Philippine Journal of Science
136 (2): 103-108, December 2007
ISSN 0031 - 7683

Total Free Sugars, Oil and Total Phenolics Content of Stored Coconut (*Cocos nucifera* L.) Water

Raissa Elaine Tanqueco*, **Felicito M. Rodriguez, Rita P. Laude,** and **Marni E. Cueno**

Institute of Biological Sciences, College of Arts and Sciences
University of the Philippines Los Baños, College, Laguna

Chemical components of stored coconut water, specifically total sugar, oil, and total phenolics content were determined in 3 varieties of coconuts namely Laguna Tall (LT), San Ramon Tall (SRT), and Aromatic Dwarf (AD) at different stages of maturity (13-23 months). The highest mean values for total sugars (2.95 mg/100g), oil (0.686 mg/100g), and total phenols (38.90 mg/100g) were observed from AD, SRT, and LT varieties, respectively. The highest mean values were also taken from the varying ages of maturity and these were 4.86 mg/100g (22 month) for total sugars, 0.866 mg/100g (23 month) for oil, and 143.48 mg/100g (13 month) for total phenols. The variety and stage of maturity of the nut apparently had significant effects on specific parameters of coconut water.

INTRODUCTION

The coconut (*Cocos nucifera* L.) of the order Palmae represents an important crop in terms of its distribution and uses. Since ancient times, it has proven time and again its incomparable value. In Sanskrit the coconut palm is called "kalpa vriksha", which is defined as "the tree which provides all the necessities of life" (Smith 2001).

The coconut has always been an inviting symbol of the tropics like the Philippines. It is no wonder that it is commonly tagged the "Tree of Life" (Ohler 1984) because in this country alone, it generates an estimated US$800 million worth in annual revenue. As of 2000, the Philippines is a major producer of coconut worldwide and leading copra exporter. (PCA 2003). Copra is derived from the more mature stages of coconut. One of the consequences of large scale copra production is that mature coconut water is often disposed of. Coconut water is usually combined with waste-water of a processing facility and dumped into bodies of water after partial treatment, significantly contributing to environmental pollution (Del Rosario et al. 2005).

Coconut water, which constitutes 26.29% of the whole coconut and found in the fruit's central cavity, is used in the production of vinegar, wine, and nata de coco dessert. It contains natural sugars, vitamins, and minerals, which makes it a functional food item that provides many health benefits aside from its nutritional content (Enig 1999). Recommended in cases of gastroenteritis, diarrhea, vomiting, and treatment of kidney stones, coconut water is isotonic because it has the same electrolytic balance as in human blood. Saat et al. (2002) summed up in their findings that "ingestion of fresh young coconut water, a natural refreshing beverage, could be used for whole body rehydration."

Despite a number of known uses for coconut water, the market is not sufficiently large enough. Also, since it is a by-product in the manufacture of copra and coconut oil, a great excess becomes a burden. It is clear that coconut water should be further studied and its qualities known and tapped to attain improved market demand. For this reason, other options such as the possibility of storage for coconut water should be considered.

Therefore, the general objective of the study is to determine the total sugar, oil, and polyphenol contents of 3 different varieties of stored coconut, namely, Laguna Tall (LT), San Ramon Tall (SRT), and Aromatic Dwarf (AD) at varying stages of maturity.

*Corresponding author: rplaude@yahoo.com

MATERIALS AND METHODS

Material

Coconut water (CW) samples were taken from the Philippine Coconut Authority-Davao Research Center (PCA-DRC). Three varieties, LT, SRT, and AD at varying ages were obtained. For LT, there were a total of 11 samples – 13-month to 23-month old. For SRT, 14 to 23-month old and for AD, 14 to 22-month old. The CW samples were immediately blast frozen at -15˚C to preserve the biological integrity of the samples during storage and transport.

Methods

All samples were analyzed for total free sugars, oil, and total phenolics content in triplicate.

Total free sugars content

Total free sugars content was determined using colorimetric assay (Yoshida et al. 1972). An aliquot of the coconut water was taken and diluted with distilled water. Anthrone reagent was then added and placed in a boiling water bath for 10 min, then cooled to room temperature. The absorbance was read at 630nm. A standard curve was prepared using different concentrations of sugars. The slope of regression line and concentration of total free sugars in the sample were calculated.

