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EVALUATION OF QUANTITATIVE TRAITS AND ANTI-OXIDANT ACTIVITY OF SNOW PEA VARIETIES AS A POTENTIAL HIGH VALUE CROP IN MIDDLE HILL CLIMATIC CONDITIONS OF UTTARAKHAND HIMALAYAS

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ABSTRACT

Snow pea (Edible Podded Pea) (*Pisum sativum* L. Var *Saccharatum* is a high value exotic vegetable typically grown in temperate regions. Seven genotypes of this crop were evaluated at Defence Institute of Bio Energy Research, Field Station, Pithoragarh in randomized block design with three replications in two consecutive years viz: 2018-19 and 2019-20. Data on yield and its yield attributing traits were recorded. The antioxidant activity of these genotype have been estimated by ABTS, DPPH and reducing power assay. The antioxidant constituents viz. total phenolics, flavonoids and tannins were also evaluated. The analysis of variance revealed that there were significant differences in all the parameters studied in this experiment. Genotype 18/GEP/ VAR2 followed by 18/GEP/ VAR1 and 18/GEP/VAR6 were found promising in respect of yield and its yield attributing traits. For ascorbic acid content, genotype 18/GEP/ VAR8 was found promising. For total chlorophyll content, genotype 18/GEP/ VAR5 was found promising. For tannins, phenolics and flavonoid contents the genotype 18/GEP/ VAR8 out yielded the other varieties in both aqueous and alcoholic extracts. The 50 % inhibition concentration by ABTS and DPPH and reducing power activity methods was found lowest (i.e. IC_{50} and EC_{50}) in the genotype18/GEP/ VAR4 both in aqueous and alcoholic extracts. These genotypes can be used in our further breeding programme for the development of antioxidant rich cultivars. Hence, it is concluded from the study that snow peas genotypes have very good potential as a high value crop for hill regions. It can be an economic source for livelihood security of marginal farmers of hills.

KEYWORDS: Edible Podded Pea, *Pisum sativum* L. var *saccharatum*, Genotype, Field Evaluation, Antioxidant Constituents

Besides conventional vegetables, the exotic vegetables are also being grown in our country. Cold climate is needed for production and seed production of these vegetables. These vegetables are also known as European vegetables. The climates of hills are similar to the climates of European countries. So European vegetables can be produced easily in hills. Nowadays, exotic vegetables are playing an important role in horticulture sector. Among these, Snow Peas (*Pisum sativum* L. var *saccharatum* is an edible podded pea with thin tender fresh pods, flat in appearance with small seeds visible via the pod walls. It is a high value vegetable typically grown in temperate region (Ferrarezi *et al;* 2016). The temperature between 13-16 ^{0}C is best for its growth. These Snow peas are harvested prior to reaching full maturity. The pods can be harvested approximately 8-10 days after flowering. The edible podded pea lacks the parchment layer inside the pod wall, hence can be eaten as whole pod (pod and seed both) in unripe stage. Edible pods having various nutraceutical values and are highly cherished as salad. It is rich source of vitamin 'A', 'B_6' and 'C', iron, potassium, dietary fiber, magnesium and little amount of healthy fats. Health benefits of this edible podded pea are useful in weight loss, improve heart health, reduce constipation and strengthen the immune system of the body. Production of good quality vegetables is the primary factor of commercial vegetable cultivation for better economic returns. It is the chemical composition that mainly plays a crucial role for determining the quality of vegetables which makes them worth acceptable for consumption. The discovery of phytochemicals in vegetables has generated tremendous attention among scientists. Vegetables act as powerful medicine which can help in reducing the risk of chronic diseases (Brown *et al*; 1999; Gosslau and Chen, 2004; Lee *et al.*, 2008). The ascorbic acid or vitamin C has a great potential against heart diseases, cancer, blood pressure and high cholesterol (Antonious, G. 2009; Byers and Perry, 1992). Chlorophyll is another bio-molecule recognized as a health promoting phytochemical. The phenols, flavonoids and tannins are the secondary metabolites synthesized by the plants. These are

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potentially powerful antioxidants that can protect the human from free radicals damage (Nadeem *et al*., 2011; Velioglu *et al*., 1998; Materska and Perucka, 2005; Chu *et al*., 2002; Kaur and Kapoor, 2002). Antioxidant activity is an important parameter to establish the health functionality of a food product. The majority of the antioxidant activities of vegetables are due to ascorbate, phenols, flavonoids and tannins (Badami and Channa, 2007).

