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Effects of cooking methods on antioxidant properties and carotenoids contents of *Moringa oleifera* Lam. pods

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Abstract

Moringa oleifera Lam. is a plant grown in tropical and subtropical regions such as Asia, Africa and Latin America. In Thailand it is called "Maroom". Moringa pods have been commonly consumed as a vegetable in Thai cuisine named sour soup or "Kaeng Som". Health benefit of Moringa pods have been revealed including the ability to suppress a colitis-related colon carcinogenesis and can serve as a chemopreventive agent. This study aimed to compare antioxidant properties including total phenolic content (TPC), oxygen radical absorbance capacity (ORAC) and 2,2-Diphenyl-1-picrylhydrazyl radical scavenging capacity (DPPH), and carotenoids contents namely β-carotene and lutein between boiled and steamed Moringa pods. Fresh pods were washed with tap water and cut into pieces about 3-inch long. Pod pieces were subjected to boil or steam for 15 min. After cooling at room temperature, flesh and seeds of the cooked pods were removed from the peels by hand, placed in laminated aluminum foil bags and kept at -20 ºC for further analyses. Fresh flesh and seeds without cooking were used as a control. Three replications were performed on three markets. The results showed that both cooking methods had significantly greater antioxidant properties (TPC, ORAC, DPPH), and β-carotene and lutein contents compared to the sample without cooking. When compared between two cooking methods, steaming provided higher TPC and DPPH, while there was no difference in ORAC. It was noticed that β-carotene and lutein contents of boiled pods were significantly higher than those of the steamed samples. Therefore, boiling would be selected as a cooking method to prepare Moringa pods for further study in development of food products containing Moringa pods for health benefits.

Keywords: Moringa flesh and seeds, boiling, steaming, β-carotene, lutein

Introduction

Moringa or drumstick tree or "Maroom" in Thai, is a member of the family Moringaceae, and there are about 13 well-recognized species. The plant can grow in tropical and subtropical areas of the world with a temperature around 25-35 ºC. In Thailand there are two species of moringa, *Moringa oleifera* Lam. and *Moringa stenopetala*. The most popular variety in Thailand is *M. oleifera* Lam. Moringa is used as a food in many countries, such as India, Philippines, Pakistan and Thailand. Every part of Moringa, such as leaves, flowers, pods and seeds, can be used for cooking. Leaves, flowers, and seeds are boiled and served as side dishes for chili pastes. In Thailand, Moringa pods are popular for sour soup (Kaeng Som). In addition, Moringa leaves, flowers, and seeds are made into dry powder and placed in capsules or packed in tea bag for drink.

Health benefits of Moringa have been revealed in many studies including the ability to reduce the risk of disease. Medicinal studies have reported that *M. oleifera* Lam. leaves can be used as a poultice for sore infection, to reduce glandular swelling, fevers, and sore throat. Flowers show high medicinal value as a stimulant and used to cure inflammations. Pods can be used to reduce cholesterol, anti-inflammatory, antibacterial, and are antioxidant. Seeds can use to protective effect by decreasing liver lipid peroxide with extract exerts (Anwar et al. 2007). *M. oleifera* Lam. is also used as a potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent. *M. oleifera* Lam. has possessed an antioxidant and has therapeutic potential for the prevention of cardiovascular disease (Chumark et al. 2012). The pod contains a high number of bio-enhancers, which can be used to reduce cholesterol in the blood (Karim and Azlan, 2012). The pod exerts suppressive effects in a colitis-related colon carcinogenesis and can serve as a chemopreventive agent (Buddha et al. 2012). Due to the health benefits of Moringa, many Moringa products have been developed diversely. This research aims to study effect of two cooking methods, boiling and steaming, on antioxidant properties and carotenoids contents of *M. oleifera* pods.

Materials and methods

Collection of *M. oleifera* Lam. pods

M. oleifera Lam. pods were obtained from three markets in Thailand which represented three replications. These markets are: Sala Namron market; Bangkok, BangYai market; Nontha Buri Province, and Talaad Thai; Prathum Thani Province. Samples were collected during May to October, 2018.

