Nutritional Composition, Mineral analysis and Sensory Evaluation of Cake and Chocolate with *Moringa oleifera* Leaf Powder for Anaemic Adolescent's

1. Abstract

Moringa oleifera is a plant native to India that thrives in tropical and subtropical climates around the world. It's also called a 'drumstick tree' or a 'horse radish tree.' Moringa is commonly farmed around the world because it can resist both severe drought and moderate winter. Every portion of the tree is suitable for nutritional or economic applications due to its high nutritious contents. Minerals, vitamins, and other phytochemicals are abundant in the leaves. The nutritional composition of dry *M. oleifera* leaf powder was investigated in this study. The leaf extract was examined for its proximate, mineral, vitamin, and sensory properties. The analysis were carried out in supplemented *M. oleifera* in cake and chocolate prepared with varying proportions such as C, 10%, 15% and 20% respectively. The results in Chocolate sample were carried out for nutritional analysis represented in moisture (1.36, 1.56, 1.73 and 1.96 g/100g), in ash (3.44, 3.75, 3.96 and 4.03 g/100g), Protein (8.25, 9.25, 9.87 and 10.01 g/100g) and Fat (36.38, 30.47, 28.29 and 27.22 g/100g). Mineral analysis for Calcium (43.13, 47.73, 48.75 and 49.22 mg), Potassium (558.55, 587.90, 589.20 and 599.73 mg), Phosphorus (76.64, 89.44, 90.24 and 91.74 mg) and Iron (8.43, 9.44, 9.78 and 9.94 mg). Vitamin analysis for β – Carotene (0.02, 0.06, 0.06 and 0.08 mg) and Vitamin – C (0.23, 0.47, 0.53 and 0.61 mg). The sensory analysis was carried out for Concentration of Leaf Powder, Colour and Appearance, Smell, Taste, Mouth Feel and over all Acceptability. Whereas in Cake sample the nutritional analysis represented in moisture (04.32, 05.23, 5.44 and 5.93 g/100g), in ash (05.73, 06.43, 6.76 and 7.06 g/100g), Protein (08.16, 08.75, 8.95 and 8.54 g/100g) and Fat (04.74, 04.23, 04.15 and 04.08 g/100g). Mineral analysis for Calcium (26.71, 27.21, 27.43 and 26.43 mg), Potassium (32.44, 35.26, 35.64 and 35.21 mg), Phosphorus (53.76, 53.99, 57.25 and 55.16 mg) and Iron (01.25, 1.86, 2.05 and 2.16 mg). Vitamin analysis for β – Carotene (00.04, 0.05, 0.05 and 0.06 mg) and Vitamin – C (00.08, 0.12, 0.13 and 0.08 mg). With the addition of *moringa* leaves powder, the sensory qualities were found to be within acceptable limits. *Moringa* leaves are a good source of proteins, minerals, and vitamins, and they can be used as a supplement to improve the nutritional profile of chocolate and cake in the baking industry.

Keywords: *M. oleifera*, Minerals, Vitamins, Nutritional analysis, sensory analysis, Cake, Chocolate.

2. Introduction

Anaemia occurs when the quantity of red blood cells or the concentration of haemoglobin within them is lower than usual. Haemoglobin is required to transport oxygen, and if you have too few or malformed red blood cells, or not enough haemoglobin, your blood's capacity to transport oxygen to the body's tissues will be reduced. Symptoms include weariness, weakness, dizziness, and shortness of breath, to name a few. Snacking is an important habit of eating that helps youngsters achieve their daily nutritional needs and contributes significantly to their healthy growth and development (Serrano and Powell, 2013). Energy, protein, iron, calcium, and vitamins are all important food sources in processed snacks. Processed snacks are becoming increasingly popular in poor and middle-income countries in Asia, Latin America, and Africa

(Huffman et al., 2014). Cakes are one of the most popular bakery foods consumed by people of all social classes due to their ready-to-eat nature and availability in a variety of flavours at a reasonable price (Ben et al., 2017).

Baked cakes are currently an important part of an adolescent's diet to meet their nutritional needs in addition to basic foods. Wheat flour, sugar, eggs, and baking powder are commonly used in traditional cakes (Atef et al., 2011). This type of cake, on the other hand, is high in sugar and high in carbohydrates and fat, but low in protein, minerals, and vitamins (Ameh et al., 2013). Furthermore, the World Health Organization (WHO) has declared high-sugar, high-fat snacks to be unhealthy (WHO, 2010). In this environment, there has been an increase in demand for functional foods that contain more nutrients and minerals. Nutrients have traditionally been thought of as food components that cannot be manufactured in the body (for example, vitamin C) or whose synthesis requires a specific ingredient that may be lacking or insufficient in certain conditions (for example, some amino acids, fatty acids, and vitamins). Many other plant-based substances, such as dietary fibre, flavonoids, sterols, phenolic acids, and glucosinolates, are increasingly being linked to a reduced risk of disease. Many good impacts on human health have been related to phytochemicals found in plant diets, including coronary heart disease, diabetes, high blood pressure, cataracs, degenerative disorders, and obesity (Liu et al., 2000).

