



## Nutritional and Functional Properties of Guava Leaf Tea Supplemented with Moringa Leaf and Ginger Powder

\*<sup>1</sup>Yusuf, A. B., <sup>2</sup>Yahaya, T. O., <sup>3</sup>Bichi, S. A. and <sup>1</sup>Sahabi, M. A.

<sup>1</sup>Department of Biochemistry and Molecular Biology, Federal University Birnin Kebbi, Kebbi State, Nigeria

<sup>2</sup>Department of Biology, Federal University, Birnin Kebbi, Kebbi State, Nigeria

<sup>3</sup>Department of Biochemistry, Kano University of Science and Technology, Nigeria

### ABSTRACT

Herbal teas are receiving increasing attention from consumers because of their perceived nutritional and health benefits. Current study evaluated the formulation of guava leaf teas supplemented with *Moringa oleifera* and dry ginger powder as supporting and activating herbs respectively. The formulated herbal combinations were packed as dip tea bags designated M<sub>1</sub> and M<sub>2</sub>. Nutritional composition, functional properties and anti-nutritional factors were investigated using standard analytical methods of Association of Official Analytical chemist. Data was analyzed by ANOVA and results expressed as mean and standard deviation. Result of proximate composition indicates that ash and moisture content were within Association of Southeast Asian Nations (ASEAN) recommended standard. The result also revealed that the formulations contain appreciable amount of all essential amino acids. Functional properties indicate that bulk density range from (0.39 - 0.36 g/cm<sup>3</sup>), swelling index (2.8 - 3.7 ml/g), reconstitution index (6.6 - 6.8 g/ml), water absorption capacity (83.52 - 89.65 ml/g) and pH (6.11- 6.22). Selected micro nutrient estimated suggested that the composite blends are good sources of minerals like Zn, Ca and Fe which are of public health importance. Based on the results of this study, it can be concluded that guava leaf tea supplemented with moringa and ginger are good reservoir of macro and micro-nutrients with potential nutritional health benefits.

**Keywords:** Nutritional profile, Functional properties, Herbal tea and Guava leaves

### INTRODUCTION

Tea belongs to a rapidly expanding market of wellness beverages. In recent times, herbal teas are gaining popularity as consumers believe that they are natural, safe and can promote health (Akila *et al.*, 2018). Herbal teas are produced from green and dried herbs, flowers, fruits, leaves, seeds, barks and roots of medicinal plants and sold in a loose form or packed in bags. Herbal tea formulations are consumed in many parts of the world due to their therapeutic and healing properties (De-Heer *et al.*, 2013).

Guava (*Psidium guajava*) is a common fruit cultivated in many tropical and subtropical regions (Akila *et al.*, 2018). It has tough dark leaves that are opposite, simple, elliptic to oval and 5–15 centimeters long. Guava leaves contains quercetin, ferulic acid, protocatehuic acid, guavin B, asiatic acid and  $\beta$ -carotene that has been known to have antioxidant activity (Elixabet *et al.*, 2017). Literature report indicate the potential of guava leaf extract for the treatment of different ailments such as diabetes mellitus, cardiovascular diseases, cancer, and parasitic infections (Akila *et al.*, 2018). Ginger (*Zingiber officinale*) is a plant whose rhizome is rich in photochemical such as gingerols and shogaols which exhibit biological activities, ranging from anticancer, anti-oxidant, antimicrobial, anti-

inflammatory and anti-allergic to various central nervous system activities (Sutarno *et al.*, 1999; Ruchi *et al.*, 2015). Literature report suggests that the consumption of ginger may help in decreasing the risk of obesity, diabetes, and cardiovascular diseases. The study also reveals that ginger is beneficial in management of digestive problems, nausea, loss of appetite, and pain (Sutarno *et al.*, 1999).

*Moringa oleifera* is one of the world's most beneficial plant ever studied (Bleasel *et al.*, 2002). It belongs to the genus of flowering plant Moringaceae. The plant is commonly referred to as the drumstick tree. Singh, (2019) reported that the leaves of *Moringa oleifera* are highly nutritious. The leaves are rich in vitamins, minerals and other essential nutrients (Singh, 2019). When the leaves are kept in hot water for some time, they release an abundance of nutrient and antioxidant in the hot water; this liquid is now full of beneficial compounds that can promote energy and wellness (Sutarno *et al.*, 1999). Therefore, the current study is aimed at evaluating the nutritional profile, functional and sensory attributes of formulated herb teas using guava leaf supplemented with moringa and ginger powder as supporting and activating herbs.