Preparation of fresh pods, and boiled and steamed *M. oleifera* Lam. pods

Fresh *M. oleifera* Lam. pods were washed with tap water and cut into pieces about 3-inch long. Pods from each market were separated into three portions; fresh, boiled and steamed. For fresh portion, flesh and seeds of some fresh pods were removed from the peels by hand, and used for color and pH measurement. The rest fresh pod pieces were placed in laminated

aluminum foil bags and kept at -20 ºC for determination of antioxidant properties and carotenoids contents. For boiled and steamed portions, fresh pod pieces were subjected to boiling or steaming for 15 min. After cooling at room temperature (approximately 25-28 ºC), flesh and seeds of the cooked pods were removed by hand. Cooked weights were recorded. Color and pH of cooked flesh and seeds mixtures were measured. Cooked samples were then placed in laminated aluminum foil bags and kept at -20 ºC.

Prior to the determination of antioxidant properties and carotenoids contents, frozen fresh pod pieces were thawed overnight in a refrigerator. Following thawing, flesh and seeds were removed and blended together using a blender. Frozen, cooked flesh and seeds mixtures were dried using a freeze-dryer. Dried samples were ground into powder.

Determination of physical properties

Cooked yield

Yield of *M. oleifera* Lam. after boiling and steaming were calculated based on fresh pods and expressed as percent yield.

$$\text{Cooked yield (\%)} = \frac{\text{Weight of } cooked\ M.\ oleifera \text{ Lam. pods (g)} \times 100}{\text{Weight of fresh } M.\ oleifera \text{ Lam. pods (g)}} \quad (1)$$

Color

Color of fresh and cooked *M. oleifera* Lam. pods were evaluated according to the CIE system. The color values (L*, a*, and b*) were measured using a spectrocolorimeter (ColorFlexEZ, Hunter Associates Laboratory, Reston, Virginia, USA.). The L* value represents lightness. The a* value represents redness where positive value means redness and a negative value means greenness. The b* value was yellowness where positive value means yellowness and a negative value means blueness.

Determination of pH

The pH of fresh and cooked *M. oleifera* Lam. pods were determined using a pH meter (EcoMet P25, Istek, Seoul, Korea).

Determination of antioxidant properties

Sample was homogenized with 25 mL of 70% ethanol for 2 h at 30 Hz. The mixture was incubated in the dark at room temperature for 48 h. After that, the mixture is centrifuged at 13,000×*g* for 5 min at room temperature. Supernatant was collected and kept in a 2-mL microtube (Ainsworth and Gillespi, 2007). The extracted sample was used for determination of total phenolic content and antioxidant properties by oxygen radical absorbance capacity and 2,2-diphenyl-1-picrylhydrazyl radical scavenging capacity methods.

Total phenolic content assay

Total phenolic content was analyzed according to the method of Ainsworth and Gillespie (2007). Twenty-five microliters of sample were mixed with 50 µL of 10% (v/v) solution of 2 N Folin-Ciocalteau reagents in deionized water in a 96-well microplate. After 5 minutes incubation, 200 µL of 7.5 % (w/v) Na_2CO_3 were added. The mixture was incubated in the dark at room temperature for 2 h. The absorbance at 760 nm was measured by using a microplate reader (Synergy HT, Bio-Tek Instruments, Winooski, Vermont, USA.). Gallic acid (10-200 µg/mL) was used as a standard, and results were calculated as gallic acid equivalent (mg GAE/g). (Ainsworth and Gillespi, 2007).

2,2-diphenyl-1-picrylhydrazyl radical scavenging capacity assay

2,2-diphenyl-1-picrylhydrazyl radical scavenging capacity assay or DPPH assay was performed according to Fukumoto L.R. and Mazza G. (2000) with modification. Twenty-two microliters sample and 200 µL solution of DPPH prepared in 95% of ethanol was transferred to a 96-well microplate and incubated at room temperature for 30 min. The reaction was monitored using the plate reader at 520 nm wavelengths. The DPPH values of the sample were determined according to a standard curve of Trolox solution (0.01-0.64 µM) and results were calculated as µmol TE/g.

