

## COMPARATIVE STUDY ON THE QUALITY CHARACTERS OF WINTER ONION (*Allium cepa* L.) VARIETIES

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### Abstract

The experiment was conducted at Spices Research Sub-Centre (SRSC) of Bangladesh Agricultural Research Institute (BARI), Faridpur, Bangladesh during 2021-22 to compare the quality characters of four existing winter onion varieties such as BARI Piaz-1, BARI Piaz-4, BARI Piaz-6 and Lal Teer King. The field trial was laid out in Randomized Complete Block Design (RCBD) and storage experiment in Completely Randomized Design (RCD). The results of the experiment revealed that the quality parameters studied significant or varied among the varieties except for the days to maturity of bulb. The BARI Piaz-4 given significantly the highest dry yield (3.27t/ha) and the minimum bolting (11.5%) over other three varieties. The BARI Piaz-1 exhibited superior performances in result of dry matter, TSS, bulb firmness, pungency, storage loss and quantity and quality (texture/color) of Beresta (caramelized onions). The BARI Piaz-6 performed in respect of incidence of split bulb and pungency. Lal Teer King showed the highest disease incidence. The BARI Piaz-1, BARI Piaz-6, BARI Piaz-4 and Lal Teer King expressed bronze red, followed by bronze red, pink red and light red skin color, respectively. The flesh color of bulb was reddish in BARI Piaz-4 and Lal Teer King. But BARI Piaz-1 and BARI Piaz-6 white flesh color. Only BARI Piaz-4 had the torpedo shape while other three varieties produced flat shaped bulbs. The BARI Piaz-1, BARI Piaz-6, Lal Teer King gave highly crispy, crispy, light crispy and soft Beresta, respectively. The excellent (richly brown) and good (brown) color of Beresta were observed in BARI Piaz-1 and BARI Piaz-6, respectively. However, the color of Beresta for BARI Piaz-4 and Lal Teer King was very poor (darkish). This present findings suggest that among the varieties, BARI Piaz-1 stands out due to its exceptional quality and beresta characteristics, although it demonstrated the lowest yield. BARI Piaz-4, on the other hand, excels in terms of dry weight and displays minimal bolting tendencies. For those seeking pungency and reduced splitting, BARI Piaz-6 is the preferred choice. Lastly, when considering disease incidence, Lal Teer King demonstrates superior resistance.

**Keywords:** BARI Piaz, Bulb weight, Dry weight, Storage loss, Winter Onion

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## Introduction

In Bangladesh, the Spices Research Centre, BARI, Bogura has developed so far three winter onion varieties viz. BARI Piaz-1, BARI Piaz-4 and BARI Piaz-6. Lal Teer Seed Limited, Bangladesh has also developed a variety namely Lal Teer King which is being grown by the farmers of the country. The quality parameters of a variety are very important aspects for sustaining the variety. Varietal quality depends on different factors such as neck size, individual bulb size, dry matter and total soluble solids (TSS) of bulb, percent of bolting and splitting bulb, bulb firmness, days to maturity, pungency, shape and color of bulb, incidence of insect pest and diseases, bulb dry yield, shelf life of bulbs. So far, no study has been done in the country to compare the quality characteristics of the aforesaid varieties. So, a comparative study on the potential of quality for the aforementioned varieties would be very useful.

The present research work was, therefore, carried out to compare the quality characteristics of four existing varieties such as BARI Piaz-1, BARI Piaz-4, BARI Piaz-6 and Lal Teer King.

