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Performance of Woodapple Germplasm in Venkatagiri, Nellore District

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ABSTRACT

A total of 10 accessions of woodapple germplasm collected from various sources in the country are maintained and evaluated for growth, yield, adoptability at Citrus Research Station Petlur, Venkatagiri dist.. Some of the accessions performed very well and some did not perform well. Among the various accessions PWAS 2 , PWAS-9 performed well in this area. The accessions unfavorable to this climate possessed low average mean for various characters in the present study. Since considerable variation exists in the species there is good scope for varietal improvement .Changes in physical and chemical properties of wood apple pulp collected from unripe, half ripe and full ripe stages were studied. Edible portion of wood apple fruit (42.9 to 60.6% total fruit weight) comprised 6.9 to 12.7% of seeds. Fresh pulp contained 75.16 % moisture, 3.0 % sugar, 2.0 % protein and 1.31 % ash. The total soluble solid, brix/acidity ratio, total sugar and reducing sugar of wood apple fruit increase with maturity, whereas moisture content, pectin content and ascorbic acid was decreased. The pH of the wood apple pulp increased with the advance in maturity. The ripe fruits were found significantly less acidic than unripe and half ripe.

Key words: *Germplasm, Performance, Woodapple.*

Wood-apple is common in the wild dry plains and native of India and Ceylon and cultivated along roads and edges of fields and occasionally in orchards. It is also grown in South East Asia, Northern Malaya and on Penang Island. In India, the fruit was traditionally a "poor man's food" until processing techniques were developed in the mid-1950's. Woodapple (*Limonia acidissima*) is common in Srilanka used in most of the Ayurvedic medicines formulations. The ripe variety, however, is recommended for a variety of illnesses and general well being. It increases appetite and reduces poison.

Wood apple belongs to the family Rutaceae Swingle. It is also called as elephant apple, monkey fruit, curd fruit and *Katha Bel* in India. The original home of wood apple is South India and Srilanka (Lande *et al.,* 2010). The wood apple is mainly found in forest and dry plain area of Indian subcontinents.The age of the plant varies from 13 to 70 years with yield potentiality in mother plants varying from 650 to 1085 kg of fruit/plant having the fruit weight between 130 and 225 g. Fruits length varies between 7.3 to 8.9 cm while breadth between 7.2 and 8.4 cm. Fruit size (length×breadth) varies in relation to fruit weight (Ghosh *et al.,* 2010). The fruit exhibits excellent nutritional and medicinal properties. Traditionally the fruit has been used for relief against the diarrhea, dysentery, tumors, asthma, wounds, cardiac debility and hepatitis (Ilango and Chitra, 2009). Fruit development starts with formation of an edible part fruit setting, seedling emergence, tuber development or stalk development and ends with loss of edible character through physiological deterioration,development of fibrous character or spoilage through microbiological intervention. The term mature implies that point in the development scale when the horticultural commodity is in a state that is ready to use (process, store) or to eat. The breadth of the implications of the term mature may be appreciated by considering a commodity such as bean sprouts, which are mature at a very young physiological age, versus apples, in which maturity occurs toward the end of the development cycle. Determining a maturity involves establishing consistent physical and chemical changes which occur in the commodity throughout its development. Therefore, the aim of the present investigation was to determine the physical and physicochemical changes during different stages of maturation.

MATERIAL AND METHODS

A total of 10 Wood apple accessions i.e. Petlur Wood apple Selections are maintained at Citrus Research Station, Petlur, Venkatagiri dist Nellore. The plants are planted during the year 2001 planted at 8 x 8 mt spacing. The soil is red loamy type and the temperatures are very hot which reaches up to 47 degrees during summer months and dry weather persists for almost nine months in a year.

Three plants in each clone at a distance of 8x8 m were planted and maintained. Nutritional requirement of woodapple recommendations on an adhoc basis for one year old tree received 10 kg FYM + 100 g N + 50g P_2O_5 + 100g K_2O and the dose be increased with age. Thus a eight year old tree received 50 kg FYM +1 kg N + 500 g P_2o_5 + 1 kg K_2o. The data was recorded for plant height, volume, yield for three cumulative years from 2010-2013 and quality parameters regarding physical and biochemical properties was analysed

Data regarding the plant height, volume yield, fruits were statistically analyzed(ANOVA) using analysis of variance and differences among the means were determined for significance at $P<0.05$ using Microsoft word 2007.

