Biochemical Differences between Bolted and Non-Bolted Onions

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Authors’ contributions

This work was carried out in collaboration among all authors. Authors KG and AT designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AK and PS managed the analyses of the study. Author MS edited the draft. All authors read and approved the final manuscript.

ABSTRACT

The present experiment was conducted to know the biochemical differences between bolted and non-bolted onion of Indian varieties. Onion is a very important vegetable consumed for its flavour and health benefits. Bolting, which is an undesirable character in onion bulb production, produces bulbs with central hard and hollow cellulosic stalk and makes them unmarketable. In this research four different varieties of onion (three red onion varieties (viz; Bhima Kiran; Bhima Shakti; N-2-4-1) and one white variety (Bhima Shweta)) were studied to verify differences between bolted and non-bolted bulbs. The results showed significant difference in total soluble solids and total phenol content in bolted and non-bolted onions. In bolted onion bulbs, total soluble solid content varied from 11.2 to 11.83 °Brix and 12.0 to 12.9 °Brix in non-bolted onion varieties. In bolted onion, the total phenol content was 27.0, 52.2, 61.3 and 65.8 mg GAE/100 g in Bhima Shweta, Bhima Kiran, N-2-4-1 and Bhima Shakti respectively. The phenol content varied from 26.2 to 48.7 mg GAE/100 g in non-bolted onion with lowest in Bhima Shweta and highest in N-2-4-1. No significant difference was observed for moisture content and total flavonoid content in bolted and non-bolted onion.

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1. INTRODUCTION

Onion (Allium cepa L.) is the most widely cultivated and consumed Allium species in the world. It adds flavour to the food preparations [1]. Onions are rich in phenolic compounds that possess antioxidant properties. Flavonoids are the most abundant in onion than other vegetables (100mg/kg in broccoli and 50mg/kg in apple), present as glycosides of quercetin and kaempferol (280–400 mg/kg) [2,3]. Because of high flavonoids, phenols and volatile sulphur compounds, regular onion consumption also contributes to prevention of heart diseases [4], blood pressure [5], cancer [6], digestive disorders, and prolonged cough [7].

Onions are winter-season biennial plants, require two seasons to complete the cycle from seed to seed. In the first season, the plants produce bulbs, then enters dormancy. The bulbs produced in the first season are replanted in the next season for seed production. However, onion plants sometimes produce premature flowering, i.e., premature seed stalk (scapes) called bolting [8]. Temperature, duration of temperature, day length, genotype, planting date, seedling age, over-fertilization influence the flowering in onion plants [9,10]. Among the factors, temperature and day length are the most important factors affecting onion bolting [10]. Bolting is driven by temperatures between 7.2° to 10°C. Alternate low and high temperature for two or more cycle, stimulates bolting in onion. Bolting is an undesirable trait in onion bulb production. This development of premature flowering stalks and seeds instead of producing bulbs, reduce the quality of onion bulbs. This produces light red and fibrous bulbs with a hard centre making them unmarketable [9], fetches low price and results in economic losses. The quality of bolted bulbs is low and cannot be stored for a longer period. Bolting in onion takes place to the extent of 5-80% in early rabi and late kharif seasons, results in loss of about 11-50 lakh tones onion bulbs every year in India.

As the physical appearance of bolted bulbs remain undisturbed, these bulbs can be used as a source of raw material for onion processing industry. The value of bolted onion can be increased through processing. Soluble solid content is a very important aspect for processing of onion. It determines the recovery percentage in dehydration. Phenol and flavonoids have therapeutic potential. Bolted onion bulbs could be used as a source of raw material and the value of bolted onion bulb could be increased by processing into dehydrated onion, onion flakes, and onion powder etc. Inclusion of bolted onion bulb as a raw material may increase the scope of processing industry. The effect of bolting and flower stem removal on the growth and chemical qualities of onion bulbs was studied by [8] and reported no difference in total soluble solid (TSS) content between bolted and non-bolted onion. In India, white onion variety is preferred for processing particularly dehydration. In this work we have studied biochemical differences in bolted and non-bolted bulbs of Indian onion varieties (red and white). It was hypothesized that biochemical qualities of bolted onion may be similar to non-bolted onion bulb.

