RESEARCH ARTICLE

NUTRIENTS AND PHYTOCHEMICAL COMPOUNDS OF TWO VARIETIES OF BUSH MANGO (IRVINGIAGABONENSIS) GROWN IN BENIN.

Sawab Deen Osseni, Fidèle Paul Tchobo, Andriano Jospin Djossou and Mouaimine Mazou.
Unité de Recherche en Génie Enzymatique et Alimentaire, Laboratoire d’Etude et de Recherche en Chimie Appliquée. Ecole Polytechnique d’Abomey-Calavi, Université d’Abomey-Calavi, Bénin, 01 BP 2009.

Manuscript Info

Manuscript History
Received: 2 August 2018
Final Accepted: 4 September 2018
Published: October 2018

Keywords:-
Irvingia gabonensis, fruit, nutrient, phytochemical, Benin.

Abstract

This study aim was to characterize Irvingia gabonensis pulp grown in Benin. Nutrient content results showed that the samples contained a large amount of sugar (9.54 -15.28%) and a very low protein content (1.20 -2.21%) and ash (0.2 -0.9). The water content and Brix degree was comparable to that of several fruits. Pulp would be a good substrate for fruit production. Pulp contained several phytochemicals such as oxalates, phytates, tannins, saponins and flavonoids in the relatively high amount.

Introduction:

Fruits and vegetables are generally the main sources of micronutrients for the dietary balance of populations. They play a complementary nutritional role by providing the body with vitamins, minerals, dietary fiber, and organic acids (Serville, 1984), essential elements for the good functioning of the body. However, the nutritional value of fruit is related to its composition, which depends on the species, the variety, the degree of maturity and the conditions of cultivation, storage and conservation (Sawadogo-Ligani et al., 2001). In Africa, non-timber forest products (NTFPs) play an important role in food and trade. These are wild or cultivated plants whose utility potential has been little exploited commercially. However, they constitute an opportunity of economic and food survival for the local populations (Gandari, 2008).

In particular, 80% of rural populations in sub-Saharan Africa depends on non-timber forest products (NTFPs) for their health needs (Kalaba et al., 2010). Their biochemical and nutritional contributions (proteins, fats, carbohydrates, minerals and vitamins and fiber (Augustino et al., 2011)) have demonstrated their potential to resolve food, nutrition and health crises in Africa (Okolo et al., 1995; et al., 2010; Ahenkan and Boon, 2011; Sossa-Vihotogbé et al., 2012). Irvingia gabonensis (bush mango) is one of NTFPs widespread in the Gulf of Guinea. It is among the species of priority food tree in traditional agroforestry systems and subject to domestication (Franzel et al., 1996). Fruits are economically very important in sub-Saharan Africa for local populations (Asaah et al., 2003, Leakey et al., 2003).

In Benin, Irvingia gabonensis is very abundant in the departments of Mono, Couffo and the dense forests of Pobè (Akouéhou, 2012). It is an important source of livelihood and income for many farmers. Indeed, some of these harvested products are intended for self-consumption and another for trade on local, national and regional markets. It is distinguished locally under two varieties («Ewoto» and «Eshito») in the national languages. This distinction has already been mentioned by Okafor (1975) in Nigeria. Thus, the aim of this work was to evaluate the physico-chemical characteristics and the antinutritional compounds of the varieties encountered in Benin.

Corresponding Author:- Fidèle Paul Tchobo
Address:- Unité de Recherche en Génie Enzymatique et Alimentaire, Laboratoire d’Etude et de Recherche en Chimie Appliquée. Ecole Polytechnique d’Abomey-Calavi, Université d’Abomey-Calavi, Bénin, 01 BP 2009.
Material and Methods:

Material

Bush mango samples consist of the two varieties identified by indigenous peoples in southern Benin. These are the varieties «Eshito» and «Ewoto». These two varieties were collected in eight township of Benin (Lalo, Tovikilin, Klwehanmè, Aplahoué, Kétou, Pobè, Ifangni, Adja-Ouèrè) and have been stored at 4-6°C before used.