## Materials and Methods

A field cum storage trial was designed at Spices Research Sub-Centre, BARI, Faridpur, during 2021-22 to compare quality characters for four existing winter onion varieties BARI Piaz-1, BARI Piaz-4, BARI Piaz-6 and Lal Teer King. The field trial was conducted in a Randomized Complete Block Design (RCBD) with four replications. Onion seeds were sown on 14 November 2021. The 42-day-old uniform and healthy seedlings were transplanted on 26 December 2021 in the trial plots with a spacing of 15 cm x 10 cm. The unit plot size was 4 m x 2 m. The experimental field was fertilized with 5000 kg well-decomposed cowdung, 120 kg N, 50 kg P, 85 kg K and 40 kg S per hectare. Nitrogen, phosphate, potash and sulphur were supplied in the form of Urea, TSP, MP and Gypsum, respectively. The entire quantity of cowdung, P, K, S and the one third of N was applied as basal dose during final land preparation. The remaining N was used as top dressed in two equal splits at 20 and 30 days after transplanting. The fungicide mancozeb/iprodione @ 3g/L of water was sprayed at fortnightly interval commencing from one month after transplanting of seedlings. All other recommended management practices were followed for each variety. The data were recorded on neck size (cm), bolting (%), split bulbs (%), individual bulb weight (g), days to maturity (days), bulb dry matter (%), TSS (°brix), incidence of diseases (0-5 scale), dry yield per hectare (t), shape index and shape of bulbs, bulb firmness, skin and flesh color of bulbs, pungency, shelf-life of bulb and percent, texture and color of Beresta (caramelized onion/crispy fried onion). Ten plants were randomly selected from each plot for data recording and averaging. Bulbs were harvested at maturity when the pseudostem became flaccid and unable to support the leaf blades (Brewster, 1990). Bulbs of four varieties were harvested over several days as per maturity symptoms. Days to maturity were recorded considering the days between the transplanting of seedlings and harvesting of bulbs. The leaves of harvested onion were removed five days after curing by cutting 2.0-2.5cm above the

bulb. After curing, the total bulb fresh weight was measured for each plot. The number of split bulbs was visually counted in each plot, recorded and expressed in percent in relation to the total number of bulbs per plot. The percent dry matter content of bulbs was calculated on a dry weight basis as per procedure of Walle *et al.* (2018). TSS content of bulbs was recorded by hand refractometer (ATAGO, Master-53M, Japan) with a range of 0-53 °brix. The purple blotch/stemphylium leaf blight severity of onion was scored a 0-5 scale, as described by Sharma (1986). The details of scales are as follows: 0-no disease symptoms, 1-a few spots towards the tip covering 10% of the leaf area, 2-several dark purplish brown patches covering up to 20% leaf area, 3-several patches with paler outer zone covering up to 40% leaf area, 4-leaf streaks covering up to 75% leaf area or breaking of the leaves from centre and 5-complete drying of the leaves or breaking of the leaves from the centre. Observations were made from the first appearance of disease symptoms on leaves; until the harvest at weekly intervals.

According to Dowker and Fennell (1974), the shape index (SI) of a lightbulb is the ratio of its height (polar diameter) to its equatorial diameter, or polar diameter/equatorial diameter. Polar diameter is the distance between the onion crown and the point of root attachment to the onion. Equatorial diameter is the maximum width of the onion in a plane perpendicular to the polar diameter. Henceforth shape of the bulb was assessed by using the bulb shape index. Where a shape index smaller than 1 ( $< 1$ ) indicates flat; a shape index equal to 1 indicates globular and a shape index greater than 1 ( $> 1$ ) indicates torpedo (Dowker and Fennell, 1974). Bulb firmness rating was measured in the subjective method by squeezing the bulbs at different points with the hand of testers repeatedly (Larsen and Cramer, 2004). Before measuring bulb firmness, the dry scales of the bulb were removed. Firmness was rated on a scale from 1 to 9, with 1 being the softest or one that gave the the least resistance to squeezing and 9 being the hardest, most firm bulb (Larsen and Cramer, 2004). The Skin and flesh color of bulbs were identified by visual assessment method. The Pungency of onion was evaluated with sensory/flavor perception (organoleptic taste) by a taste panel (Wall and Corgan, 1992). A rating scale for pungency was used, where 1 = extremely mild, 2 = mild, 3 = slightly pungent, 4 = pungent and 5 = extremely pungent. The panel was instructed to taste all of the scales (inner, middle and outer) for each sample and to clear their palates with water and apples between samples. The taste test was conducted over three days with three replications. The Beresta (caramelized onions) was made by slowly cooking the sliced onion in little oil until they were richly browned. The percent of Beresta content was calculated following bulb dry matter estimation procedure. The healthy, sound and uniform bulbs were selected to testing the shelf life of onion bulbs. Twenty-five-kilogram bulbs from each variety were taken for the study. The storage trial was conducted under a completely randomized design with three replications. The onion bulbs were stored in ambient storage for 6 months from 15 April to 15 October- 2022. The total storage loss (%) was calculated from the sum of the sprouting loss (%), physiological loss in weight (%) and rotting loss (%). The recorded data were analyzed statistically as suggested by Gomez and Gomez (1984) and the means were compared by least significant difference (LSD).