M. oleifera is one of the promising plants that could help people get more of the nutrients they need and health-promoting phytochemicals they need. *M. oleifera* is the most well-known of the thirteen Moringacae species. It is native to India, but it has been planted and naturalised all over the world (Adenipekun and Oyetunji, 2010; Martin, 2007). According to recent research, the leaves of this plant have a high nutritional value. Vitamins, minerals, and all of the essential amino acids are abundant in them (Balbir, 2006). *M. oleifera* has been touted as an excellent source of important nutrients (protein, iron, calcium, vitamins, carotenoids, and other phytochemicals) for the past two decades (Fahey, 2005). As a result, the goal of this research is to determine the proximate, mineral (iron and calcium), vitamin (ascorbate and beta-carotene), and phytochemical (flavonoids and alkaloids) composition of dry *M. oleifera* leaf extract, as well as the organoleptic properties of a beverage made from its leaf powder. As a result, the goal of this research is to assess the nutritional analysis (moisture, ash, protein, and fat), mineral analysis (calcium, potassium, phosphorus, and iron), vitamin analysis (beta-carotene and vitamin C), and sensory analysis of dry *M. oleifera* leaf powder.

3. Material and Methods

3.1 Raw material preparation

M. oleifera was found in the Erode District. Indoors, the plant was air dried and powdered with a mortar and pestle. For further investigation, the powdered material was stored in an airtight container.

3.2 Nutritional Analysis

3.2.1 Determination of Moisture Content

Empty crucibles were dried in a 105°C oven for 3 hours, cooled in a desiccator, and weighed as soon as they reached room temperature. Following that, a 5 g cake sample was taken and placed in each dried crucible. The crucible containing the samples was dried overnight in a 105°C oven, then moved to a desiccator and weighed shortly after reaching room temperature;

the moisture content of cake samples was then measured using the technique provided by (AOAC, 2012).

% Moisture = [Loss of the weight of the sample (g) / Weight of the sample (g)] × 100

3.2.2 Determination of Ash Content

A 5 g homogenised sample was obtained and measured exactly in the dry silica dish. The sample was dried for one day on an electrical coil rack in a 130°C oven, and then chipped until it was no longer smoking. After that, the sample was ignited in a 550°C muffle chamber until greyish or white ash produced. The samples were quickly cooled in desiccators and tested at room temperature to determine the ash percentage (AOAC, 2012). The proportion of ash in the sample was calculated using the formula below

% Ash = [Weight of ash (g)/ Weight of sample (g)] × 100

3.2.3 Determination of Crude Protein

The AOAC 990.033 Process was used to determine the crude protein content of the cake samples (AOAC, 2005). The LECO Truspec Nitrogen Analyser was used to determine the protein level of the cake samples. The cake samples were loaded into a 950°C combustion chamber using an autoloader. The nitrogen extracted from the samples was then converted into a protein amount by multiplying it by 6.25 and using the procedure below.

% Crude protein = %N × 6.25

3.2.4 Determination of Fat

The fat content of the cake samples was evaluated using a Soxhlet extractor and a weighted flask, as described by the AOAC in 2005. For determining fat content, petroleum ether was utilised as an extraction solvent. The following formula was used to get the crude fat content

% Fat in sample = [Weight of residue (g)/ Weight of sample (g)] × 100

3.3 Mineral determination

The sample's mineral content, such as calcium, potassium, phosphorus, and iron, was assessed using Atomic Absorption Spectroscopy, as reported in (Laveena et al., 2013).

3.4 Vitamin Analysis

3.4.1 Estimation of Vitamin C

The vitamin C content of the fruit sample was tested using the AOAC, 2006 technique. Pipette 5mL of the working standard solution into a 100mL conical flask, followed by 10mL of 4% oxalic acid, and titrate against the dye (V1 ml). The end result is the appearance of a pink colour that lasts for a few minutes. The amount of dye consumed equals the amount of ascorbic acid consumed. A 1 g sample was extracted in 4% oxalic acid, diluted to a specified volume (100ml), and centrifuged. Pipette off 5mL of the supernatant, add 10mL of 4% oxalic acid, and titrate against the dye (V2 ml).

3.4.2 Determination of Total Carotenoids

Each sample (1 g) was combined with approximately 50 mL acetone and pulverised with a pestle and mortar. The extract was filtered, and the process was repeated until the extract was colourless. In a separating funnel, the extracts were combined with 50 mL petroleum ether and 400 mL distilled water. The petroleum ether layer was separated and washed 2–3 times with water before being dried with anhydrous sodium sulphate and filled with petroleum ether up to 100 mL. The total carotene concentration was determined using the molar extinction co-efficient of -carotene and the absorbance at 452 nm (AOAC, 2006).

3.5 Organoleptic analysis

Sensory evaluation was carried out by a panel of ten semi trained panel members. Hedonic rating test was employed using 9-point hedonic scale. Sensory parameters such as colour, taste, texture and overall acceptability were evaluated (Ranganna, 2001). The following were the numerical scores assigned: 9: Like extremely 8: Like very much 7: Like moderately 6: Like slightly 5: Neither like nor dislike 4: Dislike slightly 3: Dislike moderately2: Dislike very much 1: Dislike extremely.

