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Comparison of the Nutrient Compositions in Red and Green Amaranthus (*Amaranthus hypochondriacus*)

Md. Maksudul Haque (Corresponding Author)
Senior Scientific Officer, Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Dhaka 1207, Bangladesh
Email: maksudulhq@gmail.com

Md. Shariful Islam
Scientific Officer (SO), Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Bangladesh

Elora Parvin
Scientific Officer (SO), Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Bangladesh

Prince Biswas
Scientific Officer (SO), Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Bangladesh

Rownoke Jannat Janny
Scientific Officer (SO), Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Bangladesh

Mohammad Zahir Ullah
Senior Scientific Officer (SSO), Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Bangladesh

Joti lal Barua
Principle Scientific Officer (PSO), Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Bangladesh

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Abstract

Amaranth is a commonly consumed and nutritious vegetable. Amaranth has two morphological types, one is green and another is red. In this study, we collected five red and five green morph samples to analyze in terms of proximate, minerals, antioxidants, phytochemicals, and antioxidant activity in three replications. We found remarkable potassium (6.55 mg/g), calcium (2.63 mg/g), magnesium (3.01 mg/g), iron (10.94 µg/g), manganese (13.16 µg/g), copper (2.01 µg/g), zinc (11.57 µg/g), carotenoids (47.13 mg/100g), total phenolics (14.36 GAE µg/g), vitamin C (50.74 mg/100g) and antioxidant activity (ABTS+) (25.27 TEAC µg/g) in the red amaranth leaves. These data indicated that red and green could be considered enriched in antioxidants. Red amaranth is an excellent source of nutrients, antioxidant pigments, minerals, and phytochemicals compared to green amaranth. In this investigation, it was revealed that flavonoids, phenolic compounds, and carotenoids had strong antioxidant activity and significantly contributed to the antioxidant activity of the green and red amaranth. Red amaranth could be a potential source of nutritional components. The leaves of red amaranth are an outstanding source of dietary fiber, carbohydrates, moisture, and protein.

Keywords: Nutrient; Proximate; Mineral; TPC; TFC; TAC (ABTS+) and Amaranthus.

1. Introduction

Vegetable amaranth serves as an alternative source of nutrition. Amaranthus is a fast-growing plant that is widely distributed throughout the world. Amaranth leaves and stems are respectable economic sources of carotenoids, and proteins, including the essential amino acids methionine and lysine, dietary fiber, and minerals, such as magnesium, calcium, potassium, copper, phosphorus, zinc, iron, and manganese [1-3]. It is a fabulous source of proximate, minerals, phytopigments, and bioactive compounds that had prominent significance as a food natural antioxidant [1, 3, 4]. Amaranth proteins are enriched with nutritionally essential amino acids such as lysine and methionine [5, 6] and natural antioxidant phytochemicals, such as vitamin C, β-carotene, flavonoids, and phenolic acids [7, 8], that act as reactive oxygen species (ROS) scavengers in the human body [9, 10].

Amaranth has two morphological types described as red and green morphs [11]. Bangladesh has many amaranth germplasms with great variability and phenotypic plasticity [12] that have many culinary uses. In Bangladesh, amaranth is grown in year-round and even fills in the gaps of main crops between winter and summer [2, 13]. Leafy vegetables are widely consumed in many countries because of their nutritional quality and anthocyanin, ascorbic acid, β-carotene, flavonoid, folic acid, polyphenol, and alkaloid contents. These components have a wide range of biological functions such as anti-allergic, anticancer, anti-diabetic, antimicrobial, antioxidant, and anticardiovascular diseases. Many epidemiological studies have shown that the consumption of leafy plant vegetables containing phenolic and flavonoid compounds with potent antioxidant activity is associated with a lower incidence of cardiovascular diseases, cancer, diabetes, and neurodegenerative diseases. In the present research, some common leafy vegetables will be analyzed for determining their total phenolic and flavonoid contents.

The aim of this study was to compare the Proximate compositions, dietary fiber, Mineral compositions, vitamin C, TPC, TFC, and TAC (ABTS+). So the present research was undertaken to study the Proximate compositions, dietary fiber, Mineral compositions, vitamin C, TPC, TFC, and TAC (ABTS+)content of the leafy vegetables of Bangladesh.

