

# Drumstick (*Moringa oleifera*)-based Functional Tea: Sensory Evaluation and Beneficial Effects on Health

A.K. Obidul Huq<sup>1\*</sup>, Tanzina Afrin<sup>1</sup>, Mesbah Uddin Talukder<sup>1</sup>, Mostak Ahmed<sup>2,3</sup>, Md. Abduz Zaher<sup>4</sup>, K. M. Formuzul Haque<sup>5</sup>

<sup>1</sup> Department of Food Technology and Nutritional Science, Mawlana Bhashani Science and Technology University, Tangail-1902, Bangladesh.

<sup>2</sup> Department of Botany, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh,

<sup>3</sup> Directorate General of Forces Intelligence, Dhaka Cantonment, Dhaka-1206, Bangladesh.

<sup>4</sup> Institute of Nutrition and Food Science, University of Dhaka, Dhaka-1000, Bangladesh.

<sup>5</sup> Department of Food Engineering, NPI University of Bangladesh, Manikganj-1804, Bangladesh

## Abstract

Drumstick (*Moringa oleifera*) leaves, locally known as *Sajna*, have enormous nutritional and medicinal benefits. The study was carried out to formulate drumstick-based functional teas with the aimed to explore alternative uses of *Sajna* leaves by incorporating with other natural ingredients ginger (*Zingiber officinale*), holy basil (*Ocimum sanctum*), lemon grass (*Cymbopogon schoenanthus*) and stevia (*Stevia rebaudiana*) leaves. Proximate analysis of all the formulated herbal teas was carried out and the sensory qualities were evaluated by the eleven member taste panels. We used a nine-point hedonic scale for sample's appearance, texture, flavor, smoothness, smell, color, aesthetic appeal and comprehensive parameters of taste. This study found higher amount of nutrient contents in dried drumstick leaves than the fresh one. In acceptability test regarding the appearance, it was seen that sample-3 was liked very much (>8) by the panel members. It also showed that sample-3 tea (Blended with all other ingredients including lemongrass and stevia) obtained the highest score ( $8.17 \pm 0.55$ ) on the color. On the other hand, in the acceptability test of smell and flavor, it was observed that sample- 3 was liked moderately whereas sample 1 was not liked or disliked by the judges. In acceptability test of smoothness and texture, it was seen from the Hedonic scale points that sample-3 was liked very much (8.57) and moderately liked (>7) by the judges respectively. Based on sensory evaluation, it was concluded that drumstick-based functional tea was acceptable for further consumption, distribution and marketing.

**Keywords:** Drumstick, *Moringa oleifera*, Functional tea, Hedonic scale

## Introduction

Now-a-days, functional foods attract a great attention to the scientists for their own potential health benefits rather than basic nutritional aids and might possess a role in minimizing the risk of various adverse health outcomes<sup>1</sup>. Functional components of food include beta carotenes which are known to scavenge free radicals; calcium is known to reduce the occurrence of osteoporosis; potassium is well known to minimize the probability of high blood pressure; flavonoids, fatty acids known to reduce coronary heart diseases and dietary fiber supports gastro intestine health etc<sup>2</sup>. With the rapidly changing socio-economic status, consumers have become aware and are looking for products that provide benefits beyond nutrition.

Drumstick is one of those rare plant species whose seeds, flowers, leaves, and stems are edible and extremely nutritious<sup>3</sup>. Drumstick is an easily available vegetable which is cultivated frequently in Asian and African regions. It is an excellent source of macro and micro nutrients including antioxidants. Although drumstick leaves are not as popular as other leafy vegetables like spinach, red amaranth, fenugreek around the world but are used as their substitutes in soups, lentils and other preparation in Southern and Eastern parts of India<sup>4</sup>. There is a knowledge gap in potential uses of drumstick leaves and its use in food fortification. Drumstick leaves has enormous potential uses but is very less explored although has been acclaimed for its positive effects for many years.

\*Corresponding author, Email: obidulhuq@gmail.com

Formulating new functional tea from variety of indigenous less consumed plants will offer novel utilization of less utilized plants and herbs. Drumstick leaves is such type of plant which could be explored in this study. Drumstick leaves are rich in nutritional properties and also comprises of unusual combination various antioxidants such as kaempferol, caffeoylquinic acid, sitosterol, zeatin and quercetin<sup>5,6</sup>.

