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Formulation and quality evaluation of *Moringa* leaves powder and development of value-added products

Yashasvi Rathore, Dr. Sumitra Meena and Dr. Priyanka Joshi

Abstract
Moringa oleifera is a plant native to the Indian subcontinent that has become naturalised in tropical and subtropical regions around the world and is a fast-growing, drought resistant tree also known as the drumstick tree, horseradish tree, and ben oil tree or benzolive tree that can be eaten and is extremely safe. For the formulation of *Moringa* leave powder fresh green leaves were collected from the campus which were blanched in boiling water at 100-degree Celsius for 5 minute and immersed in cold water for 2 minutes and then the blanched leaves were dried in shade to avoid loss of nutrients. The formulated *Moringa* leaves were analyzed for their physical properties such as bulk density, swelling capacity and index, hydration capacity and index. The bulk density of MLP was 179.6 g/ml swelling capacity was 3.40 ml/g, swelling index was 0.09 g/ml, hydration capacity was 3.39% and hydration index was 0.07. the nutritional composition and anti-nutritional factors were analyzed on the basis of moisture which was 6.33 g/100 g, crude fibre was 9.53 g/100 g, crude protein was 24.18 g/100 g, crude fat was 3.43 g/100 g, ash was 8.4 g/100 g, carbohydrate was 48.22 g/100 g, energy was 365.2 kcal, calcium was 94.52 mg/100 g, iron was 12 mg/100 g and phytic acid was 0.48 mg/100 g. In the lab, a variety of products were prepared using powdered *Moringa* leaves. all value-added products developed from *Moringa* leaves powder with 5%, 10% and 15% incorporation were assessed for their sensory characteristics *viz*. colour, flavor, taste, texture, appearance and overall acceptability. The mean score for overall acceptability of *mathri* was ranged from 6.60-8.50 for all the trials. Mean scores for overall acceptability of muffins was varied from 7.40-8.10 however, maximum scores were noted for control while, minimum was detected for T_3. The mean score for overall acceptability of multigrain bread was ranged from 6.80-8.00 for all the trials. The mean overall acceptability of idli ranged from 7.00-8.20 and the mean overall acceptability of chapatti was ranged from 6.40-8.10.

Keywords: *Moringa oleifera*, drumstick tree, horseradish tree

Introduction
Moringa oleifera is a plant native to the Indian subcontinent that has become naturalised in tropical and subtropical regions around the world (Busani *et al*., 2011) [10] and is a fast-growing, drought-resistant tree also known as the drumstick tree, horseradish tree, and ben oil tree or benzolive tree that can be eaten and is extremely safe (Stohs & Hartman, 2015) [26]. In common language it's also known as "sahajan" (Malemnganbi & Singh, 2021) [9]. *Moringa* is world's most useful trees which is used for various purpose such as food medicine and in industries (Busani *et al*., 2011) [10]. There are 13 species that have been identified, with the Indian-born *Moringa oleifera* being one of the most researched and used for its pharmacological, phytochemical, and nutritional properties. Ayurvedic medicine claims (traditional and alternative medicine of India) (Milla *et al*., 2021) [8]. It thrives in arid and semi-arid regions and can withstand extended droughts. It is a very adaptable species that lives for about 20 years and can grow up to 10 metres tall in a short amount of time, reaching 4 metres in just six months. Due to its excellent ability to produce edible food, which includes a variety of vegetative structures, including leaves, pod shells, stems, flowers, fruits, and seeds, it is regarded as a very adaptable plant (Milla *et al*., 2021) [8]. Its leaves, pods, seeds, gums, bark, and flowers are used in over 80 countries to treat mineral and vitamin deficiencies, support a healthy cardiovascular system, number of chronic diseases, such as inflammatory diseases, neuro-dysfunctional diseases, diabetes, and cancer (Kou *et al*., 2018) [30]. Enhance regular blood levels, neutralise free radicals, thereby reduce malignancy, provide excellent support of the body's anti-inflammatory mechanisms, enrich anaemic blood, and support the immune system (Mahmood *et al*., 2010) [32]. *Moringa* has been used in traditional medicine for centuries in many cultures around the world, for skin infections, anaemia, anxiety, asthma, blackheads, blood impurities, bronchitis, catarrh, chest congestion, cholera, conjunctivitis

Cough, diarrhoea, eye and ear infections, fever, glandular, swelling, headaches, abnormal blood pressure, hysteria, pain in joints, pimples and respiratory disorders. (Mahmood *et al*., 2010) [32].

Objectives

1. To formulate *Moringa* leaves powder.
2. To analyze the physio-chemical properties and nutritional analysis of *Moringa* leaves powder by using standard methods.
3. To develop value-added products of *Moringa* leaves powder and their sensory evaluation.

Methodology

Formulation of *Moringa oleifera* leaves powder

Drying of leaves

- **Collection:** The leaves were collected from the university campus
- **Sorting:** Fresh, green undamaged leaves were collected to produce the best quality powder.
- **Cleaning and washing:** The stalk of the leaves was cut from the main branches and were washed 3-4 times with plenty of water to remove all the adhering dust, and dirt particles.
- **Blanching and Drying:** *Moringa oleifera* leaves were immersed in boiling water at 100 ºC for 5 minutes and then it was immersed in cold water for 2 minutes. Blanched leaves were dried in neat and clean dust free dark shadow place at temperature ranged from 25-30 ºC. The leaves were completely dried in 24-38 hours. Dried them till leaves became brittle and crushed easily.

Grinding of leaves: Dried leaves were ground into fine powder

Storage: *Moringa oleifera* leaves powder were stored in airtight containers protected from humidity, heat, and light to avoid the growth of molds at room temperature.

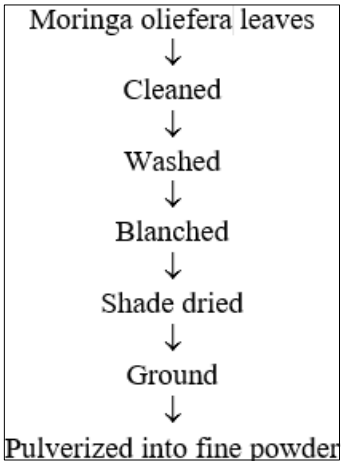

Fig 1: Flow diagram of formulation of *Moringa* leaves powder

Assessment of physical properties of *Moringa* leaves powder using standard methods

Physical properties: The following standard approach was used to analyze the physical characteristics of *Moringa oleifera* leave powder.

