



INFLUENCE OF ORGANIC AND INORGANIC NUTRIENT SOURCES ON THE PROXIMATE COMPOSITION OF SELECTED *MALVACEAE* VEGETABLES

¹Elumalero G. O, ^{2*}Akinbile, O.O, ³Amujoyegbe B. J, ⁴Odeniran A.F, ¹Ogunbela, A. A, ¹Apenah M. O, ²Samuel, A.M, ⁵Akinremi, T.I.

¹Forestry Research Institute of Nigeria, Jericho, Ibadan, Oyo State.

²Department of Soil Resources Management, University of Ibadan

³Obafemi Awolowo University, Ile-Ife, Osun State.

⁴Network of Organic Agriculture Researchers in Africa (NOARA)

⁵Department of Nutrition and Dietetics, Ladoké Akintola University of Technology, Ogbomoso

***Corresponding Author's Email:** olamideodunayoakinbile@yahoo.com, **GSM:** +2347062188613

ABSTRACT

The experiment was carried out at Obafemi Awolowo University Teaching and Research farm located at longitude 4°33' E and latitude 7°28' N, 224 meters above sea level, laid out in a split block design with three replicates including the organic, inorganic (NPK 20:10:10) and control plot. Crude fibre (5.92%) and Ether (3.79%) content of the organic fertilizer were significantly different from the NPK 20:10:10 (5.27%; 4.17%) and control (4.53%; 3.97%). NPK 20:10:10 significantly influenced Ether content (4.17%) when compared to organic fertilizer (3.79%) and control (3.97%). The influence of the nutrient sources differs for each vegetable, ranging from the crude fibre, crude protein and ether content, which were the nutritional quality parameters assessed.

Keywords: Proximate, Composition, Organic, Nutrient, Inorganic, vegetables.

INTRODUCTION

A very vital component of Malvaceae vegetables is their fiber content, which is very important in human nutrition. The fibre content of the Malvaceae family is one of their vital constituent which makes them very important in human nutrition. Fibres lower the total and Low-Density Lipoprotein (LDL) cholesterol levels in the body, thereby reducing the risk of heart failure, it also regulates blood sugar, thus reducing the symptoms of metabolic syndromes and diabetes (Nweze *et al.*, 2021; Salvin, 2008; Spiller *et al.*, 2001). Fibres also speed the passage of food through the digestive system, thereby facilitating regular defecation. Furthermore, they add bulk to the stool which helps to alleviate constipation, and they balance intestinal pH and stimulate intestinal fermentation, thus reducing the risks of colorectal (Biswas *et al.*, 2022; Fotiadis *et al.*, 2008). The nature and amount of available soil nutrients are major determinants of the chemical composition of the plants growing in such soil. Nutrient source amendments affect the proximate content of plants, and thus very crucial to evaluate their effects on the proximate content (% crude fibre, % crude protein and % ether) of selected Malvaceae vegetables (Cotton, Jute/Ewedu, Roselle, Okra) that forms the bulk of what is being used for food security. Vegetables such as Okra, Corchorus, and Roselle are some of the crops that belong to the Malvaceae family and are rich in fibre content. These vegetables are grown for their various nutritional uses and economic gains for farmers both as sole cropping, in agroforestry or mixed cropping. In agroforestry, trees are not the only source of economic benefits. Crops cultivated in these systems also provide significant financial gains, particularly from the harvesting of leaves. For instance, leaves from plants like Okra, Roselle, Corchorus and Cotton are used in traditional medicine in Nigeria and can be consumed as vegetables in soups. Notably, the yield of these vegetables have consistently increased over the years (Maroyi *et al.*, 2024; FAOSTAT, 2012). Farmers apply nutrients to their crops only if their effect on crop yield is profitable (FAO, 2006). Nutrient sources involve both the organic and inorganic source of fertilizer and amendment that are necessary for plant growth and also their external supply and internal metabolism. This increases the supply of nitrogen to the plants, which in turn increases the number of leaves and photosynthetic activities and enhances physiological processes leading to the production of more assimilates which significantly increases the chemical composition of plants (Dubey *et al.*, 2021;



Amujoyegbe *et al.*, 2007). The effect of nutrient sources leads to a significant increase in plant height, number of fruiting, branches/plant, increased yield, and increased chemical composition of leaf and seed index (Singh *et al.*, 2023; Kumar *et al.*, 2018; EDICA, 2013).

