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Assessment of Mineral and Vitamin Contents of Carrot (*Daucus carota* L.) as Influenced by Poultry Manure, Variety and Tillage

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ABSTRACT

An attempt to assess the mineral and vitamin contents of carrots led to a field (July-October, 2022) and laboratory studies conducted in the Department of Crop Science, University of Nigeria, Nsukka, in 2022, using 2 × 2 × 3 factorial (replications = 3) each, for Randomized Complete Block Design and Completely Randomized Design respectively. The roots of two carrot varieties (Touchon Mega and Kurado) with three levels of poultry manure in t/ha (0, 5, and 10) harvested from two tillage systems (Ridge and Bed) were tested for mineral and vitamin contents using standard methods. Data were subjected to analysis of variance using GenStat 12.1 edition. Differences were significant at $p < 0.05$. Variety, manure, and tillage significantly ($p > 0.05$) did not influence the mineral and vitamin contents of the root. The vitamin C content of the roots increased with manure level increase. These mineral elements: Iron (209 g/kg), Potassium (6.6 mg/100g), Phosphorus (21.3 g/kg), and Zinc (23.6 mg/100g) were higher in Kurado than Touchon mega while Calcium (23.7 mg/100g), Copper (2.9 g/kg), magnesium (4.5 mg/100g) and Selenium (9.3 g/kg) were higher in Touchon mega. The 10 t/ha of poultry manure had higher Zinc (26.5 mg/100g) and phosphorus (23.7 g/kg), while 5 t/ha had a higher content of Calcium (24.9 mg/100g), Copper (3 g/kg), Magnesium (4.6%) and Potassium (6.8 mg/100g). The study revealed the presence of the considered minerals and vitamins in the carrot roots. Kurado accumulated some of the minerals and vitamins in quantity within the recommended human rates.

***Keywords*:** Carrot, mineral content, vitamin content, poultry manure, variety selection, tillage practices.

Introduction

Carrot (*Daucus carota* L.) is a widely consumed vegetable known for its high nutritional value and health benefits.[1] The root is an excellent source of essential minerals and vitamins (Potassium, phosphorus, calcium, magnesium, vitamin A, vitamin C, etc.).[2] The nutritional composition of carrots can be influenced by various factors, such as soil fertility, crop management practices, and genetic variations .[3] Understanding the impact of these factors on the mineral and vitamin contents of carrots is essential for optimizing their nutritional quality and ensuring consumer satisfaction.

There is a global concern among vegetable consumers on the quality and safety of edible parts of these vegetables. Unfortunately, most farmers are concerned only with the proceeds' quantity and often pay less attention to the quality of the produce and more to the health risks of some of the inputs (inorganic fertilizers and other chemicals) applied to produce the bumper harvests. It is a known fact that chemical fertilizers increase yield.[4] However, it has also been proven that the application of inorganic fertilizers does not improve carrot quality.[5] The effect of these chemicals sometimes poses a threat to humans and the environment. Among the factors that affect the nutritional composition of carrots, the application of organic fertilizers has gained significant attention.

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Poultry manure, rich in organic matter, macronutrients, and micronutrients, has been widely used in agriculture as a source of nutrients for crop production. Poultry manure can improve soil fertility, enhance nutrient availability, and promote plant growth.[6] However, knowledge of the effect of poultry manure application on the mineral and vitamin contents of carrots needs more research due to a lack of comprehensive reports. However, it was reported that variety and fertilizer interaction impacted the nutrient assimilation and accumulation in carrots.[4]

However, the choice of carrot variety plays a crucial role in determining its nutritional composition. Different carrot varieties exhibit variations in their genetic makeup, resulting in varying levels of minerals and vitamins. Genotypic differences with respect to biochemical content accumulation in carrot roots were reported in studies where Carrot Touchon had a higher content of flavonoid and tannin than other varieties considered.[7] New Kuroda and Madona varieties outperformed other varieties used in the same study with respect to nutrient content accumulation.[4] thus, suggesting superiority over others in their genetic identity. It is important to note that selecting carrot varieties with higher nutritional content can contribute to improved dietary intake and overall human health.[8]

Tillage practices, including conventional and non-tillage, can also influence the nutritional quality of carrots.[9] Conventional tillage involves the mechanical disruption of the soil, while no-tillage minimizes soil disturbance. These tillage practices can impact soil structure, nutrient availability, and microbial activity, subsequently affecting the nutrient uptake and accumulation in crops.[10] A previous study reported that carrots grown on Ridge did not differ statistically ($p > 0.05$) from the bed system. However, it showed a tendency to produce higher yield metrics, proof of higher efficiency in mineral absorption from applied poultry manure and presumably, higher accumulation of minerals in the carrot roots.[11] Simenew,[12] reported higher assimilation and accumulation of some macro elements (Nitrogen, Phosphorus, Potassium, Calcium, and Magnesium) in carrot roots planted on the bed system of tillage than those roots harvested from ridge and furrow system of cultivation.

