Trends in Biosciences 11(7), Print : ISSN 0974-8431, 1599-1603, 2018

Seasonal Variation and Developmental Changes in the Biochemical Composition of Coconut Kernel in *Mohachao narel*, A Sweet Endosperm Coconut (*Cocos nucifera* L.) Population from Maharashtra

P. AJITH KUMAR[1] AND K. SAMSUDEEN [2]

[1]*Government Arts College, Thiruvananthapuram*
[2]*Central Plantation Crops Research Institute, Kasaragod*
email: ajithkumargck@gmail.com

ABSTRACT

***'Mohachao Narel',* a coconut variant characterized by sweet and soft kernel with less fibre content, has been reported from Guhaghar taluk of Ratnagiri district of Maharashtra State in India. Farmers of the area get a premium price for sweet endosperm nuts and the sweet kernel is mainly used for raw consumption. A total of 27 mother palms possessing nuts with sweet kernel have been identified in these areas. The number of nuts with sweet endosperm per bunch varies from 10 to 77 percent in these 27 palms. Thus two types of nuts (sweet and normal) have been developed in these palms. The solid endosperm, kernel, undergoes biochemical changes as it matures during its 12- month growth period after fertilization. The objective of this work was to study these biochemical changes in the coconut endosperm in relation to the maturity of the nuts and season of harvesting between and within the sweet and normal type nuts. The dried kernel or copra was analyzed for its oil, total sugars, reducing sugars, total protein, total free amino acid and fibre contents. Both the sweet and the normal nuts harvested in the post monsoon season had higher oil, total sugar and fibre contents, but lesser kernel protein and amino acid contents than the nuts harvested during pre-monsoon and monsoon seasons. Sweet nuts had higher levels of total sugar and reducing sugar contents, but less fibre and oil contents than the normal nuts. Total protein and amino acid contents were found to be similar in both types of nuts. Percentage of oil content of kernel, in both types of nuts, was increasing steadily from seventh to twelfth month of maturity. Both types of nuts were found to have a significant increase in soluble sugar with nut maturity, to a maximum in the tenth month, after which it fell significantly in the twelfth month. In both type of nuts, harvested at different seasons, reducing sugar was maximum in the seventh month, after which it decreased to a minimum by the tenth month, it again increased by the twelfth month. In both the types of nuts, there was a significant decrease in protein and free amino acid contents as the nut matured. But both type of nuts showed the same trend of increasing in fibre content as the endosperm matured.**

Key words *sweet kernel coconut; copra; season; maturity; oil; biochemical characters.*

Coconut is a versatile and unique plant. It bears fruit all year round. Due to its multifarious uses, coconut (*Cocos nucifera* L.) symbolizes an important plant for the rural communities in developing tropical countries since it provides the basis for food production and by-product utilization in addition to its uses in industrial processing (Persley, 1992). Every part of this 'tree of life' is beneficial to mankind in one manner or other, the most extensively used part being the endosperm and its derivatives. Coconut endosperm, which is hard and white in colour, is rich in proteins, amino acids, sugars, vitamins, minerals and growth factors. The endosperm is mostly used for extraction of coconut oil and culinary purposes. Studies show that every coconut cultivar has its own unique characteristic that may explain for the variances in the oil and other metabolites like carbohydrates, protein etc. in the endosperm and also the percent composition of fatty acids in the oil. This is attributed to several factors such as location and varietal differences (Laurels *et al.,* 2000) as well as maturity of the nuts (Balleza and Sierra 1976; Repellin *et al*., 1994) and time of the year the nuts are harvested.

Certain coconut palms produce nuts containing soft, jelly-like endosperm, called *Makapuno* in Philippines (Torres, 1937), which has been commercially exploited for product diversification especially in confectionary industries. Mutants similar to *Makapuno*-type have also been reported from other coconut-growing regions: Coco Gra (Seychelles), Kopyor (Indonesia), *Thairu* or *Nei Thengai* (India), Dikiri Pol (Sri Lanka), Mapharao Khati (Thailand), Sap (Vietnam), Niu Garuk (Papua New Guinea) and Pia (Polynesia) (Arunachalam and Rajesh, 2008). This *Makapuno* trait results in abortion of embryo and is known to occur because of the effect of lethal recessive gene (Zuniga, 1953). Similar types have been sporadically reported from India (Arunachalam and Rajesh, 2008).