Sample Collection

Wood apples were procured from Citrus Research Staton, Petlur, at different stage of the fruit maturity in bulk as they are highly seasonal and available only during the months of September-October . The fruits having three different maturities, based on the subjective evaluation of the aroma and density were classified as follows i.e.

a) Woody and sour aroma with density more than 0.90 - un-ripe
b) Sour aroma with density in the range of 0.90 to 0.95- half-ripe
c) Sweet aroma with density less than 0.90 - full-ripe

Ten fruits at each stage were individually analyzed for physico-chemical characteristics. Fruits were weighed in the on a balance of accuracy of 0.001g. Volume was measured by a liquid displacement method. The weight density of the fruit was obtained by the ratio of weight to volume. Pulp to shell ratio was determined by using weight difference of pulp and shell.

Color

The color of internal pulp and external cell was measured using a simple digital method

Analysis

Moisture content, protein, fat and ash percentage at each stage of fruit ripening were determined according. The total soluble solids of the sample was determined by using digital refractometers having a range from 0-45 °Brix. Results were reported as degree °Brix at 21oC. For titrable acidity, the samples were homogenized and 10 g of each sample were accurately weighed into a beaker; 40 ml distilled water were added and pH of the sample was recorded. The resulting mixture was titrated with 0.1 N NaOH. Acidity was expressed as % citric acid. pH was measured using digital pH meter. Reducing sugar and total sugar was determined as per the Lane and Eynon method (Ranganna, 1986).

Estimation of Pectin Content

In 400 ml water, 100 g of sample was taken and 1.2 g of sodium hexameta-phosphate was added to it. pH was adjusted to 4.5 and was heated at 90- 95° C for 1 hr it was filtered by adding 4 g of filter aid. Boiling was continued till the amount of liquid was at least 200ml then this filtrate was cooled and weighed. Three volumes of ethanol and 0.5 M HCL was added to it to adjust the pH of the slurry between 0.7 and 1 and was stirred for 30 min. This slurry was again filtered or centrifuged and was washed with 400 ml of 70% ethanol to make the precipitates chloride ion- free or till the pH was above 4. This precipitate was further washed in 400ml of acetone and was dried in vacuum oven (5mm Hg). This precipitate was weighed and the difference was calculated to obtain pectin content (Ranganna, 1977).

Total Ascorbic Acid Determination

Ascorbic acid in wood apple fruit at different stage of maturity was determined according to AOAC method (AOAC 1995). Wood apple pulp of 2 g was taken in a conical flask and blended with 20 ml of meta-phosphoric-acetic acid

Table No.1

S.No.	Name of the accession	Scion/stock ratio	Plant height (m)	Plant volume (cu.m)	No.of fruits/plant	Mean fruit weight (g)
1	PWAS-1	1.7	7.9	20.3	21	228
2	PWAS-2	1.4	6.0	26.0	57	255
3	PWAS-3	1.5	7.3	49.2	28	220
4	PWAS-4	2.1	5.6	38.6	39	210
5	PWAS-5	8.8	7.3	44.8	37	90
6	PWAS-6	2.2	6.2	45.3	18	240
7	PWAS-7	2.3	7.2	51.1	18	65
8	PWAS-8	2.3	7.2	59.4	16	210
9	PWAS-9	2.3	7.1	58.6	58	260
10	PWAS-10	2.3	7.1	46.6	16	228
SEd		1.508	0.121	0.815	3.39	4.88
CD 5%		3.167	0.254	1.713	7.133	8.22

Table 2: Physical properties of wood apple fruits at different stages of ripening

Parameters	Un-ripe	Half-ripe	Full-ripe	Total (mean)
Density (g/l)	0.9 ± 0.01	0.9 ± 0.01	0.8 ± 0.01	0.9 ± 0.05
Weight (gm)	292.3 ± 22.32	239.9 ± 17.76	192.7 ± 11.18	241.6 ± 49.82
Pulp/Shell Ratio	0.86 ± 0.03	0.93 ± 0.04	1.1 ± 0.13	0.9 ± 0.12
L (Internal)	47.0 ± 6.3	38.1 ± 3.31	35.3 ± 4.5	40.1 ± 6.1
a (Internal)	13.3 ± 2.4	14.5 ± 2.1	16.9 ± 2.1	14.9 ± 1.83
b (Internal)	29.9 ± 6.5	24.2 ± 2.1	19.7 ± 4.6	24.6 ± 5.1
L (External	72.2 ± 5.3	61.6 ± 5.0	49.8 ± 2.9	61.2 ± 11.2
a (External	2.1 ± 4.0	3.8 ± 2.6	6.4 ± 1.1	4.1 ± 2.1
b (External)	19.7 ± 2.67	13.6 ± 2.37	11.3 ± 2.5	14.8 ± 4.3
Juice Content (%)	10.93 ± 0.45	13.91 ± 0.72	18.4 ± 1.92	14.4 ± 3.78