2. Materials and Methods

2.1. Sample Collection

Green and Red Amaranth (*Amaranthus hypochondriacus*) were purchased at a local market in Dhaka (Two Samples) And Gazipur (Three Samples) city, Bangladesh. All parameters were measured in three replicates. After washing with distilled water, the collected vegetables were shed dry. The dried sample was ground to powder by a grinding machine and stored in air-tight containers.

2.2. Proximate Analysis

ASAE [14] were followed to measure the moisture content of the samples. *Amaranthus* leaf samples (triplicate) were oven-dried at 103 °C for 72 h, transferred to a desiccator, and allowed to cool at room temperature. AOAC Association of Analytical Chemists [15] were used to determine ash and protein contents. The leaf samples were weighed before and after heat treatment (550 °C for 12 h) and the ash content was determined. The micro-Kjeldahl method was followed to determine crude protein, multiplying nitrogen by 6.25 (AOAC method 976.05). The method [16] was used to determine dietary fiber content. *Amaranthus* leaf samples were boiled in 0.255 M sulfuric acid for 30 min. exactly 0.313 M sodium hydroxide was used to filter, wash and boil the resulting insoluble residue.

2.3. Minerals Analysis

Leaves of amaranth were dried at 70 °C in an oven for 24 h. Dried leaves were grounded finely in a mill. An 841 micron screen was used to separate finely milled powder. The final dried and milled powder was analyzed for macronutrients (calcium, magnesium, and potassium) and microelements (copper, iron, zinc, and manganese). The nitric-perchloric acid digestion method [17] was followed to determine calcium, potassium, magnesium, iron, manganese, copper, and zinc from powdered leaves. The leaves of amaranth were extracted in 80% acetone to estimate the total carotenoid contents. A spectrophotometer was used to read the absorbance at 470 nm for total carotenoids. Data were expressed as mg carotenoids per 100 g FW.

2.4. Antioxidant Analysis

Fresh amaranth leaves were used to measure ascorbate (AsA) and dehydroascorbic acid (DHA) with a spectrophotometer. At first, amaranth leaves were harvested. For chemical analysis, the leaves were dried in the air in a shade. 40 ml 90% aqueous methanol was used to extract 1 g of ground, dried leaves from each cultivar in a bottle (100 ml) capped tightly. A shaking water bath was used to extract the samples for 1 h. The extracts were filtered for the determination of polyphenols, flavonoids, and total antioxidant capacity. The method of Velioglu, *et al.* [18] was followed to estimate the total phenolic content of amaranth. The $AlCl_3$ colorimetric method outlined by Chang, *et al.* [19] was used to estimate the total flavonoid content of amaranth extracts. The method of Thaipong, *et al.* [20] was followed for the $ABTS^+$ assay. The percent inhibition of $ABTS^+$ relative to the control was used to determine antioxidant activity using the following equation:

Antioxidant activity (%) = (Abs.blank−Abs.sample/Abs.blank) × 100 Antioxidant activity (%) = (Abs.blank−Abs.sample/Abs.blank) × 100

2.5. Statistical Analysis

Replicate samples were averaged to obtain replication means. Mean data of triplicate samples were also statistically analyzed by ANOVA using Statistix 10 software, and the means were compared by Tukey's HSD test at a 1% level of probability. The results were reported as the average of three replications ± SD.