The seven genotypes of snow peas were evaluated for quantitative parameters viz: days to 50% flowering, days to pod setting, number of pods per plant ,pod length, pod width, 100 pod weight, marketable yield and biochemical parameters viz. antioxidant activity, reducing power, tannins, flavonoids, phenolics, ascorbic acid and chlorophyll. Such information will not only increase the understanding of the function of these antioxidant phytochemicals but also be helpful in breeding programme to develop new germplasm lines with high content of such phytochemicals.

MATERIALS AND METHODS

Experimental Sites, Plant Materials and Growing Conditions

Seven edible podded pea genotypes viz: 2018/EPP/VAR1, 2018/EPP/VAR2, 2018/EPP/VAR3, 2018/EPP/VAR4, 2018/EPP/VAR5, 2018/EPP/VAR6, 2018/EPP/VAR7, 2018/EPP/VAR8 were sown in randomized block design with three replications in two consecutive years viz: 2018-19 and 2019-20 at Defence Institute of Bio Energy Research, Pithoragarh, (Uttarakhand) at an altitude of 5500 feet above the sea level. This place is situated in western Himalayas, which extends from $29^0$29’ N to $30^0$49’ N latitude and $85^0$05’ E to $81^0$31’ E longitude. The annual rainfall is approximately 1250mm, out of which 70-75% is received during the rainy season. The temperature of the place ranges from a maximum of 35^0C in summer to a minimum of -2^0C during winter. The seeds were sown in first week of November with row to row spacing 30cm and seed to seed spacing 10 cm. Net plot size was 3.00m x 2.00m. Recommended cultural practices were adopted for the proper growth and stand of the crop.

Yield Parameters

Quantitative data were recorded on days to 50% flowering; days to pod setting, number of pods per plant, weight of 100 pods (g), pod length (cm), pod width (cm), pod weight (g) and marketable yield (kg/plot) were recorded during the experiment. Yield (kg/plot) was converted to (q/ha) and (q/acre = 20 Nali). The hill farmers are marginal farmers having small land holdings and measurement is in the Nali.

Antioxidants Evaluation

Three replicates each comprising of a homogenous mass of snow pea pods from 5 randomly selected plant were screened for antioxidant activity (IC_{50} mg/g) through ABTS and DPPH method, Reducing Power (EC_{50} mg/g), Tannins (mg/g), Flavonoids (mg/g), Phenolics (mg/g), ascorbic acid (mg/100g) and chlorophyll (mg/g). The edible pods were dehydrated in a hot air oven below 40^0C, powdered and stored for analysis. 1 g dried powder was extracted by cold maceration with 100 ml water and kept for 24 hrs by shaking occasionally. The aqueous filtrate was collected and stored. The same method was used for making alcoholic extract by using ethanol 100 ml.

Ascorbic Acid Assay

The chemical analyses of fresh fruits included determination of ascorbic acid (mg/100g) by 2, 6 di chlorophenol indophenol titration method (AOAC, 1980). Ascorbic acid was estimated by volumetric method. 5 g of the fresh sample was extracted with 4% oxalic acid and volume made to 100 ml and centrifuged. 5 ml of this supernatant was pipette out, added with 10 ml of 4% oxalic acid and titration was done against the dye. Ascorbic acid reduces the 2, 6-dichlorophenol dye to a colorless leuco- base and gets oxidized to dehydroascorbic acid. Ascorbic acid was measured in mg/100g. Vitamin C as % RDA was based on 60 mg/100g.

Estimation of Total Phenolic Contents

The total phenolic contents in the plant extract were determined by using Folin- Ciocalteu method (Malik *et al.*, 1980). The plant extract was taken and volume make up to 3 ml with distilled water. Then 0.5 ml Folin-ciocalteau reagent and 2 ml of 20% Na_2CO_3 were added in each tube. A blue color was developed due to the complex redox reaction with phosphomolibdic acid in folin ciocalteau reagent. The test solutions were warm for 1 minute, cooled and absorbance was measured at 650 nm. The concentration of total phenol was measured equivalent to catechol (mg catechol equivalent of phenol/g of sample) by using standard calibration curve of catechol.

