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Research article

Postharvest Performance Evaluation of Strawberry Varieties at Ambient Condition

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ABSTRACT

Though strawberry is an attractive and nutritious fruit, it perishes quickly at postharvest leading to high postharvest loss. The objective of the experiment was to evaluate the postharvest quality attributes of three strawberry varieties—RABI-3, BARI Strawberry-3, and Festival—at ambient conditions. The experiment was conducted from 30 March to 12 April 2021 at the Horticulture Laboratory of Agrotechnology Discipline, Khulna University, Bangladesh following a Completely Randomized Design (CRD) with three replications. Each replication consisted of 25 (≈ 500 g) freshly harvested strawberry fruits, which was evaluated for physical (diameter, firmness, and weight loss) and chemical (TSS, TA, pH, vitamin C, anthocyanin, and total carbohydrates) attributes along with the shelf life. Among three varieties of strawberries, Festival measured the highest polar diameter (4.48 cm) and fruit firmness (17.35 N). This variety also had the highest total soluble solids (8.86 %), titratable acidity (0.68%), and ascorbic acid (44.25 $mg100g^{-1}$). Moreover, the variety Festival resulted in the lowest fruit weight loss (16.63 %) and spoilage (18.36%) compared to RABI-3 and BARI Strawberry-3 at storage. The shelf life of this variety was the highest (8.55 days) among the studied strawberries. Considering other quality attributes like anthocyanin content and equatorial diameter, Festival also was a good variety. Therefore, the Festival is the best among the studied varieties. However, more experiments are suggested to validate the findings.

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Introduction

The cultivated strawberry (*Fragaria x ananassa* Duch.)—developed through hybridization of two native species of America, *Fragaria chiloensis* and *Fragaria virginiana*—is an attractive, tasty, luscious and nutritious fruit with a distinct, pleasant aroma and delicate flavor. Strawberry plant has very short stem or crown from where it produces leaves, runners, inflorescences as well as auxiliary crowns (Bowling, 2000; Darnell et al., 2003). Botanically, it is an aggregate non-climacteric fruit (Coombey, 1976). The fruit is extensively cultivated in the temperate and subtropical regions in the world. They are grown throughout the Europe, the United States, as well as in Canada, China, Russia, South America and many other countries.

Strawberry has been introduced in Bangladesh as an exotic fruit. Bangladesh has suitable climate in terms of photoperiod, temperature and humidity to cultivate strawberry. A number of varieties have been developed by different research organizations such as Bangladesh Agricultural Research Institute (BARI) developed BARI Strawberry-1, BARI Strawberry-2, and BARI Strawberry-3; Rajshahi University developed RABI-1, RABI-2 and RABI-3; Bangladesh Agricultural University (BAU) developed a few good varieties including FTIP-BAU Strawberry-1, FTIP-BAU Strawberry-2, and FTIP-BAU Strawberry-3; Bangladesh Agricultural Development Corporation (BADC) developed BADC Strawberry and Modern Horticulture Center of Natore developed Modern Strawberry-1, Modern Strawberry-2, Modern Strawberry-3, Modern Strawberry-4, and Modern Strawberry-5. Significant differences on field- and postharvest-performances were reported among strawberry cultivars in Bangladesh (Ahsan et al., 2014; Rahman et al., 2014; Chowhan et al., 2016). In this instance, choice of cultivars is of paramount importance (Asrey and Singh, 2004; Ahsan et al. 2014).

The postharvest quality of fruit comprises of fruit weight, polar diameter, equatorial diameter, firmness of fruit, color index, TSS, p^H, anthocyanin, carotenoid,

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flavonoids, total phenol, carbohydrate, ascorbic acid, titratable acidity, decay (%), and shelf life (Kader, 2002). These quality parameters can be retained by refrigeration, precooling, edible coatings, water/ heat/ edible oil or chemical treatments and packaging (Azam et al., 2019). Shelf life of strawberries can be extended at postharvest through modulating temperature and relative humidity, using packaging and modified atmosphere packaging, and maintaining controlled atmosphere and cold-chain system (Contigiani et al., 2018; Saad et al., 2022; Kuchi and Sharavani, 2019). Strawberry is a highly perishable fruit due to their soft texture, extreme tenderness, high level of respiration, high rate of softening and excess sensitivity to fungal attack (Quarshi et al., 2023). Postharvest losses of strawberry range from 25% - 40% due to inappropriate management practices, poor handling, low quality packaging and poor storage condition (Aday and Caner, 2014). Quality declines rapidly—by less than a week—after harvest (Wills et al., 2001). Strawberries should be kept at 0-4 °C to retain fruit quality (Khreba et al., 2014). However, farmers of our country may not have postharvest facilities or they are not capable of availing commercial postharvest amenities and therefore, they need to know about keeping quality of strawberry varieties at ambient condition. Considering the facts, the present study has been undertaken to evaluate the performance of three strawberry varieties.

