International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(6): 2292-2297

Received: 23-09-2018
Accepted: 26-10-2018

Ajay Kumar Karna1
Department of Fruit Science & Horticulture Technology, Odisha University of Agriculture & Technology, Bhubaneswar, Odisha, India

A Srinivasulu
Department of Fruit Science & Horticulture Technology, Odisha University of Agriculture & Technology, Bhubaneswar, Odisha, India

S Pavan Kumar
Department of Fruit Science & Horticulture Technology, Odisha University of Agriculture & Technology, Bhubaneswar, Odisha, India

Correspondence
Ajay Kumar Karna1
Department of Fruit Science & Horticulture Technology, Odisha University of Agriculture & Technology, Bhubaneswar, Odisha, India

Review on physico chemical characters on tender nut of coconut (*Cocus nucifera* L.)

Ajay Kumar Karna1, A Srinivasulu and S Pavan Kumar

Abstract
Coconut is an important crop grown in India and it provides livelihood to millions of people in the region. There are many variety of coconut available but selection of variety play an important role in consumer preference and higher price in the market which increases the farmer income. Irrespective of the age of tender nut, the nut water is highly nutritious, but acceptance mostly depends upon the taste and volume of nut water. It is contemplated from the recent findings that nuts are to be harvested for tender nut purpose at seven month development as they contain higher amount of nut water with desirable kernel content.

Keywords: Coconut, *Cocus nucifera* L. physico chemical

Introduction
Coconut (*Cocos nucifera* L.) eulogized as "Kalpa Vriksha" has been grown in India and other countries of Asia and Pacific region since time immemorial and it provides livelihood to millions of people in the region. Coconut is currently grown in 96 countries spread along the tropical belt. Indonesia, Philippines, India and Sri Lanka together account for 78% of the total world production. India ranks first among the coconut growing countries in production and productivity. In India, it is grown in 17 states and 3 Union Territories mostly along the coastal regions of the country in an area of around 2088.47 thousand hectares with a total annual production of 22167.45 million nuts and productivity of 10614 nuts/ha/year (CDB statistical year book, 2015-16). The traditional areas of coconut are confined in the states of Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, Odisha, Goa, West Bengal, Pondicherry, Maharashtra and islands of Lakshadweep and Andaman & Nicobar. India consumes more than 50% of its production as raw nuts for culinary and religious purposes, 35% of the production is utilized for conversion to copra, 11% for tender nuts, 2% for seed purposes and hardly 2% is utilized for value addition and industrial purposes (Muralidharan and Jayashree, 2011) [11]. Consumption of tender coconut as a dependable source of health drink and food is becoming popular among the health conscious people in several countries. Harvesting of coconut at tender nut stage is economically beneficial to coconut farmers as it indices higher yield of nuts than the harvesting nut at the mature stage. Apart from the local market, tender nut also enjoys a growing consumers' demand in the export market. The price of tender nut is much higher compared to mature nuts. The most desirable characteristics of tender coconut are large volume of water and higher concentration of total sugars at seven to eight months stage. Tender coconut water comprises of 95.5% water, 4% sugar, 0.1% fat, 0.02% Calcium, 0.01% phosphorus, 0.5% iron, a considerable amount of amino acids, mineral salts, vitamin B complex, vitamin C and cytokines etc (Vigliar *et al.,* 2006) [38]. The other components include sugar, sugar alcohol, amino acids, lipids, nitrogenous compounds, organic acids and enzymes. It has calorific value of 17.4 per 100 gm. The characteristic flavour of tender coconut is contributed by delta-lactones. Sugars in the form of glucose and fructose form an important constituent of tender coconut water. Tender coconut water contains both ascorbic acid and vitamins of B group. The concentration of ascorbic acid ranges from 2.2 to 3.7 mg per 100 ml. which decreases gradually (Lukose, 2013) [14].

There are many known varieties considered suitable for the production of tender nuts. Some of the dwarf and semi tall types such as Chowghat Orange Dwarf, Malaysian Yellow Dwarf, Malaysian Orange Dwarf, Malaysian Green Dwarf, Gangabondam, King coconut etc. are excellent source of good quality tender nut (Rethinam and Kumar, 2001) [30].

