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FIELD PERFORMANCE AND FRUIT QUALITY OF STRAWBERRY GENOTYPES UNDER SUBTROPICAL CLIMATE

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Abstract

Thirteen strawberry genotypes collected from different sources were evaluated at the Fruit Research Field of Pomology Division, HRC, BARI, Gazipur, Bangladesh during the winter season of 2009-2010 and 2010-2011 for yield, yield contributing characters and nutrient components of fruit. Among the 13 genotypes studied, the plants of FA 005 produced the maximum number of fruits (43.50 plant^{-1}) followed by FA 006 and FA 007 (37.50 plant^{-1}), while FA 009 and FA 013 produced the minimum number of fruits (9.00 plant^{-1}). The heaviest fruits were produced by FA 006 (18.73 g) followed by FA 007 (17.40 g) and FA 005 (16.96 g) which were statistically similar, while the lightest fruit was found in FA 014 (5.11 g). The fruit yield plant^{-1} of different genotypes varied from 52.00 to 737.70 g and plants of FA 005 produced the maximum yield followed by FA 006 (702.30 g plant^{-1}) and these were significantly higher than those of others. The minimum yield plant^{-1} was recorded in FA 013 and FA 014. The TSS content was highest in FA 007 (8.50 %) followed by FA 017 (8.17 %), whereas the lowest was in FA 009 (6.33 %). The TSS to acid ration was maximum in FA 006 (11.32) followed by FA 017 (11.24), FA 007 (10.80) and FA 005 (10.62), while the lowest was in FA 011 (6.95). The sugar to acid ratio significantly ranging from 3.60 to 5.98, and it was maximum in FA 006 (5.98). Plants of FA 005 contained the maximum amount of ascorbic acid (77.33 mg 100g^{-1}) followed by FA 006 (76.00 mg 100g^{-1}), while the minimum in FA 010 (53.00 mg 100g^{-1}).

Keyword: Strawberry, field performance, yield, fruit quality

Introduction

Strawberries (*Fragaria x ananassa* Duch) is a highly appreciated fruit for its excellent flavour, wonderful taste, attractive colour, high nutrient profile and cosmic medicinal value. Strawberry is now grown successfully in Bangladesh. It was demonstrated that genotype is the main source of variation and single most important factor that influenced the growth, yield and quality of fruit. Today's strawberry

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comprises about 500 commercial cultivars grown worldwide (Galletta and Maas, 1990; Hancock, 1999). Hence, a germplasm pool with good variability for the desirable characters is the basic requirement of any crop improvement program (Singhania *et al*., 2006). On the other hand, crop improvement is primarily dependent on extensive evaluation of available genotypes. Therefore, the choice of a cultivar is of paramount importance for successful strawberry cultivation (Asrey and Singh, 2004). As a new crop it is necessary to evaluate the yield, yield contributing and quality characters of fruits under Bangladesh condition. Yield and yield contributing characters is the ultimate goal of any crop production and the fruit quality and nutrient components is the basic requirement of a crop. Hence, studies about these important traits are necessary for successful cultivation of this crop in a new area like Bangladesh.

Bangladesh Agricultural Research Institute (BARI) has released one variety of strawberry namely BARI Strawberry-1, which is not enough for increasing demand of strawberry cultivation. So it is necessary to develop more variety of this promising crop with higher yield, fruit quality and nutrient profile. There are very little studies done on the performance regarding yield, yield contributing, fruit quality and nutrient components of strawberry in Bangladesh. However, a good number of investigations were done in USA, India, UK, Thailand, Turkey and elsewhere in the world. Therefore, the present study was undertaken to evaluate the collected strawberry genotypes for fruit, yield, yield contributing characters, quality parameters and nutritional components of fruits and to select superior ones.

Materials and Method

The present study was carried out at the Fruit Research Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute (Latitude $23^0 59'$ N, Longitude $90^0 24'$ E, Altitude 14.33 m), Gazipur, Bangladesh during winter season of 2009-2010 and 2010-2011. This region falls in sub-tropical zone having hot summers (May–August) and mild winter (December–February). Cumulative rainfall of about 108 mm during cultivation period with average 79.4 % relative humidity. The mean maximum and minimum temperature during cropping period were 25.89 and 17.05^0C, respectively. Soil of the experimental farm was clay loam, having pH 6.2 (slightly acidic), which was low in organic carbon (0.95 %), very low in available phosphorus (9 ppm) and low in potash (0.17 meq/100 g soil).