Materials and Methods

Experiment site, materials and experimental design

The experiment was conducted at the Horticulture Laboratory of Agrotechnology Discipline during 30th March to 12th April 2021. The temperature and relative humidity of Horticulture Laboratory ranged from 26 ˚C to 31˚C and 80% - 90%, respectively. Three strawberry varieties—RABI-3, BARI strawberry-3, and festival—were collected from the farmer's field of Jhikargacha of Jashore at the morning hours. After harvesting, the fruits were precooled through a fan to remove the field heat and the fruits were transferred immediately to Horticulture Laboratory of Khulna University. Mature, uniform sized, and good quality fruits were used for the experiment without any physical damage. The experiment was laid out in Completely Randomized design (CRD) with three replications, and each replication consisted of 25 (≈ 500 g) freshly harvested strawberry fruits. Out of 25, 14 fruits were used for firmness and chemical measurements (TSS, TA, p^H, vitamin C, anthocyanin, total carbohydrates), and thus, 1-3 fruits were sampled at each date of measurement. The rest 11 fruits were used for weight loss and shelf life calculations.

The conical, reddish fruit of RABI-3 weighs 20-25 g on an average having pleasant aroma, and grows throughout the country (Ara et al., 2013). The fruit of BARI strawbeery-3 is long, conic shaped, attractive dark red color, firm textured with excellent aroma, and it weighs 19.97 g on an average (Mia, 2022). The fruit of Festival is conical, deep red at maturity having a firm texture and excellent flavor with an average fruit weight of 15-18 g (Chandler et al., 2000).

Physical attributes

Equatorial and polar diameter (cm)

The equatorial dimeter (D_e) and polar diameter ($D_{p)}$ were measured using digital slide callipers. Equatorial diameter is the maximum width of the strawberry in a plane perpendicular to the polar diameter. Polar diameter is the distance between the strawberry crown and the point of fruit attachment to the strawberry (Afrisal et al., 2013).

Determination of weight loss (%)

Five fruits were marked from each replication and weighed everyday with an electric balance to measure the weight of fruit. Fruit weight loss (%) was calculated following Wang et al. (2005) and Kabir and Hossain (2024) with the formula as -

$$\text{Weight loss (\%)} = \frac{M_0 - M_1}{M_0} \times 100$$

Where, M_0 is the fresh weight of strawberry fruit on the first day, and M_1 is the measured weight on the respective days.

Firmness measurement

Firmness was measured at 2, 5, 8, and 11 days after storage (DAS) with Shimadzu EZ-SX, USA Texture Analyzer equipped with a 2-mm diameter cylindrical probe. At least one fruit from each replication was tested at each sampling date. The probe was penetrated 5 mm with a crosshead speed of 2 mm/s. The maximum force firmness (N) was calculated from the force vs time curve.

Colorimetric parameters of fruit (L, a*, b* and h^o)*

The skin color of sample fruit was recorded on color coordinates as L*, a* and b* from opposite positions of each fruit in Commission International de L'Eclairage (CIE) units using a chromameter (HunterLab ColorFlex, Hunter Associates Inc., Reston, VA, USA). Hue angle (h°) was calculated as h° = $\tan^{-1}$ b*/a* (McGuire, 1992). Chromaticity L* represents the lightness of the fruit color, which ranges from 0 (black) to 100 (white). Chromaticity a* indicates the redness (+a*) or greenness (-a*), and chromaticity b* indicates the yellow (+b*) or blue (-b*) color of fruit skin. Hue angle (h°) indicates absorbance or reflection and the values refers to the intrinsic luminosity.

Chemical attributes of strawberry fruits

Among the chemical attributes, p^H, TSS, TA, vitamin C, and total carbohydrates were measured at 2, 5, 8 and 11 DAS, and anthocyanin was measured at 3, 7 and 11 DAS following Mazumdar and Majumdar (2001) and Saini et al. (2006). Thus, 1-2 fruits were sampled at each date of measurement.