The tender nuts of Chowghat Orange Dwarf cultivar contain over 350 ml of water with total sugar content 7 g/100 ml of which reducing sugar accounts for 4.7 g (Thampan, 2003) [36]. In Thailand, two dwarf cultivars are reputed for production of tender nuts. They are Nam Wan and Nam Hom. Nam Wan is preferred for sweet water and Nam Hom is popular for aromatic water. Tender nuts of above two cultivars are consumed locally and also exported to Hong Kong and Singapore (Pablito 2014) [21]. Snow ball tender nut (SBTN) is a tender coconut without husk, shell and testa which is ball shaped and white in colour. At eight month age, there is no decrease in the quantity of water and kernel is sufficiently soft. So this stage is mostly suitable for making SBTN (Nampoothini and Singh, 2000) [19].

Apart from dwarf cultivars some tall types, as well as hybrids, also produce tender nuts possessing desirable characteristics. In addition to the existing varieties and hybrids, there is a substantial amount of local germplasms available in various areas. Screening of coconut cultivars for the traits such as volume of water, sweetness and flavour of water, taste and consistency of kernel and contents of minerals especially sodium and potassium can help to identify cultivars suitable for tender nut purpose. Such cultivars could be multiplied and popularized among farmers for raising gardens.

1. Physical parameters of tender nut of coconut

A. Weight of nut

Attri *et al.* (1999) [3] evaluated different cultivars of coconut at tender nut stage and found that at 7-8 months maturity, the weight of nut varied from 1.315 kg in MOD (Malayan Orange Dwarf) to 2.815 kg in AT (Andaman Tall). Likewise, quantitative analysis of mature coconut from the major states of India was carried out by Markose *et al.* (1999) [15] and found the average maximum nut weight 1472.67 g in Tamil Nadu State followed by Kerala (1373.31 g), Andhra Pradesh (1213.00 g) and Orissa (1159.67 g) and the minimum nut weight was found in Karnataka (979.00 g). The hybrids, WCT x MYD recorded the highest nut weight during all the three developmental stages. This study showed that nut weight was more in 6-month and declined during 7 and 8 month which was observed by Apshara *et al*. (2007) [2]. Whereas, Hemavathy and Balaji (2008) [10] studied the inflorescence and nut characters of dwarf cultivars in coconut and noticed that AOD (Andaman Ordinary Dwarf) was the best one for production of nuts with nut weight of 1162 gm/nut followed by MYD (Malayan Yellow Dwarf) with nut weight of 1124.5 g/nut. Tripura *et al*. (2018) studied the performance of indigenous and exotic coconut germplasm for yield and nut quality under Aliyarnagar condition and found that the genotypes Andaman Giant recorded higher nut characters *viz.*, whole nut weight (1999.50 g) and dehusked nut weight (1323.00 g) followed by San Ramon (1982.50 g and 1225.00 g, respectively) compared to lowest recorded by Arasampatti Tall (835.00 g and 512.00 g, respectively).

B. Length and breadth of nut

Attri *et al.* (1999) [3] evaluated different coconut cultivars of Malayan origin at tender nut stage (7-8 months of maturity) and found that the length and breadth of nuts exhibited significant differences among different cultivars studied. The maximum length (21.02 cm) was recorded in D x T, whereas, the breadth was maximum (16.34 cm) in AT (Andaman Tall). Ratnambal *et al.* (2000) [28] studied comparative performance of popular coconut cultivars of Goa and found the maximum length of nut in 'Nadora' cultivar (27.3 cm) followed by 'Calangute' (21.8 cm) and the minimum length was found in 'Benaulim' cultivar (21.5 cm). With respect to the breadth of nut, the maximum breadth was recorded in 'Calangute' cultivar (21.8 cm) followed by 'Nadora' (20.6 cm) and the minimum breadth was found in 'Benaulim' cultivar (18.1 cm). Sankaran *et al.* (2012) [32] studied the characterization and diversity assessment in coconut collections of Pacific Ocean Islands and Nicobar Islands and observed that the length of fruit ranged from 18.08 to 28.18 cm and the general mean was 22.78 cm Among the dwarf accessions, WCGC 05 had higher values for fruit length and breadth indicating the potential of this dwarf for production of larger nuts.