Healthy and disease free propagules of ‘thirteen strawberry genotypes collected from local and exotic source were considered as treatment and planted in the experiment field the only released strawberry variety namely BARI Strawberry-1 used as check.

The experiment was laid out in randomized complete block (RCB) design with three replications. The unit plot size was 100 x 280 cm and the plants were spaced 50 x 40 cm on open beds. Beds were raised 30 cm above main field with 50 cm drain in-between 2 beds. Each plot contains double row accommodating 14 plants. Daughter plants of strawberry genotypes were planted on 15 October, 2009 and 2010. Data were collected from inner plants from each row to avoid border effect. In each unit plot ten inner plants were selected for recording data.

Runners were removed at every 3 to 4 days intervals in order to make the crown capable to initiate flowers. Straw mulch was applied around the plants as a normal practice in order to conserve soil moisture, decreasing weed and to provide healthy condition for the fruits. Weeds were removed at 15 days interval up to final harvest to keep the crop weed free. Irrigation was given at 7 days interval and whenever necessary to keep the soil moisture available in the field for better plant growth. All other necessary cultural practices and plant protection measures were followed uniformly for all the plots and treatments during the entire period of experimentation. Fruits were usually harvested by hand picking during early in the day when environment was cool, at an interval of 3 to 4 days and handled very carefully. The fruits were harvested at commercial maturity when >80% of the fruit surface showing red colour. Immediately after harvest, strawberries were sorted to eliminate damaged fruit, and selected for uniform size and colour for collecting data.

The following qualitative characters of fruit viz. shape, uniformity, colour, firmness and flavour were recorded by close observation according to the descriptors for strawberry (IBPGR, 1986). On the other hand, number of fruits plant^{-1}, fruit weight (g), fruit length (cm), fruit diameter (cm), yield plant^{-1} (g), days to harvest, harvest duration, deform fruits (%) and number of achenes fruit^{-1} were recorded for quantitative fruit characters. Following chemical and nutrient components were recorded viz. reducing sugar, non-reducing sugar, total sugar, total soluble solid (TSS), pH, titratable acidity, TSS to acid ratio, sugar to acid ratio and ascorbic acid contents of fruits**.**

Two year’s data of different quantitative parameters were pooled and analyzed, following RCB design using MSTAT-C program. The mean comparison was done following the Duncan’s Multiple Range Test (DMRT).

Results and Discussion

Qualitative characters of fruits

Qualitative characters of different strawberry genotypes was studied and shown in Table 1. Fruit shape of different strawberry genotypes was classified into 6 shapes.

Plants of FA 001, BARI Strawberry-1, FA 008 and FA 011 produced conical shaped fruits. While fruits of FA 007 and FA 017 were long conical shaped. On the other hand, FA 006 and FA 016 produced wedged shaped fruits. Fruits of FA 009 and FA 013 was oblate shaped, and that of FA 010 and FA 014 was round shaped and FA 005 was cordate shaped. This findings are similar to that of Jamieson (2003) and Rahman and Ahmad (2009). Uniformity of fruits of different strawberry genotypes was studied and categorized into high, intermediate and low grade. Genotypes of FA 005, FA 006, FA 007, FA 016 and FA 017 produced highly uniform fruits. While fruits of BARI Strawberry-1, FA 008, FA 011 and FA 013 were intermediate in fruit uniformity. Rest of the genotypes produced fruits having low uniformity. Colour of fruits of different strawberry genotypes was studied and classified into light, intermediate, dark and very dark category. Fruits of FA 009, FA 010, FA 013 and FA 014 had light colour. While those of FA 001, FA 008 and FA 011 were intermediate in colour, BARI Strawberry-1, FA 006 and FA 016 had dark, FA 005, FA 007 and FA 017 had very dark coloured fruis.

Table 1. Qualitative characters of fruits in strawberry genotypes.

