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RESEARCH PAPER

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Variation of physicochemical parameters of coconut (*Cocos nucifera* L.) haustorium during germination

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Abstract

This study is done to determine the biochemical characteristics of coconut haustorium during germination in order to propose ways of increasing their commercial value. The Malaysia Yellow Dwarf (MYD) cultivar was used for this study. The coconut were stored during one month before putting in seedbed at the nursey.At2 and 4 months of germination, biochemical analyses were made on coconut haustorium. The results showed that the oil content fluctuate from 12.90% to 37.30% when the protein content vary from 11.25% to 13.74%. The mainly soluble sugar was sucrose, fructose and glucose with the values of 45.07%, 28.37 % and 25.63% respectively at 4 month of germination. Phosphorus (14.89%) and potassium (26.01%) are the most important minerals of coconut haustorium. The high soluble sugar content of coconut haustorium gives it to be a good source of sugars including sucrose, fructose and glucose. The haustorium is also rich in phosphorus and potassium can be used as an additive in food for children suffering from mineral deficiencies.

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Introduction

The coconut tree (*Cocos nucifera* L.) is an oil producing and lasting plant cultivated in more than 90 countries over 12 million hectare. It plays fundament al socio economic role in the whole intertropical humid zone, by bringing incomes to millions of farmers. About 10 million families, who in majority are exploiting village farms, they draw their resources from speculation in connecting with nuciculture (Moore and Batugal, 2004). Coconut also provides essential materials in diverse field, such as feeding, the craft industry, the cosmetic industry and health. (Van der Vossen and Chipunga-helo, 2007). This plant firstly know for coconut oil production is also known for its water which nutritive characteristics, make it one of the most nutrient inputs used in infant nutrition (Bachrach and Gardner, 2002; cutting, 1986), but also in area of in vitro culture of plants (Sarawut *et al.,* 2003). The Ivorian coconut plantation covers an area of 50 000 ha of which 95% is located on the coast where it represent the main cash crop for majority farmers (Konan *et al.,* 2006). In this area, the coconut tree is especially valued by its nuts. On-farm, mature nuts are often sold as is. There are some villagers who produce oil for the marketing and consumption (Assa *et al.,* 2006). Besides, many germinated nuts are abandoned in plantation by producers, pretexting they cannot be valued. This is engendering lost of income for farmers. Thus, during the coconut germination, the distal part of the embryo increases to create a haustorium which increases extensively during the almond progressively disappears in the nuts. This expansion continues until the haustorium completely fills the coconut. Moreover, previous studies on coconut haustorium during the germination were made over sugar metabolism of sugars in the haustorium from the seedling growth and function of endogenous gibberellins in haustorium (Murakami and Sugimura, 1990). However, there is no work on the biochemical parameters of haustorium during the germination of the cultivars popularized in Ivory Coast. For this reason, we decided to study the biochemical parameters of the coconuts haustorium during germination, in order to determine parameters enhancing its value.

Material and methods

Plant material

This study used mature nuts of 14 months (rank 26) of the Malaysia Yellow Dwarf (MYD) cultivar. The nuts were harvested from mature trees aged of 25 years. This Dwarf variety is the most cultivated in Ivory Coast. This material was collected at Marc Delorme research Station of the National Agronomic Research Centre (CNRA), located in Port Bouet, Ivory Coast.

Sampling

Fight coconut trees from the Malaysia Yellow Dwarf (MYD) cultivar were selected and divided in 2 sets of 4 coconut trees each. Each set represents a repetition. They are composed of 4 bunches of mature nuts from 14 months (Rank 26). Over each bunch, seven nuts were selected. This makes a total of 28 nuts per set (Fig. 3). The 56 nuts were stored a month before being put in a seedbed at the nursery at the ambient temperature. At 2 and 4 months of germinations, analyses were conducted on the over the haustorium nuts. The haustorium sample (Fig. 2) representative of each batch was composed of 10 germinated nuts (Fig. 1).

