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# Estimation of nutritional potential in leafy mustard (*Brassica juncea var. rugosa*) germplasm: Chemical characterization

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**Abstract**
Leafy Mustard (*Brassica juncea var. rugosa*) is a popular green vegetable grown in plains and hills of Northern India. It is a rich source of vitamins, minerals and protein. The present investigation carried out with 31 germplasm during November–February 2018–2019 at Vegetable Research Center (VRC). Nutraceutical properties of each genotype were determined at G.B.P.U.A & T. Laboratory Pantnagar. The estimation of micronutrient (iron, zinc manganese by atomic absorption spectrophotometer), macronutrient (phosphorus and potassium by spectrophotometer and flame photometer), protein and nitrogen (by Kjeldahl method) were done. Analysis of coefficient of variation showed significant differences among the genotypes for all the traits. All 31 genotypes showed variability in neutraceutical property. Highest protein content (33.38%), nitrogen (5.55%), phosphorus (1400.33 mg/100g), potassium (2770.00 mg/100g), iron (30.56 mg/100g), zinc (5.73 mg/100g) and manganese (4.94 mg/100g) was observed in PLM-16. We can state that above genotypes were promising and can be utilized for further improvement programme in leafy mustard. The genotypes which are rich in neutraceutical properties can be used for plant biofortification.

**Keywords:** Leafy mustard, germplasm, macronutrients, micronutrient, protein and leaves

## Introduction
Mustard is commonly known as Rai, Rayada, Sarson etc, belongs to the plants family Brassicaceae. It is also known as “bamboo mustard” and “mustard cabbage”. It is cool season crop. Mustard (*Brassica juncea var. rugosa*) is a very important crop agriculturally and economically both, which is mostly cultivated in Europe and Asia (Chen and Chen 1992) [6]. In India, tender leaves and stalks are used as green vegetable. Best-quality greens are at their best and most readily available in the season from November to March. At national level it is grown over an area of 6.45 million ha with 7.28 million tons production and 1128 kg/ha productivity (Anonymous, 2015) [1].

Leafy mustard is one of the most nutritious green leafy vegetables available around in the winter months. It’s lovely top greens, indeed, posses more amount of vitamin A (123.57%), vitamin K (691.50%), vitamin C (39.33%), carotenes, antioxidants (flavonoids, indoles) and essential minerals (Ca, Fe, Mg, K, Zn, Mn). Leaf mustard is very low in calories (27 calories/100 g raw leaves) and fats. It contain good amount of dietary fiber that helps to control cholesterol level by interfering with its absorption in the gut. It is good source of β-complex group of vitamins such as folic acid, pyridoxine, thiamin, riboflavin etc. It believed to protect from anemia, cardiovascular disease, asthma and colon and prostate cancer.

## Materials and Methods
The field trial was conducted at Vegetable Research Center (VRC), G. B. P. U. A. T., Pantnagar, U. S. Nagar, Uttarakhand in a Randomized Block Design with 3 replications. It comes under humid subtropical zone and located in the Tarai belt of North India in the foothills of great Himalayan range. Experiment material included of 31 genotypes (PLM-1, PLM-2, PLM-3, PLM-4, PLM-5, PLM-7, PLM-8, PLM-9, PLM-10, PLM-11, PLM-12, PLM-13, PLM-14, PLM-15, PLM-16, PLM-17, PLM-18, EEC-1, EEC-2, EEC-3, EEC-4, EEC-5, EEC-6, EEC-7, EEC-8, EEC-9, EEC-10, EEC-11, EEC-12 and EEC-13) of the leafy mustard out of which 17 genotypes were collected from different locations of Uttarakhand and 13

genotypes were collected from the Pantnagar Center for Plant Genetic Resources (PCPGR), GBPUA & T, Pantnagar. One prominent check variety PUSA SAG-1 was obtained from IARI, New Delhi. Spacing between row to row was 50cm while plant to plant spacing was 15 cm. Total numbers of plants per row was 20.