Oxygen radical absorbance capacity assay

Oxygen radical absorbance capacity (ORAC) assay was performed according to Ou et al. (2002). A hundred and fifty microliters of fluorescein working solution (30 nM) and 25-µL sample or Trolox (3.125-100 µM) dissolved in 75 mM phosphate buffer pH 7.4 were transferred into 96-well microplate and incubated at 37 °C for 15 min. After adding 25 µL of 2, 2'-azobis (2-amidinopropane) dihydrochloride known as AAPH (150 mM) to the microplate, the fluorescence is recorded under constant shaking at 1 min intervals for 90 min at excitation and emission wavelengths of 485 and 528 nm respectively. The results were calculated based on the differences in areas under the sodium fluorescein decay curve (AUC) and expressed as trolox equivalent (µmol TE/g). The AUC was calculated as;

$$\text{AUC} = 0.5 + \sum_{i=1}^{i=90} \frac{fi}{fo} \quad (2)$$

where f_o is the initiation fluorescence reading at 0 min and $f_{1,\,2,\,\ldots,\,90}$ is the fluorescence reading at 1,2,…,90 min.

Carotenoids content

Saponification

Homogenized *M. oleifera* pods sample was weighted around 3-5 g into a 250-mL brown round bottom flask. Ten milliliters of 10% ascorbic acid was added following by 50 mL of 2 N potassium hydroxide in 95% ethanol for saponification. The solution was refluxed at 100 °C for 30 min and cooled, then 70 mL hexane was added, followed by continuously shaking for 2 min to extract carotenoid compound from the sample. The sample was re-extracted 2 times with 35 mL of hexanes. The solution was separated into two layers. The upper layer was poured into a separating funnel containing with 5% KOH solution, then shake and intermittently released air in the flask. The separated layer of the lower part was discarded. The extract solution (upper layer) was washed with 70 mL of 10% NaCl and the lower layer was discarded again. The upper layer was washed with 100 mL deionize water until the discard solution had alkaline free. Lastly step of water washing the extract was dried with strips of filter paper (Whatman#1) and all extracted solutions were transferred into a 250-mL brown round bottom flask. The hexane in the extracted solution was dried by a rotary vacuum evaporator at 38-40 °C. The residue was re-solubilized with high performance liquid chromatography (HPLC)-mobile phase solvent.

High performance liquid chromatography

Carotenoids analysis was performed using Agilent 1100 series pumps, a diode array detector, and a YCM C_{30} column (4.6 mm x 250 mm, 5-µm internal diameter). The mobile phase consisted of 98% methanol + 2% ammonium acetate (solvent A) and Methyl tert-butyl ether (MtBE) (solvent B) at a ratio of 80:20 with a flow rate of 0.6 mL per min. The column temperature was set at 25 °C and the absorbance was read at 470 and 450 nm (Chitchumroonchokchai et al. 2017).

Statistical analysis

Statistical analysis of the experimental data was performed using a statistical program, the software package SPSS® for Windows version 18.0 (SPSS Inc. Illinois, USA.). The mean and significant among means of scores from quality determination were assessed by one-way analysis of variance (ANOVA) at 5% level of probability. The mean difference was compared using the Duncan's Multiple Range test.

Results and discussion

Cooking yield

Cooking yields of boiled and steamed *M. oleifera* pods from three markets were presented in **Table 1**. The average cooking yield of steaming method was 86.47±1.51%. When compared between two cooking methods, boiling showed numerical higher cooking yields for all three markets with the average yield of 91.21±3.68%. Boiled *M. oleifera* pods provided higher cooking yield values due to the absorption of water to pods during boiling (Chang et al. 2013).

Table 1 Cooking yields (%) of boiled and steamed *Moringa oleifera* Lam. pods.

Source	Boiling	Steaming
Market 1	95.20	88.00
Market 2	90.49	86.41
Market 3	87.95	84.99
Average of three markets	91.21±3.68	86.47±1.51

Color

Color values of fresh, boiled and steamed *Moringa oleifera* Lam. pods from three markets were presented in **Table 2**. For color parameter, the extent of color change in cooked Moringa pods was dependent on the cooking method, these results show that L* had higher value before cooking. There were significantly different ($p \leq 0.05$) in the changes of L* values subjected to cooking methods. While a* and b* values of fresh samples were significantly lower than those of cooked samples ($p \leq 0.05$). Changes in the visual color observed on cooked *M. oleifera* pods may be mainly related to the conversion of chlorophyll into pheophytin because of heat treatment (Turkmen et al. 2006). Lower b* values of boiled pods compared to steamed samples may be caused by boiling softened *M. oleifera* pods. Change in surface reflectance and depth of light penetration into tissues of boiled vegetables may be due to the loss of air and other dissolved gases by cells, and their replacement by cooking water and cell juices (Tijskens et al. 2001).

