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Sugars and pungency of different day length adapted onions (*Allium cepa* L.) grown in long day temperate climate of Kashmir valley

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Abstract
Sugar content and pungency are traits of critical importance for onion bulb quality. These traits were estimated as reducing sugars, non-reducing sugars and pyruvic acid in different photoperiod and temperature sensitive genotypes grown in long day, temperate agroclimate. Reducing sugars varied from 2.26% to 3.79%, non-reducing sugars from 2.97% to 4.29% and pyruvic acid from 1.73 to 11.33 µmol/ g fresh weight. The lowest reducing sugar content (2.26%) was found in OA-18-09 and OC-18-89 and about two-third of the germplasm (2.28% to 2.94%) was at par with them. Highest non-reducing sugar content (4.29%) was found in OA-18-27 with about two-third of the germplasm (3.41% to 4.42%) statistically at par with it. For pyruvic acid content (µmol/g fresh weight), significantly higher values were found in OB-18-58 (11.33) and OB-18-53 (10.48). The lowest content (1.73) was found in OC-18-75 with nine other entries at par.

Keywords: Onion, reducing sugars, non-reducing sugars, pyruvic acid

Introduction

Onion is a bulbous biennial plant grown as an annual for its underground bulbs, which are botanically a modification of leaves. It belongs to family Alliaceae and has shallow roots and hollow leaves that are arranged in a distichous phyllotaxy (two-ranked leaf arrangement). The general nutritional composition of onion includes moisture (88.6% to 92.8%), protein (0.9% to 1.6%), fat trace (0.2%), carbohydrates (5.2% to 9.0%) and ash (0.6%) [1]. Onions have a wide range of utility ranging from various food applications (fresh vegetable, processed commodity, spice and condiment) to pharmaceutical uses. It has been reported to have antioxidant, anticancer, antiarteriosclerosis, anticoronary heart disease and antidiabetic properties [2]. Onion grows on an area of 5.04 million hectare with a production of 96.8 million tonnes in the world and on an area of 1.31 million ha with a production of 22.1 million tonnes in India [3]. India holds first rank in total area and second in production after China. Being among the foremost exported horticultural commodities, it has a significant impact on country’s economy. In export, India ranked third with 9.1% of total share worth US$ 364.7 million after Netherlands (20.5%, $815.2 million) and China (15.2%, $604.4 million) during 2019 [4]. However, in India the productivity of onion is low (16.87 tons/hectare) against the average world productivity (19.2 tons/hectare). Low productivity has been attributed to inbreeding depression, inadequate/ faulty nutrient supply, bolting (untimely emergence of flowering stalk), bulb splitting, biotic and abiotic stresses and inefficient bulb storage facility. It not only delimits our extensive internal supply but also affects our global export market. These factors don’t adversely affect yields only but also the biochemical quality of bulbs. Therefore, biochemical evaluation of populations/ genotypes/ varieties being grown in any specified regime of climate and agricultural practices becomes important to identify the ones suitable for various industrial applications. Onion’s suitability for processing and export is determined by its sugar content and pungency. Sugars are one of the several components that render taste and flavor to vegetables. Sugar content in onion bulb varies on account of transformation of fructans in addition to the production and consumption of sucrose, fructose, and glucose [5] and metabolic transformations of mono and disaccharides, which are used in various metabolic activities [6].

Generally, total sugar content in onion bulbs has been reported to range from 5.2% to 9.0% [1]. These include reducing (glucose, galactose, fructose, lactose and maltose.) and non-reducing (sucrose and trehalose) sugars. Reducing sugars are very important in determining the quality and appearance of processed onion, which is commonly in the form of powder and dehydrated flakes. Their optimum concentration in the bulb is critical for desirable color development of the product during processing since excessive reducing sugars lead to disagreeable browning of the final product through non-enzymatic reaction with amino acids in the Maillard reaction [7]. Reducing sugars also adversely affect the storage quality of onion and its products by introducing browning.