Physicochemical analysis

pH and titratable acidity were determined according to the modified procedure of AACC 02-31.01. The pH was measured using a pH meter on a homogenized mixture of 10 g of pulp and 20 ml of distilled water. Titratable acidity is measured on a solution obtained with 10 g of pulp and 90 ml of distilled water. The solution obtained after filtration was titrated with magnetic stirring with sodium hydroxide (0.1 N) to the phenolphthalein end point.

Moisture content of samples was determined by oven methods (ISO 712: 1998). Soluble solids (Brix) was determined using a digital refractometer (ATAGO HSR-500). Protein was analyzed by the Microkjedhal nitrogen method, using a conversion factor of 6.25. Ash was determined according to the standard methods described by the Association of Official Analytical Chemists (AOAC, 1990). The total and reducing sugar contents were measured respectively by the colorimetric method developed by Dubois et al. (1959) and that described by Gonçalves et al. (1900). Ascorbic acid content was determined by dichlorophenolindophenol (Lees, 1975)

Phytochemical analysis

The Folin-Ciocalteu method (Singleton, Orthofer, and Lamuela-Raventos, 1999) was used to determine the phenolic content. The absorbance of the reaction mixture was measured at 760 nm on the spectrophotometer. Oxalates were assayed by the method of Day and Underwood (1986), phytates by the method of Reddy and Love (1999), saponins by the method of Hudson and El Difrawi (1979), flavonoids by the method of Arvouet-Grand et al (1994) and tannins by the method of Trease and Evans (1978).

Results and discussion:

Figures 1 and 2 show the pH, the titratable acidity and the Brix degree of the two varieties of Irvingia gabonesis studied. These results show that the pH of the samples varied from 4.4 to 6.1, for the variety «Ewoto» and from 5.3 to 6.1 for the variety «Eshito». For the titratable acidity, it varied from 0.03 to 0.06 for all varieties. As to Brix degree, it varied from 10.5 to 12 for the «Ewoto» variety and from 10.5 to 15.5 for variety «Eshito». The result shows that the Brix degree and the pH were varied significantly according to the variety and the production area. However, the «Ewoto» variety had the most acidic fruit so it is more stable to deterioration. Indeed, according to Bourgeois (1985), for pH below 4.5, fruit enjoy a microbiological stability and those with pH values close to neutrality would be susceptible to microbial growth. The results of Brix degree show that the variety «Eshito» have a significant concentration of soluble matter. These differences may be due to the maturity of the fruits. According to Mamiro et al. (2007) work on mangoes (Mangifera indica L.), Total soluble content increases with the ripening of the fruit. As for titratable acidity, although it seems to be influenced by maturation (Mamiro et al., 2007), there is no significant difference observed in our results.
Figure 1: pH, titratable acidity (TA) and Brix degree (Brix °) of «Ewoto» variety of *Irvengia gabonensis* from Benin.

Figure 2: pH, titratable acidity (TA) and Brix degree (Brix °) of «Eshito» variety of *Irvengia gabonensis* from Benin.
Tableau I: Nutrients of the pulp of the two varieties of *Irvingia gabonensis*