Observations were recorded for protein content (%), nitrogen content (%), phosphorus content (mg/100g), potassium content (mg/100g), iron content (mg/100g), zinc content (mg/100g) and manganese content (mg/100g). Data analysis was done by the STPR method. For analyzing the statistical data Randomized Block Design (RBD) was used.

**Nutrient analysis**

**Apparatus and glass wares**

All glass wares which were used for experiments were of Borosil. The apparatus and glass wares which were used in experiment are Funnel, Filter paper (Watman number 42 grade), Hot air oven, Tongs, Electronic balance, Wiley Mill, Micropipette, Volumatric flask (150 ml capacity), Conical flask (200 ml capacity), Hot plate.

**Leaf sample preparation for nutrient analysis**

For nutrient estimation like P, K, Fe, Mn, Zn and Cu diacid ($HNO_3$ and $HCLO_4$ in the v/v ratio of 4:1) method was used. Take fresh leaves. Dry the leaves in oven at 60°c - 70°c till weight become constant. Wiley mill was used for the grinding of the oven dry leaves. Take 2.0g of finely grind powder leaves into 200ml conical flask. Add 10ml of concentrated $HNO_3$ in conical flask of finely grind leaves powder. After covering the mouth of flask keep it for overnight. Than flask are heated on the hot plate for 30 minutes. Add 10 ml of nitric and perchloride acid (diacid) after cooling and digest the sample at 40°c till the ending of the digestion. Brown fumes of nitric acid comeout first after that at the end of the digestion process white fumes of perchloride acid comes out. A light brownish colour semi viscous material is reduced to mark of whitish residue in the bottom of the flask at the end of the digestion process. Digestion process takes usually 2-4 hours for completion. Add 10 ml of $HNO_3$ if the sample charred and digest again. After completing the process of digestion conical flask are remove from the hot plate and kept for cooling. Add 6N HCL (5ml) in conical flask along with few quantity of water. Slowly boil the material present in conical flask and transfer into 150 ml volumetric flask. Volume make up was done by the help of distilled water. Diluted samples were filtered with filter paper and kept in cool place for the further analysis.

For digestion of Nitrogen take 2.0g of dried plant sample to a 100 ml Kjeldhal flask. Add 10 ml sulphuric acid - salicyclic acid mixture and rotate slowly to bring the dry sample in the contact with the reagent and leave overnight. Next day 5g sodium thiosulphate added into flask and slowly heat for 5 minutes. To avoid frothing care should be taken. After cooling add 10g of sulphate mixture. Digestion is done at full heat (150°c for 45 minutes and then again 350°c for another 45 minutes). Digestion was done till clear solution obtained. After completion of digestion volume makeup was done by distilled water.

**Macronutrient (N, P and K) analysis**

Macronutrient i.e. Nitrogen was analyzed by Kjeldlhl's method. Phosphorus was estimated by the help of Spectrophotometer while Potassium was analyzed by the help of Flame photometer.

**Reagents for Nitrogen estimation**

Sulphuric acid, Sodium thiosulphate, Sulphate mixture- Mix 20 parts of $K_2so_4$ and one part of catalyst mixture, Boric acid (4%), NaOH (40%), Standard $H_2SO_4$ (0.02 N)

**Reagents for Phosphorus estimation**

Ammonium molybdate [$(NH_4)\ Mo_7O_{24}.4H_2O$], Ammonium vanadate, Concentrated $HNO_3$, $HCLO_4$, $H_2SO_4$, 6N HCL

**Reagents for Potassium estimation**

Concentrated $HNO_3$, $HCLO_4$, $H_2SO_4$, 6N HCL

**Procedure for Nitrogen estimation**

For determination of Nitrogen Kjeldahl method was used. Shifted digested sample into micro Kjeldhal apparatus. Swill the flask twice or thrice with the help of distilled water and add 10 ml of 40% NaOH solution to the flask. Take 10 ml of 4% boric acid (bromocresol green and methyl red indicator) solution into 200 ml conical flask. Dip the condenser outlet into the solution of this flask. Distilled for 20-30 minutes and remove the flask, heater turn off and refill next sample. After this titration of boric acid was done this contains distilled ammonia against 0.1N $H_2SO4$. Run the blank titration to the same end point.