Another crucial trait in onion is pungency, which results from a range of sulphur compounds and can be determined by the amount of pyruvic acid content in the bulb. Pungency of onions is also influenced by location and environment [8]. A vast number of onion varieties are known to exhibit great diversity in biochemical composition. Onions have been classified as sweet, moderately pungent and highly pungent based on the pyruvic acid content of 0-3, 3-7 and ›7 µmol/g, respectively [9]. Dehydrated onion is the foremost processed product of onion and the most important conditions for making it ideally are high pungency, high TSS (15-20%) and light colored flesh, preferably, white.

In the present investigation, biochemical evaluation in terms of sugar content and pungency was done in diverse onion germplasm consisting of entries proposed for varietal and hybrid release in different agroclimatic zones of India including short, intermediate and long day conditions encompassing tropical, subtropical and temperate climates. All the entries were grown and cultivated in long day temperate agroclimate of Kashmir valley and their sugars and pungency were analyzed for this specific environment.

Material and Methods

Fifty onion genotypes adapted to different agroclimates and day lengths were analysed for sugar percentage and pungency and compared with two long day check varieties (Brown Spanish and Yellow Globe) at ICAR-Central Institute of Temperate Horticulture (CITH), Srinagar, Jammu & Kashmir. The experimental location falls under temperate region at 34° 0’5.0394” Latitude and 74°45’58.3194” Longitude having 11:30 to 14:30 hours day length during bulbing, bulb growth and development stages. The experiment was laid out in a randomized complete block design (RCBD) with two replications. Sugars were determined by Lane and Eynon’s method as reported by Ranganna [10] and calculated as:

$$\text{Total sugars (\%)} = \frac{\text{mg of invert sugar} \times \text{Dilution}}{\text{Titre (after inversion)} \times \text{Weight of sample (g)}} \times 100$$

$$\text{Reducing sugars (\%)} = \frac{\text{mg of invert sugar} \times \text{Dilution}}{\text{Titre} \times \text{Weight of sample (g)} \times 1000} \times 100$$

Non-reducing sugars (%) = [Total sugar (%) − Reducing sugar (%)] × 0.95

Pyruvic acid was determined by the method described by Anthon and Barrett [11] using dinitrophenylhydrazine (DNPH) reagent and was expressed as µmol g^{-1}. Statistical analysis was carried out in SAS statistical software with 95% confidence level.

Results and Discussion

The study recorded reducing sugars, non-reducing sugars, total sugars and pyruvic acid content from 2.26% to 3.79%, 2.97% to 4.29%, 5.57% to 7.72% and 1.73 to 11.33 µmol/g of fresh weight, respectively (Table 1). These results are in concord with those obtained by Arya [12] who reported reducing sugars from 3.32% to 4.92%, non-reducing sugars from 1.66% to 3.63% and total sugars in the range of 4.98% to 8.06% in different onion genotypes. Kale and Ajjappalavara [13] observed pyruvic acid content from 4.15 to 6.10 µmol/g fresh weight, which falls within the range obtained in this study. However, wider range obtained here might imply effect of climatic factors. Onion pyruvate concentration reported by Randle [14] that ranged from 1.6 µmol/g fresh weight in mild to 13 µmol/ g fresh weight in pungent cultivars is more in conformity with our observations.

Table 1: Sugar profile, pyruvic acid content and bulb colour of evaluated genotypes