Genotypes	Shape of fruits	Uniformity of fruits	Colour of fruits	Fruit firmness	Flavour of fruits
FA 001	Conical	Low	Intermediate	Very soft	Slight
FA 005	Cordate	High	Very Dark	Intermediate	Excellent
FA 006	Wedged	High	Dark	Firm	Excellent
FA 007	Long Conic	High	Very dark	Very Firm	Excellent
FA 008	Conical	Intermediate	Intermediate	Very soft	Excellent
FA 009	Oblate	Low	Light	Soft	Poor
FA 010	Round	Low	Light	Soft	Good
FA 011	Conical	Intermediate	Intermediate	Very Soft	Good
FA 013	Oblate	Intermediate	Light	Very Soft	Poor
FA 014	Round	Low	Light	Intermediate	Slight
FA 016	Wedged	High	Dark	Firm	Excellent
FA 017	Long Conic	High	Very dark	Very Firm	Excellent
BARI Strawberry-1	Conical	Intermediate	Dark	Soft	Good

Fruit firmness of different strawberry genotypes was classified into 5 categories viz. very soft, soft intermediate, firm and very firm. Among the genotypes, FA 001, FA 008, FA 011 and FA 013 produced very soft fruits. Whereas fruits of BARI Strawberry-1, FA 009 and FA 010 were soft textured. On the other hand, fruits of FA 005 and FA 014 were intermediate textured. Fruits of FA 006 and FA 016 were firm and those of FA 007 and FA 017 were very firm in texture. Zhang *et al.* (2010) found that fruits of 'Shu Xiang' were very firm in texture. Fruit flavour was classified into 4 group viz. absent, poor, slight, good and excellent. Among the genotypes FA 009 and FA 013 produced fruits with poor in flavour, FA 001 and FA 014 were of slight in flavour. While fruits of BARI Strawberry-1, FA 010 and FA 011 were good in flavour, and FA 005, FA 006, FA 007, FA 008, FA 016 and FA 017 produced fruits with excellent flavour. Rahman and Ahmad (2009) stated that fruit flavour of different strawberry lines distinguishably differed and varied from poor to excellent. Similar fruit flavour was observed in the present investigation.

Yield and yield contributing characters

Average number of fruits plant^{-1} exhibited wide range of variation among the genotypes (Table. 2). The highest number of fruits (43.50) was harvested from FA 005 distantly followed by BARI Strawberry-1 (39.00), FA 017 (38.51), FA 006 (37.50), FA 016 (37.50), FA 008 (37.50) and FA 007 (36.00). The lowest number of fruits (9.00) was produced by the genotype FA 009 and FA 013. Asrey and Singh (2004) found a significant variation in fruits plant^{-1} among the cultivars ranging from 25.33 to 40.66. This result is in conformity with the present finding. Lutchoomun and Cangy (1997) found that strawberry cv. 'Marquise' produced the highest number of fruits plant^{-1} (69) followed by 'Mara des bois' (62), while single plant of cv. 'Selva' produced only 31 fruits which was higher than present observation. The variation in fruits plant^{-1} is due to inherent capability of the genotypes, and also influences of growing environment. The genotype significantly influenced the fruit weight (Table.2). The heaviest fruits were produced by FA 006 (18.73 g) closely followed by FA 007 (17.40 g) and FA 005 (16.96 g), while the lightest fruit was found in FA 014 (5.11 g). Fruit weight recorded in the present experiment was strongly similar to the findings of Crespo (2010), who stated that cv. Asia produced heaviest fruit (26.4 g) and cv. Antea produced the lightest fruits (14.8 g). Present findings are also confirmed with the previous reports of Cordenunsi *et al*. (2002) and Asrey and Singh (2004). They found that single fruit weight of strawberry varied significantly among the studied genotypes. In respect of length and diameter all the genotypes varied significantly probably due to the inherent characters of genotype (Table 2). The longest fruits were produced by FA 007 (5.10 cm) followed by FA 005 (4.50 cm), FA 017 (4.50 cm) and FA 006 (4.40 cm) and the shortest fruits were produced by FA-014 (1.30 cm). The thickest fruit was found in FA 006 (4.20 cm) followed by FA 005 (4.10 cm) and FA 007 (3.80 cm). The thinnest fruit was produced by FA 013 (1.30 cm). This result fully agrees with the previous findings of Asrey and Singh (2004) and Cordenunsi *et al*. (2002).

