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Comparative assessment for chemical, polyphenol and mineral composition of *Moringa* varieties

Abstract

The formulations of Moringa porridge were prepared by the assortment of peanut, wheat flour, gram daal and sugar. The formulations were formed by changing the quantity and processing conditions of the ingredients. Chemical, vitamin and mineral analysis were carried out. Similarly, the leaves and stalks from Lahore were used as green tea. The nutritional analysis as well as polyphenols was anticipated. The approximate values of protein, fat, fiber, moisture, ash, carbohydrate, and energy of the leaves were 15.5%, 11.04%, 12%, 10.418%, 11.40% 37.48%, 319.92 kcal respectively. The polyphenols for the leaves and stalk were 10.95µg and 20.02µg respectively. Vitamin A and C were 12.80mg and 232mg for the leaves respectively. Minerals like Ca, K, Zn, and Fe were 205mg, 242.52mg, 16.10 mg, 16.25mg for Lahori leaves, and 20mg, 155mg, 5.88mg, 10.595mg for Lahori leaves formulations developed correspondingly. The porridge and tea made from M. olifera leaves and stalk were essential and valuable with respect to health and medicinal point of view.

Keywords: plants, herbs, moringa, proximate analysis, polyphenols, minerals

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Introduction

Plants are very important for the mankind's health, welfare and for the immunity of the body from the beginning of life. Many herbs are present in Pakistan's environment which is very useful but usually ignored by the people. As an alternative these herbs are the best for the treatment of lethal diseases. As many herbs are used for health in Asia and Africa. Whereas the world's famous herbal treatment happened in India. Some herbs are edible, some are poisonous, and some become edible after followed by some processes. Some herbs have their fruits which are edible but leaves stem and bark is bitter in taste, but they may be nutritional as well.

The poverty rate in the Asia is becoming very high, under nourishment and mal nourishment as well. The 21st century which is also known as the century of biology as many technologies like biotechnology, bioinformatics, and herbal technology are becoming very imperative for the welfare and the prosperity of people. Mostly these disciplines work for the comfort of the human being. Considering the poverty level and the nutritional loss of the people, science always tried to help to triumph over both poverty and nutritional loss. These deficiencies can be recovered by the herbs that are unnoticed. *Moringa* variety is one of the herbs that help to accomplish these deficiencies.[1]

Moringa olifera is the valuable nutritional plant. This plant contains the high value of minerals and vitamins and other very significant nutrients so it becomes the important medicinal plant.[2] In different countries it is known by different names as there are more than 400 names for this plant in different languages such as in Bangaladash it is said to as *Sajina*, *Sajna* (bangali language), in united states it is known as *Horseradish tree*, *drumstick tree* (in English language) , in India *Moringa* is called as *Sahingan*, *Mungna* (in hindi language), in Malaysia it is said as *Murinna*, *Muringa*, *Tishnagandha* (in Malyalam language);in northern region of India *Sevaga*, *Segata* (Marathi language);in Punjab region people used to say *Moringa* as *Sohanjana* (Punjabi language);*Sobhanjana*, *Sigru*, *Murungi*, *Dvishiguru* (Sanskrit language) and *Sehjan* (Urdu language) Moringa's names in varied Indian languages and regions, well in Pakistan *Moringa* is known as *Sawanjana*, Bangladesh, Sri Lanka, tropical Africa, Arabia, Philippines, Cambodia and Central, North and South America also use different names for *Moringa olifera*.[3]

The scientific classifications for *Moringa olifera* are Kingdom Plantae, Order Brassicales, Family Morinacea, Genus Moringa, Species olifera.[4] The plant *Moringa* is found all over the world as it can grow in a dry or simple environment.[5] *Moringa olifera* is the most widely cultivated specie all around the world. Different countries contain different species of *Moringa* plant. There are different species of *Moringa* such as, arborea, borziana, longituba, rivae, stenopetala, pygmaea, ruspoliana, drouhardii, hildebrandtii, ovalifolia, concanensis, oleifera, peregrine.[6] oleifera, peregrina, stenopetalaand drouhardii are the species of *Moringa* which are rich in nutrition and used to fulfill nutritional deficiencies.[7]

