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Effects of storage temperature on physicochemical parameters of coconut (Cocos nucifera var. Dwarf of Guinea Equatorial) water

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Abstract— This present work is a comparative study between the physicochemical properties of the coconut water dwarf variety of Guinea Equatorial stored at 28°C and 10°C during two weeks. The physicochemical properties like dry matter, pH, titratable acidity, sugars, proteins and vitamin C were analyzed for comparison. The results showed that at the ambient temperature the values of dry matter, titratable acidity, proteins and vitamin C decrease during the storage time. However, at the cooled temperature (10°C) these values remain practically stable during the two weeks. These data indicated that coconut water storage at the cool temperature of 10°C preserved nutrients during two weeks. This juice could constitute a potential good drink for sportsman.

Index Terms— Coconut water, Physicochemical properties, Refrigeration, Storage temperature.

1 Introduction

The coconut plant is considered the tree of life, since it is one humanity's principal fruit resources [1]. Coconut water is the juice of the endosperm found within the cavity of the coconut; with begin to form around 2 months after the natural opening of the inflorescence [2]. Coconut water is highly valued due to its nutritional and therapeutic properties [3]. Coconut water has been used as a solution for oral hydration [4, 5]. Studies reported that coconut water could be used for intravenous rehydration [6, 7]. During the Second World War, coconut water was used instead of saline solution during emergency surgeries [8, 9].

According to the Institute of Sporting Sciences (ISS), a drink for athlete's containing less than 5 % of sugars has much interest whereas that which would have a sugar rate exceeding 10 % is known as person in charge for stomach cramp [10, 11, 12]. However, the coconut water in its natural state contains a sugar rate between 4 and 5 % [13]. This liquid is particularly soft and has all the functional characteristics necessary of a drink for athlete.

However, it was proved that the obstruction of nuts and degradation in the course of the time of its organoleptic and nutritional characteristics are the factors limiting for export after harvest [14].

Also coconut water extracted from the nut is easier to handle but is also very sensitive to biological and chemical injuries [15]. This juice abundantly consumed is deteriorated easily once exposed to air. Even if the coconut water is extracted aseptically, its exposure to air initiates some reactions such as oxidation promoted by enzymes polyphenol oxidase (PPO) and peroxidase (POD), which are naturally present in the coconut water [16, 17]. These reactions have a negative effect on sensorial and nutritional qualities as the color of the coconut water. Coconut water loses its delicate fresh flavor and some nutrients during heating [18, 19]. In order to reduce these problems, authors used process to protect the fresh flavor and nutrients content of coconut water. Several studies showed that microfiltration, microwave processing, ultrafiltration, ultraviolet-C treatment and chemicals products addition made it possible to increase the shelf life of the coconut water [20, 21, 17, 22, 23]. If those methods can guarantee a commercially sterile product, it asks competences and investments often exceeding the means of small and average processing industries. It is thus necessary to find technologies easier to implement and less expensive, but guaranteeing a level of quality and a reasonable storage time in a practical form to answer at the request of the consumer of natural product.

The aim of this study was to determine the proximate constituent of coconut water at 28°C and 10°C during two weeks. This storage will help in the choice of the storage temperature of the coconut water for a broader period of distribution.

2 Materials and methods

2.1 Collection of fruit and sampling

The coconuts were harvested from a Station MARC DELORME of the national center of agronomic research of Port Bouët (Côte d'Ivoire). They were selected according to the immature stage described by FAO [24]. An immature coconut of 9 months contains about 750 mL of water that eventually becomes the flesh [24]. The nuts were collected on piece 132. Four trees were selected in a random way.

On each tree, five (5) nuts were gathered randomly for the study of the physico-chemical characteristics that is to say on the whole twenty (20) nuts. The fruit were transported directly to the Biocatalysis and Bioprocessing laboratory of Nangui Abrogoua University (Côte d'Ivoire). The nuts are stripped then the hulls are removed and water is taken central cavity of almond using a syringe. The mixture of the water of twenty nuts constituted the sample to be analyzed. This mixture was divided into two share equalizes one preserved at the ambient temperature (28°C) and the other at the cool temperature (10°C). Each three days, 250 mL were taken of each sample for the chemical analysis.

