Analysis of Nutritional Components of Horse Radish Tree Flowers (*Moringa oleifera*) Wildly Grown in Sindh Province

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Abstract: The present research study was aimed at determining the proximate and mineral composition of horse radish tree flowers by utilizing standard methodologies. The mean moisture content in fresh, thermally dehydrated, curry, shade dried and boiled fresh /processed samples of horse radish tree flowers was 80.98, 5.40, 68.07, 5.84 and 86.26%, respectively. The vegetable had the highest pH, carbohydrates, total solids, nitrogen free extracts and calorific values in thermally dried samples and crude fiber, ash and protein values were higher in shade dried samples. Whereas, fat and total fatty acids were found higher in curry samples. There was a significant presence of dietary essential micro-nutrients. It was therefore revealed that horse radish tree flowers (*Moringa oleifera*) when consumed in curry form could also be a good source of nutrients. The inclusion of horse radish tree flowers into the diet could potentially address some of the challenges, such as health benefits, food security and increase life expectancy in Sindh, Pakistan.

Keywords: Nontraditional vegetable, horse radish tree flowers (*Moringa oleifera*), proximate and minerals.

INTRODUCTION

Nontraditional vegetables are not commonly used in our daily life, yet many of wildly grown vegetables are underutilized and their nutritional value is unknown [1]. The minor crops and/or underutilized vegetables are the species having a socioeconomic impact and habitually used as food, oil, fodder, fiber or medicinal purposes [2]. These vegetables are naturally grown throughout the world, even on poor marginal lands requiring lower management practices at minimum or no cost [3]. Most of them are tolerant, adoptive and resilient to harsh climatic conditions [4], but they are usually ignored by the higher society of developing countries [5], remain underutilized because of the dearth of awareness and commercialization technologies for their appropriate usage and consumption [3]. In Pakistan, nutritive and anti-nutritive compositions of many underutilized vegetables and their potentials are yet to be given critical attention.

Nontraditional vegetables are readily available in the fields without any formal strategy for growth and cultivation, regarded as weeds [6]. The people of remote areas have profound knowledge about these nontraditional vegetables and are endowed with the information regarding the consumption of such weeds as food, especially during the periods of civil unrest, famine and drought conditions, thereby combating diseases [5]. Hence, it is required to communicate the local communities of rural areas to improve and raise the knowledge about the importance of wild vegetables and their preservation technologies which may help in capacity building among stakeholders and food safety [7]. Vegetables are known to be low in calorie, contain low carbohydrate contents and have low glycemic index [8]. Vegetables also act as buffering agents for acidic substances produced during the digestion process [9]. Humayun *et al.* [10] surveyed that there are about 6000 wild plant species in Pakistan out of which 400-600 have great medicinal properties.

Despite the great value of these nontraditional vegetables, not much research has been carried out on them, especially in the area of nutrition and recipe development [11]. Thus, evaluating the nutritional importance of nontraditional vegetables can lead to a better understanding of the value of these plants [12]. This research is therefore sought to evaluate the nutritional composition of the aforementioned vegetables obtained from Mirpurkhas district.

MATERIALS AND METHODS

Procurement of Vegetable Samples

The flower samples of horse radish tree (*Moringa oleifera*) were collected from three different sites of the Mirpurkhas district of Sindh Pakistan. The flower samples were separated from their respective stalks and weighed on digital top loading balance. About six kilogram edible flower samples were collected and packed into polythene bags, labelled properly and kept on ice in an ice-chest box (to decrease enzymatic

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activities) for transportation to the laboratory of the Institute of Food Sciences and Technology, Sindh Agriculture University, Tandojam.

Sample Preparation

Flowers were washed thoroughly under tap water for 25- 30 seconds to remove unwanted materials (dirt and debris) and placed in a hung strainer in an open area in the air to drain away extra water. The vegetable samples were then spread over a stainless-steel tray to evaporate any extra remaining moisture for 30 minutes at room temperature. The vegetable samples were divided into four groups respectively. 1st group was named as fresh (control) and packed in properly labeled polythene bags. 2nd group was separated for boiling. The boiled sample was then separated into two equal portions, out of which one portion was packed as it is while other was subjected to cooking. Third and fourth was subjected to thermal dehydration and shade drying respectively. The dried samples were powdered and packed in pre-sterilized glass bottles. The first and third lot of contained flowers packed in properly labelled polythene bags and kept in a deep freezer at -20 °C until analysis.