Determination of pH of strawberry fruit

The p^H of strawberry fruit was measured by a desktop p^H meter. About 5 g of fresh fruit was taken in a conical flask with 10 ml of distilled water, crushed by a blender and the extract was filtrated. The pH meter was adjusted using standard buffer solutions (pH 7 and pH 4) along with temperature corrections, pH of the juice was measured and recorded.

Determination of total soluble solids (TSS, %) and titratable acidity (TA, %)

To determine total soluble solids (TSS), a drop of juice was placed on the prism of the Digital Brix Meter (Digital/Brix/RI-Check Refractometer, Reichert Technologies Inc., Japan) to get the direct reading.

Titratable acidity (TA) was measured through titration of aliquot against 0.01 N NaOH. A titration factor of 0.064 (as 0.064 g citric acid is neutralized by 1 ml 0.1 N NaOH) was included in the formula which is as follows-

$$\text{TA (\%)} = 100\times \frac{d\times 0.064\times c}{a\times b}$$

Here, a = sample weight, b = aliquot volume, c = final volume made with distilled water, d = mean burette reading.

Determination of ascorbic acid (mg 100g^{-1}) content

Ascorbic acid (mg per 100g) was estimated using the dye (2,6-dichlorophenol indophenol) titration method, as described by Nerdy (2018).

$$\text{Ascorbic acid (mg 100g}^{-1}) = \frac{e \times d \times b}{c \times a}$$

Here, a= Weight of sample

b= Volume made with metaphosphoric acid.

c= Volume of aliquot taken for estimation

d= Dye factor

e= Average burette reading for sample

Determination of total carbohydrates (g 100g^{-1})

Total carbohydrates were measured according to Mazumdar and Majumdar (2001) following the formula as stated below:

$$\text{Total carbohydrates} = \frac{mg\ of\ glucose}{Volume\ of\ test\ sample} \times 100$$

Determination of anthocyanin (mg 100g^{-1})

Ethanolic-hydrochloride is used to extract anthocyanin and the color intensity is measured calorimetrically. From the reading, the amount of the pigment present is determined according to the formula as follows:

$$\text{Total absorbance value of the sample (per 100 g)} = \frac{e \times b \times c}{d \times a} \times 100$$

Here, a denotes sample weight, b is volume made for color measurement, c indicates total volume made, d is the volume of aliquot taken for estimation, and e is the volume for 535 nm.

Anthocyanin (mg/100g) = $Total\ absorbance \div 98.2$

98.2= Constant value for equation

Fruit spoilage (%)

Spoiled fruit was counted and the percent fruit spoilage was calculated according to Matar et al. (2018) as follows:

$$\text{Fruit spoilage (\%)} = \frac{No.of\ spoiled\ fruit}{Total\ no.of\ fruit} \times 100$$

Shelf life (days)

Shelf life was determined on the basis of the physical parameters such as weight loss, change in color, firmness and % spoiled fruit. These parameters were judged through eye observation and the judgement criteria was determined in a consumer perspective to consider the fruit as acceptable for buying or selling. In this light, the average days required for losing a cumulative weight of 25%, change of color from deep red to pale red, retaining at least eating softness and reasonably minimum spoiled fruit (maximum 5%) was noted as end shelf life of the fruits (Tabassum et al., 2018).

Statistical analysis

The collected data were statistically analyzed by One-way Analysis of Variance using STATISTIX 10 computer package program. The mean differences were computed by Least Significant Difference (LSD) Test at 5% level of significance.

Results and Discussion

Physical characteristics of strawberry fruits

Fruit weight loss (%)

During the total storage period of 11 days, fruit weight loss (%) varied significantly among the three strawberry varieties (Fig. 1). The lowest fruit weight loss (16.63 %) was reported for the variety Festival followed by BARI strawberry-3 (22.57 %), and the highest weight loss (25.42%) was found for the variety Rabi-3 (Fig. 1). Strawberry varieties Camarosa, Cavendish and Chandler also differed significantly regarding weight loss (Koyuncu, 2004) suggesting existence of varietal differences among the strawberry varieties which might be due to genetical causes.

