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Nutrient Content of Kelor (*Moringa Oleifera* Lamk) Leaves Powder under Different Blanching Methods

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Abstract The aim of the present work was to study the effect of blanching method and period on the preservation of nutrition in moringa oleifera leaves powder. Unblanching Moringa oleifera leaves powder contained 340 mg 100 g–1 dry mass vitamin C, 16.51 mg 100 g–1 dry mass β-carotene and 24.59% crude protein. Treatment by blanching of Moringa oleifera lamk resulted in a decrease in the level of vitamin C about 120-238 mg 100 g–1 dry mass, increase in the level of β-carotene about 19.36-21.52 mg 100 g–1 dry mass, increase in the level of β-carotene about 24.70-30.68% (except steam blanching 5 minutes). The abundantly available inexpensive leaves of M. oleifira can serve as a pool house of nutrients and can be used in the developing countries to combat malnutrient.

Keywords Kelor, *Moringa Oleifera*, Blanching, Nutrients

1. Introduction

Moringa oleifera is the most widely cultivated species of a monogeneric family, the Moringaceae, that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan[5, 9]. *Moringa oleifera* known as Moringa is native to north India but is now found throughout the tropics. This rapidly-growing tree (also known as the horseradish tree, drumstick tree, benzolive tree, kelor, marango, mlonge, moonga, mulangay, nébéday, saijhan, sajna or Ben oil tree), was utilized by the ancient Romans, Greeks and Egyptians; it is now widely cultivated and has become naturalized in many locations in the tropics.

According to Fuglie[8] the many uses for *Moringa oleifera lamk* include: alley cropping (biomass production), animal forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed-cake), foliar nutrient (juice expressed from the leaves), green manure (from leaves), gum (from tree trunks), honey- and sugar cane juice-clarifier (powdered seeds), honey (flower nectar), medicine (all plant parts), ornamental plantings, bio-pesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tannin for tanning hides (bark and gum), water purification (powdered seeds). *Moringa oleifera* seed oil (yield 30-40% by weight), also known as Ben oil, is a sweet non-sticking, non-drying oil that resists rancidity. It has been used in salads, for fine machine lubrication, and in the manufacture of perfume and hair care products[7].

Moringa oleifera is an important food commodity which has had enormous attention as the 'natural nutrition of the tropics'. The leaves, fruits, flowers and immature pods of this tree are used as a highly nutritive vegetable in many countries, particularly in India, Pakistan, Philippines, Hawaii and many parts of Africa[3,4].

Moringa oleifera leaves have been reported to be a rich source of β-carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidants; and thus enhance the shelf-life of fat containing foods due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids [2,16]. *Moringa oleifera* leaves are edible and are of high nutritive value. It is consumed throughout West Africa as well as some Asian countries[8]. It has been reported that ounce-for-ounce, *Moringa oleifera* leaves contain more vitamin A than carrots, more calcium than milk, more iron than spinach, more vitamin C than oranges, and more potassium than bananas, noting that the protein quality of *Moringa oleifera* leaves rivals that of milk and eggs. Moreover, total protein digestibility of these leaves is high (85 % to 90 %) and its amino-acid composition corroborates with the FAO reference protein for growing child. The leaves are also free of antinutritive factors such as phenols, tannins and saponins[8].

Currently, the nutritional value of *Moringa oleifera* are well known that there seems to be little doubt of the

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substantial health benefit to be realized by consumption of *Moringa oleifera* leaves powder in situations where starvation is imminent. Nonetheless, the outcomes of well controlled and well documented clinical studies are still of great value. A leaves powder can be produced by drying the leaves and crushing or pounding them. This powder can then be added to sauces at the same time as other condiments or vegetables are added[5].