Recently, another variant with sweet and soft endosperm, named *'Mohachao Narel'* has been reported from Guhaghar taluk of Ratnagiri district (N17° 28'55" to N17° 29'50" and E73° 11'03" to E73° 19'50") of Maharashtra State in India (Anitha Karun *et al*., 2010; Samsudeen *et al*., 2010). Twenty seven

Table 1. Percentage of oil content in sweet and normal nuts at various maturity stages, harvested in different seasons.

Nut Type	Maturity (month)	Season of harvest			Mean
		Pre monsoon	Monsoon	Post monsoon	
Normal	7	45.15	41.10	45.73	43.99
	8	48.75	42.35	51.65	47.58
	10	57.45	53.48	61.65	57.53
	12	63.46	62.23	68.04	64.58
	Mean	53.70	49.79	56.77	53.42
Sweet	7	15.60	18.65	19.15	17.80
	8	18.65	20.60	24.65	21.30
	10	23.58	25.10	28.20	25.63
	12	29.47	26.70	36.64	30.94
	Mean	45.15	41.10	45.73	43.99
Mean		37.76	36.28	41.96	38.67

$CD_{0.05}$ season = 4.48; Maturity = 10.22

such palms are there. These 27 tall palms, with the stem height ranging from 7 m to 27 m, are aged between 40 to 80 years and found randomly distributed in the population. The number of nuts with sweet endosperm per bunch varied from 10 to 77 percent in different palms and the sweet endosperm nuts get a premium price and are mainly used for raw consumption (Samsudeen *et al*., 2010). One cannot differentiate the sweet nuts from the normal type nuts without organoleptic test of the kernel. Studies on fruit component traits of sweet and normal nuts of this population revealed that nuts possessing sweet endosperm types had slightly less fruit and husked fruit weight compared to normal nuts. Shell thickness was similar in both, but the shell weight was more in normal types. Likewise, endosperm thickness was similar in both, but the endosperm weight was more in normal types. Copra weight and copra recovery was more in normal nuts compared to sweet endosperm types. Total soluble sugars (Brix values) were same in both type of nuts, but organoleptic test showed that water in sweet endosperm nuts was poor in taste (Samsudeen *et al*., 2012).

The solid endosperm of coconut undergoes biochemical changes as it matures during its 12- month growth period after fertilization. Proteins and carbohydrates that accumulate during seed development are not only essential reserves that support germination and early seedling growth in plants, but are critical to human and animals as a major source of food (William H. Vensel *et al*., 2005). The objective of this work was to study these biochemical changes in the coconut endosperm in relation to the maturity of the nuts and season of harvesting, between and within the sweet and normal type nuts.

MATERIALS AND METHODS

A field survey was conducted in the initial stage of the study, in Ratnagiri region of Maharashtra. A total of 27 mother palms possessing nuts with sweet kernel ('NSD') have been identified in this area. The identified palms were marked for further studies. In this study, as many mature nuts (12 months) as possible from each of the 27 palms and four nuts, each from two selected palms (NSD 2 and NSD 28) which showed consistently higher percentage of sweet nuts in all seasons, were harvested at 7, 8 and 10 months after fertilization, for three seasons: pre monsoon (March 2011), monsoon (July 2012) and post monsoon (October 2011). They were dehusked, broken and categorized into sweet and normal types, on the basis of organoleptic test. Nut collected from the individual experimental palms processed to copra samples. Two replicates of each treatment, each a composite of two nuts, were analyzed for oil, total sugar, reducing sugar, total protein, total free amino acid and fibre contents.