At present, Drumstick leaves has been observed to be used in the herbal tea preparation. However, herbal tea prepared only from Drumstick leaves is usually not attractive in sensory appeal but this appeal is vital since consumers are usually not interested to have foods which exhibits poor sensory attributes, irrespective of their beneficial effects on health<sup>7</sup>.

One such natural food source which can be utilized to add functionality to other foods or act as functional food itself is drumstick leaves. The tree is claimed to have potential to improve nutrition, increase food security, and encourage rural development<sup>8</sup>. There are thirteen species of drumstick leaves. Out of these thirteen species *Moringa oleifera* is the most studied so far. *M. oleifera* leaves contain higher amount of protein and more enriched in essential amino acids than those of *M. hildebrandtii* and *M. drouhardii*<sup>9</sup>. It is expected that blending drumstick leaves with the little amount of ginger, stevia and lemon grass herbs in adequate proportions will produce a herbal tea which will provide acceptable sensory properties.

Drumstick leaves has been seen to enhance breast milk production irrespective of the time of intake (before or after birth of baby)<sup>10</sup>. Since breast milk is an essential food for infant and child, Drumstick leaves tea can be a beneficial product in producing more breast milk.

However, the research will bring light to the potential of the traditional plants for food product development.

The current study will enhance the understanding of sensory characteristics and likeness of herbal teas in particular. With the above facts in mind, the present study was planned and the primary objective of this study was to formulate a newly developed functional herbal tea from the drumstick leaves.

## Materials and Methods

An analytical study was carried to explore alternative uses for drumstick leaves by blending with other ingredients to formulate an herbal tea with acceptable sensory properties. The study was continued from July'2018 to June'2019.

### Place of experiment

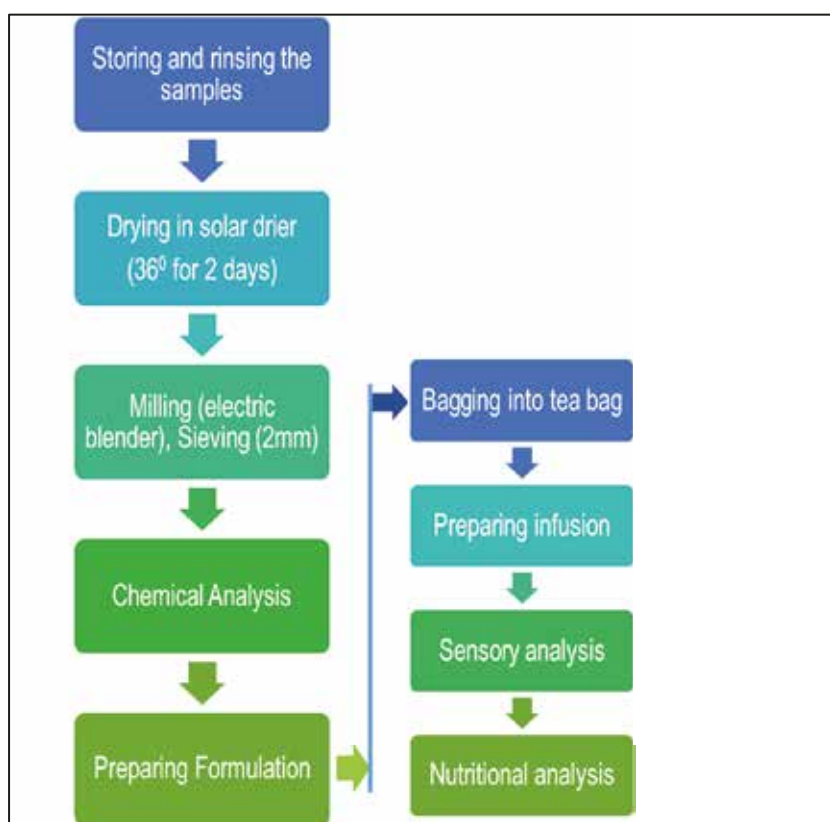
The samples were formulated in the factory of Dr. H&H Food and Tea Solutions Ltd. Dhaka Uddan, Mohammadpur, Dhaka-1207 and laboratory analyses were conducted in the laboratory of the Department of Food Technology and Nutritional Sciences, Mawlana Bhashani Science and Technology University, Tangail.

### Raw materials

Drumstick (*Moringa oleifera*), Ginger (*Zingiber officinale*), Holy basil (*Ocimum sanctum*) Lemon grass (*Cymbopogon schoenanthus*) and stevia (*Stevia rebaudiana*) leaves were procured from the local herbal garden and market.