Estimation of Total Flavonoid Contents

The total flavonoid contents were determined by aluminum chloride colorimetric method (Chang *et al.*,

2002). The assay was performed using 0.5ml of plant extract. To each test tube 1.5ml methanol, 0.1ml aluminium chloride solution, 0.1 ml potassium acetate solution and 2.8 ml distilled water added and mixed well, then kept for 30 min and measure the absorbance at 415 nm against the suitable blank (all reagents except aluminium chloride). The concentration of total flavonoid contents of the sample was measured equivalent to quercetin by using standard calibration curve of quercetin.

Determination of Total Tannin Contents

Total tannin contents were determined by Folin-Denis method (Schanderi *et al*., 1970). 0.5 g of powder was boiled for 30 min with 75 ml of double distilled water. It was cooled, centrifuged at 2000 rpm for 20 min and supernatant was collected in 100 ml volumetric flask and the volume was made up with double distilled water. 1 ml of this solution was transferred to a 100 ml volumetric flask containing 75 ml water and 5 ml Folin-Denis reagent + 10 ml of sodium carbonate solution were added and diluted up to 100 ml with water. After shaking, the absorbance was measured at 700 nm after 30 min. Total tannin content of the sample was measured equivalent to tannic acid by using standard calibration curve of tannic acid.

Chlorophyll Assay

Chlorophyll content was estimated through the method developed by (Rangana, 1976). 1 g finely cut and well mixed sample of leaf or fruit tissues was made to a fine pulp with the addition of 20 ml of 80% acetone. Centrifuged (5000 rpm for 5 min) and the supernatant were transferred to a 100 ml volumetric flask. The residue was grinded with 20 ml of 80% acetone, centrifuged and transferred the supernatant to the same volumetric flask. This process was repeated until the residue is colorless. The clear washings were collected in the volumetric flask and volume was made to 100 ml with 80% acetone. Thus chlorophyll was extracted in 80% acetone and absorption at 663 nm and 645 nm were read in a spectrophotometer. Using the absorption coefficients, the amount of chlorophyll was calculated.

Anti Oxidant Assay

The DPPH (2, 2-diphenyl-1-picrylhydrazyl) method was used for estimating free radical scavenging activity of the methanol extracts of samples. 2 ml of methanol extract (4 mg/ml) taken in test tube and final volume of 3 ml was made with methanol. The absorbance of the mixture was measured after 40 min at 517 nm against methanol as blank. Ascorbic acid was used as standard. The free radical scavenging activities (%) of tested samples were evaluated by comparing with a control (2 ml DPPH and 1 ml of methanol). Each sample was then measured in triplicate and averaged. The free radical scavenging activity (FRSA) was calculated using the formula: FRSA= [(Ac-At)/Ac-As] x 100, where Ac=Absorbance of control, As=Absorbance of standard and At = Absorbance of test. IC_{50} value = (conc. of test/ FRSA nearest to the 50%) × 50

ABTS Method

The Total Antioxidant Activity was determined according to the method given by (Re R et al; 1999). ABTS Reacts With Potassium Persulphate to Produce ABTS Radical Cation ($ABTS^{\bullet+}$), a blue green chromogen with absorption maxima at 734 nm. The extent of decolorization is a significant indicator of antioxidant activity of the sample. The effects of antioxidants on $ABTS^{\bullet+}$ radical cation is due to its hydrogen donating availability which is observed by a change in color radical cation ($ABTS^{\bullet+}$) to colorless ABTS. The percentage of inhibition of $ABTS^{\bullet+}$radicals at different concentrations were determined using the following formulae and further ic_{50} value was calculated:

FRSA (%) = [(Ac-At)/Ac] ×100, Where, Ac = Absorbance Of Control, At = Absorbance Of Test.

IC_{50} value = (conc. of test/ FRSA nearest to the 50%) × 50

Reducing Power Assay

The reducing ability was estimated by the earlier reported method (Maruthamuthu and Kandasamy 2016). The compounds having antioxidant activity form a potassium Ferrocyanide complex by reacting with potassium ferricyanide. Further with ferric trichloride, it produces a blue colored ferric ferrocyanide complex at 700nm. In brief, different aliquots of extracts mixed with the phosphate buffer (6.6 pH) and 2.5 ml of $K_3 Fe(CN)_6$ and then incubated for 20 min at 50°C. After the incubation, 2.5 ml of 10% trichloroacetic acid added to the above mixture and centrifuged for 10 min. 2.5 ml of supernatant mixed with 2.5 ml of distilled water and 0.5 ml of 0.1 % $FeCl_3$ solution and then measured the absorbance at 700 nm. EC_{50} value (mg/ml) was calculated to measure the reducing ability of the sample.

