JBAAR
Journal of Basic And Applied Research
ISSN 2413-7014

Effects of Post-harvest Storage and Boiling Time on Some Biochemical Parameters of Two Yams Species (*Dioscorea cayenensis-rotundata*variety "tambi″and*Dioscorea alata* variety‘’azaguié’’) Tubers

Nina C.J. Kouadio, Yapi A.Y.D. Patrice, Mankambou J. Gnanwa, Hubert K. Konan*, Jean Parfait E.N. Kouadio, Lucien P. Kouamé

Laboratoire de Biocatalyse et des Bioprocédés de l'Université Nangui Abrogoua (Abidjan, Côte d'Ivoire), 22 BP 801 Abidjan 22, Côte d'Ivoire.

*Corresponding author: h_k_konan@yahoo.fr

Received: 29-11-2016
Revised: 14-12-2016
Published: 22-12-2016

Keywords:
Dioscorea alata, Dioscorea cayenensis-rotunda, post-harvest, proximate composition, boiling time.

Abstract: Samples of two yams species (*Dioscore aalata variety ‘’*Azaguié*’’ and Dioscorea cayenensis-rotundata variety*’’Tambi*’’*) tubers were subjected to different boiling times after post-harvest storage. These yams tubers species were kept for six (6) months after harvest in an aired storage (26.56 ± 3 ºC; 82 ± 5 % RH). Some biochemical parameters such as dry matter, crude protein, crude fat, total sugars and reducing sugars, starch and cellulose were analyzed using standard procedures and methods. Dry matters, reducing sugars and total sugars contents increased significantly ($p \leq 0.05$) during preservation from the month 0 to the month 6 at different boiling times and varied from a tuber to another one. Starch content and cellulose content decreased and increased respectively with increased boiling time during preservation from the month 0 to the month 6.

Cite this article as: Kouadio, N.C.j., Patrice, Y.A.Y.D., Gnanwa, M.J., Konan, H.K., Kouadio, J.P.E.N., Kouame, L.P. (2017). Effects of Post-harvest Storage and Boiling Time on Some Biochemical Parameters of Two Yams Species (*Dioscorea cayenensis-rotundata variety "tambi"* and *Dioscorea alata variety "*azaguié*"*) Tubers. Journal of basic and applied Research, 3(1): 16-21

INTRODUCTION

Yam tubers constitute an important food crop in tropical countries including South America, the Asia and Africa. In Africa, yam, *Dioscorea* (spp.) is an important source of carbohydrate for many people of the sub-Sahara region, especially in the yam zone of West Africa (Akissoe et al., 2003). Babaleye (2003) reported that yam contributes more than 200 dietary calories per capita daily for more than 150 million people in West Africa and serves as an important source of income to the people. Yam as a starchy staple in West Africa is of higher per unit weight fresh tuber than cassava, cocoyam or taro (Orkwor, 1998) and hence generates more income in local markets than these other crops (Tamiru et al., 2008). Quality of the tuber for the production of yam-based food products is a major criterion for acceptance of yam varieties by the stakeholders: farmers, processors and consumers (Otegbayo et al., 2010). The food quality of stored yam tubers is usually preferred than the fresh yam tubers, hence it is usually more expensive than fresh yam tubers in the market. This is probably because of its perceived better food quality (especially textural quality and taste) compared with fresh tubers (Otegbayo et al., 2011).

In Côte d'Ivoire, the most important species are *Dioscorea cayenensis-rotundata* complex and *Dioscorea alata*, (Ondo et al., 2009). These yam tubers are usually consumed in the forms of chunks, flour, fufu, and slices resulting from any of the processes of boiling, drying, fermentation, frying, milling, pounding, roasting, and steaming (Iwuoha, 2004). Boiling as a food processing techniques has been highlighted as possible means of reducing or totally eliminating the anti-nutrients and improving the nutritive values at levels that can be tolerated by man and his animals particularly in monogastric nutrition hence, this study was designed to investigate the effect of post-harvest storage and boiling time on the nutritive values of two yams species (*Dioscorea cayenensis-rotundata* variety "tambi″ and *Dioscorea alata* variety *‘’*Azaguié*’’*) tubers.