$$N\% \text{ in plant sample} = \frac{TV \times 0.00007 \times 100 \times 100}{(0.2 \times 5)} = 0.28TV$$

**Procedure of Phosphorus estimation**

Determination of phosphorus was done by the Yellow Colour method. Take 5-10 ml plant sample from diacid digest plant material and put into 50 ml volumetric flask. Add 10 ml ammonium molybdate and 10 ml distilled water into flask. Plant sample was diluted up to 50 ml and mixed properly. After mixing yellow colour was fully developed in 15-20 minutes. When yellow colour was fully develop, recorded transmittance (%) or absorbance at 420 nm. Prepare standard curve in the range between 0-15 ppm phosphorus in the final solution.

$$P\% \text{ in plant sample} = (\mu g\ P/ml \text{ in distilled plant digest from standard curve}) \times \frac{50}{5} \times \frac{100}{1} \times \frac{1}{1000}$$

**Procedure for Potassium estimation**

For determination of potassium, sample is prepared same as in case of micro nutrient analysis after the sample preparation. Take 5ml of digestion sample in 25ml volumetric flask and dilute the sample up to mark with the help of distilled water. Standard curve is prepared for potassium with the help of flame photometer by aspirating standard k solution (0-10µg/ml) and for each solution flame photometer reading is recorded. With the help of standard curve digest the standard curve of concentrated potassium in dilute plant sample.

$$K\% \text{ in plant sample} = (\mu g\ P/ml \text{ in distilled plant digest from standard curve}) \times \frac{50}{2} \times \frac{100}{1} \times \frac{1}{1000}$$

**Micronutrient (Zn, Fe and Mn) analysis**

Micronutrients were analyzed with the help of the atomic absorption spectrophotometer.

**Reagents for micronutrient estimation**

Concentrated $HNO_3$, $HCLO_4$, $H_2SO_4$, 6N HCL

**Procedure of micronutrient estimation in plant sample**

For estimation of micronutrient those samples was used which were prepared by diacid method. Samples were again filtered by watman filter paper (grade 42) in 100 ml volumetric flask. Place the filtered sample into plastic bottles of volume 100ml. Prepared samples is now poured in atomic absorption spectrophotometer and reading is noted in µg/ml. By dilution 100 reading is multiplied and converted into mg/kg or by dilution 10 reading is multiplied into mg/100gm.

## Result and Discussion

**Protein content (%)**

Protein is rich kind of molecules in the body beside from water. With a balanced amino acid pattern mustard green leaves were reported rich in protein. Among all genotypes highly significant differences were observed for protein content. The range of protein varies from 28.61-33.38%. Highest protein content was observed in PLM-16 (33.38%) followed by EEC-9 (31.98%), PLM-12 (31.19%), PLM-10 (31.13%) and PLM-2 (31.10%) while minimum protein content was observed in EEC-11(20.61%) followed by EEC-8 (20.77%), EEC-1 (21.21%), Pusa Sag-1 (21.62%) and PLM-13 (22.26%). The protein value of the leaf protein essence from these vegetables species exceed those reported by Eggum (1970) [7] for the leaves of cassava but were less than those from the leaves of some legume species which was reported by Oke (1968) [13] and Agbede (2000). High protein value in mustard (29.82%) was also reported by the Gupta and Wagle (1988) [9]. High protein content was also reported in cruciferous vegetables by Manchali *et al.* (2012) [12]. Similar results were also observed by Gupta *et al.* (2005) [10], Aletor and Adeogen (1995) [3] and Fasuyi (2006) [8]. Bhandari (2017) [4] also recorded protein ranged between 20.12-32.68% in leafy mustard.