Given the significance of mineral and vitamin contents in carrots for human health, it is imperative to investigate the combined effects of poultry manure, variety, and tillage on the nutritional composition of carrots. This study aims to assess the mineral and vitamin contents of carrots grown under different treatments: poultry manure application, carrot variety selection, and tillage practices. The findings will contribute to understanding the factors influencing carrot nutritional quality and provide insights on sustainable crop management practices that will enhance the nutritional value of this important vegetable. This study addresses the knowledge gap regarding the influence of poultry manure, carrot variety, and tillage practices on the mineral and vitamin contents of carrots. The results will aid in developing strategies to optimize carrot production systems for improved nutritional quality, thus promoting the overall health and well-being of consumers.

Materials and Methods

The field experiment was conducted at the Teaching and Research Farm of the Department of Crop Science, University of Nigeria, Nsukka. Nsukka is located in the derived Savanna agroecological Zone (latitude 060 51'E; longitude 070 29'N, with an altitude of 400 m above sea level) .[13] The soil has a sandy loam texture, slightly acidic and highly degraded leached profiles.[14] The two carrot cultivars (Touchon Mega and Kurado) were purchased from a reputable Agro-input dealer in Jos, Plateau State, Nigeria. Jos is located in Guinea Savannah of North-Central Nigeria (latitude 090 55` 42.56" N; longitude 080 53` 31.63" E, with an altitude of 1,217 m above sea level, average monthly temperature 21-25 0C).[15]

The two cultivars were assessed using three poultry manure levels (0 t/ha, 5 t/ha, and 10 t/ha) and two tillage systems (Bed and Ridge). A split-split plot in Randomized complete block design (RCBD) with a 2 × 2 × 3 factorial design was used in the field experiment and replicated three times. Prior to planting, a well-cured poultry manure was applied. The three manure levels served as the sub-plots to the tillage system, which served as the main plots. The sub-sub-plot involved carrot cultivars. Each plot had 15 holes drilled at an 18 cm interval, each with an amount of seed afterwards reduced to two stands per hole. Roots were harvested three months (90 days) after planting. Two harvested roots from the two varieties of carrots with their corresponding manure levels for each tillage system were selected for the laboratory experiment. The laboratory experiment was laid out in a 2 × 2 × 3 factorial in Completely randomized design (CRD) with three replications, which gave rise to 36 samples. Tests for the mineral and vitamin content of the harvested roots were conducted using the standard methods.

Laboratory Analysis of the Harvested Roots

The harvested roots were appropriately cleaned, chopped, and mixed using a blender (LB20 EG/ES-Waring- Japan) to homogenize them and determine minerals and vitamins.

Determination of minerals in the carrots

Calcium, copper, phosphorous, iron, magnesium, Potassium, Selenium and zinc contents of the carrots were determined as described by AOAC,[16] ,Chukwudi *et al.* [17] Two grams of homogenized carrot sample was weighed into a crucible, reduced to ash in a muffle furnace (Model number: NUC 022141, Heraeus, Germany) and then dissolved in five millilitres of 30 % hydrochloric acid (HCl) (Assay (37.5%), Analar grade, Guagdan Guanghua Chemical Factory Co ltd, China). The dissolved ash solution was made up to 50 ml, filtered and then read directly in the Atomic absorption spectrophotometer (Model number: AA 7000, Shimadzu, Japan).

Determination of beta-carotene content of the carrots

The determination of the beta-carotene in the carrots was carried out as described by Amorim-Carrilho.[18] One gram of the homogenized carrot sample was weighed into a test tube, and the proteins precipitated with 3ml of absolute ethanol (Assay (99.5%), JHD, Gunsgdong Guandgua Chemical Factory Co ltd, China) before the extraction of pro-vitamin A with 5 ml of heptane. The test tube containing this was stirred vigorously for 5 min with a magnetic stirrer (Model L21, Labinco, Netherland). After that, the heptane layer was separated, poured into a UV- spectrophotometer cuvette (Model number: UV-7504, Cole-Parmer, USA) and read at 450 nm against a reagent blank. The standard beta-carotene was also prepared like the test carrot sample above, read at 450 nm wavelength, and the pro-vitamin A was calculated.

