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RESEARCH ARTICLE

NUTRITIONAL POTENTIAL AND FUNCTIONAL PROPERTIES OF PEELINGS OF THREE YAM CULTIVARS OF *DIOSCOREA CAYENENSIS-ROTUNDATA* COMPLEX

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ABSTRACT

Yam peelings are among the co-products whose technological applications and nutritional potential remain poorly known by agri-food sector stakeholders. The objective of this study is to contribute to the valorization of these co-products. The peelings of three yam cultivars of the Dioscorea cayenensis-rotundata complex: "Assawa", "Krenglè" and "Kponan" were studied and compared to the pulp of these cultivars. The biochemical parameters, the phyto-chemical compounds and the functional properties of these varieties were determined according to the standard methods. The results showed that the dry matter, protein, fat and ash contents of the peelings of the Assawa variety were respectively 92.02%; 5.74%; 0.82% and 3.42%. As for the peelings of the Krenglè variety, the contents in dry matter, proteins, fat and ashes are successively of 91,26%; 5.87%; 1.51% and 91.26% and 2.21%. The peelings of the Kponan variety have 92.29% dry matter, 4.30% protein, 2.15% fat and 3.71% ash. Peelings of the variety Assawa contain the highest levels of oxalates with 90.33 mg / 100 g. On the other hand, peelings of the Krenglè variety have the highest levels of total polyphenols (183.08 mg / 100 g) and tannins (143.31 mg / 100 g). The water absorption capacity, the water solubility index and the dispersibility of kponan peelings are the highest compared to peelings of the Assawa variety and peelings of the Krenglè variety. In addition, peelings of the variety Assawa have the highest hydrated densities and brightness compared to peelings of the Krenglè variety and peelings of the Kponan variety. Thus, it appears that peelings varieties "assawa", "kponan" and "krenglè" have good nutritional and functional properties allowing them to be used in food and feed.

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INTRODUCTION

Yam (*Dioscoreaspp*) of the *Dioscoreaceae* family is a monocotyledonous tuberous plant of great nutritional, economic and socio-cultural importance in the tropics. It is one of the plants that have formed the basis of the civilization of certain ethnic or socio-economic groups and religious rituals in Africa, Oceania and Latin America (Demont *et al.*, 2003). In many parts of West Africa, yam is ubiquitous on the menu of all major ceremonies, where it is offered to distinguished guests (Coursey, 1967, Gbedolo, 1991). In this region, it is a staple of hundreds of millions of people. Yam is the first non-cereal food crop with a production of more than 5.5 million tonnes in 2011, produced over an area of more than 830000 ha. It occupies an important place among the food crops produced in Côte d'Ivoire (FAO, 2013). Annual per capita consumption has risen from 105 kg to 120 kg over the last decade (Sylla, 2003). About 80% of production is used by the households that grow them, making Côte d'Ivoire the world's largest consumer of yams. Consumed in many forms, the pulp can be boiled, fried or grilled. They can be used to prepare "foutou" or "foufou". They can also be eaten in the form of cookies, flakes or flour.

Currently, the main traditional forms of yam processing are dried yam chips and flour obtained from these chips (Chinsman and Fiagan, 1991). Yams tubers are a good source of calories. They are rich enough in vitamin C which promotes metabolism, contain vitamin B1 (thiamine) and B3 (niacin) which both allow to assimilate carbohydrates, as well as iron, excellent for the blood. They contain 25% of starch as much as potatoes and 7% of proteins, which is 4 times more than cassava. *Dioscorea bulbifera* is one of the most antioxidant plants in the world, which explains its beneficial effect on health (Henri, 1947). Unlike the pulp that is totally consumed, yam peelings, for their part, are totally rejected because the interests unknown to all. With the exception of some farmers who commonly use them as fodder after having lightly boiled or dried. Yam peelings are among the co-products whose technological applications and nutritional potential remain poorly known by agro-food sector stakeholders. Since yam tubers are a popular food item and are sold at fairly high prices, the amount of tubers used for animal feed is negligible and generally represents only the part not usable for human consumption because damaged or ignored applications. Thus, very little work has been done on this co-product. The objective of this study is to contribute to the valorization of these co-products. The peelings of three yam cultivars of the *Dioscorea cayenensis-rotundata* complex): "Assawa", "Krenglè" and "Kponan" were studied and compared to the pulp of these cultivars.