**Nitrogen content (%)**

Nitrogen is the most important mineral in the body. After the analysis data revealed that there was a significant difference between all genotypes for nitrogen content. Nitrogen content ranged from 2.25-5.55%. PLM-16 has the highest nitrogen content (5.55%) followed by EEC-6 (4.89%), PLM-8 (27.45%), EEC-8 (4.7%) and Pusa Sag-1 (4.72%) while minimum nitrogen content was observed in EEC-11 (2.25%) followed by PLM-11 (2.60%), EEC-7(3.07%), PLM-13 (3.22%) and PLM-1 (3.27%). Nitrogen content was also reported in green leafy vegetables by Gupta *et al.* (2005) [10].

**Phosphorus content (mg/100g)**

After calcium, phosphorus is the 2nd most important mineral in the body. For better growth and repair of body cells phosphorus is essential mineral. After the analysis data revealed that there was a significant difference between all genotypes for phosphorus content. Phosphorus content ranged from 980-1400 mg/100g. PLM-16 and PLM-7 has the highest phosphorus content (1400 mg/100g) followed by PLM-13 (1334.33 mg/100g), PLM-8 (1305.66 mg/100g) and EEC-8 (1283.66 mg/100g) while minimum phosphorus content was observed in EEC-11 (980 mg/100g) followed by PLM-18 (981.33 mg/100g), EEC-1(1027.66 mg/100g), EEC-13 (1030.33mg/100g) and PLM-5 (1040.66mg/100g). Other genotype showed intermediate content of phosphorus. This type or result was also found by Gupta and Wagle (1988) [9]. Same result was also found by Aletor and Adeogun (1995) [3]. Bhandari (2017) [4] also recorded phosphorus ranged between 903-1471mg/100g in leafy mustard.

**Potassium content (mg/100g)**

For function of the living cells potassium ions are important. For normal nerve transmissions potassium ions transfer through nerve cells membranes is necessary. Potassium plays a major part in skeletal and smooth muscles contraction which is crucial for normal muscular and digestive function. After the analysis data revealed that there was a significant difference between all genotypes for potassium content. Potassium content ranged between 1800-2770mg/100g. PLM-16 has the highest potassium content (2770.00 mg/100g) followed by PLM-2 (2553.33 mg/100g), PLM-7 (2516.66 mg/100g), EEC-5 (2438.33 mg/100g) and EEC-7 (2416.66 mg/100g) while minimum potassium content was obtained in EEC-11 (1800.00 mg/100g) followed by PLM-3 (1812.66 mg/100g), PLM-8 (1816.66 mg/100g), EEC-13 (1030.33 mg/100g) and PLM-1 (1850.00 mg/100g). This type or result was also found by Gupta and Wagle (1988) [9]. Bhandari (2017) [4] also recorded potassium ranged between 1700-3150mg/100g in leafy mustard. Ifon and Bassir (1979) [11] and Fasuyi (2006) [8] also observed such type of result.

**Iron content (mg/100g)**

After the analysis of data iron content ranged between 9.58-30.56mg/100g. After the analysis data revealed that there was a significant difference between all genotypes for iron content. PLM-16 has the highest iron content (30.56 mg/100g) followed by PLM-9 (27.39 mg/100g), EEC-2 (24.70 mg/100g), EEC-5 (22.59 mg/100g) and EEC-9 (21.73 mg/100g) while minimum iron content was obtained in EEC-11 (9.58 mg/100g) followed by PLM-15 (10.70 mg/100g), PLM-12 (11.20 mg/100g), PLM-1 (11.40 mg/100g) and EEC-4 (12.63 mg/100g). Iron content was found highest (45mg/100g) in leafy mustard by Gupta and Wagle (1988) [9]. Bhandari (2017) [4] also recorded iron content ranged between 6.49-37.52mg/100g in leafy mustard. These findings are accordance with the findings of Bhatt and Singh (2015) [5] in fenugreek.

