



Influence of variety and season in the inflorescence sap production in *Cocos nucifera* L.

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Abstract

The unfermented inflorescence sap of coconut is nutritionally rich and is being popularized as a natural health drink. The present work was initiated to understand the influence of variety and season on the inflorescence sap production and its quality in selected varieties of coconut. Three varieties of coconut viz., West Coast tall (WCT), Laccadive Ordinary Tall (LCT) and Chawghat Orange Dwarf (COD) and one hybrid CODxWCT (Chandra Sankara) grown at CPCRI, Kasaragod were selected for the study during 2010 and 2011. The work was undertaken for four seasons viz., monsoon, post monsoon, winter and summer. The study revealed that tall varieties are better than dwarf varieties for sap production. Average sap production of 960 ml and 880 ml respectively, in WCT and DxT hybrids was the best among the varieties tested. Sap production in COD was very low and not suitable for tapping. Total sugar content in WCT (11.44 g 100 ml⁻¹) was the highest among the varieties tested. DxT had high reducing sugar content (0.37 g 100 ml⁻¹). The study also revealed that the best time for tapping is from the middle of monsoon to the beginning of winter season. Tapping should be avoided during summer months under rainfed conditions. The information generated is useful to the farmers for tapping of coconut palm by regulating the time of tapping, identifying suitable varieties and providing irrigation to increase sap production.

Keywords: *Cocos nucifera*, neera, sap quantity, sap quality, season, tapping

Introduction

Coconut is an important crop of the tropical world, cultivated in 93 countries in an area of 12 million hectares. India is the third largest producer of copra, after Indonesia and Philippines. In India, coconut is grown in an area of 1.94 million ha, spread over 19 states and 3 Union Territories (Agricultural Statistics at a Glance, 2011). Copra, oil, coir fibre and tender nut are the major traditional products from coconut. In recent years, other value added products like virgin coconut oil, desiccated coconut, vinegar, beverages, coconut chips, handicrafts, shell powder, shell charcoal and activated carbon are coming to prominence. More products from the crop will help to increase the income and improve the living standards of coconut farmers. Among the additional products from coconut, inflorescence sap is one of the most remunerative products for the

farmer. But the natural fermentation of sap in to toddy as it is tapped makes it a product under government control. Hence, its production is allowed only under licence. There are other products from unfermented sap like neera, coconut sugar and jaggery that can be exploited for the benefit of the farmers. The low glycemic index (GI) of coconut sap sugar (around 35) makes it ideal sugar source for diabetic patients (Manohar *et al.*, 2007).

Inflorescence sap is the exudate obtained by nicely chopping the distal end of unopened inflorescence. Fermented beverages from inflorescence sap are common in most of the coconut growing countries. There are other locally known products like sugar and jaggery from sap. Technologies have also been developed to tap and preserve inflorescence sap as non-fermented beverage for wider usage. The actual method of

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tapping (nicely chopping inflorescence and delicately beating) differs from place to place. According to farmer's practice, a palm is tapped for six months and left for the next six months for nut harvest.

There are reports that tapping affects the palms. It is generally believed that after a spell of tapping, palms show a marked improvement in their nut production. The number of female flowers at opening of inflorescence and fruits at the end of 4 months in tapped palms was reported as high as three times that of the high yielding palms and double that of the very high yielding untapped palms (Mathes, 1984). A few varieties are better than others for sap yield. Weather parameters play a major role in the production of sap. A study in Philippines on sequential coconut toddy and nut production (SCTNP) scheme in six coconut hybrids and cultivars at two experimental sites at Zamboanga City showed that dwarf x tall hybrids and a local tall cultivar, Laguna gave significantly higher sap and nut yield compared to the Catigan dwarf and Catigan dwarf hybrid (CAT x CAT) and a dwarf cultivar (Tacunan). In addition to the differences in coconut varieties, climatic conditions and nutrition status of the palms contributed significantly to the differences in sap and nut yields. (Secretaria, 1998). Sap flow in coconut depends on variety and soil condition on which palm is grown. The greater soil depth, water holding capacity of soil, and larger leaf area of palm are reported to be positively correlated with higher sap flow (Wasantha, 2009).

Previous studies have shown that the sap production depends on the variety and environment (Secretaria, 1998; Wasantha, 2009). No studies are available in coconut varietal or seasonal difference in sap production in India. This work was undertaken to study the varietal difference, seasonal variation and influence of irrigation in sap production under west coast agro-ecological zone in India. The objectives of the present work were to understand the variation in quantity of sap production, biochemical compositions like total sugar, reducing sugar and protein content of sap, seasonal difference in sap production and effect of irrigation on sap produced.

Materials and Methods

The work was undertaken at Central Plantation Crops Research Institute (CPCRI), Kasaragod during 2010 and 2011 on coconut palms aged 50 years. Three varieties *viz.*, West Coast Tall (WCT), Laccadive Ordinary Tall (LCT), Chawghat Orange Dwarf (COD) and one hybrid, CODxWCT (Chandra Sankara) were chosen for the study. Four palms (two replications of two palms) of each variety and hybrid were used for tapping. WCT alone was tapped under irrigated and rain fed conditions (four palms each) to study the effect of irrigation. The work was undertaken for four seasons *viz.*, monsoon (June – September), post monsoon (October – November), winter (December – February) and summer (March – May).

