NUTRIENTS AND MINERALS CONTENT OF ELEVEN DIFFERENT SAMPLES OF *MORINGA OLEIFERA* CULTIVATED IN THAILAND

Suchada Jongrungruangchok[1], Supawan Bunrathep[2] and Thanapat Songsak[2,*]

[1]Department of Pharmaceutical Chemistry, [2]Department of Pharmacognosy,
Faculty of Pharmacy, Rangsit University, Patumthani 12000, Thailand

ABSTRACT : *Moringa oleifera*, the medicinal plant in Moringaceae family, has been used worldwide in traditional medicine. Different parts of this plant contain a profile of important minerals, and a good source of protein, vitamins, and various phenolics. The objective of this study was to compare the proximate composition and mineral constituents in Moringa leaves from 11 different agro climatic regions distributed in Thailand. These leaves were found to contain 19.15-28.80 % of protein; 2.06-2.47 % of fat; 16.30-23.89 % of fiber; 8.52-13.53 % of moisture. The calcium, potassium and iron contents of Moringa leaves (100 g dry weight) were found in the range of 1510.41-2951.13 mg, 1504.23-2054.05 mg and 20.31-37.60 mg, respectively. The results of present analysis revealed that Moringa leaves indigenous to different agro-climatic regions of Thailand contained an appreciable amount of nutrients and might be used as a good supplement for some nutrients such as protein, fiber and minerals.

KEYWORDS: *Moringa oleifera*, proximate analysis, minerals content

INTRODUCTION: In recent years, interest has grown in the utilization of what have come to be known as 'multipurpose' plants. One such plant is *Moringa oleifera* Lam (syn. *Moringa pterygosperma*), the most widely cultivated species of a monogeneric family Moringaceae. Though native in the sub-Himalayan tracts, it is widely cultivated in Africa, Central and South America, Sri Lanka, India, Mexico, Malaysia, Indonesia and the Philippines[1]. In some parts of the world *M. oleifera* is referred to as the 'drumstick tree' or the 'horse radish tree' whereas in Thailand it is known as 'Ma-room' locally known as 'Makonkom มะค้อนก้อม'[1-3]. It is considered one of the world's most useful trees, as almost all parts of this plant have been used for various treatments of ascites, rheumatism and venomous bites, and also as cardiac and circulatory stimulants. Several parts of *M. oleifera* have been reported to show antitumor, antinuclear, anti-inflammatory, and antipyretic effects[4-5].

Every part of the Moringa tree can be used as medicine and food commodity which has received enormous attention as the 'natural nutrition of the tropic'. According to Jed[6] and Anwar *et al.*[7], Moringa trees have been used to combat mal-nutrition (especially among infants and breast feeding woman) in many developing countries, particularly in India, Pakistan, the Philippines, Hawaii and many parts of Africa. Moringa leaves have been reported to be a valuable source of both macro and micro nutrients, being a significant source of beta-carotene, vitamin C, protein, calcium, iron, and potassium[7-10]. In the Philippines, it is known as 'mother's best friend' because of its utilization to increase milk production in breast-feeding women and is sometimes prescribed for anemia[11]. A large number of reports on the nutritional information of Moringa leaves[12-13] are provided in various countries such as India[14], Sudan[15], Ghana[16], and Pakistan[17]. Tree for life, an NGO based in the United States has promoted this nutritional benefits of Moringa and their nutritional comparison has been widely copied and is now taken on faith by many: "Ounce for ounce *M. oleifera* leaves contain more vitamin A than carrots, more vitamin C than oranges, more calcium than milk, more potassium than bananas, more iron than spinach, and that the protein quality of Moringa leaves rivals that of milk and egg"[6]. It is also used as livestock feed and its twigs are reported to be very palatable to ruminants and have appreciable crude protein levels[18-19]. Although, the nutritional information of *M. oleifera* leaves is available in the literature. However, little bit is known about the nutritional profile of *M. oleifera* indigenous to Thailand. The primary objective of the present research was to investigate the nutrients composed in Moringa leaves from different provinces in Thailand and to determine its potential as a nutritional supplement.

*To whom correspondence should be addressed.
Tel. +66 2997 2222 ext. 1421, Fax. +66 2997 2222 ext. 1403
E-mail: thanapat@rangsit.rsu.ac.th

MATERIALS AND METHODS:

Plant Samples

Fresh green leafy vegetable were obtained from markets in 11 different provinces in Thailand i.e. Ayutthaya, Bangkok, Chaiyaphum, Kanchanaburi, Nakhonpathom, Nakhonsawan, Nongbualumphu Nonthaburi, Patumthani, Sakaeo, and Sakonnakhon. All these samples were further authenticated by comparison with the herbarium specimen (SN 202599 and SN 202600) at the Princess Sirindhorn Plant Herbarium Bangkok, Thailand. The leaves were removed from the stem and damaged ones excluded. They were put in an oven (65°C) to dry, after that they were grounded and kept in air-tight plastic containers at room temperature (30°C) for further analysis. The leaves from each region were assayed and analyzed individually in triplicate.

