



ISSN (E): 2277- 7695

ISSN (P): 2349-8242

NAAS Rating: 5.03

TPI 2020; 9(11): 29-32

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www.thepharmajournal.com

Received: 25-09-2020

Accepted: 28-10-2020

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Evaluation of different strawberry (*Fragaria x ananassa* Duch.) cultivars for Physico-chemical composition of fruits under protected condition

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Abstract

Strawberry (*Fragaria x ananassa* Duch.) is one of the most nutritious berries, which belongs to the family Rosaceae. It is mainly a temperate region fruit crop but also can be grown in tropical and sub-tropical climatic region because of availability of day neutral and thermo-insensitive varieties. A research trial was conducted at Research Farm of Centre of Excellence on Protected Cultivation and Precision Farming under net tunnel, College of Agriculture, IGKV, Raipur (C.G.) to evaluate different strawberry cultivars for physico-chemical characteristics of fruits under net tunnel condition in the plain region of Chhattisgarh. The experiment was conducted in Randomized Completely Block Design (RBD) with 12 strawberry cultivars, replicated thrice. Result revealed that regarding physical parameters of fruits *i.e.* Weight, length, diameter and volume, Nabila recorded the maximum among all the varieties, while the minimum was recorded in Gili. Regarding chemical composition of fruits, Nabila was found superior over all other varieties having maximum TSS, TSS: Acid ratio, total sugar, reducing sugar, non-reducing sugar and minimum acidity under protected condition.

Keywords: Strawberry, evaluation, Physico-chemical composition etc.

Introduction

The cultivated strawberry (*Fragaria x ananassa* Duch.) is a natural hybrid derived from North American species, *Fragaria chiloensis* and *Fragaria virginiana* in France. It belongs to the family Rosaceae. It is an octaploid. Botanically, strawberry fruit is an aggregate fruit called *etario of achenes* and the edible part is succulent thalamus. It is mainly propagated by vegetative propagation *i.e.* through runners but now a day tissue culture is being popular for its multiplication. It is being grown in temperate regions throughout the world for delicious fruits having 98% edible portion and rich source of vitamin C, Iron and other active compounds (Oszmianski and Wojdylo 2009) [9]. This is the one and most important soft fruit having a distinct tantalizing aroma (Sharma and Yamdagni, 2000) [12]. It is highly nutritious with abundant source of vitamins A, B, C and niacin, minerals like phosphorus, potassium, calcium and iron (Karkara and Dwivedi, 2002) [4]. Strawberry has vast scope in processing industries and kitchen gardens. It is utilized for the production of purees, juice concentrate, jams, preserves and rose red wine. Medicinally, strawberries have been known for its anti-viral properties against polio, these may block the formation of nitosamines, which can cause cancer, furthermore these contain relatively high quantities of ellagic acid, which has a wide range of biological activities (Rieger, 2006) [10]. Strawberry is being grown worldwide. In India, it is being cultivated in Himachal Pradesh, Uttarakhand, Maharashtra, West Bengal, Delhi, Punjab, Haryana Rajasthan and Nilgiri hills (Chadha 2001) [2]. In our country the total area of strawberry is 1000 ha with production of 5000 MT (Anonymous, 2016) [1]. In Chhattisgarh strawberry cultivation is not popular due to lack of knowledge. It is grown in Ambikapur and Surajpur district in very small areas with production 12.50 MT and 12.00 MT respectively under open field condition (ADH office balrampur, 2016). Fruit characteristics like fruit weight, length, volume and chemical compositions are significantly influenced by cultivars and climate. Poly tunnel might have created favourable micro-climate condition for faster growth as expressed by Kaska *et al.* (1988) [5] in strawberry. Based on the sensitivity of varieties to photoperiod, three types of strawberry cultivars are available *i.e.* day neutral, long day and short-day plant. But only day neutral and short-day plants are grown commercially. Long day (ever bearing type) varieties are rarely grown outside the home garden. The climate of Raipur remains tropical wet and dry throughout the year.