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was conducted during late kharif season (late monsoon season), 2017-18 at ICAR-Directorate of Onion and Garlic Research, Pune, Maharashtra, India (18.32 ° N and 73.51 ° E). The climatic condition of the experimental site is classified as subtropical dry humid climate, with average annual precipitation of 820 mm. About 99.5% of total precipitation occurred during south-west monsoon season, which is from June to October. Maximum air temperature ranged from 24.0 to 40.0°C, and minimum air temperature ranged from 4.6 to 23.1°C during the experiment. The soil was classified as a Typic Haplustepts, and the texture of the top soil (0–15 cm) is clay loam. The soil of the experimental site is alkaline, with 6.8 g/kg soil organic carbon.

2.2 Experimental Details

The experiment consisted of three red onion varieties (viz; Bhima Kiran; Bhima Shakti; N-2-4-1) and one white variety (Bhima Shweta). Onion seedlings of 45 days old were transplanted in the month of October at a spacing of 15 × 10 cm. The experiment was laid out in a randomized block design with three replications. The plot size was 14 m², and consisted of 933 plants per plot. Recommended dose of fertilizers (110:40:60:30 kg NPKS ha⁻¹) was applied to onion crop. Nitrogen, phosphorus, potassium and sulfur at 35, 40, 60 and 30 kg ha⁻¹ were applied as basal.

Keywords: Onion; bolted; non-bolted; phenol; flavonoid; biochemical.
Additional nitrogen (75 kg ha$^{-1}$) was top-dressed in two equal splits at 30 and 45 days after transplanting. Urea (46% N), complex NPK fertilizer grade 10:26:26, potassium chloride (60% K$_2$O), elemental sulfur (90% S) were used as source of N, P, K, and S. Weed, pest and diseases management measures were followed to assure healthy crop. Crop was harvested at 50% top fall. Cured onion bulbs were selected for the analysis.

2.3 Bulb Sampling

Bolted and non-bolted bulbs (ten bulbs each) of uniform size were collected randomly from each variety for biochemical analysis. The average weight of the bulbs ranged between 50-60 g. The moisture content, total soluble solid, total phenol, and total flavonoid in bolted and non-bolted bulbs were examined. Biochemical analysis of bulbs were performed 15 days after harvesting.

2.4 Sample Preparation and Analysis

Selected onion bulbs were peeled to remove the outer skin, washed with distilled water. After surface drying, the top and bottom portions were removed diced into small pieces manually using sharp stainless steel knife. The diced onion was blended to a smooth paste in a blender to form uniform sample.

2.5 Moisture Content

Five grams of diced onion sample was taken and dried in an oven at 100°C till constant weight. The moisture content was expressed in percentage on wet basis.

2.6 Total Soluble Solid Content

Soluble solid content of the sample was measured using digital refractor meter and the values were presented in °Brix.

2.7 Total Phenol

Sample taken from the homogenized paste was used for the analysis of total phenol content. Total phenol content of the samples was analysed by using the Folin-Ciocalteau (FC) reagent by following the method of [11] using gallic acid as standard (0.1, 0.2, 0.3, 0.4 and 0.5 mg/ml). Results were expressed as mg Gallic Acid Equivalents (GAE)/100 g of fresh sample.

2.8 Total Flavonoid

Total flavonoid content was estimated calorimetrically by method mentioned by [12]. One millilitre of sample extract or standard solution of quercetin (50,100,150,200,250 and 500 µg/mL) was added to 10 mL volumetric flask containing 4 mL distilled water. To the flask, 0.3 mL of 5% NaNO$_2$ was added. After 5 min, 0.3 mL 10% AlCl$_3$ was added. After 6 min, 2 mL 1 M NaOH solution were added and the total volume was made up to 10 mL with distilled water. The solution was mixed well and the absorbance was measured against a prepared reagent blank at 510 nm. Total flavonoid content was expressed as mg Quercetin Equivalents (QE)/100g of fresh sample.