Table 2 Color values of flesh and seeds mixtures of fresh, boiled and steamed *Moringa oleifera* Lam. pods.

Source	Color value	Fresh	Boiled	Steamed
Market 1	L*	64.80±0.13^{a}	62.99±0.44^{b}	65.33±0.09^{a}
	a*	-6.31±0.11^{c}	-1.50±0.16^{b}	-1.10±0.01^{a}
	b*	35.51±0.15^{b}	35.46±0.15^{b}	35.90±0.03^{a}
Market 2	L*	65.93±0.26^{a}	61.69±0.16^{c}	63.05±0.02^{b}
	a*	-3.28±0.08^{c}	-2.00±0.03^{a}	-2.12±0.02^{b}
	b*	32.95±0.09^{c}	34.19±0.38^{b}	36.38±0.08^{a}
Market 3	L*	39.56±0.94^{a}	35.94±0.10^{c}	37.13±0.05^{b}
	a*	-4.51±0.01^{b}	-1.91±0.01^{a}	-1.90±0.01^{a}
	b*	12.93±0.03^{c}	13.73±0.10^{b}	15.44±0.13^{a}

Results are expressed as mean±SD from three single sample analyses.
The values in the same row with different superscripts showed significant difference ($p \leq 0.05$).

pH

The pH of fresh, boiled and steamed *Moringa oleifera* Lam. pods from three markets were shown in **Table 3**. There were no differences in average pH values among three markets. The average pH values of fresh sample of three markets was 5.35 and those of cooked samples were between 5.52 and 5.57.

Table 3 pH of flesh and seeds mixtures of fresh, boiled and steamed *Moringa oleifera* Lam. pods.

Source	Fresh	Boiled	Steamed
Market 1*	5.56±0.01^{c}	5.75±0.01^{b}	5.85±0.02^{a}
Market 2*	5.13±0.00^{c}	5.46±0.00^{b}	5.54±0.01^{a}
Market 3*	5.35±0.02^{a}	5.34±0.00^{ab}	5.32±0.01^{b}
Average of three markets	5.35±0.22	5.52±0.21	5.57±0.27

*Results are expressed as mean±SD from three single sample analyses.
The values in the same row with different superscripts showed significant difference ($p \leq 0.05$).
The values in the same row without superscript showed no difference ($p > 0.05$).

Antioxidant properties

Total phenolic content

The results of total phenolic contents in fresh and cooked Moringa pods are presented in **Table 4**. Moringa pods showed significantly higher ($p \leq 0.05$) total phenolic contents in the cooked samples compared to the fresh samples where steamed and boiled pods had the average total phenolic contents of three markets of 310.63 and 234.82 mg GAE/100g dry basis respectively and fresh pods had 3.57 mg GAE/100g dry basis. Turkmen et al. (2005) studied the effect of different cooking methods (boiling, microwave cooking, and steaming) on total phenolics of vegetable (green beans and pea). Their results showed that cooking methods increased phenolic contents in green beans, which is consistent with the results of this study. Increased total phenolic content may be due to heat treatment increased the level of free flavonols. On the other hand, Mahanta (2012) studied about the effect of three cooking treatments (steaming, conventional boiling and microwave cooking) on the phytochemical content of vegetable. They found that green pea showed negative effect of thermal treatment on TPC values, which may be caused by thermal treatment have destructive effect on the phenolic compounds resulting to highly unstable compounds. When compared between two cooking methods of those three markets, steaming provided significantly higher total phenolic contents ($p \leq 0.05$). This may be due to water cooking may cause leaching of polyphenols and antioxidants from cells to the liquid part.

Table 4 Total phenolic contents (mg GAE/100g dry basis) of fresh, boiled and steamed *Moringa oleifera* Lam. pods.

Source	Fresh	Boiled	Steamed
Market 1*	4.24±0.25^{c}	179.50±3.52^{b}	302.50±6.09^{a}
Market 2*	4.45±0.17^{c}	268.78±2.59^{b}	319.84±3.59^{a}
Market 3*	2.01±0.18^{c}	256.19±4.00^{b}	309.56±3.83^{a}
Average of three markets	3.57±1.18^{c}	234.82±41.96^{b}	310.63±8.55^{a}

*Results are expressed as mean±SD from three single sample analyses.
The values in the same row with different superscripts showed significant difference ($p \leq 0.05$).