Oil content

Oil content was determined according to the AOAC method (1980). Approximately 20 mL of coconut water was extracted 3 times with petroleum ether. The excess solvent was then evaporated completely and the oil content was determined by difference.

Total phenolics content

Total phenolics content was determined using the Folin-Ciocalteus Phenol reagent method (Singleton 1999). An aliquot of CW was mixed with distilled water, Na_2CO_3 solution and Folin-Ciocalteus Phenol reagent. These were mixed thoroughly and placed in boiling water bath for 15 min, then cooled to room temperature. The absorbance was read at 710nm. A standard curve was prepared using different concentrations of catechin. The slope of regression line and concentration of phenols in the sample were calculated.

Statistical Analysis

The Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT) were used in the statistical analysis of the data obtained using a completely randomized design (CRD). ANOVA showed significance and information regarding single interaction effects between samples and DMRT checked which treatment means were significantly different.

RESULTS AND DISCUSSION

Total free sugars

The total free sugars (TFS) content of the samples are shown in Table 1 and Figure 1. The TFS according to variety were all found to be significantly different from each other, with the Aromatic Dwarf variety obtaining the highest mean result of 2.95 mg/100 g. This conforms with the findings of Ranasinghe on suitable varieties of coconut for industrial processing, which claims "high yield of sugar from dwarf varieties". On the other hand,

Table 1. Effect of maturity of nut on the total free sugar content of the coconut water of different coconut varieties

Age, month	Total free sugars, mg/100g		
	LT	SRT	AD
13	0.17 ± 0.01 j	ns	ns
14	0.43 ± 0.06 hij	1.33 ± 0.01 g	0.58 ± 0.01 hij
15	0.88 ± 0.03 ghij	2.34 ± 0.21 f	2.43 ± 0.15 ef
16	0.27 ± 0.02 ij	0.89 ± 0.01 ghij	2.56 ± 0.07 ef
17	0.23 ± 0.04 j	1.01 ± 0.11 ghi	3.66 ± 0.08 cd
18	2.08 ± 0.11 f	0.70 ± 0.01 ghij	4.00 ± 0.89 c
19	2.16 ± 0.09 f	0.69 ± 0.02 ghij	7.03 ± 0.14 ab
20	7.42 ± 0.03 a	0.88 ± 0.16 ghij	1.04 ± 0.12 gh
21	6.78 ± 1.22 ab	0.69 ± 0.47 ghij	2.29 ± 0.03 f
22	6.69 ± 0.18 b	ns	3.03 ± 0.15 de
23	2.11 ± 0.01 f	0.55 ± 0.20 gh	Ns
Mean	2.65b	1.00c	2.95a

ns – no sample
NOTE: Means down and across columns followed by a common letter are not significantly different among each other at 1% level of significance

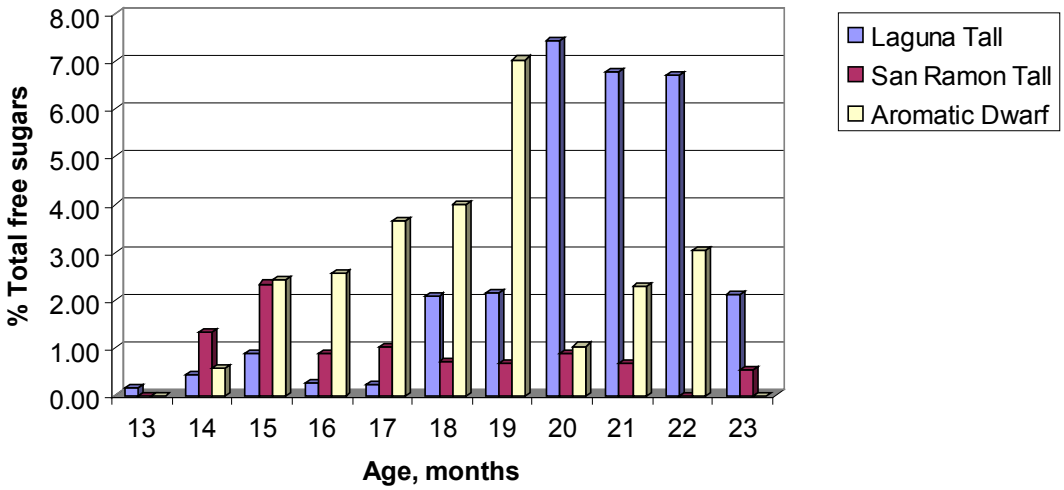

Figure 1. Effect of maturity on the total free sugars content of coconut water of 3 varieties of coconut

in terms of stages of maturity (Table 1), a number of ages were not significantly different from one another. No regular trend in the effect of age on the total free sugars can be established for each variety. This is in contrast with most studies, which would acknowledge that the concentration of sugars in the coconut water steadily increases in the early months of maturation, and then slowly falls at the stage of full maturity of the nut. However, it is to be noted that the stages of maturity under review for TFS usually ranges from ages when CW is still marketable for being young and tender. In contrast, the coconut water used in this study belonged to the matured stage and not the tender stage.