The plant grows rapidly under favorable conditions. It can also grow in very dry region, if watering then it can grow bigger and faster. World Health Organization (WHO) researched on *Moringa olifera* plant and they believed that *Moringa olifera* is rich in nutritional and medicinal values. Extract of *Moringa* has pharmaceutical properties. Different parts of *Moringa olifera* such as the leaves , root, seed, bark, fruit, flower, immature pods are used for the treatment of different diseases,like these are used for the treatment of cardiac and stimulants for the circulatory system, used against the tumor formation, pyretic, pasmodic, bacterial, fungal, diabetic and pileptic activity, against inflammation, ulcer, hypertensive and lowering the level of cholesterol, and also for the treatment of different ailments in the indigenous medicinal system. It is also used for the treatment of anemia, arthritis and other joint pain, asthma, cancer, constipation, diarrhea, epilepsy, stomach pain, intestinal ulcers and spasms, headache, heart problems, kidney stones, fluid retention, thyroid disorders, parasitic and viral infections.[2]

Moringa olifera is also used for ornamental, curative and industrial uses. All the parts of this plant are edible and contains the

important minerals (potassium, iron, calcium, sulphur, selenium, zinc, magnesium, phosphorus, copper), amino acids (9 essential amino acids (Histidine, Isoleucine, Leucine, Phenylalanine, Methionine, Lysine, Valine, Tryptophan, Threonine) proteins, vitamins{vitamin B1, vitamin B2, vitamin B3, vitamin A (Beta-carotene), vitamin C, vitamin E and choline}, Zeatin, quercetin, sitosterol, caffeoylquinic acid and kaempferol and various phenolics.[2]

All parts of the plant *Moringa olifera* has great importance, full of nutrition that's why it is known as "*Miracle Tree"*. The roots, leaves, flowers, buds, pods and the juice of roots, buds, and flowers have great importance for the medicinal uses.[3]

Moringa olifera is best nutritional food for the breasts feeding and pregnant women because during these stages the most probable chance of nutritional deficiency. But one thing should remind that the excess of anything is bad. It is likely unsafe for pregnant women to use bark, root, and flower of *Moringa* because the chemicals present in the bark, root and flower can make the uterus contract that further cause the miscarriage. *Moringa* is also used after delivery to increase the breast milk production. *Moringa* leaves and pods powder is best known for the treatment of mal nutrition and under nutrition. The main reason of mal nutrition starts from the birth; the deficiencies occur during pregnancy and after birth could not be recovered throughout the child's and mother's life. So the *Moringa* leaves powder help to overcome these deficiencies. Because of this wonderful ability, *Moringa* is known as "*Mother's Best Friend"*.[7]

Materials and methods

For the preparation of tea and porridge the stalks and leaves from nursery were collected and washed with deionized water then allowed to put into 1% saline solution for 5 minutes. Then dried at room shade for 3 days, and on 4th day put these in the sunlight for 30 minutes. The dried stalks and leaves were crushed properly. The crushed stalks and leaves infusions were used to prepare green tea and porridge formulations for sensory evaluation (Table 1).

Proximate evaluation

The proximate analysis of moringa leave, stalks and products developed was carried out. The percentage of moisture, total ash, crude fat, crude protein and crude fiber contents were performed according to AOAC (2016)[8] official methods (Table 2).