Fully emerged unopened bunches were selected for tapping. Generally it takes 6 to 8 weeks from the first emergence of bunch on the leaf axil in tall and 5 to 6 weeks in the case of dwarfs. The bunch was tied at many places to prevent opening of inflorescence and facilitate sap flow. The first cut was made on the same day of tying or within next four days. After the first cut, every day the cut surface was opened twice by slicing the cut edge again and the bunch is delicately beaten or tapped thrice a day to stimulate flow of sap. Sap flow started 8 to 12 days after the first cut was made and the flow continues for 60 to 70 days. Slicing the cut edge and tapping were repeated every day till the end of sap flow. Initially sap flow was slow then increased after 8 to 10 days, further slowed down after 50 to 60 days and eventually stopped. The sap was collected in an earthen pot tied to the bunch. The earthen pot was smeared with lime to prevent fermentation of sap. The sap was collected twice a day, morning (7:30AM to 10:00AM) and evening (3:30PM to 6:00PM), and measured. The method was similar to the traditional method and the one used by Rajagopal *et al.* (1989). For biochemical analysis, sap samples were collected in polycarbonate bottles kept for two hours on the bunch after the fresh cut was made. The collected samples were immediately analysed for biochemical content such as total sugar, reducing sugar and protein (Lowry *et al.*, 1951; Somogyi, 1952; Dubois *et al.*, 1956). Biochemical compositions of rainfed

and irrigated recorded separately in the case of variety WCT. Each analysis was replicated thrice. Weather parameters like rainfall, sunshine hours, wind velocity, relative humidity, temperature and evaporation were recorded and correlated with sap production. The data analysis was done using SAS software, Version 9.3.

Results and Discussion

Total sap production from a palm was divided by number of tapping days to get the average production per day. Average production for a variety was estimated from four palms under each variety. This average sap production was used to compare varieties. The sap flow was slow initially for 10 to 15 days, peaks around 20 days and continues in the same pattern for next 25 to 30 days. After that the flow slows down and stops in another 10 to 15 days. All varieties and the hybrid showed the same trend. Similar trend was observed in a study by Rajagopal *et al.* (1989) on sap production in healthy and diseased palms.

Average production of sap per palm was 728.4 ml when all the varieties were taken together. Highest average production of 960 ml per day was obtained in WCT followed by 880 ml in DxT hybrid. Lowest production of 104.2 ml was recorded for COD. Average sap production was statistically on par with each other in WCT, LCT and DxT hybrid and all these three were significantly higher than that of COD (Table 1). In general, tall and hybrid cultivars yielded better than dwarf cultivars. The work on sequential coconut toddy and nut production (SCTNP) in six coconut hybrids and cultivars in Philippines showed that dwarf x tall hybrids namely: Malayan Red dwarf x Baybay (MRD x BAY), Malayan Red dwarf x Tagnanan (MRD x TAG), Catigan x Laguna (CAT x LAG) and a local tall cultivar, Laguna yielded significantly

higher sap and nuts compared to the Catigan dwarf and Catigan dwarf hybrid (CAT x CAT) and a dwarf cultivar, Tacunan (Secretaria, 1998).

The influence of climate on sap production was observed in the study. Highest sap production of 1043 ml and 1003 ml per palm per day was recorded during post-monsoon and monsoon periods, respectively. Sap production was the lowest during summer months, but was statistically on par with the sap production in winter (Table 2, Fig. 2). Rain positively influenced the sap production as seen from higher sap production during monsoon and post-monsoon periods. Sap flow increased only after middle of June indicating soil moisture build up that positively affected sap flow (Fig. 2). Influence of soil depth and water holding capacity on daily total sap flow was reported by Wasantha (2009). Temperature during the period also had its impact on the sap production as seen from the lowest production in summer. In general, sap production was negatively affected by the increasing temperature. It was also observed that on cloudy days the sap production was reduced. Sap being direct product of photosynthesis, light plays a significant role in sap production. This observation is in tune with the earlier report of maximum hourly sap flux from 10:00 AM to 16:00 PM followed by a rapid decline (Wasantha, 2009). Irrigation increased sap production in WCT palms when palms under rain fed condition were compared with irrigated palms (Fig. 1). This could be due to the higher water availability for irrigated soil as observed in the case of higher water availability during monsoon and post-monsoon periods. An attempt was made to correlate weather parameters for the corresponding period on the sap production. There was no correlation of sap production with weather parameters except in the case of wind velocity and

Table 1. Varietal differences in average sap production per day

Variety	Mean (ml) palm day ⁻¹	Std Dev	Min	Max
COD	104.20	8.39	98.27	110.14
Hybrid	880.13	64.54	834.50	925.77
LCT	775.74	122.65	689.02	862.47
WCT	960.03	287.62	556.33	1328.67
CD (0.05)	308.2			