Sl. No.	Genotype	Reducing sugars (%)	Non-reducing sugars (%)	Pyruvic acid (µm/g)	Outer scale colour
1.	OA-18-03	2.71	3.69	5.50	Light Red
2.	OA-18-05	2.60	3.26	4.99	Dark Red
3.	OA-18-06	2.51	3.80	2.82	White
4.	OA-18-09	2.36	3.49	4.70	Dark Red
5.	OA-18-11	2.26	4.12	3.32	White
6.	OA-18-13	2.79	3.61	4.03	Light Red
7.	OA-18-15	3.15	3.95	4.44	Light Red
8.	OA-18-17	2.72	4.03	3.83	White
9.	OA-18-20	2.66	3.69	5.93	Brown
10.	OA-18-22	2.42	3.55	4.51	Light Red
11.	OA-18-25	2.65	3.15	4.08	Light Red
12.	OA-18-27	3.43	4.29	5.74	Dark Red
13.	OA-18-31	2.44	3.86	3.02	Yellow
14.	OA-18-33	2.69	3.84	4.08	Dark Red
15.	OA-18-34	2.84	3.48	1.81	White
16.	OB-18-51	2.43	3.14	3.56	Dark Red
17.	OB-18-53	2.94	3.64	10.48	Dark Red
18.	OB-18-56	3.31	3.41	4.76	Dark Red
19.	OB-18-58	3.35	3.33	11.33	Dark Red
20.	OB-18-60	2.36	3.85	4.61	Dark Red
21.	OB-18-62	2.61	3.74	4.91	Dark Red
22.	OB-18-64	3.79	2.97	3.80	Dark Red

23.	OB-18-67	3.58	3.03	3.95	Dark Red
24.	OB-18-69	2.28	3.63	3.74	Dark Red
25.	OB-18-70	2.33	3.70	5.01	Dark Red
26.	OB-18-72	2.50	3.36	1.92	Yellow
27.	OB-18-74	3.02	3.01	2.87	Brown
28.	OB-18-76	2.48	3.82	3.72	Dark Red
29.	OC-18-59	3.57	3.13	3.61	Dark Red
30.	OC-18-61	3.32	3.74	5.48	Dark Red
31.	OC-18-63	2.73	3.97	3.85	Dark Red
32.	OC-18-65	2.75	3.22	5.80	Dark Red
33.	OC-18-68	3.51	3.19	1.99	White
34.	OC-18-71	3.41	3.61	9.37	White
35.	OC-18-73	3.60	3.73	3.24	Dark Red
36.	OC-18-75	2.54	3.85	1.73	Dark Red
37.	OC-18-77	3.66	3.22	1.86	White
38.	OC-18-79	2.88	3.78	4.03	Dark Red
39.	OC-18-81	3.41	3.14	5.92	Dark Red
40.	OC-18-83	3.44	3.29	3.61	Dark Red
41.	OC-18-84	2.85	3.76	5.76	Dark Red
42.	OC-18-85	2.66	3.57	4.86	Dark Red
43.	OC-18-87	2.91	3.54	3.70	Dark Red
44.	OC-18-88	3.19	3.86	5.71	Dark Red
45.	OC-18-89	2.26	3.55	6.32	White
46.	OC-18-91	2.69	3.62	8.52	White
47.	OC-18-92	3.79	3.67	5.71	White
48.	OC-18-94	3.63	3.30	3.66	White
49.	OC-18-96	3.35	3.81	4.04	White
50.	OC-18-97	3.22	3.15	6.14	White
51.	Brown Spanish	2.91	3.30	4.64	Brown
52.	Yellow Globe	2.31	3.57	3.50	Yellow
Mean		*2.92*	*3.56*	*4.62*	-
LSD (0.05)		*0.79*	*0.91*	*1.51*	-
S. D.		*0.54*	*0.45*	*2.02*	-

a. Reducing and non-reducing sugars

The genotypes exhibited varied reducing sugar percentage ranging from 2.26 to 3.79 (Fig 1). The long day checks Brown Spanish and Yellow Globe recorded reducing sugar percentage of 2.91and 2.31, respectively. Reducing sugars at 3.79% in OB-18-64 and OB-18-92 were significantly higher than both the local checks Brown Spanish (2.91) and Yellow Globe (2.31). This implies their greater predisposition to undesirable browning of final processed product compared to checks. OA-18-11 and OC-18-89 recorded the lowest reducing sugars (2.26), which were at par with Yellow Globe (2.31) and Brown Spanish (2.91). However, since both these entries are white colored, they are better candidates for processing compared to both the checks, which are non-white varieties.