\*Corresponding author. E-mail: [yusuf.abdulrahman@fubk.edu.ng](mailto:yusuf.abdulrahman@fubk.edu.ng)

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## MATERIALS AND METHODS

### Procurement of Ingredients and Authentication

The guava leaves and moringa were obtained from Huchi area of Kalgo Local Government, Kebbi State. The fresh ginger was purchased from local retailers in Kalgo Market, Kebbi State, Nigeria and all the materials were authenticated by the Department of Plant Science and Biotechnology, Kebbi State University of Science and Technology, Aliero, Nigeria.

### Sample Processing and the Composite Blends

Guava leaves, moringa and fresh ginger were sorted manually to remove damage ones. Then the leaves were washed to remove the dirt. The leaves were and soak in 1% normal saline (NaCl) for 5 minutes to get rid of microbes and the ginger was peeled and cut into thin slices. The samples leaves were shade dried to avoid loss of nutrients. Then the leaves and sliced ginger were grounded separately, sieved using 1mm pore sieve and stored in air tight container.

**Table 1:** Percentage Proportion of Ingredients in the Formulations

INGREDIENTS	M1(g)	M2(g)
Guava leaf	60	40
Moringa leaf	30	30
Ginger	10	30
<b>Total</b>	<b>100</b>	<b>100</b>

### Preparation of herbal tea infusions

The guava herbal tea was prepared by infusing tea bag which contained 3g of the composite blends in 150 ml boiling water for 3 minutes (Mallikarjuna *et al.*, 2008).

### Nutrient Analysis

Proximate composition was determined in triplicate using standard procedures of Association of Official Analytical Chemists (AOAC, 1999). The moisture content was determined by oven drying method. Crude protein was determined by Micro-Kjeldahl Method. Fat was determined by soxhlet extraction utilizing hexane as solvent. Crude fibre was determined by neutralization method (Method 962.09). Ash content was determined by dry ashing method of AOAC (Method 923.03) (AOAC, 1999).

### Carbohydrate Estimation

Carbohydrate content was determined by difference  
 (% Carbohydrate) = [100 - (% Protein + % Moisture + % Ash + % Fibre + % Crude Lipid)]  
 (Mathew *et al.*, 2015).

### Determination of amino acid profile of the tea composite blends

The amino acid profile was determined with Technicon Amino Acid Analyzer (TSM-1) using Norleucine as internal standard (Adeyeye and Afolabi, 2004; AOAC, 2005).

### Determination of Phytate

Phytic acid was determined as described by Wheeler and Ferrel (1971). Phytic acid was extracted from 3g of sample with 3% trichloroacetic acid by shaking at room temperature followed by high speed centrifugation. The phytic acid was estimated by multiplying the amount of phytate phosphorus by 3.55 based on the empirical formula  $C_6P_6O_{24}H_{18}$ .

### Determination of Oxalate

Oxalate content was determined according to AOAC (2005). 1g of sample was weighed into 100 ml conical flask. Then, 75 ml of 3mol/l  $H_2SO_4$  was added. The solution was stirred intermittently for 1 hour on magnetic stirrer and then filtered using Whatman No. 1 filter paper.

25 ml of the sample filtrate was collected and titrated against hot (80-90°C) 0.1 N  $KMnO_4$  to point where a faint pink color appear that persist for 30 seconds. Oxalate was calculated using 1ml 0.1 permanganate = 0.006303 g oxalate.

### pH Measurement

The method of Mathew *et al.* (2015) was used to determine the pH of the samples. The pH was measured by making a 10% (w/v) powdered suspension of each sample in distilled water. Each sample was mixed thoroughly in a beaker, and the pH was recorded with an electronic pH meter (Model PHN-850, Villeur-Banne, France).

