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Nutritional Composition, Mineral analysis and Sensory Evaluation of Cake and Chocolate with *Moringa oleifera* Leaf Powder

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Moringa oleifera is a plant native to India that thrives in tropical and subtropical climates around the world. Moringa is commonly farmed around the world because it can resist both severe drought and moderate winter. 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), 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,

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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* leaf 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.

1. INTRODUCTION

Anaemia affects roughly a third of the world's population; half the cases are due to iron deficiency. It is a major and global public health problem that affects maternal and child mortality, physical performance, and referral to health-care professionals. 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 [1]. 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 [2]. 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 [3].

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 [4]. 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 [5]. 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, cataracts, degenerative disorders, and obesity [6].

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 Moringaceae species. It is native to India, but it has been planted and naturalised all over the world [7,8]. 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 [9]. *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 [10]. 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, mineral analysis, vitamin analysis and sensory analysis of dry *M. oleifera* leaf powder.

2. MATERIALS AND METHODS

2.1 Raw Material Preparation

M. oleifera was collected 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.

2.2 Nutritional Analysis

2.2.1 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 [11].

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

2.2.2 Determination of ash content

A 5 g homogenized 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 [11]. The proportion of ash in the sample was calculated using the formula below

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

2.2.3 Determination of crude protein

The AOAC 990.033 Process was used to determine the crude protein content of the cake samples [12]. 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

2.2.4 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

2.3 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).

2.4 Vitamin Analysis

2.4.1 Estimation of vitamin C

The vitamin C content of the sample was tested using the AOAC, 2006 technique. Pipetted 5 mL of the working standard solution into a 100 mL conical flask, followed by 10mL of 4% oxalic acid, and titrated 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 (100 ml), and centrifuged. Pipetted off 5 mL of the supernatant, add 10 mL of 4% oxalic acid, and titrated against the dye (V2 ml).

2.4.2 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 [13].

2.5 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 [14].
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.

3. RESULTS AND DISCUSSION

3.1 Nutritional Analysis

The samples Cake and chocolate were prepared and tested for different nutritional parameters, mineral analysis, Vitamin analysis and Sensory evaluation. Table 1 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 [15]. Shokery *et al*. [16] found dry *Moringa* leaf powder to have a similar moisture content (8.81%). The decreased moisture level of the leaf 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* leaf powder had 12.98 percent. Kaur *et al*. [17] discovered a similar ash concentration in whole wheat flour. Miller *et al.* [18] reported a 0.96 percent ash concentration in wheat flour. Our results for ash content of *Moringa* leaf powder are consistent with those of Sanchez-Machado *et al*. [19], who found that *Moringa* leaf 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* leaf powder, the protein level increased (7.86-8.30 percent) [20]. 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 [21]. *Moringa* leaf are extremely high in protein content, which could be due to the increased protein content of the fortified cake [22]. Yang *et al.,* [23] 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 [24]. In contrast to our findings, Sharma *et al*. [25] found that guduchi leaf powder enriched biscuits had a fat level of 17.24 to 16.865 percent.

3.2 Mineral Analysis

Were measured the following minerals 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. 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 [26,27].

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

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

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

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 [28,29]. Gernah and Sengev [30] 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.

3.3 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). 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, [30] also reported a high value of 5232.40 mg/100g total carotenoids for *Moringa* leaf powder (Table 3).

3.4 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.,* [31], 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.* [32] 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 [33-35].

4. 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* leaf powder can be employed as a functional ingredient in food items based on the results of *Moringa* leaf powder. The nutritional analysis, mineral analysis, and vitamin analysis of chocolate and cake treated with 10% *Moringa* leaf 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.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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