MATERIALS AND METHODS

Biological material: Three varieties of yam (*Dioscorea cayenensis-rotundata*), namely the varieties "Kponan", "Krenglè" and "Assawa" were used in this study. These yams were purchased at the large market of Abobo (District of Abidjan, Ivory Coast).

Production of pulp flours and yam peelings: The yam tubers have been washed to remove any foreign elements. They were then peeled with a stainless knife. The peelings and pulps of each diced variety were dried in an oven at 65 ° C for 72 hours. After drying in an oven, the dried products were ground using a blender (Blender LB20E, Torrington, USA, 2012) and sieved to obtain the flours. The flours obtained were each kept in a glass jar previously washed and dried for the determination of the physicochemical and functional parameters.

Determination of nutritional parameters of yam pulp and peelings: Dry matter, ash, protein, fat, pH and titratable acidity were determined according to AOAC (1990). Dry matter was determined by oven drying at 105 ° C for 24 h and ash with a muffle furnace at 550 ° C for 24 h. The proteins were assayed according to the Kjeldhal method. The fat content was determined according to the Soxlhet method using hexane as the solvent. Total carbohydrates were determined by difference of the total material to other biochemical compounds. The energy value was calculated using specific coefficients Atwater and Rosa (1899). PH and total titratable acidity were determined with a pH meter and acid-base assay, respectively (AOAC, 1990). The determination of total sugars and reducing sugars was carried out with the methods of Dubois *et al.* (1956) using sulfuric acid and phenol and Bernfeld (1955) using DNS. The starch content was determined according to the method of Jarvis and Walker (1993) and the raw fibers according to the method of Wende (AOAC, 1990). The determination of total polyphenols was done according to the method of Singleton *et al*. (1999) and that of tannins according to the method of Bainbridge *et al*. (1996) The method used for the oxalate assay is that of Meda *et al*., (2005). Hydrogen cyanide was determined by the alkaline titration method (FAO, 1956).

Determination of functional properties of yam pulp and peelings: The water absorption capacity (WAC) and the solubility index in water (SIW) of the flours were determined according to the respective methods of Phillips *et al*. (1988) and Anderson *et al.* (1969). The brightness of the pasta of the flours was measured according to the method of Craig *et al*. (1989). The dispersibility of the flours was determined according to the method described by Mora-Escobedo *et al.* (1991). The density of the flours was determined according to the method of Narayana and Narasinga (1982). The wettability of the flours was determined according to the technique of Onwuka (2005).

Statistical Analysis: The statistical processing of the data consisted of one-way analysis of variance (ANOVA) using SPSS software (SPSS 22.0 for Windows). Means were compared by the Newman Keuls test at 5% significance level.