### Bulk Density (BD)

The BD was determined according to the method of Okaka and Potter (1977). 20g sample was poured into a 100 ml graduated cylinder. The cylinder was tapped 40 to 50 times and the bulk density was calculated as weight per unit volume of sample.

$$BD = \frac{\text{Weight of sample (g)}}{\text{volume of sample (cm}^3\text{)}}$$

### Water Solubility Index (WSI)

WSI was measured according to the method of Anderson *et al.* (1996). 2.5g of supplemented tea sample was dispersed in 25 ml of distilled water taking care to break up any lumps using a glass rod. After 30 min of stirring, the dispersion was rinsed into tarred centrifuge tubes made up to 32.5ml and then centrifuged at 3000 rpm for 10 min. The supernatant was decanted and the weight of its solid content was determined after it had been evaporated to a constant weight. The WSI was calculated as:

$$WSI = \frac{\text{weight of the solid}}{\text{weight of dry powder sample}}$$

### Swelling Index (SI)

The swelling index (SI) was determined according to Ukpabi and Ndimele, (1990). For each sample, 4g was poured into 50ml measuring cylinders and leveled gently. Distilled water (40mls) was added to each sample and swirled. After allowing the solutions

to stand for 1hour, the volume was measured. The SI was calculated using:

$$SI = \frac{\text{change in volume of sample}}{\text{original weight of sample}}$$

#### Water Absorption Capacity (WAC)

The method of Onwuka (2005) was used to determine the water absorption capacity. Clean centrifuge tubes were weighed, 2g of dried grinded sample was dispersed into centrifuge with 20ml of distilled water and stirred with glass rod for 1minute. The tubes were centrifuged at 5000 rpm for 30 minutes. The volume of the supernatant was decanted and the tubes with its content were reweighed as water absorbed per gram of sample. The change in weight gives the water absorption capacity.

#### Reconstitution Index (RI)

From the ground sample, five grams were dissolved in 50 cm<sup>3</sup> of boiling water. The mixture was agitated for 90 seconds and was transferred into a 50cm<sup>3</sup> graduated cylinder and the volume of the sediment was recorded after settling for 30 minutes (Onwuka, 2005).

$$RI = \frac{\text{Volume of sediment}}{\text{Weight of sample}}$$

Selected mineral content (Iron, Zinc, Magnesium, Copper, Phosphorus, Potassium and Calcium) were determined by means of atomic absorption spectrophotometer (AAS) (Shimadzu AA-6200 Tokyo, Japan) according to AOAC method (AOAC, 1996).

#### Sensory Evaluation

Sensory evaluation was conducted by method of Amankwah *et al.* (2009). Quality attributes were evaluated by twenty-five semi trained panellist. The sessions were conducted one hour before lunch under adequate conditions of temperature, humidity and illumination. The panellists were required to score the herbal teas using 1 to 9-point hedonic scale.

#### Statistical Analysis

Results were presented as mean values and standard deviations. Data were subjected to analysis of variance (ANOVA) and a difference was considered significant at  $p < 0.05$ . Values were analyzed statistically using GraphPad PRISM version 6.05 software (Statcon, Witzenhausen, Germany).

### RESULTS AND DISCUSSION

The results of proximate composition of the formulated guava herbal teas at different blending ratio are given in Table 2.

**Table 2:** Percentage Proximate Composition of the Formulated herbal Teas

Parameters	M1 (%)	M2 (%)
Moisture	5.80 <sup>a</sup> ± 0.20	6.20 <sup>a</sup> ± 0.50
Ash	7.40 <sup>b</sup> ± 0.40	6.50 <sup>h</sup> ± 0.30
Lipid	2.70 <sup>f</sup> ± 0.10	3.80 <sup>f</sup> ± 0.20
Fiber	13.60 <sup>b</sup> ± 0.50	12.50 <sup>b</sup> ± 0.30
Crude protein	11.15 <sup>d</sup> ± 1.00	14.50 <sup>d</sup> ± 0.50
Carbohydrate	59.35 <sup>k</sup> ± 2.00	56.50 <sup>k</sup> ± 4.00

Values are mean ± standard deviation of triplicate determination, Values with the same superscript in the same row differ significantly at ( $P < 0.05$ ).

#### Determination of Selected Micronutrient content

Zinc, Iron, Calcium, Magnesium, and Sodium content of the formulated guava leaf teas are presented in Table 3 is a summary of the result of

selected micronutrient estimated in the sample under investigation. Calcium levels in all samples were slightly higher than the recommended values of ASEAN standard.