The second lot was subjected to advanced cooking as the horse radish tree flower is a nontraditional vegetable hence the cooking methodology is not well understood. It was therefore aimed to develop a cooking method which keeps the loss of nutrient to the minimum level. Processing, however, changes the color, texture, flavor, and nutritional quality of many fresh vegetables. It was therefore intended to cook the vegetable on a low flame (heat) to keep its nutritional quality and eye appealing characteristics. The vegetable was cooked in canola oil with standard ingredients for 20 minutes (Table **1**) and allowed to cool at room temperature. The samples were properly sealed in polythene bags and stored in refrigerator at -20°C temperature till nutritional analysis.

The third and fourth lot of vegetable was subjected to thermal dehydration and shade drying. For thermal dehydration, the flowers were then transferred carefully on a stainless-steel tray lined with paper and placed inside the dehydration chamber (Model: FPM-05-0401, GLSC equipment's Pakistan) to remove moisture under controlled conditions at 55 ºC for 24 hours [13]. For shade drying, the flowers were placed on stainless steel tray lined with paper at room temperature. Next, the lab scale grinder was used to grind the thermal dehydrated and shade dried flowers and sieved through 2.0 mm sieve prior to analysis [14]. Finally, the powder was packed into prewashed sterilized air tight glass jars and placed on dry and cool place for nutritional analysis.

Table 1: Recipe Used in Cooking Curry of Wild Horse Radish Tree Flowers (*Moringa oleifera*)

Ingredients	Weight (g)
Total vegetable	500
Salt	3
Red chili powder	3
Turmeric powder	0.5
Onion (chopped)	10
Tomato	20
Garlic	5
Chilli green	10
Oil	30 ml
Final Product	570
No of servings	5 persons

Chemical Analysis

The chemical analysis was carried out by taking each raw, boiled, thermally dried, shade dried and cooked sample. The analysis was repeated thrice to ensure the adequacy of the results. The energy (Kcal $100g^{-1}$) value of each sample was calculated using the formula of Asibey-Berko and Taiye [15] by multiplying the values obtained for fat, carbohydrate and protein by 8.37, 3.57 and 2.44, respectively.

Crude proteins, crude fibers, fats, fatty acids, carbohydrates, nitrogen free extract, ash, total solids, moisture and pH, were evaluated by the procedures of AOAC [16]. The moisture content was determined by placing 5g of sample in an oven and dried at 65±1°C for 24 hours. Ash percentage was obtained by the burning of a sample (5g) in a muffle furnace at 525±1°C for 6 hours until the ash turned grayish white. The Kjeldahl method was used for estimation of protein value. The recorded nitrogen content was multiplied by the factor 6.25 to achieve the total protein content of the given sample. However, for fat determination, 5 g of the sample was extracted with petroleum ether in a Soxhlet apparatus for 6 hours. The total fatty acid content was estimated by multiplying the obtained fat with a conversion factor of 0.80 as described by Akinyeye *et al*. [17] and Greenfield and Southgate [18].

The method of Khalil and Durrani [19] was used in calculating crude fiber content by acid and alkali digestion. The percentage carbohydrate was obtained by subtracting the sum of fiber, moisture, protein, ash and fat percentages from 100 AOAC [20]. Total solids were determined by deducting percent moisture from hundred as described by James [21]. The hydrogen ion concentration, i.e. pH of the samples was recorded by the method of AOAC [16] via pre-calibrated pH meter. The Perchloric-acid digestion method was used for mineral elemental analyses [22].

Statistical Analysis

The data obtained from present study was subjected to analysis of variance using SPSS 16.0 statistical software described by Steel *et al.* [23]. The means were compared using DMRT ($P< 0.05$).

RESULTS

Proximate, Total Solids, Total Soluble Solids and pH Value Composition of Horse Radish Tree Flowers

The analysis of variance showed significant variation in proximate, total solids, total soluble solids and pH value (Table **5**). The Table **2** shows that the boiled samples had significantly ($p<0.05$) higher water content (86.26%) than fresh (80.98%), cooked (68.07%), shade dried (5.84%) and thermally dehydrated (5.40%) samples. Possibly, the moisture content contributes to the fleshy appearance of the vegetable. The ash contents ranged from 0.50% in the fresh sample to 8.68% shade dried samples. Furthermore, the values showed that both shade dried and thermally dehydrated samples had higher ash content than the raw samples. The observed value for total solids in the raw sample (19.02 %) was less than that in thermally dehydrated (94.59%), shade dried (94.16%), curry (31.93%) and boiled (13.74%) samples.