C. Volume of water

Poduval *et al.* (1998) [22] reported that the volume of nut water increased up to a certain period, which varied with different cultivars and at different stages under investigation and thereafter decreased gradually. Nut water volume increased to its maximum during six months after fruit set in the cultivars *viz.:* Laccadive ordinary, Local Tall, Philippines Ordinary and D x T hybrid. An increase in the volume of water for remaining cultivars was noticed up to seven months. The nut water content increased by 12-18 percent from six to seven month. The volume of water in Philippines Ordinary was found maximum throughout the period of development, (470 ml, 500 ml, 450 ml and 390 ml in five, six, seven and eight months, respectively). Nadanasabapathy and Kumar (1999) [17] estimated physico-chemical constituents of tender coconut water at DFRL, Mysore. The average water yield of 'Chowghat Orange Dwarf' was 240 ml. Among other varieties, average water yield of 'Malayan Yellow Dwarf' was higher (480 ml) followed by 'Tiptur Tall' (350 ml), and 'Chowghat Green Dwarf (390 ml) varieties. Ratnambal (1999) [27] studied the biochemical constituents of tender nut water and the nut yield of 16 coconut cultivars in comparison with the released cultivar 'Chowghat Orange Dwarf'. In the study, varietal differences in yield of nut water, as well as sweetness, were found. The volume of water ranged from (200 ml) in Guam III to 650 ml in FMS cultivar. While, Jackson *et al*. (2004) observed the changes in chemical composition of coconut water during maturation of the fruit. The most significant change was observed in the volume of nut water, which increased during development from 233 ml to 504 ml, with the greatest quantity found at 9 months stage. Niral *et al.* (2013) evaluated morphological and molecular characterization of a large fruited unique coconut accession and reported that the quantity of tender nut water ranged from 200 ml to 700 ml with an average of 425 ml. Likewise, Selvaraj *et al.* (2017) reported that the tender nut water quantity of hybrid VPM-5 is 300.5 ml ± 25.5, whereas, the hybrid check VHC-1 recorded 220.7 ml ± 30.1 and tall check ECT as 205.5 ml ± 34.3. The volume of water present in the whole nut increased from stages 7 to 9 months and then decreased between stages 9 and 10 months for all varieties. As the nuts matured, they became larger and thus their water holding capacity increased.

D. Thickness of kernel

Indiresh *et al.* (1997) [11] accessed fruit and nut characteristics of eighteen coconut germplasm accessions of Maidan Tract of Karnataka and the result revealed non-significant difference with respect to the thickness of kernel. However, the maximum thickness of kernel was recorded in Arsikere Tall, FMS, Kappadam, Laccadive Ordinary, Philippines and West Coast Tall (1.2 cm). Niral *et al.* (2013) [20] evaluated

morphological and molecular characterization of a large fruited unique coconut accession and reported that the average thickness of the endosperm was around 1.10 cm with an average shell thickness of 0.44 cm.

E. Weight of kernel

Indiresh *et al*. (1997) [11] studied the performance of coconut germplasm accessions in the Maidan Tract of Karnataka for nut production and reported significant difference in the weight of copra (kernel) among different cultivars. Among 18 cultivars, the maximum kernel weight was recorded in FMS (225 g) and minimum in 'Green Dwarf' (58 g). Jayabose *et al.* (2009) studied the economical important characters of coconut hybrids and reported that kernel weight of hybrids varied from 188.33 g (MGD x ECT) to 334.60 g (CCNT x PHOT). Combinations having high kernel weight (>270 g) were SIAM x MYD, PHOT x CCNT and ECT x GBGD. Among parents, the weight of kernel varied from 129.86 g (CGD) to 336.51 g (CCNT). Sankaran *et al.* (2012) [32] studied the characterization and diversity assessment in coconut collected from Pacific Ocean Islands and the Nicobar Islands and observed that WCGC 05 was found to produce 244.27 g of copra which was the highest among the dwarf accessions evaluated in India. All the Nicobar accessions in the study recorded more copra content with the highest value in WCGC 26 (249.5 g).

F. Weight of husk

Vanaja and Sreekumari (1997) [37] carried out an evaluation of WCT and Komadan coconuts. Out of 16 characters considered for evaluation, the weight of husk on an average was not significantly different between two types under study. The maximum husk weight was recorded in WCT cultivar (991.44 g) followed by Komadan cultivar (915.68 g). Ratnambal (1999) [27] evaluated Malayan Dwarf coconut cultivars at CPCRI, Kasaragod and recorded the maximum weight of husk in 'Malayan Green Dwarf' (328 g) followed by Malayan Orange Dwarf (306.6 g) and 'Malayan Yellow Dwarf' (133.5 g). Ramanandam *et al*. (2017) [26] evaluated potential coconut hybrids for yield and quality and reported that the copra content as well as the oil yield was the highest in GBGD × PHOT (23.7 kg/palm and 16.2 kg/palm, respectively) and was on par with GBGD × LCOT (22.1 kg/palm and 15.0 kg/palm, respectively). Tripura *et al.* (2018) studied the performance of indigenous and exotic coconut germplasms and observed that the highest husk weight (677.50 g) was recorded in San Roman, which was on par with BSI (620.50 g) and St. Vincent (616.00 g), the lowest value was recorded in Arasampatti Tall (187.00 g).