Statistical Analysis

The results were represented as Mean ± Standard Deviation (n=3). The results were interpreted using One-way analysis of variance (ANOVA) and Duncan's test at 0.05 probability levels by SPSS 16.0 Software. The

difference between the means (P<0.05) was consider to be significant (Table 1, 2, 3 and Figure 1, 2, 3, 4).

RESULTS

Yield and Its Yield Attributing Traits

The analysis of variance revealed that there were significant differences in all the parameters studied in this experiment. Data revealed from Table 1 that 50% flowering occurred in genotype 18/GEP/VAR5 in 110.66 days, which is significantly different from others. Genotype 18/GEP/VAR6 took maximum time in 50% flowering (116.33 days). Genotype 18/GEP/VAR5 took minimum 116.33 days to pod setting while genotype 18/GEP/VAR4 took maximum days in pod setting (127.33). Number of pods per plant ranged from 19.33 to 28.23. Variety 18/GEP/VAR2 had maximum number of pods per plant (28.23) followed by 18/GEP/VAR1 (25.66). Genotype 18/GEP/VAR2 gave maximum yield 145.00 q/ha fresh marketable yield followed by 18/GEP/ VAR1 (140.0 q/ha) and 18/GEP/ VAR6 (112.0 q/ha). Maximum pod length was exhibited by 18/GEP/ VAR5 (11.13cm) followed by 18/GEP/ VAR4 (10.63cm) and 18/GEP/ VAR6 (9.63cm). Variety 18/GEP/ VAR8 showed maximum fruit width (5.20cm) followed by 18/GEP/ VAR1 (4.70cm) and 18/GEP/ VAR4 (4.60cm).

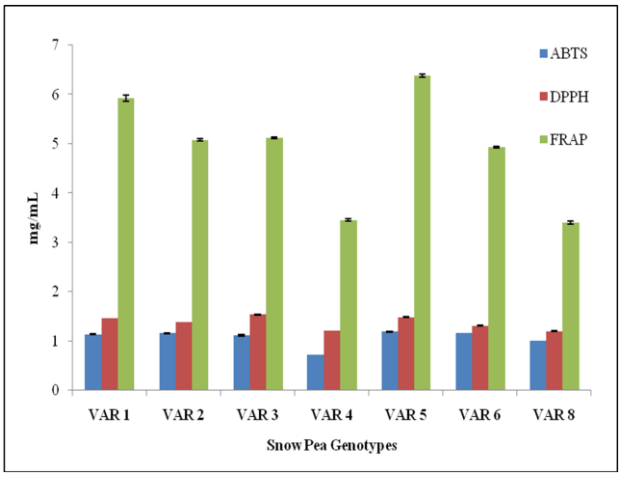

Figure 1 Antioxidant Activity of aqueous extracts of Snow Peas Genotypes by ABTS, DPPH and FRAP methods.

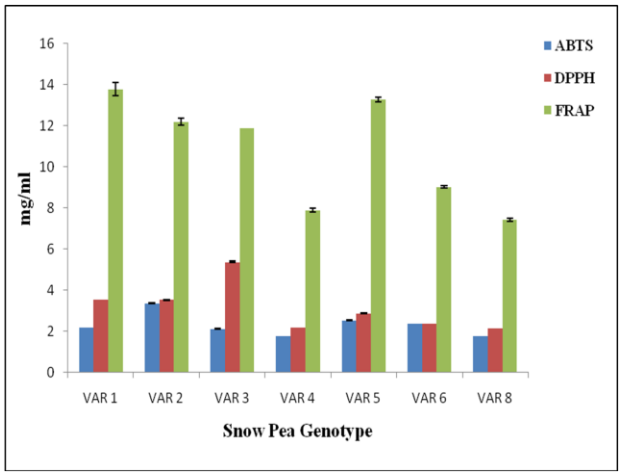

Figure 2 Antioxidant Activity of alcoholic extracts of Snow Peas Genotypes by ABTS, DPPH and FRAP methods.