4. Result and Discussion

4.1 Nutritional Analysis

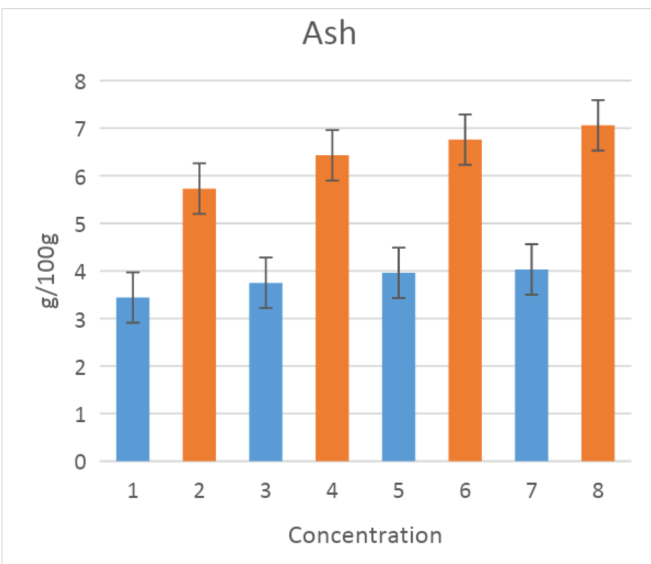
The samples Cake and chocolate were prepared and tested for different nutritional parameters, mineral analysis, Vitamin analysis and Sensory evaluation. Table 1 and Figure 1 presents the nutritional analysis for Cake and chocolate samples. The Moisture content for control (1.36 ± 0.03, 04.32 ± 0.09), 10% (1.56 ± 0.02, 05.23 ± 0.03), 15% (1.73 ± 0.01, 5.44 ± 0.04) and 20% (1.96 ± 0.04, 5.93 ± 0.04). Dry *M. oleifera* leaf extract has a high moisture content, indicating that it is sensitive to microbial development. It also means the product's shelf life is short. The high moisture content also contributes to the low quantities of protein, ash, crude fibre, fat, and carbohydrate. The lower the nutrient density of a food, the higher the moisture content (Udofia and Obizoba, 2005). Shokery et al. (2017) found dry *moringa* leaves powder to have a similar moisture content (8.81%). The decreased moisture level of the leaves powder makes it shelf stable, and when packaged appropriately, the leaves can be stored for a long time (up to a year) at room temperature.

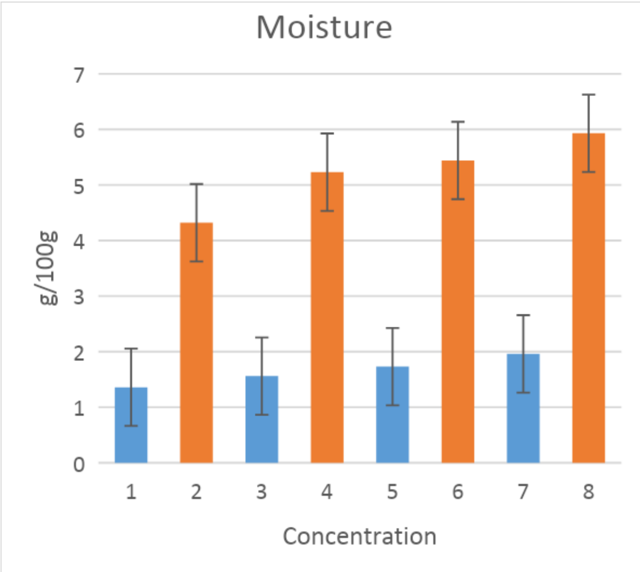
Ash content for control (3.44 ± 0.04, 05.73 ± 0.02), 10% (3.75 ± 0.03, 06.43 ± 0.04), 15% (3.96 ± 0.03, 6.76 ± 0.04) and 20% (4.03 ± 0.05, 7.06 ± 0.04). Whole wheat flour had 1.33 percent ash level, while *moringa* leaves powder had 12.98 percent. Kaur et al. (2017) discovered a similar ash concentration in whole wheat flour. Miller et al. (2016) reported a 0.96 percent ash concentration in wheat flour. Our results for ash content of *moringa* leaves powder are consistent with those of Sanchez-Machado et al. (2010), who found that *moringa* leaves have an ash percentage of 14.2 percent on a dry weight basis. When supplemented with low ash foods like wheat, the higher ash level is beneficial in terms of increasing the mineral content of the diet. Protein content for control (8.25 ± 0.01, 08.16 ± 0.02), 10% (9.25 ± 0.01, 08.75 ± 0.03), 15% (9.87 ± 0.02, 8.95 ± 0.03) and 20% (10.01 ± 0.18, 8.54 ± 0.02). When sponge cake was supplemented with up to ten percent *moringa* leaves powder, the protein level increased (7.86-8.30 percent) (Premi and Sharma, 2018). Proteins are necessary for children's body repair, growth, and maintenance. It also serves as an enzyme, a hormone, and keeps the body's electrolyte and acid-base balance in check (Adeola and Ohizua, 2018). *Moringa* leaves are extremely high in protein content, which could be due to the increased protein content of the fortified cake (Baker et al., 1998). Yang et al., 2006 observed a 17–88 percent increase in protein content in bread samples supplemented with MOLP, which is consistent with the study. The fat content (36.38 ± 0.30, 04.74 ± 0.04), 10% (30.47 ± 0.06, 04.23 ± 0.04), 15% (28.29 ± 0.12, 04.15 ± 0.02) and 20% (27.22 ± 0.02, 04.08 ± 0.02). The fat content of jering bean flour augmented biscuits was found to be between 26.54 and 25.67 percent (Cheng and Bhat, 2016). In contrast to our findings, Sharma et al. (2013) found that guduchi leaf powder enriched biscuits had a fat level of 17.24 to 16.865 percent.