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The temperature decreases from the month of November and continues till February. During the winter season the average temperature is 10°C which enables it to survive for longer time and grow faster. Sweet Charlie is a day neutral cultivar and can adjust well with growing periods. The fruits are firm having deep red in colour. Sweet Charlie fruit has two week of early production and after initial two-week, size tends to drop of drastically. In the early mid-season and even in second crop, very large fruits are produced in the last week of season. Camarosa is a short-day pedigree having larger and fruits are firm than Chandler. Its fruits are very flute, conical over an extended period at low latitude. Keeping in view the facts mentioned above, the present trial was planned and carried out to assess the performance of different cultivars in respect of fruit quality of strawberry in the climatic conditions of plain region of Chhattisgarh and to study the impact of change in weather parameters on physico-chemical characteristics of fruits *i.e.* fruit weight, length, volume, chemical composition of strawberry fruit.

The work on varietal evaluation was not done earlier in Chhattisgarh plain region under protected conditions, therefore, the present study was conducted to evaluate strawberry cultivars under ordinary tunnel type polyhouse condition for yield parameters and benefit: cost ratio.

Methods and Materials

The field trial was carried out during the year 2017-18 at Research Farm of Centre of Excellence on Protected Cultivation and Precision farming under net tunnel condition, College of Agriculture, IGKV, Raipur (C.G.). The soil of experimental field was clay-loam having pH 7.7. The experiment was laid out in Randomized Completely Block Design (RCBD) with 3 replications. The experiment was conducted with twelve strawberry cultivars *viz.* Hadar, Tamir, Sweet Charlie, Winter-dawn, Yashmin, E1-1333, Line-359, Nabila, Camarosa, Gili, Sabrina and Shani. Healthy tissue cultured plants procured from KF Bio-Plants Private Limited Pune (Maharashtra). The vigorous, healthy, free from diseases, insect-pest and well rooted saplings of all 12 varieties of Strawberry were planted in field at 30cm x 30cm distance with fertigation of recommended dose of fertilizers and maintained uniform cultural practices under net tunnel condition. All the experimental plants were uniformly maintained and same cultured practices were provided *i.e.* fertilization, irrigation and plant protection measures during whole period of investigation. Irrigation and fertilizers have been provided to the plants through the drip system of irrigation.

Under the physical parameters of fruits, the observations *i.e.* Fruits weight, length, diameter and volume were recorded. Regarding the chemical composition of fruits total soluble solids, acidity, TSS: acid ratio, total sugar, reducing sugar and non-reducing sugar were recorded.

Results and Discussion

The results of trial pertaining to various aspects of physico-chemical characteristics of fruits are summarized as follows:

Physical parameters of fruits

Fruit weight (g)

The result revealed regarding physical parameters of fruits that the varieties differed significantly in respect of fruit weight. The heaviest fruits were harvested from the cv. Nabila with average fruit weight of 33.52 gm followed by cv.

Camarosa (32.57 gm), Sabrina (31.65 gm) and Hadar (30.73 gm) respectively. The cv. Line-359 recorded minimum fruit weight (23.73 gm). Neetu and Sharma (2018)^[7] also reported that the maximum average fruit weight was observed in Nabila. According to Morgan (2006)^[6], the final size and shape of the berry depend on the number of achenes formed, which is determined by pollination and fertilization during blooming. These results are in line with findings obtained by Das *et al.* (2015)^[3] and Neetu and Sharma (2018)^[7].

Fruit length (cm)

The data presented regarding the fruit length showed significant variation among the varieties. The cv. Nabila recorded maximum fruit length (6.63 cm) which was at par with the fruit of cv. Camarosa and Hadar having fruit length 5.76 and 5.55 cm respectively. The cv. Sweet Charlie recorded minimum fruit length (2.97 cm). Neetu and Sharma (2018)^[7] also reported that cv. Nabila recorded maximum fruit length. The variations in the size of the fruit might be due to differential genetic make of the genotypes. This observation finds support from the findings of Neetu and Sharma (2018)^[7] in the plain region of Chhattisgarh.