### Sample preparation and storage

At first, all raw plant materials were screened and unwanted materials were removed. Then the samples were washed in water. The leaves of lemon grass were cut into small pieces. The stalks of drumstick were removed and a thin layer of samples were sun dried on paper for two days at 32-36°C.



**Figure 1.** Flow chart of Drumstick-based Functional Tea processing

The dried samples were blended afterwards (India, Model: Joypan) for five minutes. Sieving of the milled materials was conducted by an Aluminum sieve (2.0 mm). A portion of the sieved samples was kept in glass bottles and lid was tightly packed. The rest of the samples were used to formulate the samples and were packaged in non-drip tea bags with the help of an automatic tea bagging machine (China, Model: DXDC15). The packed tea bags were kept in dried and each tea bag contained about 2 g of product.

#### **Organoleptic or sensory quality analysis**

A panel of eleven (11) members were constructed for sensory evaluation of the formulated product. Nine point Hedonic Scale was used to rate the products in different sensory attributes<sup>11</sup>. The Hedonic scale was comprised of 1 to 9 points denoting 1=extreme dislike and 9= extreme like.

#### **Nutritive value analysis**

Samples were assessed for their nutritive values (moisture, protein, crude fat, crude dietary fiber).

#### **Moisture content determination**

Moisture content of the samples were determined by oven drying method by keeping the samples at 100-105°C for 5-6 hour<sup>12</sup>. Following formula was used in moisture content calculation:

$$\text{Moisture content (\%)} = (w_1 - w_2) \times 100 / w_1$$

$w_1$  = weight (g) of raw sample

$w_2$  = weight (g) of dried sample

#### **Ash content determination**

The ash content of the samples was measured by incineration using muffle furnace<sup>12</sup>. Following formula was used for measuring fat percentage

$$\text{Ash (\%)} = w_1 \times 100 / w_2$$

$w_1$  = weight of ash in gram

$w_2$  = weigh of sample in gram

#### Fat content determination

The fat content of the samples was measured by using an organic solvent (petroleum ether) in a Soxhlet apparatus<sup>13</sup>. Following formula was used for measuring fat percentage:

$$\text{(\% of Fat content)} = \frac{\text{Weight of the extract}}{\text{Sample weight}} \times 100$$

About 10 gm sample was taken. Then 3 pieces of filter papers and pins were also weighted. Sample was carefully packed into filter paper and pinned up. Then sample was placed into thimbles of Soxhlet apparatus and sufficient amount of petroleum ether poured into flat bottom flask through thimble. After setting condenser, condensed water was supplied. Then, Soxhlet apparatus was started for heating at (60-70)°C. After separating fat about 4 times it was stopped. Condenser and thimble are separated from apparatus. Flat bottom flask containing fat and petroleum ether was again heated for removing ether. Then the residue was poured into weighted beaker and kept into desiccators. After 5 minutes beaker with fat was weighted and then calculated.

#### Protein content determination

The protein content of the samples was determined by Kjeldahl method described by (AOAC. 2005)<sup>12</sup>.

#### Crude fiber determination

The crude fiber was measured by using the method described by (AOAC. 2005)<sup>12</sup>.

#### Statistical data analysis

All statistical data analysis was conducted by using IBM SPSS 20.0. MS Word and Excel were used to formulate the required tables.

#### Results

Table 1 shows the nutrient content of fresh and dried drumstick leaves per 100 gm. It can be seen that all the analyzed nutrients were found in higher amount in dried drumstick leaves than that of fresh leaves, except Vitamin C content since Vitamin C is effected by heat during the drying process. Protein content was almost four times in dried leaves in comparison with fresh leaves. On the other hand, Beta-carotene was found to be six folds in dried leaves than that of fresh ones. Iron, calcium and phosphorus content were also found in much higher amount in the dried leaves.