Asrey and Singh (2004) observed that the size of strawberry fruits among the genotypes varied significantly and fruit length of different strawberry cultivar ranged from 3.49 to 4.21 cm and fruit width ranged from 2.91 to 3.40 cm, respectively.

Table 2. Yield and yield contributing characters in strawberry genotypes

Genotypes	Fruits plant^{-1} (No.)	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)
FA 001	25.50 c	9.95 ef	3.40 d	2.50 de
FA 005	43.50 a	16.96 ab	4.50 ab	4.10 ab
FA 006	37.50 b	18.73 a	4.40 ab	4.20 a
FA 007	36.00 b	17.40 ab	5.10 a	3.80 a-c
FA 008	37.50 b	12.07 de	3.90 b-d	3.30 bc
FA 009	9.00 f	9.04 fg	2.20 e	2.20 e
FA 010	16.50 e	7.35 gh	2.00 e	2.20 e
FA 011	21.00 d	7.14 gh	2.10 e	2.10 e
FA 013	9.00 f	5.78 h	1.50 ef	1.30 f
FA 014	13.50 ef	5.11 h	1.30 f	1.70 ef
FA 016	37.50 b	15.33 bc	4.20 bc	3.77 a-c
FA 017	38.51 b	14.47 c	4.50 ab	3.63 a-c
BARI Strawberry-1	39.00 b	13.35 cd	3.63 cd	3.20 cd
CV (%)	6.78	8.61	8.92	11.28

Figures having the same letter(s) in a column do not differ significantly by DMRT at 1 % level of significant.

The analysis of variance indicated a high degree of variation among the genotypes in yield plant^{-1} (Fig. 1). The highest yield plant^{-1} was recorded from the genotype FA 005 (737.70 g) followed by FA 006 (702.30 g) and was significantly higher than others. The lowest yield plant^{-1} was recorded from FA 013 (52.00 g). The variation in yield plant^{-1} was might be due to the inherent character of the genotypes. This was in agreement with the findings of following investigations. From different experiments Lutchoomun and Cangy (1997) and Crespo (2010) stated that fruit yield plant^{-1} in strawberry varied significantly among the cultivars studied ranging from 179.00 to 312.40 g and 386.00 to 624.00 g plant^{-1}, respectively.

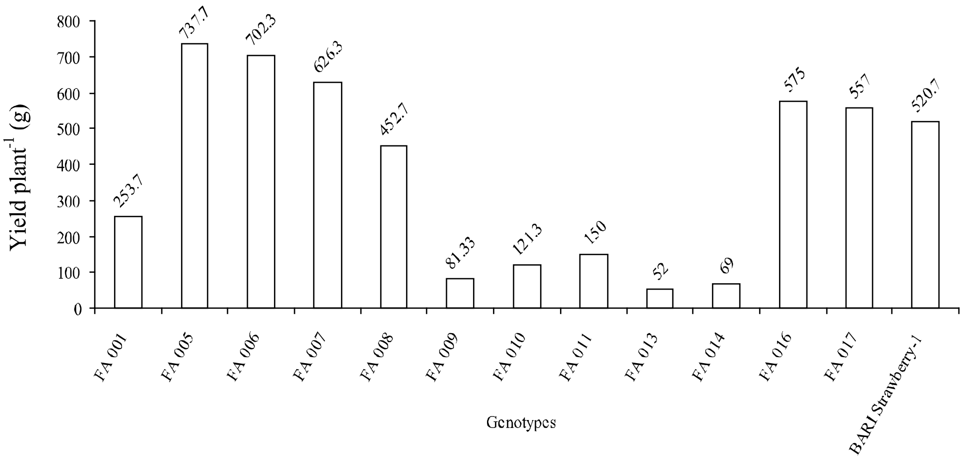

Fig. 1. Yield plant^{-1} in different strawberry genotypes.