2. Chemical components of tender water

A. Total Soluble Solids (TSS)

While studying the effect of maturity on the chemical composition of tender coconut water in var. Arsikere Tall, Chikkasubbanna *et al.* (1990) [6] reported significant differences for the TSS at different stages of maturity. Further, they found that TSS of nut water increased from 4.1 to 4.5 during six to seven months of age and thereafter declined as the maturity advanced. Poduval *et al.* (1998) [22] evaluated coconut cultivars for tender nut water in West. Bengal and reported that TSS increased with the nut maturity up to seven months in all the 10 cultivars, except 'Andaman Ordinary' where there was a continuous increase till eight months. The maximum TSS was recorded at seven months (7.4) in 'Straight Settlement Green' (SSG) and 'Laccadive Micro' and the minimum TSS was recorded in Laccadive Micro (2.4) and in Tall x Dwarf (2.0) at the five month stage. Whereas, Nadanasabapathy and Kumar (1999) [17] studied the physico-chemical constituent of tender coconut water and reported that TSS was found to be higher for 'Chowghat Green Dwarf (5.17) followed by 'Chowghat Orange Dwarf (4.90) and the minimum was recorded in 'Tiptur Tall' (4.56) at tender nut stage. Apshara *et al*. (2007) [2] observed that TSS and pH were maximum in tender nuts of hybrids COD x WCT and LCT x COD. High TSS was recorded in the hybrids COD x WCT (6.58%) and LCT x COD (6.51%). TSS was found to increase from 6th month to 8th month of development. Nakum *et al*. (2010) [18] evaluated seven coconut cultivars at different maturity stage and in different seasons and reported that the maximum TSS content was 6.53 (^{0}Brix) at 8th month age and also the maximum TSS content 6.5 (^{0}Brix) was observed in the summer season. The total soluble solids (^{0}Brix) changed from 5.08 to 6.10 from 7 to 9 months. Total sugar was 5.0 g/100 ml and 6.3 g/100 ml at 7 months and 9months, respectively (Priya and Ramaswamy, 2014) [24]. Ghosh and Bandopadhyay (2015) evaluated the performance of seven cultivars of coconut and reported that the tender nut water of Philippines Ordinary exhibited the highest TSS (6.20 ^{0}brix) and total sugar (5.32 g/100 ml) at 7 month stage

B. Sugars and vitamin

Nadanasabapathy and Kumar (1999) [17] carried out physico-chemical analysis of tender coconut water and reported maximum of both total sugar as well as reducing sugar (5.12% and 4.86%, respectively) in 'Chowghat Green Dwarf followed by COD (4.86% and 4.41%, respectively) and the minimum was recorded in 'Tiptur Tall' (4.48% total sugar and 3.74% reducing sugar, respectively). However, the non-reducing sugar was found to be maximum in 'Tiptur Tall' (0.74%), followed by MOD (0.68%) at 7 month stage. Renata *et al.* (2006) [29] observed that the biochemical profile of coconut water varied as the coconuts matured observing an increase in the concentration of fructose and glucose and also a reduction in the concentration of sucrose. Apshara *et al.* (2007) [2] observed that total sugar, reducing sugar and amino acid contents were more in COD x WCT and LCT x COD. In all the three stages of nut development, total sugar content of tender nut water was high in COD and among the hybrids, COD x WCT recorded the highest value (5.99 g/100 ml) followed by LCT x COD (5.72 g/100 ml). Mean reducing sugar content was the highest in control cultivar (COD) and among the hybrids, same was the highest in LCT x COD (3.74 g/100 ml) followed by COD x WCT (3.70 g/100 ml) and the 7 month old nuts showed more reducing sugar. Tanqueco *et al*. (2007) [35] studied the chemical components of coconut water in three cultivars at different maturity stages and found that the highest mean values were taken from the varying ages of maturity and these were 4.86 mg/100 ml (12 month) for total sugars. Yong *et al.* (2009) [39] studied the chemical composition and biological properties of coconut water and reported that the ascorbic acid content of coconut water was 7.41 mg/100 ml and 7.08 mg/100 ml in 6 months and 12 months old nut, respectively. The total sugar was 5.23 g/100 ml and 3.42 g/100 ml in 6months and 12 months old nut, respectively. Nakum *et al.* (2010) [18] evaluated seven coconut cultivars at different maturity stage and in different season and reported that the maximum total sugar (4.71%) and reducing sugar (4.09%) were observed at 8th month age and also the maximum total sugar (4.65%) and reducing sugar