## Results and Discussion

### Quality characters

#### Neck size, weight, splitting, maturity of bulb, bolting and disease

Quality characteristics such as neck size, individual bulb weight, bolting, splitting and diseases were significantly influenced by varieties except days to maturity (Table 1). The thickest neck diameter (1.31 cm) was observed in BARI Piaz-6 followed by BARI Piaz-4 (1.25 cm) and Lal Teer King (1.23 cm). However, the thinnest (1.18 cm) was attained in BARI Piaz-1. The variation in neck size among the varieties might be attributed to their genetic factor.

**Table 1.** Quality characters (neck size, bulb weight, bolting, splitting, disease, maturity) as influenced by four varieties of BARI, Faridpur, during 2021-22

Variety	Neck size (cm)	Individual bulb weight (g)	Bolting (%)	Splitting (%)	Disease rating (0-5 scale)	Days to maturity (days)
BARI Piaz-1	1.18	21.68	19.45	15.44	2.89	110.68
BARI Piaz-4	1.25	34.06	11.51	8.42	2.41	114.04
BARI Piaz-6	1.31	26.81	12.21	7.76	2.65	111.55
LalTeer King	1.23	31.16	11.84	8.99	2.12	112.99
CV (%)	9.28	8.61	11.10	22.49	17.31	7.98
LSD (0.05)	0.08	4.34	2.44	1.54	1.03	-
Level of sig.	*	**	**	**	*	NS

\*\* Significant at 1% level of probability, \* Significant at 5% level of probability and NS-Non significant

The present finding is in accordance with that of Sirajo and Namu (2019). Neck thickness is believed to influence the storability of onion with better storability from a thinner neck size (Sirajo and Namu, 2019). The heaviest individual bulb (34.1g) was noted from BARI Piaz-4 insignificantly followed by Lal Teer King (31.2g) and significantly followed by BARI Piaz-6 (26.9 g). The lightest bulb (21.7g) was observed in BARI Piaz-1. The difference in bulb weight could be attributed due to the genetic potential of the varieties. The outcome of the current study confirms the previous findings of Sirajo and Namu (2019). The highest bolting (19.5 %) was recorded from BARI Piaz-1 significantly followed by BARI Piaz-6 (12.2%) and Lal Teer King (11.8%). The lowest bolting (2.36%) resulted from BARI Piaz-4. Abu-Rayyan and Abu-Irmaileh (2004) reported that onion required cool weather during inflorescence initiation and seed stalk development. All varieties studied were grown in the same environment. So, this difference in bolting percent could be due to hereditary causes among the varieties. This result corroborates the earlier finding of Lancaster *et al.* (1995). The maximum split bulb (15.4%) was recorded from BARI Piaz-1 significantly followed by BARI Piaz-4 (8.4%). However, the minimum split bulb was counted from BARI Piaz-6 (7.76%) which was