The analysis of variance indicates a high degree of variation among the genotypes in days to harvest (Table 3). The genotypes, FA 011 required the minimum days (25.37) for attaining full maturity to harvest from flowering preceded by FA 013 (27.33 days), FA 010 (27.33 days), FA 009 (27.67 days) and FA 014 (28.67). While genotypes FA 007 required maximum days (35.67) from flowering to harvesting. This is in line with the findings of Klein and Perry (1982), who stated that strawberry usually, takes more or less 30 days to achieve full size and maturity of fruits. Anon. (2010) noted that fruits of strawberry matured rapidly, ripening occurs in 20 to 50 days after pollination. Harvest duration is an important character and it indicates a period during which a genotype is able to produce fruits. The longest harvest duration was observed in the genotype FA 007 (94 days) followed by FA 006 (93.67 days) and FA 005 (92.00 days). While, FA 014 had the shortest harvest duration (70.67 days) (Table 3). As a consequence the source-sink relation varies during the harvest and may affect the fruits composition. A significant variation among the strawberry cultivars in harvest duration under conventional system was observed by Macit *et al*. (2007), which is similar with present result.

The analysis of variance indicates a high degree of variation among the genotypes in yield plant^{-1} (Table 3). Among the genotypes, FA 001 produced minimum (10.33 %) deformed fruits preceded by FA 008 and FA 010 (12.33 %), while FA 014 produced maximum (26.00 %) deformed fruits. There was a remarkable variation among the genotypes of strawberry in number of achenes fruit^{-1} (Table 3) and it ranged from 186.70 to 473.30. The highest number of achenes fruit^{-1} was observed in FA 007 (473.30) closely followed by FA 006 (471.70), FA 017 (460.70), FA 016 (460.30) and FA 005 (441.70). The lowest number of achenes fruit^{-1} was found in

FA 013 (186.70). Hansen (1989) stated that strawberry fruits differed in fruit weight and achenes number fruit^{-1}.

Table 3. Days to harvest, harvest duration, percentage of deform fruits and number of achenes fruit^{-1} in strawberry genotypes.

Genotypes	Days to harvesting	Harvest duration	Percentage of deform fruits	Achenes fruit^{-1}
FA 001	29.67 de	88.67 ab	10.33 e	272.30 bc
FA 005	33.33 a-c	92.00 a	21.00 bc	441.70 a
FA 006	34.33 ab	93.67 a	23.33 ab	471.70 a
FA 007	35.67 a	94.00 a	24.33 ab	473.30 a
FA 008	29.67 de	90.00 ab	12.33 e	315.00 b
FA 009	27.67 ef	89.00 ab	16.33 d	276.70 bc
FA 010	27.33 ef	90.00 ab	12.33 e	221.70 cd
FA 011	25.67 f	85.00 b	19.33 cd	210.30 cd
FA 013	27.33 ef	76.00 c	24.33 ab	186.70 d
FA 014	28.67 ef	70.67 c	26.00 a	191.70 d
FA 016	30.33 c-e	90.67 ab	23.00 ab	460.30 a
FA 017	32.00 b-d	89.00 ab	23.67 ab	460.70 a
BARI Strawberry-1	29.33 de	88.67 ab	16.00 d	334.70 b
CV (%)	6.34	3.05	7.51	8.42

Figures having the same letter(s) in a column do not differ significantly by DMRT at 1 % level of significant.

Relationship between number of achenes fruit^{-1} and fruit weight

A positive linear relationship was observed between number of achenes fruit^{-1} and fruit weight (g). The equation was y = 0.0393x - 1.3015 with highly significant value of coefficient of determination (R^2 = 0.9396**) shown in Fig. 2. This regression line coupled with a significant regression coefficient indicated that fruit weight would be increased with a significant manner with the increase in number of achenes fruit^{-1}. So, there is a clear indication that the genotypes having more achenes produced larger fruits. This result corroborates the statement of Darnell (2003) who stated that number of achenes fruit^{-1} positively increased the size and weight of fruit. Annon. (2010) stated that achenes number positively correlated with fruit size and differed significantly among the cultivars, which agreed with the present investigation. Fertile achenes produce auxins that trigger the growth of receptacles during fruit ripening (Nitsch, 1950; Kronenberg, 1959). When achenes are unfertilized, the development of the area on the fruit around the achenes is inhibited, resulting in malformation of the whole fruit (Ledesma *et al*., 2008).