**Zinc content (mg/100g)**

Zinc is very essential for immune system and an important factor for the prevention of night blindness. Zinc also prevents development of cataract. Result showed that for this parameter genotypes differs significantly. Zinc content ranged between 2.22-5.73 mg/100g. PLM-16 has the highest zinc content (5.73 mg/100g) followed by EEC-1 (4.74 mg/100g), PLM-15 (4.67 mg/100g), EEC-8 (4.62 mg/100g) and EEC-12 (4.6 mg/100g) while minimum zinc content was observed in EEC-11 (2.22 mg/100g) followed by PLM-8 (3.15 mg/100g), EEC-4 (3.22 mg/100g), PLM-14 (3.39 mg/100g) and EEC-12 (3.43 mg/100g). Intermediate zinc content was present in rest genotypes. The similar result for zinc content was also observed by Aletor *et al.* (2002) [2], Singh *et al.* (2001) [14] and Manchali *et al.* (2012) [12]. Bhandari (2017) [4] also recorded zinc content ranged between 2.42-5.83mg/100g in leafy mustard.

**Manganese content (mg/100g)**

Data represent that among all the genotypes there is a significant difference. Manganese content ranged between 3.25-4.94mg/100g. PLM-16 has the highest manganese content (4.94mg/100g) followed by PLM-3 (4.70 mg/100g), PLM-8 (4.69 mg/100g), EEC-13 (4.62 mg/100g) and PLM-4 (4.58 mg/100g) while low manganese content was observed in EEC-11 (3.25 mg/100g) followed by EEC-9 (3.40 mg/100g), PLM-12 (3.43 mg/100g), EEC-4 (3.45 mg/100g)

and PLM-2 (3.45 mg/100g). Intermediate manganese content was showed by the rest genotypes. These results are similar with the result of Singh *et al.* (2001) [14] and Wagle (1988) [9]. Bhandari (2017) [4] also recorded manganese content ranged between 2.31-7.97mg/100g in leafy mustard.

**Table 1:** List of genotypes of leafy mustard

| S. No. | Genotypes | Source | S. No. | Genotypes | Source |
|---|---|---|---|---|---|
| 1. | PLM-1 | Tehri Garhwal | 17. | PLM-18 | Pantnagar Local |
| 2. | PLM-2 | Ramnagar, Nainital | 18. | EEC-1 | CRC, Pantnagar |
| 3. | PLM-3 | Pauri Garhwal | 19. | EEC-2 | CRC, Pantnagar |
| 4. | PLM-4 | Gairsain, Chamoli | 20. | EEC-3 | CRC, Pantnagar |
| 5. | PLM-5 | Kashipur, USN | 21. | EEC-4 | CRC, Pantnagar |
| 6. | PLM-7 | Rudrapur, USN | 22. | EEC-5 | CRC, Pantnagar |
| 7. | PLM-8 | Mehalchori, Chamoli | 23. | EEC-6 | CRC, Pantnagar |
| 8. | PLM-9 | Matkot, Chamoli | 24. | EEC-7 | CRC, Pantnagar |
| 9. | PLM-10 | Rudraprayag | 25. | EEC-8 | CRC, Pantnagar |
| 10. | PLM-11 | Almora | 26. | EEC-9 | CRC, Pantnagar |
| 11. | PLM-12 | Badowala, Dehradun | 27. | EEC-10 | CRC, Pantnagar |
| 12. | PLM-13 | Pantnagar (Kisan mela) | 28. | EEC-11 | CRC, Pantnagar |
| 13. | PLM-14 | Karanpur, Dehradun | 29. | EEC-12 | CRC, Pantnagar |
| 14. | PLM-15 | Pantnagar local | 30. | EEC-13 | CRC, Pantnagar |
| 15. | PLM-16 | Pantnagar local | 31. | PUSA SAG -1 | IARI, New Delhi (Check var.) |
| 16. | PLM-17 | Pantnagar local | | | |

**Table 2:** Analysis of variance (ANOVA) for different character in leafy mustard germplasm

| Source | df | Protein | N | P | K | Fe | Zn | Mn |
|---|---|---|---|---|---|---|---|---|
| Replication | 2 | 4.49 | 0.11 | 13466.41 | 85160.01 | 0.03 | 0.06 | 0.037 |
| Treatment | 30 | 42.62** | 1.61** | 35,103.66** | 205,733.42** | 70.14** | 1.2** | 0.72** |
| Error | 60 | 1.22 | 0.03 | 14,566.91 | 33,573.83 | 1.64 | 0.08 | 0.04 |