**Table 1.** Nutritional content of fresh and dried drumstick leaves (per 100 gm)<sup>3</sup>.

Nutrients	Fresh leaves (Mean ± SD)	Oven dried (Mean ± SD)
Moisture (%)	75.9 ± 2.27	6 ± 0.32
Energy (Kcal)	92 ± 7	271 ± 13
Protein (g)	6.7 ± 0.45	23.78 ± 0.94
Carbohydrates (g)	12.5 ± 1.1	28.32 ± 2.3
Fat (g)	1.7 ± 0.2	7.014 ± 0.37
Fiber (g)	0.9 ± 0.15	11.8 ± 1.1
Vitamin C (mg)	220 ± 9	56 ± 7
Beta-carotene (µg)	6780 ± 126	37800 ± 263
Iron (mg)	0.85 ± 0.1	19 ± 0.68
Calcium (mg)	440 ± 23	3467 ± 85
Phosphorus (mg)	70 ± 12	215 ± 31

Table 2 shows the various ingredients used for the recipe development of drumstick leaves-based different sample herbal teas. In case of all samples, dried drumstick leaves was used as similar amount (95g in each sample). Ginger was used as increase in good flavor and taste and it was added in 3g, 2 g and 1.5 g for sample 1, 2 and 3 respectively.

Similarly, Holy basil also added in 2 g, 2 g and 1.5 g for sample 1, 2 and 3 respectively. Lemon grass leaves were added in sample 2 and 3, as a result, the products of sample 2 and 3 was more taste and aesthetic appeal. Natural sweeteners stevia leaves was added only

sample three and it was improves overall taste, smoothness and best aesthetic appeal.

### Comparison of sensory qualities of newly developed functional tea

Sensory evaluation or organoleptic tests of the newly developed functional tea depends on its first appearance, color, flavor & smell, texture, smoothness, aesthetic appeal and overall taste of the sample. Table 3 shows the comparison among the three newly developed functional tea of their organoleptic quality factors.

**Table 2.** Recipe for different Drumstick leaves-based herbal tea.

Food ingredients	Sample-1 (g)	Sample-2 (g)	Sample -3 (g)
Drumstick leaves	95	95	95.0
Ginger	3	2	1.5
Holy Basil Leaves	2	2	1.5
Lemon Grass leaves	0	1	1.0
Stevia leaves	0	0	1.0
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>

**Table 3.** Comparison of the different organoleptic quality parameters (Sensory evaluation) of drumstick leaves-based functional teas

Quality Parameters	Sample -1		Sample-2		Sample -3	
	Points	Results	Points	Results	Points	Results
	Mean $\pm$ SD		Mean $\pm$ SD		Mean $\pm$ SD	
Appearance	6.08 $\pm$ 0.27	> 6	7.05 $\pm$ 0.26	> 7	8.08 $\pm$ 0.22	> 8
Color	6.17 $\pm$ 0.05	> 6	8.05 $\pm$ 0.40	> 8	8.17 $\pm$ 0.57	> 8
Flavor & Smell	5.53 $\pm$ 0.70	> 5	7.13 $\pm$ 0.56	> 7	7.73 $\pm$ 0.65	> 7
Texture	6.20 $\pm$ 0.56	> 6	7.05 $\pm$ 0.14	> 7	7.25 $\pm$ 0.75	> 7
Smoothness	6.77 $\pm$ 0.05	> 6	8.45 $\pm$ 0.40	> 8	8.57 $\pm$ 0.57	> 8
Aesthetic	5.76 $\pm$ 0.70	> 5	7.43 $\pm$ 0.56	> 7	7.93 $\pm$ 0.65	> 7
Overall taste acceptance	6.43 $\pm$ 0.53	> 6	7.33 $\pm$ 0.43	> 7	8.24 $\pm$ 0.57	> 8

In the appearance acceptability test, Hedonic scale showed that sample-3 liked very much (>8) by the Judge. This table also shows sample-3 tea (Blended with all other ingredients including lemongrass and stevia) obtained the highest score ( $8.17 \pm 0.55$ ) which indicates the color was liked very much. Color of sample 3 tea largely depends on the color quality of other ingredients lemon grass and stevia. In the flavor and smell acceptability test showed that sample- 3 was liked moderately whereas sample 1 was not liked or disliked by the judges. The mean score of texture in Sample 1, 2 and 3 were  $6.20 \pm 0.56$ ,  $7.05 \pm 0.24$ ,  $7.25 \pm 0.75$  respectively and texture of sample-3 was moderately liked (>7) by the judges. In the smoothness acceptability test, Hedonic scale showed that sample-3 liked very much (8.57) by the Judge. In overall taste acceptability test, Hedonic scale showed that the sample-3 tea was more acceptable comparing with all quality characteristics by the judge.