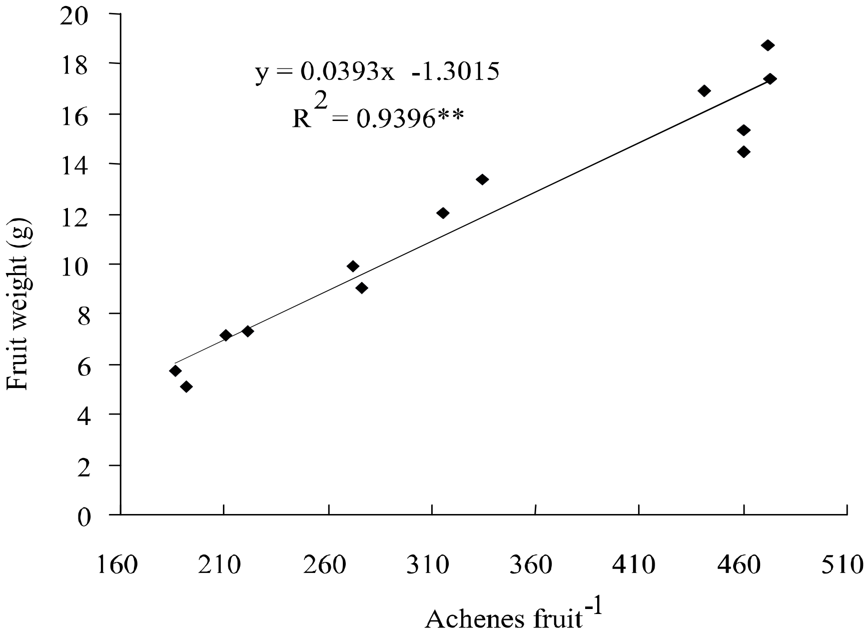

Fig. 2. Relationship between achenes fruit^{-1} and single fruit weight in strawberry.

Chemical and nutrient components

Highly significant variation was observed in reducing sugar content in fruits of different genotypes (Table 4). The highest quantity of reducing sugar was obtained from FA 006 (2.98 %) closely followed by FA 005 (2.95 %), FA 007 (2.94 %), FA 001 (2.91 %), FA 017 (2.91 %), BARI Strawberry-1 (2.89 %). Result of the present investigation is in accord with those of Asrey and Singh (2004), who revealed a significant variation in reducing sugar content of strawberry. Kader (1991) found a large genotypic variation in reducing sugar content which ranged from 3.7 to 5.2 %. This result is higher than that recorded in the present studies probably due to genotypic and environmental variations.

The quantity of non-reducing sugar of strawberry fruit ranging from 1.10 and 1.39 % were statistically non significant.

The component, which affects the taste of the fruit, is the sugar content. The result exhibited highly significant difference in the content of total sugar among the genotypes which ranged from 4.28 % to 3.43 % (Table 4). The highest quantity of total sugar was obtained from FA 005 closely followed by FA 006 (4.23 %), FA

007 (4.20 %), FA 016 (4.13 %), FA 001 (4.10 %), FA 017 (4.10 %) and BARI Strawberry-1 (4.02 %), and the lowest total sugar content was obtained in FA 009 (3.43 %). Total sugar content of strawberry fruits is a heritable trait, and is highly influenced by variability of genotypes. Kader (1991) reported that there is a large genotypic variation in total sugar content of strawberries ranging from 4.10 to 6.60 %. Crespo (2010) stated that total sugar content of strawberry fruits varied among the cultivars and ranged from 40.9 mg g^{-1} (cv. Matis) to 51.8 mg g^{-1} (cv. Asia) which supported the result of present investigation.

Total soluble solids (TSS) of fruits of strawberry genotypes varied significantly and ranging from 8.50 to 6.33 % (Table 4). Among the genotypes, FA 007 contained the highest amount of TSS (8.50 %) closely followed by FA 017 (8.17 %), FA 017 (8.17 %), FA 006 (8.00 %), FA 005 (7.83 %) and FA 016 (7.67 %). The lowest TSS was exhibited by FA 009 (6.33 %). The variation in TSS among the genotypes might be due to the variation of genotypes. Capocasa *et al*. (2008) found that TSS of strawberry fruits varied significantly and rangedfrom 5.8 % to 9.7 % among the cultivars which is in consonance with the present findings. According to Kader (1991) the TSS content of strawberry fruits harvested at commercial ripening stage ranged from 5 to 12 %, depending on cultivar and pre-harvest factors. This is within the range of the present observation. Resende *et al*. (2008) recorded the TSS content of different strawberry cultivars ranging from 7.20 to 8.10 %, which is similar with the present findings. Asrey and Singh (2004) revealed found a strong cultivar variation in TSS which ranged from 4.90 to 7.50 % among the cultivars, while Shaw (1988) reported that this variation was mostly affected by environmental factors.