**Table 3:** Nutrient content in different genotypes of leafy mustard

| Genotypes | Protein (%) | Nitrogen (%) | Phosphorus (mg/100g) | Potassium (mg/100g) | Iron (mg/100g) | Zinc (mg/100g) | Manganese (mg/100g) |
|---|---|---|---|---|---|---|---|
| PLM-1 | 22.36 | 3.27 | 1126.67 | 1850.00 | 11.40 | 3.58 | 3.64 |
| PLM-2 | 31.11 | 4.49 | 1084.33 | 2553.33 | 20.15 | 4.28 | 3.45 |
| PLM-3 | 25.36 | 3.66 | 1052.67 | 1812.67 | 18.50 | 3.92 | 4.70 |
| PLM-4 | 29.45 | 4.57 | 1246.00 | 2023.33 | 18.38 | 3.47 | 4.58 |
| PLM-5 | 27.46 | 4.35 | 1040.67 | 1616.67 | 21.56 | 3.80 | 4.36 |
| PLM-7 | 24.44 | 3.66 | 1352.00 | 2516.67 | 19.57 | 3.63 | 4.16 |
| PLM-8 | 27.45 | 4.75 | 1305.67 | 1816.67 | 21.54 | 3.15 | 4.69 |
| PLM-9 | 23.11 | 4.55 | 1085.00 | 2000.00 | 27.40 | 3.58 | 4.40 |
| PLM-10 | 31.13 | 3.59 | 1060.00 | 1916.67 | 18.49 | 3.90 | 4.11 |
| PLM-11 | 24.10 | 2.60 | 1238.00 | 2453.33 | 18.39 | 4.00 | 3.55 |
| PLM-12 | 31.19 | 3.65 | 1111.33 | 2116.67 | 11.21 | 4.60 | 3.43 |
| PLM-13 | 33.38 | 5.03 | 1364.00 | 2600.00 | 30.70 | 5.49 | 5.00 |
| PLM-14 | 23.35 | 4.63 | 1163.33 | 2120.00 | 18.12 | 3.39 | 4.34 |
| PLM-15 | 28.38 | 3.66 | 1146.00 | 2133.33 | 10.70 | 4.67 | 4.19 |
| PLM-16 | 33.23 | 5.55 | 1400.00 | 2770.00 | 30.00 | 5.73 | 4.94 |
| PLM-17 | 26.80 | 4.46 | 1146.00 | 2000.00 | 20.41 | 4.04 | 4.57 |
| PLM-18 | 28.70 | 4.61 | 981.33 | 2060.00 | 19.92 | 3.45 | 3.86 |
| EEC-1 | 21.21 | 4.39 | 1027.67 | 2323.33 | 20.65 | 4.74 | 4.19 |
| EEC-2 | 23.26 | 4.69 | 1049.33 | 2166.67 | 24.71 | 2.99 | 4.53 |
| EEC-3 | 24.12 | 4.65 | 1172.33 | 1893.33 | 15.91 | 3.44 | 3.80 |
| EEC-4 | 27.09 | 3.60 | 1168.00 | 1913.33 | 12.67 | 3.22 | 3.45 |
| EEC-5 | 31.11 | 3.70 | 1071.67 | 2438.33 | 22.59 | 3.60 | 3.86 |
| EEC-6 | 25.43 | 4.89 | 1105.33 | 2086.67 | 12.96 | 4.16 | 4.50 |
| EEC-7 | 29.32 | 3.07 | 1235.33 | 2416.67 | 19.61 | 3.95 | 4.45 |
| EEC-8 | 20.77 | 4.78 | 1283.67 | 2323.33 | 13.57 | 4.62 | 4.19 |
| EEC-9 | 31.98 | 4.38 | 1022.67 | 1800.00 | 21.73 | 4.44 | 3.40 |
| EEC-10 | 28.66 | 4.46 | 1155.33 | 2036.67 | 17.71 | 3.99 | 3.91 |
| EEC-11 | 20.61 | 2.25 | 98 0.000 | 1800.00 | 9.58 | 2.25 | 3.25 |
| EEC-12 | 27.93 | 4.60 | 1058.67 | 1963.33 | 15.62 | 3.43 | 3.58 |
| EEC-13 | 26.92 | 4.35 | 1030.33 | 1846.67 | 14.41 | 4.03 | 4.62 |
| Pusa sag-1 | 21.62 | 4.72 | 1043.67 | 2400.00 | 18.41 | 4.45 | 4.39 |
| C.D. | 1.81 | 0.30 | 197.61 | 300.01 | 2.10 | 0.46 | 0.31 |
| SE(m) | 0.64 | 0.10 | 69.68 | 105.79 | 0.74 | 0.16 | 0.11 |
| SE(d) | 0.90 | 0.15 | 98.55 | 149.61 | 1.05 | 0.23 | 0.15 |
| C.V. | 4.12 | 4.32 | 10.63 | 8.70 | 6.98 | 7.30 | 4.51 |