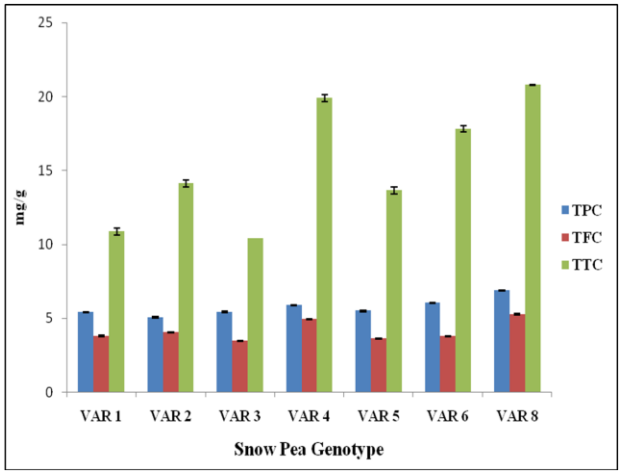

Figure 3 Antioxidant constituents of aqueous extracts of Snow Peas Genotypes.

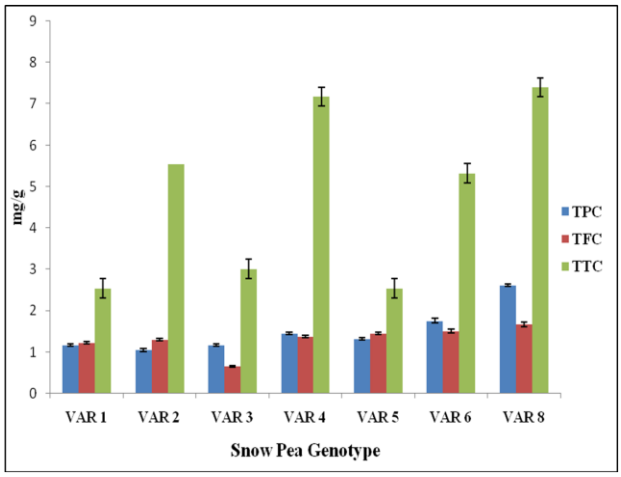

Figure 4 Antioxidant constituents of alcoholic extracts of Snow Peas Genotypes.

Table 1: Yield Parameters in Snow Peas Genotypes

Sn	Varieties	Days to 50% Flowering	Days to Pod Setting	Number of Pods Per Plant	100 Pod Weight (g)	Pod Length (cm)	Pod Width (cm)	Yield (Kg/Plot)	Yield (q/ha)	Yield (q/acre =20 Nali)
1.	18/GEP/ VAR1	114.33 ±0.577 c	125.32 ±0.577 c	25.66 ±0.577 b	280 ±0.00 b	7.20 ±0.200 e	4.70 ±0.100 b	8.416 ±0.261 c	140.00	56.00
2.	18/GEP/ VAR2	113.67 ±0.577 c	123.66 ±0.577 b	28.33 ±0.577 a	310 ±2.00 a	9.00 ±0.200 d	4.20 ±0.00 d,e	8.700 ±0.230 c	145.00	58.00
3.	18/GEP/ VAR3	112.35 ±0.577 b	123.35 ±0.577 b	21.66 ±0.577 d	265 ±1.00 d	8.93 ±0.351 d	4.40 ±0.200 c,d	6.400 ±0.234 b	106.00	42.40
4.	18/GEP/ VAR4	115.67 ±0.577 d	127.33 ±0.577 d	23.33 ±0.577 c	270 ±2.00 c	10.63 ±0.152 b	4.60 ±0.00 b,c	6.708 ±0.362 b	111.00	44.40
5.	18/GEP/ VAR5	110.66 ±0.577 a	116.33 ±0.577 a	19.33 ±0.577 e	250 ±1.00 g	11.13 ±0.305 a	4.00 ±0.200 e	4.320 ±0.0700 a	72.00	28.80
6	18/GEP/ VAR6	116.33 ±0.577 d	125.35 ±0.577 c	24.33 ±0.577 c	258 ±2.00 e	9.63 ±0.152 c	4.00 ±0.00 e	6.740 ±0.140 b	112.00	44.80
7	18/GEP/ VAR8	112.00 ±0.00 b	122.67 ±0.577 b	21.34 ±0.577 d	255 ±1.00 f	10.23 ±0.251 b	5.20 ±0.200 a	4.843 ±0.401 a	80.00	32.00

