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Performance of Litchi (*Litchi Chinensis* Sonn) Cultivars for Some Morphological, Chemical and Yield Related Traits Under the Agro-climatic Conditions of D.I. Khan, Pakistan

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Abstract

Frye Litchi cultivars viz Purbi, Bedana, Serai, Bombai and Gola were evaluated for their morphological characteristics and physic-chemical composition. The highest yield of 15.52 kg per plant was recorded in cv. Serai compared to the least (7.72 kg/Tree) by Bedana. The mean fruit weight, length diameter were 13.94 g. 3.20 cm and 2.55 cm respectively. Reducing, non-reducing and total sugars varied from 4.47 to 6.92, 4.10 to 5.30 and 8.60 to 11.60% respectively. Vitamin-C content ranged from 45.72 to 60.02 mg/100g pulp. "Bedana" proved to be of the best quality with low acidity and highest sugars; TSS Vitamin-C and pulp contents.

Introduction

Litchi (*Litchi chinensis*) is a tropical fruit and belongs to family Sapindaceae. It is native to Southern China where it was cultivated in 114-86 B.C. The spread of litchi from China to the other parts of the world was slow probably due to its peculiar climatic requirements. Other countries where it has been spread are Indonesia, Australia, USA, New Zealand, South Africa, India and Bangladesh.

Besides a rich source of vitamin C, litchi contains a fair amount of Phosphorus, Calcium, Iron, Vitamins A and B. Litchi fruit contains 15.9 percent seed, 9.6 percent pericarp, 74.5 percent edible portion, 78.2 percent moisture, 1.2 percent acid, 0.97 percent oil, 0.94 percent protein, 0.69 percent ash, 6.89 percent free reducing sugars, 6.68 percent hydrolyzable sugars and 13.75 percent total sugars (Ahmad, 1956). The sugar contents in different varieties ranges from 6.74-20.6 percent (Singh and Singh, 1964; Miller anu Bazore, 1945).

Being an infamous fruit, very little is reported about the morphological characteristics of the tree, yield and chemical composition of the Litchi cultivars. The botanical character of *Litchi chinensis* have been described by Singh (1980) and Ginai (1968). Maiti (1985) noticed that the trees of Litchi attained an average height of 4-7.6 m and spreadth of 6-10 m in India. He reported 12-15 percent sugars in Litchi fruit grown in Florida whereas 11.8-20.6 percent sugar was recorded in fruits grown in Hawaii. It has also been mentioned that Litchi contains 0.7 percent protein, 0.3 percent tat, 0.7 percent minerals particularly Calcium and Phosphorus and 64 mg Vitamin C per 100 g of pulp. Groff (1921) listed 49 varieties of Litchi in Kwangfung, China and reported some important characteristics of prominent cultivars. He noticed that the fruit yield of Bedana cv. ranged from 40-100 kg. The average fruit weight was 29 g and the average seed weight was 0.85 g. The fruit contained 18 percent TSS, 13.8 percent sugars, 0.44 percent acid and pulp, seed ratio was 28:1 compared to 17 percent TSS, 11 percent sugar, 0.45 percent acidity and pulp/seed ratio ranged from 4.5-5.1:1 in cv. Bombai. Bombai yielded 80-90 kg per tree. Singh and Yadav (1988) studied the physio-chemical changes during fruit development in Litchi cultivars. It was observed that fruit development occurs in two stages. Total soluble solids (TSS) and sugar increased with an increase in aril content. The non-reducing sugar declined at the advanced stage of maturity while the reducing sugar showed an increasing trend. Titratable acidity and ascorbic acid content declined as the maturity advanced but the brix/acid ratio declined. Singh *et al*. (1986) reported an increase in TSS content, fruit weight, fruit length and diameter, pulp seed ratio, TSS: acidity ratio and total sugar contents, whereas acidity and moisture content decreased during ripening.

Knowledge of distinguishing characters of different cultivars is not only important for nurserymen but also for plant breeders and persons engaged in the field of horticulture. The present investigation was undertaken to study the performance of various cultivars of Litchi grown under the Agro-climatic conditions of D.I. Khan.

Materials and Methods

Experimental Methods: Some germplasm of Litchi are available at the farm of Fruit and Vegetable Board, D.I. Khan (N.W.F.P). Six trees of about ten years old from each of five cultivars viz Bedana, Bombai, Gola, Purbi and Serai were selected for the study. The experimental design was randomized complete block with three repeats. Each treatment comprised of two trees, thus involving total of thirty trees in the experiment.

Morphological and Growth Characteristics: Plant height, stem girth, tree spread, number of fruit per panicle and yield data were recorded.

Physio-chemical Analysis of Tree

Physical Characteristics: Fruit size, average fruit weight and pulp percentage were determined.

