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Nutrient Composition of Red and White Cultivars of Dried *Moringa oleifera* Leaves from Probolinggo, Indonesia

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KEYWORDS

leaves;
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Abstract *Moringa oleifera* is a popular plant for combating malnutrition that grows well and is commonly consumed by Indonesian as a vegetable, but local varieties' nutrient composition never was studied before. Methods: Proximate, amino acids, minerals, vitamin C, and total phenolic composition of red and white cultivars of *Moringa oleifera* leaves from Probolinggo were determined on a dry weight basis based on AOAC methods. Results: Crude protein and fat were higher in white cultivar (35.36%, 6.25%). Total Amino Acid in both cultivars (83.06 g/100g for red and 82.86g/100g for white) were higher than in previous studies. Total Essential Amino Acid (TEAA) percentage of both of the cultivars was 46-49% and met the ideal protein needs of children (26%) and adults (11%). Iron, Zinc, Copper, Calcium, and Manganese was higher in white cultivar (36.21±0.08 mg/kg, 16.32±0.02%, 6.76±0.08mg/kg, 1.56±0.00 mg/kg, 7.11±0.00 mg/kg), while Magnesium, Potassium, Sodium, Phosphorus was higher in red cultivar (0.61±0.00%, 0.89±0.00%, 0.65±0.00%, 0.99±0.00). The content of vitamin C and total phenols was higher in the red cultivar (4162.8mg/kg and 239.8mg/kg). Conclusions: The red cultivar were best in 10/22 parameters (45%), white cultivar was best in 14/22 (55%). Those characteristics can contribute significantly to the nutrient requirements for protein and energy malnutrition treatment.

Introduction

Malnutrition is a form of excess or lack of nutrition and still a double burden on the world's nutritional problems. In Indonesia, the undernourished is becoming the focus of attention. Undernourished is caused by low consumption of energy and protein in the long term. Undernourished occurs to five years old, considered the most critical one (Black *et al.*, 2008; Liu *et al.*, 2012). We are handling undernourished children focused on providing food intake in quality and quantity, which is following the needs of the body and contains all the nutrients, including protein, carbohydrates, fats, vitamins, and minerals. *Moringa oleifera* leaves are an excellent source of all essential amino acids and contain sulfur at a higher level than on FAO/WHO/UNU for children aged 2-5 years (Simmons *et al.*, 2011; Manaois *et al.*, 2013). *Moringa oleifera* leaves rich in protein (38 g/100 g) and micronutrients (minerals total 9.7 g/100 g) (Tete-Benissan *et al.*, 2013; Kayalto *et al.*, 2013). With good proteins and amino acid content, *Moringa oleifera* leaves powder is effective against malnutrition. Moringa leaves powder does not cause an allergic reaction and digestive problems (Tete-Benissan *et al.*, 2013), so it is safe for children's consumption. The LD_{50} of the ethanol extract from Moringa leaves in rats reached 2600 mg/kg to 5000 mg/kg body

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weight, so it is safe to use traditional medicine (*ethnomedicine*) (Ugwu *et al.*, 2013). *Moringa oleifera* leaves also contain several anti-nutritional compounds such as oxalic acid which inhibits the absorption of calcium (Thurber & Fahey, 2009). Another weakness that has been reported is the taste and color. Moringa leaves meal have the bitter taste and the unusual green color that affect the acceptability (Mclellan *et al.*, 2010; Zongo *et al.*, 2013).

Moringa oleifera is a plant that grows well and commonly consumed by Indonesia people as vegetable. Names of *Moringa oleifera* in Indonesia are different depending on the region of origin, Aceh: *Murong*. Minangkabau: Marunggai, *Munggai*. Lampung: *Kilor*. Sunda: *Kelor*. Java: *Kelor*. Madura: *Marongghi*. Kangean: *Kelor*. Bali: *Moringa, Celor*. Bima: *Karongge*. Sumba: *Kawona, Wonâ*. Sawu: *Marungga, Wonâ*. Flores: *Moltong (Larantuka)*. Alor: *Marungga, Cut*. Sangi: *Kelohe*. North Sulawesi: *Kelo, Wori, Kero*. Gorontalo : *Kelo*. Timor: *Haufo, Po*. Buru: *Kerol*. South Halmahera, North Halmahera, Ternate, Tidore: *Kelo* (Heyne, 1987).