Analysis of Vitamin C

This determination was done as described by Olokodana.[19] One gram of the homogenized carrot sample was weighed into a 10 ml volumetric flask, added 2.5 ml of 20% meta-phosphoric acid (Assay (60%) Trust Chemical Laboratories, China) as stabilizing agent and diluted to the volume with distilled water. One ml of the solution was pipetted into a small flask, and 0.25 ml of acetone was added (Assay (95%), Merck, Germany). This was filtered, and the absorbance was read in a UV-spectrophotometer (Model number: UV-7504, Cole-Parmer, USA) at a wavelength of 264 nm against a reagent blank. The concentration of vitamin C was calculated from the standard ascorbic acid prepared the same way as the test carrot sample.

Statistical Analysis

Data collected were subjected to analysis of variance in CRD using GenStat Discovery 12.1 edition, and the treatment means were compared using F-LSD at a 5% probability level as outlined by Obi.[20]

Results and Discussion

The mineral content of carrots, as influenced by tillage, poultry manure, and variety, is presented in Table 1. Tillage and variety did not vary significantly ($p > 0.05$) in all the minerals determined, but significant variation among poultry manure levels was observed with respect to the zinc content of the roots. The Bed tillage had higher contents of calcium (Ca = 23.3 mg/100 g), copper (Cu = 3 g/kg), iron (Fe = 218 g/kg), potassium (K = 6.8 mg/100 g), magnesium (Mg = 4.4%), selenium (Se = 10.2 g/kg), and zinc (Zn = 23.9 mg/100 g) when compared with the Ridge tillage system. Tillage practices can impact soil structure, nutrient availability, and microbial activity, subsequently affecting crop nutrient uptake and accumulation.[10] The present study, which revealed a better response of bed over ridge tillage system on the nutrient accumulation in carrot roots, did not prove true with a previous study, where carrots grown on a Ridge showed a tendency to produce higher yield metrics, proof of higher efficiency in mineral absorption and accumulation in the roots.[11] Previously, a study also reported higher assimilation and accumulation of some macro elements (Nitrogen, Phosphorus, Potassium, Calcium, and Magnesium) in carrot roots planted on the bed system of tillage than those harvested from ridge and furrow systems of cultivation.[12]

The same Table 1 revealed that the mineral content was dose-dependent; the higher the manure level, the more the accumulation of these minerals: Fe (200 g/kg), phosphorus (P =23.7 mg/100 g), and Zn (26.5 mg/100 g). However, 5 t/ha had higher contents of Ca (24.9 mg/100 g), Cu (3 g/kg), K (6.8 mg/100 g), Mg (4.6%), and Se (9.4 g/kg) while unfertilized plots had the lowest content of all the elements considered except for P (19.4 mg/100 g) where it recorded higher mean value than 5 t/ha (17.7 mg/100 g). The soil microbes that depended on organic carbon as a source of energy for mineralization may have generated many organic acids at higher manure rates that decreased soil pH, thereby making some microelements readily available for absorption; the abundance and assimilation may have accounted for the high iron and other micro mineral content at a higher manure dose.[8]

Table 1 revealed also that these minerals: Fe (209 g/kg), K (6.6 mg/100 g), P (21.3 mg/100 g), and Zn (23.6 mg/100 g) were higher in Kurado variety while Touchon mega (Tmega) had higher content of Ca (23.7 mg/100 g), Cu (2.9 g/kg), Mg (4.5%), and Se (9.3 g/kg). Different carrot varieties exhibit variations in their genetic makeup, resulting in varying levels of minerals and vitamins. These variations among the carrot genotypes could suggest the superiority of one over others in the type and level of accumulation of these mineral elements in their roots. Genotypic differences concerning biochemical content accumulation in

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carrot roots were reported in previous studies where the Carrot Touchon variety had a higher flavonoid and tannin content than other varieties considered.[7] New Kuroda and Madona varieties outperformed other varieties used in the same study concerning nutrient content accumulation,[4] thus suggesting superiority over others in their genetic identity. Previous studies noted valuable contributions to quality health by carrot varieties with higher nutritional contents.[8]