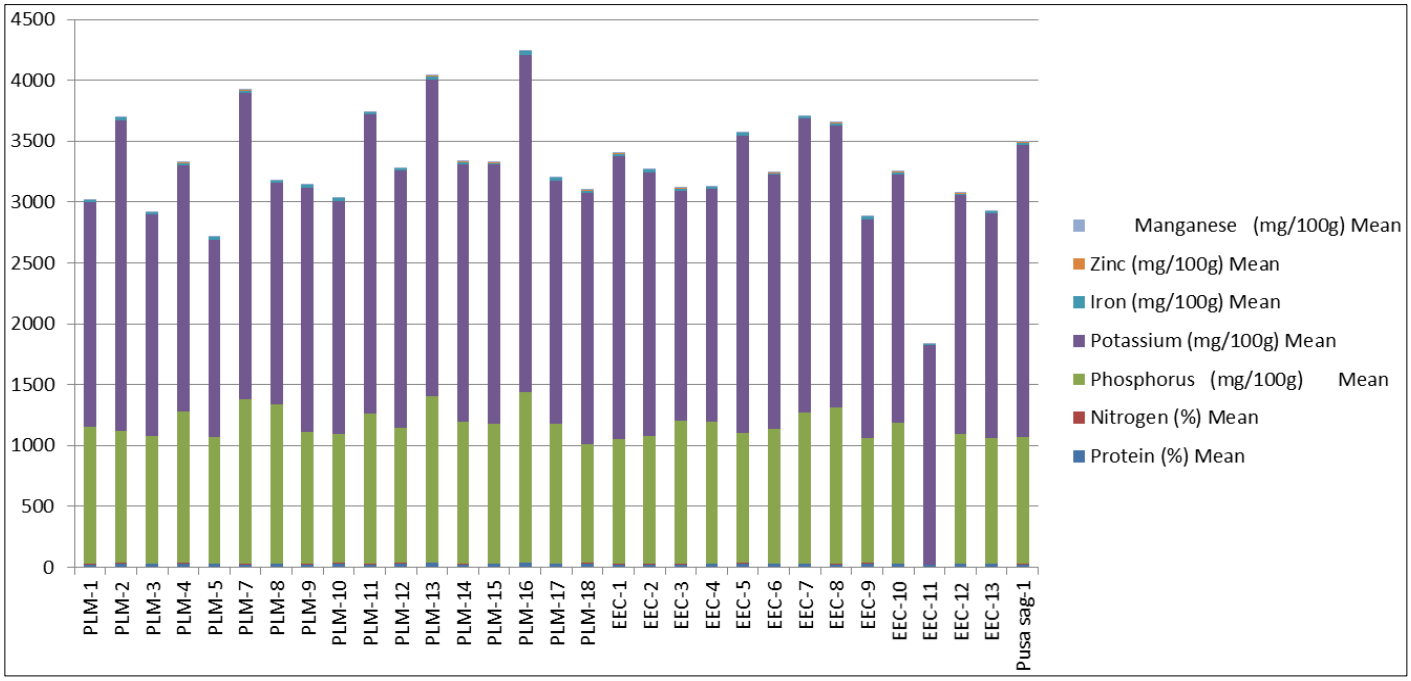


**Fig 1:** Variation in nutrient content in different genotypes of leafy mustard

**Summery and conclusion**

Highest protein content was observed in PLM-16 (33.38%) followed by EEC-9 (31.98%), PLM-12 (31.19%), PLM-10 (31.13%) and PLM-2 (31.10%) while minimum protein content was observed in EEC-11(20.61%) followed by EEC-8 (20.77%), EEC-1 (21.21%), Pusa Sag-1 (21.62%) and PLM-13 (22.26%). Highest nitrogen content PLM-16 (5.55%) followed by EEC-6 (4.89%), PLM-8 (27.45%), EEC-8 (4.7%) and Pusa Sag-1 (4.72%) while minimum nitrogen content was observed in EEC-11 (2.25%) followed by PLM-11 (2.60%), EEC-7(3.07%), PLM-13 (3.22%) and PLM-1 (3.27%). Highest phosphorus content PLM-16 (1400 mg/100g) followed by PLM-13 (1334.33 mg/100g), PLM-8 (1305.66 mg/100g) and EEC-8 (1283.66 mg/100g) while minimum phosphorus content was observed in EEC-11 (980 mg/100g) followed by PLM-18 (981.33 mg/100g), EEC-1 (1027.66 mg/100g), EEC-13 (1030.33mg/100g) and PLM-5 (1040.66mg/100g). PLM-16 has the highest potassium content PLM-16 (2770.00 mg/100g) followed by PLM-2 (2553.33 mg/100g), PLM-7 (2516.66 mg/100g), EEC-5 (2438.33 mg/100g) and EEC-7 (2416.66 mg/100g) while minimum potassium content was obtained in EEC-11 (1800.00 