Table 1: Nutritional Analysis for Chocolate and Cake

Analysis	**Control**		**10%**		**15%**		**20%**	
	Chocolate	**Cake**	**Chocolate**	**Cake**	**Chocolate**	**Cake**	**Chocolate**	**Cake**
Moisture (g/100g)	1.36 ± 0.03	04.32 ± 0.09	1.56 ± 0.02	05.23 ± 0.03	1.73 ± 0.01	5.44 ± 0.04	1.96 ± 0.04	5.93 ± 0.04
Ash (g/100g)	3.44 ± 0.04	05.73 ± 0.02	3.75 ± 0.03	06.43 ± 0.04	3.96 ± 0.03	6.76 ± 0.04	4.03 ± 0.05	7.06 ± 0.04
Protein (g/100g)	8.25 ± 0.01	08.16 ± 0.02	9.25 ± 0.01	08.75 ± 0.03	9.87 ± 0.02	8.95 ± 0.03	10.01 ± 0.18	8.54 ± 0.02
Fat (g/100g)	36.38 ± 0.30	04.74 ± 0.04	30.47 ± 0.06	04.23 ± 0.04	28.29 ± 0.12	04.15 ± 0.02	27.22 ± 0.02	04.08 ± 0.02

Figure 1: Nutritional Analysis for Chocolate and Cake

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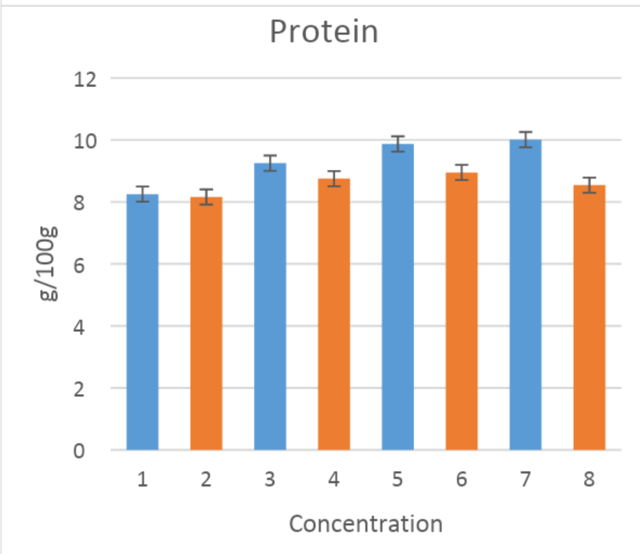
7
6
5
4
3
2
1
0
g/100g
1 2 3 4 5 6 7 8
Concentration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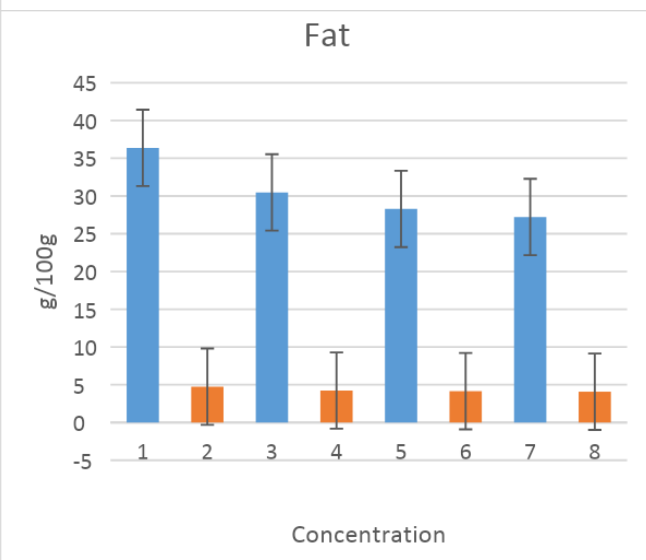
8
6
4
2
0
g/100g
1 2 3 4 5 6 7 8
Concentration