(3.79%) were observed in the summer season. According to Prades *et al.* (2012) [23] the vitamin C content of tender nut water varied from 20 to 40 mg/L and the total sugar contents varied from 2.7 to 7.0 g/100 ml in 6 or 7 onths old fruit. Tender coconut water contains both ascorbic acid and vitamins of B group those are Nicotinic acid, Pantothenic acid, Biotin, Riboflavin, Folic acid and Thiamine. The concentration of ascorbic acid in tender coconut water ranged from 2.2 to 3.7 mg/100 ml, which gradually diminished as the kernel surrounding the water began to harden (Lukose, 2013) [14].

C. Acidity (%)

Chikkasubbanna *et al.* (1990) [6] studied the influence of maturity on the chemical composition of tender coconut of var. Arsikere Tall and reported that the acidity of tender nut water declined with the advancement of maturity. The treatment differences were found to be significant among various stages of development. The maximum acidity (0.21%) was recorded at six months stage followed by a decline in advanced stages. Nadanasabapathy and Kumar (1999) [17] studied the physico-chemical constituents of tender coconut water and reported significant difference in acidity among different cultivars. The highest content of acidity was recorded in 'Malayan Orange Dwarf (0.092 mg/100 ml) followed by 'Tiptur Tall' (0.084 mg/100 ml) and the minimum was recorded in 'Chowghat Green Dwarf (0.049 mg/100 ml). Attri *et al.* (1999) [3] carried out an evaluation of different cultivars of coconut at tender nut stage and found significant differences in acidity among various cultivars. The maximum acidity was reported in 'Malayan Green Dwarf (0.155%) followed by 'Malayan Yellow Dwarf (0.105%) and the minimum acidity was recorded in D x T (0.089%). Nakum *et al.* (2010) [18] evaluated seven coconut cultivars at different maturity stage and in different seasons and reported that the acidity content varied from 0.94% to 0.63% which was minimum at 8th month age and minimum acidity content (0.50%) was also recorded in the summer season. Appaiah *et al.* (2015) [1] evaluated the physico-chemical characteristics of coconut water at different stages of maturity and reported that the acidity of CW (as citric acid) decreased with maturity from 1.74 to 0.46% (TCW1), 1.74 to 0.49% (TCW2) and 1.84 to 0.34% (MCW).

D. Potassium and sodium content of nut water

Chikkasubbanna *et al.* (1990) [6] reported that the sodium content in nut water of var. 'Arsikere Tall' showed significant difference at various stages of evaluation. However, the potassium content showed non-significant differences. The potassium content showed unsteady behaviour (increasing-decreasing) but sodium content showed increasing trend. The maximum potassium content (310 mg/100 ml) was reported at six months age and the maximum sodium content (105 mg/100 ml) was reported at eight and nine month age. Dhamodaran *et al.* (1993) [8] observed significant differences between the coconut cultivars in respect of sodium and potassium levels. The potassium level ranged from 1998 ppm in 'Malayan Yellow Dwarf' to 2797 ppm in WCT, lower potassium levels were recorded in *MYD* (1998 ppm) and COD (2003 ppm). The lowest level of sodium was recorded in COD (20 ppm) and the maximum was recorded by Spikeless (38 ppm).

Satyavati (1995) [33] carried out chemical analysis of matured and tender coconut water of about seven months maturity and reported 290 mg/100 ml and 247 mg/100 ml of potassium and 42 mg/ 100 ml and 48 mg/100 ml of sodium content in tender coconut water and mature coconut water respectively. Poduval *et al.* (1998) [22] reported that the potassium content of nut water showed a different trend. It was initially higher during the five and six months and decreased subsequently with the nut development. During the seven months period 'Laccadive Ordinary' showed minimum value (266 mg/100 ml) and T x D (266 mg/100 ml). 'Andaman ordinary' registered the highest amount of potassium (460 mg/100 ml) at the six month stage.