RESULTS

Nutritional characteristics of yam varieties studied: The biochemical characteristics of the pulp and peelings of the different varieties of yams studied are presented in Table I. The dry matter contents of the pulp and peelings of the yam varieties are between 87.87% (pulp of the Assawa variety) and 92.29% peelings of the Krenglè variety. The yams of the yam varieties have a titratable acidity of between 0.36 and 0.46% while the peelings of these varieties are between 0.52 and 0.61%. The lipid contents of the peelings and pulps of the varieties studied are statistically different from each other ($p<0.05$%). Assawa pulp has the highest rate of fat (3.27%). In addition, the protein levels of Krenglè pulp (pulp (8.22%) and peel (5.87%)) are the highest. As for the variety Assawa, protein levels are 5.06% for pulp (lower protein content for pulp) and 5.74% for peelings. Assawa, Krenglè and Kponan pulps have ash contents of 2.09%, respectively; 2.64% and 2.41%, and those of their peelings are respectively 3.42%; 2.21% and 3.71%. The pulp varieties Assawa, Krenglè and Kponan contain 83.48%; 78.94% and 83.79% total carbohydrates; higher than peelings (78.19% for peelings of the variety Assawa, 78.49% for peelings of the Krenglè variety and 77.20% for peelings of the Kponan variety). On the other hand, the starch contents obtained with the pulp of the Assawa variety (74.28%) and the pulp of the Kponan variety (66.28%) are greater than the peelings of the Assawa variety (65.49%). and peelings of the Kponan variety (66.28%). As for the pulp and peelings of the Krenglè variety, the starch levels are significantly identical (54.04% and 54.29%) ($p<0.05$%). The peelings of Assawa, Krenglè and Kponan showed lower total sugar contents of 4.85%; 6.01% and 5.94% relative to the pulp with contents of 7.87% for Assawa pulp, 8.59% for Krenglè pulp and 6.01% for Kponan pulp. The peelings of the varieties Assawa, Krenglè and Kponan have lower levels of reducing sugars respectively of 0.82%, 1.43% and 1.41% against 2.80%; 2.50% and 1.94% for the respective pulps. The peelings of Assawa, Krenglè and Kponan have energy values of 343.11; 351.03; 345.35 kcal / 100 g, lower than those of their pulps with successive values of 383.57; 369.52 and 378.52 kcal / 100 g. Table II shows the quantities of phyto-chemical compounds present in the pulp and the peelings of the three varieties of yams studied. The total polyphenol contents of Assawa (157.95 mg / 100g) and Kponan (152.02 mg / 100g) peelings are higher than those of Assawa pulp (151.63) mg / 100g) and pulp of the Kponan variety (149.55 mg / 100g). The pulp of the Krenglè variety contains polyphenol content (151.84 mg / 100g), which is higher than that of its peelings (183.08 mg / 100g). The peelings of the variety Assawa and the variety Krenglè have contents respective tannins of 54.15 mg / 100g; 143.31 mg / 100g, higher than the pulp of the variety Assawa (48.28 mg / 100g) and the pulp of the Krenglè variety (37.88 mg / 100g), while the tannin content of the pulp of the Kponan variety (53.43 mg / 100g) was higher than that of its peelings (23.69 mg / 100g). The oxalate contents of the peelings and pulps of the three yam varieties are statistically identical ($p> 0.05$). Thus, the pulp and peels Assawa have respective contents of 88.50 mg / 100g and 90.33 mg / 100g. The pulp and peelings of Krenglè have levels of 65.14 mg / 100g and 50.16 mg / 100g. The pulp and peelings of Kponan contain contents of 80.99 and 61.22 mg / 100g mg / 100g. Hydrogen cyanide is in trace form in the dried yam varieties studied.

Table I. Nutritional characteristics of the three varieties of yams studied

Varieties of yam		Content (g/100g)										
		Dry Matter	Fat	Protéin	Ash	Carbohydrate	Starch	Fiber	Total Sugar	Reducing sugars	Titratable acidity	Energy (Kcal/100)
Assawa	Pulp	87.87±0.13^{b}	3.27±0.99^{d}	5.06±0.09^{b}	2.09±0.01^{a}	83.48±1.02^{d}	74.28±0.66^{c}	6.10±0.07^{a}	7.87±0.61^{c}	2.80±0.34^{d}	0.39±0.04^{ab}	383.59±7.22
	Peel	92.02±0.05^{d}	0.82±0.51^{a}	5.74±0.12^{c}	3.42±0.02^{e}	78.19±0.66^{b}	65.49±7.74^{b}	11.83±0.18^{c}	4.85±0.47^{a}	0.82±0.15^{a}	0.61±0.01^{e}	343.11±2.23
Krenglè	Pulp	88.00±0.16^{b}	2.32±0.18^{bcd}	8.22±0.11^{d}	2.64±0.07^{d}	78.94±0.05^{bc}	54.04±2.28^{a}	7.88±0.06^{b}	8.59±0.00^{c}	2.50±0.10^{d}	0.46±0.09^{bc}	369.52±1.35
	Peel	91.26±0.00^{c}	1.51±0.19^{ab}	5.87±0.06^{c}	2.21±0.06^{b}	78.49±0.18^{b}	54.29±1.79^{a}	13.92±0.15^{e}	6.01±0.35^{b}	1.43±0.05^{b}	0.52±0.02^{cd}	351.03±1.23
Kponan	Pulp	87.63±0.01^{a}	2.52±0.16^{cd}	5.17±0.17^{b}	2.40±0.06^{c}	83.79±0.35^{d}	66.28±0.77^{b}	6.11±0.13^{a}	6.01±0.38^{b}	1.94±0.34^{c}	0.36±0.00^{a}	378.52±0.89
	Peel	92.29±0.03^{e}	2.15±0.15^{bc}	4.30±0.04^{a}	3.71±0.02^{f}	77.20±3.37^{a}	53.68±1.77^{a}	12.64±0.33^{d}	5.94±0.34^{b}	1.41±0.04^{b}	0.56±0.03^{de}	345.35±1.89