It is generally considered that there is sufficient documentation to conclude that food based on approaches using provitamin A sources, when adequately implemented, are effective in the control of vitamin A deficiency, and contribute to alleviating the other usual accompanying nutritional deficits. Other studies have shown that beta carotene from foods may have only limited availability as compared to isolated β-carotene in animal models. Bioavailability trials using fresh as well as blanched and sulphited shade dehydrated drumstick leaves were conducted on vitamin A deficient rats. The results revealed that the dehydrated drumstick leaves produced a marked increase in food intake, weight gain and liver vitamin A, compared to fresh drumstick leaves or synthetic vitamin A. In the developing countries like India, sources of vitamin A such as drumstick leaves are valuable in overcoming the problem of vitamin A deficiency. These findings also accentuate the importance of carotene on the vitamin A status, and underscore its equivalence to synthetic vitamin A when fed in the right amount[11].

Leafy vegetables are sometimes processed by blanching which is an important pre-processing heat –treatment of vegetable destined for dehydration. They are also cooked or dried depending on the mode of utilization[13]. The principle of preservation by dehydration process is to remove the moisture content of a material to a level where micro-organism may not be able to grow and spoil it. *Moringa oleifera* leaves with very high moisture contents, dehydration results in considerable reduction in weight and bulk and consequent savings in storage and distribution costs. Also, unit operations that intentionally separate the component of foods alter the nutritional qualities of each fraction compared with the raw material[11].

Before drying, vegetables are sometimes blanched. After blanching, vegetables are quickly chilled by spraying with cold water. Blanching which is an important pre-processing heat –treatment of vegetable destined for dehydration inevitably causes separation and losses of water soluble nutrients (minerals, water soluble vitamins and sugars). Blanching is a unit operation prior to drying *Moringa oleifera* are heated for the purpose of inactivating enzymes; modifying texture; preserving color, flavor, and nutritional value; and removing trapped air. Hot water and steam are the most commonly used heating media for blanching in industry.

However the process itself can result in significant nutrient losses from vegetables. The nutrient losses will depend on several factors the method used (steam blanching or hot water blanching). The use of higher temperatures during blanching will reduce the time available for leaching but may result in more thermal degradation of nutrients, as many of the deleterious enzymes destroyed by blanching are heat resistant. When blanching vegetables the addition of sodium bicarbonate (or other alkali) to the blanching water for preserving the color should be considered carefully, as while preserving the color, it also has the effect of softening the texture of the vegetable and increasing destruction of vitamin C and thiamine[10].

The objectives of this study is to determine the effect of 6 treatments blanching methods that is; boil blanching for 5 minutes (B5M), boil blanching for 10 minutes (B10M), steam blanching for 5 minutes (S5M), steam blanching for 10 minutes (S10M), boil blanching addition of sodium bicarbonate for 5 minutes (BSB5M) and boil blanching addition of sodium bicarbonate for 10 minutes (BSB10M) and un-blanching (UB) on the nutritional properties of *Moringa oleifera* leaves powder.

2. Material and Methods

2.1. Materials

Moringa leaf was harvested from Beji village, Malang, Indonesia. It was transferred in a airtight containers to the laboratory. Other ingredients were purchased from local stores.

2.2. Methods

2.2.1. Blanching

Boil Blanching: The *Moringa oleifera* leaves were washed, approximately 100 g of fresh *moringa oleifera* were immersed in boiling water at 100^0C for periods of 5 and 10 minutes, respectively. The samples were drained on a stainless sieve until cold and then weighed.

Steam Blanching: The *Moringa oleifera* leaves were washed, approximately 100 g of fresh *moringa oleifera* then steam blanched for 5 and 10 minutes (blancher chamber temperature of 97 ± 2℃).

Boil Blanching addition of sodium bicarbonate: The *Moringa oleifera* leaves were washed, approximately 100 g of fresh *moringa oleifera* were immersed in boiling water boiling addition of sodium bicarbonate 1500 ppm at 100℃ for periods of 5 and 10 minutes, respectively.