MATERIALS AND METHODS

Raw materials

Plant material: Varieties "Azaguié" from *D. alata* and "Tambi" from *D. cayenensis-rotundata* complex species were selected in the department of Bondoukou, in the North-East of Côte d'Ivoire. Yam tubers were harvested at physiological maturity from fields of village named Kouakoukankro in December 2014. They were immediately transported in a heap aired store and stored in which the temperature and the relative humidity rate were 26.56 ± 3 °C and 82 ± 5% respectively for a period of 6 months of subsequent experiments.

Sample Preparation

Four (4) tubers of each yam cultivar were randomly made a pick, every two months during for up to six (6) months. These yams were washed with clean water. They peeled and cut into small slices (3x3x3 cm thickness) using a stainless steel knife. The slices were rewashed with clean water in order to remove much mucilaginous material. After washing, they were divided into four lots of 500 g each. Three lots were boiled at 100°C for 10 min, 15 min and 20 min in a pan containing 1 L of water distilled. At the end of boiling, the three lots with treatment and the remaining one part with no treatment and were dried in an oven at 45°C for 48 hours. The dried slices were ground into powder, sieved with 250 µm mesh sieve and then stored in airtight containers for analysis AOAC (1995).

Proximate Composition Analysis

Dry matters were determined by drying in an oven at 105 ºC during 24 h to constant weight (AOAC, 1990). Crude protein was calculated from nitrogen (Nx6.25) obtained using the Kjeldahl method by AOAC (1990). Crude fat was determined by continuous extraction in a Soxhlet apparatus for 8 h using hexane as solvent (AOAC, 1990). Total ash was determined by incinerating in a furnace at 550 ºC (AOAC, 1990). Method described by Dubois et al. (1956) was used to determine total sugars while reducing sugars were analyzed according to the method of Bernfeld (1955) using 3.5 dinitrosalycilic acids (DNS). Starch content was determined with the method of Dubois and al. (1956). Hot ethanol was used to extract starch from the flour sample. The digest (from the residue) was quantified calorimetrically for starch, using phenol-sulphuric acid as the colour developing reagent; absorbance was read at 490 nm.

The starch and cellulose content were determined according to the polarimetric method described by BIPEA (1976) and method described by Multon et al. (1991) respectively.

Statistical analysis

All analyses were performed in triplicates. Results were expressed by means of ± SD. Statistical significance was established using Analysis of Variance (ANOVA) models to estimate the effect of storage period on biochemical composition of different parts of yam tubers. Means were separated according to Duncan's multiple range analysis ($p \leq 0.05$), with the help of the software Statistica (StatSoftInc, Tulsa USA Headquarters).

RESULTS AND DISCUSSION

Dry matter

The dry matter content was presented figures 1 (A and B). Dry matter increased significantly ($p \leq 0.05$). However, it decreased during different boiling times 0, 10, 15 and 20 min. The highest dry matter at month 0 was found to be 88.70 ± 0.15 and 89.60 ± 0.21 % for ''Azaguié'' and ''Tambi'' flours respectively. It increased signicantly ($p \leq 0.05$) during storage till 92.70 ± 0.12 % for "Azaguié" and 93.80 ± 0.22 % for "Tambi" at month 6. Dry matter was significantly ($p \leq 0.05$) different from a tuber variety to another one during preservation and boiling time. Flour from "Tambi" yam tuber showed the highest dry matter at the end of storage period. Dry matter increasing was due to the loss of water by tubers during storage. This phenomenon was caused by the setting up of the germination process that requires a strong increase of the respiratory intensity and perspiration acceleration. High level of dry matter in of both "Azaguié" and "Tambi" could be explained by the presence of old tissues in all part of the tuber (Trèche, 1989).