Values are Means ± SD of triplicate determinations

| Variety | Township | Total sugar(%) | Reducing sugar(%) | Ascorbic acid (mg/100g) | Protein (%) | Dry matter (%) | Ash(%) |
|---------|----------|---------------|------------------|------------------------|-------------|----------------|--------|
| «Ewoto» Lalo | 14,57±0,04ij | 8,22±0,01b | 1,4±0,23h | 1,54±0,05f | 27,6±0,4h | 0,33±00,1c d |
| Tovikilin | 14,04±0,11h | 9,74±0,3e | 1,04±0,04c | 1,75±0,13i | 26,06±0,4e | 0,36±0,14c |
| Klouékamè | 11,15±0,06d | 10,29±0,02f | 1,21±0,04h | 1,66±0,07h | 26,76±3,1f | 0,21±0,02b |
| Aplahoué | 10,39±0,03c | 9,76±0,02d e | 0,96±0,11b | 1,57±0,09g | 25,57±2,5de | 1,1±0,94f |
| kétou | 9,54±0,04a | 7,9±0,07a | 1,38±0,08g | 1,5±0,01e | 26,36±1,64d e | 0,36±0,14c |
| Pobè | 12,86±0,15f | 9,86±0,05e | 0,87±0,1a | 1,83±0,17j | 25,5±0,18d | 0,33±0,01c |
| Ifangni | 12,1±0,02e | 10,23±0,02f | 1,11±0,02d | 1,4±0,05d | 24,47±1,38b c | 0,2±0,03b |
| Adja-Ouèrè | 10,19±0,07b | 8,86±0,07c | 1,08±0,06c d | 1,2±0,09a | 24,5±0,59c | 0,38±0,06c d |
| «Eshito» Lalo | 13,2±0,04g | 10,95±0,09g | 1,09±0,13c d | 1,4±0,21d | 36,69±0,3g | 0,36±0,06c d |
| Tovikilin | 12,19±0,08e | 9,47±1,10d | 1,12±0,03d | 2,1±0,18k | 27,2±0,8fg | 0,49±0,14e |
| Klouékamè | 15,28±0,02k | 9,98±0,04e | 1,46±0,08h | 1,31±0,07c | 24,7±1,7c | 0,37±0,06c d |
| Aplahoué | 14,45±0,08i | 11,10±0,07h | 1,25±0,02f | 1,4±0,12d | 23,9±1,8a | 0,80±0,01a |
| kétou | 12,29±1,02e | 10,90±0,01g | 1,43±0,11h | 1,66±0,01h | 24,1±1,26ab | 0,49±0,14e |
| Pobè | 12,16±0,09e | 9,73±0,02de | 1,22±0,08e | 1,75±0,25i | 27,04±5,1fg | 0,39±0,05d |
| Ifangni | 14,89±0,01j k | 12,97±0,09j | 0,99±0,01b | 1,22±0,07b c | 24,22±7,3ab c | 0,23±0,001b |
| Adja-Ouèrè | 14,89±0,08j k | 11,6±0,01i | 1,57±0,09i | 1,91±0,07d | 26,74±4,6f | 0,89±0,05a |

Mean with the same superscripts in the same column are not significantly different (P= 0.05).

The results of the physico-chemical composition are presented in Table 1. Results related to the pulp indicate that the dry matter for all sample varied from 23.90 to 36.69 %. The fruits were therefore susceptible to considerable alteration during storage (moisture greater than 60%) when they were not properly stored. This high-water content is comparable to that of fruit pulp such as mango, shea tree, *Borassus aethiopum*, *Vitex domania* sweet and Annona species (Folorunso et Modupe, 2007; Makalao et al., 2015), the combined results of water content and Brix degree may suggest the use of *Irvingia gabonensis* pulp for fruit juice production.

Total sugar and reducing sugar varied respectively between 9.54 and 15.28% and between 7.54 and 12.97. The lowest values were obtained for samples of the «Ewoto» variety and the highest values for the sample of the «Eshito» variety. These high values for the «Eshito» variety confirm the values obtained for Brix degrees. In fact, sugars constitute the majority of the total soluble compounds. protein content (1.2 - 2.21%) and ash (0.2 – 0.9) were low, although there is variability in the same variety, and variation from one variety to another, these values are similar to those obtained by Onimawo et al., (2003). However, the quality of the constituents of these two fractions could be an asset. Indeed, Onimawo et al., (2003) noted the presence of a high amount of calcium (262.3mg / 100g).
Ascorbic acid content (0.87 - 1.43 mg / 100g) is very low compared to that obtained by Onimawo et al., (2003) (66.7mg / 100mL) and Achinewhu (1983).

Table 2 presented oxalates, phytates, tannins, saponins and flavonoids content of the samples of *Irvingia gabonensis* studied. The presence of some of these compounds in fruits gives them well-known medicinal properties. Indeed, flavonoids, saponins and tannins have antimicrobial activity, as well as other physiological activities (Evans 2005). However, they constitute factors of non-absorption or mal-absorption of nutrients in the body.