Determination of physicochemical parameters

Haustorium weight was measured using a 1/100 precision scale (Sartorius).The haustorium's dry matter content (% MS) was determined through Lyophilisation at -60°C, under a pressure of 8 millibars during 72 hours (BIPEA, 1976). The lipid contents were obtained by the Soxshlet method (AFNOR, 1973). The amounts of total and reducing sugar were evaluated respectively with the Sulphuric phenol method (Dubois *et al*., 1956) and with the 3.5 dinitro-salicylic acid (DNS) methods (Bernfeld, 1955) by using a Spectrophotometer (Spectronic Genesis 5). The amount of protein was determinate by the Kjeldhal method (AOAC, 2000). The qualitative and quantitative analysis of different minerals was performed using a microanalyzer (CNIB OXFORD instruments) which is an energy distribution spectrometer (EDS).

The qualitative and quantitative analysis of different soluble sugars was performed using a High Performance Liquid Chromatography (Dionex Corp., Sunnyvale, USA) equipped with a column Carbopac MA-1 and a pulsed amperometric detector ED40.

Statistical analysis

The data were subject to an analysis of variance (ANOVA) using the software SPSS 16.0 for windows. Mean and standard deviations were calculated and, when *F* values were significant at the $p < 0.05$ level, the mean difference was separated using the Newman Keul's test.

Results

Physicochemical composition

The analysis of variance showed a significant difference for the majority parameters measured.

Fig. 1. The germinated nut of MYD.

Thus, From 2 to 4 months of germination, the weight of the coconuts haustoium increased statically from 20.98g to 88.47g (Fig. 4). The dry matter, lipid and protein content statistically increased from 17.29% to 24.23%; 12.90% to 37.30% and 11.25% to 13.74% respectively at 2 and 4 months of germination (Fig. 5).

The reducing sugar content of the haustorium coconut has statistically increased from 9.94 mg/ml (2 months of germination) to 16.89 mg/ml (4 months of germination), excepted total sugars with values ranging from 40.03 mg/mL to 45.99 mg/mL (Fig. 6).

Sugar chromatographic profile

In coconut haustorium, the main soluble sugars during germination are fructose, glucose and sucrose (Fig. 7).

At 2 months of germination, the glucose proportion was 16.61%. Then, it has increased statistically at 4 months of germination to the value of 25.63%. As well, from 2 to 4 months of germination, the sucrose proportion has statistically decreased from 57.93% to 45.07%.

Fig. 2. The haustorium of MYD.

However, the myo-inositol and fructose proportion of haustorium coconut is statistically the same during germination. Thus, the values were respectively of 0.89% and 0.93%; 24.57% of 28.37% at 2 and 4 months of germination.

Minerals chromatographic profile

The analysis of variance showed a significant difference for all minerals determinate.

Potassium (K) and phosphorus (P) were the most profuse in haustorium during germination (Fig. 8).

From 2 and 4 months of germination, the sodium, sulfur and potassium proportion has statistically increased respectively from 9.32% to 12.79%; 2.20% to 3.48% and 4.003% to 5.93%.Nevertheless, at 2 months of germination, the potassium and phosphorus proportion statistically decreased respectively from 36.77% and 23.96% to reach 26.01% and 14.89% at 4 months of germination.