- Bulk density
- Hydration capacity and Hydration index.
- Swelling capacity and swelling index

Bulk density: The method recommended by Okaka and Potter (1977) [33] was used to determine the bulk density of *Moringa oleifera* leave powder. A 100 ml graduated cylinder containing 50 grams of powder was filled with the substance and packed by gently tapping the cylinder 20 to 30 times from a height of 5 to 6 cm on the bench top. The weight per unit in grams per milliliter was used to express the bulk density of powder.

$$\text{BD} = \frac{\text{Weight of Sample (g)}}{\text{Volume of Sample (ml)}}$$

Hydration capacity and hydration index: *Moringa* leave powder's capacity for hydration was calculated using the techniques described by Bishnoi and Khetarpal (1993) [42]. 100 ml of water and 50 grams of *Moringa* leave powder were placed to a clean, dry beaker. After giving the *Moringa* leave powder sample a light stir, aluminum foil was placed on top, and it was left at room temperature overnight. The subsequent day, extra water was filtered out using filter paper, and the weight change was noted. The difference between the weight of the *Moringa* leave powder after and before soaking was used to compute the hydration capacity, which was then divided by the sample's initial weight.

$$\textit{Hydration Capacity}\ (\%) = \frac{\text{Weight after soaking (g)} - \text{Weight before soaking(g)}}{\text{Weight of sample (g)}}\ x\ 100$$

Weight of sample (g)

$$\text{Hydration Index} = \frac{\text{Hydration capacity per gram leave powder}}{\text{Weight of one grame leave powder}}$$

Swelling capacity and swelling index: The *Moringa oleifera* leave powder's swelling capacity was roughly calculated in accordance with Bishnoi and Khetrapal's (1993) [42] description. Weighing a 3 gram of sample powder into 50 ml clean, dry graduated measuring cylinders allowed measuring the swelling capacity. Before adding 30 ml of distilled water, the powder sample was gently leveled, and its volume was recorded. The volume change was measured after the cylinder had been physically spun and left to stand for one to two hours. The difference in volume between the sample's after and before soaking in the cylinder was used to compute the powder's swelling capacity, which was then divided by the sample's original weight.

$$\text{Swelling capacity}\left(\frac{\text{ml}}{\text{g}}\right) = \frac{\text{Volume after soaking(ml)} - \text{Volume before soaking (ml)}}{\text{Weight of sample(g)}}\ x\ 100$$

Weight of sample (g)

$$\text{Swelling index} = \frac{\text{Swelling capacity per gram leave powder}}{\text{Volume of one gram leave powder}}$$

Assessment of chemical properties of *Moringa* leaves powder

Numerical data regarding the amount of nutrient in a measured quantity of food is provided by quantitative analysis of the nutrient composition of *Moringa oleifera* leaf powder. For proximate composition (moisture, carbohydrates, crude protein, fat, crude fibre, and ash), nutritional evaluation of *Moringa oleifera* leaf powder was performed using standard procedure for estimation. The carbohydrate content of

Moringa oleifera leave powder sample was calculated using a different method, while minerals (iron, calcium) were analyzed using standard procedure. Analyses of *Moringa oleifera* leave powder's anti-nutritional factor (phytate) was also assessed. Below is the way the process has been laid out.

Proximate composition

Moisture: The standard method of analysis was adopted to estimate the moisture content (AOAC, 2012) [43].

Procedure: A sample of 5 grams was placed in a petri dish, dried in a hot air oven at 100 °C to a constant weight, and the percentage of moisture in the sample was measured.

$$\text{Moisture}\left(\frac{g}{100g}\right) = \frac{\text{initial weight (g)} - \text{final weight (g)}}{\text{Weight of the sample (g)}} x\ 100$$

Crude fibre: The estimation of crude fibre was performed using a standard analytical method (AOAC, 2012) [43].

Reagents

1.25% H2SO4 (W/V) solution
1.25% NaOH (W/V) solution

Procedure

A sample free of moisture and fat, weighing about 2 grams, was transferred to a beaker of 1 litre. 200 ml of Sulphuric acid 1.25% were added and placed on a hot plate for 30 minutes and allowed to reflux. 5 minutes later, shake the contents. After 30 minutes of boiling, remove the beaker from the hot plate and suction-filter the liquid through muslin fabric. Wash the residue in hot water until the acid is removed. Added 200 ml of a 1.25% NaOH solution to the beaker after transferring the material inside. Reflux the contents again for 30 minutes. Used a vacuum or suction pump to filter the Muslin fabric once more, then washed the residue in hot water to remove any remaining alkali (A wash of residue on Muslin cloth with dilute HCl before washing with hot water facilitates removal of alkali). Transferred the entire residue to a crucible, put it in a hot air oven, let it dry to a consistent weight between 80 and 110 degrees Celsius, and then the weight was recorded. The residue was ignited in a muffle furnace at 550–600 °C for 2–3 hours, cooled, and weighed once again. Crude fibre compensates up for the weight dropped during ignition.

$$\text{Crude fibre}(\%) = \frac{\text{Wegith of sample after ignition}}{\text{Wegith of Sample Taken}}\ \text{x}\ 100$$

Crude protein: The Micro kjeldahl technique was used to determine crude protein (AOAC, 2012) [43].

Reagents

Sulphuric acid: concentrated and nitrogen free
Hydrochloric acid: 0.01N standardized Boric acid solution (40%): dissolved 400 g of boric acid in distilled water and diluted to one litre Sodium hydroxide solution (40%): dissolved 400 g of carbonate free sodium hydroxide (NaOH) in distilled water and diluted to one litre.
Copper Sulphate catalyst: Mixed copper sulphate (CuSO4:5H2O) and potassium sulphate in ratio of 1:9
Mixed indicator solution: dissolved 2 g of methyl red and one g methylene blue or bromo-cresol green in 1litre of ethanol. In dark brown bottle.

Boiling regulator: Glass beads (for digestion)

Procedure

Digestion

A few boiling regulators and a little amount of the catalytic salt solution were added to the Kjeldhal flask. Place two grams of the sample in the Kjeldhal flask. Swirled the liquid gently while adding 20 ml of sulphuric acid. Until the liquid was clear and of a light blue green colour, the sample was digested by vigorously boiling it while frequently turning the flask. Added 50 ml of water after cooling. To produce 100 ml in a volumetric flask, combine, let cool, and then dilute.

Distillation

150 ml conical flask was filled with 10 ml of boric acid solution. Two to three drops of mixed indicator Maintain contact between the condenser and the flask. A two-ml portion of an aliquot was transferred to the distillation flask, and the inlet was washed with water. 10 ml of a NaOH solution were added to the distillation unit, and then the inlet was stopped. 0.1N HCL was used to titrate the flask's contents after distilling the sample. The amount of HCL used was noted. Likewise, a blank solution was run. Total nitrogen (%) was multiplied by a factor of 6.25 to determine the amount of crude protein.

Ash

By applying the authorized analysis method, ash in the sample was determined (AOAC, 2012) [43].

Procedure

Two grams of dry sample was weighed in a crucible, and it was ignited until no charred material was left. Once a white Ash had been formed, the crucible was placed in the muffle furnace (550 °C) for 6 hours. Reweighed after cooling the crucible in a desiccator. The amount of ash was determined by the crucible's weight loss.

Crude fat: Soxhlet technique was applied to calculate crude fat (AOAC, 2012) [43].

Reagents: Petroleum ether (boiling range 40- 60 degree centigrade)

Procedure

5 grams of the powdered sample was placed in an extraction thimble. Place the thimble in the extractor and the associated weighted flask with 100ml of petroleum ether. The material was extracted under reflux for 5–6 hours after being connected to the reflex condenser. After six hours of extractions, the thimble was taken out of the extraction device and dried in a hot air oven to a constant weight before being cooled to room temperature in a desiccator and weighed. Thimble weight loss revealed the level of fat in the sample.