Polar diameter (cm) and equatorial diameter (cm)

Polar and equatorial diameters (cm) of strawberry varieties were measured at 2, 5, 8, and 11 days after storage (DAS) and both the diameters for all the strawberry varieties showed a decreasing trend over the period of storage (Table 1-2). The variety Festival resulted in the highest polar diameter (4.48 cm) at 2 DAS and the variety Rabi-3 had the lowest (3.27 cm) polar diameter at 11 DAS. Variety Festival always had the highest polar diameter which is generally followed by BARI strawberry-3 and Rabi-3 (Table 1). BARI strawberry-3 measured the highest equatorial diameter (4.16 cm) followed by Festival (3.71 cm) and Rabi-3 (3.41 cm) at 2 DAS (Table 2). Similar trends were observed for other DAS (5, 8, and 11) regarding equatorial diameter and the lowest equatorial diameter (3.10 cm) was found in Rabi-3. It is reported that fruit diameter decreases day by day at storage (Rolle, 2006) which may be due to genetic composition of variety. Similarly, diameters varied among Festival, Rabi-3, and Camarosa varieties of strawberries (Ahsan et al., 2014), and diameters and lengths varied among EMCO 33, EMCO 32, Florida Fortuna, Florida Beauty, and Sweet Sensation varieties of strawberries (Dhakal et al., 2022).

Fruit firmness (N)

At 2 DAS, the variety Festival showed the highest fruit firmness (17.35 N) which was 2.28 and 1.17 times higher than Rabi-3 and BARI strawberry-3, respectively (Table 3). Though fruit firmness of all the strawberry varieties decreased as the storage period increased, it was faster for the variety Festival followed by BARI strawberry-3 and Rabi-3. However, seven varieties of strawberry did not differ based on firmness (Sturzeanu, 2020) though the firmness loss of fruit during storage was found to be significant.

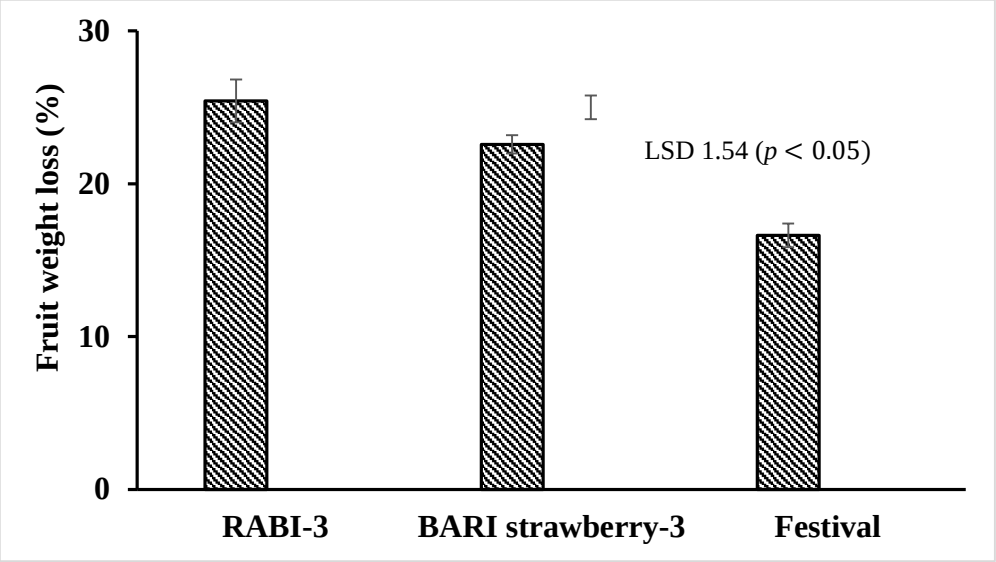

Figure 1: Fruit weight loss (%) as affected by strawberry varieties at ambient condition. The error bar represents mean ± SE (standard error). LSD stands for least significant difference.

Table 1: Varietal differences regarding polar diameter (cm) of strawberry at different days after storage (DAS)

	Polar diameter (cm) [a]			
Varieties	**2 DAS**	**5 DAS**	**8 DAS**	**11 DAS**
RABI-3	4.18 b	3.93 c	3.59 de	3.27 g
BARI strawberry-3	4.20 b	3.91 c	3.54 ef	3.32 fg
Festival	4.48 a	4.31 ab	3.8 cd	3.37 efg
LSD (0.05)			0.23	

[a] Values represent average of at least three measurements. Treatment means with similar letter(s) are statistically non-significant at 5% level of probability (p<0.05). LSD is least significant difference.