The results in Table 2 show that the highest values for oxalates, phytates, tannins and saponins were 0.99, 0.91, 0.20 and 6.01%, respectively. These values for total phenols and flavonoids were 0.26 mg GA/100g and 1.06 mg CAT/100g of pulp. The high content of saponides (3.07 - 7.47%) were certainly responsible for the bitter aftertaste of the pulp of *Irvingia gabonensis*. The results do not reveal a significant difference between the values obtained for each parameter. The «Eshito» variety has the highest levels of oxalates, tannins, and flavonoids, while the highest levels of phenolics, phytates, and saponins are obtained from «Ewoto». These results can be explained by the variation of storage duration after harvest. Indeed, according to the work of Etubu (2012), while the content of flavonoids decreases those of saponins and tannins.

**Conclusion:**

The nutritional contribution of the two varieties of *Irvingia gabonensis* to the diet of indigenous populations in Benin remains important. These fruits can contribute to the diversification of food in the regions where they are found and constitute a very good source of nutrients for the population. The physico-chemical characteristics studied reveal no significant differences between the two varieties of Irvingia gabonensis. However, further studies will be needed to differentiate them.

**Tableau II:** - phytochemical compounds of the pulp of the two varieties of *Irvingia gabonensis*

| Varieties | Township | Total polyphenols (mg GA/100g) | Oxalates (%) | Phytates (%) | Tannins (%) | Saponins (%) | Flavonoids (mg CAT/100g) |
|-----------|----------|-------------------------------|--------------|-------------|-------------|--------------|----------------------|
| «Eshito»  | Lalo     | 0.21±0.01bcd                  | 0.54±0.23    | 0.90±0.01a  | 0.19±0.01e  | 6.01±0.0027  | 0.93±0.004          |
|           | Tovikilin| 0.23±0.004bc                  | 0.67±0.21c   | 0.95±0.11cd | 0.20±0.09f  | 5.45±0.019b  | 1.04±0.02c          |
| «Ewoto»   | Klouékamè | 0.14±0.002a                   | 0.99±0.09g   | 0.99±0.08d  | 0.13±0.08ab | 3.07±0.008a  | 1.03±0.001          |
|           | Aplahoué | 0.22±0.004bc                  | 0.71±0.12e   | 0.82±0.01a  | 0.15±0.05bc | 6.86±0.001c  | 0.82±0.001a         |
|           | kétoù    | 0.22±0.002bc                  | 0.59±0.11b   | 0.91±0.11ab | 0.12±0.06c  | 5.94±0.006b  | 0.82±0.092a         |

Table II: phytochemical compounds of the pulp of the two varieties of *Irvingia gabonensis*
| Varieties | Pobè | Ifangni | Adja- Ouèrè |
|-----------|------|---------|-------------|
| Mean ± SD | 0.17±0.0007a | 0.19±0.001bc | 0.24±0.01cd |
|          | 0.8±0.15 | 0.73±0.09 | 0.76±0.21 |
|          | 0.89±0.04ab | 0.85±0.01ab | 0.9±0.09cd |
|          | 0.15±0.01 | 0.15±0.02 | 0.17±0.02 |
|          | 3.77±0.009a | 5.50±0.001a | 5±0.008ab |
|          | 1.06±0.004c | 0.98±0.099 | 1.03±0.05c |

Values are Means ± SD of triplicate determinations
Mean with the same superscripts in the same column are not significantly different (P= 0.05).