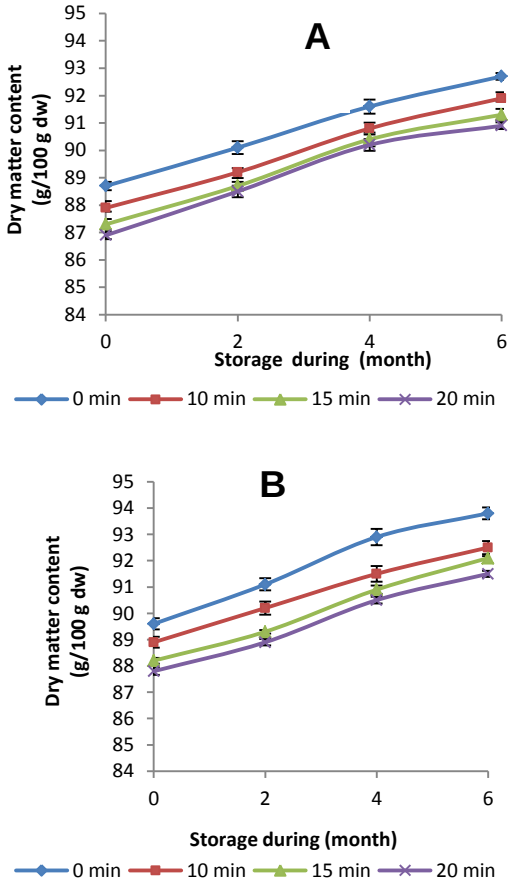

Fig. 1. Dry matter content in raw and boiled flour from two yams species tubers during the post-harvest storage. [A] *Dioscorea alata* variety ''Azaguié''; [B] *Dioscorea cayenensis-rotundata* variety "Tambi".

Crude protein content

The crude protein content was presented in figure 2 (A and B). Crude protein content decreased significantly ($p \leq 0.05$) during different cooking times (0-20 min) and post harvest storage (0-6 months). The values of crude protein content

ranged from 8.00 ± 0.26 % dw to 6.40 ± 0.27 % dw and from 8.60 ± 0.39 % dw to 6.9 ± 0.3 % dw for the flour from raw ‘’Azaguié’’ and ‘’Tambi’’ tubers at month 6 respectively. The flour from the raw tuber had the highest crude protein content whereas the flour from the boiled tuber at 20 min had the lowest crude protein content. However, high differences were observed between the crude protein content of the flour from the boiled ‘’Azaguié’’ and ‘’Tambi’’ tubers at 15 min and 20 min, with respective rate ranged from 6.30 ± 0.28 % dw to 4.00 ± 0.19 % dw and from 7.10 ± 0.19 % dw to 4.70 ± 0.14 % dw. Obviously flour from "Tambi" yam tuber showed a considerably higher protein content upon different cooking times and storage. The boiling reduced meaningfully ($p \leq 0.05$) the crude protein content of flour from yam tuber at different boiling times. The decreased in protein content on the application of heat can be attributed to protein forming complexes with tannins and therefore decreasing its availability (Enonfon-Akpan and Umoh, 2004).