Table 2: Varietal differences regarding equatorial diameter (cm) of strawberry at different days after storage (DAS)

	Equatorial diameter (cm) [a]			
Varieties	**2 DAS**	**5 DAS**	**8 DAS**	**11 DAS**
RABI-3	3.41 ef	3.33 fgh	3.2 hi	3.1 i
BARI strawberry-3	4.16 a	3.89 b	3.53 de	3.38 fg
Festival	3.71 c	3.59 cd	3.4 f	3.26 gh
LSD (0.05)			0.13	

[a] Values represent average of at least three measurements. Treatment means with similar letter(s) are statistically non-significant at 5% level of probability (p<0.05). LSD is least significant difference.

Table 3: Varietal difference regarding firmness of strawberry at different days after storage (DAS)

	Firmness (N) [a]			
Varieties	**2 DAS**	**5 DAS**	**8 DAS**	**11 DAS**
RABI-3	7.59 g	7.35 gh	7.02 h	6.56 i
BARI strawberry-3	14.78 c	13.41 d	11.41 e	10.25 f
Festival	17.35 a	16.45 b	14.42 c	11.94 e
LSD (0.05)			0.45	

[a] Values represent average of at least three measurements. Treatment means with similar letter(s) are statistically non-significant at 5% level of probability (p<0.05). LSD is least significant difference.

Table 4: Fruit color (L*, a*, b*, and h^o) attributes of strawberry at different days after storage (DAS) [a]

Varieties	3 DAS	7 DAS	11 DAS
		L*	
RABI-3	38.43 ab	37.5 bc	33.29 e
BARI strawberry-3	39.14 a	36.92 c	34.72 d
Festival	39.11 a	35.66 d	34.98 d
LSD (0.05)		1.17	
		a*	
RABI-3	13.96 bc	13.77 bc	13.03 cd
BARI strawberry-3	14.86 ab	14.38 b	12.93 cd
Festival	15.78 a	14.35 b	12.08 d
LSD (0.05)		1.09	
		b*	
RABI-3	14.36 ab	13.36 cde	14.12 abc
BARI strawberry-3	12.91 ef	14.78 a	12.31 f
Festival	14.06 a-d	13.68 b-e	13.14 def
LSD (0.05)		0.97	
		Hue (h°)	
RABI-3	42.62 a	32.79 d	33.63 cd
BARI strawberry-3	38.68 b	33.94 cd	37.41 b
Festival	34.17 c	32.85 d	33.75 cd
LSD (0.05)		1.3	

[a] *Values represent average of at least three measurements where an L* is lightness (0 = black and 100 = white); a* (negative = greener and positive = redder); b* (negative = bluer, positive = more yellow), and h° represents hue angle. Treatment means with similar letter(s) are statistically non-significant at 5% level of probability (p<0.05). LSD is least significant difference.*

Colorimetric parameters (L*, a*, b* and h^o) of strawberry fruits

Colorimetric parameters were measured at 3, 7, and 11 days after storage (DAS) and were significant among the varieties. Most of the parameters showed a falling off trend as the times elapsed (Table 4). The highest value of color L* (39.14) was obtained from the variety BARI strawberry-3 at 3 DAS and lowest was obtained from RABI-3 (33.29) at 11 DAS. The variety Festival yielded the highest (15.78) and the lowest (12.08) value of color a* at 3 and 11 DAS, respectively (Table 4). Similarly, the strawberry variety BARI strawberry-3 resulted in the highest (14.78) and the lowest (12.31) value of color b* at 3 and 11 DAS, respectively (Table 4). The highest and the lowest hue angle (h^o) were recorded at 3 DAS (42.62) and at 7 DAS (32.79), respectively for RABI-3. Varietal differences on color attributes (a*, b* and h^o) of strawberry were reported (Koyuncu, 2004). Slow development of color may indicate lower respiration rate along with reduced ethylene production resulting in slow down the process of ripening and senescence (Ali et al., 2011). A gradual decrease in color L* means dark color with ripening of fruits and beginning to spoil (Ngo et al., 2021). A decreasing trend of color a* and color b* were reported for Camarosa, Cavendish and Chandler variety of strawberry (Koyuncu, 2004). However, h^o increased in strawberry in the cold storage (Koyuncu, 2004) indicating that cold storage can enhance development of color attributes of fruits.