statistically similar to that of Lal Teer King (8.99%). The variation in multiplier bulbs was mainly attributed to the genetic variation in varieties. Similar claims were also made by Arya *et al.* (2017). The score of disease incidence ranged from 2.12 to 2.89 with eye estimation. The maximum disease incidence score was observed in BARI Piaz-1 (2.89) consistently followed by BARI Piaz-6 (2.65) and BARI Piaz-4 (2.41). The minimum incidence rating was exhibited in Lal Teer King (2.12). The present evaluation revealed that no variety was recorded in the disease severity categories 0, 1, 4 and 5 under a 0-5 scale (Sharma, 1986). The apparent cause of the variation in disease severity among the varieties might have been due to their genetic potential. The days to maturity ranged from 110.7 to 114.1 days from transplanting to bulb harvest. The variety BARI Piaz-4 took a maximum of days to maturity (114.1 days). The minimum days to mature (110.7 days) was required for BARI Piaz-1. Walle *et al.* (2018) found significant differences in the days to maturity of bulbs among the varieties.

### **Quality characters**

#### **Dry matter, TSS, firmness, pungency, dry yield and storage loss**

Considerable variations were observed among the varieties in quality characteristics of dry matter, TSS of bulb, bulb firmness, pungency, dry yield and storage loss of bulb (Table 2). The maximum dry matter (DM) content (19.72%) was obtained from BARI Piaz-1 significantly followed by BARI Piaz-6 (16.70%) and BARI Piaz-4 (16.18%). However, the minimum DM content was noted in Lal Teer King (15.70%). The variation in DM content might be due to characteristic derived genetically from an ancestor. These results agree with those of Arya *et al.* (2017) who reported that the varieties significantly influenced the percent DM of bulbs. The topmost TSS content (19.25 °brix) was obtained in BARI Piaz-1 consistently followed by BARI Piaz-4 (15.08 °brix). The least TSS content (14.58 °brix) was observed from Lal Teer King. The variation in TSS content among the varieties might have been due to their inherent characteristics. Similar variability in TSS content among the varieties was also registered by Arya *et al.* (2017). The variety BARI Piaz-1 exhibited firmer bulbs (9.00) than those of Lal Teer King (8.50) and BARI Piaz-6 (8.63). Moreover, the lowest firmness rating (8.38) was observed in BARI Piaz-4. The firmness score of BARI Piaz-4 was mutually identical to those of BARI Piaz-6 and Lal Teer King. The probable cause of firmness variation might be due to differences in genetic nature among the varieties studied. The Flavor perception score for pungency ranged from 4.60 to 5.00. The strongest pungency (5.00) was recorded in BARI Piaz-1 and BARI Piaz-6 insignificantly followed by Lal Teer King (4.62) and BARI Piaz-4 (4.60). The variation in the pungency of onions among the varieties might be due to their genetic potential. Wall and Corgan (1992) found wide variation in pungency among the varieties. The variety BARI Piaz-4 produced the maximum dry yield of 3.27t/ha which was statistically superior over the remaining three varieties-Lal Teer King (2.84t/ha), BARI Piaz-1 (2.29 t/ha) and BARI

Piaz-6 (2.24 t/ha). The superior performance of BARI Piaz-4 over the remaining varieties was due to its highest fresh yield of onion bulb. In spite of the highest dry matter, BARI Piaz-1 gave the lowest dry yield due to its lowest fresh yield of onion bulb. Walle *et al.* (2018) found variation among the varieties on dry yield. The BARI Piaz-1 had the lowest storage loss (41.81%) insignificantly followed by BARI Piaz-6 (45.12%). The maximum storage loss was observed in the Lal Teer King (48.11%), followed by BARI Piaz-4 (47.05%). The lowest storage loss from BARI Piaz-1 might be due to higher dry matter, TSS, bulb firmness and pungency in BARI Piaz-1. The DM content is also believed to influence the long storage period of onion (Mahanthesh *et al.*, 2008). Rabbani *et al.* (1986) obtained significant variation among the varieties on storage loss.