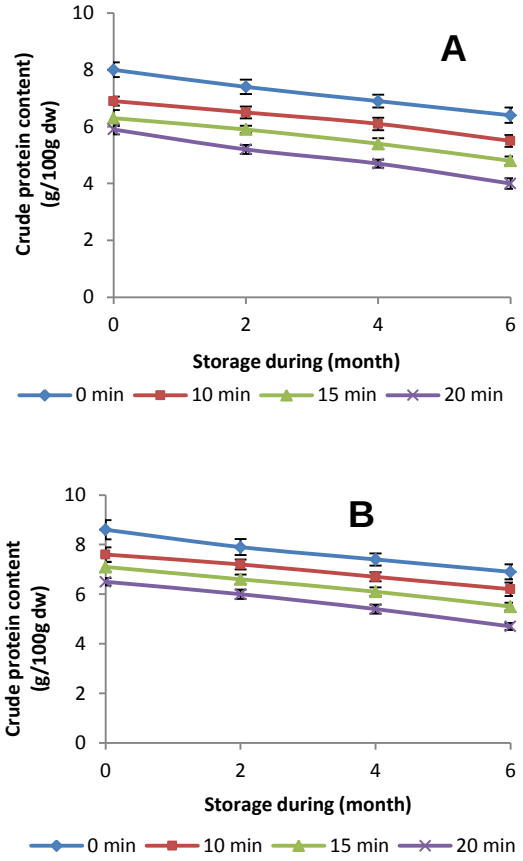

Fig. 2. Crude protein content in raw and boiled flour from two yams species tubers during the post-harvest storage. [A] *Dioscorea alata* variety ‘’Azaguié’’; [B] *Dioscorea cayenensis-rotundata* variety "Tambi".

Similar results had been be recorded by Agoreyo et al. (2011) for *D. rotundata* using various drying methods. Decrease in cooking time resulted also to progressive decrease in the protein isolate yield from the flour (Nzewi and Egbuonu, 2011). It appeared that protein content of yam tuber flour was higher than that reported on bananas (1.09%) (Mahapatra et al., 2012); white yam (5.15%) and sweet potato (3.64%) (Alaise and Linden, 1999). Thus, incorporating yam tuber flour in diet could contribute in amino acid balance.

Crude fat content

The crude fat content was presented in Figure 3 (A and B). Crude content varied little between the raw and cooked products, showing inconsistency in the changes (increase or decrease) among the two yam tubers studied. The values of crude fat content ranged from 0.299 ± 0.010 % dw and 0.237 ± 0.010 % dw to 0.133 ± 0.010 % dw and 0.085 ± 0.010 % dw for the flour from ‘’Azaguié’’ and ‘’Tambi’’ raw and boiled tubers at 20 min respectively. It appeared slight differences between the crude fat content of flour from the two yam tubers at different boiling times (0 min to 15 min). However, the crude fat contents of flour from ‘’Azaguié’’ yam tubers were highest at different boiling times. The gotten values were in agreement with those of the whole tuber reported by Trèche et al. (1982) on *D. cayenensis* and *D. rotundata* ranging from 0.15 to 0.30 % and from 0.20 to 0.25 %. They were lower if compared to 0.70 and 1.10% record by Amani and Kamenan (2003) for "Florido" and "Kponan".

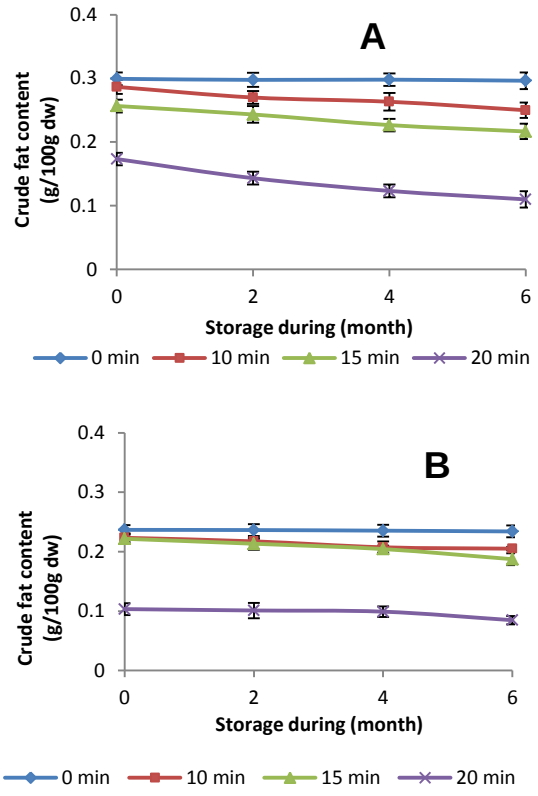

Fig. 3.Crude fat content in raw and boiled flour from two yams species tubers during the post-harvest storage. [A] *Dioscorea alata* variety ‘’Azaguié’’; [B] *Dioscorea cayenensis-rotundata* variety "Tambi".