2,2-Diphenyl-1-picrylhydrazylradical scavenging capacity

The radical scavenging activity of Moringa pods subjected to different cooking methods was tested using 2,2-diphenyl-1-picrylhydrazylradical scavenging capacity (DPPH) assay. DPPH radical scavenging ability of fresh and cooked Moringa pods samples are shown in **Table 5**. Steamed and boiled pods provided 1262.75 and 1042.97 µmole TE/100g dry basis respectively which were significantly ($p \leq 0.05$) higher scavenging activity than the fresh sample (4.86 µmole TE/100g dry basis). Turkmen et al. (2005) studied the effect of different cooking method on DPPH antioxidant activity. They reported that DPPH of green beans significantly increased during cooking procedures (boiling, microwave cooking, and steaming) compared with the values of the fresh one. On the other hand, Preti et al. (2017) who studied the effect of steaming and boiling on green bean reported that boiling resulted in the highest loss of antioxidant activity when compared to steaming. Increase of DPPH in steamed samples are agreed with the study of Preti et al. (2017). Loss of DPPH scavenging capacity during boiling may be due to the water-soluble compounds leaching into the cooking water and breakdown of these compounds during cooking.

Table 5 2,2-Diphenyl-1-picrylhydrazylradical scavenging capacity (µmole TE/100g dry basis) of fresh, pods of boiled and steamed *Moringa oleifera* Lam.

Source	Fresh	Boiled	Steamed
Market 1*	4.59 ± 0.17^{c}	831.17 ± 50.12^{b}	1147.90 ± 38.57^{a}
Market 2*	6.55 ± 0.60^{c}	1186.50 ± 63.53^{b}	1353.23 ± 93.06^{a}
Market 3*	3.44 ± 0.48^{b}	1111.24 ± 80.72^{a}	1287.13 ± 207.10^{a}
Average of three markets	4.86 ± 1.42^{c}	1042.97 ± 171.93^{b}	1262.75 ± 146.63^{a}

*Results are expressed as mean±SD from three single sample analyses.
The values in the same row with different superscripts showed significant difference ($p \leq 0.05$).

Oxygen radical absorbance capacity

Oxygen radical absorbance capacity (ORAC) assay was used to evaluate the antioxidant activity of Moringa pods as effect of cooking methods shown in **Table 6**. Moringa pods showed significantly higher ($p \leq 0.05$) ORAC in their cooked samples compared to the fresh samples. Steamed and boiled pods provided ORAC values of 3408.61 and 3134.47 µmole TE/100g dry basis respectively, while only 312.12 µmole TE/100g dry basis was presented in the fresh pods. Xu et al. (2008) studied the effect of soaking, boiling and steaming processes on the total phenolic components and antioxidant activity in food legumes including green pea, yellow pea, chickpea, and lentil. The results showed that boiling for 15 min has increased ORAC values when compared to the raw sample. Jocelyn et al. (2016) studied about antioxidants in terms of their total phenolics and ORAC of 69 species of vegetables. They found that the cooking process significantly ($p<0.05$) increase the antioxidant capacity. No difference between average ORAC values of boiled and steamed pods from three markets was found in this study.

Table 6 Oxygen radical absorbance capacity (µmole TE/100g dry basis) of fresh, boiled and steamed *Moringa oleifera* Lam. pods.

Source	Fresh	Boiled	Steamed
Market 1*	331.80 ± 3.86^{c}	3401.58 ± 305.15^{b}	3801.89 ± 40.63^{a}
Market 2*	331.58 ± 2.71^{b}	3103.15 ± 393.15^{a}	3151.39 ± 327.51^{a}
Market 3*	272.96 ± 6.13^{b}	2898.69 ± 215.79^{a}	3272.56 ± 215.79^{a}
Average of three markets	312.12 ± 29.62^{b}	3134.47 ± 361.24^{a}	3408.61 ± 358.64^{a}

*Results are expressed as mean±SD from three single sample analyses.
The values in the same row with different superscripts showed significant difference ($p \leq 0.05$).

