



## Research Article

# EFFECT OF ENVIRONMENTAL CONDITIONS AND VARIETIES ON QUALITY PARAMETERS OF SPROUTING BROCCOLI (*Brassica oleracea* VAR. *ITALICA* L.)

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**Abstract-** The experiment was performed at the Research field of Department of Vegetable Science, College of Horticulture, Mandsaur, (M.P.) during rabi 2014-15. The experiment was laid out in a Factorial Randomized Block Design having two environmental conditions viz, open field and naturally ventilated polyhouse with six varieties i.e. Palam Haritika, Palam Kanchan, Palam Samridhi, Palam Vichitra, MSB-12 and Ganesh with three replications. Quality attributes like protein content and ascorbic acid was found maximum in case of variety Ganesh, dry matter content in case of Palam Samridhi, total sugar and non reducing sugar in case of Palam Kanchan whereas reducing sugar in case of Palam Haritika. Among environmental conditions, naturally ventilated polyhouse was found best for quality attributes except dry matter content as compared to open field. Interaction effect of varieties with environmental conditions was significant for all the characters. Variety Ganesh under polyhouse condition was found best treatment combination with respect to total chlorophyll, protein and ascorbic acid content

**Keywords-** Sprouting broccoli, Environmental condition, Polyhouse, Open field, Varieties

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## Introduction

Sprouting broccoli is one of the important members of the cole group of vegetables and is considered to be the first to originate from wild cabbage *Brassica oleracea* var. *oleracea* (syn. *sylvestris*) which is found growing wild along the Mediterranean Sea. It possesses both antioxidant and anti carcinogenic properties and dietary intake of such food provides effective support for the building of strong defensive system of body. Sprouting broccoli is a highly nutritious, rich in vitamins and minerals. It is fairly high in vitamin 'A' and ascorbic acid and contains good amount of thiamin, riboflavin, niacin and minerals like calcium and iron. Besides anti carcinogenic properties, broccoli has about 130 times more Vitamin 'A' content than cauliflower and 22 times more than cabbage. It is also a rich source of sulphoraphane, a compound associated with reducing the risk of cancer. The curd of broccoli contains following nutrients per 100 g of edible portion; moisture 89.9 g, carbohydrates 5.5g, fat 0.2g, protein 3.3g, vitamin A 3500 IU, thiamine 0.05 mg, riboflavin 0.12 mg, phosphorous 79 mg, calcium 80 mg, iron 0.8 mg, ascorbic acid 137 mg and calories 37 g [9].

Sprouting broccoli is a cool-season crop. Sprouting broccoli is very sensitive to high temperature, which causes the heads to be distorted and unevenly-sized flower buds on inflorescence, making it a high-risk crop [1]. Different cultivars have different quality parameters varying with growing conditions [11]. Open field cultivation is often affected with sudden adverse changes in weather conditions. Whereas natural ventilated polyhouses provides protection from such conditions. Therefore, the present study was planned to evaluate the biochemical parameters of dietary significance in the heads of the prominent sprouting broccoli cultivars grown under open field and naturally ventilated polyhouse condition.

## Materials and Methods

The investigation was carried out at the Research Field of the Department of Vegetable Science, College of Horticulture, Mandsaur, (M.P.), during 2014-15. The experiment was laid out in a Factorial Randomized Block Design having two environmental conditions viz, Open field (E<sub>1</sub>) and naturally ventilated polyhouse (E<sub>2</sub>) with six varieties i.e. Palam Haritika (V<sub>1</sub>), Palam Kanchan (V<sub>2</sub>), Palam Samridhi (V<sub>3</sub>), Palam Vichitra (V<sub>4</sub>), MSB-12 (V<sub>5</sub>) and Ganesh (V<sub>6</sub>) with three replications. The seeds were sown in raised beds on 4<sup>th</sup> Sep 2014. One month old seedlings were transplanted at spacing of 50cm×45 cm. Fertilizer was applied at the rate of 100 kg N, 80 kg P<sub>2</sub>O<sub>5</sub> and 60 kg K<sub>2</sub>O/ha. Optimum soil moisture was maintained in the open field and naturally ventilated polyhouse through drip irrigation system. Regular cultural practices, crop protection measures were adopted as per the requirement of crops in both environmental conditions.