Fat
45
40
35
30
25
20
15
10
5
0
-5
g/100g
1 2 3 4 5 6 7 8
Concentration

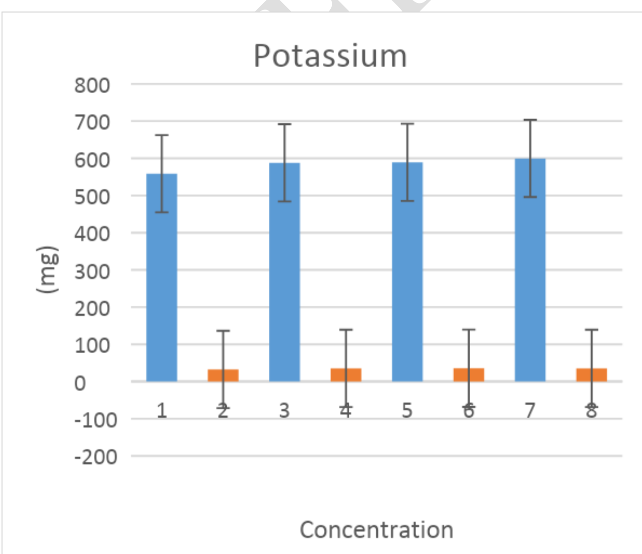
4.2 Mineral Analysis

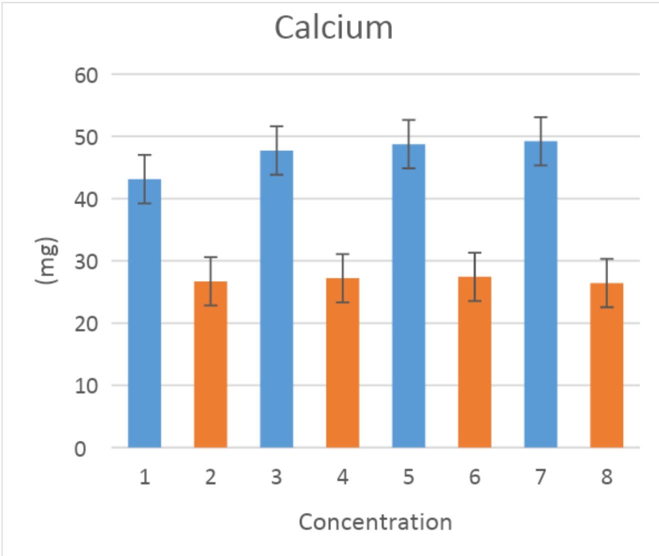
During the mineral analysis, many factors such as calcium, potassium, phosphorus, and iron were measured. Calcium is required for blood clotting, blood pressure regulation, appropriate brain function, and bone health in the body. The calcium content for control is (43.13 ± 0.50, 26.71 ± 0.02), 10% (47.73 ± 0.04, 27.21 ± 0.02), 15% (48.75 ± 0.05, 27.43 ± 0.04) and 20% (49.22 ± 0.03, 26.43 ± 0.04). The potassium content for control is (558.55 ± 0.30, 32.44 ± 0.03), 10% (587.90 ± 0.61, 35.26 ± 0.04), 15% (589.20 ± 0.07, 35.64 ± 0.05) and 20% (599.73 ± 0.03, 35.21 ± 0.01). The phosphorus content for control is (76.64 ± 1.94, 53.76 ± 0.02), 10% (89.44 ± 0.31, 53.99 ± 0.07), 15% (90.24 ± 0.03, 57.25 ± 0.02) and 20% (91.74 ± 0.04, 55.16 ± 0.07) Table 2 and Figure 2. Potassium and phosphorus, which are important for heart and blood pressure control, were shown to be considerably greater in fortified cakes than in non-fortified cakes. This could be owing to the addition of MOLP and RBF, which have a greater phosphorus and potassium content (Kraithong and Issara, 2021; Ma et al., 2020).

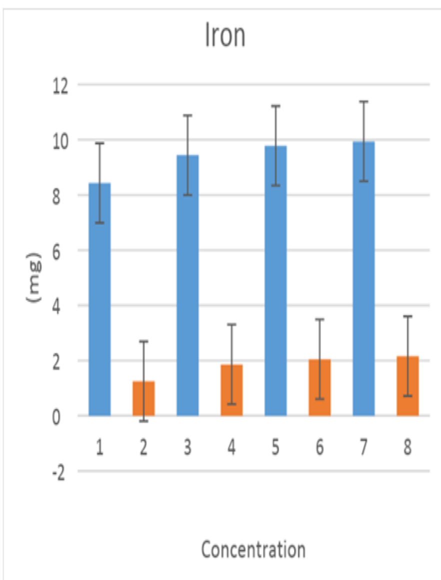
Table 2: Mineral Analysis for Chocolate and Cake

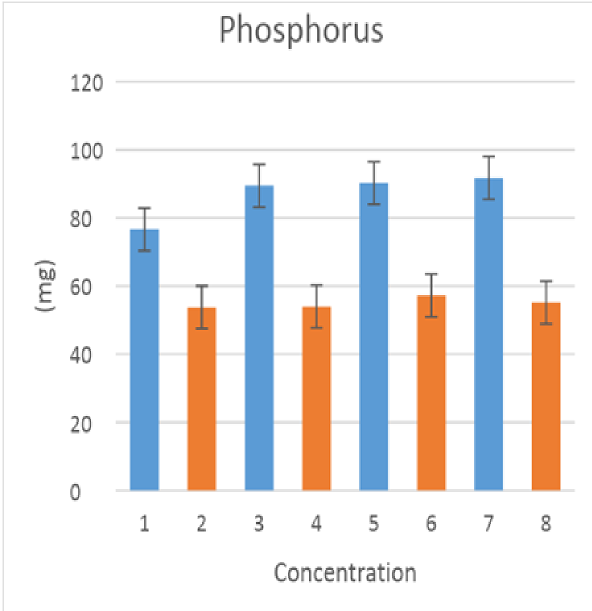
Analysis	Control		10%		15%		20%	
	Chocolate	Cake	Chocolate	Cake	Chocolate	Cake	Chocolate	Cake
Calcium (mg)	43.13 ± 0.50	26.71 ± 0.02	47.73 ± 0.04	27.21 ± 0.02	48.75 ± 0.05	27.43 ± 0.04	49.22 ± 0.03	26.43 ± 0.04
Potassium (mg)	558.55 ± 0.30	32.44 ± 0.03	587.90 ± 0.61	35.26 ± 0.04	589.20 ± 0.07	35.64 ± 0.05	599.73 ± 0.03	35.21 ± 0.01
Phosphorus (mg)	76.64 ± 1.94	53.76 ± 0.02	89.44 ± 0.31	53.99 ± 0.07	90.24 ± 0.03	57.25 ± 0.02	91.74 ± 0.04	55.16 ± 0.07
Iron (mg)	8.43 ± 0.04	01.25 ± 0.05	9.44 ± 0.03	1.86 ± 0.03	9.78 ± 0.03	2.05 ± 0.03	9.94 ± 0.08	2.16 ± 0.07