Fruit diameter (cm)

The result revealed that the cv. Nabila recorded maximum fruit diameter (4.19 cm) which was found at par with the cv. Camarosa, Hadar, Sabrina and Shani having fruit diameter 4.04, 3.93, 3.89 and 3.67 respectively. The cv. Sweet Charlie recorded minimum fruit diameter (2.47 cm) which was at par with Winter Dawn, Line-359, Gili and Tamir having respective fruit diameter of 2.63, 2.67, 2.77 and 2.86 cm. Neetu and Sharma (2018)^[7] also reported that cv. Nabila recorded fruit size. The variations in the size of the fruit might be due to differential genetic make of the genotypes. This observation finds support from the findings of Neetu and Sharma (2018)^[7] in the plain region of Chhattisgarh.

Fruit volume (cc)

The data presented regarding the fruit volume showed significant differences among the varieties. The cv. Nabila recorded maximum fruit volume (22.15 cc) followed by Camarosa having fruit volume 19.89 cc. The cv. Hadar, Shani, Sabrina, Gili and E1-1333 were found at par with Camarosa having fruit volume 19.86, 19.83, 19.69, 19.52 and 19.05 cc respectively. The cv. Sweet Charlie recorded minimum fruit volume (18.06 cc). These results are in accordance with findings obtained by Neetu and Sharma (2018)^[7] in the plain region of Chhattisgarh.

Chemical composition of fruits

Total Soluble Solids (TSS %)

The cv. Nabila recorded maximum TSS (8.17%) which was found at par with cv. Sabrina and Camarosa having TSS 7.78 and 7.74% respectively. The cv. Tamir and Yashmin recorded minimum TSS (6.84%) which was at par with Line-359 and E1-1333 having TSS 7.01 and 7.26% respectively. These results are in accordance with findings obtained by Saima *et al.* (2014)^[11], Neetu and Sharma (2018)^[7].

Acidity (%): The significantly minimum acidity (0.62%) was recorded by Cv. Nabila. The maximum acidity (0.64%) was noticed in cv. Tamir, Line-359 and Yashmin. These results are in confirmation with findings obtained by Saima *et al.* (2014)^[11], Neetu and Sharma (2018)^[7].

TSS: Acid Ratio

The cv. Nabila recorded maximum TSS: Acid ratio (12.93) which was found at par with cv. Sabrina and Camarosa having TSS: Acid ratio 12.80 and 12.57 respectively. This high value of TSS: acid ratio might be attributed to the higher TSS content in Nabila as compared to other cultivars. The cv. Tamir and E1-1333 recorded minimum TSS: Acid ratio (11.94). These results are in accordance with findings obtained by Saima *et al.* (2014)^[11], Neetu and Sharma (2018)^[7].

Total Sugar (%)

Highest total sugar (7.34%) was recorded by cv. Nabila followed by cv. Sabrina having 6.99% total sugar. The cv. Line-359 recorded minimum total sugar (5.81%). This observation finds support from the findings of Neetu and Sharma (2018)^[7] on varietal evolution of strawberry in the plain region of Chhattisgarh.

Reducing sugar (%)

The result revealed that varieties differed significantly in

respect of reducing sugar % in the fruits. The fruits of cv. Nabila recorded maximum reducing sugar (5.28%) which was at par with the fruits of cv. Sabrina, Camarosa, Hadar, Yashmin, Sweet Charlie, Gili and Winter Dawn having reducing sugar 5.22, 5.01, 5.00, 4.98, 4.97, 4.96 and 4.94% respectively. The cv. Line-359 recorded minimum reducing sugar (4.16%). This observation finds support from the findings of Saima *et al.* (2014)^[11], Negi and Upadhyay (2016)^[8] & Neetu and Sharma (2018)^[7].

Non-reducing Sugar (%)

Highest non-reducing sugar (2.28%) was recorded by the fruits of cv. Nabila which was at par with the fruits of cv. Sabrina, Camarosa, Hadar, Gili, Sweet Charlie and Winter Dawn having non-reducing sugar 2.15, 2.12, 2.11, 2.10, 2.09 and 2.07% respectively. The cv. Line-359 recorded minimum reducing sugar (0.98%). This observation finds support from the findings of Saima *et al.* (2014)^[11], Negi and Upadhyay (2016)^[8] & Neetu and Sharma (2018)^[7].