The mineral content of the harvested carrot roots, as influenced by treatment interactions, is presented in Table 2. It was observed among Tillage × Manure interaction that there were no significant ($p > 0.05$) variations in all the mineral contents considered. However, Bed × 10 t/ha and Ridge × 10 t/ha interactions had higher Ca (25.7 mg/100 g), Cu (3.3 g/kg), Fe (225 g/kg), Mg (5.1%) and P (27.5 g/kg), Zn (27.9 mg/100 g) contents respectively than the other interactions. In contrast, Bed × 5 t/ha interaction had a higher content of Se (11.7 g/kg) than the rest of the treatment combinations. The Bed system and Ridge system, with the application of poultry manure at a rate of 10 t/ha, each generally led to higher levels of Calcium, copper, Iron, Magnesium, Phosphorus and Zinc in carrots. The application of organic fertilizer can improve the soil's mineral composition, which in turn helps plants absorb more nutrients from the soil and increase its constituent parts.[10] A significant ($p < 0.05$) variation among the tillage × variety interactions was observed only in Mg content. Bed × Kurado (4.7%) and Ridge × Tmega (4.7%) interactions were statistically similar in response and accumulated higher Mg content than the other interactions. It was observed that Kurado planted on Bed tillage system had higher content of Cu (3.1 g/kg), Fe (245 g/kg), K (6.9 mg/100 g), and Zn (24.5 mg/100 g), Bed × Tmega interaction had higher Ca (24 mg/100 g) and Se (10.8 g/kg) while Kurado variety planted on Ridge system of tillage had higher content of P (24.2 g/kg) than the other treatment interactions. A significant ($p < 0.05$) variation among the variety × manure interactions was observed only in the Cu content of the carrot roots. Kurado treated with 5 t/ha (3.5 g/kg) had higher Cu content than the other interactions. In contrast, the Kurado variety that received no manure treatment had the lowest value of Cu (1.8 g/kg) content. Furthermore, Kurado that received 5 t/ha had a higher content of Fe (223 g/kg), K (6.9 mg/100 g), Kurado × 10 t/ha interaction had higher P (24.6 g/kg), Tmega × 5 t/ha interaction had higher Mg (4.7%), Se (10.8 g/kg) while Tmega treated with 10 t/ha of poultry manure had higher content of Ca (26.9 mg/100 g) and Zn (27.2 mg/100 g) than the other treatment interactions (Table 2). It was reported that variety and fertilizer interaction impacted carrots' nutrient assimilation and accumulation.[4]

Table 1: Mineral contents of carrot roots as influenced by Tillage, Poultry manure and Variety

Tilage System	**Ca (mg/100 g)**	**Cu (g/kg)**	**Fe (g/kg)**	**K (mg/100 g)**	**Mg (%)**	**P (g/kg)**	**Se (g/kg)**	**Zn (mg/100 g)**
Bed	23.30	3.00	218.00	6.80	4.40	18.50	10.20	23.90
Ridge	20.90	2.60	174.00	6.30	4.10	22.10	7.40	22.20
F-LSD$_{(0.05)}$	NS	NS	NS	NS	NS	NS	NS	NS
Poultry Manure								
0 t/ha	19.20	2.40	191.00	6.30	4.00	19.40	8.20	19.80
5 t/ha	24.90	3.00	196.00	6.80	4.60	17.70	9.40	23.10
10 t/ha	22.30	2.90	200.00	6.50	4.20	23.70	8.70	26.50
F-LSD$_{(0.05)}$	NS	NS	NS	NS	NS	NS	NS	3.42
Variety								
Kurado	20.50	2.80	209.00	6.60	4.10	21.30	8.20	23.60
Touchon Mega	23.70	2.90	183.00	6.50	4.50	19.30	9.30	22.70
F-LSD$_{(0.05)}$	NS	NS	NS	NS	NS	NS	NS	NS

Ca = calcium, Cu = cupper, Fe = Iron, K = Potassium, Mg = Magnesium, P = phosphorus, Se = selenium,
NS = not significant, F-LSD = , Fishers least significant difference

Table 2: Mineral content of carrot roots as influenced by the interaction of tillage, poultry manure and variety