The values express the mean ± standard deviation (n = 3). Values of the same column affected by the same letter are not significantly different at the threshold of 5% (p> 0.05).

Table II. Phyto-chemical compound content of the three varieties of yams studied

Variety of yam		Phyto-nutrients (mg/100g)		Anti-nutrients(mg/100g)	
		Total Polyphénols	Tannins	Oxalates	HCN
Assawa	Pulp	151.63 ± 0.04^{c}	40.28 ± 4.10^{b}	88.5 ± 12.62^{bc}	Trace
	Peel	157.95 ± 0.04^{f}	54.15±4.26^{c}	90.33± 25.17^{c}	Trace
Krenglè	Pulp	15.,84 ± 0.04^{d}	37.88±4.09^{b}	65.14±12.67^{a}	Trace
	Peel	183.08±3.86^{d}	143.31 ± 0.07^{a}	50.16±12.67^{a}	Trace
Kponan	Pulp	149.55 ± 0.04^{b}	53.43 ± 4.02^{c}	80.99±21.83^{bc}	Trace
	Peel	152.02 ± 0.04^{e}	23.69 ± 4.10^{a}	61.22±21.84^{ab}	Trace

The values express the mean ± standard deviation

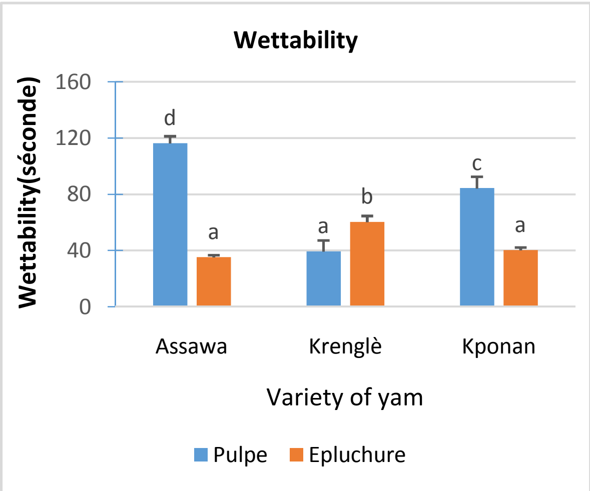

Figure 1. Wettability

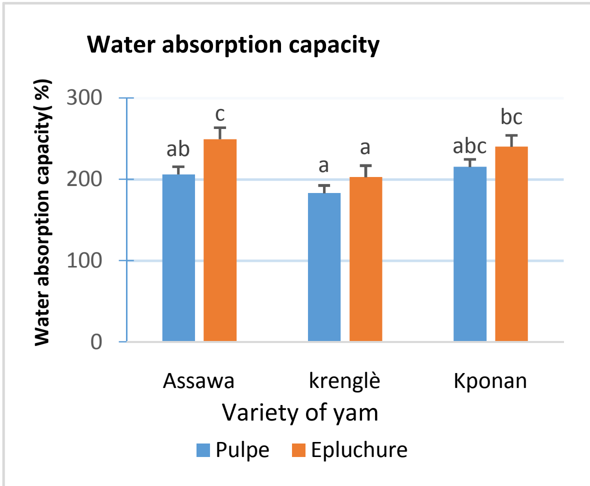

Figure 2. Water absorption capacity

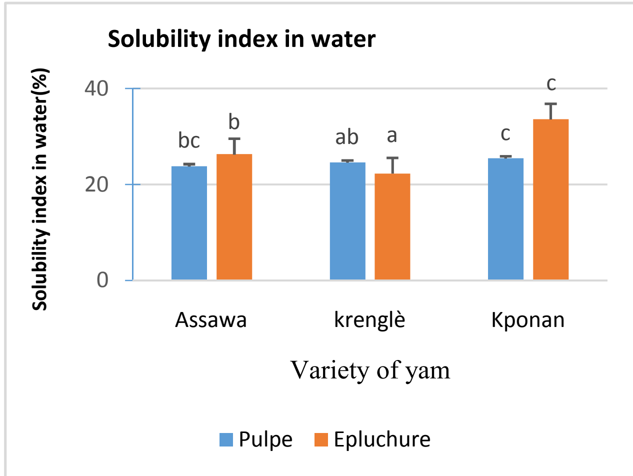

Figure 3. Solubility index in water

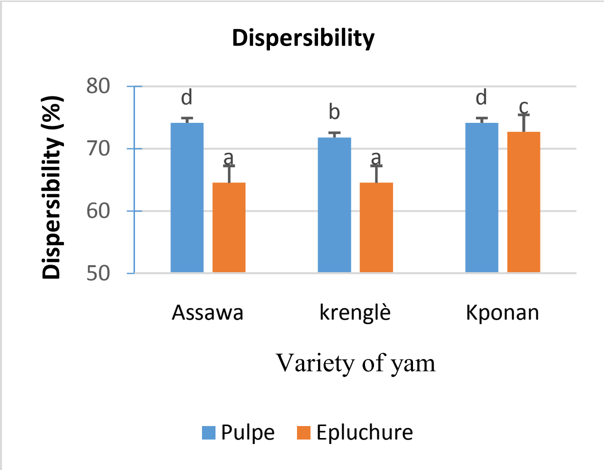

Figure 4. Dispersibility of flour

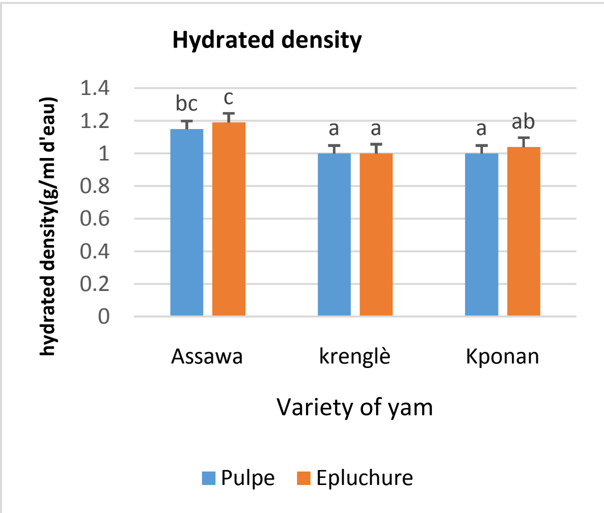

Figure 5. Hydrated density

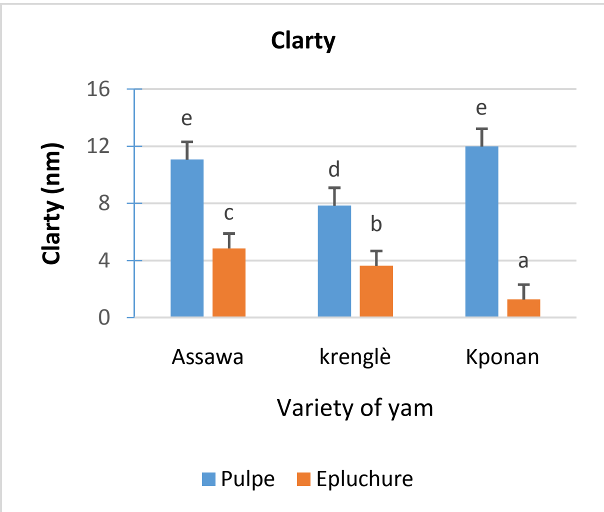

Figure 6. Clarty of the flour

Functional properties of yam varieties studied: The functional properties of the different varieties of yams are illustrated in Figures 1, 2, 3, 4, 5 and 6. The wettability times of the pulp of the variety Assawa (116.33 s) and the pulp of the variety of Kponan (84.33s) are longer than those of their peelings (35.33s for the variety Assawa and 40.33s for the variety Kponan). On the contrary, the