Chemical attributes

Chemical attributes such as total soluble solid (TSS, %), titratable acidity (TA, %), pH, ascorbic acid (mg100g^{-1}) and total carbohydrates (g100g^{-1}) of strawberry varieties were measured at 2, 5, 8, and 11 days after storage (DAS) and anthocyanin (mg100g^{-1}) content was measured at 3, 7, and 11 DAS.

TSS (%)

TSS content varied among the strawberry varieties at different DAS and it decreased as the storage time increased. At 2 DAS, the maximum TSS (%) was measured for the variety Festival (8.86 %) which was 1.55 times higher than the variety RABI-3 and the minimum TSS was recorded for the variety RABI-3 (5.19 %) at 11 DAS (Table 5). TSS content varied from variety to variety (Aziz et al., 2018) and the highest TSS (12.6%) was reported for the variety Festival (Ahsan et al., 2014). TSS content also varied among EMCO 33, EMCO 32, Florida Fortuna, Florida Beauty, and Sweet Sensation strawberries (Dhakal et al., 2022).

Titratable acidity (TA) (%)

TA also varied among the strawberry varieties and at 2 DAS, the highest TA (0.68%) was observed for both BARI Strawberry-3 and Festival and the lowest TA (0.66%) was measured for the variety RABI-3 (Table 5). However, TA content of 'Chandler' strawberry was 0.91% (Aziz et al., 2018). TA content decreased gradually as the storage period increased. Similarly, decreasing trend of TA from DAT 0 to DAT 10 for the varieties Camarosa, Cavendish and Chandler were reported (Koyunch, 2004). Varieties EMCO 33, EMCO 32, Florida Fortuna, Florida Beauty, and Sweet Sensation had different titratable acidity (Dhakal et al., 2022).

pH

The differences were observed during the storage period for all three varieties. The pH values of strawberry fruits fluctuated without following any trend and varied from 3.29 to 3.69 indicating acidic nature of strawberry fruits (Table 5). Similarly, p^H varied among EMCO 33, EMCO 32, Florida Fortuna, Florida Beauty, and Sweet Sensation strawberries (Dhakal et al., 2022).

Ascorbic acid (mg100g^{-1})

The ascorbic acid content differed significantly among the strawberry varieties and the maximum ascorbic acid (44.31 mg100g^{-1}) was measured for the variety BARI strawberry-3 which was statistically similar with Festival (44.25 mg100g^{-1}) as 2 DAS (Table 6). The ascorbic acid content decreased for all three varieties as the storage period increased and the lowest ascorbic acid (37.85 mg100g^{-1}) was reported for the variety Festival at 11 DAS which was statistically similar to RABI-3 at 11 DAS (Table 6). The findings from the present study are similar to the findings of other studies which reported varietal difference regarding ascorbic acid content of strawberry fruits (Akter et al., 2018; Singh et al., 2008). Similarly, ascorbic acid content differed among EMCO 33, EMCO 32, Florida Fortuna, Florida Beauty, and Sweet Sensation strawberries (Dhakal et al., 2022).

Total carbohydrates (g100g^{-1})

The total carbohydrates content (g100g^{-1}) of strawberry varieties varied significantly and at 2 DAS, RABI-3 had the highest total carbohydrates (7.99 g100g^{-1}) followed by Festival (7.73 g100g^{-1}) and BARI strawberry-3 (7.49 g100g^{-1}) (Table 6). Very similar trend of decreasing total carbohydrates was noticed for all the three varieties. Other studies also reported that the total carbohydrates content of strawberry varieties varied (Saied et al., 2005) and the higher total carbohydrates (6.81%) were reported from the variety Camarosa (Ahmed et al., 2018).

Anthocyanin (mg100g^{-1})

The variety RABI-3 contained the highest amount of anthocyanin (38.68 mg100g^{-1}) at 7 DAS and the lowest anthocyanin (36.15 mg100g^{-1}) was reported from the variety BARI strawberry-3 at 11 DAS (Table 7). Varietal differences of anthocyanin content of strawberry fruit were also documented (Singh et al., 2008).

Fruit spoilage (%)

The minimum fruit spoilage (%) was calculated for the variety Festival (18.36 %) followed BARI strawberry-3 (20.53 %), and the maximum spoilage was recorded from the variety RABI-3 (21.01%) at the end of 11 days of storage (Fig. 2). Similarly, the variety Festival has been reported as the less susceptible to spoilage (Das et al., 2015). The variety Elsanta also showed resistant to spoilage compared to the other strawberry varieties (Nes, 1996) suggesting varietal differences of spoilage among the strawberry varieties which might be due to their genetic make-up.