**Table 3:** Mineral Composition of the Formulated herbal Teas

Minerals	M1(mg/100g)	M2(mg/100g)
Na	112.50 <sup>a</sup> ± 0.50	55.00 <sup>a</sup> ± 1.00
K	729.33 <sup>b</sup> ± 1.10	610.00 <sup>b</sup> ± 1.00
Ca	595 <sup>c</sup> ± 0.05	574.54 <sup>c</sup> ± 0.05
Mg	203 <sup>d</sup> ± 0.40	201 <sup>d</sup> ± 0.10
P	6.13 <sup>e</sup> ± 0.30	5.36 <sup>e</sup> ± 0.36
Zn	5.30 <sup>m</sup> ± 0.30	5.90 <sup>m</sup> ± 0.50
Fe	47.90 <sup>g</sup> ± 0.20	36.00 <sup>g</sup> ± 0.10
Cu	0.91 <sup>f</sup> ± 0.01	1.60 <sup>f</sup> ± 0.20

Values are mean ± standard deviation of triplicate determination. Values with the same superscript in the same row differ significantly at  $P < 0.05$ .

The amino acids profile of the formulated composite blends of the guava leaf teas are presented in Table 4. All the essential amino acids were present in the formulations.

The result of functional properties of the composite blends of the guava herbal teas is presented in Table 5. The data reveals no significant difference between the functional properties of the formulations.

**Table 4:** Amino acids Compositions of the Formulated herbal Teas

Amino Acids	M1(mg/100g)	M2(mg/100g)
Arginine	13.70 <sup>b</sup> ± 0.30	15.50 <sup>b</sup> ± 0.50
Histidine	2.30 <sup>g</sup> ± 0.30	2.60 <sup>g</sup> ± 0.20
Isoleucine	3.00 <sup>h</sup> ± 0.20	3.60 <sup>h</sup> ± 0.60
Leucine	6.60 <sup>i</sup> ± 0.30	7.50 <sup>i</sup> ± 0.50
Lysine	1.50 <sup>k</sup> ± 0.10	1.70 <sup>k</sup> ± 0.20
Methionine	1.60 <sup>m</sup> ± 0.10	1.80 <sup>m</sup> ± 0.40
Phenylalanine	4.10 <sup>n</sup> ± 0.10	4.60 <sup>n</sup> ± 0.30
Threonine	2.10 <sup>r</sup> ± 0.10	2.40 <sup>r</sup> ± 0.30
Valine	3.60 <sup>s</sup> ± 1.00	4.10 <sup>s</sup> ± 0.10

Values are mean ± standard deviation of triplicate determination; Values with the same superscript in the same row did not differ significantly at  $P > 0.05$ .

**Table 5:** Functional Properties of the Formulated herbal Teas

Functional properties	M1	M2
pH	6.11 <sup>a</sup> ± 0.11	6.22 <sup>a</sup> ± 0.22
RI (g/ml)	6.60 <sup>b</sup> ± 0.30	6.80 <sup>b</sup> ± 0.20
BD (g/cm <sup>3</sup> )	0.39 <sup>c</sup> ± 0.05	0.36 <sup>c</sup> ± 0.01
WAC (ml/g)	83.52 <sup>d</sup> ± 0.20	89.65 <sup>d</sup> ± 0.05
SI (ml/g)	2.80 <sup>e</sup> ± 0.20	3.70 <sup>e</sup> ± 0.10
WET. (sec.)	77.00 <sup>f</sup> ± 3.00	81.00 <sup>f</sup> ± 5.00

Values are mean ± standard deviation of triplicate determination; Values with the same superscript in the same row did not differ significantly at ( $P > 0.05$ ). RI= Reconstitution Index, BD= Bulk Density, WAC= Water Absorption Capacity, SI= Swelling Index, WET= Wettability.

Table 6 presents phytate and oxalate contents of the formulated guava herbal teas. Oxalate content was found to be higher in M1 even though M1 recorded lower levels of phytate.

**Table 6:** Anti-nutritional factors of the Formulated herbal Teas

Anti-nutrients	M1(mg/g)	M2(mg/g)
Oxalate	6.57 <sup>h</sup> ± 0.30	5.36 <sup>h</sup> ± 0.20
Phytate	7.63 <sup>m</sup> ± 0.20	8.14 <sup>m</sup> ± 1.00

Values are mean ± standard deviation of triplicate determination, Values with the same superscript in the same row differ significantly at  $P < 0.05$ . Table 7 is a result of the organoleptic properties of the formulations as revealed by the panellists. The results

indicate that M1 was rated best in all the organoleptic properties evaluated. The scores for overall acceptability indicate that the products are highly accepted by the panellist.