Probolinggo district in East Java, Indonesia, has established a working group on the utilization of *Moringa oleifera* leaves and its processed products to overcome the undernourished problem of December 2013. People there were familiar with the two local cultivars of *Moringa oleifera* leaves. Red cultivars of *Moringa oleifera* leave (with reddish-green colored rod) are more often used as vegetables because they have a better taste than white cultivars (green colored rod). Both of these cultivars are never studied before.

Material and Methods

Collection and Preparation of Samples

The leaves of red and white cultivars of *Moringa oleifera* were collected from the yard of 'Waluyo Jati' Government Hospital in Probolinggo District, East Java, Indonesia, and identified by the color of the rod. The red cultivar has a reddish rod color, while the white cultivars have a greenish color of the rod. According to the (Kirana *et al.*, 2013) method, the steam blanching drying process was used (Kirana *et al.*, 2013).

Figure 1. *Moringa oleifera* leaves: red cultivar (left) and white cultivar (right)

The leave with dark green color was stalked, washed, and approximately 100g of fresh *Moringa oleifera* and steamed for 10 minutes (97±1°C). The samples were drained on a stainless sieve until cold and then weighed. The blanched *Moringa oleifera* leaves were dried in 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°C, and a loaded tray was added each time until all the leaves were done. The temperature was maintained at 40°C, and the leaves were left for an hour until dried. The leaves were sufficiently dried till they became crisp and brittle to touch. The leaves took four hours of complete drying and milled with a food processor to achieve the expected. The resultant powder was sieved using a laboratory size of 0.25 mm to obtain uniform particle size. The final result is 30g *Moringa oleifera* leaf powder.

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Proximate Analysis

The proximate compositions of the dried Moringa leaves were determined using standard analytical methods. All measurements were done in triplicates, and values were presented in percentage.

Determination of Protein

The amount of protein was determined by micro-Kjeldahl according to AOAC method number 984.13. Samples were weighed (1g) and digested in concentrated sulphuric acid with one Kjeldahl tablet, followed by distillation in 40% sodium hydroxide. The resulting solution was titrated with 0.1N hydrochloric acid using a mixed indicator (methyl red and Bromocresol green).

Determination of Carbohydrate

Carbohydrate was determined by the difference in ash, moisture, fat, crude fiber, and protein, while energy was calculated.

Amino Acid Analysis

Sample Preparation: Weigh sample ± 0.2 to 0.6 grams, put in a test tube with a lid. Add 3 ml of 6 NHCl, the homogeneous. Hydrolysis at 110°C for 12 hours. Cool, filtered with filter whatman paper. Adjust pH to normal pH 7 with NaOH ± 6 N. Add to 10.0 ml with aqua bidest. Grab ± 3 ml, filtered with a 0.45 µm millex. For injection into the HPLC take millex solution as much as 50 ml + 950 ml OPA vortek. Right reaction was 3 minutes. 30 mL of filtrate was injected into the HPLC. HPLC conditions: Column: Eurospher 100-5 C18, 250x4.6 mm with Eluent A = 0:01 M acetate buffer pH 5.9. B = (MeOH: buffer 00:01 M Acetate pH 5.9: THF -> 80:15:5) ΛExc 340 nm Em: 450 nm.

Estimation of Predicted Protein Efficiency Ratio (P-PER)

The predicted protein efficiency ratio (P-PER) was estimated by using the equation given by Olaofe *et al.* (2013). P-PER = -0.468 +0.454 (Leu) -0.105 (Tyr).

Estimation of Dietary Protein Quality

The amino acid scores were calculated using three different procedures (Olaofe *et al.*, 2013):

- The total amino acids scores were calculated based on the whole hen's egg amino acid profiles (gold standard),
- The essential amino acids scores were calculated using the formula (provisional amino acid scoring pattern of the FAO): Amino acid scores = Amount of amino acid per test protein [mg/g]/ Amount of amino acid per protein in reference [mg/g],
- The essential amino acid scores (including His) based on preschool child suggested requirement.