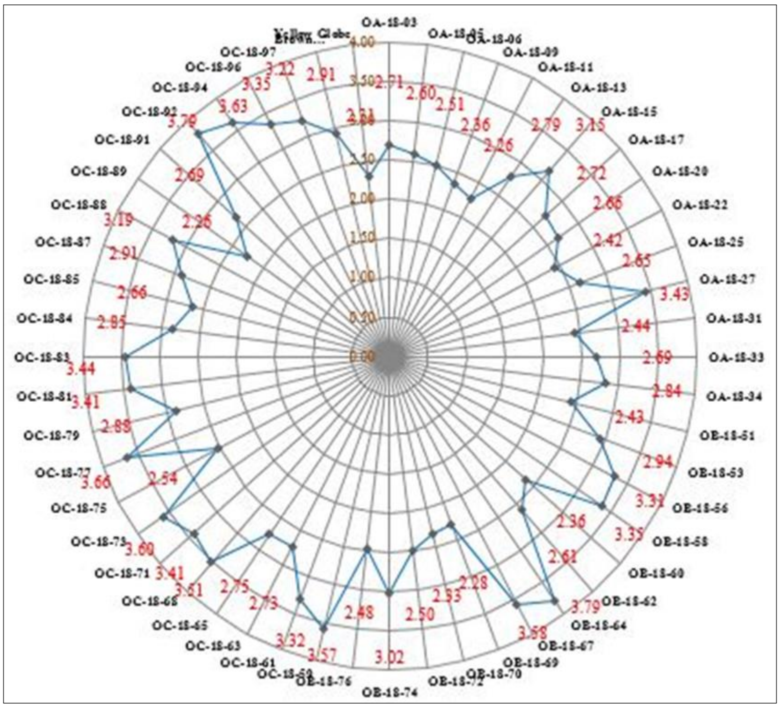

Fig 1: Depiction of reducing sugar percentage of onion genotypes

Non-reducing sugar content of germplasm varied from 2.97% to 4.29% (Fig 2). However, there were no genotypes with significantly higher non-reducing sugars than the higher value check Yellow Globe (3.57%). Higher the non-reducing sugars, better the storage quality of onion and its processed products. So, none of the entries tested for non-reducing sugars may perform better than Yellow Globe for the purpose.