Chemical analysis of the ingredients and diets

Proximate analysis procedure including the percentage of moisture content, crude protein, crude fat, ash contents and crude fiber in the sample were determined by The Association of Official Analytical Chemists methods (AOAC, 1990)[20]. Likewise, calcium, potassium and iron were determined by the use of atomic absorption spectrophotometer (AAS), Varian SpectrAA 220.

Chemical analysis

Moisture content: The aluminium dish was placed inside drying oven for 105°C for 2 h. After that, the crucible was placed in the desiccators to allow cooling. The aluminium dish was weighed and 2 g of the powder was placed in the aluminium dish. The sample was dried in drying oven (Memmert 600, Germany) for 3 h at 105°C and then weighed to determine the percentage of dry weight and the percentage of moisture content.

Ash: The preparation for ash analysis was the same as that for moisture content. Two grams of sample was put into crucible, the weight recorded and placed in muffle oven (Furnace Nabertherm, Germany) at 550°C for 8 h.

Fat: The fat content was determined by directly extracting the sample with petroleum ether in an intermittent Soxhlet extractor (Soxhlet Extractor Gerhadt, Germany) for 4 h. The residue in round bottom flask after solvent removal represents the fat content of the sample.

Crude protein: The crude protein content of the samples was estimated by macro-Kjeldahl method, in which the sample was digested with a known quantity of acid. The digested material was distilled after the addition of alkali. The release ammonia was collected in 4% boric acid. The resultant boric acid which now contained the ammonia released was then titrated against 0.1 NHCl. The percentages of nitrogen were converted to protein by multiplying by 6.25.

Crude fiber: Two grams of sample was put into 250 mL conical flask and 1.25% Sulfuric acid solution was added. The sample was heated for about 30 min, filtered then washed until traces of acid could not be detected using pH paper. The Whatman paper 5B with 125 micrometer pore size was placed in the Buchner flask. The acid extracted was transferred into 250 mL conical flask and 1.25% NaOH solution was added subsequently. The sample was heated again for 30 min, filtered using vacuum filter and washed with water until base was undetected. The whole material was transferred into crucible and dried for 12 h at 120°C. After that the crucible was placed into muffle oven at 550°C for 12 h and weight of crucible was recorded.

Mineral Analysis

Mineral content was determined by Association of Official Analytical Chemists methods (AOAC, 1990)[20] using the flame system of the atomic absorption spectrophotometry (AAS), (Varian SpectrAA 220, USA). Moringa leaves were ashed at 550°C overnight and the ash was dissolved in concentrated nitric acid and filtered, diluted to 50 mL with deionized water and the absorbance of the samples was read directly on the AAS.

Working standard solutions of calcium (Ca), potassium (K) and iron (Fe) were prepared from stock standard solution (1000 ppm), in 2 N HNO_3 and absorbance was noted for standard solution of each element and samples using atomic absorption spectrophotometer (AAS). The calibration curves obtained for concentration vs. absorbance. Data were statistically analyzed using fitting of straight line by least square method. A blank

reading was also taken and necessary corrections were made during the calculation of concentration of various elements.

Reagents and apparatus

Authentic standards of Ca, K and Fe were of Fluka. All the reagents and chemicals used were of analytical grade and obtained from E. Merck. Deionized water was used throughout the analysis.

Statistical Analysis

The data are presented as group mean±SD. The calculations were performed using Microsoft Excel data sheet. The data were analyzed using SPSS window program version 11.0.

RESULTS AND DISCUSSION: We studied the nutritional content of Moringa leaves which were regularly consumed by Thai people. Proximate analysis of the eleven different samples of Moringa leaves is presented in Table 1, for comparison some of the values from literature are also included. Results showed that the range of the moisture content were 8.52 g% (Bangkok) to 13.53 g% (Nakhonsawan). Protein content was generally high and varied between of 19.15 g% (Chaiyaphum) to 28.8 g% (Nakhonsawan). Fat ranged from 2.06 g% (Sakaeo) to 2.47g% (Chaiyaphum). Fiber ranged from 16.30 g% (Sakaeo) to 23.89 g% (Patumthani). Ash content varied between 6.39 g% (Sakonnakhon) to 7.99 g% (Bangkok). The high protein and low fat characteristic of Moringa leaves has been previously reported by Makkar and Becker[21]. These results are in agreement with the values reported by Oduro *et al.*[16] and Fuglie[13].