The data were recorded on 5 randomly selected curds in each plot and their mean values were worked out. Dry matter content was determined by hot air oven drying method and fiber content was determined by the method given by [7]. Total chlorophyll content was estimated in the edible portion of fresh heads by following the method given by [6]. The protein content in sprouting broccoli curd was estimated by following the method of Lowry's [7]. Sugar was estimated by following the method of Lane and Eynon given by [6]. The principle of method was the copper in Fehling's solution reduces to red, insoluble cuprous oxide due to presence of invert sugar. Ascorbic acid was estimated following the procedure 2, 6-dichlorophenolindophenol titration method described by Rangana, [6]. The data were analysed statistically as per the procedure described by Panse and Sukhatme, [5].

## Results and Discussion

The findings [Table-1] of the present experiment revealed significant effect of

varieties on dry matter content in curd. Among the varieties, maximum dry matter content (12.14%) was determined with Palam Samridhi. Minimum dry matter content (8.50%) was noted with variety Palam Kanchan. These findings are in agreement with [4 & 3]. Environmental condition had exhibited significant effect on dry matter content in sprouting broccoli. Highest dry matter content (11.03%) was

recorded in open field. It was significantly higher than polyhouse condition. Similar results were obtained by [8] in sweet pepper. Among the treatment combinations [Table-2], E<sub>1</sub>V<sub>6</sub> had highest dry matter content while E<sub>2</sub>V<sub>4</sub> had recorded lowest dry matter content.

**Table-1** Effect of varieties and environmental conditions on quality attributes of sprouting broccoli

Treatment Varieties (V)	Dry matter content (%)	Fiber content (mg/g)	Total chlorophyll (mg/g)	Protein (mg/100g)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)	Ascorbic acid (mg/100g)
V <sub>1</sub>	9.92	194.00	0.408	244.50	1.72	1.35	0.37	70.00
V <sub>2</sub>	8.50	167.17	0.337	195.67	2.91	2.38	0.54	49.00
V <sub>3</sub>	12.14	124.00	0.400	292.50	2.81	2.36	0.46	85.50
V <sub>4</sub>	8.98	169.50	0.278	338.67	2.09	1.66	0.43	40.00
V <sub>5</sub>	10.16	119.17	0.450	400.83	1.94	1.61	0.33	74.33
V <sub>6</sub>	12.07	127.33	0.520	557.83	2.23	1.72	0.51	91.50
SEm ±	0.17	2.90	0.007	2.89	0.04	0.04	0.01	1.27
CD(P=0.05)	0.48	8.03	0.026	8.02	0.11	0.10	0.04	3.53
Environmental condition (E)								
E <sub>1</sub>	11.03	163.11	0.365	288.28	2.03	1.63	0.40	62.78
E <sub>2</sub>	9.56	137.28	0.433	388.39	2.54	2.07	0.47	74.00
SEm ±	0.10	1.67	0.004	1.67	0.02	0.02	0.01	0.73
CD(P=0.05)	0.28	4.64	0.015	4.63	0.06	0.06	0.02	2.04