Chemical Characteristics: Total acidity of the extracted juice was determined according to Ruck (1978) whereas pH, vitamin C and TSS were determined according to AOAC (1984). Total and reducing sugars were estimated by Lane and Eynon (1923) as described in AOAC (1984). Non reducing sugars was calculated as:

Non reducing Sugar = (%Total Sugars-%Reducing Sugars)x0.95

Statistical analysis: The data were subjected to analysis of variance as described by Leclerg *et al*. (1972). To test the differences among the cultivars and make pairwise comparisons, the procedure of Duncan's Multiple range Test was adopted (Steel and Torrie, 1980). All the statistical analysis were carried out using MSTAT-Computer programme.

Results and Discussion

Morphological and Growth Characteristics of Plant:

Tree Height: Plant height (Table 1) showed significant variations among the cultivars. "Purbi" was the tallest cultivar with an average height of 3.00 m which was at par with Gola (2.87 rn) and Bombai (2.83 m) "Serai" (2.67 rn) was medium saturated and Bedana was found to be the dwarf cultivar with an average height of 2.05 m. Groff (1921) reported an average height of 7.5 m in different cultivars of Litchi grown in China. The difference in observations can be attributed to the genetically and climatic variations.

Tree Girth: Average plant girth was significantly different ($p = 0.05$) from cultivar to cultivar (Table 1). "Purbi" had the maximum tree girth of 46.67 cm being significantly different from all the other varieties. It was followed by Bombai, Bedana and Gola whereas Bedana and Gola were at par with each other. Serai had the lowest tree girth of 27.67 cm.

Tree Spreadth: Tree spreadth (Table 1) differed significantly. "Serai" gave the highest spreadth of 355 cm which was significantly highest from all the other cultivars. Purbi was at par with Bombai while the minimum spread of 245 cm was recorded in Bedana. Groff (1921) reported a spread of 10 m in some cultivars of Litchi in China. These variations may be due to the difference in cultivars, climatic conditions and the soil nutrition.

Numbers of Fruits per Panicle: Data pertaining to the number of fruits per panicle indicated significant difference among the cultivars. The maximum number of fruits (19) per panicle was recorded in cv. Serai followed by Bombai which was at par with Gola and Purbi possessing 11 fruits per panicle each. The minimum number of fruits per panicle (9) was recorded in cv. Bedana.

Yield: Highly significant variations existed in the yield among the cultivars. "Serai" produced the highest yield of 15.52 kg per tree followed by Bombai (13.33) kg and Purbi (11.97) kg whereas the Bedana produced significantly lowest yield of 7.72 kg per plant and was at par with Gala. The fruit yield per tree recorded in the present study was much lower than that reported by other workers (Groff 1921; Nijjar 1972; Sharma and Roy, 1987). They reported 681, 80-150 and 71.4-104.6 kg per tree respectively. These differences may be due to the difference in cultivars, agro-climatic conditions, flowering and fruiting behaviour, number of panicles borne on the tree and age of the tree etc.

Physical Characteristics of Fruits

Fruit Length: Data pertaining to the fruit length (Table 2) showed significant variations among the cultivars. "Serai" produced the longest fruit of 3.49 cm closely followed by Gala (3.36 cm) which were at par with each other but differed significantly from other cultivars. The smallest fruits (2.96 cm) were recorded in cv. Bedana being significantly different from all other cultivars except Bombai.

Fruit Diameter: The maximum fruit diameter of 2.80 cm was recorded in cv. Serai closely followed by Gala (2.791 cm and Purbi (2.51) cm. The minimum fruit diameter of 2.30 cm was recorded in Bombai which was at par with Bedana.

Fruit Weight: Various cultivars of litchi had significantly different fruit weight (Table 2). Fruits of cv. Serai had significantly the highest average weight of 17.33 g followed by Bedana (15.27 g) and Gala (12.27 g). The minimum fruit weight of 12.02 g was recorded in Bombai which was significantly lower than all other cultivars.

Table 1: Morphological and Yield Characteristics of different cultivars of Litchi

Cultivars	Height (cm)	Girth (cm)	Spread (cm)	Fruit/ Panicle	Yield Kg/tree)
Purbi	300.00a	46.67a	282bc	11b	11.97bc
Bedana	205.00c	32.33bc	245d	09c	07.72d
Bombai	283.33a	34.00ab	296b	11b	13.33ab
Serai	226.67b	27.67c	355a	19a	15.52a
Gala	286.67a	32.67bc	263cd	11b	9.80cd

Means not followed by the same letters are significant at 5% level of probability

Table 2: Physical Characteristics of fruits of different cultivars of Litchi

Cultivars	Length (cm)	Dia (cm)	Av.wt (g)	Pulp %
Purbi	3.197b	2.507ab	12.595d	59.33be
Bedana	2.962c	2.348b	15.271b	72.69a
Bombai	3.015c	2.304b	12.021e	60.07b
Serai	3.485a	2.799a	17.332a	58.80c
Gola	3.360ab	2.785a	12.619c	54.91d

Table 3: Chemical Characteristics of fruits of different cultivars of Litchi

Cultivars	Vitamin-C (mg/100 g)	Total Acidity (percent)	pH
Purbi	52.512c	1.666c	3.85b
Bedana	60.020a	0.894e	4.20a
Bombai	47.635d	1.907b	3.60c
Serai	45.720e	2.108a	3.10d
Gola	57.150b	1.120d	3.90b