**Table 2.** Quality characters (dry matter, TSS of bulb, bulb firmness, pungency, dry yield, storage loss) of four varieties of onion

Variety	Bulb dry matter (%)	TSS of bulb (°brix)	Bulb firmness (1-9 scale)	Pungency (0-5 scale)	Bulb dry yield (t/ha)	Storage loss (%)
BARI Piaz-1	19.7	19.3	9.00	5.00	2.29	41.8
BARI Piaz-4	16.2	15.1	8.38	4.60	3.27	47.1
BARI Piaz-6	16.7	15.0	8.63	5.00	2.24	45.1
LalTeer King	15.7	14.6	8.50	4.62	2.84	48.1
CV (%)	9.2	6.5	3.05	14.23	8.02	4.7
LSD (0.05)	2.5	1.7	0.42	0.28	0.41	4.9
Level of sig.	*	**	*	**	**	*

\*\* Significant at 1% level of probability, \* Significant at 5% level of probability

### Shape of bulb

A marked variation was recorded in the shape index and shape of bulb among varieties (Table 3). The highest shape index (1.12) was attained in the BARI Piaz-4 significantly followed by BARI Piaz-6 (0.92) and Lal Teer King (0.91). The BARI Piaz-1 showed the lowest shape index (0.81). The shape index might be genetically attributed to the varieties. These results are in harmony with the findings of Sirajo and Namu (2019) and Arya *et al.* (2017) as they recorded a considerable variation in the bulb shape index of onion varieties. The recorded data exhibited that only BARI Piaz-6 had the torpedo shape (Fig. 1b). However, BARI Piaz-1 (Fig. 1a), BARI Piaz-6 (Fig. 1c) and Lal Teer King (Fig. 1d) showed the similar shapes like flat. A shape index smaller than 1 (< 1) indicates flat; a shape index equal to 1 indicates globular and a shape index greater than 1 (> 1) indicates torpedo (Dowker and Fennell, 1974).

**Table 3.** Shape index value and shape of bulb of varieties of onion

Variety	Shape of bulb		
	Index values	Types of index	Shape
BARI Piaz-1	0.81	< 1	Flat shape
BARI Piaz-4	1.12	> 1	Torpedo shape
BARI Piaz-6	0.92	< 1	Flat shape
Lal Teer King	0.91	< 1	Flat shape
CV (%)	12.51	-	-
LSD (0.05)	0.12	-	-
Level of sig.	**	-	-