Calculation of Other Protein Quality Parameters

Determination of the ratio of total essential amino acids (TEAA) to the total amino acids (TAA), i.e. (TEAA/TAA), total sulphured amino acids (TSAA), percentage cystine in TSAA (%Cys/TSAA), total aromatic amino acids (TArAA), total neutral amino acids (TNAA), total acidic amino acids (TAAA) and total basic amino acids (TBAA) were estimated from the results obtained for amino acids profiles.

Mineral, Vitamin C, and Total Phenolic Content Analysis

Mineral content was analyzed using an atomic absorption spectrophotometer as described by the AOAC method(AOAC, 1990). Vitamin C is determined using iodine titration (da Silva *et al.*, 2017); The total phenolic content using the Folin-Ciocalteau micro method of Waterhouse (Romero-de Soto *et al.*, 2013); and all the methods done in Duplo.

Mineral Analyses

Mineral content was analyzed using an atomic absorption spectrophotometer as described by AOAC method number 975.03. Samples (2g) were digested with concentrated nitric acid and hydrogen peroxide. Calcium

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(Ca), manganese (Mn), magnesium (Mg), iron (Fe), copper (Cu), zinc (Zn), sodium (Na), potassium (K) were determined at wavelengths 317.9 nm, 520nm, 285.2 nm, 259.9 nm, 324.7 nm, 213.9 nm, 589.6 nm, and 766.5 nm, respectively, using an air-acetylene flame. Sodium chloride (NaCl) and potassium chloride (KCl) were used as standards for determination of Na and K. Standard solutions of magnesium oxide (MgO), calcium carbonate ($CaCO_3$) and ferrous ammonium sulfate ($Fe(NH_4)_2(SO_4)_2$) were used for determining concentrations of Mg, Ca and Fe. Phosphorus was determined calorimetrically using the spectronic 20 equipment. Potassium dihydrogen phosphate (KH_2PO_4) was used as a standard for the determination of phosphorus concentration.

Vitamin C analysis

Vitamin C determination by iodine titration. Standardizing solution and titration of juice samples: Vitamin C solution (25 ml) was titrated into 100 ml conical flask, and 10 ml conical flask and 10 drops of the starch solution was added. This will be until the first blue color, which persisted for about 20 sec, was observed. Juice samples (25 ml) were titrated.

Total phenolic content analysis

The Folin-Ciocalteau micro method of Waterhouse was used. Twenty μL of the extract solution were diluted with deionized water to 4.8 mL, and 300 μL Folin-Ciocalteau reagent were added and shaken. After 8 minutes, 900 μL of 20% sodium carbonate was added with mixing. The mixture was allowed to stand at 40°C for 30 min. Before the absorbance at 765 nm was read. Gallic acid (0-50 μg) was used as standard, and the results of TPC were reported as mg gallic acid equivalent per gram (dried leaves).

Statistical Analysis

Statistical analysis was carried out to determine the coefficient of variation in percent (CV%), mean, and standard deviation (SD) for the parameters (Olaofe *et al.*, 2013).

Results and Discussion

Proximate Contents

Table 1 depicts the proximate composition of *Moringa oleifera* leaves two cultivars on a dry basis. The content of crude protein and fat was higher in the white cultivar. Carbohydrate content was higher in the red cultivar. The various parameters determined were variously distributed among the samples; this could be seen in the coefficient of variation percent (CV%) with values of 3.25-11.1 being the highest in fat.

Amino acid content

Table 2 shows the amino acid (AA) composition of each cultivar. Aspartic acid, serine, glycine, histidine, threonine, alanine, isoleucine, leucine, and lysine was higher in the red cultivar. The proline, valine, methionine, phenylalanine, cysteine, and tyrosine content was higher in the white cultivar. Glutamic acid and arginine content were the same in both cultivars. The highest amino acid content of both cultivars was glutamic acid, and the lowest was cysteine. The amino acid tryptophan was not tested for this study, related to the limitation of testing tools and cost.