References:
1. Adegbekinghe, K.T., Adeleke .B.S. and Fakoya,S.(2017) : Solid substrate fermentation of bush mango (Irvingia gabonensis) seeds. Journal of advances in microbiology 3(1): 1-9
2. Agustino, S., Mataya, B., Senelwa, K., Achigan-Dako, E.G. (2011): Non-Wood Forest Products and Services for Socio-Economic Development. A Compendium for Technical and Professional Forestry Education. The African Forest Forum, Nairobi, Kenya
3. Ahenkan, A. and Boon, E. (2011): Improving Nutrition and Health through Non-timber Forest Products in Ghana. Journal of Health Population and Nutrition 29(2): 141-148
4. Akouéhou, G. S.(2012) : Evaluation et analyse socio-économique des marchés des produits forestiers non ligneux, cas du Néré, du Kariié, du Rônier, du Baobab, du Pommier sauvage et de l’Arbre à Pain : les chaînes de commercialisation, les différents maillons, les caractéristiques, les différents acteurs directs et indirects, les interrelations et les différents flux dans les zones d’intervention du projet. Rapport FAO. Cotonou. 118 p.
5. Arvouet-Grand, A., Vennat, B., Pourrat, A. and Legret, P. (1994) : Standardisation d’un extrait de polysipol et identification des principaux constituants. Journal de Pharmacie de Belgique, 49, 462–468.
6. Asaah, E.K., Tchoundjeu, Z. and Atangana, A.R.(2003): Cultivation and conservation status of Irvingia woubolumba humid lowland forest of Cameroon. Food Agriculture and Environment1(3-4): 251-256.
7. Besançon P. (1990) : Besoins alimentaires et qualité nutritionnelle des aliments In «Introduction à la biochimie et à la technologie des aliments».
8. Chadare, F.J., Gayet, D.P., Azokpota, P., Nout, M.J.R., Linnemann, A.R., Hounhouigan, J.D. and van Boekel, M.A.J.S. (2010): Three Traditional Fermented Baobab Foods from Benin, Mutchayan, Dikouanyori, and Tayohounta: Preparation, Properties, and Consumption. Ecology of Food and Nutrition 49(4):279-297.
9. Chelule,P.K., Mbongwa,H.P., Carries,S. and Gquleni,N.(2010) : Lactic acid fermentation improves the quality of Amahewu , a traditional South African maize-based porridge. Food Chem. 122(3): 656-661
10. Day, R.A. and Underwood, A.L.(1986): Quantitative analysis. 5th ed.Prentice-Hall publication. 701 p.
11. Dubois, M.K.A., Gilles, Y.K. and Hamilton, P.A.(1956): Colemtrimethod for determination of sugars and related substance. Anal and Chem Jour: 28. P: 350-356
12. Eromosele, I.C, Eromosele .C.O. and uzhkuzha, D.M.(1991): Evaluation of mineral elements and ascorbic acid contents in fruits of some wild plants, Plant Food. Hum. Nutr. 41 : 151–154.
13. Franzel, S., Jaenicke, H. and Janssen, W. (1996): Choosing the right trees: Setting priorities for multipurpose tree improvement. ISNAR Research Report No. 8, International Service for National Agricultural Research, The Hague Gandari, J., 2008 : Les fruits indigènes. Spore , 136, 8-10
14. Gbesso.F.G. H. , Loubegnon, T.O. and SossouAgbo.P.(2015) :Critères De Reconnaissance Paysanne Et Variabilité Phénotypique De Deux Variétés De Irvingia GabonensisAubry-Le Comte Dans Le Sud-Ouest Du Bénin. Rev. Ivoir. Sci. Technol., 26 : 99 – 114
15. Greiner,M.A.R. and Jany, K.D.(2011): Purification and charcterisation of two intracellular phytases from the tempeh fungus Rhizopus oligosporus. J. Food Biochem. 35: 213–227
16. Hudson, J.B., Anani K., Lee, M.X., De Souza J.T., Arnason J.T. and Gbeassor M.(2000): Further investigations on the antiviral activities of medicinal plants of Togo, Pharm. Biol. 38 (1) : 46–50.