Tillage	**Manure**	**Ca (mg/100g)**	**Cu (g/kg)**	**Fe (g/kg)**	**K (mg/100g)**	**Mg (%)**	**P (g/kg)**	**Se (g/kg)**	**Zn (mg/100g)**
Bed	0 t/ha	19.60	2.70	221.00	6.50	3.80	18.40	9.30	22.70
Bed	5 t/ha	24.40	3.00	206.00	6.90	4.40	17.00	11.70	24.10
Bed	10 t/ha	25.70	3.30	226.00	6.90	5.10	19.90	9.50	25.10
Ridge	0 t/ha	18.70	2.10	161.00	6.20	4.30	20.40	7.00	16.80
Ridge	5 t/ha	25.30	3.10	187.00	6.60	4.70	18.40	7.20	22.10
Ridge	10 t/ha	18.80	2.60	173.00	6.00	3.24	27.50	8.00	27.90
F-LSD$_{(0.05)}$		NS	NS	NS	NS	NS	NS	NS	NS
Tillage	Variety								
Bed	Kurado	22.50	3.10	245.00	6.90	4.70	18.30	9.60	24.50
Bed	Touchon Mega	24.00	2.90	191.00	6.60	4.20	18.90	10.80	23.50
Ridge	Kurado	18.50	2.40	172.00	6.30	3.40	24.20	6.90	22.70

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Ridge	Touchon Mega	23.40	2.80	175.00	6.30	4.70	19.90	7.90	21.90
F-LSD$_{(0.05)}$		NS	NS	NS	NS	2.40	NS	NS	NS
Variety	Manure								
Kurado	0 t/ha	17.90	1.80	216.00	6.80	3.60	19.40	8.70	19.80
Kurado	5 t/ha	25.90	3.50	223.00	6.90	4.40	19.80	8.00	25.00
Kurado	10 t/ha	17.70	2.90	186.00	6.20	4.10	24.60	8.00	25.80
Touchon Mega	0 t/ha	20.50	3.00	167.00	5.80	4.40	19.50	7.70	19.70
Touchon Mega	5 t/ha	23.90	2.70	170.00	6.70	4.70	15.60	10.80	21.20
Touchon Mega	10 t/ha	26.90	2.90	213.00	6.80	4.20	22.90	9.50	27.20
F-LSD$_{(0.05)}$		NS	1.17	NS	NS	NS	NS	NS	NS

Ca= calcium, Cu= cupper, Fe= Iron, K= Potassium, Mg= Magnesium, P= phosphorus, Se= selenium,
NS = not significant, F-LSD= Fishers least significant difference.

Table 3: Vitamin content of carrot roots as influenced by variety, manure and Tillage

Tilage System	VIT A(B-carotene) (mg/100g)	VIT C (Ascorbic acid) (mg/100g)
Bed	13.40	29.80
Ridge	10.80	24.30
F-LSD$_{(0.05)}$	NS	NS
Manure		
0 t/ha	9.60	20.30
5 t/ha	8.80	22.20
10 t/ha	18.00	38.80
F-LSD$_{(0.05)}$	NS	NS
Variety		
Kurado	14.50	29.80
Touchon Mega	9.80	24.40
F-LSD$_{(0.05)}$	NS	NS

Vit = Vitamin, NS = not significant, F-LSD= Fishers least significant difference

The vitamin content of carrot roots, as influenced by tillage, poultry manure and variety, is presented in Table 3. The table revealed no significant ($p > 0.05$) differences in the Vitamin content of the roots. It was observed that the Bed tillage system recorded higher vitamin A (13.4 mg/100 g) and vitamin C (29.8 mg/100 g) than the Ridge tillage system, which had 10.8 mg/100 g and 24.3 mg/100, respectively. The roots treated with 10 t/ha had a higher Vitamin A (18 mg/100 g) value than the other manure treatments. The Vitamin C accumulation was dose-dependent. The highest manure rate (10 t/ha) had the highest mean value for Vitamin C (38.8 mg/100 g), while the unfertilized roots had the lowest value (20.3 mg/100 g). This agrees with the findings of Stefanson *et al*, [10] which concluded that applying organic manure at higher levels increased the vitamin contents of the carrot roots. Kipkosgei *et al*, [6] also reported that the beta carotene content increases with increasing fertilizers. Carrots consumed daily by raw or cooked humans are valued because they are a significant precursor of vitamin A in the body.[21] The Kurado variety had higher concentrations of Vitamin A (14.5 mg/100 g) and Vitamin C (29.8 mg/100 g) when compared with Tmega (Vitamin A = 9.8 mg/100 g, Vitamin C = 24.4 mg/100 g). Higher beta carotene and vitamin contents were found in the Kurado variety, although the comparison was with the Amazona variety .[22] This could be attributed to the distinct genetic constituent of the Kurado variety, thus giving it an edge over Tmega in assimilating and storing more of these referenced vitamins in the root. It was reported earlier that the different genetic identities of carrot cultivars were implicated seven to eleven times in the variations observed in the beta-carotene content of carrot.[23] The vitamin A concentration in Kurado (14.5 mg/100 g) approximately agreed with the range (15 mg/100 g – 38 mg/100 g) reported previously by Uguru *et al,*[13] Ibeto *et al.*[3] Carotenoids are essential micronutrients for human health;[2] their concentration may account for the biological and medicinal properties of carrots.[24]