Table 1 Ingredient formulations of *Moringa* porridge

1st formulation	2nd formulation	3rd formulation	4th formulation	5th(a) formulation	5th(b) formulation
Dry *M.olifera* leaves Lahori	Roasted *M.olifera* leaves Lahori	Fried *M.olifera* leaves Lahori	Roasted *M.olifera* leaves Lahori	Dry *M.olifera* leaves Lahori	Dry *M.olifera* leaves (Kashmiri)
Jiggery	sugar	sugar	Sugar	Sugar	sugar
Fried nuts	Fried nuts	Fried nuts	Fried nuts	Simple nuts	Simple nuts
Fried daal	Fried daal	Fried daal	Fried daal	Simple daal	Simple daal
Fried wheat flour	Fried wheat flour	Roasted wheat flour	Roasted wheat flour	Simple wheat flour	Simple wheat flour

Table 2 Proximate composition of green tea formulations of *Moringa* variety

Varieties	Moisture %	Ash %	Protein %	Fat %	Fiber %	Carbohydrates %	Energy (kcal)
Lahori leaves	10.41	11.40	18.4	11.04	12.00	36.8	320.16
Kashmiri leaves	6.79	20.15	15.9	6.76	6.00	44.40	302.04
Lahori stalks	1.08	12	9.6	2.84	10.2	64.275	321.06

Mineral profile

The samples were subject to mineral assay through wet digestion considering the protocols of AOAC (2016).[8] For the estimation of Calcium and potassium, Flame Photometer-410 (Sherwood Scientific Ltd., Cambridge, UK) will be used whilst iron and Zinc measured through Atomic Absorption Spectrophotometer (Varian AA240, Victoria Australia).

Vitamin A & C contents

Vitamin A & C was measured spectrophotometrically by following the method described by Karnjanawipagul et al. 2010[9] and Raghu et al., 2007[10] respectively.

Total phenolic contents:

Total phenolic content determination was performed for samples by using procedures described by Singleton *et al.*(1999). Total phenolic content was calculated and expressed as Gallic Acid Equivalent (mg Gallic Acid/100g).

Results and discussions

Results of this study revealed that *Moringa olifera* is not only enriched with essential macro nutrients (Protein, fiber and carbohydrates) but also with minerals, vitamins and polyphenols.

The moisture for Lahori *Moringa* leaves, Kashmiri *Moringa* leaves and Lahori *Moringa* stalks were 10.41%, 6.79% and 1.08% similarly ash content for Lahori *Moringa* leaves, Kashmiri *Moringa* leaves and Lahori *Moringa* stalks were 11.40%, 20.15% and 12.00% respecively which showed similarity to the results of Jongrungruangchok *et al.,*(2010)[11] that were in the range of 8.52%-13.53% for moisture content and 6.39%-7.99% for ash content. As the less moisture content helped in the long preservation of edible things and the ash content determine the mineral contents.

The leaves of the *Moringa olifera* were observed for protein which showed 18.40%, 15.90% and 9.60% of Lahori *Moringa* leaves, Kashmiri *Moringa* leaves and Lahori *Moringa* stalks respectively. These results are to some extent similar to the results of Joshi and

Mehta et al.,(2010)[12] which showed the protein contents in range of 23.42%-23.78%. This difference may be depends upon variety, land conditioning and climate. Protein content also comparable with pulses protein as *Moringa* is affordable for community of developing countries like Pakistan, because in a study by Shaheen *et al.,* (2012)[13] protein contents of whole mash beans lies in range of 21%-30%. So, ultimately the *Moringa* is cheap source of protein rather than pulses.

Analysis of fat showed the range of 11.04%, 6.76% and 2.84% of lahori *Moringa* leaves, kashmiri *Moringa* leaves and lahori *Moringa* stalks respectively. These results looked like with the findings of Foidl *et al*., (2001).[14] In which fat contents showed to be 5.2%-6.5%. The fiber estimation of Lahori *Moringa* leaves, Kashmiri *Moringa* leaves and Lahori *Moringa* stalks showed results 12.00%, 6.00% and 10.20% correspondingly resembled to the work of Joshi and Mehta et al.,(2010).[12] In their work the fiber content was 12.10

The results of carbohydrates for Lahori *Moringa* leaves, Kashmiri *Moringa* leaves and Lahori *Moringa* stalks were 36.8%, 44.40% and 64.27% in that order. These values look a lot like to the struggle of Price, et.al., (2007)[7] which showed 38.2% for carbohydrates. Whereas the herbs are not well thought-out for carbohydrates source but due to dried form the carbohydrate content compared with cereals and vegetables is higher, which help in better body functioning.