2.2 Proximate Composition Analysis

Dry matters were determined by drying in an oven at 105ºC during 24 h to constant weight [25]. The hydrogen potential (pH) of the samples was measured with a digital pH-meter (HANNA HI2211, Romania). Fifty mililiter of coconut water are filtered, the solution is collected in a glass bottle. Then the pH was read on a digital screen while directly by immersing the electrode of the pH-meter in to solution.

Titratable acidity was determined according to the method AOAC [26].

Crude proteins were determined by method using folin ciocalteus [27]. Method described by Dubois [28] was used to determine total sugars while reducing sugars were analyzed according to the method using 3.5 dinitrosalycilic acids (DNS) [29]. Vitamin C was determined by method described by Pongracz [30].

2.3 Statistical analysis

Analysis of the data was carried out using Stastica 7.1 software. The analysis of the variance with one factor (ANOVA) and the test of Duncan were realised to compare the variables analysed on coco water during the storage. The differences were considered significant for values of P ≤ 0.05.

3 Results and Discussion

The percentage of dry matter of the coconut water storage at 28°C decrease day 0 (0.98%) at day 12 (0.76%). On the other hand, at the cooled temperature (10°C), the percentage of dry matter of the coconut water remains practically stable during the two weeks of storage (Figure 1). The statistical analysis showed that there was a significant difference with the threshold of 5% between the dry matter values of coconut water preserved at 28°C as from day 3. The fall of the percentage of dry matter could be explained by the reduction in free sugars. Indeed, in the presence of the lactic bacteria and of oxygen, of sugars transform themselves into water, carbon dioxide and heat. However, its intensity depends on the factors such as the temperature and the moisture of the vegetable material as well as the quantity of oxygen present in the cell of storage.

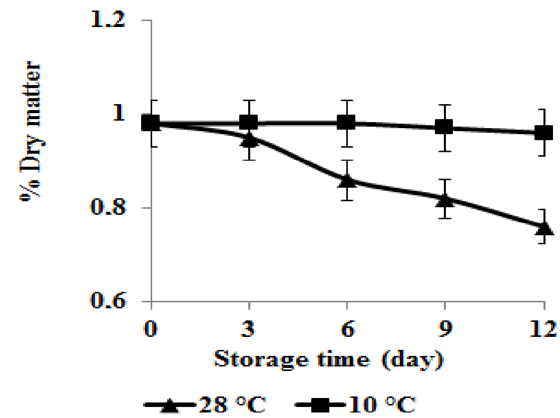

Fig. 1. Evolution of dry matter content of coconut water when stored at temperatures of 10°C and 28°C.

The pH (4.8) of the coconut water storage at 28°C lowers as the shelf life increases to reach a value of 2.39 at day 12. On the other hand, one notes a very weak variation of pH for the coconut water storage at 10°C (Figure 2A). In addition, the titratable acidity of the coconut water storage at 28°C increases during the two weeks of conservation to reach a value of 0.192 meq/100g. Acidity of the coconut water storage at 10°C almost doesn't vary during the shelf life (Figure 2B). The evolution of the pH at the green dwarf of Equatorial Guinea is different from that observed by Jackson et al. [31]. These authors noted an increase in the pH with other varieties of coconut. This difference in results could be related to the storage conditions. Indeed, in our experiments, we preserved the coconut water but Jackson et al. [31] preserved the coconuts during their work. Reduction of pH and the increase in the titratable acidity of the coconut water stored at 28°C could be explained by the action of the micro-organisms which would use the nutriments coconut water making thus the acid medium. In addition, the fermentation of sugars by the lactic bacteria involves also fast increase in acidity at the temperature of 28°C. Our results are similar to those of Agnememel [32]. It showed that the acidity of the coconut water increased during storage to the air. On the other hand with the cool temperature (10°C) acidity remains stable because of the inhibiting effect of the low temperature. Indeed, the cold prevents the proliferation of the micro-organisms in the coconut water [33].