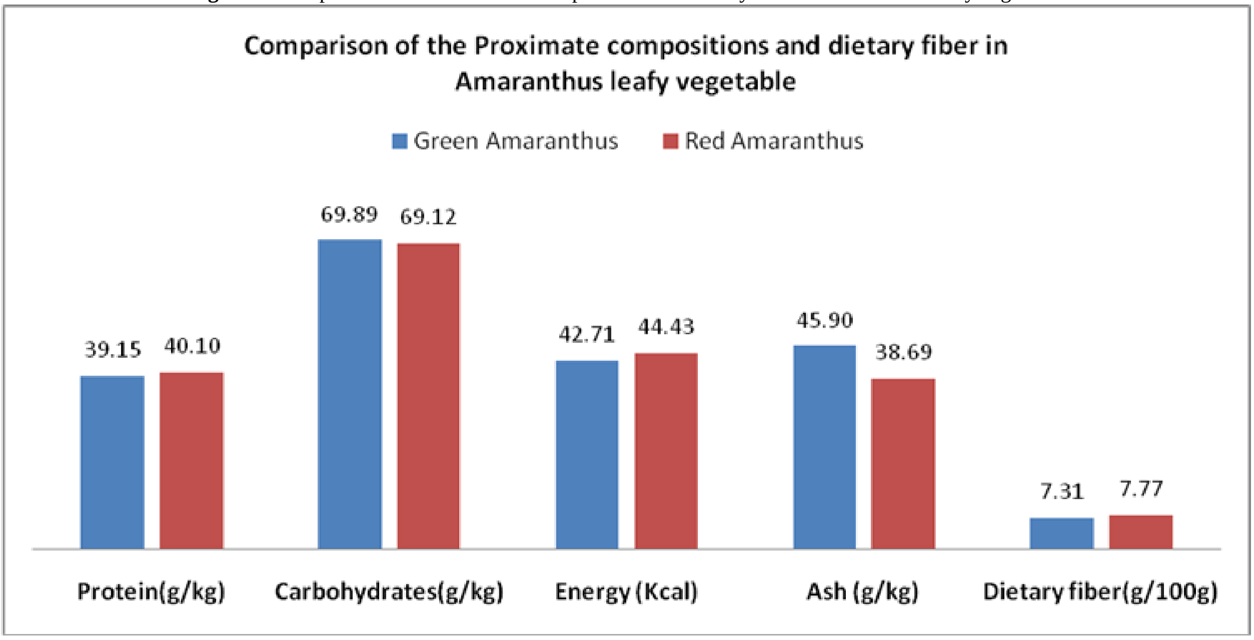
3. Results and Discussion

3.1. Proximate Compositions

The results for the proximate compositions of the green morph amaranth leaves showed clear differences in protein content. Vegetarians and numerous people in low-income countries frequently depend on amaranth for their protein basis. The protein content of the green amaranth (39.15 g kg−1) was much higher than that of the red amaranth (40.10 gkg−1). Green amaranth was the highest carbohydrate content (69.89 g kg^{-1} FW), followed by the lowest carbohydrate content was recorded in red amaranth (69.12 g kg^{-1} FW). The red amaranth was the highest energy (44.43 kcal 100 g^{-1} FW), while the lowest energy was observed in green amaranth (42.71 kcal 100 g^{-1} FW). The ash content was the highest in green amaranth (45.90 g kg^{-1} FW) and the lowest ash content was noted in red amaranth (38.69 g kg^{-1} FW). The dietary fiber content exposed significant differences amongst the amaranths studied. Dietary fiber was highest in red amaranth (7.77 g 100 g^{-1} FW), whereas the lowest was in green amaranth

(7.31 g 100 g^{-1} FW) (Figure 1). The average ash content for Amaranth accessions are worse than those reported by Akubugwo, *et al.* [21] and Asaolu, *et al.* [22]. However, ash content values are equivalent with values in native vegetables such as Corchorus olitorius, Cleome gynandra and Hibiscus sabdariffa Patricia, *et al.* [23]. Asaolu, *et al.* [22] reported connected content of Amaranth ash but with actual high protein content while Silva, *et al.* [24] reported moderately high content of both ash and protein. Dietary fiber significantly contributes to mitigate constipation and to food digestibility and palatability [1].

Figure-1. Comparison of the Proximate compositions and dietary fiber in Amaranthus leafy vegetable