mg/100g) followed by PLM-3 (1812.66 mg/100g), PLM-8 (1816.66 mg/100g), EEC-13 (1030.33 mg/100g) and PLM-1 (1850.00 mg/100g). PLM-16 has the highest iron content (30.56 mg/100g) followed by PLM-9 (27.39 mg/100g), EEC-2 (24.70 mg/100g), EEC-5 (22.59 mg/100g) and EEC-9 (21.73 mg/100g) while minimum iron content was obtained in EEC-11 (9.58 mg/100g) followed by PLM-15 (10.70 mg/100g), PLM-12 (11.20 mg/100g), PLM-1 (11.40 mg/100g) and EEC-4 (12.63 mg/100g). PLM-16 has the highest zinc content (5.73 mg/100g) followed by EEC-1 (4.74 mg/100g), PLM-15 (4.67 mg/100g), EEC-8 (4.62 mg/100g) and EEC-12 (4.6 mg/100g) while minimum zinc content was observed in EEC-11 (2.22 mg/100g) followed by PLM-8 (3.15 mg/100g), EEC-4 (3.22 mg/100g), PLM-14 (3.39 mg/100g) and EEC-12 (3.43 mg/100g). PLM-16 has the highest manganese content (4.94mg/100g) followed by PLM-3 (4.70 mg/100g), PLM-8 (4.69 mg/100g), EEC-13 (4.62 mg/100g) and PLM-4 (4.58 mg/100g) while low manganese content was observed in EEC-11 (3.25 mg/100g) followed by EEC-9 (3.40 mg/100g), PLM-12 (3.43 mg/100g), EEC-4 (3.45 mg/100g) and PLM-2 (3.45 mg/100g). Some genotypes like PLM-16, PLM-8 and EEC-8 rich I nutrient like nitrogen, phosphorus and potassium.

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