Percentage of oil was estimated gravimetrically, following the method of Sadasivam and Manikam

Table 2. Total soluble sugars (mg/gm dry weight) and reducing sugars (mg/gm dry weight.) in sweet and normal nuts at various maturity stages, harvested in different seasons.

Nut Type	Maturity (Months)	Season of harvesting					
		Pre monsoon		Monsoon		Post monsoon	
		Total soluble sugars	Reducing sugars	Total soluble sugars	Reducing sugars	Total soluble sugars	Reducing sugars
Normal	7	35.29	8.56	35.47	12.92	45.08	12.66
	8	42.98	6.85	41.57	10.35	60.38	8.31
	10	55.21	3.71	63.45	5.37	79.69	4.39
	12	49.22	5.14	46.56	8.73	70.67	6.33
Sweet	7	87.07	21.02	54.75	21.96	109.07	18.03
	8	61.41	14.43	56.56	20.13	119.73	18.44
	10	87.60	15.98	90.62	17.45	113.55	16.25
	12	90.24	17.99	103.53	23.11	109.57	20.89

(2008). Defatted (oil extracted) copra samples were kept in the oven, 70^0C for 1 hour and ground with mortar and pestle. From the powdered sample 250 mg. were taken for biochemical analysis. Spectrophotometric quantification of total soluble sugar was done by the phenol-sulphuric acid method (Dubois *et al*., 1956), reducing sugar by the method of Nelson - Somogyi (Somogyi, 1952), total soluble protein by using Bradford (1976) method as standardized by Naresh Kumar *et al*., in 2007; total free amino acids by the method of Lee and Thakahashi (1966) and crude fibre was calculated gravimetrically by the method described by Sadasivam and Manickam (2008). The mean, standard deviation and coefficient of variation were computed and the data was subjected to three- way ANOVA by using SAS.

RESULTS AND DISCUSSION

Oil content: The oil content of nuts harvested in the post monsoon season was maximum, followed by the pre monsoon and the monsoon seasons respectively, in both type of nuts. Oil content was much higher in normal type while very low in sweet type nuts. The difference in oil contents of nuts differing in maturity was significant at 5% level. Percentage of oil content of kernel, in both types of nuts, was increasing steadily from seventh to twelfth month of maturity.

Total soluble sugars and reducing sugars: Sweet type nuts had greater total soluble sugar content than the normal type in all seasons. Total soluble sugars of nuts harvested in the pre monsoon and monsoon seasons were on par, while that of nuts harvested in the post monsoon season was significantly higher. Both types of nuts were found to have a significant increase in soluble sugar with nut maturity, to a maximum in the tenth month, after which it fell significantly in the twelfth month. The reducing sugar content was more in nuts harvested in monsoon, followed by those in post monsoon season. Of the two types of nuts, sweet type had the highest reducing sugar concentration than the normal type nuts. In both type of nuts, harvested at different seasons, reducing sugar was maximum in the seventh month, after which it decreased to a minimum by the tenth month, it again increased by the twelfth month(Table 2).

Thus there was a significant inverse relationship in the trends of total soluble sugar and the reducing sugars in both types of nuts in all three seasons. It can be concluded that for maximum total soluble sugar content, the tenth month kernel is the best. The same trend of variation was reported in some selected cultivars/ hybrids of coconut by Shamina Azeez and John George (2004).

Protein, Amino acid and Fibre contents: Nuts harvested in pre monsoon season had greater protein and free amino acid contents, followed by those harvested in monsoon. In sweet and normal type nuts the concentration of both the metabolites was on par, irrespective of other variables. In both the types of nuts, there was a significant decrease in protein and free amino acid contents as the nut matured (Table 3). The decrease in protein and free amino acid contents with nut maturity reflects on their utilization for cell division and proliferation in the maturing of

Table 3. Total protein (mg/gm dry weight), total free amino acid (mg/gm dry weight) and fibre (% dry wt.) in sweet and normal nuts at various maturity stages, harvested in different seasons.