2.2.2. Experimental Design

Three field replications of *Moringa oleifera* leaves were grown at Beji village. Crops were packed in airtight containers and that was cooled to 4℃ with dry ice. Processing took place at the State University of Malang. Samples were randomly divided to undergo one of 3 treatments blanching (boiling, steaming and boiling addition of sodium bicarbonate) and 2 periods (5 and 10 minutes).

The samples were drained on a stainless sieve until cold and then weighed. The blanched *moringa oleiefera* leaves were then dried in a hand spinning kitchen vegetable drier

and the blanched leaves were loaded on the trays forming one single layer of the cabinet dryer and were dried in the cabinet dryer. The cabinet dryer was preheated to 40℃ and then the loaded tray was added each time, until all the leaves were done. The temperature was maintained at 40℃ and the leaves were left for 1 h for their drying. Vegetables were sufficiently dried till they became crisp and brittle to touch. The leaves took four hours for complete drying and milled with the aid of stainless Kenwood Chef Warring Blender, Model KM001 (0067078) series. The resultant powder was sieved through 0.25 mm laboratory sieve to obtain uniform particle size. The *moringa oleifera* leaf powder samples were then analyzed for (i) Crude protein (ii) β-carotene and (iii) Vitamin C. Using the standard procedure of AOAC[1].

2.2.3. Determination of Crude Protein

The sample (0.5g) was weighed into the micro-Kjeldahl flask. To this were added 1 Kjeldahl catalyst tablet and 10ml of conc. H_2SO_4. These were set in the appropriate hole of the digestion block heaters in a fume cupboard. The digestion was left on for 4 hours after which a clear colourless solution was left in the tube. The digest was carefully transferred into 100ml volumetric flask, thoroughly rinsing the digestion tube with distilled water and the volume of the flask made up to the mark with distilled water. 5ml portion of the digest was then pipetted to Kjeldahl apparatus and 5ml of 40% (w/v) NaOH added.

The mixture was then steam distilled and the liberated ammonia collected into a 50ml conical flask containing 10ml of 2% boric acid plus mixed indicator solution. The green colour lsolution was then titrated against 0.01 NHCl solution. At the end point, the green colour turns to wine colour, which indicates that, all the nitrogen trapped as ammonium borate have been removed as ammonium chloride. The percentage nitrogen was calculated by using the formula:

% N = Titre value x atomic mass of nitrogen x normality of HCl used x 4

The crude protein is determined by multiplying percentage nitrogen by a constant factor of 5.75[1].

2.2.4. β-Carotene Determination

0.05 g of the sample was weighed and ground smoothly with celite using mortar and pestle. 50 ml acetone was added while grinding to extract carotene. The extracts were filtered using the hand aspirator and the filtrate added to 20 ml of petroleum ether in a separating funnel. Water was gently added at the side of the funnel with each addition being allowed to separate from the removal residual acetone, and the extract dried over anhydrous sodium sulphate. A volume of 100 ml of the concentration was evaporated to dryness with nitrogen gas and re-dissolved (reconstituted) in varying volumes of the mobile phase depending on anticipated concentration. The absorbance was then determined by spectrophotometer at 260 nm.

2.2.5. Determination of vitamin C Content

Ascorbic acid was determined using the procedure described by Adebayo (17). Standard indophenol's solution was prepared by dissolving 0.05g 2,6-dichloro Indophenol in water diluted to 100ml and filtered. To standardize, 0.053g of ascorbic acid was dissolved in 90ml of 20% metaphosphoric acid and diluted with water to 100ml. 10ml of this solution was pipette into a small conical flask and titrated with indophenol's solution until a faint pink colour persists for 15seconds. 2ml of the extracted juice from the calyces was pipette into a conical flask and 5ml of 20% metaphosphoric acid (as stabilizing agent) was added and made up to 10ml mark with water. It was titrated with the indophenols solution a faint pink colour persists for 15seconds. The vitamin content in the calyces was calculated

$$\text{Vitamin C in mg/100g} = \frac{\text{Titre value} \times 0.212 \times 100}{\text{Wt of sample}}$$