Table 5: Total soluble solid (TSS), titratable acidity (TA), and pH of strawberry varieties at different days after storage (DAS) [a]

Varieties	**2 DAS**	**5 DAS**	**8 DAS**	**11 DAS**
	Total soluble solid (TSS) (%)			
RABI-3	5.68 f	5.9 e	5.73 ef	5.19 g
BARI strawberry-3	8.04 b	7.95 b	7.47 c	7.13 d
Festival	8.86 a	8.82 a	8.69 a	8.04 b
LSD (0.05)		0.18		
	Titratable acidity (TA) (%)			
RABI-3	0.66 c	0.65 d	0.63 e	0.62 f
BARI strawberry-3	0.68 a	0.66 b	0.64 d	0.62 f
Festival	0.68 a	0.67 b	0.64 d	0.62 f
LSD (0.05)		0.01		
	pH			
RABI-3	3.54 abc	3.51 abc	3.41 cd	3.38 cd
BARI strawberry-3	3.61 ab	3.43 bcd	3.29 d	3.41 cd
Festival	3.64 a	3.69 a	3.56 abc	3.38 cd
LSD (0.05)		0.19		

[a] Values represent average of at least three measurements. Treatment means with similar letter(s) are statistically non-significant at 5% level of probability (p<0.05). LSD is least significant difference.

Table 6: Ascorbic acid (mg100g^{-1}) and total carbohydrates (g100g^{-1}) content of strawberry varieties at different days after storage (DAS) [a]

Varieties	**2 DAS**	**5 DAS**	**8 DAS**	**11 DAS**
	Ascorbic acid (mg100g^{-1})			
RABI-3	43.34 b	41.6 d	40.05 f	38.27 h
BARI strawberry-3	44.31 a	42.71 c	40.76 e	39 g
Festival	44.25 a	41.78 d	39.42 g	37.85 h
LSD (0.05)		0.58		
	Total carbohydrates (g100g^{-1})			
RABI-3	7.99 a	7.84 b	7.63 d	7.45 ef
BARI strawberry-3	7.49 e	7.38 f	7.27 g	7.14 h
Festival	7.73 c	7.59 d	7.41 ef	7.29 g
LSD (0.05)		0.08		

[a] Values represent average of at least three measurements. Treatment means with similar letter(s) are statistically non-significant at 5% level of probability (p<0.05). LSD is least significant difference.

Table 7: Varietal difference regarding anthocyanin content of strawberry varieties at different days after storage (DAS)

Varieties	Anthocyanin (mg100g^{-1}) [a]		
	3 DAS	7 DAS	11 DAS
RABI-3	38.57 ab	38.68 a	37.33 e
BARI strawberry-3	37.79 d	37.88 d	36.15 g
Festival	38.29 bc	38.05 cd	36.9 f
LSD (0.05)		0.32	

[a] *Values represent average of at least three measurements. Treatment means with similar letter(s) are statistically non-significant at 5% level of probability (p<0.05). LSD is least significant difference.*