Table 4 shows that the nutritive values of different functional teas were very similar range as all the teas contains 95% Drumstick leaves dried leaves. Other ingredients like ginger, lemongrass and stevia was incorporated in a minute amounts to increase the taste and flavor and other organoleptic tests. Therefore, nutritive value of all the samples were analysis and found moisture level was 5.9-6.8%, protein 22.1-22.7%. It was noted that fat contents was significant amount, ranged from 5.9-6.3 g/100g dried teas. The ash contents also high indicate that all the teas

were rich in mineral contents. Crude fiber range was 11.2-11.4% indicates that it possess the essential phytonutrients contents of these newly developed teas.

## Discussion

In the present study, it was demarcated that dried drumstick leaves was used as similar amount (95g in each sample). Ginger was used as increase in good flavor and taste and it was added in 3g, 2 g and 1.5 g for sample 1, 2 and 3 respectively. Similarly Holy basil also added in 2 g, 2 g and 1.5 g for sample 1, 2 and 3 respectively. Lemon grass leaves were added in sample 2 and 3, as a result, the products of sample 2 and 3 was more taste and aesthetic appeal. Natural sweeteners stevia leaves was added only sample three and it was improves overall taste, smoothness and best aesthetic appeal.

This study also represented different organoleptic tests of the functional teas depend on its first appearance, color, flavor & smell, texture, smoothness, aesthetic appeal and overall taste of the sample. The findings from the study shows that sample-1 obtained lower score  $6.08 \pm 0.27$  for its appearance which indicates the appearance of this tea was like slightly, whereas in sample 2, it was moderate likely and in sample 3, it was like very much. Appearances of teas depend on appearance of dried Drumstick leaves and other raw ingredients like stevia and lemon grass etc. and on processing technique. In the appearance acceptability test, Hedonic scale showed that sample-3 liked very

**Table 4.** Nutritive values of drumstick-based different functional teas

Nutrients	Contents per 100 g		
	Sample - 1	Sample - 2	Sample - 3
Moisture (%)	$6.8 \pm 0.13$	$6.6 \pm 0.12$	$5.9 \pm 0.11$
Protein (g/100 g)	$22.1 \pm 0.46$	$22.3 \pm 0.47$	$22.7 \pm 0.44$
Fat (g/100 g)	$6.1 \pm 0.2$	$5.9 \pm 0.18$	$6.3 \pm 0.17$
Ash (g/100 g)	$3.9 \pm 0.16$	$4.5 \pm 0.17$	$4.7 \pm 0.17$
Crude fiber (g/100 g)	$11.2 \pm 0.34$	$11.3 \pm 0.31$	$11.4 \pm 0.31$



much (>8) by the Judge. On the other color acceptability of the newly developed samples were significant and Sample 1 tea (only Drumstick leaves, Ginger and Holy Basil leaves) obtained the lowest score ( $6.17 \pm 0.25$ ) for its color whereas sample-3 tea (Blended with all other ingredients including lemongrass and stevia) obtained the highest score ( $8.17 \pm 0.55$ ) which indicates the color was like very much. Color of sample 3 tea largely depends on the color quality of other ingredients lemon grass and stevia. Usually, flavor and smell of the products depends on the volatile constituents of raw material. The mean score of flavor and smell were  $5.53 \pm 0.70$ ,  $7.13 \pm 0.56$ ,  $7.73 \pm 0.65$  of sample-1, sample-2, sample-3 respectively. In the flavor and smell acceptability test showed that sample- 3 was like moderately whereas sample 1 was not liked or disliked by the judges.

In the current study texture of the various teas depends mainly upon the rate of development of the sun dry of the leaves and granular properties of the leaves during blending time. The mean score of texture in Sample 1, 2 and 3 were  $6.20 \pm 0.56$ ,  $7.05 \pm 0.24$ ,  $7.25 \pm 0.75$  respectively. Texture of sample-3 was moderately liked (>7) by the judges. Smoothness acceptability of the newly develop sample-1 obtained lower score  $6.77 \pm 0.25$  for its appearance which indicates the appearance of this tea was like slightly, whereas in sample 2 and in sample 3, it was like very much. Smoothness of teas depends on granular and fineness of dried drumstick leaves and other raw ingredients like stevia and lemon grass etc. and on processing technique. In the smoothness acceptability test, Hedonic scale showed that sample-3 liked very much ( $8.57$ ) by the Judge.

The study also showed the overall taste is also influenced by the quality of the raw materials used in

the processing of teas. The mean taste score of sample 1, 2 and 3 teas were  $6.43 \pm 0.53$ ,  $7.33 \pm 0.43$ ,  $8.24 \pm 0.57$  respectively. In overall taste acceptability test, Hedonic scale showed that the sample-3 tea was more acceptable comparing with all quality characteristics by the judge.