The levels of pH in the fresh and boiled samples were noted 5.36 and 6.66 which increased in thermal dehydration, cooking curry and shade drying up to the levels of 6.12, 5.83 and 5.54, respectively. Due to the lipophilic nature of flowers, the fat content obtained was 2.40 and 1.90% in fresh and boiled samples, respectively, 2.7 and 2.10% in dehydrated and shade dried samples, respectively whereas, 3.85% in curry samples.

The horse radish tree flowers are an excellent source of fiber in fresh and boiled samples (2.50 and 2.35%, respectively) which increased in thermally dehydrated and shade dried samples (10.40 and 13.35%, respectively). The carbohydrate percentage was found less in raw samples (8.86%) as compared with other samples. With this comparison, it shows that the thermally dehydrated samples had higher carbohydrate content i.e. up to 68.13%. The protein values were found greatest in thermally dehydrated samples (5.53%) as compared with other samples. This might be due to heat resistant nature of nitrogen content. The fat content was found in greater amount in curry sample (3.85%) followed by thermally dehydrated (2.70%), fresh (2.40%), shade dried (2.10%) and then boiled (1.90%) samples. Similarly, the total soluble solid content was found in high amount in shade dried samples (2.52 ^{o}Brix) than other treatments.

Table 2: Proximate, Total Solids, Total Soluble Solids and pH Composition of Horse Radish Tree Flowers (*Moringa oleifera*) (Mean ± SD, Triplicate Samples)

Parameters	Fresh	Thermally dehydrated	Curry	Shade dried	Boiled
Moisture (%)	80.98^{b} ±0.24	5.40^{d} ±0.27	68.07^{c} ±1.21	5.84^{d} ±0.22	86.26^{a}±0.54
Ash (%)	0.50^{e} ±0.11	7.75^{b} ±0.07	1.92^{c} ±0.07	8.68^{a} ±0.08	0.88^{d} ±0.08
Total Solids (%)	19.02^{c} ±0.24	94.59^{a} ±0.27	31.93^{b} ±1.21	94.16^{a} ±0.22	13.74^{d} ±0.54
pH	5.36^{d} ±0.02	6.12^{b} ±0.06	5.83^{c} ±0.08	5.54^{d} ±0.05	6.66^{a} ±0.06
*CF (%)	2.50^{d} ±0.21	10.48^{b} ±0.32	4.25^{c} ±0.15	13.35^{a} ±0.60	2.35^{d} ±0.95
*CHO (%)	8.86^{d} ±0.17	68.13^{a} ±0.19	16.66^{c} ±1.02	65.75^{b} ±0.34	4.59^{e} ±0.56
*CP (%)	4.74^{c} ±0.005	5.53^{a} ±0.05	5.23^{b} ±0.008	4.28^{d} ±0.005	3.34^{e} ±0.10
Fat (%)	2.40^{bc} ±0.13	2.70^{b} ±0.22	3.85^{a} ±0.27	2.10^{cd} ±0.22	1.90^{d} ±0.26
*TSS (^{o}Brix)	0.95^{c} ±0.03	1.83^{b} ±0.05	0.75^{d} ±0.04	2.52^{a} ±0.03	0.41^{e} ±0.03

Values are expressed as mean ± standard deviation (n=3); Values with different superscripts down the column are significantly different from each other at $p<0.05$ DMRT; *TSS= Total Soluble Solids; *CHO: Carbohydrate; * CF: Crude fiber; *CP: Crude protein.

Fatty Acid (%), Energy (Kcal 100g^{-1}) and Nitrogen Free Extract (%) Composition of Horse Radish Tree Flowers

The analysis of variance showed a significant effect of processing methods on fatty acid, energy and nitrogen free extract (Table **6**). The total fatty acid content was observed greater in cooked samples (3.08%) than thermally dehydrated (2.16%), shade dried (1.68%), boiled (1.52%) and fresh (1.92%) samples. The energy value of fresh, dehydrated, cooked, shade dried and boiled samples was estimated 21.11, 93.10, 34.83, 87.58 and 13.48 Kcal100g^{-1} respectively, which is an indication that it could be an important source of dietary calories. Similarly, Nitrogen free extracts were observed highest in thermally dehydrated and shade dried samples (57.64 and 52.39%), respectively (Table **3**).

