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Research Note

# Green leafy mustard: A healthy alternative

**Usha Pant*, Ram Bhajan, Anita Singh,Kalpana Kulshesthra, A K Singh and Himanshu Punetha**

G B Pant University of Agriculture & Technology, Pantnagar-263145, India.
***E-Mail:** ushabhattgpb@rediffmail.com, ushapantgpb@gmail.com

**Abstract**
Peppery, crispy mustard greens are indeed one of the most nutritious green leafy vegetable available during the winter season. The mustard greens similar to spinach and fenugreek are the storehouse of the number of phytonutrients and have health promotional and disease prevention properties. Five selections from germplasm lines from Uttarakhand hills were evaluated for leaf traits, micronutrient profile and anti-oxidative properties. These lines were very tall, late maturing and slow-growing. The maximum leaf area was found in EEC-1 (590.42 $cm^2$) by virtue of its broadleaf (21.89cm) with high protein (26.68%) and zinc content (2.73mg). EEC-5 showed the highest fresh leaf weight (66.53g) and maximum content of iron (20.23mg). With maximum leaf length (40.72cm), EEC-4 was identified as an excellent source of â-carotene (6480µg) which is precursor of vitamin A. Leafy mustard selection EEC-3 possessed the highest amount of micronutrients like phosphorous (720mg), calcium (240mg) and manganese (6.49mg). Fresh mustard greens were found to be an excellent source of antioxidant like flavonoids (EEC-4, 4.88mg) and also show very high total antioxidative activity (EEC-5, 20.09mg). Therefore, from the above investigation, it was found that green mustard leaves can serve as a healthy alternative to most of the winter season leafy vegetables with their high nutraceutical and disease defensive role.

**Keywords**
*Brassica rugosa*, Nutritional profile, Phenol, Anti-oxidative

*Brassica* crops are commonly cultivated as an *oleiferous* crop for its valuable oil, which is major cooking oil in Indian homes. The crop, in seed form, has registered a high level of heterosis and tolerance against biotic and abiotic stresses (Singh *et al.*, 2017 and Meena *et al.,* 2015). In spite of oil, its leaf especially yellow sarson and mustard are also taken as a green vegetable. In India Brassica crops under cultivation are *B. rapa* var. toria, brown sarson and yellow sarson and *Brassica juncea*. *B rapa* var. toria and brown sarson are grown in small pockets especially in the hilly regions whereas yellow sarson is grown for its high-quality oil. *B juncea* is predominantly grown throughout the country for its oil. One of the leafy variants of *Brassica juncea* i.e. *Brassica rugosa* is mostly cultivated for vegetable purposes. Its seed is also used as a condiment for pickles and curries. Farmers sometimes pick the tender leaves for use as *saag*, a kind of meshed-leafy vegetable. In high hills of Uttarakhand, it is usually grown in the kitchen garden and is profusely consumed in form of *Saag* in the daily diet during winter months. It is tall, slow-growing mustard with lust green foliage varying from light green to deep purple in color. It has broad, crumpled or flat textured leaves and may have either toothed scalloped, frilled, or lacey edges. Mustard green is utilized in foods around the world, from China to South America. Although the Asian countries, including India, China, Japan as well as Nepal, still remain the top suppliers of mustard greens. Peppery, crispy mustard greens are indeed one of the most nutritious green leafy vegetable available during the winter season (www.whf.org). In hills of Uttarakhand, this leafy mustard is grown commonly and huge variation is available in the crop. The mustard greens alike spinach and fenugreek are the storehouse of the number of phytonutrients and have health promotional and disease prevention properties. As it is easily available and can serve as an inexpensive source to supply essential nutrients to the deprive people especially women and growing children. With the view of above germplasm lines were collected and their nutritional profiling was done to identify potential *B. rugosa* lines for their further use to improve nutritional status and well being of people.

Exploration visits were made to different parts of Uttarakhand hills and local germplasms were collected. These collections were grown in NEB, CRC GB Pant University of Agriculture and Technology, Pantnagar-263

145 (Uttarakhand) for the purification, multiplication, characterization and identification for unique traits. Unique germplasm lines were found in the collections with very high foliage yield and suitability towards the vegetable purpose. They were purified by selfing for 4-5 years. There was a huge variation for pigmentation, maturity, height and other morpho-physiological traits. Out of the collections, five lines with a fairly good amount of uniformity and distinct features were isolated. As they have very long and broad leaves so selections were named as Elephant Ear Collection (EEC). Leaves from five random plants were picked up for data recording. During the course of the investigation the leaf characteristics, biochemical analysis including total phenol content, antioxidative activity and micronutrients profile of selections was done. All the parameters were estimated on a dry weight basis following the standard protocol.