Hence, an increase in the concentration of proximate compounds as a result of fertilizer application has been reported (Amujoyegbe *et al.*, 2007; Tolera *et al.*, 2006). Increased proximate composition of plants has been reported by researchers such as in Carbohydrates (Khafaga *et al.*, 2000), moisture content (Osuagwu and Edeoga, 2013), dry matter (Bolovic *et al.*, 2005) ash (Tolera *et al.*, 2006), crude proteins (Jacobs *et al.*, 2002; Springer *et al.*, 2005) crude fibre (Iqbal *et al.*, 1998; Akanbi *et al.*, 2007), crude fat (Elsheikh and Elzidany, 1997; Khafaga *et al.*, 2000; Akanbi *et al.*, 2007). However, it has also been reported that fertilizer treatment decreased the proximate content of plant quality: Carbohydrates (Jacobs *et al.*, 2002), dry matter (Khan *et al.*, 1999), crude fibre (Akanbi *et al.*, 2007), crude fat (Bouba *et al.*, 2012).

The concentration of chemical constituents of plants is determined by the nature and amount of nutrients available in the soil in which the plants are growing, thus fertilizer treatment affects the proximate content of the plants. Hence, the need to evaluate and document the effects of the application of different nutrient sources on the proximate content of these Malvaceae vegetables that form the bulk of that being used for food security, especially among the smallholder farmers in sole cropping or those engaged in agroforestry. Therefore, this study aimed to study the effect of applied nutrient sources on the proximate composition of the selected Malvaceae vegetables.

MATERIALS AND METHODS

Research Location

The field experiment was carried out during the early cropping season of 2013 at Obafemi Awolowo University Teaching and Research farm (OAU T&R), Ile-Ife which is located in longitude 4.33° E and latitude 7.28° N, 224 m above sea level. The soil textural class is sandy loam.

Experimental Layout and Cultivation Practices

Seeds of okra, cotton, jute and roselle were obtained from the teaching and research farm of O.A.U. Ile Ife. Planting was done on the 14th day of May 2013 in an intercropping pattern on ridges. Weeding was manually carried out on the 2nd, 4th, and 6th week of planting. Organic fertilizer in the form of decomposed bat droppings with 13% nitrogen was applied at the rate of 0.75 kg for the plot and NPK 20:10:10 as inorganic fertilizer was applied at the same rate, and the application of these nutrient sources was done two weeks after planting. This was done to ensure the crops are well established and hardened on the field to withstand abiotic and biotic shock. The experiment was laid out in a split block design with three replicates including the organic, inorganic and control which represents the main plot while the crops planted and treated with the nutrient sources (okra, cotton, roselle and corchorus) represents the subplot for the study. The total area of land used was 112.5 square meters or 15 m x 7.5 m with each plot having 7.5 m x 4 m.

Proximate Analysis.

The percentages of crude fibre, ether and crude protein were determined according to standard procedure by USFDA, 2004.

Ether Extract

The ether extract of a feed represents the fat and oil in the feed. Soxhlet apparatus is the equipment used for the determination of ether extract.

It consist of 3 major components

1. An extractor: comprising the thimble which holds the sample
2. Condenser: for cooling and condensing the ether vapour
3. 250ml flask

Procedure: about 150ml of an anhydrous diethyl ether (petroleum ether) of boiling point of 40-60°C is placed in the flask. 2-5g of the sample is weighed into a thimble and the thimble is plugged with cotton wool. The thimble with content is placed into the extractor; the ether in the flask is then heated. As the ether vapour reaches the condenser through the side arm of the extractor, it condenses to liquid form and drop back into the sample in the thimble, the ether soluble substances are dissolved and are



carried into solution through the siphon tube back into the flask. The extraction continues for at least 4 hrs. The thimble is removed and most of the solvent is distilled from the flask into the extractor. The flask is then disconnected and placed in an oven at 650C for 4 hours, cool in desiccator and weighed.

$$\% \text{Ether extract} = \frac{\text{wt of flask + extract} - \text{tare wt of flask} \times 100}{\text{wt of sample}}$$

Crude Fibre

The organic residue left after sequential extraction of feed with ether can be used to determine the crude fibre, however if a fresh sample is used, the fat in it could be extracted by adding petroleum ether, stir, allow it to settle and decant. Do this three times. The fat-free material is then transferred into a flask/beaker and 200mls of pre-heated 1.25% H₂SO₄ is added and the solution is gently boiled for about 30mins, maintaining constant volume of acid by the addition of hot water.