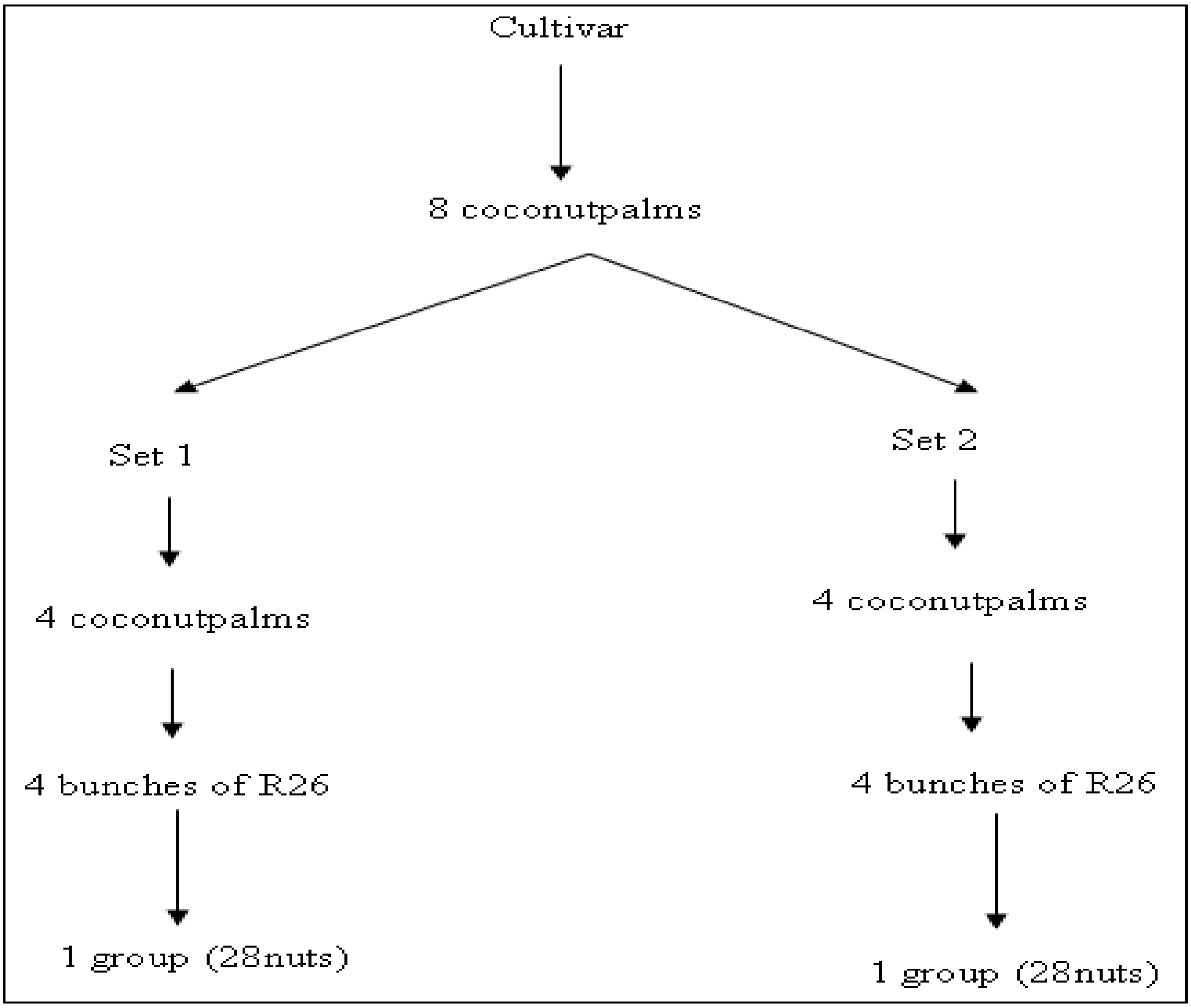

Fig. 3. Sampling method for coconuts.

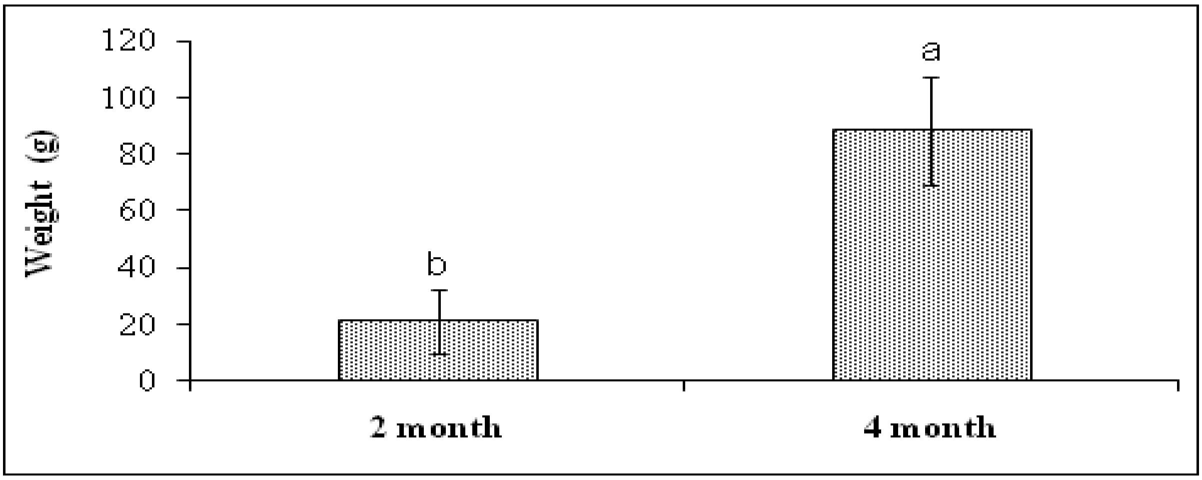

Fig. 4. Variation of weight haustorium coconut of MYD cultivar during germination.