Carbohydrates

On a dry weight basis, the sample's carbohydrate content was determined using a difference approach. (Jain and Mogra, 2006) [35] Described below:

Carbohydrates (g/100g) = 100- (moisture + crude fibre + ash + protein + fat)

Energy

Physiological fuel value i.e., 4, 9, 4 kcal per gram of protein, fat, and carbohydrate, was used to determine the energy value of the sample.

Energy (kcal/100g) = [(%protein×4) + (% carbohydrate × 4) + (% fat×9)]

Anti-nutritional factors

Antinutritional variables have an impact on the digestion and nutrient quality of plant nutrients. Following test was done to estimate the antinutritional factor in the leaves to improve the nutritional availability and digestibility in develop product

Phytate

Phytic acid content of the sample was calculated using the Jain and Mogra method (2006) [35]. A conical flask containing one gram of totally dry material was filled with 50 ml of HCl. The mixture was filtered after 3 hours of shaking in a shaker. The resulting clear filtrate was reduced to 25 ml over a water bath. By adding the necessary amount of sodium hydroxide, the filtrate was neutralized. The liquid was then heated over a water bath for 15 minutes with 10 ml of 0.01 percent ferric chloride, cooled to room temperature, and then filtered one more time using pre-weighed filter paper. After washing with ethanol, the residue was cleaned with ether. The filter paper was weighed after drying.

$$\text{Phytin phosphorus (g)} = \frac{\text{weight of ferric phytin (B - A)}}{\text{weight of sample(g)}} \; x\; 100$$

Where
A= weight of filter paper (g)
B= weight of filter paper with ferric phytin (g)

Mineral profile

Using the wet ashing method, the mineral solution of a selected sample was produced by Jain and Mogra (2006) [35]. In order to create a clear, white precipitate that had a specific volume, leave powder was digested using a variety of acids. This was used to determine the presence of specific minerals using an aliquot.

Wet Ashing

5 ml of concentrated HNO3 was added to a one-gram moisture-free sample that had been placed in a digestion tube, which was then left overnight. After being gradually heated for 30 minutes, it was cooled. In order to completely digest the particles and purify the solution, 5 ml of 70% perchloric acid was added and heated over the digestion block. During digestion, 50 ml of the digested materials were formed using double-distilled water. Prepared mineral solution was preserved in cosmetic bottles and Mineral analysis was carried out using an atomic absorption spectrophotometer (AAS4141).

Iron: Iron content of *Moringa oleifera* leaf powder was examined by using atomic absorption spectrophotometer.

Procedure

Diluted sample was drawn up in the atomizer burner assembly through a capillary and transformed into a fine spray using a stream of compressed air after a large droplet condensed, mixed with acetylene, and burned in a long flame. This fine spray then entered a monochromatic wave that was set at an element's unknown wavelength and fell on the photo multiplier tube (photocells). The light radiation was transformed into electrical energy in this tube, which was then measured using a galvanometer.

Fe (ppm) = ppm Fe (from calibration curve) × V/Wt

Where
V= total volume of the leave powder digest (ml)
Wt= weight of leave powder (g)

Calcium

It was determined by titrimetric method (Cheng and Bray 1951) [34]. Ethylenediaminetetra acetic acid (EDTA) solution (0.01N) solution.

Procedure

A digested sample of 5ml was collected in conical flasks. 1ml of 4N NaOH and 50 mg of ammonium purpurate indicator were added to the mineral solution. 0.01N EDTA solution was used to titrate the material. The transition of the colour from orange red to lavender purple represented the readings at the finish point.

The following formula was used to determine the calcium content

Meq. /litre of ca ++ = {ml versante solution (EDTA) required} × normality of versante solution

Development and Standardization of value-added product using *Moringa* leaves powder

Standardization was done in term of ingredients, amount, processing steps and sensory qualities of products. For the purpose basic ingredients were replaced with *Moringa oleifera* leave powder in different proportion to find out best combination for preparing each product

Different products were developed from *Moringa oleifera* leaves powder and were standardized using its different proportions (5%, 10%, 15%).

The following products were developed

1. *Mathri*
2. Muffins
3. Idli
4. Multigrain bread
5. Chapati

Table 1: The products were as follows. Multigrain bread

S. No.	Ingredients (g)	Percent Replacement			
		Control	T_1 (5%)	T_2 (10%)	T_3 (15%)
1	Wheat Flour	30	28.5	27	25.5
2	Jowar flour	30	28.5	27	25.5
3	Kala Chana flour	25	23.5	22.5	21.25
4	Ragi flour	15	14.75	13.5	12.75
5	Refined flour	100	100	100	100
6	*Moringa* leave powder	-	5	10	15
7	Salt	3	3	3	3

8	Sugar	8	8	8	8
9	Yeast	10	10	10	10
10	Gluten	16	16	16	16
11	Bread Improver	8	8	8	8
12	Water(ml)	100-120	100-120	100-120	100-120
13	Oil(ml)	4	4	4	4

Method

1. Mix all the flour together and sieve them and add *Moringa* leave powder, salt, and pinch of sugar, yeast, bread improver and oil.
2. Mixed all the ingredients and add water accordingly to make dough.
3. Grease the mould properly.
4. Now put the dough in the mould and bake the mixture in the microwave at temp 220℃.
5. Remove the mould from the oven and cut them into piece.

Table 2: Muffins

S.No.	Ingredients (g)	Percent Replacement			
		Control	T_1 (5%)	T_2 (10%)	T_3 (15%)
1	Refined flour	100	95	90	85
2	*Moringa* leave powder	0	5	10	15
3	Curd	120	120	120	120
4	Baking powder	2.0475	2.0475	2.0475	2.0475
5	Baking soda	2.275	2.275	2.275	2.275
6	Sugar (ml)	65.975	65.975	65.975	65.975
7	Oil (ml)	39.8125	39.8125	39.8125	39.8125

Method

1. Preheat oven to 180℃.
2. Take refined flour, *Moringa* leave powder, baking soda, sugar and baking powder sieves them and mix them together.
3. Add curd in the above mixture and gently mix all the ingredients.
4. Grease the mould properly and pour the mixture in it.
5. Place the baking tray in pre heated oven for 18 mins
6. Remove the mould from the oven.

Table 3: Idli

S. No.	Ingredients(g)	Percent Replacement			
		Control	T_1 (5%)	T_2 (10%)	T_3 (15%)
1	Semolina	100	95	90	85
2	*Moringa* leave powder	-	5	10	15
3	Curd	100	100	100	100
4	Salt	2.5	2.5	2.5	2.5
5	Baking soda	1.25	1.25	1.25	1.25
6	Oil (ml)	5	5	5	5
7	Water (ml)	50	50	50	50

Method

1. Sieve the semolina, *Moringa* leave powder and baking soda.
2. Now add curd, salt and mix them well.
3. Add water gradually into the mixture and make a thick batter.
4. Grease the idli stand and pour the batter in the mould one by one.
5. Now put some water in the idli maker for steaming.
6. Place the idli stand between the idli makers for 15-20 min on medium flame.
7. After 15-20 mins check whether it is properly cooked with the help of toothpick if it comes clean then it is cooked if not then cook it for 2-3 mins more.