Mineral Analysis

The analysis of variance (ANOVA) indicated significant differences in mineral content of horse radish tree flower under the influence of processing treatments (Table **7**). The results of the mineral elements concentration of the wild horse radish tree flowers are reported as mg 100g^{-1} in Table **4**. This study shows that copper was the least abundant in all the treatments. The species analyzed in this study contained remarkably high amount of calcium in

Table 3: Effect of Different Processing Methods on Fatty Acid (%), Energy (Kcal / 100g) and Nitrogen Free Extract (%) Composition of Horse Radish Tree Flowers (*Moringa oleifera*)

Treatments	Fatty Acid (%)	Energy (Kcal / 100g)	Nitrogen free Extract (%)
Fresh	1.92^{bc} ±0.11	21.11^{d} ±0.26	6.36^{d} ±0.38
Thermally dehydrated	2.16^{b} ±0.18	93.10^{a} ±0.46	57.64^{a} ±0.26
Curry	3.08^{a} ±0.22	34.83^{c} ±1.98	12.42^{c} ±1.17
Shade dried	1.68^{cd} ±0.18	87.58^{b} ±1.04	52.39^{b} ±0.93
Boiled	1.52^{d} ±0.21	13.48^{e} ±1.27	1.57^{e} ±0.72

Values are expressed as mean ± standard deviation (n=3); Values with different superscripts down the column are significantly different from each other at p<0.05 DMRT.

Table 4: Effect of Different Processing Methods on Mineral Content (mg 100g^{-1}) of Horse Radish Tree Flowers (*Moringa oleifera*)

Treatments	Copper	Iron	Zinc	Manganese	Calcium	Magnesium	Sodium	Potassium
Fresh	4.15^{d} ±0.03	39.38^{d} ±0.02	2.35^{d} ±0.03	6.55^{d} ±0.02	499.60^{d} ±0.03	271.50^{d} ±1.00	401.60^{d} ±0.43	762.40^{d} ±0.02
Thermally dehydrated	8.25^{b} ±0.002	84.63^{a} ±0.03	5.52^{a} ±0.02	14.85^{a} ±0.04	1074.10^{a} ±0.04	583.50^{a} ±0.36	1094.50^{a} ±0.036	1035.40^{a} ±0.02
Curry	5.78^{c} ±0.002	49.35^{c} ±0.02	2.44^{c} ±0.02	8.75^{c} ±0.03	624.60^{c} ±0.26	339.18^{c} ±0.02	554.60^{c} ±0.04	834.45^{c} ±0.02
Shade dried	8.75^{a} ±0.004	80.13^{b} ±0.04	4.37^{b} ±0.02	13.34^{b} ±0.04	1024.10^{b} ±0.02	556.50^{b} ±1.00	1003.50^{b} ±0.05	942.40^{b} ±0.04
Boiled	3.45^{e} ±0.04	38.98^{e} ±2.00	1.85^{e} ±0.02	5.55^{e} ±0.04	498.60^{e} ±0.02	270.75^{e} ±0.07	399.60^{e} ±0.06	751.43^{e} ±0.02

Values are expressed as mean ± standard deviation (n=3); Values with different superscripts down the column are significantly different from each other at p<0.05 DMRT.

Table 5: Mean Square for Proximate, Total Solids, Total Soluble Solids and pH Composition of Horse Radish Tree Flowers (*Moringa oleifera*) Under the Effect of Processing Methods

SOV	DF	Moisture	Ash	Total solids	pH	CF	CHO	CP	Fat	TSS
Replication	2	0.04	0.0082	0.04	0.00165	0.4287	0.08	0.006	0.03050	0.00038
Processing	4	4903.03**	46.6295**	4903.03**	0.80719**	75.7777**	2971.51**	2.22488**	1.76400**	2.23074**
Error	8	0.47	0.0084	0.47	0.00421	0.2562	0.37	0.00192	0.05987	0.00198
Total	14									