Discussion

The result shows an increase of the weight haustorium during the germination. In fact, during the coconut germination the distal part of the embryo increases to form the haustorium, which stays inside the nut, and develop itself by digesting the almond. These results corroborate those of Sugimura and Murakami (1990).

The dry matter content of the haustorium coconuts during germination is very low. This low dry matter is due to its high water content. Indeed, during the development of the haustorium, half reduce the coconut water, and haustorium enlarges itself inside the nut. Then, all the water disappears and the haustorium filled the nut cavity (Samonte *et al.*,1989). Besides, the haustorium is sometimes called "apple" in Asian countries because of high water content compared to the kernel (Van der Vossen and chipungahelo, 2007).

The lipid content increase in haustorium coconut during germination. This increase is due to the almond lipids absorption by haustorium. During the germination, lipids migrate from outer part of the almond to the haustorium by the inner part of the almond.

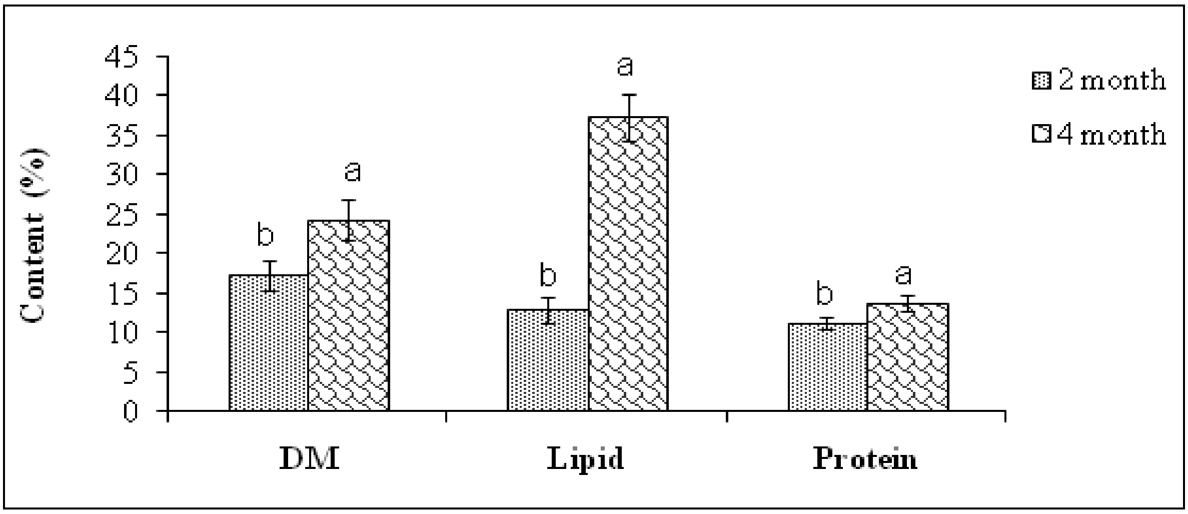

Fig. 5. Variation of dry matter (DM), lipid and protein contents of haustorium coconut of MYD cultivar during germination.