Figure 2: Mineral Analysis for Chocolate and Cake




Calcium
(mg)
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
Concentration


Iron
(mg)
12
10
8
6
4
2
0
-2
1
2
3
4
5
6
7
8
Concentration

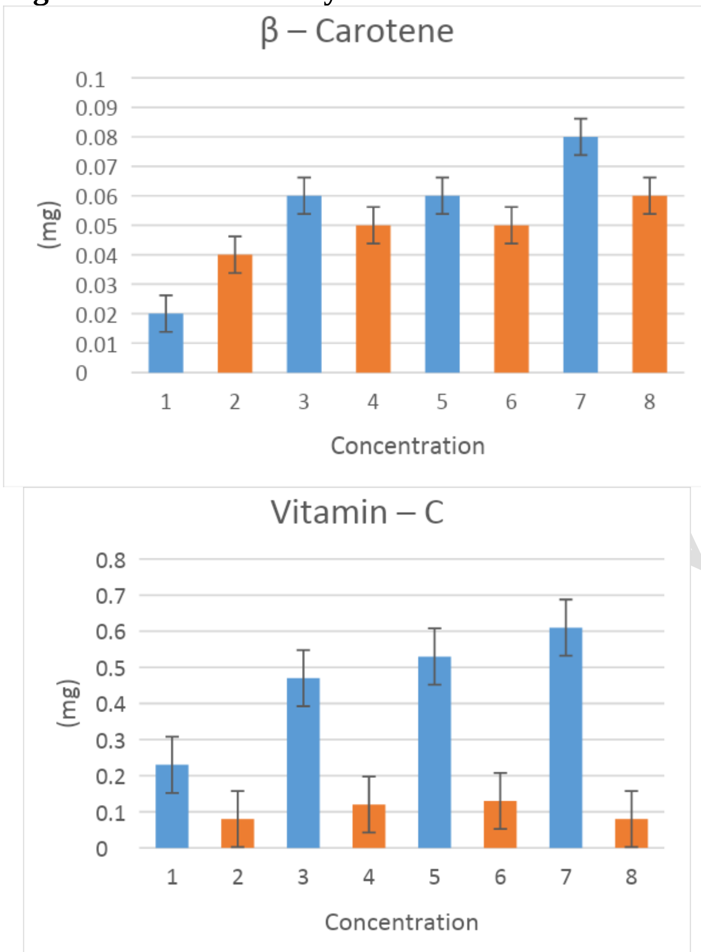


The Iron content for control is (8.43 ± 0.04, 01.25 ± 0.05), 10% (9.44 ± 0.03, 1.86 ± 0.03), 15% (9.78 ± 0.03, 2.05 ± 0.03) and 20% (9.94 ± 0.08, 2.16 ± 0.07). With increasing levels of MOLP in the flour blend, the iron concentration increased considerably. This was to be predicted, given the high iron content of *Moringa* leaves and ripe bananas (Fuglie, 2005; Bibiana et al., 2014). Gernah and Sengev (2011) found 26.20 mg/100g iron in *Moringa* leaf powder, and Barminas et al., 1998 found 454.00 mg/100g calcium and 450.60 mg/100g magnesium in *Moringa* leaf powder.

4.3 Vitamin Analysis

The vitamin analysis is carried out for β – Carotene and Vitamin – C. In β – Carotene the control is (0.02, 00.04), 10% (0.06, 0.05), 15% (0.06, 0.05) and 20% (0.08, 0.06).

Figure 3: Vitamin Analysis for Chocolate and Cake



In Vitamin- C analysis the control is (0.23, 00.08), 10% (0.47, 0.12), 15% (0.53, 0.13) and 20% (0.61, 0.08). Gernah and Sengev, 2011 also reported a high value of 5232.40 mg/100g total carotenoids for *Moringa* leaf powder (Table 3 and Figure 3).

Table 3: Vitamin Analysis for Chocolate and Cake

Analysis	Control		10%		15%		20%	
	Chocolate	Cake	Chocolate	Cake	Chocolate	Cake	Chocolate	Cake
β – Carotene (mg)	0.02 ± 0.00	00.04 ± 0.00	0.06 ± 0.00	0.05 ± 0.00	0.06 ± 0.00	0.05 ± 0.00	0.08 ± 0.00	0.06 ± 0.00
Vitamin – C (mg)	0.23 ± 0.02	00.08 ± 0.02	0.47 ± 0.01	0.12 ± 0.03	0.53 ± 0.02	0.13 ± 0.01	0.61 ± 0.02	0.08 ± 0.02