The pH value of strawberry fruit were statistically non significant and ranged from 3.71 to 3.36. The highest pH value was obtained from in FA 001 while, the lowest in FA 006, and FA 017 (Table 4). Kafkas *et al*. (2007) found that the pH ranging from 3.33–3.43 in the ripe stage of the strawberries but did not change significantly, which is strongly in concur with the present findings.

Titratable acidity (TA) varied significantly among the genotypes (Table 5.). The highest titratable acidity was found in FA 011 (0.960 %) followed by FA 008 (0.923 %), FA 013 (0.920 %) and FA 001 (0.883 %) which were statistically different from others (Table 4). The lowest was found in FA 006 (0.707 %). The titratable acidity and the organic acid content are genetically determined and varied significantly among the genotypes, while less influenced by environment (Shaw, 1988). The result about titratable acidity of present studies agrees with those of

Asrey and Singh (2004), and Resende *et al*. (2008). They reported that the titratable acidity of strawberry fruits varied significantly and ranged from 0.80 to 0.91 % and 0.60 to 0.88 %, respectively among the studied cultivars. Macit *et al*. (2007) found TA of strawberry genotypes varied from 0.34 to 0.41 %, which was lower than present findings and this might be due to differences either in cultivars or in the growing environments.

Table 4. Chemical component and nutrient content of fruits in strawberry.

Genotypes	Reducing sugar (%)	Non reducing sugar (%)	Total sugar (%)	TSS (%)	pH	Titratable acidity (%)
FA 001	2.91 a	1.19	4.10 a-c	6.83 de	3.71	0.883 ab
FA 005	2.95 a	1.13	4.28 a	7.83 a-c	3.63	0.737 de
FA 006	2.98 a	1.34	4.23 a	8.00 ab	3.44	0.707 e
FA 007	2.94 a	1.25	4.20 a	8.50 a	3.36	0.787 c-e
FA 008	2.80 ab	1.26	4.08 a-c	7.17 b-e	3.37	0.923 a
FA 009	2.33 bc	1.29	3.43 d	6.33 e	3.42	0.833 bc
FA 010	2.32 bc	1.10	3.54 cd	6.50 e	3.62	0.777 c-e
FA 011	2.22 c	1.22	3.46 d	6.67 de	3.37	0.960 a
FA 013	2.21 c	1.24	3.60 b-d	6.83 c-e	3.68	0.920 a
FA 014	2.30 bc	1.39	3.44 d	6.67 de	3.41	0.820 bc
FA 016	2.89 a	1.14	4.13 ab	7.67 a-d	3.38	0.780 c-e
FA 017	2.91 a	1.24	4.10 a-c	8.17 a	3.37	0.727 de
BARI Strawberry-1	2.89 a	1.19	4.02 a-c	7.00 c-e	3.36	0.790 cd
CV (%)	7.80	5.55	5.81	5.49	7.35	2.99

Figures having the same letter(s) in a column do not differ significantly by DMRT at 1 % level of significant

Ascorbic acid content of genotypes varied significantly (Fig. 3), and it was found that ascorbic acid content 100 g^{-1} of pulp was the highest in FA 005 (77.33 mg) followed by FA 006 (76.00 mg), while the lowest was found in FA 010 (53.00 mg). Olsson *et al*. (2004) stated that the ascorbic acid content depends on the species and cultivation conditions, which was corroborated with the present investigation. Proteggente *et al*. (2002) recorded 61 mg 100 g^{-1} of ascorbic acid from fresh strawberry, which is within the range of the present observation. This variation in ascorbic acid content might be due to differences in cultivar and climatic condition. According to Lee and Kader (2000), cultivar type can be defined as an important factor affecting ascorbic content of strawberry.