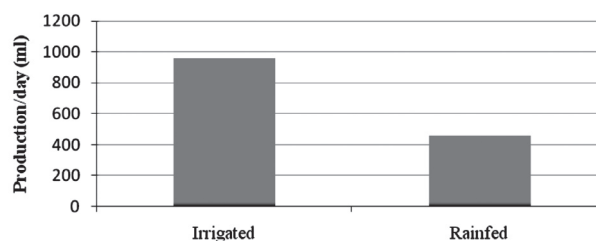
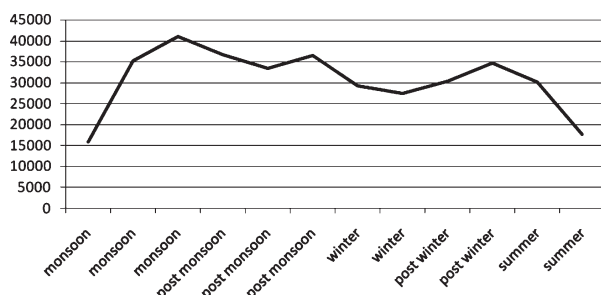


Fig. 1. Effect of irrigation on sap production in WCT

Table 2. Seasonal difference in average sap production per day

Season	Mean (ml) palm day ⁻¹	SD	Min	Max
Summer (March-May)	899	305	425	1606
Winter (December-February)	971	234	354	1548
Monsoon (June-September)	1003	368	251	1727
Post-monsoon (October-November)	1043	366	130	1717
CD (0.05)	95.6			

**Fig. 2. Seasonal distribution of sap production (ml)**

evaporation. Wind velocity and evaporation showed significant negative correlation with sap production (Table 5).

Biochemical parameters were tested using fresh samples to study the difference among varieties. Total sugar was the highest in WCT followed by LCT. Lowest total sugar content was recorded in COD. There was no significant difference in reducing sugar and protein content among the varieties tested though reducing sugar was slightly higher in DxT and LCT. Protein content also did not show any significant difference among the varieties (Table 3). Difference in quality of sap

Table 3. Differences in biochemical parameters of sap among the coconut varieties

	COD	DxT	LCT	WCT	CD (0.05)
Total sugar (g 100 ml ⁻¹)	6.39	7.40	8.85	11.44	2.165
Reducing Sugar (g 100 ml ⁻¹)	0.24	0.37	0.34	0.14	NS
Protein (g 100 ml ⁻¹)	0.05	0.05	0.07	0.06	NS

was noticed between sap collected during monsoon and winter in the case of WCT. The total sugar content was 4.31g/ml more during monsoon while reducing sugar content was less by 0.85 g/100 ml (Table 4). This is only a preliminary observation on the seasonal difference in sap quality of WCT and needs further studies to understand the reasons for the same.

Table 4. Differences in biochemical parameters between seasons in WCT (pooled for irrigated and rainfed palms)

	Winter	Monsoon
Total sugar (g100 ml ⁻¹)	7.13	11.44
Reducing Sugar (g 100 ml ⁻¹)	0.99	0.14
Protein (g 100 ml ⁻¹)	0.09	0.06

Conclusions

The study has revealed that there is difference among varieties in sap production. Tall varieties are better than dwarf varieties for sap production. WCT and DxT hybrid are suitable for tapping for sap production both from quantitative and qualitative point of view. The study also revealed that sap production was affected by seasons and irrigation. In west coast of India best months for tapping are June to December.

Table 5. Correlation coefficient analysis of sap production with weather parameters

Month	MaxTemp °C	MinTemp °C	Wind velocity (km hr ⁻¹)**	Humidity (%)	Rainfall# (mm)	Evaporation (mm)*	Subshine Hrs	Sap/palm (l)
January	37.01	14.45	1.85	68.13	0.00	3.38	8.44	27.50
February	32.25	13.68	2.11	63.36	0.00	4.20	6.92	30.42
March	32.46	21.66	2.45	73.98	0.00	4.25	7.69	34.82
April	32.74	23.92	2.57	77.07	6.13	4.14	6.12	30.15
May	32.88	23.52	2.13	67.94	12.54	4.39	6.62	17.70
June	24.28	23.08	3.51	87.48	33.79	1.79	2.96	15.88
July	25.21	21.99	2.08	94.29	32.61	1.11	1.47	35.28
August	24.63	21.95	1.97	89.50	18.93	1.55	2.98	41.09
September	21.32	17.41	1.59	81.43	27.68	2.05	4.72	36.76
October	22.38	19.09	1.82	80.92	12.46	2.64	5.43	33.47
November	24.54	21.10	1.61	79.53	6.35	2.34	5.07	36.57
December	25.35	17.71	1.56	73.60	6.65	2.97	7.19	29.23
Corr coefficient	-0.062	-0.064	-0.268	0.041	-0.080	-0.126	-0.070	
Probability	0.24	0.23	0.00	0.45	0.15	0.02	0.22	

** Significant at 0.01; * Significant at 0.05; # Average for the month

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