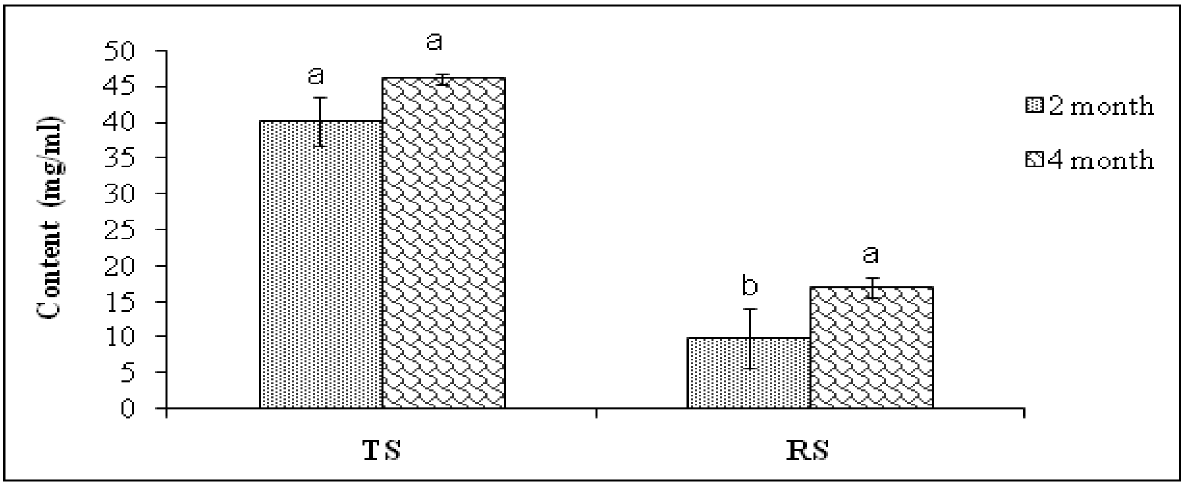

Fig. 6. Variation of total sugar (TS) and reducing sugar (RS) contents of haustorium coconut of MYD cultivar during germination.

The lipid content increases in the haustorium proceeds from the almond. Thus, the almond lipids are absorbed by the haustorium and are stored in its external part. They are then transformed into sugar by glyoxylate cycle to provide energy to the seedling and the roots (Balachandran and Arumughan, 1995a). Thus, during germination, the kernel lipids are hydrolysed by haustorium lipases (Balachandran and Arumughan, 1995b).

These results also corroborate those of Davies (1983); Oo and Stumpf (1983) and Villalobos *et al.,* (2001). Therefore, the haustorium is biochemically an active tissue able to synthesize the enzymes for the lipids metabolism during coconut germination. It also plays an important role in the glyoxylate cycle during the coconut germination. Thus, the entire process of germination is therefore facilitated by the effective participation of coconut water, almond, the embryo and haustorium (Balachandran and Arumughan 1995b).

The lipid contents present in the haustorium are lower than those present in the kernel coconut (Konan *et al.,* 2009). This difference is due to the fact that major components of the kernel coconuts are sugars and fats. These results corroborate those of Santoso *et al.,* (1996).

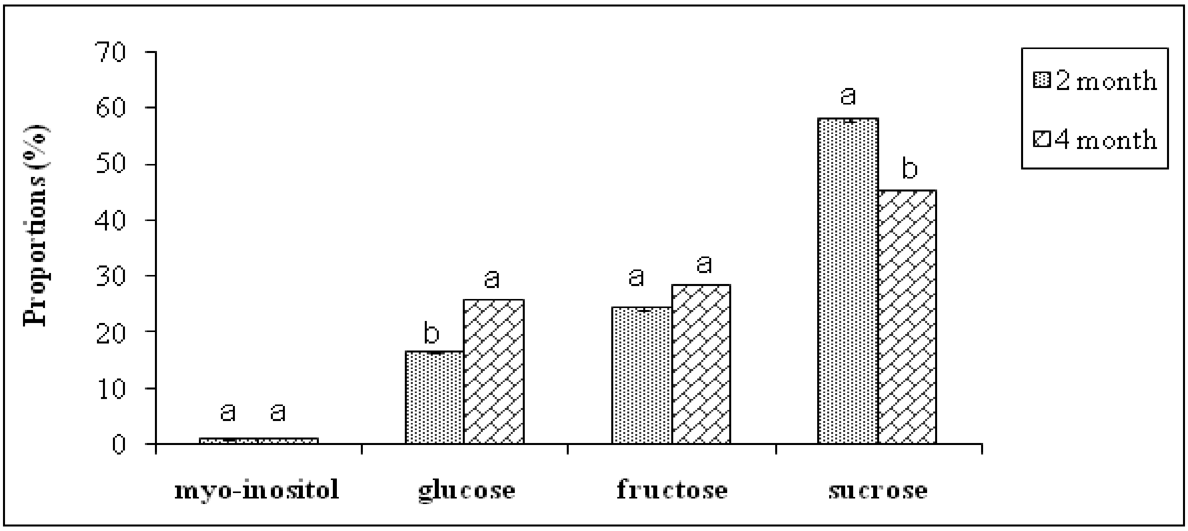

Fig. 7. Variation of soluble sugar proportions of haustorium coconut of MYD cultivar during germination.