The buckner flask funnel fitted with whatman filter is pre-heated by pouring hot water into the funnel. The boiled acid sample mixture is then filtered hot through the funnel under sufficient suction. The residue is then washed several times with boiling water (until the residue is neutral to litmus paper) and transferred back into the beaker. Then 200mls of pre-heated 1.25% Na₂SO₄ is added and boiled for another 30mins. Filter under suction and wash thoroughly with hot water and twice with ethanol. The residue is dried at 650C for about 24hrs and weighed. The residue is transferred into a crucible and placed in muffle furnace (400-6000C) and ash for 4hrs, then cool in desiccator and weigh.

$$\% \text{Crude fibre} = \frac{\text{Dry wt of residue before ashing} - \text{wt of residue after ashing} \times 100}{\text{wt of sample}}$$

Crude Protein

Crude protein is determined by measuring the nitrogen content of the feed and multiplying factor of 6.25. This factor is based on the fact that most protein contains 16% nitrogen. Crude protein is determined by kjeldahl method. The method involves: Digestion, Distillation and Titration. Digestion: weigh about 2g of the sample into kjeldahl flask and add 25mls of concentrated sulphuric acid, 0.5g of copper sulphate, 5g of sodium sulphate and a speck of selenium tablet. Apply heat in a fume cupboard slowly at first to prevent undue frothing, continue to digest for 45mins until the digesta become clear pale green. Leave until completely cool and rapidly add 100mls of distilled water. Rinse the digestion flask 2-3 times and add the rinsing to the bulk. Distillation: Markham distillation apparatus is used for distillation. Steam up the distillation apparatus and add about 10mls of the digest into the apparatus via a funnel and allow it to boil. Add 10mls of sodium hydroxide from the measuring cylinder so that ammonia is not lost. Distil into 50mls of 2% boric acid containing screened methyl red indicator. Titration: the alkaline ammonium borate formed is titrated directly with 0.1N HCl. The titre value which is the volume of acid used is recorded.

The volume of acid used is fitted into the formula which becomes

$$\%N = \left(\frac{14 \times VA \times 0.1 \times w \times 100}{1000 \times 100} \right)$$

VA = volume of acid used

w= weight of sample

$$\% \text{crude protein} = \%N \times 6.25$$

Statistical Analysis

The data were subjected to analysis of variance (ANOVA) using a Statistical Analytical System (SAS) and the means were separated using Duncan's Multiple Range Test (DMRT) at P<0.05 significant level.

RESULTS AND DISCUSSION

The proximate content was influenced differently by the nutrient sources for different malvaceae vegetables as shown in Table 1 which is in agreement with the findings of Njira and Nabwami (2015), Vihotogbe (2013), Ashfaq *et al.* (2024) and Ahmed *et al.* (2022) as relates to the influence of nutrient sources to crop quality. The decomposed bat droppings performed best in

improving the crude fibre content of the crop and also greatly reduced the ether content of the crops. The inorganic nutrient source of NPK 20:10:10 and control were more influential in improving the crude protein. However, the NPK was not significantly different to the decomposed bat droppings for crude protein composition

Table 1: The effect of applied Nutrient Sources on the Proximate Composition of the Selected Malvaceae Vegetables

Nutrient sources	Crude fibre (%)	Crude protein (%)	Ether (%)
Control	4.53c ** (0.89)	21.98a** (0.95)	3.97b** (0.32)
Decomposed bat droppings	5.92a ** (0.90)	20.01b ** (1.71)	3.79c** (0.44)
NPK 20:10:10	5.27b ** (0.96)	21.00ab** (1.28)	4.17a** (0.42)

Means separated by different alphabets across columns are significantly different from each other at $P < 0.05$. Figures in bracket represents standard error of mean. Level of significance is represented by double asterisk (**) at $p < 0.001$.