\*\* Significant at 1% level of probability

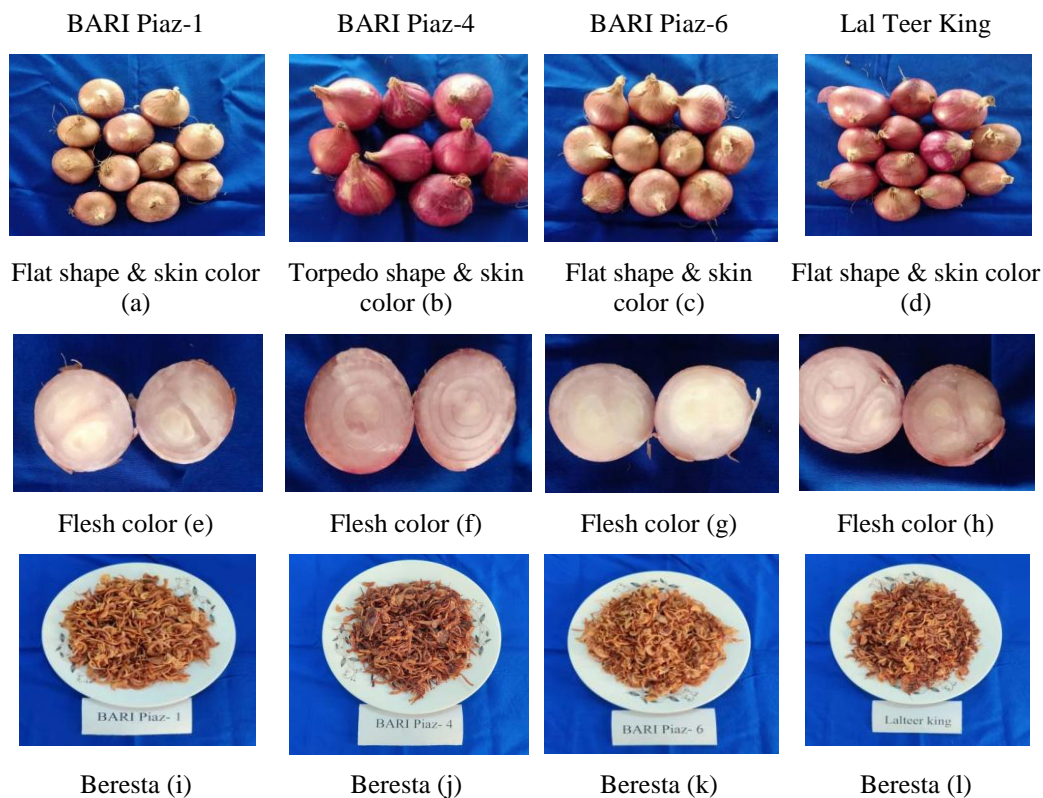
### Bulb color and beresta

There was a variation among the varieties of color of a bulb and Beresta (caramelized onion) shown in Table 4. The variety BARI Piaz-1, BARI Piaz-4, BARI Piaz-6 and Lal Teer King expressed bronze-red (Fig.1a), pink-red (Fig. 1b), next to bronze-red (Fig. 1c) and light-red skin color (Fig. 1d), respectively. The flesh color of bulb was reddish in BARI Piaz-4 (Fig. 1f) and Lal Teer King (Fig. 1h). But BARI Piaz-1 (Fig. 1e) and BARI Piaz-6 (Fig. 1g) demonstrated white flesh color in the bulb. The recorded variation in color of the bulb among the varieties might be due to their differences in genetic makeup. Similarly, Ratan *et al.* (2017) and Lancaster *et al.* (1995) also published significant variation among the varieties for the color of bulbs.

**Table 4.** Bulb color and Beresta quality of four varieties of onion

Variety	Color of bulb		Beresta (caramelized onion)		
	Skin	Flesh	Quantity (%)	Texture	Color
BARI Piaz-1	Bronze red	White	38.40	Highly crispy	Excellent
BARI Piaz-4	Pink red	Reddish	29.87	Soft	Darkish
BARI Piaz-6	Next to bronze red	White	32.31	Crispy	Good
Lal Teer King	Light red	Reddish	31.88	Light crispy	Darkish
CV (%)	-	-	3.95	-	-
LSD (0.05)	-	-	2.09	-	-
Level of sig.	-	-	**	-	-

\*\* Significant at 1% level of probability



**Fig. 1 (a-l)**

The highest amount of Beresta (38.4%) was made from BARI Piaz-1 significantly followed by BARI Piaz-6 (32.3%) and Lal Teer King (31.88%). Nonetheless, the lowest percent of Beresta was recorded from BARI Piaz-4 (29.87%). In respect of texture, BARI Piaz-1, BARI Piaz-6, Lal Teer King gave highly crispy, crispy, light crispy and soft beresta, respectively. The excellent (richly brown) and good (brown) colors of Beresta were observed in BARI Piaz-1 (Fig. 1i) and BARI Piaz-6 (Fig.1k), respectively. However, the colors of Beresta for BARI Piaz-4 (Fig.1j) and Lal Teer King (Fig.1l) were very poor (darkish). The darkish color of Beresta in BARI Piaz-4 and Lal Teer King might be due to their reddish flesh color. The variation for the quantity, texture and color of Beresta might be due to varietal characters.

### Conclusion

The findings of this study lead to the conclusion that among the varieties examined, BARI Piaz-1 exhibit superior quality and Beresta characteristics, but its yield was low. On the other hand, BARI Piaz-4 demonstrates remarkable dry weight and notable resistance to bolting. In terms of pungency and reduced splitting tendency, BARI Piaz-6 appeared as the top-performing variety. Lastly, when considering disease incidence, Lal Teer King stands out for its exceptional resistance.



## Conflicts of Interest

The authors declare no conflicts of interest regarding publication of this manuscript.

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