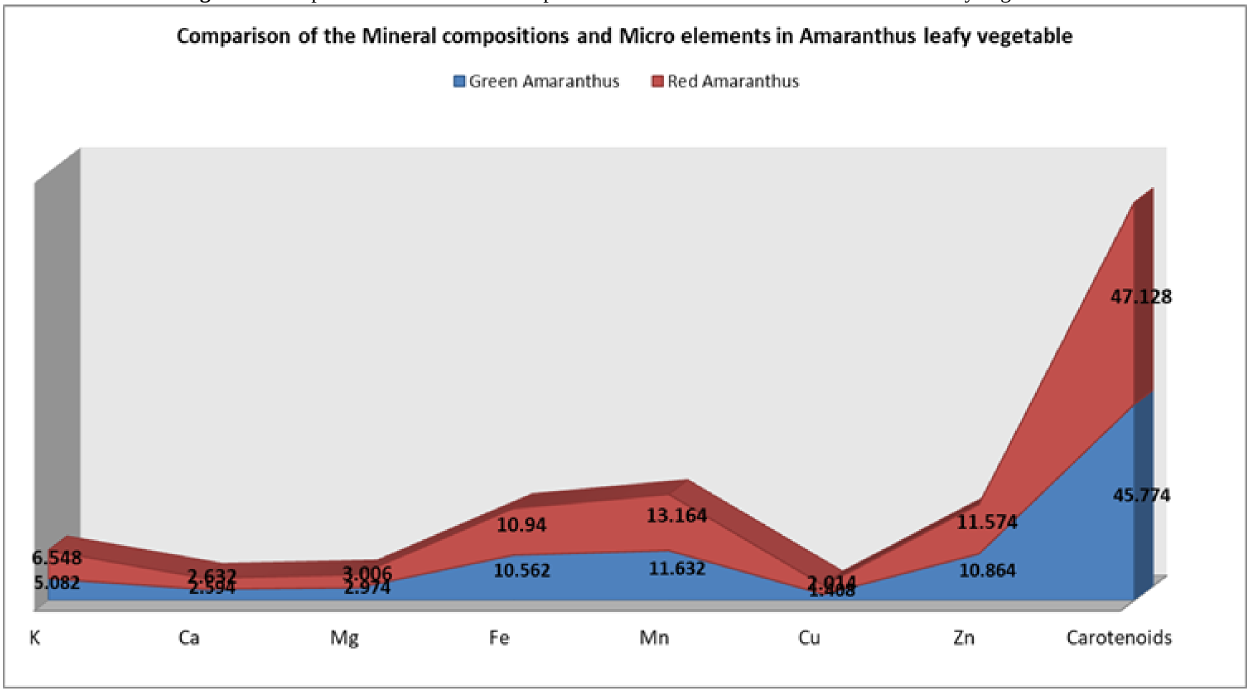
3.2. Mineral Compositions

The mineral compositions of the green and red amaranth are shown in Figure 2. Our study revealed that the Potassium (K) content ranged from 4.99 mg g^{-1} to 5.14 mg g^{-1} FW for green amaranth and red amaranth ranged from 6.14 mg g^{-1} to 6.98 mg g^{-1} FW . The Potassium (K) content was the highest in red amaranth (6.55 mg g^{-1} FW) and the lowest ash content was noted in green amaranth (5.08 mg g^{-1} FW). The calcium (Ca) content ranged from green amaranth (2.16 to 2.98 mg g^{-1} FW) and red amaranth (2.41 to 2.99 mg g^{-1} FW). In this study, the samples did not show substantial differences in terms of Ca content and Magnesium (Mg) content ranged from green amaranth (2.92 to 3.02 mg g^{-1} FW) and red amaranth (2.89 to 3.15 mg g^{-1} FW). The Magnesium (Mg) content was the maximum in red amaranth (3.01 mg g^{-1} FW) and the lowermost ash content was renowned in green amaranth (2.97 mg g^{-1} FW). In our present study, we found noteworthy amounts of K (6.55 mg g^{-1}) and Mg (3.01 mg g^{-1}) in the Red amaranth (fresh weight basis) (Figure 2).