Ratnambal (1999) [27] evaluated 'Malayan Dwarf Coconut cultivars at tender nut stage (seven months) and found maximum potassium (2142 ppm) in MOD and the lowest in MYD (1988 ppm). The sodium content was maximum (36 ppm) in MYD and the minimum in MGD (19.5 ppm). Solang and Iqbal (2011) [34] reported that major portion of stored Ca, Mg, and Na was lodged in the nut water. The nutrients like Na, K and Ca were more or less evenly distributed in the kernel and water, whereas, higher concentration of P and Mg was found in the water. The K (56% to 81%) was higher in nut water as compared to other nutrients. The results showed the level of Mg (45% to 70%) and Na (1% to 53%) in mature and immature meat, respectively**.** They evaluated the varieties of the coconut (Tall, Dwarf and Hybrid) for physico-chemical properties of nut water and found that the maximum potassium (1249 ppm) in the hybrids and the maximum sodium (33.96 ppm) in dwarf varieties at 11 to 12 months.

Chidambaram *et al*. (2013) [5] found that tender coconut water was dominated by K^+ among cations and by Cl^- among anions. The pH of the tender coconut water was acidic to neutral, with high electrical conductivity. Priya and Ramaswamy (2014) [24] reported that the potassium content was maximum 198.7 mg/100 ml and 215.8 mg/100 ml at 7 months and 9 months stage, respectively.

Appaiah *et al.* (2015) [1] evaluated the physico-chemical characteristics of coconut water at different stages of maturity and observed that the potassium content was high in coconut water than in coconut kernel. In TCW1 (tender coconut water 1) and TCW2 (tender coconut water 2), the potassium content was 249.6 mg/100 ml and 256.2 mg/100 ml, whereas, in mature coconut water, it was 154.6 mg/100 ml. The sodium content also decreased with maturity i.e., TCK1 (34.7 mg/100 ml), TCK2 (23.7 mg/100 ml) and MCK (21.6 mg/100 ml).

3. Organoleptic evaluation of tender coconut water

Ratnambal (1999) [27] studied some Tall and Dwarf varieties suitable for tender coconut in comparison with the released cultivar 'Chowghat Orange Dwarf and reported that all ten tall cultivars and six dwarf cultivars were found to be good in organoleptic taste rank. Apshara *et al*. (2007) [2] conducted the organoleptic evaluation for the quality of tender nut of coconut and found that the hybrids Chandrasankara and Chandralaksha were the best for tender nut purpose as both of them ranked good for the taste of water and meat at the age of 7 months during the summer season.

Rachel *et al.* (2013) [25] studied the sensory characteristics of coconut water from four coconut cultivars during nuts ripening. The parameters were tastes (sweet, salty and sour), gustatory preferences and sugar contents. The results showed significant interactions between cultivars and maturity stages for analyzed parameters. So, during the ripening of nut, the sweet taste of coconut water predominated according to the maturity stages. It was maximal at the rank 21 of dwarf cultivars with perception equivalent from 5.80 to 6.10% sugar contents. At full maturity, the coconut water sweet taste was

lowered because its sugars enhanced the formation of the kernel. The results of hedonic tests led to the preference of the coconut water according to its sweet taste. So, the water of dwarf cultivars with immature nuts was more sweetened and most appreciated.

4. Varieties suitable for tender nut

Ratnambal (1999) [27] reported that dwarf cultivars of coconut like COD, Chawghat green dwarf (CGD), Gangabondam, MOD, Cameroon dwarf and King coconut were suitable for tender coconut production. Among tall cultivars, Benaulim, Fiji, Cochinchina, Guam III, FMS, West African Tall, Tripura Tall and Sakhigopal tall were also found suitable for tender nut purpose. Apshara *et al*. (2007) [2] evaluated six coconut hybrids for their suitability as tender nut and they observed that the tender nuts of hybrids COD x WCT and LCT x COD weighed less but had more volume of water. TSS and pH were maximum in the same hybrids. Total sugar, reducing sugar and amino acid contents were more in COD x WCT and LCT x COD. The organoleptic evaluation showed that the hybrids,, Chandrasankara‟ and „Chandralaksha‟ were the best for tender nut purpose as both of them ranked good for taste of water and meat at the age of 7 months during the summer season.