**Highly significant at p<0.01.

Table 6: Mean Square for Fatty Acid, Energy and Nitrogen Free Extract Composition of Horse Radish Tree Flowers (*Moringa oleifera*) Composition of Horse Radish Tree Flowers (*Moringa oleifera*) Under the Effect of Processing Methods

SOV	DF	Fatty acid	Energy	Nitrogen free extract
Replication	2	0.01952	0.60	0.46
Processing	4	1.12896**	4251.03**	2148.30**
Error	8	0.03832	1.59	0.64
Total	14			

**Highly significant at p<0.01.

Table 7: Mean Square for Minerals Composition of Horse Radish Tree Flowers (*Moringa oleifera*) Under the Effect of Processing Methods

SOV	DF	Copper	Iron	Zinc	Manganese	Calcium	Magnesium	Sodium	Potassium
Replication	2	0.0014	0.00026	0.00006	0.0022	0.01022	0.04082	0.07904	0.00086
Processing	4	16.9681**	1485.72**	7.36329**	50.8210**	241260**	71242.2**	335805**	44534.0**
Error	8	0.0004	0.00109	0.00101	0.0014	0.01610	0.02377	0.03017	0.00096
Total	14								

**Highly significant at p<0.01.

dehydrated (1074.10 mg $100g^{-1}$) and shade dried (1024.10 mg $100g^{-1}$) samples. The richest source of zinc and manganese was in thermally dehydrated samples that are 5.52 and 14.85 mg $100g^{-1}$, respectively. Magnesium and potassium content were observed less in raw samples (271.50 and 762.40 mg $100g^{-1}$, respectively) and were higher in thermally dehydrated (583.50 and 1035.40 mg $100g^{-1}$, respectively) samples. Likewise, the sodium and iron content was found increased in thermally dehydrated (1094.50 and 84.63 mg $100g^{-1}$, respectively) samples. The cooked samples had the greater amount of sodium and iron content (554.60 and 49.35 mg $100g^{-1}$, respectively) as compared with raw (401.60 and 39.38 mg $100g^{-1}$, respectively) samples. This may be due to the fact of leaching of the iron from utensils utilized in cooking methodology. The highest content of minerals in thermally dehydrated and shade dried samples might be due to increased amount of dry matter in the form of powder.

DISCUSSION

Proximate Analysis

Table **2** shows the results of the proximate composition (moisture, ash, total solids, pH, crude fiber, carbohydrates, crude protein, fat and total soluble solids) of fresh, boiled, thermally dehydrated, shade dried and cooked flowers. Moisture content of fresh flowers was greater in amount and reduced in drying processes. The high moisture content reveals that these vegetables need care for appropriate preservation as they will be prone to deterioration. The results are in agreement with Serrano-Diaz *et al*. [24] who reported the initial moisture values of the *Crocus sativus* flower samples expressed on a fresh weight were higher than 70 g $100g^{-1}$, decreasing significantly due to the drying process. Some of the differences in the percentage composition might be linked to factors like climate, species, and nature of soil, growing conditions, application of natural or artificial manure and the period of analysis.

The results of the ash content of flowers are also compared with the *Ipomea batatas* with ash percentage of 11.10%, *Vernonia colorate* and *Moringa oleifera* with ash content of 15.86 and 15.09%, respectively [25, 26]. Verma *et al*. [27] also observed ash percentage of Kachnar bud and flowers as 6.53 and 4.33% respectively on dry weight basis. The total solid content was found much higher in dried samples while, slight decreased value was obtained in curry followed by raw and boiled samples. The results are compared with the previous findings of Abdurahman *et al*. [28] who reported the total solids of *O. virdis* (2.03%) and *O. gartissimum* up to 2.03% and 1.79%, respectively. According to Kwenin *et al*. [29] the high moisture content however has a negative correlation with the total solid content. The pH of flowers was found in

between the ranges of slightly acidic as the flowers may contain certain organic acids inside the petals. This nature of flowers is linked to improvements in memory and cognition, reduced pain, a lower risk of hypertension and stroke [30]. The protein content in the Table **2** is compared well with the value presented by Akubugwo *et al*. [31] which was 24.90 g $100g^{-1}$ for S*. Nigrum* from Afikpo-Nigeria. The vegetables are a good source of protein and consumption of these could contribute well to the protein needs of an individual [32].