The iron content showed significant and remarkable variations in green amaranth (11.21 µg g^{-1} FW to 11.90 µg g^{-1} FW) and red amaranth (10.78 µg g^{-1} FW to 11.15 µg g^{-1} FW) among the sample. The green amaranth was the highest iron content. Conversely, the red amaranth showed the lowest iron content, with an average value of 10.94 µg g^{-1} FW. In this study, the manganese content ranged between green amaranth (11.21 µg g^{-1} FW and 11.90 µg g^{-1} FW) and red amaranth (12.95 µg g^{-1} FW and 13.37 µg g^{-1} FW), with an average of green amaranth (11.63 µg g^{-1} FW) and red amaranth (13.16 µg g^{-1} FW). Additionally, the samples showed significant and notable variations in copper content green amaranth (1.31 µg g^{-1} FW and 1.51 µg g^{-1} FW) and red amaranth (1.89 µg g^{-1} FW and 2.14 µg g^{-1} FW), with an average of green amaranth (1.41 µg g^{-1} FW) and red amaranth (2.01 µg g^{-1} FW). The copper content was the highest in red amaranth (2.01 µg g^{-1} FW), followed by that in green amaranth (1.41 µg g^{-1} FW). The samples differed significantly and remarkably in terms of zinc content green amaranth (10.68 µg g^{-1} FW and 11.10 µg g^{-1} FW) and red amaranth (11.23 µg g^{-1} FW and 11.86 µg g^{-1} FW), with an average of green amaranth (10.86 µg g^{-1} FW) and red amaranth (11.57 µg g^{-1} FW). The zinc content was the highest in red amaranth (11.57 µg g^{-1} FW), followed by that in green amaranth (10.86 µg g^{-1} FW). In this study, we found remarkable Fe (10.94 µg g^{-1}), Mn (13.16 µg g^{-1}), Cu (2.01 µg g^{-1}) and Zn (11.57 µg g^{-1}) contents in the red amaranth (fresh weight basis) (Figure 2).

The samples differed significantly and remarkably in terms of carotenoids content green amaranth (44.94 mg/100g FW and 46.45 mg/100g FW) and red amaranth (46.49 mg/100g FW and 47.89 mg/100g FW), with an average of green amaranth (45.77 mg/100g FW) and red amaranth (47.13 mg/100gFW). The carotenoids content was the highest in red amaranth 47.13 mg/100g FW), followed by that in green amaranth (45.77 mg/100g FW) (Figure 2).

Figure-2. Comparison of the Mineral compositions and Micro elements in Amaranthus leafy vegetables



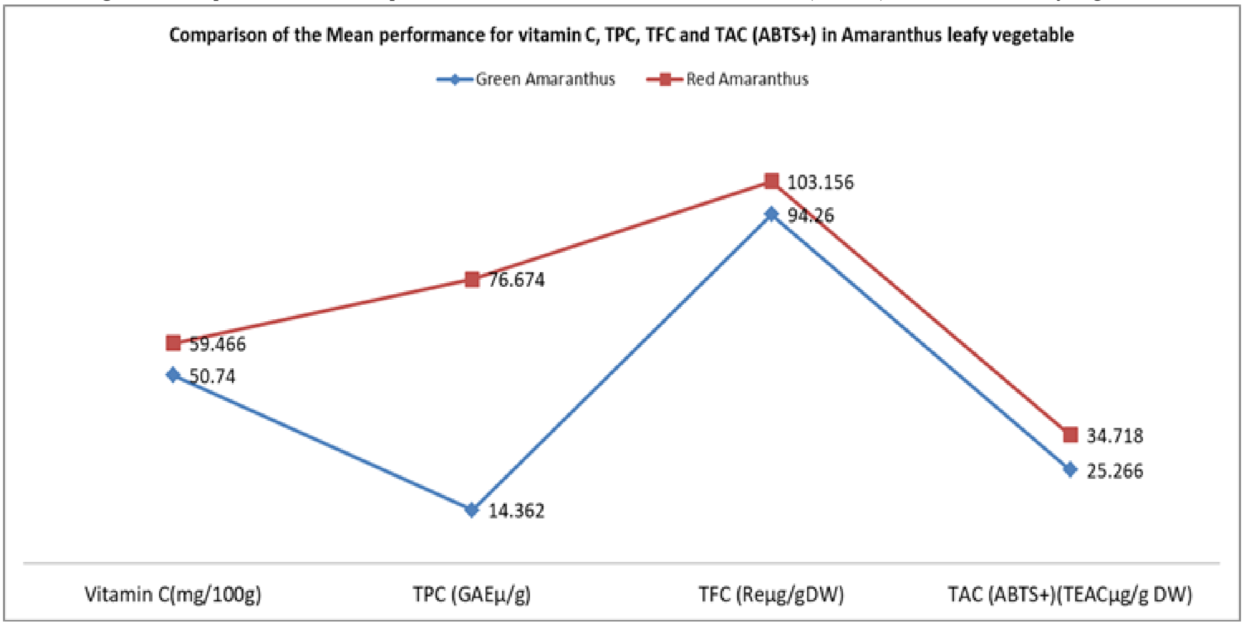
3.3. Antioxidant, Phytochemicals and Antioxidant Capacity