pulp of the Krenglè variety (39.33 s) is shorter than that of its peelings (60.33 s) (Figure 1). The water absorption capacity of the pulp of the Assawa variety (206.06%) is lower than that of its peelings (249.40%); while the water absorption capacity of Krenglè pulp (183.07%) and Kponan pulp (215.16%) are statistically identical to those of their peelings (202.74% for peelings of the Krenglè variety and 240.10% for the Kponan variety peelings (Figure 2). Concerning the water solubility indices of the Assawa (23.83%) and Krenglè varieties (24.58%)), they are statically identical to those of their peelings, with 26.30% for the variety Assawa and 22.30 ± 1.72% for the Krenglè variety, whereas the pulp of the Kponan variety has a solubility index in water of 25.46% smaller than that of its peelings which is 33.59% (Figure 3) .The dispersibility values of the pulp of varieties Assawa (74.17%), Krenglè (71.82%) and Kponan (74.17%) are higher than those of their peelings with respective values of 64.55%, 64.55% and 72.73% (Figure 4). s hydrated pulps yam varieties are between 1.00 and 1.15 g / ml of water. These densities are statistically identical to those of their peelings between 1.00 and 1.19 g / ml of water (FIG. 5). On the other hand, the clarity of the pulp of the yam varieties varies between 7.85 nm (pulp of the Krenglè variety) and 11.99 nm (pulp of the Kponan variety). They are twice as high as peelings between 1.28 nm (kponan peelings) and 4.85 nm (peelings of the Assawa variety) (Figure 6).

DISCUSSION