Oil content

Taken collectively, the oil content of the varieties increased (Table 2 and Fig. 2). The average oil content for all the 3 varieties were significantly different from one another and the SRT had the highest mean value of 0.686%. It is recognized that the more mature the coconut, the higher is the oil content. The lowest values were obtained at 13 months old for LT and AD and at 14 months old for SRT. Nuts at 21, 22, and 23 months old had the highest mean values for AD, SRT, and LT, respectively. Considering that the coconut water under study came from mature nuts, the values are consistent with the findings that mature nuts have higher oil content than the tender nuts.

Table 2. Effect of maturity of the nut on oil content of the coconut water of the different coconut varieties

Age, month	Oil content, g/100g		
	LT	SRT	AD
13	0.135 ± 0.012 p	0.591 ± 0.002 h	0.369 ± 0.005 l
14	0.172 ± 0.006 o	0.456 ± 0.007 k	0.452 ± 0.006 k
15	0.323 ± 0.014 m	0.681 ± 0.020 g	0.661 ± 0.020 g
16	0.555 ± 0.010 i	0.606 ± 0.009 h	0.584 ± 0.003 h
17	0.739 ± 0.009 f	0.841 ± 0.007 d	0.832 ± 0.016 d
18	0.730 ± 0.005 f	0.901 ± 0.005 ab	0.851 ± 0.005 cd
19	0.111 ± 0.002 p	0.515 ± 0.009 j	0.500 ± 0.009 j
20	0.879 ± 0.005 bc	0.749 ± 0.001 f	0.730 ± 0.004 f
21	0.213 ± 0.003 n	ns	0.920 ± 0.006 a
22	0.797 ± 0.013 e	0.834 ± 0.059 d	ns
23	0.899 ± 0.005 ab	ns	ns
Mean	0.509c	0.686a	0.655b

ns – no sample
NOTE: Means down and across columns followed by a common letter are not significantly different among each other at 1% level of significance

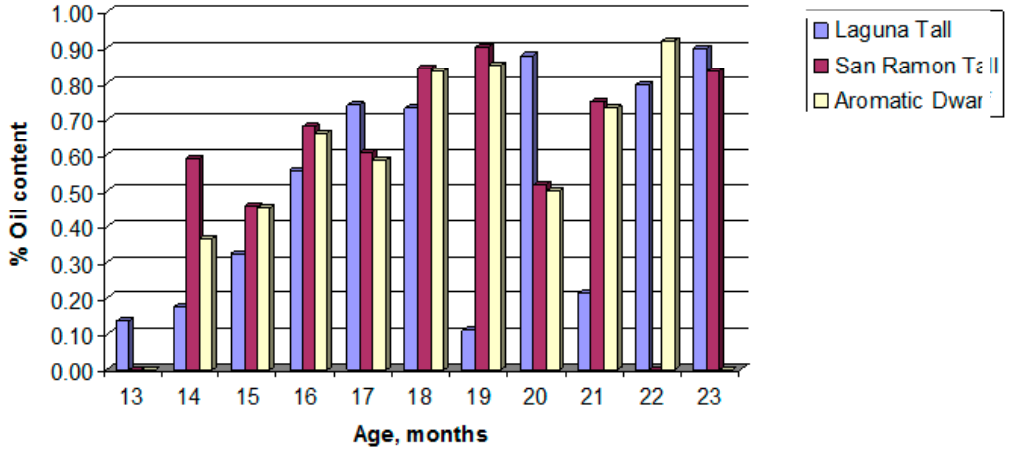

Figure 2. Effect of maturity on the oil content of coconut water of 3 varieties of coconut

Total phenolics content

The mean total phenolics content of all the 3 varieties were significantly different from each other with the highest phenolic content at 36.90 mg/100 g for LT followed by AD at 36.71 mg/100 g. SRT had the lowest mean value for total phenolics content (Table 3 and Fig.3).