Mec while, the lipid contents of the haustorium can be compared to those of the soybean seed, and Hylocereus, which are respectively 21% (Daydé *et al.,* 2002) and 32% (Abdul *et al.,* 2009).

The protein contents of the haustorium increased during germination. These results are similar to those Yamaoka *et al.,* (1994). Garcia *et al.,* (1991). These authors showed the implication of proteolytic enzymes in the degradation and accumulation of protein in germination seeds cotyledon. However, the proteins contents of haustorium are low comparatively to those of kernel coconut obtained during germination. Nevertheless, these proteins contents are comparable to those of the safou (Silou *et al.,* 1999b). Besides, the proteins contents of haustorium are higher than those of giginya, while copra and akpi which are respectively 0.18% (Barminas *et al.,* 2008); 5.72% (Marikkar *et al.,* 2009) and 8.86% (Tchiegang *et al.,* 1997).

The chromatographic profil of the soluble sugar of haustorium revealed that the main sugar is sucrose, glucose and fructose. However, during germination, these sugars increase in haustorium except sucrose. Those results are in congruence with those of Murakami and Sugimura (1990). According to them, sucrose is used to provide energy to the seedling causing its decline in the haustorium. The haustorium is particularly the storage and absorption organ, which provides the seedling the products of the almond's hydrolysis before the young seedling be able to develop through photosynthesis. The results obtained have also show the increase of reducing sugars content in the haustorium during germination. In fact, during the coconut's germination, the enzymatic activities take place in coconut water and in the haustorium.

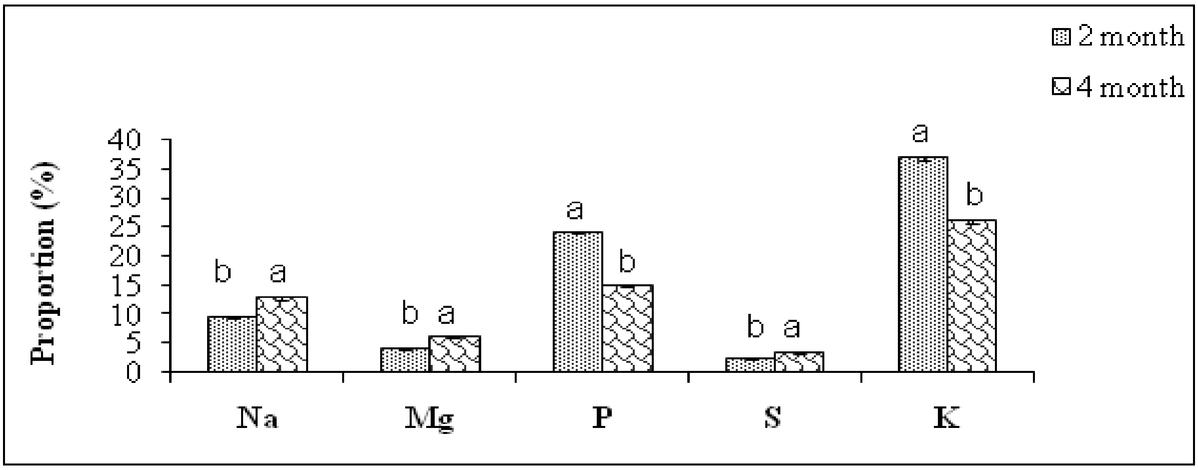

Fig. 8. Variation of mineral proportion of haustorium coconut of MYD cultivar during germination.

The strong enzymatic activities explain the major drop of polysaccharides both in the almond and in the haustorium during germination. This decrease is followed by the decrease of total and reducing sugars in the kernel and an increase of reducing sugars in the haustorium (Samonte *et al.,* 1989).

This observation confirms the works of Balasubramaniam *et al.,* (1973) which showed that the coconut only depends of the carbohydrate reserves during germination. The works of Balachandran and Arumughan (1995b) also showed that during the germination, the embryo formation depends on coconut water reserves and of the almond in particularly sugar. Thus, the content of fructose, glucose and the total and reducing sugar of the haustorium increase. As against, the sucrose content decrease.