Table 1. Proximate Contents of *Moringa oleifera* Leaves Two Cultivars in g/100g

Parameter	Red Cultivars	White Cultivars	Mean	SD	CV %
Crude Protein	34.36	35.36	34.86	0.71	2.03
Fat	5.34	6.25	5.795	0.64	11.1
Carbohydrate	42.09	40.09	41.09	1.41	3.44

Sd = Standard deviation; CV %= coefficient of variation per cent

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Table 2. Amino acid Composition of *Moringa oleifera* Leaves Two Cultivars (g/100g)

Amino acid	Red Cultivar	White Cultivar	Mean	SD	CV %
Aspartic acid	8.70	8.64	8.67	0.04	0.49
Glutamic acid	13.15	13.15	13.5	0	0
Serine	3.75	3.49	3.62	0.18	5.08
Glycine	4.54	4.48	4.51	0.04	0.94
Histidine*	2.27	2.21	2.24	0.04	1.89
Arginine*	5.21	5.21	5.21	0	0
Threonine*	3.87	3.67	3.77	0.14	3.75
Alanine	5.09	5.03	5.06	0.04	0.84
Proline	4.16	4.19	4.175	0.02	0.51
Valine*	5.85	5.79	5.82	0.04	0.73
Methionine*	0.15	1.02	0.585	0.62	105
Isoleucine*	4.45	4.28	4.365	0.12	2.75
Leucine*	7.28	7.16	7.22	0.08	1.18
Phenilalanine*	5.53	5.62	5.575	0.06	1.14
Lysine*	6.20	5.97	6.085	0.16	2.67
Cysteine	0.03	0.06	0.045	0.02	47.1
Tyrosine	2.82	2.88	2.85	0.04	1.49

*Essential amino acid

Glutamic acid had the highest concentration in their groups, and it's an acidic AA. The highest essential AA in each sample was leucine. The CV% of the AA value were generally low except for methionine and cysteine with respective CV% values of 105 g and 47.1 g while the rest CV% values ranged from 0-5.08 g, showing the closeness of the AA values in the various samples of each other.

The concentration of total AA (TAA), total non-essential AA (TNEAA), total essential AA (TEAA), total neutral AA (TNAA), total acidic AA (TAAA), total basic AA (TBAA), total sulphured AA (TSAA), and total aromatic AA (TarAA) and their percentage levels can be seen in Table 3.

Table 3. The Concentration of Amino acid in the Red and White Cultivar of *Moringa oleifera* during the Research (g/100 g crude protein)

Amino acid	Red cultivar	White cultivar	Mean	SD	CV %
Total amino acid (TAA)	83.06	82.86	82.96	0.14	0.17
Total non-essential amino acid (TNEAA)	42.26	41.94	42.1	0.23	0.54
Total essential amino acid (TEAA)					
-with Histidine	40.80	40.92	40.86	0.08	0.21
-without Histidine	38.53	38.71	38.62	0.13	0.33
Total neutral amino acid (TNAA)	47.53	47.67	47.6	0.1	0.21
Total acidic amino acid (TAAA)	21.86	21.80	21.83	0.04	0.19
Total basic amino acid (TBAA)	13.68	13.39	13.54	0.21	1.52

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Total sulphured amino acid (TSAA)	0.17	1.08	0.625	0.64	103
Total aromatic amino acid (TArAA)	8.35	8.50	8.425	0.11	1.26
%TNEAA	50.88	50.61	50.75	0.19	0.38
%TEAA					
-with Histidine	49.12	49.39	49.26	0.19	0.39
-without Histidine	46.39	46.72	46.56	0.23	0.5
%TNAA	57.22	57.53	57.38	0.22	0.38
%TAAA	26.31	26.31	26.31	0	0
%TBAA	16.47	16.16	16.32	0.22	1.34
%TSAA	0.21	1.30	0.755	0.77	102
%Cys/TSAA	13.84	4.48	9.16	6.62	72.3
%TarAA	10.06	10.26	10.16	0.14	1.39
Predicted Protein Efficiency Ratio (P-PER)	2.54	2.48	2.51	0.04	1.69

The CV% of TAA, TNEAA, TEAA (with and without histidine), TNAA, TAAA, TBAA, TSAA, TarAA, %TNEAA, %TEAA (with and without histidine), %TNAA, %TAAA, %TBAA, %Sis/TSAA, %TarAA and P-PER both of cultivars were generally low with respective CV% values of 0-1,69, showing the closeness of the values to each other, except for the CV% of TSAA and %cys/TSAA (102 and 72,3).

Amino acid scores of red and white cultivars of *Moringa oleifera* leaves were calculated based on the amino acid profile of hen's eggs, pre-school children's requirements, and FAO pattern shown in Table 4, 5 and 6.