Peppery, crispy mustard greens have broad, long and soft leaves with high moisture content and thick tender stem which can conveniently be used for *saag* preparations. The plants are very tall, late maturing slow-growing and flower very late in the season (during January). The seed size was very small (1.5g to 2.0g/1000 seeds). Some of the lines also showed *Alternaria* blight resistance under field condition.The leaf area ranged from 488.58cm$^2$ (EEC-3) to 590.42 cm$^2$ and was found maximum in EEC-1 (590.42 cm$^2$) by virtue of its broadleaf (21.89 cm). The maximum leaf length was reported in EEC-4 (40.72 cm) and width was observed in EEC-1 (21.89 cm). Leaf fresh weight ranged from 42.47g (EEC-2) to 66.53g (EEC-5). The moisture content ranged from 88% (EEC-4) to 68% (EEC-2). Protein content varied from 22.98 % (EEC-2) to 26.68% (EEC-1) % which was similar to the fenugreek and spinach leaf. The per cent ash content ranged from 10.94% to 15.48% (**Table 1**). EEC collections have also shown huge variation for anthocyanin (green to dark purple). EEC-1 has completely green leaves whereas rest have pigmentation in varying intensities and distribution. EEC-2 showed light pigmentation on the leaf periphery and EEC-4 & 5 have pigmentation on the whole leaf.

**Table 1. Leaf characteristics, micronutrients profile and antioxidative activity in leaves of *Brassica rugosa* lines**

| S. No. | Leafy *Brassica* genotypes | Leaf characters (AS) | | | | Micronutrients (mg/100g) (AS) | | | *Protein content (%) |
|---|---|---|---|---|---|---|---|---|---|
| | | Leaf length (cm) | Leaf width (cm) | Leaf area (cm$^2$) | Fresh leaf weight / leaf (g) | Fe | Zn | Mn | |
| 1. | EEC-1 | 38.98 | 21.89 | 590.42 | 54.73 | 13.98 | 2.73 | 4.17 | 26.68 |
| 2. | EEC-2 | 38.04 | 19.18 | 501.12 | 42.47 | 11.81 | 1.79 | 4.53 | 22.98 |
| 3. | EEC-3 | 40.24 | 18.40 | 488.58 | 57.00 | 14.08 | 2.61 | 6.49 | 24.21 |
| 4. | EEC-4 | 40.72 | 18.84 | 516.03 | 49.67 | 16.64 | 2.72 | 5.21 | 23.53 |
| 5. | EEC-5 | 40.18 | 19.11 | 532.97 | 66.53 | 20.23 | 1.36 | 5.46 | 26.11 |

**Table1 continue…**

| S. No. | Leafy *Brassica* genotypes | Ash content (% DW) | Dry weight µg/100 gm β-carotene | Calcium (mg/100g mDW) | Moisture % | Phosphorus content (mg/100g) | Phenols and antioxidative activity (HP) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Total Phenol Content (mg/g) | o-Dihydroxy Phenol Content (mg/g) | Flavonoid Content (mg/g) | Total Antioxidant Activity (mg/g) |
| 1. | EEC-1 | 13.13 | 4845 | 153.2 | 86 | 547 | 5.25 | 0.40 | 3.77 | 14.94 |
| 2. | EEC-2 | 15.48 | 3525 | 187.2 | 68 | 586 | 5.46 | 0.52 | 4.74 | 16.25 |
| 3. | EEC-3 | 13.02 | 5800 | 240.0 | 85 | 720 | 5.47 | 0.99 | 4.88 | 15.03 |
| 4. | EEC-4 | 10.94 | 6480 | 150.0 | 88 | 633 | 4.67 | 0.44 | 3.10 | 15.94 |
| 5. | EEC-5 | 11.36 | 4810 | 216.0 | 87 | 513 | 4.83 | 0.47 | 4.59 | 20.09 |