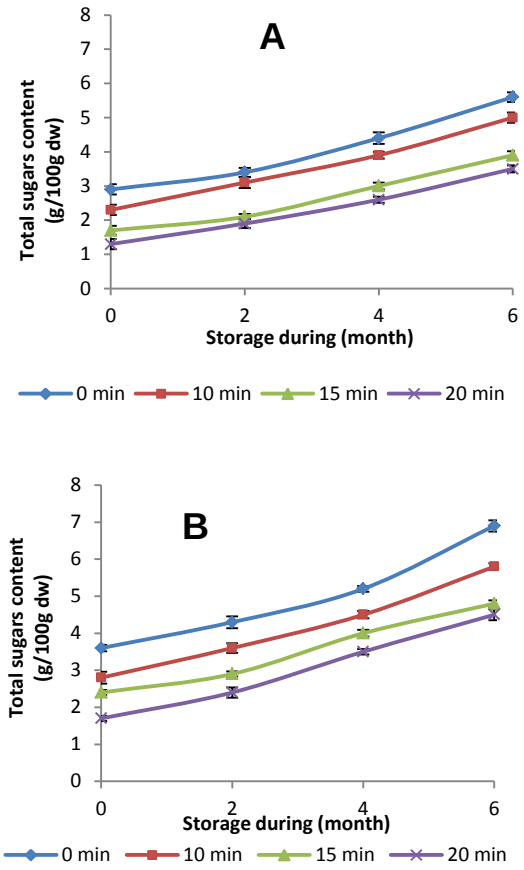

Fig. 4. Total sugars content in raw and boiled flour from two yams species tubers during the post-harvest storage. [A] *Dioscorea alata* variety ‘’Azaguié’’; [B] *Dioscorea cayenensis-rotundata* variety "Tambi".

Total sugar and Reducing sugar content

Concerning total sugars, the highest values obtained at month 0 were 2.90 ± 0.15 g/100g dw and 3.60 ± 0.09 g/100g dw respectively for flour of "Azaguié" and "Tambi" (Figure 4A and 4B) After six months, the flour from the two yam tubers still showed highest and significant increased amount with 5.60 ± 0.14 g/100g dw and 6.90 ± 0.15 g/100 g dw for "Azaguié" and "Tambi" respectively. The values of flour from tubers of "Azaguié" and ‘’Tambi’’ yam varieties during boiling was presented in Figure 4 (A and B). They ranged from 02.30 ± 0.15 % dw and 2.80 ± 0.16 % dw to 5.00 ± 0.15 % dw and 5.80 ± 0.09 % dw respectively during boiling. The lowest total sugar content was obtained with flour from raw tubers of ″Azaguié″ yam variety, while the flour from the boiled tubers at 10 min had the highest total sugar content. The boiling time main effect appeared to be stronger. Indeed, the statistical analysis revealed that boiling reduced significantly ($p \leq 0.05$) the total sugar content at different times.

Concerning Reducing sugar content, the data in Figure 5 (A and B) showed a significant increase of reducing sugars during storage. The values ranged from 0.71 ± 0.03 g/100g dw and 0.90 ± 0.01 g/100g dw to 2.01 ± 0.02 g/100g dw and 2.60 ± 0.09 g/100g dw respectively for "Azaguié" and "Tambi". The values of flour from tubers of "Azaguié" and ‘’Tambi’’ yam varieties during boiling ranged from 0.30 ± 0.03 and 0.50 ± 0.06 % dw to 1.40 ± 0.04 and 1.80 ± 0.03 % dw tubers at 20 min respectively. The flour from raw tuber had the lowest reducing sugar content while the highest value was obtained with the flour from boiled tubers at 10 min. Otherwise, the analysis of variance showed that the boiling time had significant effect ($p \leq 0.05$) on reducing sugar content of flour from yam tubers. Indeed, the reducing sugar contents increased meaningfully ($p \leq 0.05$) until 20 min after boiling.