17. Kalaba, F.K., Chirwa, P.W., Syampiongani .S. Ajayi, O.C. (2010): Contribution of agroforestry to biodiversity and livelihoods improvement in communities of southern African regions. In: Tropical rainforests and agroforests under global change (Eds Tschamntke T, Leuschner C,Veldkamp E, Faust H, Guhardja E, Bidin A): 461-476. Springer-Verlag Berlin Heidelberg, DOI 10.1007/978-3-642-00493-3-22.
18. Kengni, E., Kengue J., Ebenezer E.B.K. and Tabuna, H.(2011) : Irvingia gabonensis, Irvingia woubolu, pommiersauvage. Conservation et utilisation durable des ressources génétiques des espèces ligneuses alimentaires prioritaires de l’Afrique subsaharienne. Bioversity International
19. Lal, H. and Prasad, A. (1980): Pruning in ber (Zizyphus mauritiana Lamk.). III. Effect on yield and fruit quality, Punjab Hortic. J. 20: 162–166
20. Leakey, R., Schrechtering, K. and Tchoundjev, Z. (2003): The participatory domestication of West African indigenous fruits. Int. Forest. Rev. 5: 338-347
21. Okolo, C.O., Johnson, P.B., Abdurahman, E.M., Abdu Aguye I., Hussaini, I., M. (1995): Analgesic effect of *I. gabonensis* stem bark extract. *Journal of Ethnopharmacology* 45(2): 125-129.
22. Onimawo, I. A., Oteno, F., Orokpọ, G. and Akabor, P. I. (2003): Physicochemical and nutrient evaluation of African bush Mango (*Irvingia gabonensis*) seeds and pulp. *Plant Foods for Hum. Nutr.* 58: 1-6.
23. Sawadogo – Lingani, H. (1993): Valorisation technologique de la variété Amélie de mangue du Burkina Faso : Maîtrise des paramètres physico-chimiques pour une meilleure stabilisation des produits de transformation. Thèse de Doctorat de 3e cycle. Sciences Biologiques Appliquées option Biochimie – microbiologie, université de Ouagadougou (Burkina fas0) 164 p.
24. Serville, Y. (1984): Valeur alimentaire des aliments du 5e et 6e groupe. IN : « Manuel d’alimentation Humaine. Tome 2 : Les Aliments »
25. Singleton, P. (1999): Bactériologie, 4ème Eds. Dunod, Paris, pp: 380-415.
26. Sossa-Vihotogbé, C.N.A., Akissoe, N.H., Anihouvì, V.B., Ahohuendo, B.C., Ahanchede, A., Sanni, A. and Hounhouigan, D.J. (2012): Endogenous knowledge of four leafy vegetables used by rural populations in Benin. *Ecology of Food and Nutrition* 51(1): 22-39
27. Reddy, M.B. and Love M. (1999): The impacts of food processing on the nutritional quality of vitamins and minerals. *Adv. Exp. Med. Bio.* 459: 99-106
28. Trease, G.E. and Evans W.C. (1978): A Text book of pharmacognosy. 11ed. Bailiire-Tindall, London.
29. Okafor, J.C., 1975: Varietal Delimitation in *Irvingia gabonensis* (Irvingiaceae). *Bulletin du Jardin botanique National de Belgique* Vol. 45, No. 1/2 pp. 211-221.
30. Makalao M. M., Savadogo A., Zongo C. and Traore A. S. (2015): Composition nutritionnelle de 10 fruits sauvages consommés dans trois départements du Tchad. Int. J. Biol. Chem. Sci. 9(5): 2385-2400.
31. Achinenwu, S. C. (1983). Ascorbic acid content of some Nigerian local fruits and vegetables. *Qualitas Plantarum Plant Foods for Human Nutrition*, 33(4), 261–266. doi:10.1007/bf01094751.
32. Etebu, E. (2012). Postharvest pathology and phytochemicals of *Irvingia gabonensis* (Aubry-Lecomte ex O’Rorke) fruits and wastes. *Agricultural Science Research Journal* Vol. 2(6) pp. 285 – 294.
33. Adepoju, O. T. (2009) Proximate composition and micronutrient potentials of three locally available wild fruits in Nigeria. *African Journal of Agricultural Research* Vol. 4 (9), pp. 887-892.
34. Lees, R. (1975). Food analysis: Analytical and quality control methods for the food manufacturer and buyer. London: Leonard Hill Books.