The result of nutritionally valuable minerals is presented in Table 2. The micronutrient profile, in terms of calcium, potassium and iron was analyzed. Highest amount of calcium was found in the samples of leaves from Chaiyaphum (2951.13 mg%) while lowest amount of calcium was found in the samples of leaves from Nongbualumphu (1510.41 mg%). Potassium levels were the highest in Sakaeo (2054.10 mg%) whereas Kanchanaburi had the lowest level with 1504.41 mg%. Moringa leaves of Kanchanaburi had a high content of iron at 37.60 mg% whereas Sakonnakhon had the lowest level of 20.31mg%.

The chemical composition of Moringa leaves observed in the present study compare well with the values reported by Fuglie[12]; Verma *et al.*[13]; Council of scientific and Industrial research[14] Elkhalifa *et al.*[15]; Oduro *et al.*[16] and Aslam *et al.*[17]. Most of the values obtained in this study were in the same range as those found in the report of Oduro *et al.*[16] and Aslam *et al.*[17]. Slight difference in proximate composition and mineral

Table 1 Proximate of *M. oleifera* leaves from eleven different samples and some results reported in the literature

Sample	Moisture (%)	Ash (%)	Crude fat (%)	Crude Protein (%)	Crude fiber (%)
Ayutthaya	12.51	7.11	2.43	20.90	20.11
Bangkok	8.52	7.99	2.10	22.44	17.99
Chaiyaphum	10.50	7.86	2.47	19.15	18.30
Kanchanaburi	9.07	6.83	2.22	24.25	19.66
Nakhonpathom	9.05	7.01	2.35	24.46	20.11
Nakhonsawan	13.53	6.78	2.16	28.80	16.39
Nongbualumphu	10.0	7.05	2.20	23.05	22.25
Nonthaburi	8.83	6.55	2.22	20.68	22.45
Patumthani	12.45	6.95	2.46	20.8	23.89
Sakaeo	10.06	7.30	2.06	27.34	16.30
Sakonnakhon	10.77	6.39	2.15	24.38	21.53
mean±SD	**10.48 ± 1.68**	**7.07 ± 0.49**	**2.26 ± 0.15**	**23.29 ± 2.95**	**19.91**
Oduro et al. [16]	-	*7.13 ± 0.03*	*2.23 ± 0.03*	*27.51 ± 0.0*	*19.25 ± 0.07*
Fuglie[12]	-	-	*2.29*	*27.08*	*19.21*
Elkhalifa et al.[15]	-	*8*	*1.7*	*16.7*	*3.5*
Council of Scientific and Industrial Research[14]	-	*2.3*	*1.7*	*6.7*	*0.9*
Verma et al .[13]	-	*0.9*	*1.7*	*6.7*	*2.3*

Table 2 Mineral Composition of *M. oleifera* leaves studied from different regions and some results reported in the literature

Sample	Calcium	Potassium	Iron
Ayutthaya	1955.83	2029.50	25.82
Bangkok	1575.00	2004.22	22.74
Chaiyaphum	2951.13	1983.10	29.75
Kanchanaburi	1523.38	1504.41	37.60
Nakhonpathom	2286.17	1732.20	22.15
Nakhonsawan	1858.33	1724.30	20.58
Nongbualumphu	1510.41	1584.90	25.74
Nonthaburi	2481.96	1732.50	21.55
Patumthani,	1566.92	1705.60	25.70
Sakaeo	1595.21	2054.10	33.79
Sakonnakhon	1640.58	1695.37	20.31
mean±SD	**1904.08 ± 476.21**	**1795.13 ± 189.90**	**25.97 ± 5.62**
Aslam et al. (3 regions)[17]	*2293.1 ± 8.89*	*2098.2 ± 7.98*	*20.5 ± 1.52*
	1895.0 ± 6.52	*1973.2 ± 6.83*	*39.7 ± 2.93*
	2634.9 ± 9.52	*2493.7 ± 8.52*	*57.3 ± 5.64*
Fuglie[12]	*2003.00*	*1333.33*	*28.21*
Council of scientific and Industrial research[14]	*440*	-	*7*
Verma et al.[13]	*440*	-	*7*

contents were found among the eleven different samples of Moringa leaves and those from other published studies[12,16-17]. The variation in the nutritional values will differ for a wide range of reasons, such as cultivated regions, growing conditions, nature of soil, seasonal changes, genetically different cultivars, storage conditions or due to the period of analysis[15,22-23]. From the experimental results (Table 1), *M. oleifera* from Nakhonsawan has the highest protein (28.80%) which may be due to likely application of manure to enrich the nitrogen content of the soil where it was cultivated. On the whole, Moringa leaves studied were found to be a good source of protein, fiber and trace minerals, especially calcium, potassium and iron. The results were in good agreement with those reported by Estrella *et al.*[11] ; Siddhuraju and Becker[9].