solution to extract ascorbic acid. The mixture was filtered using a Whatman filter paper and transferred to a volumetric flask. 2 ml of the filtrate extract with 5 ml meta-phosphoricacetic acid solution was rapidly titrated with 2, 6 dichlorophenol indo-phenol solution until light distinct rose pink colour persisted for more than 5 sec.

Statistical analysis

Data were analyzed statistically (ANOVA) using analysis of variance (Steel and Torrie, 1980) and differences among the means were determined for significance at $P<0.05$.

RESULTS AND DISCUSSION

Data on the growth parameters in Wood apple clonal selections

The data presented in Table 1 reveals that there is significant difference between the clones for various characters like scion stock ratio, plant height plant volume, number of fruits per plant and mean fruit weight.

Among the clones maximum height was recorded in PWAS -1 of 7.9 mt followed by PWAS-3 with 7.3 mt. Regarding plant volume maximum volume was recorded in PWAS-8 followed by PWAS-9. Among the clones maximum fruits was recorded in PWAS-9 followed by PWAS-2. Maximum fruit weight was recorded in PWAS-9 followed by PWAS-2. Only two clones Petlur Woodapple Selection – 2 and 9 performed very well under rainfed condition giving good yields up to 58 fruits/plant during October month and was

Table 3. Bio-chemical and compositional properties of wood apple fruit.

Parameters	Un-ripe	Half-ripe	Full-ripe	Total (mean)
TSS (%)	11.5 ± 0.56	12.6 ± 0.48	15.8 ±0.67	13.3 ± 2.21
Total Sugar (%)	1.6 ± 0.14	1.8 ± 0.07	2.1 ± 0.09	1.8 ± 0.26
Reducing Sugar (%)	1.1 ± 0.10	1.1 ± 0.07	07 1.2 ± 0.16	1.1 ± 0.07
Acidity (%Citric acid	2.9 ± 0.06	2.4 ± 0.06	1.7 ± 0.08	2.3 ± 0.59
Moisture content %	76.3 ± 0.42	75.1 ± 0.43	74.0 ± 0.71	16 ± 1.15
Brix/Acidity Ratio	3.9 ± 0.25	5.2± 0.26	9.0 ± 0.52	6.1 ± 2.66
pH	3.5 ± 0.02	3.6 ± 0.06	3.7 ± 0.06	3.6 ± 0.11
Ascorbic Acid	7.1 ± 0.09	6.6 ± 0.10	5.7 ± 0.28	6.4 ± 0.67
Pectin Content (%)	2.0 ± 0.15	15 1.8 ± 0.07	1.0 ± 0.08	1.6 ± 0.53
Protein (%)	2.0 ± 0.38	04 ± 0.08	1.9 ± 0.19	2.0 ± 0. 04
Fat (%)	3.7 ± 0.30	3.5 ± 0.75	3.3 ± 0.34	55 ± 0.23

highly vigorous followed by PWAS 4 & 5 with yield up to 39 fruits/plant . This finding is in agreement with the findings of (Morton, 1987, Joshi and Jain 2008) wherein such a wide variation in growth characters may passively be attributed due to variation in temperatures, relative humidity. Better nutrient uptake and faster plant growth of clones due to congenial temperature and humidity conditions resulted in early bearing and good quality of the wood apple during the study.