Table 2 shows that Okra has higher crude fibre content as compared to the other crops with cotton, Roselle and Corchorus in that descending order. Cotton had more crude protein as influenced by the nutrient sources with no significant difference between Okra and Roselle crude protein content and Corchorus and Roselle showed no significant difference. The ether content of cotton was greatly improved to the other crops with Roselle, Corchorus and Okra in that decreasing order.

Table 2: Selected proximate composition of the Malvaceae Vegetable Leaves studied.

Crop	Crude fibre (%)	Crude protein (%)	Ether (%)
Cotton	6.82b** (0.54)	27.27a** (0.48)	6.15a** (0.14)
Corchorus	1.97d** (0.11)	18.11c** (0.61)	2.83d** (0.08)
Okra	9.33a** (0.06)	19.96b** (0.44)	3.32c** (0.14)
Roselle	2.84c** (0.14)	18.64bc** (1.65)	3.61b** (0.07)

Means separated by different alphabets across column are significantly different from each other at probability level $P < 0.05$. Figures in bracket represents standard error of mean. Level of significance (LS) is represented by double asterick (**) at $p < 0.001$.

Figure 1 shows the crop nutrient interaction, highlighting how each crop reacted to the nutrient application. It shows that the decomposed bat droppings as a form of organic nutrient source had increases the crude fibre content most, across all the tested crops followed by NPK 20:10:10 with the control being the least.

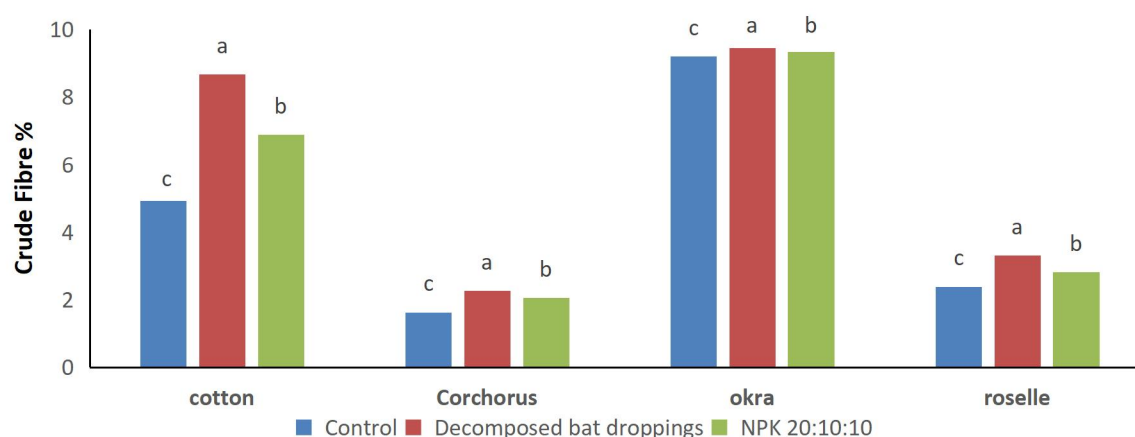


Figure 1: Effect of Nutrient sources amendment on the Crude Fibre content of selected Malvaceae Vegetables

Figure 2 highlights that crude protein shows that the nutrient sources behaved differently as influencing the test crops even though they belong to the same Malvaceae family. Organic nutrient source influenced more crude protein for cotton whereas the content of Corchorus was more increased by the inorganic nutrient source while control of no application influenced the crude protein content of Roselle more than all other nutrient sources.