CONCLUSION: This study demonstrated that leaves of *M. oleifera* cultivated in Thailand are an important source of proteins, crude fiber and minerals. The high protein of the leaves with a fairly high concentration of calcium, potassium and iron; make it a potential leaf source food that is suitable for fortification of foods. These plant organs might be explored as a viable supplement and a ready source of dietary minerals in human food.

REFERENCES:

1. Anwar F, Bhanger MI. 2003. Analytical characterization of *Moringa oleifera* seed oil grown in temperate regions of Pakistan. J Agric Food Chem 51: 6558-63.

2. Food and Agriculture Organization of the United Nations, The Vegetable Sector in Thailand. 1999. http://www.fao.org/docrep/004/ac145e/AC145E09.htm Accessed on 22 May 2010.

3. Ramachandran C, Peter KV, Gopalakrishnan PK. 1980. Drumstick (*Moringa oleifera*): A multipurpose Indian vegetable. Econ Bot 34(3):276-83.

4. Caceres A, Saravia A, Rizzo S, Zabala L, De Leon E, Nave F. 1992. Pharmacologic properties of *Moringa oleifera*. 2: Screening for antispasmodic, antiinflammatory and diuretic activity. J Ethnopharmacol 36: 233-7.

5. Singh KK, Kumar K. 1999. Ethnotherapeutics of some medicinal plants used as antipyretic agents among the tribals of India. J Econ Tax Bot 23(1): 135-41.

6. Jed W. Fahey. 2005. *Moringa oleifera*: A review of the medical evidence for its nutritional, therapeutic, and prophylactic properties. Part 1. Trees for Life J 1: 5-20.

7. Anwar F, Latif S, Ashraf M, Gilani AH. 2007. *Moringa oleifera*. A food plant with multiple medicinal uses. Phytother Res 21: 17–25.
8. Pullakhandam R, Failla ML. 2007. Micellarization and intestinal cell uptake of β-carotene and Lutein from Drumstick (*Moringa oleifera*) Leaves. J Med Food 10(2):252–7.
9. Siddhuraju P, Becker K. 2003. Antioxidant properties of various extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (*Moringa oleifera* Lam.) leaves. J Agric Food Chem 51: 2144-55.
10. Thurber MD, Fahey Jed W. 2009. Adoption of *Moringa oleifera* to combat under-nutrition viewed through the lens of the "diffusion of innovations" theory. Ecol Food Nutr 48(3): 212-25.
11. Estrella MCP, Mantaring JBV, David GZ. 2000. A double-blind, randomized controlled trial on the use of malunggay (*Moringa oleifera*) for augmentation of the volume of breast milk among non-nursing mothers of preterm infants. Philippine. J Pediatr 49: 3–6.
12. Fuglie LJ (ed.). 2001. The Miracle Tree-The Multiple Attributes of Moringa. Dakar, Senegal: Church World Service.
13. Verma SC, Banerji R, Misra G, Nigam SK. 1976. Nutritional value of Moringa. Current Sci 45(21): 769-70.
14. Council of Scientific and Industrial Research. 1962. The Wealth of India- A dictionary of Indian raw materials and industrial products. New Delhi. p 425-9.
15. Elkhalifa AO, Ahmed SA, Adam S. 2007. Nutritional evaluation of *Moringa Oleifera* leaves and extracts. Ahfad Journal 24: 113 -22.
16. Oduro W, Ellis O, Owusu D. 2008. Nutritional potential of two leafy vegetables: *Moringa oleifera* and *Ipomoea batatas* leaves. Sci Res Essay 3(2):57–60.
17. Aslam M, Anwar F, Nadeem R, Rashid U, Kazi TG, Nadeem, M. 2005. Mineral composition of *Moringa oleifera* leaves and pods from different regions of Punjab, Pakistan. Asian J Plant Sci 4(4):417-21.
18. Nambiar VS, Seshadri S. 2001. Bioavailability trials of β-carotene from fresh and dehydrated drumstick leaves (*Moringa oleifera*) in a rat model. Plant Foods Hum Nutr 56: 83–95.
19. Sarwatt SV, Kapange SS, Kakengi AMV. 2002. Substituting sunflower seed-cake with *Moringa oleifera* leaves as supplemental goat feed in Tanzania. Agroforest Syst 56: 241-7.
20. AOAC. 1990. AOAC, Official Methods of Analysis. Gaithersburg, MD, USA, 15th ed. Association of Official Analytical Chemists, Arlington, VA.
21. Makkar HPS, Becker K. 1996. Nutritional value and antinutritional components of whole and ethanol extracted *Moringa oleifera* leaves. Ani Feed Sci Technol 63(1-4): 21-8.
22. McCance and Widdowson's. 1992. The Composition of Foods. 5thed. The Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food, UK.
23. Imeh U, Khokhar S. 2002. Distribution of conjugated and free phenols in fruits: antioxidant activity and cultivar variations. J Agric Food Chem 50: 6301-06.