Physical properties of wood apple fruit of each stage shows significant difference in weight and density, as both decreases with maturity, being minimum (192.79 g) and (0.89) respectively at ripe stage. Results in the same range are also reported by Ghosh *et al.* (2010). Pulp to shell ratio value shows continuous increment from unripe to half ripe and to full ripe fruit, being maximum at this stage i.e. 0.86, 0.93 and 1.10 respectively. Juice content (%) in wood apple fruit at the three maturity stage as 10.93, 13.91 and 18.43 for unripe, half ripe and full ripe respectively. Color directly affects the appearance and the consumer acceptability of the fruits. As can be seen from Table 2, a large variation in lightness (L), redness (a) and yellowness (b) values of wood apple fruit shell and pulp at each stage was observe. As can be seen from Table I1, for each fruit at different maturity level the values of L and +b decreased significantly while +a value increased from un-ripe to full-ripe stage for both external shell and internal pulp. Thus lightness and yellowness tend to decreases as fruit ripen. As we can also observe from the Table 2, juice content of wood apple fruit also depends upon the maturity stage of the fruit. The juice content is also increasing as fruit ripen. In this study, the full ripe fruit had the maximum juice content (18.43%), and showed a significant difference from unripe and ripe fruit. These differences could be attributed to metabolic changes during ripening (Narain *et al.,* 1992).

Physicochemical parameters of wood apple fruit are presented in Table III. Moisture content varied significantly from unripe to full-ripe wood apple fruit. As we can observe from Table the moisture content of fruit is increasing as the fruit ripens. On average, wood apple fruit contained moisture content 75.16%. This value is higher than (64.2%) reported by Gopalan *et al.* (1997) and very comparable with result of Morton(1987). The mean protein content of the pulp was 2% (Table 3). There were no significant changes in protein content of wood apple pulp at three maturity stage as 2.0, 2.04 and 1.96 for unripe, half ripe and full ripe respectively. The ascorbic acid content decreased

significantly with advance in maturity, being 7.10 for unripe, 6.61 for half-ripe and 5.76 mg/100 gm for full ripe fruit. On average, pulp contains 6.49% ascorbic acid which is comparatively very lower than the result(15.9 mg/100 gm) reported by Joshi and Jain (2008) and comparatively higher than the results of Lande *et al.* (2010). On average, fat (3.55%) was obtained, and with no significant difference at all three maturities. Results are comparable to those of Joshi and Jain (2008). Ash contents of pulp was 1.31 and these value was close to those values reported by Ghosh *et al.*(2010) and slightly lower than the result (1.9%) reported by Roy and Mazumder (1988) and comparable with the results of Joshi and Jain (2008). The pH of the wood apple pulp increased with maturity, being a maximum 3.72 at the full-ripe stage. pH characterized the acidic taste of juice (Cemeroglu *et al.,* 1992). The titrable acidity decreased with the advance in maturity. Ripe fruits were less acidic (1.74%) than both un-ripe (2.92%) and half-ripe (2.40%) respectively. These values are very high than (1%) reported by Lande *et al.* (2010) and in the range with the results of Ghosh *et al.* (2010). Total soluble solids content is significantly increased from un-ripe to full-ripe stage and being maximum (15.82%) in full ripe fruits. Total Soluble Solids increases with maturity and ripening (Dann and Jerie, 1988). The Brix/acid ratio increased from 3.96 for unripe to 9.08 for ripe fruits, which is a 43.7% increment. The ratio of Brix/acid content has been found to be more closely related to quality than acid content or Brix alone but it still varied between years (Kader *et al.,* 1982; Meredith *et al.,* 1989). The pectin content decreased significantly with advance in maturity, being 2.05 for unripe, 1.83 for half-ripe and 1.04 % for full-ripe fruit which is low compare to result. On average wood apple contain 1.64% pectin, which is very good amount for jelly making. Results revealed that when wood apple fruit attained ripeness, the total and reducing sugar reached maximum level (Table 3). As a whole, total sugars and reducing sugar showed a significant difference. Ripe fruit had significantly more total and reducing sugars 2.12 and 1.23% than unripe 1.60 and 1.10 respectively which is comparatively lower than the results of Lande *et al.* (2010).

Conclusion

This study provides important data for the varieties suitable to grow in Nellore region. Among the various accessions PWAS 2, PWAS-9 performed well in this area. The calorific and compositional changes of the wood apple fruits (e.g. sugars, ascorbic acid and ash) at different stages of ripening, emphasizing that wood apple fruit be a good source of nutrients. Physical properties of wood apple fruits such as juice recovery (%) and pulp/shell ratio increase whereas weight and density decrease, with advance in maturity. Bio-chemical properties of wood apple fruits such as TSS, brix/acidity ratio, pH, total sugar and reducing sugar increase whereas moisture content, fat, acidity, pectin content and ascorbic acid decrease, with advance in maturity.

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