Table 4: *Mathri*

S. No.	Ingredients (g)	Percent Replacement			
		Control	T_1 (5%)	T_2 (10%)	T_3 (15%)
1	Refined flour	100g	95g	90g	85g
2	*Moringa* leave powder	-	5g	10g	15g
3	Carom seed	2.5	2.5	2.5	2.5
4	Salt	2.5	2.5	2.5	2.5
5	Baking soda	2.5	2.5	2.5	2.5
6	Water (ml)	50	50	50	50

Method

1. Weigh the refined flour and add *Moringa* leave powder, baking soda and sieve them.
2. Add carom seeds, oil and salt to it. Mix them all.
3. Add water into the mixture and prepare dough.
4. Divide them into small balls, roll chapatis and cut strips out of it.
5. Now take pan, pour oil and fry them.

Table 5: Chapati

S. No.	Ingredients(g)	Percent Replacement			
		Control	T1 (5%)	T2 (10%)	T3 (15%)
1	Wheat flour	100	95	90	85
2	*Moringa* leave powder	-	5	10	15
3	Salt	2.5	2.5	2.5	2.5
4	Water (ml)	50	50	50	50

Method

1. Weigh wheat flour and *Moringa* leave powder and sieve them together.
2. Add salt and knead them properly to make soft dough.
3. Divide the dough into small balls
4. Roll the balls and prepare round chapati.
5. Roast them on flat tawa.

Sensory evaluation of value-added products

Sensory evaluation

The sensory evaluation of value-added products developed from *Moringa* leave powder was done using a nine-point hedonic scale with the help of selected panel judges.

Selection of panel members

The panel member was chosen using a threshold test. Ten panel members were selected based on their convenience, experience, knowledge, willingness, and interest. The panel include staff member, PG students from the College of Community and Applied Sciences, MPUAT Udaipur.

Preparation of score card

A score card was developed for product acceptability based on certain qualities sought in food preparation such as appearance, color, taste, texture, flavour and overall acceptability. The judges were given a nine-point hedonic scale (Appendix-I) to score on.

Statistical analysis of data

i) Mean: The mean (average) of a data set is found by adding all numbers in the data set and then dividing by the number of values in the set.

$$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} Xi$$

X_i = Observation
n = no. of observation
i = 1, 2, 3…… n.

ii) Standard deviation: the standard deviation is a measure of the amount of variation or dispersion of a set of values. A low standard deviation indicates that the values tend to be close to the mean of the set, while a high standard deviation indicates that the values are spread out over a wider range.

$$S.D. = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(X - \bar{X})^2}$$

S.D. = standard deviation
X_i= mean of observation
$\bar{X}$ = Mean of Observation
n = no. of observation

iii) Standard error: The standard error of a statistic is the standard deviation of its sampling distribution or an estimate of that standard deviation.

$$S.E = \frac{\sigma}{\sqrt{n}}$$

σ = Standard deviation
n = no. of observations

Result & Discussion

Physical properties

Physical properties are those properties that can be observed or measured without changing the chemical makeup of the material. Physical properties can give us clues about their chemical composition and processing characteristics. The formulated *Moringa* leaves powder was analyzed for their physical properties such as bulk density, swelling capacity, swelling index, and hydration capacity and hydration index.

The Bulk density is one of the important physical property of powders and granules of food materials. It is also called apparent density or volumetric density. The data revealed that the bulk density of MLP was observed to be 179.6 g/ml (Table 6).

The swelling capacity of any product is determined by the amount of water that is absorbed by it. The result presented in Table 6 showed that the MLP had a swelling capacity of 3.40 ml/g which was relatively lower than the values recorded by Mamta (2016) [50], who observed that the swelling capacity of shade dried *Moringa* leaves powder 2.0 ml/g. The swelling index reveals the water absorption capacity of developed powder. Table 6 extrapolates the swelling index of *Moringa* leaves powder was observed to be 0.09.

Hydration capacity (water absorption, water uptake, or water holding or binding) is determined as the maximum amount of water that 1 g of material will imbibe and retain under low-speed centrifugation. The data pertaining to hydration capacity and hydration index of MLP was found to be 3.39 and 0.07.

Singh and Prasad (2013) [45] had characterized various properties of un blanched and blanced *Moringa* leaf powder dried at 60 ºC. They reported that water solubility index and water absorption index was varied from 3.37- 3.91 and 33.15-38.73, respectively.

Table 6: Physical properties of formulated *Moringa* leaves powder

S. no.	Physical properties	Mean ± SD
1.	Bulk Density (g/ml)	179.6±14.83
2.	Swelling Capacity (ml/g)	3.40±0.094
3.	Swelling index	0.09±0.02
4.	Hydration Capacity (%)	3.39±0.241
5.	Hydration Index	0.07±0.09

Proximate and mineral composition

The nutritional composition provides basic information about the components and quality of the products. Hence, proximate

and mineral composition (Ca and Fe) were analyzed to evaluate the nutritional quality of the MLP. The moisture content is one of the most important and commonly measured properties of food products. The results presented in Table 6 indicates that moisture content of MLP was found to be 6.35 g/100g which was relatively lower than the values reported by Okiki *et al*. (2015) [36]. They found that dried leaves of *Moringa* contained appreciable low level of moisture i.e., 7.88% which would prolong the shelf life of powder and also prevent from the harmful effects of microorganism. On the other hand, Sakr *et al*. (2020) [38] observed that relatively higher amount (9.7 g / 100 g) of moisture content in dried *Moringa* leaves.

The crude protein content of MLP was discerned to be 24.18 g/100 g (Table 6) which was relatively lower than the previous findings of Okiki *et al*. (2015) [36] and Gopalakrishanan *et al*. (2016) [28] those found that the protein content of dried leaves of *Moringa* was 28 g/100g and 27.1 g/100 g, respectively. Jongrungruangchok *et al*. (2010) [39] carried out an investigation on protein content of *Moringa Oleifefra* and found that normal protein values were ranged from 19.15% and 28.8%. The variation in protein content in *Moringa Oleifera* may be due to many reasons i.e., varietal difference, weather conditions, state of maturity of the plant and crop management process (Castillo-López *et al*., 2017) [40].

With respect to crude fat content, it was found to be 3.43 g/100 g in MLP (Table 7). Okiki *et al*. (2015) [36], who found that the mean fat content of dried leaves of *Moringa* was 3.88 g/100 g which was in accordance with the researcher value. However, Gopalakrishanan *et al*. (2016) [28] reported that relatively lower (2.3%) value of crude fat content in dried leaves of *Moringa*.

The ash and crude fibre content of MLP was noted to be 8.4 g/100 g and 9.53 g/100 g (Table 7). The values of current finding were relatively lower than the values detected by Okiki *et al*. (2015) [36], who reported the ash and crude fibre content of dried leaves of *Moringa* were 9.88 g and 12.57 g in 100 g. The values showed that *Moringa* leaves contained good amount of inorganic minerals and dietary fibre.