Nut Type	Maturity (Months)	Season of harvesting								
		Pre monsoon			Monsoon			Post monsoon		
		Total Protein	Total free amino acid	Fibre	Total Protein	Total free amino acid	Fibre	Total Protein	Total free amino acid	Fibre
Normal	7	93.42	12.29	14.25	88.91	11.97	12.92	47.37	12.19	16.39
	8	79.25	11.91	16.67	79.63	11.47	18.22	38.07	9.93	26.41
	10	71.93	10.71	20.19	63.04	10.07	22.38	27.20	8.83	28.42
	12	56.56	11.23	22.03	50.15	10.47	21.97	22.92	8.45	29.21
Sweet	7	73.15	12.67	10.72	77.49	12.44	11.40	34.69	11.44	9.99
	8	86.29	11.62	11.00	56.19	13.23	10.24	27.47	10.05	12.44
	10	69.95	12.40	9.78	54.02	11.51	10.44	28.22	9.35	12.30
	12	55.14	11.68	10.63	49.73	10.21	10.33	23.51	9.10	12.50

the kernel.

Nuts harvested in post monsoon season had greater fibre content in the solid endosperm than the other two seasons. Maximum fibre content was noticed in normal type nut than the sweet type one, irrespective of the seasons. But both type of nuts showed the same trend of increasing in fibre content as the endosperm matured (Table 3). Balleza and Sierra (1976), Repellin *et al*., (1994) who observed the same trend, are of the opinion that as the solid endosperm matures, more of the sugars are transformed into cellulose.

The results of the present study revealed the existence of wide variability in oil, total sugar, reducing sugar and fibre contents between the sweet and normal type of nuts , produced in the same palm. Concentration of total sugars and reducing sugars were greater but percentage of oil and fibre contents were much lower in sweet type of nuts, compared to that of the normal type nuts. The total protein and free amino acid contents of both types of nuts were found to be on par. A significant observation made in the present study was that both the sweet and the normal type nuts followed the same trend of variation in all the metabolites- total sugar, reducing sugar, protein and free amino acid – oil and fibre contents with respect to seasons and maturity. The oil content of nuts harvested in the post monsoon season was maximum, followed by the pre monsoon and the monsoon seasons respectively, in both type of nuts. Percentage of oil content of kernel, in both types of nuts, was found to be increasing steadily from seventh to twelfth month of maturity. Total soluble sugars of nuts harvested in the pre monsoon and monsoon seasons were on par, while that of nuts harvested in the post monsoon season was significantly higher. Both types of nuts were found to have a significant increase in soluble sugar with nut maturity, to a maximum in the tenth month, after which it fell significantly in the twelfth month. The reducing sugar content was more in nuts harvested in monsoon, followed by those in post monsoon season. In both type of nuts, harvested at different seasons, reducing sugar was maximum in the seventh month, after which it decreased to a minimum by the tenth month, it again increased by the twelfth month. Nuts harvested in post monsoon season had greater fibre content in the solid endosperm than the other two seasons. Maximum fibre content was noticed in normal type nut than the sweet type one, irrespective of the seasons. But both type of nuts showed the same trend of increasing in fibre content as the endosperm matured.

Seed nuts from identified palms were collected and a population was conserved at CPCRI, Kasaragod for further evaluation and possible utilization in the coconut improvement programme. Exploitation of sweet kernel trait will help in product diversification in coconut which will lead to profitability of coconut industry. The results can pave the way for devising strategies for conservation and management of the sweet kernel coconut population and their use in future breeding programmes.

ACKNOWLEDGEMENTS

The authors are greatly indebted to the University Grants Commission for awarding FDP, teacher fellowship to Mr. Ajith Kumar P., for the completion of this work. We express our heartfelt thanks to the Director, CPCRI, Kasaragod for the kind permission and for providing all necessary laboratory facilities for the present study. We acknowledge the help rendered by Dr. D.D.Nagwekar, Dr. V.S. Sawant and Mr. Praveen of Regional Coconut Research Station, Bhatye, Ratnagiri during our field survey and collection of experimental materials at Guhagar, Maharashtra.