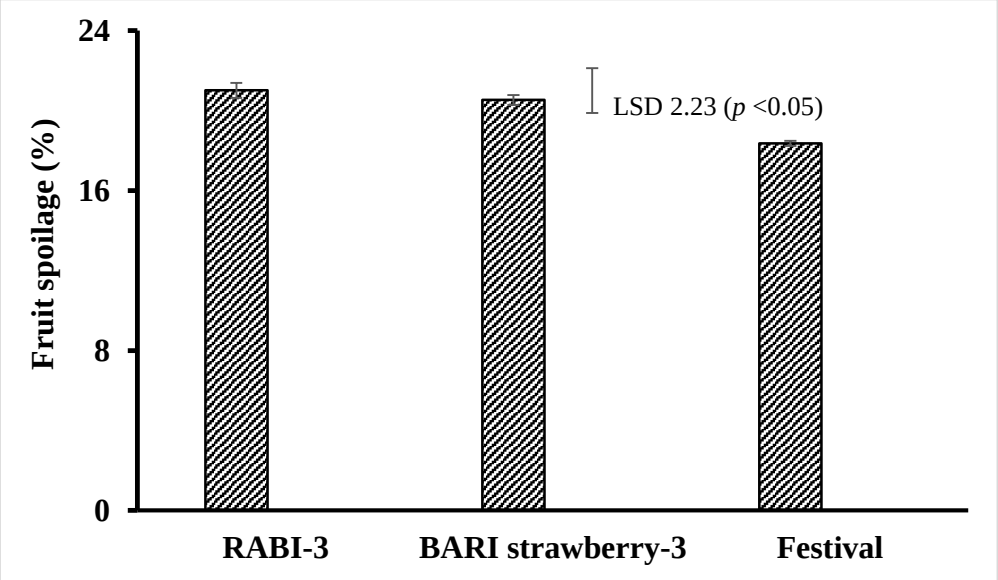

Figure 2: Fruit spoilage (%) as affected by strawberry varieties at ambient condition. The error bar represents mean ± SE (standard error). LSD stands for least significant difference.

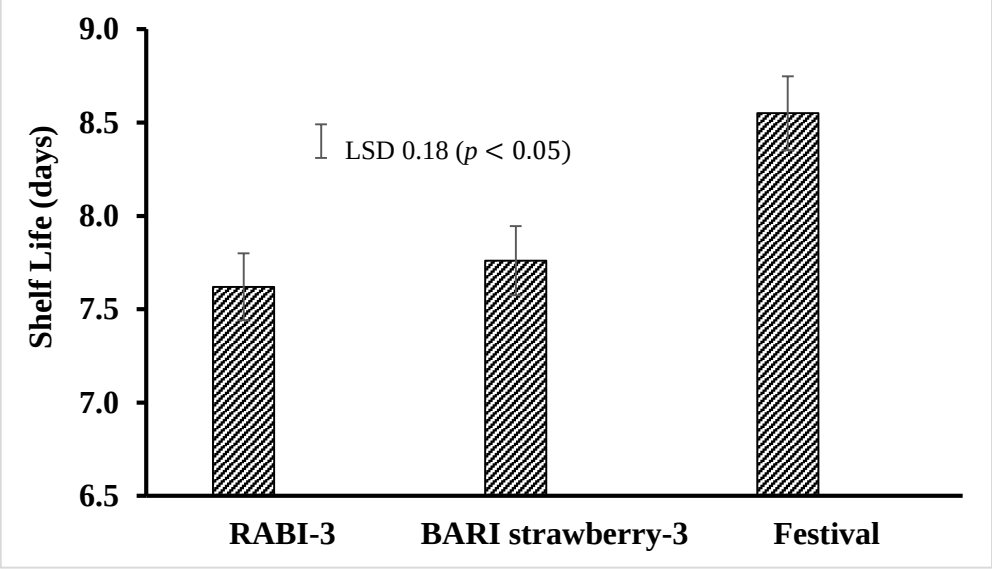

Figure 3: Shelf life (day) of strawberry varieties at ambient condition. The error bar represents mean ± SE (standard error). LSD stands for least significant difference.

Shelf life (days)

The shelf life varied among the strawberry varieties and the maximum shelf life (8.55 days) was obtained from the variety Festival. The shelf life of RABI-3 and BARI strawberry were very similar and ranged from 7.62 days (RABI-3) to 7.76 days (BARI strawberry). The shelf life strawberry fruits vary from variety to variety (Akter et al., 2018; Nes, 1996) suggesting involvement of genetic constitution regarding shelf life of strawberry varieties.

Conclusion

The variety Festival resulted in the highest polar diameter, fruit firmness, TSS, TA, ascorbic acid, and shelf life. Moreover, this strawberry variety had the lowest fruit weight loss and lowest rate of spoilage during the period of storage. The festival had a moderate equatorial diameter and anthocyanin content among the strawberry varieties, suggesting that the festival performed better at the ambient conditions among the studied varieties. However, we recommend more studies comprising other strawberry varieties to have a better understanding of strawberry varieties regarding postharvest storage at ambient conditions.

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Competing Interest

The authors report that there are no competing interests to declare.

Credit Author Statement

Sheikh Nymur Rashid Lekhon: Methodology, Investigation, Data Analysis, Writing – the first draft; Shamim Ahmed Kamal Uddin Khan: Supervision, Conceptualization; Sadia Shawkat: Methodology, Physical and Chemical Analyses; Md. Yamin Kabir: Co-supervision, Data Analysis, Writing – final draft, review & editing.

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