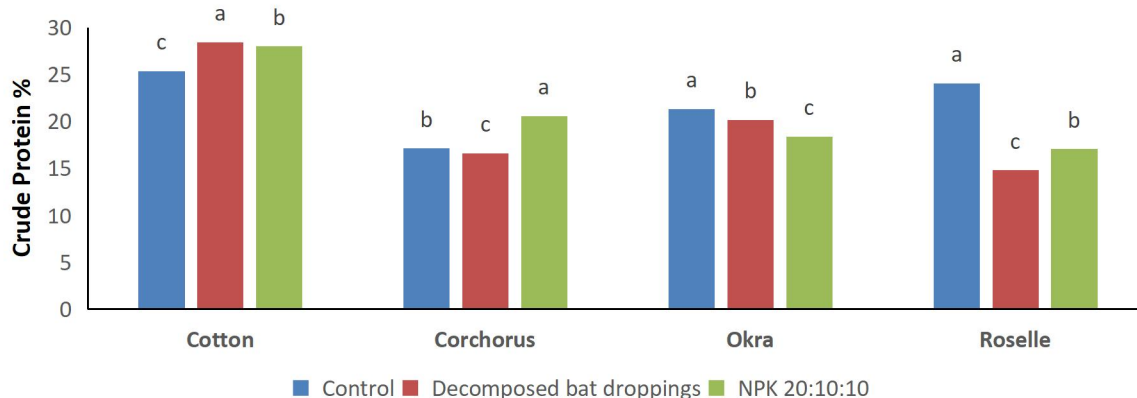


Figure 2: Effect of Nutrient sources amendment on the Crude Protein content of selected Malvaceae Vegetables

The ether content in Figure 3 also shows that the Malvaceae vegetables tested, responded differently to nutrient source applied with inorganic nutrient source increasing the ether content of cotton, Corchorus and okra more than the organic and the control. However, for okra control and inorganic nutrient source performed better than the organic nutrient source.. However, Roselle showed a different trend to others with the control performing better in increasing the ether content compared to other nutrient sources. The ether content being a fat constituent might be carefully checked as regards the influence of the organic nutrient source as it reduces the fat content of the crops except in Roselle where the inorganic nutrient source (NPK 20:10:10) had the most effect in lowering the fat content.

This also further proves and agrees with the findings of Fracchiolla *et al.* (2021) and Horta and Cameiro (2021) that nutrient source amendment behaves and influences crops differently as regards their quality parameter as shown in the Malvaceae vegetables. Furthermore, this study also shows that there are genuine differences in the nutrient content of crops treated with organic, inorganic and control (no treatment) which is essential for optimal nutrient use efficiency in plant nutrition for food security (Cheraghi *et al.* 2023).

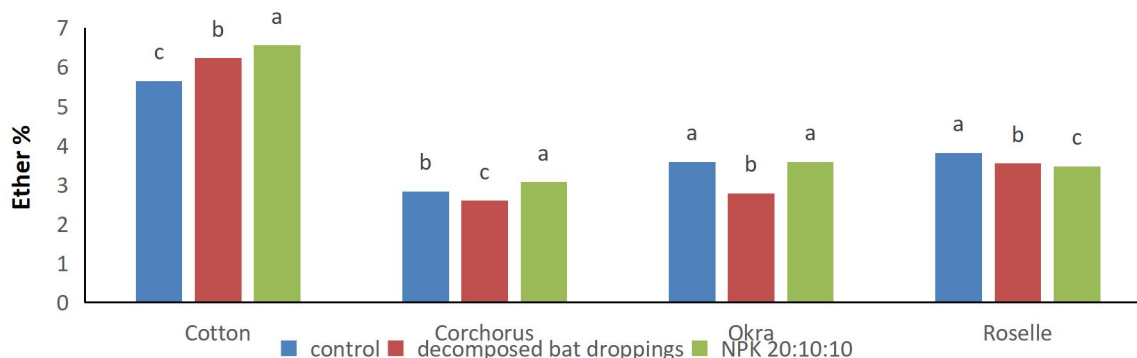


Figure 3: Effect of Nutrient sources amendment on the Ether content of selected Malvaceae Vegetables



CONCLUSION AND RECOMMENDATION

Nutrient source amendment influenced the proximate component of the selected Malvaceae vegetables. However, the influence of the nutrient sources differs for each leaf of the Malvaceae vegetables ranging from the crude fibre, crude protein and ether content which were the quality parameters assessed. Nutrient sources should be applied and amended into the soil based on individual vegetables and nutritional needs targeted. More organic sources should be applied and further assessed as it has an overall advantage as compared to the inorganic source and control when it comes to human nutrition, food quality, systems and livelihood security. This can be adapted to farming systems such as alley cropping, agroforestry or sole cropping systems.