*Value are expressed as Mean±SD (n=3), different alphabets represents the significant difference among the Snow pea genotypes (Duncan's test at P >0.05)

Antioxidant Constituents

In edible podded pea varieties ascorbic acid (mg/100g) contents ranged from 43.00 to 71.60. The genotype 18/GEP/VAR8 exhibited maximum ascorbic acid contents (71.60mg/100g) followed by 18/GEP/ VAR4 (70.00 mg/100g) and18/GEP/VAR6 (68.00mg/100g). 18/GEP/ VAR2 showed minimum ascorbic acid (43.00 mg/100g). Except 18/GEP/ VAR2 and 18/GEP/ VAR3, all were found to be an excellent source of ascorbic acid and fulfilled more than 100% RDA values for vitamin 'C' (Table 2).

Table 2 Antioxidant Constituents of Snow Peas Genotypes

Genotype	Ascorbic Acid (mg/100g)	Vitamin C (% RDA)	Total Chlorophyll (mg/100g)	Tannins (mg/g)		Flavonoids (mg/g)		Phenolics (mg/g)	
				Aqueous	Alcoholic	Aqueous	Alcoholic	Aqueous	Alcoholic
18/GEP / VAR1	60.00 ±1.0 d	100.0	0. 098 ±0.002 e	10.87 ±0.404 e	3.00 ±0.404 c	3.80 ±0.092 d	1.22 ±0.046 d	5.40 ±0.051 d	1.17 ±0.051 e
18/GEP / VAR2	43.00 ±2.0 f	71.60	0. 096 ±0.004 e	14.11 ±0.404 d	5.55 ±0.000 b	4.03 ±0.046 c	1.29 ±0.040 d,e	5.06 ±0.051 e	1.04 ±0.057 f
18/GEP / VAR3	58.00 ±3.0 e	96.70	0.125 ±0.000 c	10.41 ±0.000 e	2.54 ±0.398 c	3.46 ±0.046 f	0.65 ±0.045 f	5.43 ±0.051 d	1.17 ±0.051 e
18/GEP / VAR4	70.00 ±2.0 a	116.66	0.138 ±0.002 b	19.90 ±0.398 b	7.17 ±0.398 a	4.94 ±0.046 b	1.37 ±0.046 c,d	5.89 ±0.051 c	1.44 ±0.057 c
18/GEP / VAR5	63.00 ±4.0 c	105.00	0.174 ±0.003 a	13.65 ±0.398 d	2.54 ±0.398 c	3.61 ±0.046 e	1.45 ±0.046 b,c	5.49 ±0.103 d	1.32 ±0.051 d
18/GEP / VAR6	68.00 ±1.73 b	113.30	0.123 ±0.001 c	17.82 ±0.398 c	5.32 ±0.398 b	3.77 ±0.046 d	1.50 ±0.092 b	6.05 ±0.051 b	1.75 ±0.095 b
18/GEP / VAR8	71.60 ±0.577 a	119.33	0.115 ±0.002 d	20.79 ±0.057 a	7.40 ±0.398 a	5.26 ±0.086 a	1.67 ±0.092 a	6.88 ±0.051 a	2.62 ±0.051 a

*Value are expressed as Mean±SD (n=3), different alphabets represents the significant difference among the Snow pea genotypes (Duncan's test at P >0.05)

Total chlorophyll (mg/100g) ranged from 0.096 to 0.174. The variety 18/GEP/ VAR5 exhibited maximum chlorophyll content (0.174mg/100g) followed by 18/GEP/ VAR4 (0.138mg/100g) and further followed by 18/GEP/ VAR3 (0.125mg/100g). The genotype 18/GEP/VAR2 exhibited minimum amount of chlorophyll content (0.096 mg/100g). The tannin contents in aqueous extract ranged from 10.41 mg to 20.79 mg/g, while in the alcoholic extract, it varied from 2.54 to 7.40 mg/g. Maximum tannin contents was exhibited by genotype 18/GEP/ VAR8 in both aqueous (20.79 mg/g) and (7.40mg/g) in alcoholic extract followed by genotype 18/GEP/ VAR4

(19.90 mg/g) and (7.17mg/g) respectively and further followed by in genotype 18/GEP/ VAR6 in aqueous (17.82 mg/g) and alcoholic extract (5.32mg/g). In genotype 18/GEP/ VAR3 minimum tannin contents were found (10.41 mg/g) in aqueous extract and (2.54mg/g) in alcoholic extract.