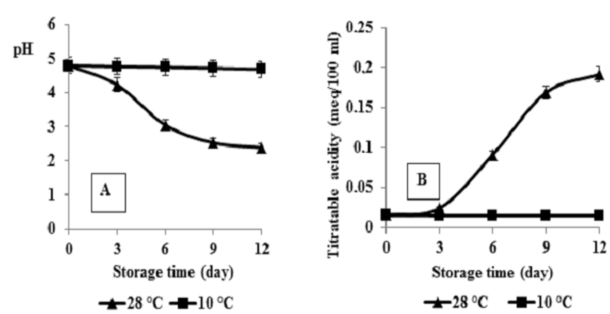

Fig. 2. Evolution of pH and titratable acidity of coconut water when stored at temperatures of 10°C and 28°C. A: pH; B: titratable acidity.

The total sugars and reducing sugars contents of the coconuts water stored at 28°C decreases considerably as of the third day of conservation (Figure 3A). While with the cold storage temperature, these sugar contents remain almost stable during the two weeks of conservation (Figure 3B). The decrease in the sugar content of coconut water during the storage period could be explained by the using of glucose, fructose and sucrose reported by Assa [34]. Indeed, glucose and fructose are metabolized by bacteria and follow the path of fermentation. As for sucrose, it suffers from the bacteria a hydrolysis which leads to the release of the simple sugars which will be degraded by fermentation. The bacteria ferment the sugar contained in the coconut water stored at 28°C to transform it into alcohol (ethanol) and this is perceptible by the odor that emerges when we open the jars containing our samples.

On the other hand, the reduction in the level of reducing sugars before that of the total sugars of coconut water could be explained by the fact that the non-reducing sugars of the coconut water would first undergo hydrolysis before transforming into simple sugars to be fermented by bacteria into alcohol. According to Asiedu [35], coconut water contains 0.80% reducing sugar while it contains 2.08% total sugars. So the bacteria fermenting the sugar will quickly reduce the level of reducing sugars in the medium. In the refrigerator, the sugar level remains practically stable because the cold prevents the proliferation of micro-organisms [33]

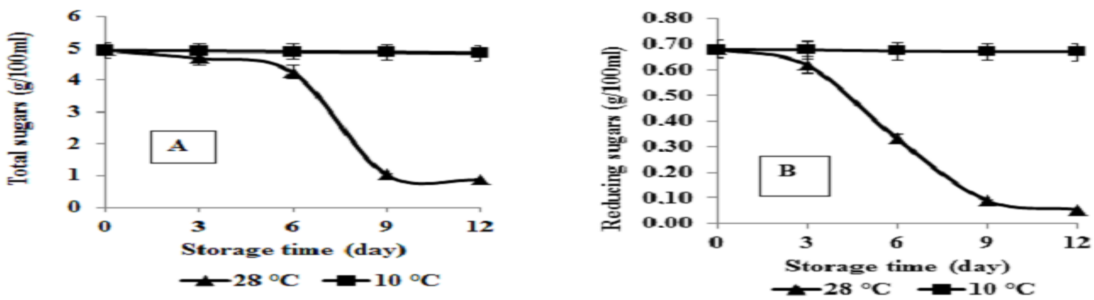

Fig. 3. Evolution of sugars content of coconut water when stored at temperatures of 10°C and 28°C. A: reducing sugars:

Concerning the proteins content of the coconut water stored at 28°C., it decreases from the third day while that stored at 10°C doesn't vary (Figure 4). With an initial content of 61.81 mg / ml of protein, coconut water loses more than 2/3 of its content on the twelfth day of storage at room temperature (28°C). On the other hand, it retains more than 98% of its protein content after this storage time at 10°C. The decrease in protein content could be explained by the action of micro-organisms that would use the nutrients for food, thus making the medium poor in nitrogenous substances, in amino acids. This resulted in a decrease in the protein content during the storage of coconut water at 28°C. This decrease is very small for coconut water stored at 10°C because of the effect of cold.