Table 1: Physical parameters of fruits of different strawberry cultivars under protected condition

Varieties	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit volume (cc)
Hadar	30.73 ^f	5.55 ^{efg}	3.93 ^c	19.86 ^{bc}
Sweet Charlie	25.71 ^b	2.97 ^a	2.47 ^a	18.06 ^a
E1-1333	25.93 ^b	5.21 ^{cdef}	3.14 ^b	19.05 ^{abc}
Tamir	26.58 ^c	4.44 ^{bcde}	2.86 ^{ab}	18.63 ^{ab}
Yashmin	28.70 ^{de}	4.28 ^{bcd}	3.06 ^b	19.45 ^b
Camarosa	32.57 ^h	5.76 ^{fg}	4.04 ^c	19.89 ^c
Gili	26.78 ^c	4.45 ^{bcde}	2.77 ^{ab}	19.52 ^{bc}
Shani	29.46 ^e	4.36 ^{bcd}	3.67 ^c	19.83 ^{bc}
Winter-Dawn	28.24 ^d	4.22 ^{bc}	2.63 ^{ab}	19.46 ^b
Line-359	23.73 ^a	3.74 ^{ab}	2.67 ^{ab}	18.84 ^{ab}
Sabrina	31.65 ^g	5.35 ^{def}	3.89 ^c	19.69 ^{bc}
Nabila	33.52 ⁱ	6.63 ^g	4.19 ^c	22.15 ^d
SE(m)±	0.26	0.38	0.18	0.42
C.D.	0.77	1.11	0.52	1.23

The superscript letter indicates that the treatment means with same letters are at par at 5% level of significance, while the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD- value comparison of treatment means

Table 2: Chemical composition of fruits of different strawberry cultivars under protected condition

Varieties	TSS (%)	Acidity (%)	TSS: Acid Ratio	Total Sugar (%)	Reducing sugar (%)	Non-reducing Sugar (%)
Hadar	7.70 ^{de}	0.63 ^d	12.26 ^{ab}	6.89 ^b	5.00 ^{bcd}	2.11 ^{de}
Sweet Charlie	7.44 ^{bcd}	0.62 ^{cd}	12.03 ^a	6.95 ^b	4.97 ^{bcd}	2.09 ^{de}
E1-1333	7.26 ^{ab}	0.63 ^{cd}	11.94 ^a	6.85 ^b	4.87 ^b	2.01 ^d
Tamir	6.84 ^a	0.64 ^a	11.94 ^a	6.96 ^b	4.88 ^{bc}	1.71 ^c
Yashmin	6.84 ^a	0.64 ^a	12.00 ^a	6.96 ^b	4.98 ^{bcd}	1.41 ^b
Camarosa	7.74 ^{def}	0.63 ^{bc}	12.57 ^{bc}	6.91 ^b	5.01 ^{bcd}	2.12 ^{de}
Gili	7.51 ^{cde}	0.63 ^{cd}	11.96 ^a	6.94 ^b	4.96 ^{bcd}	2.10 ^{de}
Shani	7.36 ^{bcd}	0.63 ^d	12.01 ^a	6.98 ^b	4.92 ^{bc}	2.05 ^d
Winter-Dawn	7.32 ^{bc}	0.63 ^{bcd}	11.99 ^a	6.92 ^b	4.94 ^{bd}	2.07 ^{de}
Line-359	7.01 ^{ab}	0.64 ^{ab}	12.05 ^a	5.81 ^a	4.16 ^a	0.98 ^a
Sabrina	7.78 ^{def}	0.63 ^d	12.80 ^c	6.99 ^b	5.22 ^{cd}	2.15 ^{de}
Nabila	8.17 ^f	0.62 ^c	12.93 ^c	7.34 ^c	5.28 ^d	2.28 ^c
SE(m)±	0.15	0.002	0.14	0.10	0.12	0.08
C.D.	0.43	0.007	0.41	0.30	0.34	0.22

The superscript letter indicates that the treatment means with same letters are at par at 5% level of significance, while the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD- value comparison of treatment means

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