Micronutrient profile: With respect to micronutrient profiling leafy mustard green is reported to be an excellent source of micronutrient. In the present study in phosphorous content ranged from 513mg/100gm (EEC-5) to as high as 720 mg/100g (EEC-3). Iron is extremely important for women and growing children and mustard green can become the best alternative to meet out their daily requirements. The *B. rugosa* lines under investigation possessed iron ranged from 11.81mg/100g (EEC-2) to 20.23mg/100g (EEC-5). High iron content was also reported in EEC-4 (16.64 mg/100g). Calcium is equally important for bone health, especially in women and

growing children and mustard green, can provide a fairly good amount of calcium. It varied from 150 mg/100g (EEC-4) to 240.0 mg/100g (EEC-3). Another accession reported to be high in calcium content was EEC-5 (216.0mg/100g). The Zinc content ranged from 13.6 mg/100g (EEC-5) to 2.73 mg/100g (EEC-1). The range of manganese in *B. rugosa* lines was also encouraging with a maximum of 6.49 mg/100g (EEC-3) and a minimum of 4.17 mg/100g (EEC-1). EEC-5(5.46 mg/100g) and EEC-4 (5.21 mg/100g) was also identified as a good source of manganese. Beta carotene, the precursor of Vitamin A ranged from 3525g/100g (EEC-2) to 6480g/100g (EEC-4) (**Table 1**). Vitamin-A is an essential nutrient required for maintaining healthy mucosa and skin.

Biochemical analysis: Biochemical analysis in terms of the amount of phenol and antioxidative activity was done to ascertain health promotional and disease prevention properties. The total phenol content ranged from 4.68mg/g (EEC-4) to 5.47mg/g (EEC-3). The range of o-hydroxy phenol was from 0.40 mg/g (EEC-1) to 0.99 mg/g (EEC-3). Flavonoid content has many disease preventive roles. It varied from 3.10 mg/g (EEC-4) to 4.88 mg/g (EEC-3) (**Table 1**). A high amount of flavonoid was also found in EEC-5 (4.59 mg/g) and EEC-2 (4.74 mg/g). Consumption of natural fruits rich in flavonoids protects from lung and oral cavity cancers. Flavonoids are best known for their antioxidant and anti-inflammatory health benefits as well as they support the cardiovascular and nervous systems. Because they also cause detoxification of potentially tissue-damaging molecules so their intake has often, although not always, been associated with decreased risk of certain types of cancers, including lung and breast cancer (Macready *et al*., 2014).High level of total anti-oxidative activity is also an indicator of disease prevention role of green vegetable. The antioxidative activity was lowest in EEC-1 (14.94 mg/g) and highest in EEC-5 (20.09 mg/g). Anti-oxidants are proven cancer fighters, keeping free radicals and oxidized cells from damaging neighbouring cells. If free radicals go unchecked for long spans of time, it causes mutation to occur and become the birthing ground for many types of cancer. Mustard green's high anti-oxidant properties prevent many types of cancer from forming and they also offer wonderful benefits to people struggling with asthma, heart diseases.

The selections from the local material have show a high amount of iron, zinc, calcium, manganese, phosphorous and â-carotene. These selections emerged as valuable sources for phenol and also showed high anti-oxidative properties. Regular consumption of mustard green in the diet is known to prevent iron deficiency, osteoporosis and offer excellent protection against cardiovascular diseases, colon and prostate cancer so the green mustard leaves can serve as a healthy alternative to the most of the winter season leafy vegetables. Their inclusion in the diet is known to prevent arthritis, asthma and mental illness as well. (Macready *et al.* 2014).

The leaves are used in a range of folk medicines as stimulants, diuretics and expectorants as well as a spice. It is used for both food itself and the major ingredient of many traditional fermented vegetable foods, and mustard leaf has recently attracted a lot of attention as a functional food for health maintenance and disease prevention (Kim *et al*., 2003). *Brassica juncea* is known to produce several other classes of bioactive phytochemicals including glycosides, flavonoids, phenolic compounds, sterols and triterpene alcohols, proteins and carbohydrates (Appelqvist *et al*., 1973; Das *et al*., 2009; Fabre *et al*., 1997; Jung *et al*., 2009; Li *et al*., 2000; Sang *et al*., 1984; Yokozawa *et al*., 2002;). The potential importance of such secondary metabolites of the plant in diverse therapeutically interesting bio-activities of preparations obtainable from its seeds and leaves has often been pointed out in more recent years.During recent decades in mustard green, diverse bioactive molecules and their therapeutically interesting pharmacological properties have also been described, and they are now often considered to be effective substitutes for other so called "healthy" Brassica vegetables (Kumar *et al*., 2011).

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