**Table-2** Combined effect of varieties and environmental condition on quality characters of sprouting broccoli

Treatment	Dry matter content (%)	Fiber content (mg/g)	Total chlorophyll (mg/g)	Protein (mg/100g)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)	Ascorbic acid (mg/100g)
E <sub>1</sub> V <sub>1</sub>	10.90	203.67	0.360	145.67	1.55	1.27	0.28	63.33
E <sub>1</sub> V <sub>2</sub>	8.83	181.33	0.300	135.00	2.75	2.22	0.53	43.33
E <sub>1</sub> V <sub>3</sub>	12.48	138.67	0.313	267.67	2.29	1.90	0.39	76.00
E <sub>1</sub> V <sub>4</sub>	10.47	193.00	0.253	345.67	2.11	1.63	0.49	35.33
E <sub>1</sub> V <sub>5</sub>	10.94	124.67	0.447	297.33	1.56	1.30	0.26	72.00
E <sub>1</sub> V <sub>6</sub>	12.54	137.33	0.517	538.33	1.93	1.45	0.49	86.67
E <sub>2</sub> V <sub>1</sub>	8.93	184.33	0.457	343.33	1.89	1.43	0.46	76.67
E <sub>2</sub> V <sub>2</sub>	8.17	153.00	0.373	256.33	3.08	2.53	0.55	54.67
E <sub>2</sub> V <sub>3</sub>	11.81	109.33	0.487	317.33	3.34	2.81	0.52	95.00
E <sub>2</sub> V <sub>4</sub>	7.50	146.00	0.303	331.67	2.07	1.70	0.37	44.67
E <sub>2</sub> V <sub>5</sub>	9.37	113.67	0.453	504.33	2.32	1.92	0.40	76.67
E <sub>2</sub> V <sub>6</sub>	11.61	117.33	0.523	577.33	2.53	2.00	0.53	96.33
SEm ±	0.25	4.10	0.010	4.09	0.05	0.05	0.01	1.80
CD(P=0.05)	0.68	11.36	0.037	11.35	0.15	0.15	0.05	4.99

Fiber content in broccoli was recorded on fresh weight basis. Variety Palam Haritika had recorded maximum fiber content (194 mg/g). Minimum fiber content (119 mg/g) was recorded in case of variety MSB-12. Open field condition had showed significantly higher fiber content over polyhouse. Highest fiber content was found with E<sub>1</sub>V<sub>1</sub> which was at par to E<sub>1</sub>V<sub>4</sub>. Rest of the combinations had significantly lower fiber content. Minimum fiber content was recorded with E<sub>2</sub>V<sub>3</sub>. Variety Ganesh registered maximum total chlorophyll (0.520 mg/g) content, which was higher than all other varieties. Minimum total chlorophyll content (0.278 mg/g) was observed in case of variety Palam Vichitra. The study further indicated that dark green varieties of broccoli exhibited significantly higher values for total chlorophyll than grey-green or violet types. Similar results have been also reported by [3, 2, 10 & 11]. Highest total chlorophyll content (0.433 mg/g) was found in polyhouse condition. It was significantly superior over open field condition, which had recorded minimum chlorophyll content. These results are in agreements with the findings of [11] who reported higher total chlorophyll content in polyhouse grown plants. Treatment combinations, E<sub>2</sub>V<sub>6</sub> had highest total chlorophyll content while E<sub>1</sub>V<sub>2</sub> had lowest value of total chlorophyll. Treatment combination E<sub>1</sub>V<sub>6</sub> and E<sub>2</sub>V<sub>6</sub> were at par.

Vegetable proteins are of vital importance to living organisms, as these constitute an important component of tissues and body fluids imparting structural, regulatory and immune functions. As such, the status of protein content in the broccoli varieties was evaluated. The protein content of broccoli curd was estimated on fresh weight basis. Among the varieties, maximum protein content (557.83 mg/100g) was recorded with variety Ganesh. Minimum protein content (195.67 mg/100g) was found in case of variety Palam Kanchan. Similar findings have been found by [3 & 2]. Highest protein content (388.39 mg/100g) was found under polyhouse condition. It was significantly superior over open field condition.

Treatment combination E<sub>2</sub>V<sub>6</sub> had highest protein content, which was significantly superior over other combinations. Treatment E<sub>1</sub>V<sub>2</sub> had lowest protein content. Maximum total sugar content (2.91%) was determined with Palam Kanchan. Minimum total sugar content (1.72%) was noted with variety Palam Haritika. These findings are corroborated by [10 & 11]. Highest total sugar content (2.54%) was found in polyhouse. It was significantly higher than open field condition. These results are in agreement with [11]. Among the treatment combinations, E<sub>2</sub>V<sub>3</sub> had highest total sugar content while E<sub>1</sub>V<sub>1</sub> had registered lowest total sugar content in sprouting broccoli curd.