Carbohydrates are compounds made up of sugars and are source of energy for vital metabolic processes. They add flavor to the diet. The carbohydrate content of MLP was observed to be 48.22 g/100 g (Table 7) but this concentration was relatively higher than the earlier studies conducted by Okiki *et al*. (2015) [36], Gopala krishanan *et al*. (2016) [28] and Penalver *et al*. (2022) [46]. Since the carbohydrate content was calculated by difference method, the differences in carbohydrate content may be attributed to the variations in other components like protein, fats, ash and fibre.

It is apparent from the data given in Table 7, the energy value of MLP was observed to be 365 kcal which was calculated on the basis of carbohydrate, protein and fat content of the food.

Minerals are inorganic substances present in all living and non-living things including man, animals, rocks and soil. Their presence in living things is necessary for the maintenance of certain physiological processes (Ozcan, 2003) [37]. Table 7 delineates the mineral content found in MLP. It can be seen that the calcium and Iron of MLP was found to be 94.52 mg/100 g and 12 mg per 100 g. Penalver *et al*. (2022) [46] and Okiki *et al*. (2015) [36] observed that calcium content of MLP was 148 mg/100 g and 82.50 mg/100 g which were relatively more or less than the researcher findings. The nutritional content of *Moringa* were varied due to varietal difference, climacteric condition, fertilizer used and among cultivars.

Table 7: Nutrient composition and anti-nutritional factors of formulated *Moringa* leaves powder

S. No.	Nutrients	Mean ± SD	SE
1	Moisture (g/100 g)	6.33±0.25	0.14
2	Crude Fibre (g/100g)	9.53±0.50	0.29
3	Crude protein (g/100g)	24.18±0.06	0.034
4	Fat (g/100g)	3.43±0.35	0.202
5	Ash(g/100g)	8.4±0.458	0.264
6	Carbohydrate (g/100g)	48.22±0.192	0.110
7	Energy (kcal)	365.2±0.190	0.109
8	Calcium (mg/100g)	94.52±0.2	0.115
9	Iron (mg / 100g)	0.049±0.002	0.001
10.	Phytic acid (mg/100g)	0.48±0.17	0.101

Anti-nutritional factors

Phytic acid also known as inositol hexaphosphate or phytate as a salt, is the storage form of phosphorous in all grains and oil seeds. Data presented in the Table depicts the phytic acid content of MLP was 0.48 mg/100 g which was much higher than the values obtained by Sakr *et al*. (2020) [38], who observed the phytic acid content of dried leaves was 0.014% in 100g. In contrast, Gallaher *et al*. (2017) [8] reported much higher amount i.e., 6.4 g/100 g dry weight of phytic acid in dried *Moringa oleifera* leaves. Gidamis *et al*. (2003) [49] reported the phytic acid content of cooked leaves was 0.23 mg/100 g. The amount of phytate in leaves, grains, nuts, legumes and seeds is highly variable; the levels that researchers find when they analyze a specific food probably depends on growing conditions, harvesting techniques, processing methods, testing methods and even the age of the food being tested. Phytic acid will be much higher in foods grown using modern high-phosphate fertilizers than those grown in natural compost (Srivastava *et al*., 1955) [44].

Value addition and Product development

Value addition to existing diet is an effective way of improving nutrition security. Value can be added to commodity by upgrading its quality, reducing its perishability, extending shelf life, ensuring off season availability, changing their form and purity as required in the market. To get high nutritional value-added products, MLP can be incorporated in different concentration in commonly consumed recipes. Five commonly consumed products i.e. *mathri*, *muffin*, multigrain bread, *idli* and chapati were selected for formulation of product with MLP at 5%, 10% and 15% level of incorporation.

Standardization of products

The five food products were selected and standardized in terms of quantity of ingredients, methods of preparation, and sensory characteristics, Standardization was done to obtain the reproducible results.

a. **Quantity of ingredients:** Combination permutation of various ingredients were tried to get best product. Once accepted as best, quantity of ingredients was fixed for further trials.
b. **Methods of cooking:** Various common unit operations were identified and tried till give same results in terms of quality of product. Each operation was standardized for duration, temperature and textural qualities at the end of that processing. Once the reproducibility is assured with acceptable quality of product the processing treatment was considered as standardized.
c. **Sensory Characteristics:** Sensory characteristics like colour, texture, appearance, taste, doneness etc. were evaluated after each trial till the reproducibility with optimum quality is achieved to standardize.

Sensory evaluation of developed products

Success of a food product is counted upon its potential in being able to be used in the most beneficial form its development is intended to be. Perceivable sensory characteristics have been recognized to be the deciding factors in the acceptance and enjoyment of food by masses. Thus, all value-added products developed from MLP with 5%, 10% and 15% incorporation were assessed for their sensory characteristics *viz*. colour, flavor, taste, texture, appearance and overall acceptability.

Table 4. 3 present's data on sensory evaluation of *mathri* formulated from MLP with 5%, 10% and 15% incorporation. These results indicated that scores for all the parameters of sensory evaluation (colour, flavor, taste, texture, appearance and overall acceptability) of *mathri* (C, T1, T2 and T3) were ranged from liked slightly to liked very much by the panel members indicating that all the products was found acceptable.

In case of colour parameter, mean scores were ranged from 6.80- 8.60, however, highest scores (8.60) were obtained for control and lowest (6.80) was observed for T3. Similar results were also found for flavor, taste and texture parameters of *mathri* and the mean scores were varied from 6.20-8.50, 6.30-8.40 and 6.40-8.20, respectively. With regards to appearance of *mathri*, highest scores were observed for T_1 whereas, T_3 obtained lowest scores. Mean scores for overall acceptability of *mathri* was ranged from 6.60-8.50 for all the trials.

Table 8: Sensory evaluation of *Mathri*

S. No.	Variation	Sensory attributes											
		Colour		Flavour		Taste		Texture		Appearance		Overall Acceptability	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	Control	8.60	0.51	8.50	0.707	8.40	0.516	8.20	0.422	8.00	0.471	8.50	0.527
2	T_1 (5%)	8.10	0.31	8.00	0.471	8.00	0.667	8.10	0.738	8.10	0.568	8.10	0.316
3	T_2 (10%)	7.30	0.67	7.20	0.789	7.10	0.568	7.00	0.667	7.10	0.876	7.10	0.738
4	T_3 (15%)	6.80	1.22	6.20	0.789	6.30	0.823	6.40	0.966	6.40	1.174	6.60	1.075
5	SEm±	0.194		0.162		0.186		0.210		0.224		0.184	
6	CD5%	0.557*		0.465*		0.534*		0.602*		0.643*		0.527*	
7	CV%	7.98		6.86		7.91		8.94		9.58		7.68	

Scores of sensory evaluations showed that the developed products i.e., muffin (C, T_1-T_3) prepared with different concentration of MLP was not only acceptable but also liked moderately to like very much by the panel experts (Table 9). Data regarding the colour of muffin (C, T_1-T_3) ranged from 7.60-8.10. The highest value was measured for both T_1 & T_2 (8.10) and lowest one (7.60) was found for both C and T_3. With reference to flavor and taste attributes, T_2 obtained highest scores i.e., 7.90 and 7.80 followed by control (7.70 for both parameters) and T3 (7.30 and 6.90) and T_1 (7.10 and 6.80), respectively. Mean scores for overall acceptability of muffins were varied from 7.40- 8.10 however, maximum scores were noted for control while, minimum was detected for T_3.