The calories for Lahori *Moringa* leaves, Kashmiri *Moringa* leaves and Lahori *Moringa* stalks were 320.16Kcal/100g, 302.04 Kcal/100g and 321.06 Kcal/100g resembled to the work of Price, et.al., (2007)[7] that had worked on it and his results showed 205.00 Kcal/100g calories.

The four different constituted porridge formulations by Lahori *Moringa* leaves had approximate values ash (5.03%, 2.14%, 1.73%, 2.75%), protein (9.81%, 6.71%, 6.25%, 10.35%) , fat (10.83%, 24.45%, 23.68%, 9.5%) and carbohydrates (68.08%, 62.91%, 64.84%, 73.51%) these value correlated to the work of keyetasi, et al., (2009) whose worked was on approximate values of sorgum porridge that were 1.50% ash, 11.7% protein, 1.40% fat, and 85.40% carbohydrates. In the results of *Moringa* porridge the approximate value for the 4th formulation was comparatively best in respond to the low fat content and high protein values. In accordance to the *Moringa* variety from Lahore and Kashmir the porridge formulation by Lahori *Moringa* leaves was comparitivly good but the Kashmiri *Moringa* leaves porridge was not poor as both have little bit differences in relation to approximate values (Table 3).

The calorific value of porridge formulations from Lahori *Moringa olifera* were 409.03kcal, 398.58 kcal, 497.48kcal and 420.94 kcal that was significant to the struggle of Muoki et al., (2012)[15] who searched that the complementary food require 356.00 kcal energy. The energy content in the complementary food was less due to the selection of ingredients as the ingredients used by Muoki et al., (2012)[15] were less important for the energy consumption whereas the *Moringa* porridge had the ingredients rich in energy sources that's why the *Moringa* leaves porridge had good calorific value.

Table 3 Proximate values for the porridge formulations of Lahori *Moringa*

Formulation	Moisture %	Ash %	Protein %	Fat %	Fiber%	Carbohydrates%	Energy(kcal)
1st	2.52	5.03	9.81	10.83	3.73	68.08	409.03
2nd	1.47	2.14	6.71	24.45	2.30	62.91	398.58
3rd	0.22	1.73	6.25	23.68	3.28	64.84	497.48
4th	0.19	2.75	10.35	9.5	3.70	73.51	420.94
5th (a)	7.15	3.40	12.65	5.35	0.2	71.25	383.75
5th (b)	6.27	5.42	12.02	6.13	2.6	67.54	373.47

Mineral estimation of Lahori *Moringa* leaves and Kashmiri *Moringa* leaves for iron was 16.25mg and 60.90mg respectively that resembled to the work of Joshi and Mehta et al.,(2010)[12] that had results for Iron 24.00mg. The zinc content in the Lahori *Moringa* leaves and Kashmiri *Moringa* leaves were 16.10mg and 33.80mg related to the zinc content 13.70mg studied by Foidl *et al.,* (2001).[14] The calcium and potassium content in Lahori *Moringa* leaves and Kashmiri *Moringa* leaves were 205.00mg and 285.00mg for calcium, 242.50mg and 255.00mg for potasium respectively that resembled to the values calculated by Price, et.al., (2007)[7] which were 440.00mg calcium and 259.00mg potassium (Table 4).