Variety Palam Kanchan had recorded maximum reducing sugar (2.38%). Minimum reducing sugar (1.35%) was determined in variety Palam Haritika. Similar results were obtained by [10 & 11]. Highest reducing sugar (2.07%) was recorded under polyhouse. Minimum reducing sugar content was found under open environmental condition. Similar findings were obtained by [11]. Highest reducing sugar was recorded with E<sub>2</sub>V<sub>3</sub>. Minimum reducing sugar was estimated with E<sub>1</sub>V<sub>5</sub>.

Variety Palam Kanchan registered maximum non reducing sugar (0.554%) which was higher than all other varieties. Minimum non reducing sugar (0.33%) was observed in case of variety MSB-12. These findings are in line with [10 & 11]. Highest non reducing sugar was found under polyhouse environment condition. These results have parity with [11]. Among the treatment combinations E<sub>2</sub>V<sub>2</sub> had highest non reducing sugar while E<sub>1</sub>V<sub>5</sub> had lowest value of non reducing sugar.

Among the varieties, maximum ascorbic acid (91.50 mg/100g) was determined with Ganesh. Minimum ascorbic acid content (40.00 mg/100g) was noted in variety Palam Vichitra. These results have parity with [2, 3, 4 & 10]. Highest ascorbic acid (74.00 mg/100g) was recorded under polyhouse. It was significantly

higher than open field condition. Among the treatment combinations, E<sub>2</sub>V<sub>6</sub> had highest ascorbic acid while E<sub>1</sub>V<sub>4</sub> had lowest ascorbic acid content.

## Conclusion

From the findings of the present investigation, it may be inferred that naturally ventilated polyhouse was superior as compared to open field for quality attributes except dry matter and fiber content in sprouting broccoli. Quality attributes like protein content and ascorbic acid was found maximum in case of variety Ganesh, dry matter content with Palam Samridhi, fiber content in case of MSB-12, total sugar and non reducing sugar in case of Palam Kanchan and reducing sugar in case of Palam Haritika. Interaction effect of varieties with environmental conditions was significant for all the parameters.

**Conflict of Interest: None declared**

## References

- [1] Bjorkman Thomas and Pearson Karen J. (1998) *J. Exp. Bot.*, 49(318), 101-106.
- [2] Dogra Diksha and Awasthi C.P. (2009) *Indian J. Agric. Biochem.*, 22 (1), 45-50.
- [3] Gautam Vishal, Sharma Bindu, Mahajan Anil and Sharma Susheel (2005). *J. Res., SKUAST-J.*, 4(2), 175-178.
- [4] Koh E., Wimalasiri K. M.S., Chassy A.W. and Mitchell A.E. (2009) *J. Food Comp. Anal.*, 22, 637-643.
- [5] Panse V.G. and Sukhatme P.V. (1985) *Statistical Methods for Agricultural Workers. Fourth edition. ICAR Publication, New Delhi.* p.347.
- [6] Rangana S. (1977) *Manual for analysis of fruit and vegetable products. Tata McGraw Co. Pvt. Ltd., New Delhi*
- [7] Saini R.S., Sharma K.D., Dhankhar O.P. and Kaushik R.A. (2006) *Laboratory manual of analytical techniques in horticulture. Agrobios (India).* pp. 5- 28.
- [8] Singh K.G., Singh Angrej and Mahajan Gulshan (2010) *Indian J. Agri. Sci.*, 80(5), 82-84
- [9] Singh D.N. and Nath Vishal (2012) *Winter Vegetables: Advances and Developments. Satish Publishing House, Delhi (India).* p. 360.
- [10] Thapa U. and Rai R. (2012) *Int. J. Agric. Sci.*, 4(7), 284-286.
- [11] Thapa Umesh, Rai Rashmi, Lyngdoh Yvonne Angel, Chattopadhyay Sankhendu Bikash and Prasad Param Hans. (2013) *Afr. J. Agric. Res.*, 8(15), 1315-1318.