A general decline in the total phenolics content can be observed. A recent study by Mantena et al. (2003) showed that coconut water also possesses antioxidant properties and had the ability to scavenge free radicals. The activity was noted to be more significant for fresh samples and drastically decreased as the coconut matured. Decrease in antioxidative properties of the coconut water could be attributed to the decrease in phenolic compounds. The highest means for total phenols were relatively exhibited at 13 months old.

Effect of maturity

Maturity as a factor in the oil, total free sugars, and total phenolics contents of stored coconut water is shown in Table 4. The fact that oil content in coconut water is higher in old nuts can be observed in general terms. While total free sugars, which is supposed to have the reverse trend was not observed in the samples. This could be attributed to the long storage of coconut water where some enzymatic or oxidative processes may have already occurred. Another possible explanation could be the concentration of coconut water as a result of freezing.

The great variability can be observed on the total phenolics. Total phenolics content is lower on older nuts as a result of oxidation. Generally, the coconut water used in this study can be considered as coming from mature coconuts since the youngest nut is 13 months old. Tender

Table 3. Effect of maturity on the total phenolics content of the coconut water of the different coconut varieties

Age, month	Total phenolics content, mg/100g		
	LT	SRT	AD
13	143.49 ± 2.70 a	68.42 ± 0.34 b	51.35 ± 042 e
14	44.06 ± 0.69 g	28.42 ± 0.22 k	18.86 ± 1.21 l
15	7.58 ± 0.69 q	3.69 ± 0.28 r	50.76 ± 0.83 e
16	8.21 ± 0.58 q	19.22 ± 0.17 l	42.86 ± 0.33 gh
17	36.88 ± 0.43 i	1.18 ± 0.42 s	48.62 ± 0.59 f
18	17.07 ± 0.66 mn	16.72 ± 0.16 n	56.48 ± 0.49 c
19	56.48 ± 0.49 c	15.05 ± 1.09 o	18.55 ± 0.26 lm
20	53.35 ± 0.67 d	36.18 ± 0.56 i	31.66 ± 1.10 j
21	41.70 ± 0.65 h	ns	11.34 ± 0.21 p
22	7.32 ± 0.19 q	2.12 ± 0.16 s	ns
23	11.84 ± 0.21 p	ns	ns
Mean	36.90a	21.22c	36.71b

ns – no sample
NOTE: Means down and across columns followed by a common letter are not significantly different among each other at 1% level of significance

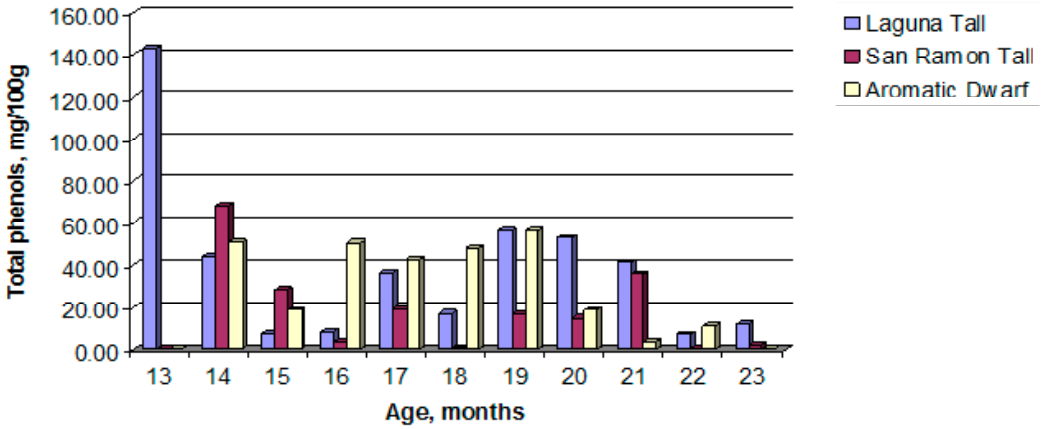

Figure 3. Effect of maturity on the total phenolics content of coconut water of 3 varieties of coconut

Table 4. Effect of maturity of coconut on the oil content, total free sugars and total phenolics contents of coconut water

Maturity, months	Total free sugars mg/100g	Oil content g/100g	Total phenolics mg/100g
13	0.17g	0.135h	143.48a
14	0.78f	0.377g	54.61b
15	1.88dc	0.410f	18.28i
16	1.23e	0.632dc	20.88h
17	1.62de	0.643c	32.98e
18	2.26c	0.801b	22.28g
19	3.29b	0.621d	43.23c
20	3.11b	0.631dc	28.98f
21	3.25b	0.564e	36.51d
22	4.86a	0.858a	9.32j
23	1.33e	0.866a	6.98k

NOTE: Means down and across columns followed by a common letter are not significantly different among each other at 1% level of significance

coconuts are only about 6 to 8 months old. All values showed statistically significant differences at 1% level.