**Table 7:** Sensory evaluation of Herbal Tea Formulations

PARAMETERS	M1	M2
Color	8.5 <sup>a</sup> ±0.5	7.8 <sup>a</sup> ±0.3
Flavour	7.6 <sup>b</sup> ±0.3	7.7 <sup>b</sup> ±0.2
Taste	8.2 <sup>c</sup> ±0.2	7.8 <sup>c</sup> ±0.4
Consistency	8.3 <sup>d</sup> ±0.3	8.1 <sup>d</sup> ±0.2
Overall acceptability	8.15 <sup>e</sup> ±0.1	7.85 <sup>e</sup> ±0.3

Values are mean ± standard deviation of triplicate determination, Values with the same superscript in the same row differ significantly at ( $P < 0.05$ ).

Table 8 presents a ranking system using nutritional, sensorial and functional properties that characterize

an appropriate complementary food. The two blends were ranked from 1 (most desirable) to 2 (least desirable). The blend yielding the lower score was considered to possess the most suitable nutritional and functional characteristics.

**Table 8:** Ranking of the Formulated Herbal Teas based on Nutritional and Functional Properties

PARAMETERS	M1	M2
Moisture	1	2
Fiber	1	2
BD	2	1
Carbohydrate	1	2
Oxalate	2	1
Phytate	1	2
Minerals	1	2
WAC	1	2
Swelling Index	1	2
Ash	1	2
Amino Acid	2	1
Overall acceptability	1	2
<b>TOTAL</b>	<b>15</b>	<b>21</b>

Most desirable (1) to least desirable (2)

## DISCUSSION

The proximate composition of the herb teas under investigation indicates that moisture content of the formulations was within standard recommended for tea products by Association of Southeast Asian Nations (ASEAN) and International Organization for Standardization (ISO). These values of moisture contents translate to good storage stability and shelf life; as higher moisture contents may encourage microbial growth and spoilage (Sanni and Oladapo, 2008).

There was significant difference ( $p < 0.05$ ) for ash content between the formulations. Even though values recorded were within ASEAN standard and similar to a previous study (Sotelo *et al.*, 2007). The values recorded for ash content may be attributed to inclusion of moringa in the ingredients which is a good reservoir of micronutrients (Singh, 2019). Ash content of food substances could be used as an index of mineral constituent of the food. Minerals play a vital role in many biochemical processes such as in optimal functioning of the nervous system, water, and electrolyte balance (Sanni and Oladapo, 2008; Singh, 2019).

The crude lipid was low in both samples. The low lipid content is not an anomaly and is in agreement with literature report (Lintas, 1992). The plants which constitute the ingredients of the composite blends have low lipid contents (Lintas, 1992). However, both samples have high fiber content which is not an aberration as some of the ingredients of the formulations are vegetables. Fiber plays a very crucial role in the human nutrition. Fiber is a component of food that cannot be digested and absorbed (Gordon, 1999). Therefore, it facilitates intestinal motility. Fiber adds bulk to fecal matter facilitating its passage and elimination from the digestive system (Gordon, 1999).

The protein content of the formulated teas is similar to values reported by Akila *et al.* (2018). The protein content may be attributed to moringa in the ingredients. The quantity and quality of protein is playing a crucial role in the diet. Proteins are essential constituents of all body tissues (Sanni and Oladapo, 2008). Similarly, both samples had high carbohydrate content which is essential for energy provision and prevention of depletion of body tissues.

The values of selected minerals indicate amount of potassium, sodium, calcium, and magnesium. These elements play a significant in electrolyte homeostasis and participate in biochemical reactions. Calcium and magnesium levels reported in the current study were higher than values reported by Richard *et al.* (2004). However, Richard *et al.* (2004) reported higher values of iron, zinc and copper. Earlier studies on humans have shown that optimal intakes of minerals can reduce individual's risk for several health problems and diseases (Mohammed and Sulaiman, 2009).

The results of functional properties indicate that while bulk density was higher in M1; reconstitution index, water absorption capacity, pH, and swelling index were higher in M2. There was no significant difference ( $p > 0.05$ ) in the swelling index between samples M1 and M2. Both samples recorded low swelling index. It is pertinent to note that a high swelling index implies that the more water would be required to prepare the tea infusions. Similarly, there was no significant difference ( $p > 0.05$ ) in the bulk density. Bulk density is a measure of heaviness of flour or powder food sample. Nutritionally and economically, lower bulk density is preferred for food samples (Afam-Anene and Ahiarakwem, 2014).