Table 4 Minerals of leaves and formulations of *M.olifera* variety

Samples	Minerals (mg/100g)			
	Calcium (Ca)	Potassium (K)	Zinc (Zn)	Iron (Fe)
Lahori leaves	205.00	242.50	16.10	16.25
Kashmiri leaves	285.00	255.30	33.80	60.90
Lahori stalks	112.00	110.22	10.56	14.35
Formulation 5th (a)	20.25	155.10	5.88	10.595
Formulation 5th (b)	30.17	300.15	7.20	30.80

The vitamin A for Lahori *Moringa* leaves, Kashmiri *Moringa* leaves and Lahori *Moringa* stalks was 12.80mg, 12.80mg and 7.41mg similar to the results of Price, et.al., (2007)[7] that was 16.30mg and the vitamins C for Lahori *Moringa* leaves and Kashmiri *Moringa* leaves was 232.00mg and 210.00mg showed a litte bit similarity to the work of Mahmood *et al.,* (2010)[1] whose result was 220.00mg for vitamin C (Table 5 & 6).

Table 5 Vitamin A & C of *M. Olifera* variety

Samples	Vitamin A (mg)	Vitamin C (mg)
Lahori leaves	12.80	232.00
Kashmiri leaves	12.80	210.00
Lahori stalks	7.41	182.00

Table 6 vitamin A & C of formulations of *Moringa* variety

Formulations	Vitamin A (mg)	Vitamin C (mg)
1st formulation	12.80	161.23
2nd formulation	4.17	79.10
3rd formulation	3.98	85.71
4th formulation	13.47	140.10
5th (a) formulation	12.13	150.17
5th (b) formulation	10.78	125.20

The polyphenols in the extract/concentrate of Lahori *Moringa* leaves, Kashmiri *Moringa* leaves and Lahori *Moringa* stalks were 10.95µg, 10.19µg and 20.02µg correspondingly that resembled little bit to the values calculated by Mukunzi *et al.,* (2011)[16] that were in the range of 24.65µg-30.02µg. The flavonoids in the extraction of *Moringa olifera* leaves and stalks variety were indicated as the positive sign shows the presence of flavonoids in the leaves of *Moringa olifera*, which were same as to the results of Kasolo *et al*., (2010).[17] The flavonoids contents of Lahori stalks were more than the Lahori and Kashmiri *Moringa* leaves in this research work (Table 7).

Table 7 Polyphenols of leaves and stalk of *M.olifera* variety

Samples	Polyphenol content (µg)
Lahori leaves	10.95
Kashmiri leaves	10.19
Lahori stalks	20.02

The results for the sensory evaluation from the panelists of 15 members the calculated average values showed in Table 8. Sensory evaluation for the *Moringa* tea was according to six hedonic scales with the reference of Oduro *et al*., (2014)[18] who had evaluated that the taste of tea from *Moringa olifera, Hibiscus sabdariffa* and *Cymbopogon citrates*, the taste of *Moringa olifera* is best according to hedonic scale. On the basis of 50 panelists the 50 % results were in the favour of *Moringa olifera* and the others two had 30% and 20%.[19–21] Similarly this research work had 60% results for tea of Lahori *Moringa* stalks and 40 % for Lahori *Moringa* leaves on the source of 15 panelists. The sensory attribute for *Moringa* green was the best.[22,23]

Table 8 Averaged values for the sensory evaluation

	Colour	Aroma	Flavor	Aftertaste	Astringency	Overall acceptance
1st	40%	60%	40%	40%	20%	40%
2nd	80%	80%	80%	80%	80%	80%
3rd	60%	80%	60%	60%	40%	60%
4th	100%	100%	80%	80%	80%	100%
5th (A)	40%	60%	40%	40%	20%	40%
5th (B)	40%	60%	40%	40%	20%	40%
Tea (L)	100%	80%	80%	60%	60%	80%
Tea (S)	100%	100%	100%	100%	100%	100%

Conclusion

Results of current study concluded that 4th formulation is better as compared to others with high opinion to nutritional and sensory evaluation as well as minerals. Similarly the green tea of *Moringa* stalks is better as compared to *Moringa* leaves with respect to polyphenols and sensory evaluation. Addition of moringa into local dishes showed the significant increase of the micronutrients level in the fortified formulations. This supplementation could be good sources of Vitamin A & C. it is recommended to use moringa leave in routine local dishes to enhance nutritional status of children and adults.

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Conflicts of interest

The authors declare that there was no conflict of interest.

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