4.4 Sensory analysis

The Sensory analysis for colour and appearance in control (Dark Brown Colour, Smooth, Bright Surface and Light Brownish Green), 10% (Dark Brown Colour, Smooth, Bright Surface and Light Greyish Green), 15% (Lower Dark Brownish Colour, Air Bubbles (Small Numbers) and Dark Brownish Green) and 20% (Lower Dark Brownish Colour, Air Bubbles (Small Numbers) and Dark Brownish Green). Smell for each concentration is flavoured. Taste for control is Sweet, 10% is Sour, 15% and 20% is bitter. The mouth feel for different concentration is Sour and Sweet with Bitterness. In overall acceptability control and 10% is acceptable and 15%, 20% is not acceptable. The colour score of the control and *moringa* enriched biscuits agrees with Galla et al., (2017), who found a colour score of 8.33 to 6.63 for spinach powder supplemented cookies. Other studies have backed up the findings of the current study. Batista et al. (2017) conducted study on green algae integration in cookies. The green colour of the cookies, according to their findings, had a unique and appealing appearance and was well received by the consumer. The findings of this study correspond with those of Gramza-Michalowska et al., (2016), who found a substantial change in the colour score of cookies supplemented with green and yellow tea leaves.

5. Conclusion

Two samples (Chocolate and Cake) were prepared and tested for different parameters such as nutritional analysis, mineral analysis, Vitamin analysis and Sensory analysis. Compared to each and every results of chocolate and cake, chocolate shows better activity. AS the chocolate shows more activity the nutrient analysis for moisture is (1.36, 1.56, 1.73 and 1.96 g/100g), Ash is (3.44, 3.75, 3.96 and 4.03 g/100g), Protein is (8.25, 9.25, 9.87 and 10.01 g/100g) and Fat is (36.38, 30.47, 28.29 and 27.22 g/100g) results were listed in different concentration such as control, 10%, 15% and 20%. In mineral Analysis Calcium is (43.13, 47.73, 48.75 and 49.22 mg), Potassium is (558.55, 587.90, 589.20 and 599.73 mg), Phosphorus (76.64, 89.44, 90.24 and 91.74) and Iron (8.43, 9.44, 9.78 and 9.94). Vitamin analysis for β – Carotene is (0.02, 0.06, 0.06 and 0.08 mg) and Vitamin – C (0.23, 0.47, 0.53 and 0.61 mg). It may be inferred that *moringa* leaves powder can be employed as a functional ingredient in food items based on the results of *moringa* leaves powder. The nutritional analysis, mineral analysis, and vitamin analysis of chocolate and cake treated with 10% *moringa* leaves powder increased significantly. Both the chocolate and the cake had sensory scores that were satisfactory. Because the different content of chocolate and cake increased by 10%, more research should be done to identify the microbiological analysis of the chocolate and cake.

References

Liu S., Manson J.E., Lee I.M., Cole S.R., Hennekens C.H., Willett W.C. and Buring J.E. (2000). Fruit and vegetable intake and risk of cardiovasculardisease: the women's health study. American Journal of Clinical Nutrition, 72:922–8.

Adenipekun C.O and Oyetunji O.J (2010) Nutritional value of some tropical vegetables. Journal of Applied Bioscienes, 35: 2294-2300.

Martin, L. P. (2007). "The Moringa Tree". ECHO Technical Note. North Forth Myers, USA.

Balbir, M. (2006). Moringa for cattle fodder and plant growth. Trees for Life.

Fahey, J. (2005). 'Moringa oleifera: A review of the Medical Evidence for its Nutritional, Therapeutic, and Prophylactic Properties Part 1', Trees for Life Journal.

Serrano, E.L.; Powell, A. Healthy Eating for Children Ages 2 to 5 Years Old: A Guide for Parents and Caregivers; Virginia State University: St. Petersburg, FL, USA, 2013.

Huffman, S.L.; Piwoz, E.G.; Vosti, S.A.; Dewey, K.G. Babies, soft drinks and snacks: A concern in low-and middle-income countries? Matern. Child Nutri. 2014, 10, 562–574.

Ben, J.K.; Bouaziz, F.; Zouari-Ellouzi, S.; Chaari, F.; Ellouz-Chaabouni, S.; Ellouz-Ghorbel, R.; Nouri-Ellouz, O. Improvement of texture and sensory properties of cakes by addition of potato peel powder with high level of dietary fiber and protein. Food Chem. 2017, 217, 668–677.

Atef, A.M.A.Z.; Mostafa, T.R.; Al-Asklany, S.A. Utilization of faba bean and cowpea flours in gluten free cake production. Aust. J. Basic Appl. Sci. 2011, 5, 2665–2672.

Ameh, M.O.; Gernah, D.I.; Igbabul, B.D. Physico-chemical and sensory evaluation of wheat bread supplemented with stabilized undefatted rice bran. Food Nutr. Sci. 2013, 4, 43.

World Health Organization. Set of Recommendations on the Marketing of Foods and Non-Alcoholic Beverages to Children; World Health Organization: Geneva, Switzerland, 2010.

Association of Official Analytical Chemists (AOAC). Official Methods of Analysis, 19th ed.; Association of Official Analytical Chemists: Arlington, VA, USA, 2012.

Association of Official Analytical Chemists (AOAC). Official Methods of Analysis, 18th ed.; Association of Official Analytical Chemists: Arlington, VA, USA, 2005.

Official methods of analysis. 17th ed. Association of Official Analytical Chemists. Arlington, VA. AOAC. (2006).