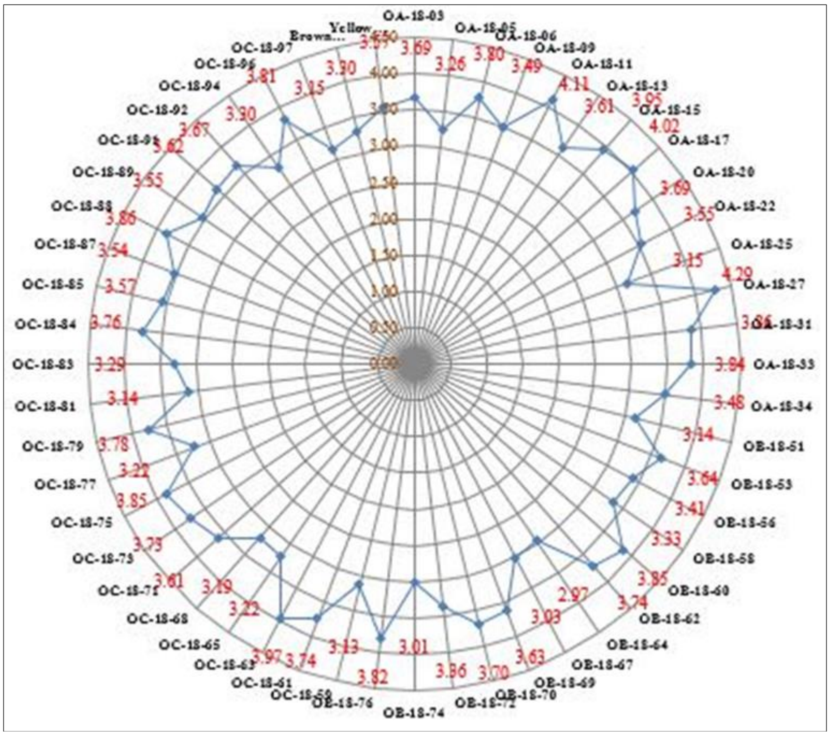

Fig 2: Depiction of non-reducing sugar percentage of onion genotypes

b. Pyruvic acid

Entries also showed significant differences for pyruvic acid content (Fig. 3) and were accordingly grouped into low, moderate and highly pungent categories. Checks Brown Spanish (4.64) and Yellow Globe (3.50) were found to be moderately pungent according to the classification [9]. OB-18-58 (11.33), OB-18-53 (10.48), OC-18-71 (9.37), OC-18-89 (6.32) and OC-18-91 (8.52) had significantly higher pyruvic acid content than Brown Spanish and also fell in the category of highly pungent onion group (›7µmol/g FW). So, they can serve as potential candidates for highly pungent varieties or parents for breeding higher pungency for this region. Since highly pungent dark red onions are in great demand in India and neighboring countries and especially in recent times Kashmiri onion growers have started expressing greater interest in cultivating such varieties, entries BO-18-58 and OB-18-53 are at special advantage because of their dark red bulbs. On the other hand, entries OC-18-71, OC-18-89 and OC-18-91 are more favorable for dehydrated onion processing by virtue of being white colored.

On the contrary, genotypes OC-18-75 (1.73), OA-18-34 (1.81), OC-18-77 (1.86) and OB-18-72 (1.92) and OA-18-31 (3.02) didn't only fall in the sweet onion category but also had significantly lower pyruvic acid than checks Brown Spanish and Yellow Globe except OA-18-31 (3.02) being at par with Yellow Globe. These entries may be used as a source of milder pungency having application in export market and fresh onion market for salad purpose.