The results for the sensorial attributes of the formulations indicate that the composite blends differ in some sensorial attributes evaluated. Muhimbula *et al.* (2011) suggest that sensory evaluation is easy in its principle but its implementation in the field could be challenging particularly because of the literacy level of the panellist. It is pertinent to note that some processing techniques can improve some of the sensorial attributes.

Aroma is an integral part of taste and general acceptance of the food before it is put in the mouth. It is therefore an important parameter when testing acceptability of food sample (Muhimbula *et al.*, 2011). Taste is another an important parameter when evaluating sensory attribute of food. The product might be appealing but without good taste, such a product is likely to be unacceptable. Similarly, the colour or appearance of formulations is an important attribute in food choice and preference.

Plant based food contain numerous antinutrients which are secondary metabolites essential for their survival. These antinutrients can hinder the bioavailability of nutrients in the gastro-intestinal tract by binding chelating them. Phytic acid and oxalic acid are two prominent antinutrients found in plant based foods (Dahouenon-Ahoussi *et al.*, 2012). The result of phytate and oxalate content of the formulations is presented. While amount of Phytate is higher in M2, Oxalate was higher in M1

Phytic acid binds to mineral elements such as calcium, zinc, manganese, iron and magnesium to form complexes that are indigestible, thereby decreasing the bioavailability of these elements (Dahouenon-Ahoussi *et al.*, 2012). Oxalate is a salt formed from oxalic acid. A typical example is calcium oxalate which is widely distributed in plants.

Oxalate is an anti-nutrient which can bind minerals, such as calcium, magnesium, sodium, and potassium. This chemical combination results in the formation of oxalate salts. Oxalate is an anti-nutrient which under normal conditions is confined to separate compartments. However, when it is processed and/or digested, it comes in contact with the nutrients in the gastrointestinal tract. When released, oxalic acid binds with nutrients, rendering them inaccessible to the body. If food with excessive amounts of oxalic acid is consumed regularly, nutritional deficiencies are likely to occur, as well as severe irritation to the lining of the gut (Dahouenon-Ahoussi *et al.*, 2012).

## CONCLUSION

The current study established the chemical compositions and nutritional qualities of the formulated guava herbal teas. The result of the sensory evaluation as revealed by the panellists, point to acceptability of the formulated teas. Equally, the study has shown that the herb tea brewed from product M1 is more preferred in colour, flavour, overall acceptability and nutritional composition. Hence, a blend of guava leaf, moringa and ginger powder can produce herbal tea with appealing sensory attributes. Furthermore, it can be inferred that guava leaf tea supplemented with moringa and

ginger are reservoir of macro and micro-nutrients and may be an alternative to commercial tea from *Camellia sinensis*.

## REFERENCES

- Adeyeye, E. I. and Afolabi, E. O. (2004): Amino acid composition of three different types of land snails consumed in Nigeria. *Journal of Food Chemistry*, **85**: 535-539.
- Afam-Anene, A. and Ahiarakwem, Y. (2014). Technological aspects of preparing affordable fermented complementary foods. *Food Control*, **8**:279-287.
- Akila, B., Vijayalakshmi, R., Hemalatha, G. and Arunkumar, R. (2018): Development and evaluation of property of guava leaf based herbal tea. *Journal of Pharmacognosy functional and Phytochemistry*; **7**(3): 3036-3039
- Amankwah, E., A., Barimah, J., Acheampong, R., Addai, L. O. and Nnaji, C. O. (2009). Effect of Fermentation and Malting on the Viscosity of Maize-Soyabean Weaning Blends. *Pakistan Journal of Nutrition*, **8**:1671-1675.
- Anderson, A. A. (1996): Hypoglycemic and hypolipidemic effects of fresh leaf aqueous extract of *Cymbopogon citratus* Stapf in rats. *Journal of Ethnopharmacology*, **112**: 440-444.
- AOAC, (1999): Association of Official Analytical Chemists. Official Methods of Analysis of the Association of Official Analytical Chemist. 15<sup>th</sup> ed. Washington D.C. USA, Pp 69-80.
- AOAC (1996) Official Method of Analysis of the Association of Official Analytical Chemists. AOAC International, Arlington.Pp239.
- AOAC, (2005): Association of Official Analytical Chemists. Official Methods of Analysis of the Association of Analytical Chemists. 16<sup>th</sup> ed. Washington, D.C. USA. Part IV, Pp 9.
- Dahouenon  
Ahoussi, E., Adjou, E.S., Lozes, E., Yehouenou, L.L., Hounye, R., Famy, N. and Sohounhloue, D.C.K. (2012). Nutritional and microbiological characterization of pulp powder of locust bean (*Parkia biglobosa Benth.*) used as a supplement in infant feeding in Northern Benin. *African Journal of Food Science* **6**, 232-238.
- De-Heer, B., Dakappa, S. S., Adhikari, R., Timilsina, S. S. and Sajjekhan S. A. (2013). A review on the medicinal plant *Psidium guajava* linn. (Myrtaceae). *Journal of Drug Delivery and Therapeutics*, **3**(2): 162-8.
- Elixabet, D. C., Vito V., Ana, M. G., Alberto F. G. and Antonio S. C. (2017). Health Effects of *Psidium guajava* L. Leaves: An Overview of the Last Decade. *International Journal of Molecular Science*, **18**(4):897.
- Gordon, M.W. (1999). *Perspectives in Nutrition*. 4th Edition, McGraw Hill, New York, Pp 75-372.

