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Assessment of bulb pungency level in different Indian cultivars of onion (*Allium cepa* L.)

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Abstract

Onion (*Allium cepa* L.) is an important vegetable crop consumed primarily for its ability to enhance the flavor of other foods. The quality of onion depends on its pungency. While highly pungent onions are popular in India, less pungent ones are preferred in other countries. However, the variability in pungency in bulbs of different cultivars however has not been investigated. The present investigation was therefore undertaken to determine the pungency in three popular Indian onion cultivars viz. N-2-4-1, B-780 and Phule Safed. Randomly selected bulb samples of the cultivars were analyzed for the content of pyruvic acid, total soluble solids (TSS) and reducing, non-reducing and total sugars. The red variety N-2-4-1 showed higher level of pungency, while other two varieties were comparatively less pungent.

Keywords: *Allium cepa* cultivars; Pungency; Pyruvic acid; Sugars

1. Introduction

Onion is one of the most important vegetable crops grown throughout the world. India is the second largest producer of onion in the world next to China. Although onions contribute significantly to the human diet and have therapeutic properties, they are primarily consumed for their ability to enhance the flavor of the other foods. A special class of biologically active organosulfur compounds dominates onion flavor. The pungent flavor of onions is produced by hydrolysis of the flavor precursor compounds, like, *S*-alk (en)yl-L-cysteine sulfoxides, when the cells are mechanically ruptured, such as by cutting or macerating. The hydrolysis reaction is catalyzed by allinase and is completed within 6 min (Schwimmer & Weston, 1961). This reaction produces thiopropanol *S*-oxide (lacrymator), pyruvic acid, ammonia and many sulfur volatiles (Whitaker, 1976). The determination of pyruvate as an indicator of pungency is perhaps the most established method for pungency assessment in onion and garlic. The consumption of onion is increasing in developed and developing countries every year. The compounds like sugars and organic acids are contributing to the organoleptic test and contribute to the distinctive flavour and aroma. Pungency level and total soluble solids are important quality attributes of onion bulbs. The contents of soluble carbohydrates contribute to onion sweetness. All of the above parameters are important in processing and export quality of bulbs (Simon, 1995). Many of such compounds can be chemically quantified. Estimation of pungency in bulbs has become necessary as the popularity of low pungency onion has increased. At present there are no data on the variation in the pungency level of Indian varieties of onion. Hence, the present attempt is made to evaluate the pungency level in different popular cultivars of onion in India.

2. Materials and methods

The onion bulbs of the three varieties namely, N-2-4-1, Basavant-780 and Phule Safed grown in the experimental field at Hadapsar, Pune, were harvested after

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their maturity. Ten randomly selected bulbs of each cultivar were used for the analysis of pyruvic acid, total soluble solids (TSS), reducing, non-reducing and total sugar content.

The content of pyruvic acid was estimated using dinitro phenyl hydrazine (DNPH) reagent (Anthon & Barrett, 2003) with slight modification to the Schwimmer and Weston (1961) method. The selected bulbs were cut longitudinally into two pieces. Out of these, one half was immediately chopped and homogenized with water (1:1). The homogenate was filtered through cheesecloth and centrifuged at 10,000*g* for 5 min. It was the source for total pyruvic acid (P_T)

To determine the background level of pyruvic acid or control (Pc), the remaining piece was put in a plastic bag and microwaved (microwave power equal to 1200 W) for one second per gram of the bulb weight to deactivate the allinase. It was cooled and homogenized in water and then filtered and centrifuged as mentioned above. For the assay of background or control pyruvic acid (Pc), 25 μl clarified filtrate was taken and to this 1.0 ml of distilled water was added. After that 1.0 ml of 0.25 g/l DNPH (prepared in 1 N HCl – hydrochloric acid) was added to it. The reaction mixture was placed in a water bath at 37 °C for 10 min. After removing the samples from the water bath, 1.0 ml of 1.5 N NaOH was added. The absorbance was recorded at 515 nm (Shimadzu UV 1601 Double Beam Spectrophotometer).