Table 4. Amino acid Scores with Respect to Whole Hen's Egg (Amino acid Value were in g/100g)

Amino Acid g/100g	Hen's egg	Red Cultivar	White Cultivar	Amino acid scores	
				Red Cultivar	White Cultivar
Aspartic acid	11	8.70	8.64	0.81	0.81
Glutamic acid	12	13.15	13.15	1.10	1.10
Serine	7.9	3.75	3.49	0.48	0.44
Glycine	1.8	4.54	4.48	1.51	1.49
Histidine*	2.4	2.27	2.21	0.95	0.92
Arginine*	6.1	5.21	5.21	0.85	0.85
Threonine*	5.1	3.87	3.67	0.76	0.72
Alanine	5.4	5.09	5.03	0.94	0.93
Proline	3.8	4.16	4.19	1.10	1.10
Valine*	7.5	5.85	5.79	0.78	0.77
Methionine*	3.2	0.15	1.02	0.05	0.32
Isoleucine*	5.6	4.45	4.28	0.80	0.76
Leucine*	8.3	7.28	7.16	0.88	0.86
Phenilalanine*	5.1	5.53	5.62	1.08	1.10
Lysine*	6.2	6.20	5.97	1.00	0.96

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Amino Acid g/100g	Hen's egg	Red Cultivar	White Cultivar	Amino acid scores	
				Red Cultivar	White Cultivar
Cysteine	1.8	0.03	0.06	0.02	0.03
Tyrosine	4	2.82	2.88	0.71	0.72

*Essential amino acid

Table 5. Amino acid Scores with Respect to Pre-school Children Requirements (Amino acid Value were in g/100g)

Amino Acid g/100g	Pre school children	Red Cultivar	White Cultivar	Amino acid scores	
				Red Cultivar	White Cultivar
Valine*	3.5	5.85	5.79	1.67	1.65
Methionine*+Cysteine	2.5	0.18	1.08	0.07	0.43
Isoleucine*	2.8	4.45	4.28	1.59	1.53
Leucine*	6.6	7.28	7.16	1.10	1.08
Phenilalanine*+Tyrosine	6.3	8.35	8.5	1.33	1.35
Lysine*	5.8	6.2	5.97	1.07	1.03
Histidine*	1.9	2.27	2.21	1.19	1.16
Threonine*	3.4	3.87	3.67	1.14	1.08
Tryptophan	1.1	-**	-**	-**	-**

*: Essential amino acid, **: not tested

Table 6. Amino acid with Respects to Provisional Amino acid Scoring Pattern of the FAO (Amino acid Value were in g/100g)

Amino Acid g/100g	Scores Value	Red Cultivar	White Cultivar	Amino acid scores	
				Red Cultivar	White Cultivar
Threonine*	4	3.87	3.67	0.97	0.92
Valine*	5	5.85	5.79	1.17	1.16
Methionine*+Cysteine (TSAA)	3.5	0.18	1.08	0.05	0.31
Isoleucine*	4	4.45	4.28	1.11	1.07
Leucine*	7	7.28	7.16	1.04	1.02
Phenilalanine*+Tyrosine	6	8.35	8.5	1.39	1.42
Lysine*	5.5	6.2	5.97	1.13	1.09
Tryptophan	1	-**	-**	-**	-**

*: Essential amino acid, **: not tested

Minerals, Vitamin C and Total Phenolic Content

Minerals, Vitamin C, and Total Phenolic Content of *Moringa oleifera* leaves were showed in Table 7. Iron (Fe), Zinc (Zn), Copper (Cu), Calcium (Ca), Manganese (Mn), and phenol were higher in the white cultivar. At the same time, magnesium (Mg), Potassium (K), Natrium (Na), phosphor (P total), and Vitamin C were higher in the red cultivar. The CV% were ranged from 3.25-120, being the highest in phenol and lowest in Ca.