Table 9: Sensory evaluation of Muffin

S. No.	Variation	Sensory attributes											
		Colour		Flavour		Taste		Texture		Appearance		Overall Acceptability	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	Control	7.60	1.35	7.70	0.94	7.70	1.059	8.30	0.949	8.30	0.823	8.10	0.738
2	T_1 (5%)	8.10	0.87	7.10	0.56	6.80	0.422	7.80	0.789	7.70	0.675	7.60	0.516
3	T_2 (10%)	8.10	0.87	7.90	0.87	7.80	1.135	7.80	0.919	8.00	0.471	8.00	0.816
4	T_3 (15%)	7.60	1.26	7.30	0.67	6.90	0.876	7.70	0.949	7.70	0.949	7.40	0.516
5	SEm ±	0.286		0.217		0.254		0.222		0.219		0.182	
6	CD5%	0.821		0.623		0.730		0.638		0.628		0.523	
7	CV%	11.53		9.16		11.02		8.90		8.74		7.42	

It is apparent from the data given in Table 10, the mean acceptability scores for developed multigrain bread with 5%, 10% and 15% incorporation of MLP. The overall mean acceptability scores were observed to be 8.0, 8.5, 7.4 and in C, T_1, T_2 and T_3, respectively. Highest scores were seen in T1 (8.5) and lowest scores was found in T_2 (7.4), represents that all the multigrain bread i.e. C and T_1-T_3 were highly acceptable by the experts. The means scores for other sensory attributes i.e., colour (8.50), flavor (8.20), taste (8.50), texture (8.60) and appearance (8.30) were found to be highest in case of T_1. Hence, multigrain bread prepared with 5% incorporation of MLP was highly acceptable by panel of judges.

Table 10: Sensory evaluation of multigrain bread

S. No.	Variation	Sensory attributes											
		Colour		Flavour		Taste		Texture		Appearance		Overall Acceptability	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	Control	7.70	0.82	7.60	0.966	7.80	1.229	7.90	0.738	8.00	0.667	8.00	0.816
2	T_1 (5%)	8.50	0.52	8.20	0.422	8.50	0.707	8.60	0.516	8.30	0.675	8.50	0.527
3	T_2 (10%)	7.80	0.63	7.30	0.949	7.00	0.816	7.90	0.738	7.40	0.966	7.40	0.699
4	T_3 (15%)	7.40	1.07	7.40	1.075	6.50	0.850	6.50	1.434	6.50	1.434	6.80	0.789
5	SEm±	0.154		0.189		0.240		0.233		0.245		0.144	
6	CD5%	0.441		0.542		0.688		0.667		0.703		0.413	
7	CV%	6.19		7.84		10.18		9.52		10.26		5.94	

Table 11 portrays that the overall appearance of all the treatment and control sample of idli was ranged from 7.0 to 8.20 indicates that appearance of all developed idli (C, T_1-T_3) were highly acceptable by the panel members. With respect to control sample, highest mean scores were observed for all the sensory attributes (8.0-8.30) except overall acceptability (7.90) and the highest overall acceptability scores (8.20) was recorded for T_1. However, lowest scores were graded for T_3 with regards to all 5 sensory attributes and the values ranged from 6.70-7.0.

Table 11: Sensory evaluation of idli

S. No.	Variation	Sensory attributes											
		Colour		Flavour		Taste		Texture		Appearance		Overall Acceptability	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	Control	8.00	0.66	8.10	0.876	8.30	0.949	8.30	0.823	8.20	0.632	7.90	0.568
2	T_1 (5%)	7.80	0.78	7.70	0.675	7.60	1.265	7.90	0.738	8.10	0.568	8.20	1.033
3	T_2 (10%)	7.20	0.63	6.70	0.675	6.80	1.033	7.20	0.919	7.30	0.949	7.40	0.843
4	T_3 (15%)	6.80	1.22	6.70	1.160	6.70	1.252	6.80	0.919	7.00	0.816	7.00	1.155
5	SEm±	0.232		0.243		0.323		0.222		0.214		0.222	
6	CD5%	0.666		0.698		0.927		0.638		0.614		0.637	
7	CV%	9.85		10.54		13.90		9.31		8.85		9.22	

Table 12 shows that mean acceptability scores of chapati given by panel members on 9-point hedonic scale. With reference to control sample (chapatti prepared from wheat flour), mean scores for all the sensory parameters i.e., colour, flavor, taste, texture, appearance, and overall acceptability were varied from 7.90-8.40. These results indicated that the chapati prepared from wheat flour was highly acceptable by the experts when it compared to all 3 treatments containing MLP at different concentration i.e., 5%, 10% and 15%. Wheat, rice and maize are the staple food of Indians and hence, the products prepared from these foods had relatively more acceptability. The data pertaining to the flavor of chapati formulated with 5% MLP scored highest values i.e., 8.30 over control sample.

When the researcher compared the mean scores of all sensory attributes among the 3 treatments, chapati containing 5% *Moringa* leaves powder scored highest scores (colour-8.10, flavor -8.30, taste -8.0, texture -7.70, appearance-7.60 and overall acceptability -8.0). Hence, T_1 was very much liked by the judges from their other counter parts.

Table 12: Sensory evaluation of Chapati

S. No.	Variation	Sensory attributes											
		Colour		Flavour		Taste		Texture		Appearance		Overall Acceptability	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	Control	8.40	0.51	8.20	0.632	8.30	0.675	8.20	0.422	7.90	0.568	8.10	0.568
2	T_1 (5%)	8.10	0.73	8.30	0.675	8.00	0.943	7.70	0.823	7.60	1.075	8.00	0.943
3	T_2 (10%)	7.20	0.63	6.90	0.738	6.40	0.516	6.70	0.949	7.00	0.816	7.00	0.667
4	T_3 (15%)	6.40	1.07	6.30	1.059	5.80	1.317	6.20	1.135	6.00	1.054	6.40	0.843
5	SEm±	0.183		0.198		0.253		0.224		0.218		0.160	
6	CD5%	0.525		0.569		0.725		0.641		0.626		0.458	
7	CV%	7.70		8.45		11.21		9.82		9.69		6.85	

Yadav *et al.* (2022) [41] recently conducted research on formulation and quality evaluation of biscuits prepared with *Moringa*. Biscuits were prepared with five formulations (A-E) using different concentration of flower and leaf powder. The results revealed that the formulation D was highly acceptable by the panelists when statistically analyzed. With reference to nutritional values, formulations A and B were superior to their other counter parts.

Farzana *et al.* (2016) [47] attempted an investigation on formulation and quality evaluation of healthy vegetable soup powder supplemented with *Moringa* leaf powder. Scores of sensory evaluations on nine point hedonic scale showed that the healthy vegetable soup was not only rich in nutrients but was highly acceptable by panel members.