Table 4: T.S.S and Sugar contents of different cultivars of Litchi

Cultivars	Percent			
	T. Sugars	R. Sugars	N.R. Sugars	T.S.S
Purbi	10.50c	5.51c	4.99b	12.92c
Bedana	11.60a	6.92a	4.68c	14.35a
Bombai	08.60e	4.47e	4.13d	10.01e
Serai	08.95d	4.85d	4.10d	10.26d
Gola	10.97b	5.67b	5.30a	13.87b

T.Sugars = Total sugars; R. Sugars = Reducing sugars; N.R.Sugars = Non-reducing sugars

Table 5: Quality indices of Litchi fruits in different cultivars

Cultivars	TSS-Acid Ratio	Sugars-Acid Ratio
Purbi	07.75	06.30
Bedana	16.05	12.97
Bombai	05.25	04.51
Serai	04.86	04.15
Gola	12.38	09.79

Means not followed by the same letters are significant at % level of probability

Chemical Constituents of Fruits

Vitamin-C: Vitamin-C (Ascorbic acid) content of fresh pulp various litchi cvs. varied from (45.72-60.02) mg per 100 g of the pulp (Table 3). The highest vitamin-C contents (60.02 mg) was recorded in cv. Bedana being significantly different from all the other cvs. It was followed by Gola, Purbi, Bombai and Serai possessing 57.15, 52.51, 47.64 and 45.72 mg vitamin-C per 100 g of pulp respectively. All the cvs. were significantly different from one another. These results are in fair agreement with those of Miller and Bazore (1945), Singh and Singh (1964) and Hussain (1985) who have reported 45-64 mg vitamin-C per 100 g pulp in Litchi cvs.

Total Acidity: Total acidity in different cvs, ranged from (0.89-2.11%) (Table 3). The differences among the cvs. with respect to acidity were highly significant. The fruits of cv. Serai were found significantly the most acidic (2.11%) whereas Bedana fruits were the least acidic (0.89%). Bornbai, Purbi and Gala possessed 1.91, 1.67 and 1.12 percent total acidity respectively and were comparable with each other. Groff (1921) and Cabin (1954) reported similar results for acid percentage in different Litchi cvs. They found that Bedana and Bombai fruits contained 0.44 and 0.45 percent acid. However, 1.32 percent acid was recorded in some other Litchi cultivars.

pH Value: Highly significant differences existed in pH values among the cultivars. The maximum pH value of 4.20 was recorded in the fruit of cv. Bedana. It was followed by Gala and Purbi containing a pH value of 3.90 and 3.85, respectively. Serai fruits contained significantly the least pH value of 3.10.

Total Sugars: The nutritive value of a fruit mainly depends on its sugar contents which varies due to different varieties and climate. There was highly significant differences in the total sugar content of these cultivars (Table 4). Fruits of cv. Bedana possessed the maximum quantity of total sugar (11.60%) being significantly higher than other cultivars. It was followed by Gola, Purbi and Serai which contained 10.97, 10.50 and 8.95 percent total sugars respectively. The lowest total sugars of 8.06 percent as recorded in Bombai fruits. Total sugars content found in this study differed considerably from those of Miller and Bazore (1945) who reported 12-20 percent sugars in Litchi fruits. However, these results are in conformity with those of Cobin (1954), Singh and Singh (1964) and Hussain (1985). The differences in the sugars content are probably due to differences in cultivars, locations and climatic conditions.

Reducing Sugars: Reducing sugars varied from 4.47-6.92 percent (Table 4). Bedana possessed the highest percentage among in the tested cultivars whereas Bombai contained the least amount of reducing sugars. All the cultivars were statistically different from each other.

Non-Reducing Sugars: Non-reducing sugars ranged from 4.10-5.30 percent. Gala fruits possessed the maximum amount of non-reducing sugars, whereas the least amount was recorded in Serai which was statistically alike to cv. Bombai containing 4.13 percent non-reducing sugars. "Purbi" and Bedana fruits contained 4.99 and 4.68 percent non-reducing sugars being significantly different from one another.

Total Soluble Solids: Total soluble solids (TSS) varied from 10.01-14.35 percent. Fruits of cv. Bedana had the maximum quantity of TSS (14.35 percent) being significantly higher than other cultivars. It was followed by

Gola containing 13.87 percent TSS. The lowest TSS of 10.01 percent was recorded in Bombai fruits. These findings are not comparable with those of Groff (1921) who reported 17-18 percent TSS in different cultivars of Litchi. This variation in the results an be expected due to difference in cultivars, climatic conditions, stage of maturity and method of analysis.

Quality Indices: The TSS-acid ratio and sugar-acid ratios are important quality indices from organoleptic point of view. These ratios were calculated from the results given in Table 4 and 5. Both the TSS-acid ratio and sugar-acid ratios were highest in Bedana followed by Gola, Purbi and Bombai. The cultivar Serai had the lowest TSS and sugars to acids ratios. These results suggest that Bedana fruits were of better quality.

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