Chattopadhyay *et al*. (2013) [4] evaluated ten cultivars to identify suitable cultivars for tender nut purpose and reported that the cultivars Jamaican Tall, East Coast Tall and Zanzibar were found to have appreciable amounts of water, sugar and minerals at 7 months. These three cultivars, therefore, may be recommended for cultivation as tender nuts and should be harvested at 7 months to obtain the highest nutritional benefits. Tripura *et al.* (2018) evaluated different coconut genotypes during 2015-2017 to identify superior coconut genotypes for nut water. According to them the maximum amount of nut water content in tender and matured nut was recorded in Andaman Giant (724.00 ml and 655.00 ml, respectively).

Reference

1. Appaiah P, Sunil L, Kumar P, Krishna AG. Physico-chemical characteristics and stability aspects of coconut water and kernel at different stages of maturity, Journal of Food Science and Technology. 2015; 52(8):5196-5203.
2. Apshara SE, Arunachalam V, Jayabose C, Kumaran PM. Evaluation of coconut hybrids for tender nut purpose, Indian Journal of Horticulture. 2007; 64(3):320-323.
3. Attri BL, Sharma TVRS, Suryanarayana MA, Nair SA. Evaluation of different coconut *(Cocos nucifera* L.) at Tender nut stage, Indian coconut Journal. 1999; 30(1):8-10.
4. Chattopadhyay N, Samanta MK, Hore JK, Alam K. Evaluation of coconut cultivars for tender nut water, Acta Horticulture. 2013; 975(28):255-262.
5. Chidambaram S, Singaraja C, Prasanna MV, Ganesan M, Sundararajan M. Chemistry of tender coconut water from the Cuddalore Coastal Region in Tamil Nadu, India, Natural Resources Research. 2013; 22(2):91-101.
6. Chikkasubbanna V, Jayaprasad KV, Subbaiah T, Poonacha NR. Effect of maturity on chemical composition of tender coconut (Var. Arisekere Tall) water, Indian Coconut Journal. 1990; 20(12):10-13.
7. Coconut Devlopment Board. Ministry of Agriculture and Farmers Welfare, Government of India, Kochi, India, 2016.
8. Dhamodaran S, Ratnambal MJ, Chempakom B, Pillai RV, Viraktamath R. Evaluation of tender nut water in coconut cultivars. In. Advances in coconut research and development. Nair M. K. (eds), 1993, 124-128.
9. Ghosh DK, Bandopadhyay A. Performance of some coconut cultivars and hybrids in alluvial plains of West Bengal, Journal crop and weed. 2015; 11(1):197-199.
10. Hemavathy AT, Balaji K. Inflorescence and nut characters of dwarf cultivars in coconut (*Cocos nucifera* L.), Asian Journal of Bio Science. 2008; 3(1):222-223.
11. Indiresh KM, Hanumanthappa H, Shankar S, Maharudrappa K, Palanimuthu V. Evaluation of coconut germplasm in the Maidan tract of Karnataka, Indian Coconut Journal. 1997; 28(8):2-4.
12. Jackson JC, Gordon A, Wizzard G, McCook K, Rolle R. Changes in chemical composition of coconut (*Cocos nucifera*) water during maturation of the fruit, Journal of the Science of Food and Agriculture. 2004; 84:1049-1052.
13. Jayabose C, Ganesh S, Mohanan KV, Arulraj S. Estimation of heterosis of economical important characters of coconut (*Cocos nucifera* L.) hybrids, Journal of Plantation Crops. 2009; 36(3):151-154.
14. Lukose RM. The chemical composition of tender coconut (*Cocos nucifera* L.) water and coconut meat and their biological effect in human body, International Journal of Green and Herbal Chemistry. 2013; 2(3):723-729.
15. Markose VT, Poduval SK, Joseph PN. Quantitative analysis of mature coconuts from the major States of India, Indian Coconut Journal. 1999; 30(6):25-31.
16. Muralidharan K, Jayashree A. Value added products from coconut: Coconut for health & wealth, Indian Coconut Journal. 2011; 54(8):24-28.
17. Nadanasabapathy S, Kumar R. Physico-chemical constituents of tender coconut *(Cocos nucifera* L.), Indian Journal of Agricultural Sciences. 1999; 69(10):750-751.
18. Nakum VH, Kakade DK, Tomar S, Memane PG, Deshmukh NA, Sharma SJ, Patel CD. Evaluation of coconut (*Cocos nucifera* L.) cultivars for age of tender nuts in different season, The Asian Journal of Horticulture. 2010; 4(2):367-369.
19. Nampoothiri KIJK, Singh HP. Coconut cultivation technology, CDB, 2000.
20. Niral V, Devakumar K, Umamaheswari TS, Naganeeswaran S, Nair RV, Jerard BA. Morphological and molecular characterization of a large fruited unique coconut accession from Vaibhavwadi, Maharashtra, India, Indian Journal of Genetics and Plant breeding. 2013; 73(2):220-224.
21. Pablito PP. Oppertunities in growing coconut for sweet aromatic water and young, tender nuts, Agrimag, 2014.
22. Poduval M, Hasan MA, Chattopadhyay. Evaluation of coconut cultivars for tender nut water for West Bengal, Indian Coconut Journal. 1998; 29(1):3-6.
23. Prades A, Dornier M, Diop N, Pain J. Coconut water uses, composition and properties: a review, Fruits. 2012; 67:87-107.
24. Priya SR, Ramaswamy L. Tender coconut water – nature's elixir to mankind, International Journal of Recent Scientific Research. 2014; 5(8):1485-1490.
25. Rachel AR, Alexia P, Georgette KA, Jean N, Jean-Louis K. Sensory evaluation and sugars contents of coconut (*Cocos nucifera* L.) water during nuts ripening, African Journal of Food Science. 2013; 7(7):186-192.