The TAC, TPC, vitamin and TFC values of the green and red amaranth are presented in Figure 3. The samples differed significantly and remarkably in terms of vitamin C content green amaranth (49.08 mg/100g FW and 52.81 mg/100g FW) and red amaranth (58.56 mg/100g FW and 60.15 mg/100g FW), with an average of green amaranth (50.74 mg/100g FW) and red amaranth (59.47 mg/100g FW). The vitamin C content was the highest in red amaranth 59.47 mg/100g FW), followed by that in green amaranth (50.74 mg/100g FW).

The total polyphenol content (TPC) showed a wide range, with an average content of green amaranth (14.36 GAE µg g^{-1} FW) and red amaranth (76.67 GAE µg g^{-1} FW). The total polyphenol content (TPC) content was the highest in red amaranth (76.67 GAE µg g^{-1} FW), followed by that in green amaranth (14.36 GAE µg g^{-1} FW). The Total flavonoid content (TFC) showed a wide range, with an average content of green amaranth (94.26 RE µg/g DW) and red amaranth (103.16 RE µg/g DW). The total polyphenol content (TPC) content was the highest in red amaranth (103.16 RE µg/g DW), followed by that in green amaranth (94.26 RE µg/g DW) (Figure 3).

In this study, we found the samples differed significantly and remarkably in terms of total antioxidant capacity (TAC) ($ABTS^+$) content green amaranth (24.87 and 25.90 TEAC µg/g DW) and red amaranth (33.46 and 36.26 TEAC µg/g DW), with an average of green amaranth (25.27 TEAC µg/g DW) and red amaranth (34.72 TEAC µg/g DW). The total antioxidant capacity (TAC) ($ABTS^+$) content was the highest in red amaranth (34.72 TEAC µg/g DW) (Figure 3).

Figure-3. Comparison of the Mean performance for vitamin C, TPC, TFC and TAC (ABTS+) in Amaranthus leafy vegetables



3.4. Correlation Coefficient Analysis

The correlations of carotenoids, vitamin C, TPC, TFC and TAC ($ABTS^+$) of green and red amaranth are presented in Table 1 and 2. The above-mentioned correlations showed interesting results. Carotenoids exhibited significant positive associations with TPC, TFC and TAC ($ABTS^+$). This signifies that the increases in carotenoids were directly related to the increases in TPC, TFC and TAC ($ABTS^+$). Vitamin C had a minor and positive interrelationship with TAC, TFC, and TPC, although it exhibited negative and insignificant associations with carotenoids.

TPC, TFC and TAC ($ABTS^+$) showed a significant positive association. These results indicate that TFC and TPC have strong antioxidant activity. Similarly, the significant interrelationship TAC ($ABTS^+$) validated the antioxidant capacity of green and red amaranth. The phenolic compounds, vitamin C, carotenoids, and flavonoids had strong antioxidant activity. In the present investigation, it was revealed that flavonoids, phenolic compounds, and carotenoids had strong antioxidant activity and significantly contributed to the antioxidant activity of the green and red of amaranth. Our data was found to be in agreement with previously published research articles which stated that very good and strong correlations were observed between the total polyphenols, total flavonoids and antioxidant activities [25, 26]. The leaves of the amaranth were good sources of K, Ca, Mg, iron, manganese, copper, zinc, protein, dietary fiber, carbohydrates, carotenoids, vitamin C, phenolic compounds, flavonoids, and antioxidants.