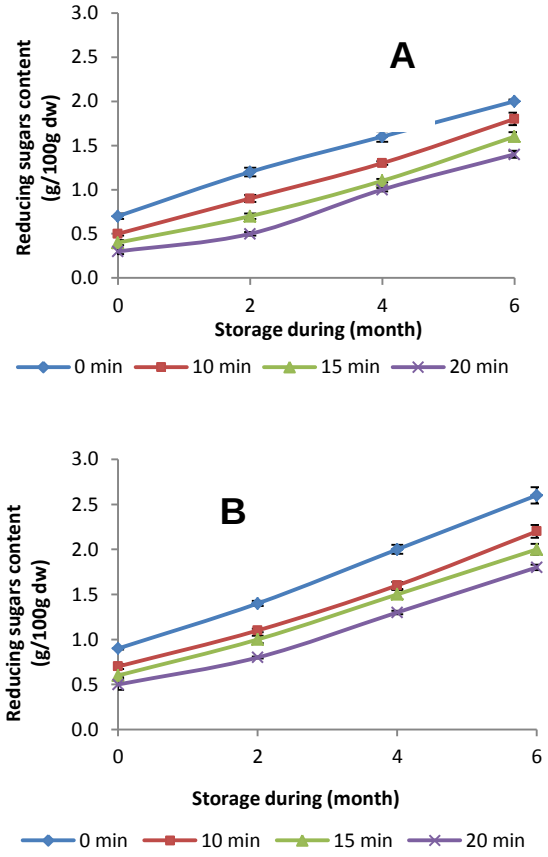

Fig. 5: Reducing sugars content in raw and boiled flour from two yams species tubers during the post-harvest storage. [A] *Dioscorea alata* variety ‘’Azaguié’’; [B] *Dioscorea cayenensis-rotundata* variety "Tambi".

Total and reducing sugars increasing could be attributed to hydrolysis of starch by the amylolytic enzymes present in the tuber (Diopoh and Kamenan, 1981; Trèche, 1989). This was in accordance with the observation of Sahoré and Amani (2005) on of *D. alata* tubers. Flour from ‘’Tambi’’ yam tubers contained the most elevated rate of total and reducing sugar at different boiling times after six months storage.

Starch content

The starch content decreased as the cooking time increased. Values obtained indicated that starch

content were highest in the raw and least in ‘’Azaguié’’ and ‘’Tambi’’ yam tubers cooked for 20 minutes (Figures 6 A and B). The values of starch content ranged from 66.54 ± 0.78 % dw and 79.02 ± 0.1
7 % dw to 16.82 ± 0.33 % dw and 37.64 ± 0.49 % dw for the flour from raw and boiled tubers at 20 min respectively. The flour from the raw tuber had the highest starch content whereas the flour from the boiled tuber at 20 min had the lowest starch content. The analysis of variance showed that the boiling had significant effect ($p \leq 0.05$) on starch content. It reduced meaningfully ($p \leq 0.05$) the starch content during the boiling times. However, slight differences were observed between the starch content of the flour from the boiled tubers at 10 min and 15 min, with respective rate of (62. 81 ± 0.09 - 64.71 ± 0.11 % dw and 73.66 ± 0.22 - 75.47 ± 0.47 % dw) for "Azaguié" and "Tambi" respectively. This reduction is may be due to the hydrothermal degradation and extraction of starch in boiling water (El Sohaimy, 2013). Indeed, boiling caused swelling and distortion of all starch granules. The starch is the most important chemical component in the flours. It provided the major source of physiological energy in human and monogastric diets; its occurrence in high amounts in these grains underscores their potential energy supply. Apart from its energy contribution, starch in most of the processed food systems is known to contribute to the texture, and as a result, to the organoleptic properties of food (Tharanathan and Mahadevamma, 2003).
Based on above results, it is concluded that boiling had both positive and negative effect on some biochemical parameter (dry matter, crude protein, crude fat, total and reducing sugar and starch) in flour from tubers of "Azaguié" and ‘’Tambi’’ yam varieties. Indeed, the negative effect will be derived from the reduction of the starch and crude protein contents while the positive effect was as a result of the increase of total and reducing sugar content. Otherwise, analysis of variance (ANOVA) indicated that the boiling time main effect appeared not to be stronger for total and reducing sugar contents in flour from "Azaguié" and ‘’Tambi’’ yam tubers. It is important to avoid overcooking since from the data obtained, it has been shown that the longer the cooking, the higher the loss in nutrients. Boiling times of 10 and 15 min were recommended for tuber of "Azaguié" and ‘’Tambi’’ yam varieties.