REFERENCES

- Ahmed, N., Zhang, B., Chachar, Z., Li, J., Xiao, G., Wang, Q., Hayat, F., Deng, L., Bozdar, B., & Tu, P. (2024). Micronutrients and their effects on horticultural crop quality, productivity and sustainability. *Scientia Horticulturae*, **32**(3):112-121.
- Akanbi, W.B., Adeboye, C.O., Togun, A.O., Ogunrinde, J.O., Adeyeye, S.A., Akinfasoye, J.A and Olaniran, O.A., (2007). Growth, Herbage and Seed yield and Quality of *Telfaria Occidentalis*, as influenced by cassava peel compost and mineral fertilizer. *Journal of Agriculture*; **2**: 588-595.
- Amujoyegbe, B.J., Opabode, J.T., and Olayinka, A., (2007). Effect of organic and inorganic fertilizers on yield and chlorophyll content of maize (*Zea mays* L.) and sorghum (*Sorghum bicolor* L.) (Moench). *Africa journal of biotechnology*; **6**: 1869-1873.
- Ashfaq, A., Khan, Z. I., Arif, M., Abbas, G., Abbas, T., Gatasheh, M. K., Shaffique, S., & Shah, A. A. (2024). The proximate composition of vegetables enriched by incorporation of municipal solid waste into fertilizers and its impacts on environment and human health. *BMC Plant Biology*, **24**(1): 887- 894.
- Biswas, V., Praveen, A., Marisetti, A. L., Sharma, A., Kumar, V., Sahu, S. K., & Tewari, D. (2022). A mechanistic overview on impact of dietary Fibres on gut microbiota and its association with Colon Cancer. *Dietetics*, **1**(3): 182-202.
- Bolovic, B.M., Stolavic, J., and Markovic, A., (2005). Effects of fertilization on chloroplast pigment content, leaf surface and dry matter weight in some Wheat cultivars. *ACTA Agricultural Series* **10**: 29-37.
- Bouba, A. A., Njintang, N. Y., Foyet, H. S., Scher, J., Montet, D., and Mbofung, C. M. F. (2012). Proximate composition, mineral and vitamin content of some wild plants used as spices in Cameroon. *Food and Nutrition Sciences*, **3**: 423 – 432.
- Cheraghi, M., Moteszarezhadeh, B., Alikhani, H. A., & Mousavi, S. M. (2023). Optimal management of plant nutrition in tomato (*Lycopersicon esculent* Mill) by using biologic, organic and inorganic fertilizers. *Journal of Plant Nutrition*, **46**(8): 1560-1579.
- Dubey, R. S., Srivastava, R. K., & Pessarakli, M. (2021). Physiological mechanisms of nitrogen absorption and assimilation in plants under stressful conditions. In *Handbook of plant and crop physiology* (pp. 579-616). CRC Press.
- EDICA (2013). Egyptian Documentation and Information Center for Agriculture (accessed March 4, 2022).
- Elsheikh, E.A.E, and Elzidany, A.A., (1997). Effect of Rhizobium, organic and chemical fertilizers on proximate and chemical fertilizers on proximate composition, in vitro protein digestibility, tannin and sulphur content of faba beans. *Food Chemistry* **59**: 41-45.
- Epstein, E., (1992). Mineral nutrition of plant; Principles and perspectives. (Accessed December 10, 2021).
- FAO, (2006). Plant nutrition for food security. A guide for integrated nutrient management. FAO fertilizer and plant nutrition bulletin, vol. 16: ISBN 92-5-105490-8
- FAOSTAT, (2012). Statistical database of the Food and Agriculture Organization of the United Nations. FAO, Rome, Italy. <http://faostat.fao.org/>