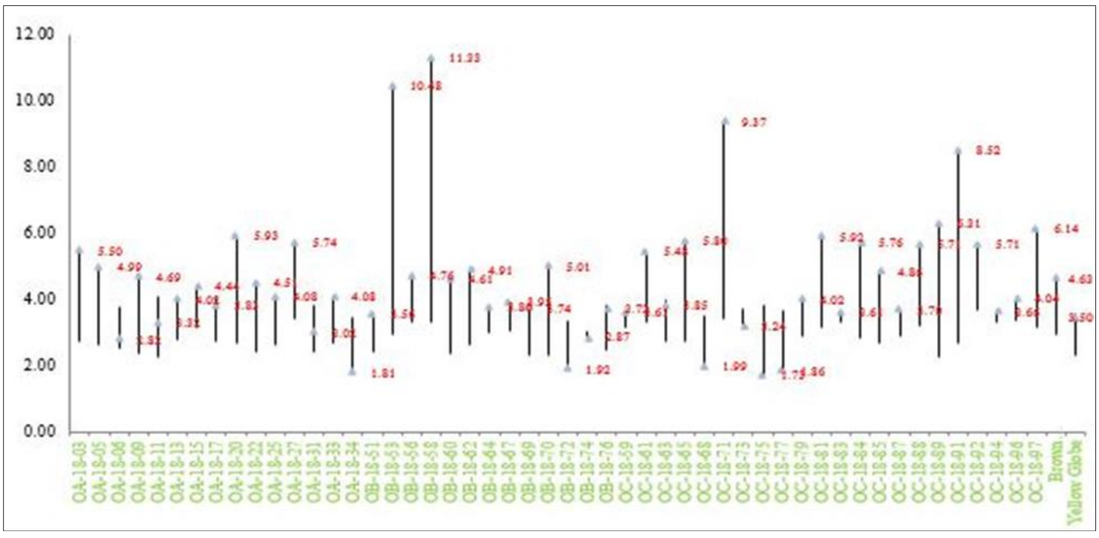

Fig 3: Pyruvic acid content of onion genotypes

Conclusion

Variation within a population or group of individuals is an indication of genetic diversity, which is pre-requisite to selecting or developing cultivars of desire. In order to widen our genetic base of onion for better domestic supply and export, it is imperative to identify optimal genotypes for developing cultivars suitable for various purposes that very importantly include long shelf life and industrial application of bulbs. Both these qualities depend highly on sugar content, balance of reducing and non-reducing sugars and pungency of bulbs. Since these traits tend to be influenced by environment, their measurement in the genetic material becomes imperative for a specific set of climatic conditions. Therefore, cultivars from short and intermediate day climates with high to moderate temperatures were evaluated in colder and longer days of Kashmir valley for their suitability to this place. The genotypes found significantly better than local checks Brown Spanish and Yellow Globe can be used either directly or as breeding material for developing cultivars for specific purposes for Kashmir region.

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References

1. Lawande KE. Onion-In: Handbook of herbs and spices (Peter, K.V., Ed.), Cambridge: Woodhead Publishing Limited, 2001, 249-259.
2. Kumar KPS, Bhowmik D, Chiranjib Biswajit, Tiwari P. *Allium cepa*: A traditional medicinal herb and its health benefits. Journal of Chemical and Pharmaceutical Research. 2010; 2(1):283-291.
3. FAOSTAT. http://faostat3.fao.org/home/E, 2018.
4. Workman D. Onion exports by country. http://www.worldstopexports.com/onions-exports-by-country/. 2020.
5. Vijn I, Van Dijken A, Lüscher M, Bos A, Smeets E, Weisbeek P *et al*. Cloning of sucrose: sucrose 1-fructosyltransferase from onion and synthesis of structurally defined fructan molecules from sucrose. Plant Physiology. 1998; 117:1507-1513. DOI: 10.1104/pp.117.4.1507.
6. Yasin HJ, Bufler G. Dormancy and sprouting in onion (*Allium cepa* L.) bulbs. I. Changes in carbohydrate metabolism. The Journal of Horticultural Science and Biotechnology. 2007; 82:89-96.
7. Liang N, Chen XM, Kitts DD. Sugar loss attributed to non-enzymatic browning corresponds to reduce calories recovered in low-molecular-weight fraction. Journal of Nutrition & Food Science. 2018; 8:2. DOI: 10.4172/2155-9600.1000674
8. Yoo KS, Pike L, Crosby K, Jones R, Leskovar D. Differences in onion pungency due to cultivars, growth environment, and bulb sizes. Scientia Horticulturae. 2006; 110:144-149.
9. Pozzo Ardizzi MC, Aschkar G, Pellejero G. Caracterizacion de distintos cultivares de cebolla (*Allium cepa* L.) segun las sustancias de reserva durante la conservacion en el Valle Inferior de rıo Negro. In: Proceedings of the Actas del 26th Congreso Argentino de Horticultura, Parana, Argentina, 2003.
10. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. Edn 2, Tata-McGraw-Hill Publishing Company Limited, New Delhi, 1986, 182.
11. Anthon GE, Barrett DM. Modified method for the determination of pyruvic acid with dinitrophenylhydrazine in the assessment of onion pungency. Journal of the Science of Food and Agriculture. 2003; 83:1210-1213. DOI: 10.1002/jsfa.1525.
12. Arya JS. Characterization and evaluation of onion (*Allium cepa* L.) germplasm at Leh, trans-Himalaya, India, Ph. D. Dissertation, Jaypee University of Information Technology, 2019, 126.
13. Kale SM, Ajjappalavara PS. Varietal evaluation of some important nutritional constituents in onion (*Allium cepa* L.) genotypes. The Asian Journal of Horticulture. 2015; 10(2):242-245.
14. Randle WM. Onion germplasm interacts with sulfur fertility for plant sulfur utilization and bulb pungency. Euphytica. 1992; 59:151-156.