Table-1. Correlation co-efficient for carotenoids, vitamin C, TPC, TFC, and TAC (ABTS+) in green Amaranthus leafy vegetable

Traits	Vitamin C (mg/100g)	TPC (GAEµ/g FW)	TFC (Reµg/gDW)	TAC ($ABTS^+$)(TEACµg/g DW)
Carotenoids(mg/100g)	−0.171	0.56**	0.58**	0.77**
Vitamin C(mg/100g)		0.09	0.09	0.09
TPC (GAEµ/g FW)			0.73**	0.64**
TFC (Reµg/gDW)				0.72**

TAC:Total antioxidant capacity; TPC:Total polyphenol content; TFC:Total flavonoid content; **Significant at 1% level

Table-2. Correlation co-efficient for Carotenoids, vitamin C, TPC, TFC, and TAC (ABTS+) in Red Amaranthus leafy vegetable

Traits	Vitamin C (mg/100g)	TPC (GAEµ/g FW)	TFC (Reµg/gDW)	TAC ($ABTS^+$)(TEACµg/g DW)
Carotenoids(mg/100g)	-0.016	0.56**	0.52**	0.74**
Vitamin C(mg/100g)		0.06	0.03	0.07
TPC (GAEµ/g FW)			0.75**	0.65**
TFC (Reµg/gDW)				0.76**

TAC, Total antioxidant capacity; TPC, Total polyphenol content; TFC, Total flavonoid content; **Significant at 1% level.

4. Conclusions

Red morphs amaranth leaves have abundant antioxidant such as carotene, vitamin C, TAC, TPC and TFC. It also has abundant protein, dietary fiber and minerals such as Ca, K, Mg, Fe, Cu, Zn and Cu compared to other leafy vegetables. Correlation study discovered that natural antioxidant capacity. It could be a prospective leafy vegetable as a basis of natural antioxidant action along with nutritional constituents in our daily diet.

References

[1] Sarker, U., Islam, M. T., Rabbani, M. G., and Oba, S., 2014. "Genotypic variability for nutrient, antioxidant, yield and yield contributing traits in vegetable amaranth." *Journal of Food Agriculture and Environment*, vol. 12, pp. 168–174.

[2] Sarker, U., Islam, M. T., Rabbani, M. G., and Oba, S., 2015. "Genotype variability in composition of antioxidant vitamins and minerals in vegetable amaranth." *Genetika*, vol. 47, pp. 85–96.

[3] Sarker, U., Islam, M. T., Rabbani, M. G., and Oba, S., 2017. "Genotypic diversity in vegetable amaranth for antioxidant, nutrient and agronomic traits." *Indian J. Genet. Pl. Br.*, vol. 77, pp. 173–176.

[4] Chakrabarty, T., Sarker, U., Hasan, M., and Rahman, M. M., 2018. "Variability in mineral compositions, yield and yield contributing traits of stem amaranth (*Amaranthus lividus*)." *Genetika*, vol. 50, pp. 995–1010.

[5] Sarker, U., Islam, M. T., Rabbani, M. G., and Oba, S., 2015a. "Variability, heritability and genetic association in vegetable amaranth (*Amaranthus tricolor*)." *Spanish Journal of Agricultural Research*, vol. 13, pp. 1-8. Available: http://dox.doi.org/10.5424/sjar/2015132-6843

[6] Sarker, U., Islam, M. T., Rabbani, M. G., and Oba, S., 2016. "Genetic variation and interrelationship among antioxidant, quality and agronomic traits in vegetable amaranth." *Turkish Journal of Agriculture and Forestry*, vol. 40, pp. 526-535.

[7] Sarker, U., Islam, M. T., Rabbani, M. G., and Oba, S., 2018c. "Phenotypic divergence in vegetable amaranth for total antioxidant capacity, antioxidant profile, dietary fiber, nutritional and agronomic traits." *Acta Agric. Scand. Section B- Soil Plant Sci.*, vol. 68, pp. 67-76.

[8] Sarker, U. and Oba, S., 2019f. "Antioxidant constituents of three selected red and green color Amaranthus leafy vegetable." *Sci. Rep.*, Available: https://doi.org/10.1038/s41598-019-52033-8

[9] Repo-Carrasco-Valencia, R., Hellstrom, J. K., Pihlava, J. M., and Mattila, P. H., 2010. "Flavonoids and other phenolic compounds in Andean indigenous grains: Quinoa (*Chenopodium quinoa*), kaniwa (*Chenopodium pallidicaule*) and kiwicha (*Amaranthus caudatus*)." *Food Chem.*, vol. 120, pp. 128–133.