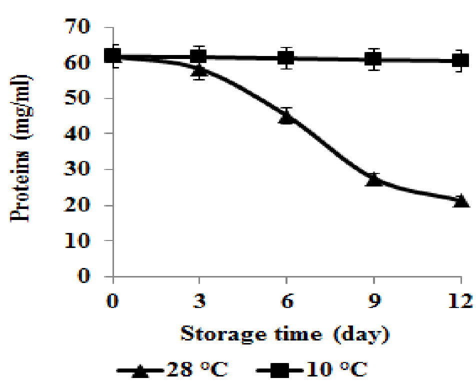

Fig. 4. Evolution of the proteins content of coconut water when stored at temperatures of 10°C and 28°C.

The vitamin C content of coconut water decreases during storage at 28°C and 10°C, but this decrease is more pronounced at 28°C (Figure 5). The decrease in vitamin C is due to its instability at temperature, its sensitivity to oxygen and ultraviolet rays. As a result, it degrades rapidly during storage. The vitamin C content of freshly harvested coconut water (1.89 mg/100 ml) is close to that found by Dignan et al. [36] which is 2 mg/100 ml. The content of the coconut water drops during storage in refrigerator because of the transparency of the bottle of conservation. The bottle used was out of transparent glass.

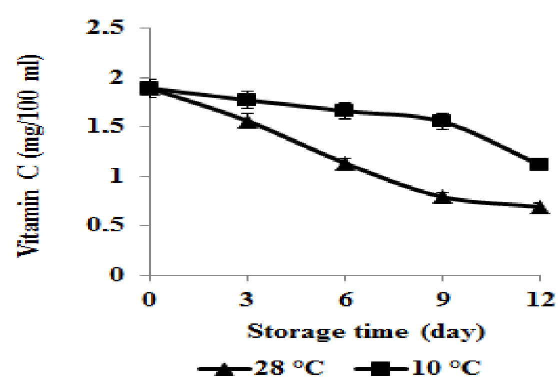

Fig. 5. Evolution of the vitamin C content of coconut water when stored at temperatures of 10°C and 28°C.

4 Conclusion

This study was carried out to determine the physicochemical characteristics of coconut water during two weeks of storage at refrigerated temperature (10°C) and at ambient temperature (28°C). The results obtained show that the physicochemical parameters of coconut water do not evolve almost in the cold temperature. On the other hand, these parameters fall for most of the parameters studied at ambient temperature. Coconut water refrigerated at 10°C appears to be a natural healthy beverages and good alternatives to artificial sport drinks.

REFERENCES

[1] A.O Adegoke, E.O Bamigbowu, M.I. George-Opuda, and P. Edomwande, "Electrolyte and glucose contents of ripe and unripe coconut liquid as source of oral rehydration solution" Journal of Applied Research in Natural Products, vol. 5, no. 1, pp. 18-21, Apr-May 2012.

[2] R. Vigliar, V. L. Sdepanian, and U. Fagundes-Neto, "Biochemical profile of coconut water from coconut palms planted in an inland region" Jornal de Pediatria, vol. 82, no. 4, pp. 308-312, Jul-Aug 2006.

[3] S.R. Priya, and L. Ramaswamy, "Tender coconut water –nature elixir to mankind" International Journal of Recent Scientific Research, vol. 5, no. 8, pp. 1485-1490, Aug 2014.

[4] M.N Khan, Muti-Ur-Rehman, and K.W. Khan, "A study of chemical composition of Cocos nucifera L. (Coconut) water and its usefulness as rehydration fluid" Pakistan Journal of Botany, vol. 35, no. 5, pp. 925-930, 2003.

[5] A. Adesakin, O. Akinloye, and Y. Omidiran, "Comparative analysis of water in tender and matured coconut fruits and use as oral rehydration solution" Chemistry and Materials Research, vol. 7 no. 2, pp. 7-10, 2015.

[6] B. Eiseman, "Intravenous infusion of coconut water"American Medical Association Archives of Surgery, vol. 68, pp. 167-78, Feb 1954.