2.2.6. Statistical Analyses

Data obtained were expressed as means. The statistical significance of differences was assessed using analysis of variance. A two-tailed P value of less than 0.05 was considered to be statistically significant. Values that were signifi-cantly different were separated by Duncan Multiple Range test using SPSS for windows Version 16.0 statistical pack-age. LSD Test was used to compare mean variance. Significance was accepted at 5% level of probability following

3. Result and Discussion

3.1. Vitamin C

All blanching treatments, except steam blanching for periods of 5 minutes, caused a dramatic loss of vitamin C (P<0.05). The greatest loss of vitamin C was observed in *moringa oleifera* powder after boil blanching for periods of 10 minutes (64.7%) treatments, followed by boil blanching addition of sodium bicarbonate for 10 minutes, boil blanching for periods 5 minutes, steam blanching for periods 10 minutes and boil blanching addition of sodium bicarbonate for 10 minutes (16% and 24%, respectively) treatments. Vitamin C content of the blanched *moringa oleifera* leaves powder was less than the un-blanched *moringa oleifera* leaves powder.

The present study showed that vitamin C content significantly declined during the three blanched methods for periods of 5 minutes and 10 minutes respectively, ranging from 120–238 mg 100 g^{-1} dry mass, with the greatest loss found in boiled for 10 min (120 mg 100 g^{-1} dry mass). Boiling seriously destroyed vitamin C in almost all the samples, ranging from 30% to 64%, due to its instability at high temperatures and its water-soluble nature that causes it to leech into cooking water, which is generally discarded after cooking.

Many studies indicated that the loss of vitamin C content during blanching could be attributed to the fact that vitamin C is very soluble in water and not stable at high temperatures.

Thus, the temperature of the blanching process could have inactivated most of the vitamin C in the vegetables, while the water would also wash away the vitamin C during the blanching process[10,14].

Table 1. Ascorbic acid content of *moringa oleifera* leaves powder under different blanching methods

Treatment	(mg 100 g^{-1} dry mass)
Unblanching	340a
Steam blanching 5 minutes	238b
Steam blanching 10 minutes	179c
Boil blanching + sodium bicarbonate 5 minutes	179c
Boil blanching 5 minutes	176d
Boil blanching + sodium bicarbonate 10 minutes	130e
Boil blanching 10 minutes	120f

Note: Values are means of triplicate determinations. Within column values with different superscripts are statistically significant

Data in this study showed that un-blanched vegetables were normally good sources of vitamin C. It clearly showed that blanching methods (boiling, steaming or boling with sodium bicarbonate) lead to excessive loss of vitamin C. The boiling method was found to greatly destroy the amount of vitamin C concentration in all blanched vegetables. This finding was consistent with the observations of Suttikomin [16]. Suttikomin[8] demonstrated that among blanching methods produces higher percent vitamin C loss (60–94%) when Thai vegetables such as Chinese white cabbage (*Brassica pekinensis* Rupr) (60%), ivy-gourd leaves (*C. grandis* Voigt) (94%), Chinese swamp cabbage (*I. reptans*) (88%), fruit producing plant (71%), egg plant (*S. melongena* Linn) and young-pod wing beans (*Psophocarpustetragonol obus*) (58%) were studied.

3.2. β-Caroteen

The results of *moringa oleifera* leaf powder β-carotene content under the three blanching methods are summarized in Tables 2. The β-carotene content was 16.51 mg 100 g–1 dry mass unblanced *moringa oleifera* leaf DM, but decreased significantly ($p<0.5$) in dried samples regardless of the blanching method. For all blanched *moringa oleifera* leaf demonstrated higher ($p<0.05$) β-carotene content than the un-blanched samples.