[10] Venskutonis, P. R. and Kraujalis, P., 2013. "Nutritional components of amaranth seeds and vegetables: A review on composition, properties, and uses." *Comp. Review in Food Sci. Food Saf.*, vol. 12, pp. 381–412.

[11] Shukla, S., Bhargava, A., Chatterjee, A., Pandey, A. C., and Mishra, B., 2010. "Diversity in phenotypic and nutritional traits in vegetable amaranth (*A. tricolor*), a nutritionally underutilized." *Crop. J. Sci. Food Agric.*, vol. 90, pp. 139–144.

[12] Rajan, S. and Markose, B. L., 2007. *Horticultural science series-6. in peter, K. M. V. (Ed.), propagation of horticultural crops*. New Delhi, India: New India Publishing Agency.

[13] Sarker, U., Islam, M. T., Rabbani, M. G., and Oba, S., 2014. "Genotypic variability for nutrient, antioxidant, yield and yield contributing traits in vegetable amaranth." *J. Food Agri. Environ,* vol. 12, pp. 168–174.

[14] ASAE, 1983. *ASAE Standard: ASAE S352.1. Moisture measurement-grains and seeds*. Michigan: ASAE, St. Joseph.

[15] AOAC Association of Analytical Chemists, 2000. *Official methods of analysis*. 17th ed. Gaithersburg, MD: USA: AOAC International.

[16] ISO International Standards Organization, 1981. *Organization for standardization. Iso 5498:1981. Determination of crude fiber content, general method*. Geneva: Switzerland: ISO.

[17] Zasoski, R. J. and Burau, R. G., 1977. "A rapid nitric-perchloric acid digestion method for multi-element tissue analysis." *Communications Soil Sci. Plant Anal,* vol. 8, pp. 425–436.

[18] Velioglu, Y. S., Mazza, G., Gao, L., and Oomah, B. D., 1998. "Antioxidant activity and total phenolics in selected fruits, vegetables, and grain products." *J. Agric. Food Chem.,* vol. 46, pp. 4113–4117.

[19] Chang, C. C., Yang, M. H., Wen, H. M., and Chern, J. C., 2002. "Estimation of total flavonoid content in propolis by two complementary colorimetric methods." *J. Food Drug Anal.*, vol. 10, pp. 178–182.

[20] Thaipong, K., Boonprakob, U., Crosby, K., Cisneros-Zevallos, L., and Byrne, D. H., 2006. "Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from guava fruit extracts." *J. Food Compos. Anal,* vol. 19, pp. 669–675.

[21] Akubugwo, I. E., Obasi, N. A., Chinyere, G. C., and Ugbogu, A. E., 2007. "Nutritional and chemical value of Amaranthus hybridus L. leaves from Afikpo, Nigeria." *African Journal of Biotech,* vol. 6, pp. 2833-2839.

[22] Asaolu, S. S., Adefeni, O. S., Oyakilome, I. G., Ajibulu, K. E., and Asaolu, M. F., 2012. "Proximate and mineral composition of nigerian leafy vegetables." *Journal of Food Research,* vol. 1, pp. 214-218. Available: http://dx.doi.org/10.5539/jfr.v1n3p214

[23] Patricia, O., Zoue, L., Megnanou, R., Doue, R., and Niamke, S., 2014. "Proximate composition and nutritive value of leafy vegetables consumed in northern cote d'ivoire." *European Scientific Journal,* vol. 10, pp. 212-227.

[24] Silva, H. P., Scoles, G. E., and Covas, G. F., 2000. *Integral chemical analysis of the amaranth (amaranthus greggii s. Wats)*. Argentina: College of Exact and Natural Resources.

[25] Salucci, M., Stivala, L. A., Maiani, G., Bugianesi, R., and Vannini, V., 2002. "Flavonoids uptake and their effect on cell cycle of human colon adenocarcinoma cells (Caco2)." *British Journal of Cancer,* vol. 86, pp. 1645-1651.

[26] Santas, J., Carbo, R., Gordon, M. H., and Almajano, M. P., 2008. "Comparison of the antioxidant activity of two Spanish onion varieties." *Food Chemistry,* vol. 107, pp. 1210- 1216.