[7] G.A Petroianu, M. Kosanovic, I.S. Shehatta, B. Mahgoub, A.Saleh, and W.H. Maleck, "Green Coconut Water for Intravenous Use: Trace and Minor Element Content " The Journal of Trace Elements in Experimental Medicine, vol. 17, pp. 273–282, 2004.

[8] D. Campbell-Falck, T. Thomas, T.M Falck, N. Tutuo, and K. Clem, "The intravenous use of coconut water" American Journal of Emergency Medicine, vol. 18, pp. 108-11, Jan 2000.

[9] W.M.A. Aragão, "Importância do coqueiro-anão verde" http://www21.sede.embrapa.br/noticias/artigos/2000/artigo.2004-12-07.2461636373/ mostra_artigo, 20 Jun 2000.

[10] B. Campbell, C. Wilborn, P. La Bounty, L. Taylor, M.T Nelson, M. Greenwood, T.N Ziegenfuss, H.L Lopez, J.R. Hoffman, J.R Stout, S. Schmitz, R. Collins, D. Kalman, J. Antonio, and R.B. Kreider, "International Society of Sports Nutrition position stand: energy drinks" Journal of the International Society of Sports Nutrition, vol. 10, no. 1, 2013. DOI: 10.1186/1550-2783-10-1.

[11] K.L Beck, J.S Thomson, R.J Swift, and P.R. Von Hurst, "Role of nutrition in performance enhancement and postexercise recovery. Open" Access Journal of Sports Medicine, vol. 6, pp. 259–267, 11 Aug 2015.

[12] A. Malhotra, T. Noakes, and S. Phinney, "It is time to bust the myth of physical inactivity and obesity: you cannot outrun a bad diet" British Journal of Sports Medicine http://dx.doi.org/10.1136/bjsports-2015-094911, 2015.

[13] Z.A.B Deffan, R.R. Assa, B.R. Konan, A.B. Agnememel, K.J.L. Konan, and L.P. Kouamé, Physicochemical characteristics of coconut water from “in vitro culture” (Cocos nucifera L.) according to fruit maturation stage and storage period. British Journal of Applied Science & Technology, vol. 4, no. 1, pp. 54-66, 2014.

[14] M.I. Maciel, S.L Oliveira, and I.P. Silva, "Effects of different storage conditions on preservation of coconut (Cocos nucifera) water" Journal of Food Processing and Preservation,16: 13-22, Feb 1992.

[15] E.B.C. Lima, C.N.S Sousa, L N. Meneses, N.C. Ximenes, M. A. Santos, Júnior, G.S. Vasconcelos, N.B.C. Lima, M.C.A Patrocínio, D. Macedo, and S.M.M. Vasconcelos, "Cocos nucifera (L.) (Arecaceae): A phytochemical and pharmacological review" Brazilian Journal of Medical and Biological Research, vol. 48, no. 11, pp. 953–964, 18 Aug 2015.

[16] A.C.P. Duarte, M.A.Z. Coelho, and S.G.F. Leite, "Identification of peroxidase and tyrosinase in green coconut water" Ciencia Y Tecnologia Alimentaria, vol. 3, no. 5, pp. 266-270, 28 May 2002.

[17] K. N. Matsui, J.A.W. Gut, P.V. de Oliveira, and C.C. Tadini, "Inactivation kinetics of polyphenol oxidase and peroxidase in green coconut water by microwave processing" Journal of Food Engineering, vol. 88, pp. 169–176, 9 Feb 2008.

[18] A. Gobin, K.O. Falade, and J.O. Akingbala, "Effect of packaging on physical, chemical and sensory attributes of coconut water during storage" Journal of Food, Agriculture & Environment, vol. 7, no. 1, pp. 62-65, 2009.

[19] S. Damar, (2006) "Processing of coconut water with high pressure carbon dioxide technology" A dissertation presented to the graduate school of the University of Florida in partial fulfillment of the requirements for the degree of Doctor of Philosophy, University of Florida, 9 Mar 2006.