Therefore, nutritive value of all the samples were analysis and found moisture level was 5.9-6.8%, protein 22.1-22.7 g/ 100 g sample. It was noted that fat contents was significant amount, ranged from 5.9-6.3 g/ 100g dried teas. The ash contents also high indicates that all the teas were rich in mineral contents. Crude fiber range was 11.2 -11.4 indicates that it retain the essential phytonutrients contents of these newly developed teas.

## Conclusion

The overall acceptance for all sensory parameters like appearance, color, flavor & smell, texture, smoothness, aesthetic appeal and overall taste were significantly high in sample-3 of the sample. The nutritive value of all the samples were analyzed and found moisture level was 5.9 -6.8% and protein content was 22.1-22.7 g per 100g of sample. The study also found significant amount of fat in the samples, ranged from 5.9-6.3 g per 100g of dried teas. In the appearance acceptability test, hedonic scale showed that sample-3 liked very much (>8) by the panelists. It also showed that sample-3 tea (Blended with all other ingredients including lemongrass and stevia) obtained the highest score ( $8.17 \pm 0.55$ ) which indicates the acceptability of color and taste. Sensory parameters of sample-3 tea are more acceptable than the other samples. Further investigations are needed to determine the actual functionality of this tea.

## References

1. Gul K, Singh AK, Jabeen R. Nutraceuticals and functional foods: The foods for the future world. *Critical reviews in food science and nutrition*. 2016 Dec 9;56(16):2617-27.
2. Proestos C. Superfoods: Recent data on their role in the prevention of diseases. *Current Research in Nutrition and Food Science Journal*. 2018 Dec 24;6(3):576-93.
3. Abd Rani NZ, Husain K, Kumolosasi E. Moringa genus: a review of phytochemistry and pharmacology. *Frontiers in Pharmacology*. 2018 Feb 16;9:108.
4. Ananthanarayan L, Dubey KK, Muley AB, Singhal RS. Indian traditional foods: Preparation, processing and nutrition. In *Traditional Foods 2019* (pp. 127-199). Springer, Cham.
5. Taher MA, Nyeem MA, Ahammed MM, Hossain MM, Islam MN. Moringa oleifera (Shajna): the wonderful indigenous medicinal plant. *Asian Journal of Medical and Biological Research*. 2017 Apr 14;3(1):20-30.
6. Anwar F, Latif S, Ashraf M, Gilani AH. Drumstick leaves oleifera: a food plant with multiple medicinal uses. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*. 2007 Jan;21(1):17-25.
7. Sultana N, Alimon AR, shahidul Huque K, Sazili AQ, Yaakub H, Hussain SM, Das NG. Study of Anti-nutritional Compounds, Antioxidant Activity and Fatty Acid Composition of Drumstick leaves (*Drumstick leaves oleifera Lam.*) Foliage. *Asian Journal of Agriculture and Food Sciences* (ISSN: 2321–1571). 2017 Jun;5(03).
8. Mahmood KT, Mugal T, Haq IU. Drumstick leaves oleifera: a natural gift-A review. *Journal of Pharmaceutical Sciences and Research*. 2010 Nov 1;2(11):775.
9. Ojiewo C, Tenkouano A, Hughes JD, Keatinge JD. Diversifying diets: using indigenous vegetables to improve profitability, nutrition and health in Africa. *Diversifying food and diets: using agricultural biodiversity to improve nutrition and health*. 2013 Jun 26:291-302.
10. Boateng L, Quarpong W, Ohemeng A, Asante M, Steiner-Asiedu M. Effect of complementary foods fortified with *Moringa oleifera* leaf powder on hemoglobin concentration and growth of infants in the Eastern Region of Ghana. *Food science & nutrition*. 2019 Jan;7(1):302-11.
11. Raghuramulu, N., Nair, M.K. & Kalyanasundaram S. (2003). *A manual of laboratory techniques*. National Institute of Nutrition, ICMR, JamaiOsmania, Hyderabad, India.
12. AOAC. *Official Methods of Analysis*. 18th edn. Association of Official Analytical Chemists; Arlington, VA, USA: 2005.
13. Prosky, L., Asp, N-G., Furda, I., DeVries. J. W., Schweizer, T. F. & Harland, B. F. (1985). *J. AOAC Int.*, 68, 677-679.