2.9 Statistical Analysis

The data was analyzed by two way ANOVA by taking variety as one factor and type of bulb (non-bolted or bolted) as a second factor. Significant differences among the means were compared at a 5% level of significance. Statistical analysis was conducted using SAS 9.3. Means were separated using the least significant difference test (LSD), P = 5%.

3. RESULTS AND DISCUSSION

3.1 Total Soluble Solid Content (SSC)

Soluble solid content is one of the important processing qualities of onion which not only determines bulb sweetness but also the keeping quality and total recovery. Principal component in soluble solids of onion is soluble sugars, glucose, fructose, sucrose and a series of fructosyl polymers called fructans which determines the sweetness of onion [13]. Soluble solids content was significantly lower in bolted onion bulbs than non-bolted bulbs in all four varieties. This could be due to diversion of nutrients for developing reproductive organs. In bolted onion bulbs, total soluble solid content varied from 11.2 to 11.83 °Brix. It varied from 12.0 to 12.9 °Brix in non-bolted onion varieties (Fig. 1). The lowest SSC was observed in N-2-4-1 and the highest in Bhima Kiran. No significant difference in mean soluble solid amongst onion genotype in red, pink and white was reported by [13]. Significant difference in total soluble solids in three onion cultivars (11.3, 12.8 and 13.3 °Brix in Phule Safed, B-780 and N-2-4-1 respectively) was reported by [14]. In contrast to our results, no
difference in soluble solid content between bolted and non-bolted onion was reported by [8].

### 3.2 Moisture Content

No significant difference was observed for moisture content between bolted and non-bolted onion bulbs. Moisture content of the bolted bulbs ranged from 84.1 to 85.4% in non-bolted onion. In bolted onion bulbs, the moisture content varied from 83.9 to 85.0% (Fig. 2). Difference in moisture content in red and white onion genotypes (88.5% in red to 86.6% in white onion) was reported by [13].

### 3.3 Total Phenol

Phenols and flavonoids constitute the most predominant functional components of onions [13]. Significant difference was observed in bolted and non-bolted onion bulbs. In general, the total phenol content was significantly more in bolted onion compared to non-bolted onion. In bolted onion, the total phenol content was 27.0, 52.2, 61.3 and 65.8 mg GAE/100g in Bhima Shweta, Bhima Kiran, N-2-4-1 and Bhima Shakti respectively (Fig. 3). Flavonoid content in non-bolted samples varied from 30.7 to 36.6 mg QE/100g. The total flavonoid content in bolted onion varied from 23.6 to 41.9 mg QE/100g (Fig. 4). In general, the total flavonoid content was also more in red varieties (Bhima Kiran, Bhima Shakti and N-2-4-1) and less in white variety (Bhima Shweta, however the difference was not significant. Predominantly high quercetin content in red genotypes, followed by pink and least in white types was also reported by [13]. The content varied from 608.3, 498.0 and 73.2 mg quercetin/kg in red, pink and white types, respectively [13].

![Fig. 1. Total soluble solid content in bolted and non-bolted onion bulbs](image-url)
Fig. 2. Moisture content in bolted and non-bolted onion bulbs

Fig. 3. Total phenol content in bolted and non-bolted onion bulbs

Fig. 4. Total flavonoid content in bolted and non-bolted onion bulbs
4. CONCLUSIONS

Our results showed that, soluble solid content is less in bolted onions compared to non-bolted onions. Whereas, total phenol content is more in bolted onions compared to non-bolted onions. No difference in moisture content and flavonoid content for bolted and non-bolted onions. As the storage quality of bolted onion bulbs is poor compared to non-bolted bulbs, bolted bulbs needs to be disposed in the market at low price immediately after harvest. Based on this information, the bolted onion which doesn’t fetch much market value can be processed into different alternative value added products.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES


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