[20] M. Satin, and G. Amorrigi, "Coconut beverage, FAO, Patent GB2318969" Italy, Rome, 13 May 1998.

[21] L.M.C., Costa, G.A Maia, J.M.C. da Costa, R.W. de Figueiredo, M. do C.P Rodrigues, P.H.M. de Sousa, , and A.M. Pinheiro, Qualidade e vida de prateleira da agua de coco obtida pelo processo de enchimento a quente. Revista Brasileira de Armazenamento, vol. 31, no. 1, pp. 95-102, 2006.

[22] E.H.M., Walter, D. Y. Kabuki, L.M.R. Esper, A.S. Sant’Ana, and A. Y. Kuaye, "Modelling the growth of Listeria monocytogenes in fresh green coconut (Cocos nucifera L.) water" Food Microbiology, 26: 653–657, 22 Apr 2009.

[23] S, Shivashankar, P. Soumya, and P.R. Srinivasa, "Effect of Ultraviolet-C Treatment on Some Physico-Chemical Properties of Tender Coconut Water" International Journal of Current Microbiology and Applied Sciences, vol. 6, no. 5, pp. 2893-2904, 10 May 2017.

[24] FAO, "Food and Agricultural Organization. AG21: Magazine. New sports drink: coconut water" 2005, Available from: http://www.fao.org/ag/magazine/9810/spot3.htm.

[25] AOAC, "Association of Official Analytical Chemists – Official Methods of Analysis (15th edn) Washington DC" 771p, 1990.

[26] AOAC, "Official Methods of Analysis, 17th ed. Gaithersburg, Washington DC, 2000.

[27] O.H. Lowry, N.J. Rosebrough, A.L. Farr, and R.J. Randall, "Protein measurement with the folin phenol reagent" Journal of Biology and Chemistry, vol. 193, pp. 265-275, Nov 1951.

[28] M. Dubois, K.A. Gilles, J.K Hamilton, P.A. Rebers, and F. Smith "Colorimetric method for determination of sugars and related substances" Analytical Chemistry, 28: 350-356, Mar 1956.

[29] P. Bernfeld, "Amylase α and β. Methods in enzymology 1" S. P. Colswick and N. O. K., Ed Academic Press Inc, New-York, pp. 149-154, 1955.

[30] G. Pongracz,"Neue potentiometrische Bestimmungsmethode füe Ascorbinsäure und deren Verbindungen" Journal of Analytical Chemistry, vol. 253, pp. 271 – 274, 1971.

[31] J.C Jackson, A. Gordon, G. Wizard, K. Mc Cook, and R. Rolle "Changes in chemical composition of coconut (cocos nucifera L) water during maturation of the fruit" Journal of Sciences and Food Agriculture, vol. 84, pp. 1049-1052, 2004.

[32] A. Agnememel, "Évolution post-récolte de quelques caractéristiques physicochimiques de l'eau des fruits matures de vitroplants d'hybrides de cocotier (Cocos nucifera L.) PB 121 selon les stades de maturité et la durée de stockage" DEA, Université d'Abobo-Adjamé, Abidjan, Côted'Ivoire, 2007.

[33] M.M., Chowdhury, M. G. Aziz, and M.B. Uddin, "Development of shelf-stable ready-to-serve green coconut water" Biotechnology, vol. 4, pp. 121–125, 2005.

[34] R. Assa, "Diagnostic de la cocoteraie du littoral ivoirien : étude physicochimique et organoleptique de l'eau et de l'amande de quatre cultivars du cocotier (Cocos nucifera L.)selon les stades de maturité" Doctorat de Thèse Unique, Université de Cocody, Abidjan, Côte d'Ivoire, 2007.

[35] J.J. Asiedu, "La transformation des produits agricoles en zone tropicale. Edition Karthala et CTA", 1991.

[36] C. Dignan, B. Burlingame, S. Kumar, and W. Aalbersberg "The Pacific Islands Food Composition Tables" 2 Ed., 153p. FAO, Rome, 2004.