Another study on sensory and nutrition evaluation of value-added products prepared with drumstick leaves was carried out by Mamta and Dunkwal (2016) [50]. Seven products were prepared with 5% and 7% incorporation of sun and shade dried *Moringa* leaves and got evaluated for sensory characteristics on 9-point hedonic scale. Results demonstrated that all the developed products were highly acceptable by the judges. *Khakhara* scored highest score i.e., 8.8 in terms overall acceptability when compared to other products. The study concluded that there is very huge scope for value added

products of *Moringa*.

Conclusion

For the study blanched leaves were dried in shade to avoid the loss of nutrients till the leaves become brittle and crushed easily and then ground into fine powder and stored in the airtight container. Physical properties can give us clues about their chemical composition and processing characteristics. The physical properties such as bulk density, swelling capacity, swelling index, and hydration capacity and hydration index. The bulk density of MLP is 179.6 g/ml, swelling index of *Moringa* leaves powder was observed to be 0.09 and swelling capacity of shade dried *Moringa* leaves powder is 3.40 ml/g. The data revealed that the hydration capacity and hydration index of MLP is 3.39 and 0.07.

Moringa leaves powder contained 6.35 g per 100 g moisture. It provided 24.18 g per 100g of protein, 3.43 g per 100g crude fat, 8.4 g per 100g of ash and 9.53 g per 100g of crude fiber. Carbohydrate and energy were respectively 48.22 g per 100g and 365 kcal. Calcium and Iron content of *Moringa* leave powder was 94.53 mg per 100 g and 12 mg per 100g. The phytic acid content of MLP was 0.48 mg/100g.

Success of a food product is counted upon its potential in being able to be used in the most beneficial form its development is intended to be. Thus, all value-added products developed from MLP with 5%, 10% and 15% incorporation were assessed for their sensory characteristics *viz*. colour, flavor, taste, texture, appearance and overall acceptability. These results indicated that scores for all the parameters of sensory evaluation (colour, flavor, taste, texture, appearance and overall acceptability) of *mathri* (C, T_1, T_2 and T_3) were ranged from liked slightly to like very much and muffin (C, T_1-T_3) prepared with different concentration of MLP was not only acceptable but also liked moderately to like very much. Along with developed multigrain bread with 5%, 10% and 15% incorporation of MLP. Highest scores were seen in T_1 (8.5) and lowest scores was found in T_2 (7.4), represents that all the multigrain bread i.e. C and T_1-T_3 were highly acceptable by the experts. The overall appearance of all the treatment and control sample of idli was ranged from 7.0 to 8.20 indicates that appearance of all developed idli (C, T_1-T_3) were highly acceptable by the panel members. The mean acceptability scores of chapati given by panel members with reference to control sample (chapatti prepared from wheat flour), mean scores for all the sensory parameters i.e., colour, flavor, taste, texture, appearance and overall acceptability were varied from 7.90-8.40. These results indicated that the chapati prepared from wheat flour was highly acceptable by the experts.

Reference

1. Chhikara N, Kaur A, Mann S, Garg MK, Sofi SA, Panghal A. Bioactive compounds, associated health benefits and safety considerations of *Moringa oleifera* L. An updated review. Nutrition & Food Science. 2020;51(2):255-277.
2. Mouminah HHS. Effect of dried *Moringa oleifera* leaves on the nutritional and organoleptic characteristics of cookies. Alexandria science exchange Journal 36 (October-December); c2015. p. 297-302.
3. Bolarinwa IF, Aruna TE, Raji AO. Nutritive value and acceptability of bread fortified with *Moringa* seed powder. Journal of the Saudi Society of Agricultural Sciences. 2019;18(2):195-200.
4. Nweze NO, Nwafor FI. Phytochemical, proximate and mineral composition of leaf extracts of *Moringa oleifera* Lam. from Nsukka, South-Eastern Nigeria; c2014.
5. Thapa K, Poudel M, Adhikari P. *Moringa oleifera*: A review article on nutritional properties and its prospect in the context of Nepal. Acta Sci. Agric. 2019;3:47-54.
6. Alegbeleye OO. How functional is *Moringa oleifera*? A review of its nutritive, medicinal, and socioeconomic potential. Food and Nutrition Bulletin. 2018;39(1):149-170.
7. Vergara-Jimenez M, Almatrafi MM, Fernandez ML. Bioactive components in *Moringa oleifera* leaves protect against chronic disease. Antioxidants, 2017;6(4):91.
8. Milla PG, Peñalver R, Nieto G. Health benefits of uses and applications of *Moringa oleifera* in bakery products. Plants 2021;10(2):318.
9. Malemnganbi CC, Singh N. Standardization of different products by using different level of *Moringa* leaves powder and its acceptability. The Pharma Innovation J 2021;10(4):239-244.
10. Busani M, Patrick JM, Arnold H, Voster M. Nutritional characterization of *Moringa* (*Moringa oleifera* Lam.) leaves. African journal of biotechnology. 2011;10(60): 12925-12933.
11. De Saint Sauveur A, Amenglor MG, Kinda J, Colomban F. Nutritional Quality and Benefits 12.2 Enhancing Nutrient Intake from *Moringa* Leaves Through Adequate Consumption Patterns. The Miracle Tree: *Moringa Oleifera*; c2019.
12. El-Gammal RE, Ghoneim GA, ElShehawy SM. Effect of *Moringa* leaves powder (*Moringa oleifera*) on some chemical and physical properties of pan bread. Journal of Food and Dairy Sciences. 2016;7(7):307-314.
13. Tesfay SZ, Bertling I, Odindo AO, Workneh TS, Mathaba N. Levels of antioxidants in different parts of *Moringa* (*Moringa oleifera*) seedling. African Journal of Agricultural Research. 2011;6(22):5123-5132.
14. Dixit S, Tripathi A, Kumar P. Medicinal properties of *Moringa oleifera*: A review. International Journal of education and Science research review. 2016;3(2):173-185.
15. Srikanth VS, Mangala S, Subrahmanyam G. Improvement of protein energy malnutrition by nutritional intervention with *Moringa oleifera* among Anganwadi children in rural area in Bangalore, India. International Journal of Scientific Study. 2014;2(1): 32-35.
16. Liu Y, Wang XY, Wei XM, Gao ZT, Han JP. Values, properties and utility of different parts of *Moringa oleifera*: An overview. Chinese Herbal Medicines. 2018;10(4):371-378.
17. Fejér J, Kron I, Pellizzeri V, Pľuchtová M, Eliašová A, Campone L, *et al*. First report on evaluation of basic nutritional and antioxidant properties of *Moringa oleifera* Lam. from Caribbean Island of Saint Lucia. Plants. 2019;8(12):537.
18. Karim O, Kayode R, Oyeyinka S, Oyeyinka A. Physicochemical properties of stiff dough amala prepared from plantain (*Musa Paradisiac*) flour and *Moringa* (*Moringa oleifera*) leaf powder. *Hrana u zdravlju i* bolesti*: znanstveno-stručni časopis zanutricionizam i dijetetiku*. 2015;4(1):48-58.
19. Oyeyinka AT, Oyeyinka SA. *Moringa oleifera* as a food fortificant: Recent trends and prospects. Journal of the