LITERATURE CITED

Anitha Karun, Nagwekar D.D., Samusdeen K., Sajini K.K., Radha E., Rajesh M.K., Ritto Paul, Bobby Paul and Nair R.V. 2010. *In vitro* retrieval and diversity studies of *Mohachao Naral* coconut from Maharashtra. In: *Proceedings of National Conference on Horticultural Bio-diversity for Livelihood, Economic Development and Health Care*. University of Horticultural Sciences, Bangalore, India, 12.

Arunachalam V. and Rajesh M.K. 2008. Breeding of coconut palm (*Cocos nucifera* L.). **In**: *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources*, No. 053. doi: 10.1079/PAVSNNR20083053.

Balleza C.F. and Sierra Z.N. 1976. Proximate analysis of the coconut endosperm in progressive stages of development. *Phil. J. Coco. Studies*. **I** (2): 37-43.

Bradford M.M. 1976. "A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding". *Analytical Biochemistry 72:* 248-254.

Laureles L.R., F.M. Rodriguez, M.A.A. Caraos, C.E. Reano, G.A. Santos, A.C.Laurena, and E.M.T. Mendoza.2000. Storage Lipid Variability in Promising Coconut Cultivars and Hybrids: FattyAcids and Triacylglycerol Composition. PJCS XXV # 1&2, 42-54.

Lee Y.P. and Takahashi T. (1966). An improved colorimetric determination of amino acids with the use of ninhydrin. *Analytical Biochemistry* 14: 71-77.

Naresh Kumar S., Kasturi Bai K.V., John George, Balakrishnan A. and Siju T. Thomas.2007. Stress responsive proteins in coconut seedling subjected to water, high light, flooding and high temperature stress. *Indian Journal of Horticulture*. **64(4)**: 373- 380.

Persley G. J. 1992. Replanting the Tree of Life. Commonwealth Agricultural Bureau International. Wallingford, UK.

Repellin,A.,A.D'Arcy Lameta, A.T. Pham Thi, A. Tashakorie and Y. Zuily Fodil. 1994. Physiological parameters as screening tools for drought stress resistant varieties of coconut palm (*Cocos nucifera* L.) Pp 299. In: Proceedings of the Societe Francaise Physiologie Vegetale, Colloque Sciences Vegetales, Saint-Malo. 12-14 October 1994, Paris, France.

Sadasivam,S and Manikam,A.1996.Biochemical Methods For Agricultural Sciences. Published by Willy Eastern Limited and Tamil Nadu agricultural university.

Samsudeen, K., Nagwaker, D.D., Anitha Karun, Niral, V., Jerard, B.A., Ajith Kumar, P, Devadas, K. and Nair, R.V. 2010. Exploration and collection of sweet endosperm coconut '*MOHACHAO NARAL'* from Maharashtra, India. **In**: *Book of Abstracts of International Conference on Coconut Biodiversity for Prosperity.* CPCRI, Kasaragod, India, pp.19.

Shameena Aziz and John George. (2004). Changes in the composition of coconut kernel (*Cocos nucifera* L.) with maturity and season of fertilization in selected cultivars/ hybrids. Journal of Plantation Crops. 32 (suppl.): 433-436.

Somogyi, M. (1952). Notes on sugar determination. *J. Biol. Chem*. 195(1): 19-23.

Torres, J.1937. Some notes on makapuno coconut and its inheritance. *Ph. J. Agri.* **8**:27–37.

William H. Vensel, Charlene K. Tanaka, Nick Cai, Joshua H. Wong, Bob B. Buchanan and William J. Hurkman (2005). Developmental changes in the metabolic protein profiles of wheat endosperm. *Proteomics*, **5:**1594–1611.

Zuniga, L.C.1953. The possible inheritance of makapuno character of coconut. *Ph. Agricult.* **36**:403–14.

Received on 07-02-2018 Accepted on 12-02-2018