The interaction effects of the Variety, Manure and Tillage systems on the vitamin contents of the carrot roots are presented in Table 4. There were no significant ($p > 0.05$) differences among the treatment interactions. It was observed that bed tillage × 10 t/ha manure rate had higher value in Vitamin A (23.9 mg/100 g) and Vitamin C (50.5 mg/100 g) content than the rest treatment combinations while Bed (18.3 mg/100 g) and Ridge (8.4 mg/100 g) treated with 5 t/ha each had the least value. Furthermore, the interaction between Bed tillage × Kurado had the highest value for Vitamin A (19.3 mg/100 g) and Vitamin C (31.8 mg/100 g) contents, while the lowest value was obtained with Bed × Tmega (7.8 mg/100 g) and Ridge × Tmega (20.9 mg/100 g) for Vitamin A and Vitamin C respectively. Table 4 further revealed that Kurado variety that was treated with 10 t/ha of poultry manure outperformed other treatment interactions with respect to Vitamin A (24.3 mg/100 g) and Vitamin C (43.5 mg/100 g) accumulation while Kurado × 5 t/ha (7.3 mg/100 g) and Tmega × 0 t/ha (16.3 mg/100 g) interactions, poorly performed in terms of Vitamin A and Vitamin C accumulation respectively. The nutritional composition of carrots can be influenced by various factors, such as soil fertility, crop management practices, and genetic variations.[12:25] The Kurado variety showed higher vitamin content compared with the Tmega variety. These findings indicated that careful selection of tillage practices, appropriate use of organic fertilizers, and choice of carrot variety could enhance carrot roots' vitamin content, thereby improving their nutritional value.

Conclusion

In summary, the study showed that some mineral and vitamin constituents were present in the carrot (*Daucus carota*) roots. The carrot varieties Kurado and Touchon Mega contain a considerable amount of the minerals and vitamins considered, and these bio-elements fall within the recommended rates for humans. It is important to note that Iron, Potassium, Phosphorus, Zinc, B-carotene (Vitamin A) and Ascorbic acid (vitamin C) were higher in the Kurado than in the Touchon mega variety. This offers Kurado a higher chance of improving human health and nutritional status. It is, therefore, advised that the Kurado carrot variety should be made part of the daily human meals. The outcome of this research gives an insight into the selection and genetic improvement of these two carrot genotypes. Application of 10 t/ha of poultry manure or a higher dose could be used in the production of carrots for the food and drug industries.

Based on the limitations of this research, the authors, therefore, make the following suggestions for further studies;

A study which will cover the minerals, vitamins, anti-nutrients and proximate contents of carrot roots as influenced by tillage, manure, and variety.

A further study should also be carried out to ascertain the absorption ability of carrot roots with other manure types.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

Table 4: Vitamin content of carrot roots as influenced by the interactions of variety, tillage and manure

Tillage	**Manure**	**VIT A(B-carotene) (mg/100g)**	**VIT C (Ascorbic acid) (mg/100g)**
Bed	0 t/ha	7.20	20.70
Bed	5 t/ha	9.20	18.30
Bed	10 t/ha	23.90	50.50
Ridge	0 t/ha	12.10	19.80
Ridge	5 t/ha	8.40	26.10
Ridge	10 t/ha	12.00	27.10
F-LSD$_{(0.05)}$		NS	NS
Tillage	Variety		
Bed	Kurado	19.00	31.80
Bed	Touchon Mega	7.80	27.90
Ridge	Kurado	9.90	27.80
Ridge	Touchon Mega	11.80	20.90
F-LSD$_{(0.05)}$		NS	NS
Variety	Manure		
Kurado	0 t/ha	11.80	24.20
Kurado	5 t/ha	7.30	21.70
Kurado	10 t/ha	24.30	43.50
Touchon Mega	0 t/ha	7.40	16.30
Touchon Mega	5 t/ha	10.20	22.70
Touchon Mega	10 t/ha	11.70	34.20
F-LSD$_{(0.05)}$		NS	NS

Vit = Vitamin, NS = not significant, F-LSD= Fishers least significant difference.

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