher in Tomato (Solanum Lycopersicum) 1434.0 mg/kg. Tomatoes are often cultivated in potassium rich soil enhaning it's uptake the least concentration of potassium was obtained in Baobab leaves-(Adansonia digitata) 225.8 mg/kg as shown in (Table1) [23]. This might be because baobab tree grows in diverse environment where potassium level in the soil may vary affecting its concentration [21]. Table2. showed positive correlation between Potassium, magnesium and sodium. Hence, disclosing similar source.

The results obtained showed that the concentrations of the samples analyzed were below the recommended permissible limit 3500 mg/kg [17]. Analysis of variance (ANOVA) in table4 showed that there was no significant difference between the levels of potassium in the analyzed vegetables (P>0.05).

Hana etal. reported the concentrations range of Potassium (4846 mg/kg to 93024 mg/kg) in Fruits and Vegetables which were higher than what was obtained in this study [22]. Fahad etal. also reported 91632 mg/kg, 88021 mg/kg, 97723 mg/kg, 92381 mg/kg, 83412 mg/kg in Basella alba, Spinacia oleracea, Lactuca sativa, Lablab niger and Brassica oleracea respectively [18].

In contrast, Otitoju etal. reported a concentration of Potassium ranged between (46.43 mg/kg to 423.0 mg/kg), which were lower than what was found in this study [23]. Also reported concentrations of Potassium in Sesanum indium leaf (27.47 mg/kg), Amaranthus hybridus (134.44 mg/kg), Adasonia digitata (64.48 mg/kg), Brassica oleracea (104.49 mg/kg), Alinum cepha (435.37 mg/kg) and Vernonia amygdalina (133.7 mg/kg) [20].

The average concentration of Mg in the analyzed samples ranged from 185.66 to 31.48 mg/kg, the maximum concentration was obtained in Pumpkin while Bitter leaf (Vernonia Amygdalina) has the least concentration of Magnesium in all the samples analyzed as represented in (Table1). Pumpkins are vigorous growers with high nutrients demand, especially magnesium to support their leaves and fruit development. In contrast, bitter leaf being smaller with different growth patterns may not absorb or require much magnesium Akpata etal. [24]. Table 2. showed that magnesium is moderately correlated with only sodium, calcium and potassium. Therefore, this might be from similar source.

Analysis of variance (ANOVA) in (Table4) above showed that there was no significant difference for magnesium between the samples analyzed ($P>0.05$). The concentrations of all the samples analyzed were found to be below the recommended permissible limit 350 mg/kg [17].

Reported the concentrations of magnesium in Grewia tiliifolia (402.2 mg/kg), Ficus racemosa (272.9 mg/kg), Glycosmis pentaphylla (332.0 mg/kg) [25]. These concentrations were higher than what was obtained in this study. Similarly, reported 267 m/kg, 279 mg/kg in Brassica rapa and Rapharus Sativus respectively [26].

In contrast, other researchers reported lower concentration of magnesium among them were who reported concentrations of Magnessium in Hisbiscus aspeo leaf (1.31 mg/kg), Lactuca capensis (23.22mg/kg), Ameranthus hybridus (9.73 mg/kg), Adasonia digitata (31.29 mg/kg), Brassica oleracea (44.27 mg/kg) and Alium cepha (1.00 mg/kg) [20]. Ficus capensis (19.99 mg/gk), Mucuna prurien (14.69 mg/kg) and Moringa oleifera (25.34 mg/kg) [27].

The mean concentrations of sodium in the samples analyzed were shown in (Table1) Cucumis Sativus (Cucumber) (551 mg/kg) recorded higher concentration of sodium in all the samples analyzed, while Sesame Leaves (524.4 mg/kg) has the least concentration. Analysis of variance (ANOVA) indicated that there was no significant difference in the levels of sodium in all the samples analyzed as shown in Table5. ($P>0.05$). The results obtained were also below the recommended permissible limit 2500 mg/kg [17]. This clearly indicated that the plants are safe to be used by diabetic patients. The concentration obtained in this research work is higher than that of who reported the concentrations of sodium 118.22 and 47.22 mg/kg in L. acutangula and S. molengena respectively [28]. Ogundua etal. also reported the concentration of sodium in C. procera and E, balsimifera as 127.778 and 117.222 mg/kg respectively [29].

Conclusion and Recommendations

This study assessed the concentrations of calcium, potassium, magnesium and sodium in vegetables from Kura-Dakasoye Agriculcutural area. The results in this study showed that all the mineral elements analysed are within the recommended permissible limit set by Food and Agriculture Organization (FAO).

the results indicated that calcium, Potassium, magnesium and sodium were present in adequate amount and are free from any health risk associated with their consumption.

Monitoring of essential elements in Vegetables need to be continued because these are the main sources of food for human in many parts of the world and considered as bio-indicators of environmental pollution.

Further studies should explore the bioavailability of these minerals in human body and investigate other potentially beneficial or toxic elements (eg heavy metals) in vegetables from Dakasoye village.

There is need to promote consumption of indigenous Vegetables because of their high levels of essential macro elements.

Research on effect of seasonal variation, soil conditions on the levels of macro Vegetables covered in this study need to be conducted.

Research on levels of macro elements in the leaves, roots and barks of the plants varieties should be studied. This is because the leaves of these plants were used as vegetables. The leaves, roots and barks were also used as herbal medicine.

Acknowledgement

We hereby wish to acknowledge the support and the guidance of Prof MD saeed throughout this study, Chemistry department of Bayero University, Kano for providing the reagents and fully equipped laboratory for the samples preparation and digestion, Malam musa Beli of Bayero University Central laboratory for his assistance.

Conflict of Interest

The authors declare that no conflict of interest exist

Funding

No any financial assistance was received during this study.

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