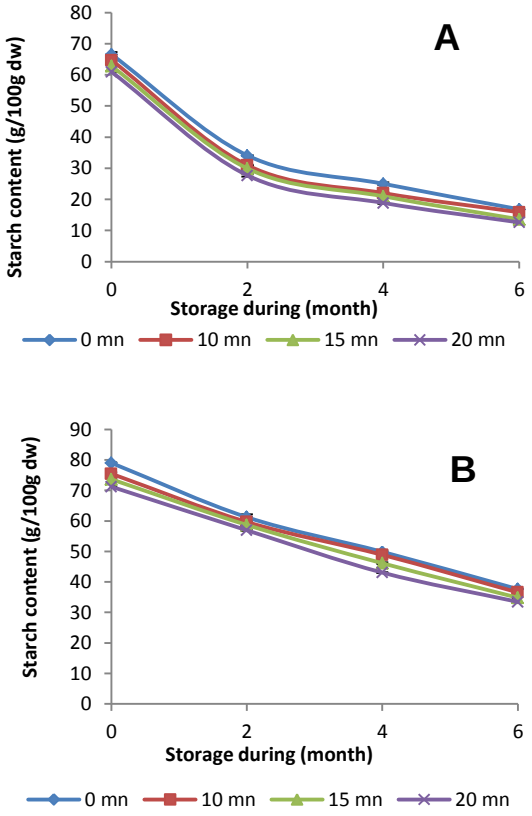

Fig. 6.Starch content in raw and boiled flour from two yams species tubers during the post-harvest storage.[A] *Dioscorea alata* variety ‘’Azaguié’’; [B] *Dioscorea cayenensis-rotundata* variety "Tambi".

REFERENCES

Agoreyo, B.O., Akpiroroh, O., Orukpe, O.A. and Akissoe, O.A. (2011).Physical, chemical and sensory evaluation of dried yam (Dioscorearotundata) tubers, flour and amala, a flour-derived product.*Journal of Tropical Science*, 41, 151-155.

Akissoe, W.H., Hounhouigan, J.D., Mestres, C. and Nago, M. (2003). How Blanching and Drying Affects the Colour and Functional Characteristics of Yam (*D. cayenesis-rotundata*) Flours. *Food Chemistry*, 82, 257-264.

Alaise, C. and Linden, G. (1999). *Food Biochemistry*. Chapman and Hall, Food Science Book. Aspen Publishers Inc. Maryland, pp: 15-121.

Amani, N.G. and Kamenan, A. (2003).Nutritional potential and traditional technological of transformation of starchy foods in Côte d'Ivoire. Second International Workshop: Ways to improve food nutrition in West Africa: the role of food technologists and nutritionists (Ouagadougou, 23-28 November). *Research Institute for Development*, Wageningen University, FAO.

AOAC.(1990). Official Methods of Analysis.15th E dn., Association Official Analytical Chemists.Washington DC. USA.

AOAC.(1995). Officiel Method of Analysis.Association of Agricultural Chemist, Washington D.C., 34.

Babaleye, T. (2003).Raising the status of the yam, a major food crop in West Africa, ANB- BIA Supplement, 463: 1-3.

Bernfeld, P. (1955). Amylase α and β. Methods in enzymology 1.S. P. Colswick and N.O.K., (Eds). *Academic Press Inc*, New-York. pp. 149-154.

CEE-BIPEA.(1976). Bureau international d'étudesanalytiques.Recueil de méthodesd'analyses des communautésEconomiquesEuropéennes.

Diopoh, J. and Kamenan A. (1981).Distribution de l'amylase, de la phosphorylase et de la phosphatase acidedansquelquesdioscoréacées (Ignames) de Côte d'Ivoire. *PhysiologieVégétale*, 19, 401-405.