- Ranganna S. Proximate constituents. Handbook of analysis and quality control for fruit and vegetable products. 2001; 2:12-17.
- Cheng, Y.F. and R. Bhat. 2016. Functional, physicochemical and sensory properties of novel cookies produced by utilizing underutilized jering (pithecellobium jiringa jack.) legume flour. Food Biosci, 14: 54-61.
- Sharma, P., V. Velu, D. Indrani and R. Singh. 2013. Effect of dried guduchi (Tinospora cordifolia) leaf powder on rheological, organoleptic and nutritional characteristics of cookies. Food Res. Int., 50(2): 704-709.
- Premi, M. and H. Sharma. 2018. Effect of drumstick leaves powder on the rheological, micro-structural and physico-functional properties of sponge cake and batter. J. Food Meas. Charact., 12(1): 11-21.
- Adeola, A.A. and E.R. Ohizua. 2018. Physical, chemical, and sensory properties of biscuits prepared from flour blends of unripe cooking banana, pigeon pea, and sweet potato. Food Sci. Nutr., 6(3): 532-540.
- Sanchez-Machado, D.I., J.A. Nunez-Gastelum, C. Reyes-Moreno, B. Ramirez-Wong and J. Lopez-Cervantes. 2010. Nutritional quality of edible parts of moringa oleifera. Food Anal. Methods, 3(3): 175-180.
- Miller, R., R. Chavan, K. Sandeep, S. Bhatt, K. Tiefenbacher, C. Wrigley, S. Zydenbos, V. Humphrey-Taylor, C. Wrigley and S. Cauvain. 2016. Biscuits, cookies and crackers: Nature of the products.
- Kaur, M., V. Singh and R. Kaur. 2017. Effect of partial replacement of wheat flour with varying levels of flaxseed flour on physicochemical, antioxidant and sensory characteristics of cookies. Bioact. Carbohyd. Diet. Fibre, 9: 14- 20.

- Shokery, E., M. El-Ziney, A. Yossef and R. Mashaly. 2017. Effect of green tea and moringa leave extracts fortification on the physicochemical, rheological, sensory and antioxidant properties of set-type yoghurt. J. Adv. Dairy Res., 5(179): 2.
- Udofia, I. and Obizoba I.C. (2005). Effects of sun and shade drying on nutrient and antinutrient content of some green leafy vegetables consumed in Uyo communities, Akwa Ibom state. Journal of Biochemical Investigation, 3(1), 1-5.
- Fuglie, L.J. The Moringa Tree: A local solution to malnutrition. Church World Serv. Senegal 2005, 5, 75–83.
- Bibiana, I.; Grace, N.; Julius, A. Quality evaluation of composite bread produced from wheat, maize and orange fleshed sweet potato flours. Am. J. Food Sci. Tech. 2014, 2, 109–115.
- Ma, Z.F.; Ahmad, J.; Zhang, H.; Khan, I.; Muhammad, S. Evaluation of phytochemical and medicinal properties of Moringa (Moringa oleifera) as a potential functional food. S. Afr. J. Bot. 2020, 129, 40–46.
- Kraithong, S.; Issara, U. A strategic review on plant by-product from banana harvesting: A potentially bio-based ingredient for approaching novel food and agro-industry sustainability. J. Saudi Soc. Agric. Sci. 2021, in press.
- Gernah D. I. and A. I. Sengev, "Effect of Processing on Some Chemical Properties of the Drumstick Tree (Moringa oleifera) Leaves," Nigerian Food Journal, Vol. 29, No. 1, 2011, pp. 70-77.
- Barminas J. T., M. Charles and D. Emmanuel, "Mineral Composition of Non-Conventional Leafy Vegetables," Plant Foods for Human Nutrition, Vol. 53, No. 1, 1998, pp. 29-36.
- Yang R., L. Chang, J. Hsu, B.B.C. Weng, C. Palada, M.L. Chadha, V. Levasseur, Nutritional and functional properties of moringa leaves from germplasm, to plant, to food, to health, Am. Chem. Soc. (2006) 1–17.
- Baker K., C.B. Marcus, K. Huffman, H. Kruk, B. Malfroy, S.R. Doctrow, Synthetic combined superoxide dismutase/catalase mimetics are protective as a delayed treatment in a rat stroke model: a key role for reactive oxygen species in ischemic brain injury, J. Pharmacol. Exp. Ther. 284 (1998) 215–221.

Galla, N.R., P.R. Pamidighantam, B. Karakala, M.R. Gurusiddaiah and S. Akula. 2017. Nutritional, textural and sensory quality of biscuits supplemented with spinach (Spinacia oleracea L.). Int. J. Gastronomy Food Sci., 7: 20- 26.

Batista, A.P., A. Niccolai, P. Fradinho, S. Fragoso, I. Bursic, L. Rodolfi, N. Biondi, M.R. Tredici, I. Sousa and A. Raymundo. 2017. Microalgae biomass as an alternative ingredient in cookies: Sensory, physical and chemical properties, antioxidant activity and in vitro digestibility. Algal Res., 26: 161-171.

Gramza-Michałowska, A., J. Kobus-Cisowska, D. Kmiecik, J. Korczak, B. Helak, K. Dziedzic and D. Górecka. 2016. Antioxidative potential, nutritional value and sensory profiles of confectionery fortified with green and yellow tea leaves (camellia sinensis). Food Chem., 211: 448-454.