Carotenoid content

β-carotene

The results of β-carotene contents in fresh and cooked Moringa pods in **Table 7** showed that the β-carotene in all cooked Moringa pods were significantly ($p \leq 0.05$) higher compared to their fresh pods. Boiled and steamed Moringa pods showed higher β-carotene contents with 227.62 and 190.51 µg/100g dry basis respectively, and the fresh Moringa pods provided 27.78 µg β-carotene/100g dry basis. Because boiling and steaming has induced to a softening of the plant tissue and the denaturation of proteins, therefore the carotenoids can be extracted easier (Rodriguez-Amaya, 1997). Change in tissue morphology, which occur as a result, allow greater penetration of extracting solvent into the cells and increase the release of β-carotene as well as the common chloroplast in a green vegetable like lutein that is resistant to heat treatment (Chandra-Hioe et al. 2017). Shin et al. (2016) studied β-carotene contents of plant food materials (kidney beans, mung beans and peas) prepared by boiling,

steaming, or baking. Their results showed that after boiling, β-carotene contents of peas significantly increased from 382.8 to 463.2 µg/100g. They explained that when peas were heated, the peptide chain structures of proteins are denatured, then tissues were loosened. This would facilitate extraction resulting in increasing β-carotene extraction rates. No difference in average β-carotene contents between boiling and steaming methods was found in this study.

Table 7 β-carotene content (µg/100g dry basis) of fresh, boiled and steamed Moringa *oleifera* Lam. pods.

Source	Fresh	Boiled	Steamed
Market 1*	22.30±0.92^{b}	229.30±11.59^{a}	220.78±9.90^{a}
Market 2*	43.37±5.26^{c}	243.39±8.54^{a}	198.22±2.86^{b}
Market 3*	17.66±1.09^{c}	210.18±8.78^{a}	152.54±26.65^{b}
Average of three markets	27.78±13.70^{b}	227.62±16.67^{a}	190.51±34.77^{a}

*Results are expressed as mean±SD from six single sample analyses.
The values in the same row with different superscripts showed significant difference ($p \leq 0.05$).

Lutein

Lutein contents of fresh, boiled and steamed *Moringa oleifera* Lam. pods from three markets was analyzed using HPLC, as shown in **Table 8**. Lutein contents of fresh pods ranged from 72 to 126 µg/100g dry basis, and of boiled and steamed samples ranged from 799 to 881 and 454 to 944 µg/100g dry basis respectively. Lutein is classified as a xanthophyll belonging to the carotenoid family. According the results in this study, the boiled and steamed Moringa pods are a good source of lutein. Delchier et al. (2012) studied about quality and quantity of water-soluble compounds (folates and ascorbic acid) and lipid soluble substance (lutein) in the cooked products and their liquid part. Their results shows similar trend with this study. Increased lutein contents may be due to heat treatment facilitates the extraction of carotenoids as cell walls disruption. It is noticed that steaming provided high variation of lutein contents among three markets, while boiled pods had narrow range of lutein contents. Nunn et al. (2006) and Palermo et al. (2014) studied about the effect of boiling, conventional boiling, and microwave steaming on carotenoid retention of broccoli, carrots, green beans, and sweet potatoes. Their results have shown that lutein values of broccoli, carrot, and green beans cooked by those three methods were similar but had low values when compared with the raw one. Reduction in the concentrations of carotenoids after boiling may be due to the degradation of carotenoids.

Table 8 Lutein (µg/100g dry basis) of fresh, boiled and steamed *Moringa oleifera* Lam. pods.

Source	Fresh	Boiled	Steamed
Market 1*	72.11±4.22^{c}	815.20±41.88^{b}	944.44±87.90^{a}
Market 2*	126.03±14.56^{b}	799.77±36.06^{a}	773.47±34.94^{a}
Market 3*	105.12±12.71^{c}	881.69±61.78^{a}	454.92±69.96^{b}
Average of three markets	101.09±27.19^{a}	832.22±43.53^{a}	724.28±248.44^{a}

*Results are expressed as mean±SD from six single sample analyses.
The values in the same row with different superscripts showed significant difference ($p \leq 0.05$).

Conclusions

Fruit and vegetables are a good source of natural antioxidant for example carotenoids and another phenolic compound. Boiling and steaming methods had significantly greater antioxidant properties (TPC, ORAC, DPPH), and β-carotene and lutein contents of *Moringa oleifera* Lam. pods. compared to the sample without cooking. When compared between two cooking methods, steaming provided higher TPC and DPPH, while there was no difference in ORAC. It was noticed that β-carotene and lutein contents of boiled pods were significantly higher than those of the steamed samples. Therefore, boiling would be selected as a cooking method to prepare Moringa pods for further study in development of food products containing Moringa pods for health benefits.

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