The chromatographic profile of the minerals in haustorium revealed that potassium and phosphorus are the main minerals and their proportion decrease during germination.. This decrease of the haustorium's main minerals might be due to their use for the metabolism of the young seedling (Manciot *et al.,* 1979). Meanwhile, the mineral contents of the haustorium obtained during our experiments can be compared to those the coconut almond and are similar to those of the wild mango (Silou *et al.,* 2004); seed squash (Silou *et al.,* 1994) and Safou (Silou *et al.,* 1999b).

Conclusion

The mainly haustorium soluble sugar are glucose, fructose and sucrose. Phosphorus and potassium are the most predominant minerals of the haustorium coconut. The high content of soluble sugar of the haustorium coconut grants is to be a good source of sugar. The haustorium coconut is also rich in phosphorus and potassium can be used as an additive in food for children suffering from minerals deficiencies.

Références

Abdul A, Jamilah B, Chin-Ping T, RusslyA, Roselina K, Chia L. 2009. Essential fatty acids of *Pitaya* (dragon fruit) seed oil. Food chemistry **114**, 561-564.

AFNOR. 1973. Norme Francaise homologuée NF V03-905. Graines oléagineuses: détermination de l'extrait à l'hexane, 48-54.

AOAC. 2000. Association of official analytical chemical; official methods of analysis. 14^{th} ED. Washington D.C USA.

Assa R. R, Konan JL, Nemlin J, Prades A, Agbo N, Sie R. 2006. Diagnostic de la cocoteraie paysanne du littoral ivoirien. Sciences et Nature, **2 (3),** 113-120.

Bachrach L, Gardner J. 2002. Caregiver knowledge, attitude, and practices regarding childhood diarrhea and dehydration in Kingston, Jamaica. Panam Salud Publica **12**, 37-44. http://dx.doi.org/10.1590/S1020498920020007000006

Balachandran C, Arumughan C. 1995b. Biochemical and cytochemical transformations in germinating coconut (*Cocos nucifera* L.) Journal of the American Oil Chemists' Society***72,*** 1385-1391. http://dx.doi.org/10.1007/BF02546216

Balachandran C, Arumughan C. 1995a. Triglyceride deposition in tissues of germinating coconut (*Cocos nucifera* L.) Journal of the American Oil Chemists' Society***72***, 647-651. http://dx.doi.org/10.1007/BF02635649

Balasubramaniam K, Jayalath T, Wijesundera Hoover A, De Silva M. 1973. Biochemical changes during germination of coconut. Annals of Botany **37**, 439-445. http://doi.org/10.1093/oxfordjournals.aob.a084710

Barminas T, Onen A, WilliamsT, Zaruwa Z, Mamuru A, Haggai D. 2008. Studies on functional properties of borassus starch from fresh germinating nuts of giginya (*Borassus aethiopum*) palm. Food hydrocolloids **22,** 298-304. http://dx.doi.org/10.1016/j.foodhyd.2006.11.018

Bernfeld P. 1955. Amylase β and α (Assay method) in methods in enzymology I, colowick and Kaplan, Ed., Academic press, New York, 149-154.

BIPEA. 1976. Bureau Interprofessionnel d'Etudes Analytiques : Recueil des méthodesd'analyses des communautés Européennes ,160 p. French.

Cutting W. 1986. Coconut water and home rehydration, lancet 2 **8507,** 640-641.

Davies H. 1983. Medium chain acyl-ACP hydrolysis activities of developing oilseeds, phytochemistry **33**, 1353-1356. http://dx.doi.org/10.1016/00319422(93)85089-A

Daydé J, Berger M, Theodorou V. 2002. Variation of soybean isoflavones content and composition. Proceedings of CISCE (China and International Soybean Conference and Exhibition), November 6-9, Beijing, China, 361-362.

Dubois M, Gilles K, HamiltonJ, Rebers P, Smith F. 1956. Colorimetric methods for determination of sugar and related substances. Chemistry Analytical **28**, 350-356.