The fat and fatty acids were observed 2.4 and 1.92% in raw which increased in curry samples due to addition of extra cooking oil. This statement is in line with Verma *et al*. [27] the crude fat content for Kachnar buds was 2.42% while, in flowers, it was 2.44 %. The crude fiber content was in the range from 2.50 to 13.35% in raw and shade dried samples, respectively. Oduro *et al*. [33] also determined about 19.25% fiber content in their study on dry weight basis. This is also in line with the 2.1% fiber content of fresh cocoyam leaves by Tindal [34]. This shows that the fiber content of horse radish tree flowers could help in digestion of foods and in preventing constipation. Ishida *et al*. [35] also reported that increased intake of roughage can help to lower the cholesterol level of the blood, coronary heart disease, breast and colon cancer constipation and also hypertension. The difference can be linked to the soil nutrients available for the formation of fiber in leaves. If the nutrient is not in adequate amount, the fiber content of the leaf can be affected [36]. The carbohydrate level of the horse radish tree flower vegetable ranged from 8.86% in raw samples to 68.13% in thermally dried samples. However, the carbohydrate content was noted in curry samples up to the level of 16.66%. FAO [37] reported the carbohydrate level of *T. occidentalis* was slightly less than the horse radish tree flowers i.e. 8g. This showed that the utilization horse radish tree flowers may impart a greater source of food supplements as compared with *T. occidentalis.*

The mean calorific values of horse radish tree flowers were found much higher i.e. in thermally dehydrated (93.10 Kcal $100g^{-1}$) samples followed by other samples indicating an important dietary constituent for calories as it is reported by WHO/FAO [38] that the average energy for adults is in the range between 2500 to 3000 Kcal. Chionyedua *et al*. [39] reported the energy values of *C. olitorius* (177.55 Kcal $100g^{-1}$), *A. cruentus* (176.67 Kcal $100g^{-1}$) and *C. argenta* (174.93 Kcal $100g^{-1}$). The energy value of plant tubers was estimated within the range of 272.4 - 266.04 Kcal $100g^{-1}$ [40].

Mineral Analysis

The mineral analysis of the horse radish tree flowers is presented in Table **4**. This study shows that copper was the less abundant. The samples analyzed in this study contained a significantly high quantity of calcium (499.60- 1074.10 mg $100g^{-1}$). Hence, the calcium rich vegetables in daily diet give about 20- 25% of calcium on a daily basis which helps in bone and teeth strengthening and healthy teeth [41]. These are also important in maintenance of bones, muscles and teeth [42] as Ca are the minerals that are present in abundant quantity in body skeleton [39]. The richest source of zinc was found in thermally dehydrated flowers (5.52 mg $100g^{-1}$). All the treatments analyzed were an excellent source of magnesium ranging between 271.50- 583.50 mg $100g^{-1}$ in dried and raw samples, respectively. These flowers showed an adequate level of K, Na and Mg (762.40, 401.60 and 271.50 mg $100g^{-1}$) in raw samples. Fe and Na were found higher in thermally dried samples as compared with raw. Increased Na content in cooked than raw samples may be because of table salt use as an ingredient in cooking of vegetable while Fe might have leached from the utensils used during cooking. Iron in an important trace element for hemoglobin synthesis, CNS functioning and in the carbohydrate, fats and protein oxidation [43]. The results clearly indicate that horse radish tree flower iron content from 39.38- 84.63 mg $100g^{-1}$ which is also comparable to the values of 4.3-119 mg$100g^{-1}$ found in some Nigerian leafy vegetables [44]. Moreover, the high percentages of micro-nutrients have never appeared to pose any severe health hazards. The present study revealed that the horse radish tree flowers are useful sources of dietary essential micro-nutrients and their deficiency may lead to any human related severe hazards.

CONCLUSION

It is therefore concluded that horse radish tree flowers contain sufficient amount of fat, carbohydrate, protein, calorific value, fiber and appreciable amounts of minerals required for normal body functions, maintenance and reproduction. It was observed that the vegetable cooked with given processing methodology did not pose a significant loss of the nutritional values. Hence, horse radish tree flowers when consumed in cooked form could be a good source of nutrients.

Thus, it is recommended that more information on horse radish tree flowers leaves and on its fruit might be gathered and enlightenment campaign may also be carried out to aware the public as the inclusion of flowers into the diet could potentially address some of the challenges, such as food security, and increase life expectancy in Sindh, Pakistan.

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