The flavonoid contents in edible podded pea genotype varied from 3.46 to 5.26 mg/g in aqueous extract and 0.65 to 1.67 mg/g in alcoholic extract. Maximum flavonoid contents were found in the genotype 18/GEP/ VAR8 (5.26mg/g) in aqueous and (1.67mg/g) alcoholic extract followed by genotype 18/GEP/ VAR4 (4.49 mg/g) in aqueous and (1.37mg/g) alcoholic extract. In the genotype 18/GEP/ VAR3 minimum tannin contents were found in aqueous (3.46 mg/g) and in alcoholic extract (0.65mg/g).

In edible podded pea varieties, total phenolic contents ranged from 5.06 to 6.88 mg/g in aqueous extract and 1.04 to 2.62 mg/g in alcoholic extract. The genotype 18/GEP/VAR8 exhibited maximum flavonoid contents (6.88mg/g) in aqueous and (2.62mg/g) in alcoholic extract followed by (6.05mg/g) and (1.75mg/g) respectively in the genotype 18/GEP/ VAR6. Minimum tannin contents were exhibited (5.06 mg/g) in aqueous and (1.04mg/g) in alcoholic extract by the genotype 18/GEP/ VAR2.**)**

Anti-oxidant activity using DPPH, ABTS and Ferric Reducing Antioxidative Power (FRAP)

It is evident from the table 3 that anti-oxidant method i.e. Inhibition concentration 50 (IC_{50}) was varied 1.205 to 1.537 mg/ml in aqueous extract and 2.146 to 5.373 mg/ml in alcoholic extract in different pea genotypes by DPPH method. Lowest IC_{50} value i.e. highest anti-oxidant activity was found (IC_{50} 1.205 mg/ml) in aqueous extract and (2.146 mg/ml) in alcoholic extract in the genotype 18/GEP/ VAR8 followed by (1.212 mg/ml) and (2.186 mg/ml) respectively in the genotype 18/GEP/ VAR4. While, lowest antioxidant activity was found (IC_{50} 1.537 mg/ml) in aqueous extract and (5.373 mg/ml) in alcoholic extract in the genotype 18/GEP/ VAR3.

Table 3: Antioxidant Activity of Snow Peas Genotypes

Genotypes	ABTS (IC_{50}= mg/ml)		DPPH ($IC_{50=}$ mg/ ml)		FRAP (EC_{50}= mg/ml)	
	Aqueous	**Alcoholic**	**Aqueous**	**Alcoholic**	**Aqueous**	**Alcoholic**
18/GEP/ VAR1	1.135 ± 0.012 c	2.186 ± 0.010 c	1.465 ± 0.005 d	3.565 ± 0.006 d	5.92 ± 0.106 d	13.27 ± 0.572 d
18/GEP/ VAR2	1.159 ± 0.005 d	3.370 ± 0.032 f	1.389 ± 0.001 c	3.533 ± 0.030 d	5.08 ± 0.028 c	12.19 ± 0.300 c
18/GEP/ VAR3	1.112 ± 0.031 c	2.126 ± 0.008 b	1.537 ± 0.004 f	5.373 ± 0.065 e	5.11 ± 0.028 c	11.90 ± 0.00 c
18/GEP/ VAR4	1.006 ± 0.008 b	1.778 ± 0.010 a	1.212 ± 0.006 a	2.186 ± 0.013 a	3.46 ± 0.036 a	07.89 ± 0.144 a
18/GEP/ VAR5	1.190 ± 0.006 e	2.537 ± 0.038 e	1.484 ± 0.008 e	2.879 ± 0.016 c	6.38 ± 0.051 e	13.77 ± 0.207 e
18/GEP/ VAR6	1.169 ± 0.003 d	2.370 ± 0.018 d	1.315 ± 0.002 b	2.388 ± 0.006 b	4.93 ± 0.028 b	9.03 ± 0.0981 b
18/GEP/ VAR8	0.719 ± 0.005 a	1.772 ± 0.012 a	1.205 ± 0.013 a	2.146 ± 0.011 a	3.40 ± 0.057 a	07.42 ± 0.127 a