Dubois, M., Mc Cowen, L.K., Schotch, T.J., Rebers, P.A. and Smith, F. (1956).Colorimetric methods for determination of sugars and related substances.*Analesof Chemistry*, 2, 350-356.

El Sohaimy, S.A. (2013). The effect of cooking on the chemical Composition of Artichoke (*Cynarascolymus* L.).*AfricanJournal of Food Science*, 4 (8), 182-187

Enomfon, J. A. and Umoh, I. B. (2004).Effect of Heat and Tetracycline Treatments on the Food Quality and Acridity Factors in Cocoyam [*Xanthosomasagittifolium* (L) Schott].*Pakistan Journal of Nutrition*, 3 (4), 240-243.

Iwuoha, C.I. (2004). Comparative Evaluation of Physico-chemical Characteristics of Flours from Steeped Tubers of White Yam (*Dioscorearotundata*Poir), Water Yam (*Dioscorealata*L.) and Yellow Yam (*Dioscoreacayenensis*Lam).*Tropicultura*, 22 (2), 56-63.

Mahapatra, A.K., Mishra, S., Basak, U.C. and. Panda, P.C. (2012). Nutrient Analysis of Some Selected Wild Edible Fruits of Deciduous Forests of India: an Explorative Study towadsNon Conventional Bio-Nutrition.

Multon, K. D., Brown, S. D., and Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of Counseling Psychology*, 18, 30–38.

Nzewi, D.C. and Egbuonu, A.C.C. (2011). Effect of boiling and roasting on some

anti-nutrient factors of asparagus bean (Vignasesquipedalis) flour. *African Journal of Food Science and Technology*, 2(3), 075-078.

Ondo, O.P., Kevers, C. and Dommes, J. (2009). Effects of reducing sugar concentration on in vitro tuber formation and sprouting in yam (*Dioscoreacayenensis-D. rotundata complex*). *Plant Cell Tissues and Organs*, 99, 55-59.

Orkwor, G.C. (1998). The importance of yams. In: Orkwor, G.C., Asiedu, R. and. Ekanayake, I.J. (eds.) Food Yams: Advances in Research. IITA, Ibadan, Nigeria and NRCRI, Umudike, Umuhahia, Abia state, Nigeria, pp. 1 – 11.

Otegbayo, B.O., Bokanga, M. and Asiedu, R. (2011).Physico-chemical composition of yam starch: Effect on textural quality of yam food product (pounded yam). *Journal of Food Agriculture and Environment*, 9(1), 145 – 150.

Otegbayo, B.O., Samuel, F.O., Kehinde, A.L., Sangoyomi, T.E., and Okonkwo, C.C. (2010). Perception of food quality in yam by some Nigerian farmers.*African Journal of Food Science*, 4 (8), 541 – 549.

Sahoré, D. and Amani, N.G. (2005).Composition of wild yams of Côte d'Ivoire.*Tropical Science*, 45 (3), 110-113.

Tamiru, M., Mass, B.L. and Pawelzik, E. (2008). Characterizing diversity in composition and pasting properties of tuber flour in yam germ plasm (Dioscorea spp.) from Southern Ethiopia. *Journal of Science and Food Agriculture*, 88, 1675 – 1685.

Tharanathan, R. N. and Mahadevamma, S. (2003). Grain legumes- a boon to human nutrition.*Trends Food Science and Technology*, 14, 507-518.

Trèche, S. (1989).Nutritional Potential of Yam (Dioscorea Spp.)Grown in Cameroon. Vol: I. text. Vol. II: Appendices. ORSTOM Ed., Collection Studies and Thesis, Paris, pp: 595.

Trèche, S., Gallon, G. and Joseph, A. (1982). Changes in nutrient contents during the ripening and storage of yam tubers (*Dioscoreadumetorum* and *Dioscorearotundata*) nutritional implications. *Journal of Science and Technology*, (Health Sci.), 3, 69-79.