- Mallikarjuna, K., Sahitya, C. P., Sathyavelu, R. K. and Rajendra, W. (2008). Ethanol toxicity: rehabilitation of hepatic antioxidant defense system with dietary ginger. *Fitoterapia*, **79**(3):174-178.
- Lintas, A. (1992). Maternal and child nutrition in sub-Saharan Africa: challenges and interventions. *Proceedings of the Nutrition Society*, **67**:105-108.
- Mathew, J.T., Ndamitso, M. M., Shaba, E.Y., Muhammed, S. S., Salihu, A. B. and Abu, Y. (2015). The determination of nutritive and anti-nutritive value of pelophylax esculentus (Edible Frog). *Advance Resources*, **4**(6): 412-420.
- Mohammed, M.I. and Sulaiman, M.A. (2009). Analysis of some metals in some brands of tea sold in Kano Nigeria. *Bayero Journal of Pure and Applied Sciences*, **2**(2): 34-39
- Muhimbula, H. S., Issa-Zacharia, A. and Kinabo, J. (2011). Formulation and sensory evaluation of complementary foods from local, cheap and readily available cereals and legumes in Iringa, Tanzania. *African Journal of Food Science*, **5**:26-31.
- Okaka, J. C. and Potter, N. N. (1977). Functional and storage properties of cowpea-wheat flour blends in bread making. *Journal of Food Science*, **42**: 828- 833.
- Onwuka, G. I. (2005). Food Analysis and Instrumentation. Theory and Practice. Naphtali Prints. Surulere Lagos Nigeria. Pp. 133 - 137.
- Richard, R., Aruna, K., Varma, P. S., and Menon, V. P. (2004). Influence of ferulic acid on circulatory prooxidant antioxidant status during alcohol and PUFA induced toxicity. *Journal of Physiology and Pharmacology*. **55**:551-561
- Ruchi, B., Semwal, A., Deepak, K., Semwal, A., Sandra, C. A. and Alvaro, V. M. (2015). Gingerols and shogaols: Important nutraceuticals from ginger. *Journal of Phytochemistry*, **117**:554-568.
- Sanni, O. and Oladapo, F., O. (2008). Chemical, Functional, and Sensory Properties of Instant Yam Bread Fruit Flour. *Nigerian Food Journal* **26**:2-12.
- Singh, M. (2019). "My Mom Cooked Moringa Before It Was A Superfood". NPR.org.
- Sotelo, H., Hadad, E. A. and Brink, M. (2007). "Zingiber officinale Roscoe". In De Guzman CC, Siemonsma JS (eds.). Plant resources of South-East Asia: no.13: Spices. Leiden (Netherlands): Backhuys Publishers. Pp. 238-244.
- Sutarno, H., Hadad, E. A. and Brink, M. (1999). "Zingiber officinale Roscoe". In De Guzman CC, Siemonsma JS (eds.). Plant resources of South-East Asia: no.13: Spices. Leiden (Netherlands): Backhuys Publishers. Pp. 238-244.
- Ukpabi, U. J. and Ndimele, C. (1990). Evaluation of the Quality of Garri Produced in Imo State. *Nigerian Food Journal*, **8**:105-110.
- Wheeler, E. I. and Ferrel, R. E. (1971). A Method of Phytic Acid Determination in Wheat and Wheat Fractions. *Journal of Cereal Chemistry*, **48**:312-320.