- Fotiadis, C.L., Stoidis, B.G., Spyroulous and E.D. Zografos, (2008). Rule of probiotics and symbiotics in chemoprevention of Colorectal Cancer. *World Journal of Gastroenterology*; 14: 6453-6457.
- Fracchiolla, M., Renna, M., Durante, M., Mita, G., Serio, F., and Cazzato, E., (2021). Cover crops and manure combined with commercial fertilizers differently affect yield and quality of processing tomato (*Solanum lycopersicum* L.) organically grown in Puglia. *Agriculture* 11(8): 757 - 768.
- Horta, C., & Carneiro, J. P. (2021). Use of digestate as organic amendment and source of nitrogen to vegetable crops. *Applied Sciences*, 12(1): 248 - 256.
- Jacobs, J.L., McKenzie, F.R., and Keamy, G.A., (2002). Nitrogen fertilizer effects on nutritive characteristics of perennial Rye grasses during late autumn and mid and late winter in western Victoria. *Australian Journal of Experimental Agriculture*, 412; 541-548.
- Khafaga, E.R., Abed, A.M., Agamy, R.A., (2000). Effect of some fertilizers and growth regulators on botanical characters and yield of *Cotula cinerea* Del. *Annual Agricultural Science, Matachtohor*, 38: 1949-1982.
- Kumar, M., & Chaudhary, V. (2018). Effect of integrated sources of nutrients on growth, flowering, yield and soil quality of floricultural crops: A review. *International Journal of Current Microbiology and Applied Sciences*, 7(3): 2373-2404.
- Maroyi, A., Adeogun, O. O., & Mapaya, R. J. (2024). Exploring the Potentials of Underutilized Leafy Vegetable *Corchorus olitorius* L. In *Food Security and Nutrition* (pp. 117-141). CRC Press.
- Manyanwu, G.J., Chakoma, C., Sibanda, S., Mutisi, C., and Chakoma, I.C., (2003). The effect of harvesting interval on Herbage yield and nutritive value of Napier grass and hybrid pennies tums. *Asian- Australian Journal of Science*; 16: 996-1002.
- Myers, R.L., (1998). Nitrogen fertilizer effect on grain Amaranth. *Agronomy Journal*, 90: 597-602.
- National Research Council, (2006). 'Okra', Lost crops of Africa; Volume II (accessed December 10, 2021).
- Njira K.O.W., and Nabwami, J., (2015). A review of Effects of Nutrient Elements on Crop Quality. *African Journal of Food, Agriculture, Nutrition and Development*, 15(1): 7-15.
- Nweze, C. C., Nebechukwu, E. W., & Bawa, M. Y. (2021). Dietary fiber and risk of coronary heart diseases. *GSC Advanced Research and Reviews*, 9(3): 001-009.
- Osuagwu G.G.E and Edeoga H.O, (2013). Influence of NPK Inorganic Fertilizer Treatment on the Proximate Composition of the Leaves of *Ocimum gratissimum* (L.) and *Gongrenema latifolium* (Benth). *Pakistan Journal of Biological Sciences*, 16: 372-378.
- Peoples, A.D., Lochmiller, R.L. Lessie, D.M.J., and Engle, D.M., (1994). Production and nutritional quality of western ragweed seed in response to fertilization. *Journal of Range Management*, 47: 467- 469.
- Salvin, J.L., (2008). Position of the American Dietetic Association; Health implication of Dietary fiber. *Journal of America Dietetic Association*, 108; 1716-1731.
- Singh, N. U., Venkatachalapathi, V., Amrutha, T. G., Naveen, D. V., & Reddy, M. V. (2023). Crop Growth, Yield Attributes, Yield and Quality of Chia (*Salvia hispanica* L.) as Influenced by Spacing and Fertilizer Levels. *International Journal of Environment and Climate Change*, 13(10): 1585-1597.
- Sossa-Vihotogbe A.N.C, Anihouvi B.V., Akissoe H.N., Amadji L.G., and Hounhouigan D.J., (2013). Effect of organic and mineral fertilization on proximate composition of three leafy vegetables harvested at different periods. *International Journal of Biological and Chemical Sciences* 7(1): 271-286.
- Spiller, G.A., Woods, M.N., and Gorbach, S.L., (2001). Influence of fibre on the ecology of the intestinal flora; Hand book of Dietary Fiber in Human Nutrition, Third edition; Spiller (Edition) CRC Press, New York, USA, page 709.
- Springer, T.L., Taliaferro, C.M., and Hattey J.A, (2005). Nitrogen source and rate effect on the production of buffalo grass forage grown with irrigation. *Crop Science Journal*, 45: 668- 672.



- Tolera, A., Kindane, A., and Tesfamarian, W., (2006). The effect of Nitrogen fertilization and cutting age on dry matter yield and protein content of Rhodes grass at Awasa, Southern Ethiopia. *Journal of Tropical Science*, **46**: 87-91.
- USFDA, (2004). United States Food and Drug Administration, Quality health claims subject to enforcement Discretion, Docket No. 2004Q-0201.