26. Ramanandam G, Kumar KR, Padma E, Kalpana M, Maheswarappa HP. Potential coconut (*Cocos nucifera*) hybrids for yield and quality for coastal region of Andhra Pradesh (India), Indian Journal of Agricultural Sciences. 2017; 87(8):1073-6.
27. Ratnambal MJ. Varieties suitable for tender coconut, Indian Coconut Journal. 1999; 30(5):64-67
28. Ratnambal MJ, Krishnan M, Devadas K. Popular coconut cultivars of Goa, Indian Coconut journal. 2000; 31(2):1-3.
29. Renata V, Sdepanian VL, Fagundesneto U. Biochemical profile of coconut water from coconut palms planted in an inland region, Jornal de Pediatria. 2006; 82(4):308-312.
30. Rethinam P, Kumar TBN. Tender coconut-an overview, Indian Coconut Journal. 2001; 32:2-22.
31. Selvaraj VKS, Rajendran R, Saraladevi T, Maheswarappa HP. Evaluation of coconut hybrids developed for high nut and copra, Agricultural Research & Technology: Open Access Journal. 2017; 5(4):555667.
32. Sankaran M, Damodaran V, Singh DR, Sankar IJ, Jerard BA. Characterization and diversity assessment in coconut collections of Pacific Ocean Islands and Nicobar Islands, African Journal of Biotechnology. 2012; 11(97):16320-16329.
33. Satyavati K. Products from matured coconut water, Indian Coconut Journal. 1995; 26(1 & 2):12-13.
34. Solangi AH, Iqbal MZ. Chemical composition of meat (kernel) and nut water of major coconut (*Cocos nucifera* L.) cultivars at coastal area of Pakistan, Pakistan Journal of Botany. 2011; 43(1):357-363.
35. Tanqueco RE, Rodriguez FM, Laude RP, Crueno ME. Total free sugars, oil and total phenolics content of stored coconut (*Cocos nucifera* L.) water, Philippine Journal of Science. 2007; 136(2):103-108.
36. Thampan PK. Handbook on coconut pallm. Oxford and IBH Publishing Co.Pvt. Ltd., New Delhi, 1993, 357.
37. Vanaja T, Sreekumari AJ. Evaluation of WCT coconut and Komadan coconut, Indian Coconut Journal. 1997; 28(8):5-7.
38. Vigliar R, Sdepanian VL, Fagundes-Neto U. Biochemical profile of coconut water from coconut palms planted in an inland region, Journal de Pediatria. 2006; 82(4):308-312.
39. Yong JWH, Ge L, Feing Y, Tan SN. The chemical composition and biological properties of coconut (*Cocos nucifera* L.) water. Molecules. 2009; 14:5144-5164.