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Table 7. Minerals, Vitamin C and Total Phenolic Content of *Moringa oleifera* Leaves Two Cultivar

Parameter	Unit	Red Cultivar	White Cultivar	Mean	SD	CV%
Fe	mg/kg	24.58±0.27	36.21±0.08	30.4	8.22	27.1
Zn	%	15.29±0.09	16.32±0.02	15.81	0.73	4.61
Mg	%	0.61±0.00	0.48±0.06	0.545	0.09	16.9
Cu	mg/kg	4.43±0.09	6.76±0.08	5.595	1.65	29.4
Ca	%	1.49±0.00	1.56±0.00	1.525	0.05	3.25
K	%	0.89±0.00	0.75±0.00	0.82	0.1	12.1
Na	%	0.65±0.00	0.44±0.00	0.545	0.15	27.2
P Total	%	0.99±0.00	0.77±0.00	0.88	0.16	17.7
Mn	mg/kg	3.05±0.00	7.11±0.00	5.08	2.87	56.5
Phenol	mg/kg	9.802±0.00	117.35±0.00	63.58	76	120
Vit. C	mg/kg	4162.8±0.12	3120.1±0.46	3641	737	20.2

Discussion

The crude protein content of red and white cultivars per 100g dried weight basis worth over daily value pattern of Indonesian children aged 1-3 years (26g per day) (Muhilal, 1998). It showed that both of the cultivars can be used to fulfill the protein needs of children aged 1-3 years. The protein content of both cultivars was higher than previous research: 1.4% (Aja *et al.*, 2013), 17.08 to 18.49% (Kirana *et al.*, 2013); 23.7 to 28.08% (Bamishaiye *et al.*, 2011); and 24.2% (Offor *et al.*, 2014). Those differences were caused by soil factors, climate, solvents used in the analysis, cultivation, plant age, and flouring method (Anjorin *et al.*, 2010; Offor *et al.*, 2014). This study was in line with the results reported by Kirana *et al.* (2013) that making *Moringa oleifera* leaves powder with steam blanching method provides the most significant results in protein content.

The fat content was higher in the white cultivar of *Moringa oleifera* leaves, lower than the previous study by 20% (Aja *et al.*, 2013) and higher from the previous study by 2.5% (Bamishaiye *et al.*, 2011). Carbohydrate content was higher in the red cultivar. Other studies have reported a higher carbohydrate value of 55.14% (Bamishaiye *et al.*, 2011) and a lower 23.6% (Aja *et al.*, 2013). Proximate content of red and white cultivars shows a consistent characteristic that higher protein values than the previous study.

TAA and TNEAA both of cultivars were higher than previous studies (76.4g/100g and 40.97 g/100g) (Olaofe *et al.,* 2013). TEAA percentage of both of the cultivars was 46-49%, almost close to the TEAA value of eggs (50%) and met the ideal protein needs of children (26%) and adults (11%) (Food and Agricultural Organization/World Health Organization, 1973). TSAA content in both cultivars had the lowest values and lower than the recommended value of infants, 5.8 g/100 g (Food and Agricultural Organization/World Health Organization, 1973). %Sis/TSAA values in both cultivars were lower than the previous study, 48.5% (Olaofe *et al.,* 2013). Cysteine and methionine can improve the quality of protein and positively affect the absorption of minerals, especially zinc (Olaofe *et al.,* 2013). TarAA values in both cultivars meet the ideal protein values, range from 6.8 to 11.8 g/100 g (Olaofe *et al.,* 2013). Aromatic amino acid serves as a precursor of epinephrine and thyroxine (Robinson, 1987).

Amino acid scores show part of the essential amino acids utilized by the body. The

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lowest value of amino acid is a limiting amino acid of foodstuffs. Limiting amino acids in the third calculation of the scores was cysteine and methionine or sulfur amino acids. Table 4 shows cysteine was a limiting amino acid in both cultivars of *Moringa oleifera* leaves compared to hen's eggs, with a scoscore0.02 (red cultivar) and 0.03 (white cultivar). To meet the daily needs of amino acids, it needs 100/2 or 50 times more protein of red cultivar and 100/3 or 33.33 times more protein of white cultivar to be eaten when used as the sole source of protein the diet. Table 5 shows the methionine+cysteine (sulfur amino acid) is a limiting amino acid in both cultivars of *Moringa oleifera* leaves compared to the needs of pre-school requirements, with a score of 0.07 (red cultivar) and 0.43 (a white cultivar). The correction factor of the value of amino acid scores was 100/7 or 14.3 for the red cultivar and 100/43 or 2.3 for the white cultivar. Table 6 shows the methionine+cysteine (sulfured amino acid) is a limiting amino acid in both of the cultivars of Moringa leaves powder compared with the FAO pattern, with a score of 0.05 (red cultivar) and 0.31 (a white cultivar). The correction factor of the value of amino acid scores is 100/5 or 20 for the red cultivar and 100/31 or 3.23 for the white cultivar.