*Value are expressed as Mean±SD (n=3), different alphabets represents the significant difference among the Snow pea genotypes (Duncan's test at P >0.05)

By ABTS method, IC_{50} was ranged from 0.719 to 1.190 mg/ml in aqueous extract and 1.772 to 3.370 mg/ml in alcoholic extract in different pea genotypes. The highest anti-oxidant activity (IC_{50} 0.719 mg/ml) was found in aqueous extract and (1.772 mg/ml) in alcoholic extract in the Genotype 18/GEP/VAR8 followed by (1.006 mg/ml) and (1.778 mg/ml) respectively in the Genotype 18/GEP/VAR4. While, lowest anti-oxidant activity was found (IC_{50} 1.190 mg/ml) in aqueous extract of Genotype 18/GEP/VAR5 and (3.370 mg/ml) in alcoholic extract in the Genotype 18/GEP/VAR2.

EC_{50} was ranged from 3.40 to 6.38 mg/ml in aqueous extract and 7.42 to 13.77 mg/ml in alcoholic extract in snow pea genotypes by FRAP method. The highest anti-oxidant activity (EC_{50} 3.40 mg/ml) was found in aqueous extract and (7.42 mg/ml) in alcoholic extract in the genotype 18/GEP/ VAR8 followed by (3.46 mg/ml) and (7.89 mg/ml) respectively in the genotype 18/GEP/ VAR4. While, lowest anti-oxidant activity was found (EC_{50} 6.38 mg/ml) in aqueous extract and (13.77 mg/ml) in alcoholic extract in the genotype 18/GEP/ VAR5.

DISCUSSION

In the present study, seven genotypes were evaluated for yield and its yield attributing traits. Genotype 18/GEP/ VAR2 followed by 18/GEP/VAR1 and 18/GEP/ VAR6 were found promising in respect of yield and its yield attributing traits. Field evaluation of Snow Pea varieties was also studied by previous workers Thakur *et al;* (2015), Islam *et al;* (2002), Antonio *et al;* (2005) and Paul *et al;* (2004). Snow Pea can be an alternative crop for marginal farmers of hills owing to the short gestation period, high yield and nutritional quality (Kahn and Nelson, 1991). Farmers can get a better remuneration by growing this crop. Evaluation of edible podded pea cultivars for horticultural traits was also studied by De Ron *et al*., 2005. For ascorbic acid content, genotype 18/GEP/ VAR8 was found promising followed by 18/GEP/VAR4. The ascorbic acid content of the legume seeds were studied by Moriyama *et al;* 2008. The genotype 18/GEP/VAR5 total chlorophyll content was found promising highest followed by 18/GEP/VAR4. The genotype 18/GEP/ VAR8 was found best for tannins, flavonoids and phenolics followed by the 18/GEP/VAR4 than the other varieties in both aqueous and alcoholic extracts. The evaluation of isoflavone contents in vegetable soybean was also done by Mebrahtu *et al;* 2004.

The anti-oxidant activity by ABTS and DPPH and FRAP methods was found maximum in the genotype18/GEP/VAR8 having lowest IC_{50} and EC_{50} values in both aqueous and alcoholic solution followed by the genotype18/GEP/ VAR4. Evaluation of antioxidant activity in different vegetables was also studied by Saha *et al;* 2014, Turkmen *et al;* 2014, Ismail *et al;* 2009, Nilsson *et al;* 2004, Kumar *et al;* 2014.

CONCLUSION

Among these seven edible podded pea cultivars Genotype 18/GEP/ VAR2 and 18/GEP/ VAR1 and 18/GEP/ VAR6 were found superior in yield and its yield attributing traits. The genotype 18/GEP/ VAR8 exhibited highest ascorbic acid, tannins, flavonoid, and phenolics contents followed by the genotype 18/GEP/ VAR4. The genotype 18/GEP/ VAR8 also exhibited highest antioxidant potential among the other genotypes. Hence, these promising genotypes can be used for further studies/ breeding programmes for improving the present day cultivars. Increase its production through quality genotypes for global nutritional security is the need of the hour. Since, edible podded pea cultivars is a new vegetable for hills of Uttarakhand so farmers can get a better remuneration by growing this type of vegetable crop.

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