Saudi Society of Agricultural Sciences. 2018;17(2):127-136.
20. Mishra SP, Singh P, Singh S. Processing of *Moringa oleifera* leaves for human consumption. Bulletin of Environment, Pharmacology and life sciences. 2012;2(1): 28-31.
21. Pandey A, Pandey RD, Tripathi P, Gupta PP, Haider J, Bhatt S, *et al*. *Moringa oleifera* Lam. Sahijan)-A Plant with a Plethora of Diverse Therapeutic Benefits: An Updated Retrospection. Medicinal and Aromatic Plants. 2012;1(1):1-8.
22. Mensah JK, Ikhajiagbe B, Edema NE, Emokhor J. Phytochemical, nutritional and antibacterial properties of dried leaf powder of *Moringa oleifera* (Lam) from Edo Central Province, Nigeria. J Nat. Prod. Plant Resour. 2012;2(1):107-112.
23. Saini RK, Sivanesan I, Keum YS. Phytochemicals of *Moringa oleifera*: a review of their nutritional, therapeutic and industrial significance. 3 Biotech. 2016;6(2):1-14.
24. Zongo U, Zoungrana SL, Savadogo A, Traoré AS. Nutritional and clinical rehabilitation of severely malnourished children with *Moringa oleifera* Lam. leaf powder in Ouagadougou (Burkina Faso); c2013.
25. Glover-Amengor M, Aryeetey R, Afari E, Nyarko A. Micronutrient composition and acceptability of *Moringa oleifera* leaf-fortified dishes by children in Ada-East district, Ghana. Food Science & Nutrition. 2017;5(2):317-323.
26. Stohs SJ, Hartman MJ. Review of the safety and efficacy of *Moringa oleifera*. Phytotherapy Research. 2015;29(6):796-804.
27. Islam Z, Islam SM, Hossen FMahtab-ul-Islam K, Hasan M, Karim R. *Moringa oleifera* is a prominent source of nutrients with potential health benefits. International Journal of Food Science; c2021.
28. Gopalakrishnan L, Doriya K, Kumar DS. *Moringa oleifera*: A review on nutritive importance and its medicinal application. Food science and human wellness. 2016;5(2):49-56.
29. Essa MM, Subash S, Parvathy S, Meera A, Guillemin G. J, Memon MA.*et al*. Brain health benefits of *Moringa oleifera*. Food and Brain Health; c2014. p. 113.
30. Kou X, Li B, Olayanju JB, Drake JM, Chen N. Nutraceutical or pharmacological potential of *Moringa oleifera* Lam. Nutrients. 2018;10(3):343.
31. Abdull Razis AF, Ibrahim MD, Kntayya SB. Health benefits of *Moringa oleifera*. Asian pacific journal of cancer prevention. 2014;15(20):8571-8576.
32. Mahmood KT, Mugal T, Haq IU. *Moringa oleifera*: a natural gift-A review. Journal of Pharmaceutical Sciences and Research. 2010;2(11):775.
33. Potter II. Pressure corrections for fluid-inclusion homogenization temperatures based on the volumetric properties of the system NaCl--H/sub 2/O. J Res. US Geol. Surv.;(United States). 1977 Jan 1;5(5).
34. Cheng KL, Bray RH. Determination of calcium and magnesium in soil and plant material. Soil science. 1951 Dec 1;72(6):449-58.
35. Jain S, Mogra R. Analysis of food components. Maharana Pratap Unive. Agric. Tech., Udaipur (India); c2006. p. 61-2.
36. Okiki PA, Osibote IA, Balogun O, Oyinloye BE, Idris OO, Adelegan O, *et al*. Evaluation of proximate, minerals, vitamins and phytochemical composition of *Moringa oleifera* Lam. cultivated in Ado Ekiti, Nigeria. Advances in Biological Research. 2015;9(6):436-43.
37. Özcan M, Vallittu PK. Effect of surface conditioning methods on the bond strength of luting cement to ceramics. Dental Materials. 2003 Dec 1;19(8):725-31.
38. Sakr Y, Giovini M, Leone M, Pizzilli G, Kortgen A, Bauer M, *et al*. Pulmonary embolism in patients with coronavirus disease-2019 (COVID-19) pneumonia: a narrative review. Annals of intensive care. 2020 Dec;10(1):1-3.
39. Jongrungruangchok S, Bunrathep S, Songsak T. Nutrients and minerals content of eleven different samples of *Moringa oleifera* cultivated in Thailand. Journal of Health Research. 2010;24(3):123-7.
40. Castillo-López RI, Gutiérrez-Grijalva EP, Leyva-López N, López-Martínez LX, Heredia JB. Natural alternatives to growth-promoting antibiotics (GPA) in animal production. JAPS: Journal of Animal & Plant Sciences. 2017 Apr 1;27(2).
41. Yadav PD, Sapkal GN, Abraham P, Ella R, Deshpande G, Patil DY, *et al*. Neutralization of variant under investigation B. 1.617. 1 with sera of BBV152 vaccinees. Clinical Infectious Diseases. 2022 Jan 29;74(2):366-8.
42. Bishnoi, Khetrapal N. Variability in physio-chemical properties and nutrient composition of different pea cultivators. Food Chemistry. 1993;47:371-373.
43. AOAC. Association of Official Analytical Chemists. Official methods of analysis (19th Ed.). Arlington, V.A; c2012.
44. Srivastava BN. Others. Influence of Fertilizers and Manures on the Content of Phytin and Other Forms of Phosphorus in Wheat and Their Relation to Soil Phosphorus. Journal of the Indian Society of Soil Science; c1955. p. 33-40.
45. Singh Y, Prasad K. Moringa Oleifera Leaves as Functional Food Powder. Charact. Uses. 2013;4:317-324.
46. Penalver R, Martínez-Zamora L, Lorenzo JM, Ros G, Nieto G. Nutritional and Antioxidant Properties of *Moringa oleifera* Leaves in Functional Foods. Foods. 2022;11(8):1107.
47. Farzana T, Mohajan S, Saha T, Hossain MN, Haque MZ. Formulation and nutritional evaluation of a healthy vegetable soup powder supplemented with soy flour, mushroom, and moringa leaves. Food Sci Nutr. 2017 May 3;5(4):911-920. Doi: 10.1002/fsn3.476. PMID: 28748080; PMCID: PMC5520860.
48. Gallaher DD, Gallaher CM, Natukunda S, Schoenfuss TC, Mupere E, Cusick SE. Iron bioavailability from *Moringa oleifera* leaves is very low. The FASEB Journal. 2017;31:786-13.
49. Gidamis AB, Panga JT, Sarwatt SV, Chove BE, Shayo N. B. Nutrient and ant nutrient contents in raw and cooked young leaves and immature pods of *Moringa oleifera*, Lam. Ecology of food and nutrition. 2003;42(6),399-411.
50. Mamta Dunkwal. Quality Evaluation of Value-Added Products Using Drumstick Leaves Powder (*Moringa oleifera*); c2016. https://krishikosh.egranth.ac.in/displaybitstream?handle=1/5810090806&fileid=cc11d4da-ba17-4936-9187-cf9a97cccbfb.