PER value has a range of 0-4 (Muller & Tobin, 1980), 0 for a very low protein to a maximum possible of just over 4. P-PER values of both cultivars of *Moringa oleifera* leaves were higher than previous studies (1.72) (Olaofe *et al.,* 2013). P-PER values in this study are approaching the P-PER value of eggs at 2.88. This showed that red and white cultivars of *Moringa oleifera* leaves could be used well physiologically.

Fe, Zn, Ca, P content, Mn content was lower than the previous study (107.08±8.81mg/kg (Ogbe & Affiku, 2011), 60.06 ± 0.30 mg/kg (Ogbe & Affiku, 2011) and 21.70 mg/kg (Ogbe & Affiku, 2011), 1.91 ± 0.08% (Ogbe & Affiku, 2011), 30.15 ± 0,47mg/kg (Ogbe & Affiku, 2011), 81.65 ± 2,31mg/kg (Ogbe & Affiku, 2011) and 57.34 mg/kg (Mutayoba *et al.*, 2011). Mg, Cu content was higher than the previous study (0.38 ± 0.01% (Ogbe & Affiku, 2011), 6.1 ± 0.2 mg/kg (Ogbe & Affiku, 2011) and 5.73 mg/kg (Mutayoba *et al.*, 2011). Overall, the content of all minerals in two cultivars, except Mg and Cu, was lower than in the previous study. This was caused by differences in the place where growth and leaf maturity when harvested. Minerals were necessary for normal growth, muscle and bone development activities (such as Ca), cellular activity and oxygen transport (Co and Fe), absorption in the intestine (Mg), fluid balance and nerve transmission (K and Na), and acid-base regulation in the body (P), the prevention of anemia (Fe), energy production and immune system (Mn), protein synthesis, growth and healing body (Zn) (Mutayoba *et al.*, 2011; Ogbe & Affiku, 2011).

The content of vitamin C and phenols were high. This is in line with Zongo's (Zongo *et al*., 2013) research reported that *Moringa oleifera* leaves are high in vitamin C and can enhance iron absorption in the body. Previous research reported that phenol was also found in the *Moringa oleifera* leaves extract (Bamishaiye *et al.*, 2011). The phenols' content in plants is useful as powerful antioxidants to prevent oxidative cell damage in chronic diseases such as cancer and cardiovascular disease (Bamishaiye *et al.*, 2011). Based on the literature, *Moringa oleifera* leaves have high phenol content, rich in polyphenols, and their antioxidant capacity was stronger than the leaves of basil, stevia, and oregano. Similar to beta-carotene and vitamin C profiles, these characteristics can enhance the antioxidant content (Muller & Tobin, 1980).

Red cultivars of Moringa leaves powder have specific characteristics with lower Fe value and higher Mg. Higher Mg content is useful to assist in the absorption of nutrients that are very favorable for protein and energy

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malnutrition that has impaired absorption of nutrients due to changes in the digestive tract structure, especially the small intestine (Khare *et al.*, 2014). The higher content of vitamin C and phenol was also very advantageous because it can be a powerful antioxidant agent. High antioxidant from food was very important in handling cases of protein and energy malnutrition. The antioxidant is a catcher of free radicals (reactive oxygen species), which is overproduced due to metabolic stress on protein and energy malnutrition.

This study showed that both red and white cultivars of Moringa leave had an appreciable amount of fat, carbohydrate, protein and amino acid profile, minerals, vitamin C, and total phenolic compound in different parameter determined levels. This is demonstrated as follows: red cultivar was higher in carbohydrate, TAA, TNEAA, TAAA, TBAA, Mg, K, Na, P total, and Vitamin C. White cultivar was higher in crude protein, fat, TEAA, TNAA, TSAA, TarAA, Fe, Zn, Cu, Ca, Mn, phenol. On the whole, the red cultivar was best in 10/22 parameters (45%), the white cultivar was best in 14/22 (55%). Those characteristics can contribute significantly to the nutrient requirements and need further research about the formulation of both red and white cultivars of Moringa leaves for protein and energy malnutrition treatment.

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