Garcia-Agustin P, Benaches G, Primo-Milo E. 1991. Control by the embryo axix of the breakdown of storage proteins in cotyledons of germinating seeds of Citrus limon, J. Sci. Food Agr **56**, 435-443.

Konan B, koana JL, Assa R, Oulé M, Amani G. 2009. The physicochemical characteristics of coconut (*Cocos nucifera* L.) kernel in germination.Seed Science and Biotechnology **3**, 1-7.

Konan J, Allou K, N'goran A, Diarrassouba L, Ballo K. 2006. Bien cultiver le cocotier en Côte d'Ivoire. Fiche technique sur le cocotier. Direction des Programmes de Recherches et de l'Appui au Développement 4p.

ManciotR, Ollagnier M, Ochs R. 1979. Nutrition minérale et fertilisation du cocotier dans le monde. Oléagineux **34,** 563-576.

Marikkar J, Banu M, Yalegama C. 2009. Evaluation of the modified-ceylon copra kiln for accelerated production of ball copra. International Food Research Journal**16**, 175-181.

MooreC, Batugal P. 2004. Banking on the tree of life: in Geneflow. A Publication about the earth's genetic resources. Ruth D. Raymond (Eds). Rome, Italy. 35p.

Murakami T, Sugimura Y. 1990. Structure and function of the haustorium in germinating coconut palm seed. Japan Agricultural Research Quarterly**24**, 1-14.

Oo K, Stumpt P. 1983. The metabolism of the germinating oil palm (*Elaeis guineensis*) seedling. Plant physiology **73,** 1033-1037.

Samonté J, Mendoza E, Llag L, De La Cruz N, Ramirez D. 1989. Galactomannan, degrading enzymes in maturing normal and makapuno and germinating normal coconut endosperm. Phytochemistry **28,** 2269-2273. http://dx.doi.org/10.1016/S00319422(00)97966-4.

Santoso U, Kazuhiro K, Toru O, Tadahiro T, Akio M. 1996. Nutrient composition of *kopyor* coconuts (*Cocos nucifera* L.) Food chemistry **52**, 299-304. http://dx.doi.org/10.1016/0308-8146(95)00237-5

Sarawut B, Suchada V, Pimehai A, Sangtiwa S, Elke P. 2003. Induced desiccation tolerance by ABA treatment in sugarcane somatic embryos, in "Technological and institutional innovations for sustainable rural development" Deutscher Tropentag, October 8-10, Gottingen.

Silou T, Biyoko S, Heron S, Atchapla, Maloumbi G. 2004. Caractéristiques physico-chimiques et potentialités technologiques des amandes de *Irvingia gabonensis*. Rivista Italiana della Sostanze Grasse **80**, 49-57.

Silou T, Mampouya D, Loka L. 1999a. Composition globale et caracteristiques des huiles extraites de 5 espèces de cucurbitacées du Niger.Rivista Italiana della Sostanze Grasse **76**, 85-89.

Silou T, Rocquelin G, Gallon G, Molangui T. 1999b. Contribution à la caractérisation des safous d'Afrique Centrale II. Composition chimique et caractéristiques nutritionnelles des safous du district de Boko (Congo-Brazzaville). Variation inter arbre, Rivista Italiana della Sostanze Grasse77, 85-89.

Tchiegang C, Kapseu C, Ndjouenkeu R, Ngassoum B. 1997. Amandes de *Ricinodendron heudelotii* (Bail) : Matière première potentielle pour les industries agro-alimentaire tropicales. Journal of Food Engineering **32**, 1-10. http://dx.doi.org/10.1016/S0260-8774(97)00094-0

Van der Vossen H, e Fagbayide J.2007. *Helianthus annuus* L. In: van der Vossen, H.A.M. & Mkamilo, G.S. (Editeurs). PROTA 14: Vegetable oils/Oléagineux. [CD-Rom]. PROTA, Wageningen, Pays Bas.

Villalobos L, Dodds F, Hornung R. 2001. Changes in fatty acid composition during development of tissues of coconut (*Cocos nucifera* L.) embryos in the intact nut and *in vitro*. Journal of experimental botany **52,** 933-942.

Yamaoka Y, Takeuchi M, Morohashi Y. 1994. Purification and characterization of a cysteine endopeptidase in cotyledons of germinated mung bean seeds, Plant Physiology **94**, 561-566.