β-carotene contents in blanched leaves were significantly ($p < 0.05$) higher than those of their corresponding un-blanched leaves. By inference, blanched leaves had lower moisture values than un-blanched leaves causing an increase in solid matter content[19]. More so, blanching does not destroy β-carotene, since β-carotene is heat stable and therefore is not destroyed by most methods of cooking[6]. These are possible reasons why β-carotene content in blanched leaves are higher than un-blanched leaves. The results showed that Moringa oleifera powder leaves have very high levels of ß-carotene with values ranging from 16.51 mg 100 g^{-1} dry mass to 21.52 mg 100 g^{-1} dry mass. This observation is of significant interest since reports indicate that β-carotene content is high in quality moringa oleifera powder. Also, this observation is desirable since Moringa leaves when treated have ß-carotene contents (per 100g of edible portions) which exceed the Recommended Daily Allowance for children (1.5 mg/100g) and for women and lactating mothers (5.7 mg/100g) (Fuglie, 2001). ßcarotene particularly has strong antioxidant effects in vitro, eliminating free radicals. It has been demonstrated to quench singlet oxygen (1O2), scavenge peroxyl radicals and inhibit lipid peroxidation. Antioxidants effects help prevent aging and cancer.

Table 2. β-carotene content of *moringa oleifera* leaves powder under different blanching methods

Treatment	(mg 100 g^{-1} dry mass)
Boil blanching + sodium bicarbonate 5 minutes	21.52^{a}
Boil blanching 5 minutes	21.05^{a}
Boil blanching 10 minutes	20.27^{a}
Steam blanching 5 minutes	19.68^{b}
Steam blanching 10 minutes	19.76^{b}
Boil blanching + sodium bicarbonate 10 minutes	19.36^{b}
Unblanching	16.51^{c}

Note: Values are means of triplicate determinations. Within column values with different superscripts are statistically significant

3.3. Crude Protein

Table 3. Crude protein content of *moringa oleifera* leaves powder under different blanching methods

Treatment	Crude protein (%)
Boil blanching 5 minutes	30.68a
Boil blanching 10 minutes	30.66a
Boil blanching + sodium bicarbonate 10 minutes	30.47a
Boil blanching + sodium bicarbonate 5 minutes	29.80b
Steam blanching 5 minutes	24.70c
Unblanching	24.59c
Steam blanching 10 minutes	23.37d

Note: Values are means of triplicate determinations. Within column values with different superscripts are statistically significant

The protein content in the 6 samples of the blanched moringa oleifera leaves powder was in the range of 24.70 - 30.68 mg 100 g^{-1} dry mass, except steam blanching 5 minutes. Maximum protein content (30.68 mg 100 g^{-1} dry mass) was in the boil blanching sample and the minimum was in steam blanching 5 minutes sample. The protein content in the blanched moringa oleifera leaves powder increased from the ublanched moringa oleifera leaves powder sample of drumstick leaves. The ublanched moringa oleifera leaves powder contain 24.59 mg 100 g–1 dry mass protein. The difference in the protein content of the 6 blanching samples of the leaves compared to the unblanching leaves was statistically significant ($p < 0.05$). Their values are in agreement with the protein content (27.1 %) Fuglie[8] reported for M. oleifera. The author also stated that the protein quality of Moringa oleifera rivals that of meat and eggs and protein digestibility is high (85 % to

90 %), with its amino-acid composition corroborating with the FAO reference protein for a growing child.

4. Conclusions and Suggestion

Blanching pretreatement was used to improve nutrition properties of *moringa oleifera*. Blanching leafy vegetable samples were higher in compositional attributes than unblanched vegetables. Blanched is one of the most possible strategies for preservation of *moringa oleifera* leaves, which are highly seasonal and perishable too. The abundantly available inexpensive leaves of *M. oleifira* can serve as a pool house of nutrients and can be used in the developing countries to combat micronutrient deficiencies.

The current study clearly shows that nutrient and health-promoting compounds in *moringa oleifera* powder are significantly affected by blanching. All blanching treatments, caused great losses of vitamin C. Blancing for 5 minutes had minimal effects on crude proteins, vitamin C and β-carotene.

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