For the assay of total pyruvic acid (P_T), 25 μl clarified filtrate from immediately chopped one half part of the onion (without microwave) was used. The remaining procedure was same as used for the assay of background pyruvic acid. A blank and standards were prepared by adding 25 μl of sodium pyruvate solutions.

As pyruvic acid exists universally in the plant tissue as a part of the intermediate metabolism (Goodwin & Mercer, 1983), the background levels of pyruvic acid or control (Pc), were therefore subtracted from the total pyruvic acid (P_T) concentrations to calculate the enzymatically produced pyruvate (P_E) (Yoo & Pike, 2001).

The amount of reducing and total sugar was estimated by DNSA (Dinitrosalicylic acid) reagent (Miller, 1959) and Anthrone reagent (Hedge & Hofreiter, 1962) methods. TSS (Total soluble solids) were measured by using a hand refractometer.

3. Results and discussion

The content of pyruvic acid is given in Table 1. The variety N-2-4-1 showed the highest value for both total and background pyruvic acid followed by B-780 and Phule Safed. Pungency is known to differ with variety, stage of maturity, type of soil, soil moisture and other growing conditions (Kalra, Sood, & Pandey, 1995; Saghir, Mann, & Yamaguchi, 1965). Enzymatically formed pyruvic acid and TSS content differed in the cultivars of onion in other studies also (Havey et al., 2002; Kopsell & Randle, 1997). The present investigation also confirms the above findings.

Table 1
Pyruvic acid content in bulbs of onion (*Allium cepa* L.) cultivars

Cultivar	Background pyruvate (μmol g^{-1})	Total pyruvate (μmol g^{-1})
N-2-4-1	0.89	8.87
B-780	0.69	5.93
Phule Safed	0.29	3.32
SE±	0.018	0.115
CD at 5%	0.050	0.452

Table 2
TSS, reducing, non-reducing and total sugar contents in bulbs of onion (*Allium cepa* L.) cultivars

Cultivar	TSS (%)	Reducing sugar (g/100 g FW)	Non-reducing sugar (g/100 g FW)	Total sugar (g/100 g FW)
N-2-4-1	13.3	6.69	9.56	16.1
B-780	12.8	4.43	8.45	12.8
Phule Safed	11.3	3.17	7.17	10.4
SE±	0.194	0.052	0.058	0.095
CD at 5%	0.759	0.207	0.228	0.371

The values for TSS, reducing, non-reducing and total sugars differed in all the three cultivars. The level of TSS, reducing, non-reducing and total sugar was significantly higher in variety N-2-4-1 as compared to B-780 and Phule Safed (Table 2). The amount (g/100 g FW) of reducing (6.69), non-reducing (9.56) and total sugars (16.1) was higher in red onion N-2-4-1 compared to that of B-780 (4.43, 8.4 and 12.8, respectively) and white onion Phule Safed (3.17, 7.17 and 10.4, respectively).

Sweetness in onion is a balance between single sugars and pungency. Pyruvic acid levels ranged from 1 to 18 μmol for different onion cultivars. The same guideline is followed in the present work to analyze the pungency strength, which is also used by the sweet onion industry in Georgia, USA. The onions are classified on the basis of pungency as low pungency/sweet (0–3 μmol pyruvic acid/g FW); medium pungency (3–7 μmol pyruvic acid/g FW); high pungency (above 7 μmol pyruvic acid/g FW). As per this classification, N-2-4-1 can be considered as highly pungent, B-780 and Phule Safed as medium pungent cultivars.

Pungency and TSS are important attributes of onion bulb quality for processing and storage. The contents of reducing and total sugars determine the storage life of bulbs. TSS content was slightly higher in the cultivars N-2-4-1 and B-780 compared to that of Phule Safed (Table 2). TSS contributes to the flavor, texture and storability of onions.

All the three popular cultivars of onion included in the present investigation differ in the content of pyruvic acid (pungency), TSS, reducing and total sugars. Pungency in onion bulbs contributes to the post harvest life and the processing. The studies on pungency, TSS, water soluble

carbohydrates and their association will definitely help to improve the quality of onion bulbs. However, breeding onion for desired pungency is a time consuming and a very challenging task.

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