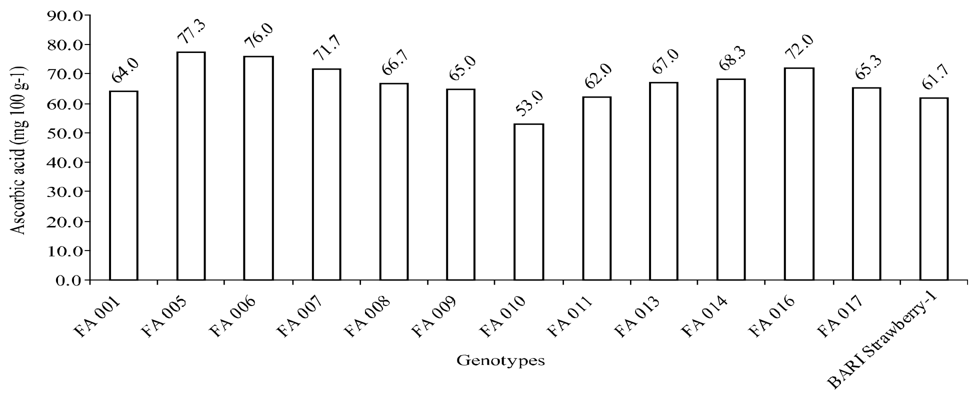

Fig. 3. Ascorbic acid content in fruits of different strawberry genotypes.

The ratio of total soluble solids to acid and sugar to acid is most important for evaluating the taste and determining the maturity of strawberry. According to Kader (1991) high sugar and relatively high acid are required for good flavour. High acid and low sugars produced a tart strawberry, and low acid and high sugar result in a bland taste, while the low sugars and acids, results a tasteless strawberry. The TSS to acid and sugar to acid ratio of fruits of different strawberry genotypes were evaluated and found to be significant (Fig. 4), due to highly significant value of TSS, total sugar and titratable acidity (Table 4). The TSS to acid ratio was found to be highest in FA 006 (11.3) followed by FA 017 (11.2), FA 007 (10.8) and FA 005 (10.6), while the lowest in FA 011 (6.9). The sugar to acid ratio of different genotypes also varied significantly and ranged from 3.6 to 6.0 and followed more or less similar trend of TSS to acid ratio. Among the genotypes, FA 006 exhibited the highest sugar to acid ratio (6.0) followed by FA 005 (5.8) and FA 017 (5.6), while it was lowest in FA 011 (3.6). In an earlier publication, Kafkas *et al.* (2007) reported that the TSS to acid ratio and the sugar to acid ratio in strawberry varied significantly.

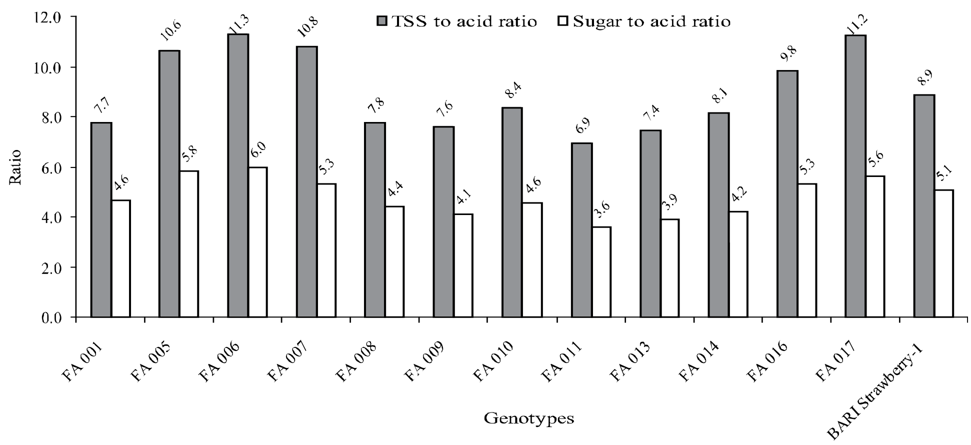

Fig. 4. TSS to acid and sugar to acid ratio in fruits of different strawberry genotypes

Conclusion

The genotypes of strawberries showed remarkable variation in nutrient as well as chemical components of fruit. On the basis of physico-morphological characters, it was concluded that genotype FA 006 and FA 007 were identical with FA 016 and FA 017, respectively. Considering total soluble solids (TSS), sugars, ascorbic acid, TSS to acid and sugar to acid ratio of fruits, the genotypes FA 005, FA 006 and FA 007 were superior to others and found to be promising under Bangladesh condition.

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