SUMMARY AND CONCLUSION

Coconut water of 3 coconut varieties stored for several months were analyzed for total sugar, oil, and total phenolic contents. Results revealed that oil content, total free sugars, and total phenolics content expressed as catechin were significantly different with respect to variety and nut maturity. Among all 3 varieties, equivalent LT obtained the highest mean for total phenolic content, SRT for oil content, and AD for its total sugar. A trend on total sugar could not be established. This can be attributed to the effect of prolonged freezing. Generally, enzymatic activity occurs even on cold storage, only at a minimum rate so that the conversion of sugars to starch or the possible concentration of coconut water cannot be discarded. An increase in oil content on the coconut water is observed and this is a general trend in maturing nuts. There is an observed decrease in total phenolics content with maturity.

ACKNOWLEDGEMENT

This study would not have been possible if not for the UPLB-PCARRD-DOST funded project entitled "Gene Discovery in Coconut", headed by Dr. Rita P. Laude. The experiments and analyses were conducted at the Institute of Plant Breeding, University of the Philippines Los Baños. The authors wish to thank Eureka Teresa M. Ocampo for the statistical analysis of the data, Ms. Elenita R. Castillo and Teresita Maligalig for their assistance in the laboratory during the conduct of the study. All the assistance we received were truly invaluable!

LITERATURE CITED

[AOAC] ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS. 1980. The Official Methods of Analysis. 13th Edition. Washington DC. Pergamon Press. 1018 p.

DEL ROSARIO EJ, DELA CRUZ JI, RIVERA KJM, SALISI MSD, ABACA CL JR, DIMAALA BA and ACDA RI. 2005. Separation of growth hormones and sugars in coconut water using micellar-enhanced ultrafiltration. The Philippine Agricultural Scientist. 88(1): 95-108.

ENIG MG. 1999. Coconut: In Support of Good Health in 21th Century. Asian Pacific Coconut Community's 36th sessions. <livecoconutoil.com/marjenig.htm>. Accessed January 14, 2006. 10 p.

MANTENA SK, JAGADISH SR, BADDURI KB, SIRIPURAPU MK and UNNIKRISHNAN ??. 2003. *In vitro* evaluation of antioxidant properties of *Cocos nucifera* Linn. water. Nahrung 47(2): 126-131.

[PCA] PHILIPPINE COCONUT AUTHORITY. 2005. PCA Coconut – Tree of Life.

RANASINGHE TKG. 1996. Suitable varieties of coconut for industrial processing. http://www.ipri.cgiar.org/Publications/HTML Publications/198/Ch06.htm.

SAAT M, SINGH R, SIRISINGHE RG and NAWAWI M. 2002. Rehydration after exercise with fresh young coconut water, carbohydrate-electrolyte beverage and plain water. J Physiol Anthropol Appl Human Sci. 21(2): 93-104.

ROLFES S and WHITNEY E. 2002. Understanding Nutrition, 9th ed. Singapore: Thomson Learning Asia. ____ p.

SINGLETON VL, ORTHOFER R, LAMUELA-RAVENTOS RM. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu Reagent. Methods in Enzymology. 299: 152-178

SMITH K. 2001. *Cocos nucifera*. Ethnobotanical Leaflets. 10p.

TAMPO MMT. 2006. Partial Molecular Characterization of Free Nucleic Acids (FNA) from the water of aromatic dwarf variety of coconut (*Cocos nucifera* L.). B.S. Thesis. University of the Philippines Los Baños. the resistance of low density lipoproteins to oxidation in rabbits. Atherosclerosis. 120(1-2): 15-23.

YOSHIDA S, FORNO DA, COCK JH and GOMEZ KA. 1972. Laboratory Manual for physiological studies of rice. 2nd edition. International Rice Research Institute. pp 36-37.