Nutritional characteristics of yam varieties studied: Dry matter levels are high in the pulp and peel flours of the yam varieties. Low water levels promote the conservation of food by limiting the proliferation of microorganisms. The high starch and total carbohydrate contents of the pulps compared to those of the peelings would be due to the composition of these. Indeed, during the growth of the reserve organs, an increase in dry matter and starch contents due to physiological phenomena is observed (Martin, 1979). Thus, the results obtained are in agreement with those of Wanasudera and Raviend (1994) which obtained a starch rate ranging from 57 to 88 g/100 g of yam. Similarly, Agbor-Egbeet Trèche (1995) confirmed these results by establishing a range of the starch content of *Dioscorea* yam from 60.8 to 88 g per 100 g. In addition, our results are consistent with those of Soro *et al.* (2013) who obtained 86.76% starch for Kponan and 89.02% yam for the variety "Beta Beta" in its infant food formulations based on yam flour enriched with soy. The lower ash content of Assawa pulps and Kponan pulps compared to their peelings may be related to the surface (direct contact) that they provide to soil minerals. However, the biodiversity of mineral salts could be limited by anti-nutritional components (Gibson *et al.,* 1998). As a result, the results obtained remain higher than those of Soro *et al* (2013) which is 1.93% and Agbor-Egbeet Trèche (1995) which found an ash content of 2.53 mg / 100 g. The fiber contents of the peelings are twice as high as those of the pulps. This increase is due to nitrogen input. According to Eppendorfer *et al.* (1979), the increase in digestibility may be the consequence of a lower proportion of nitrogen retained in the fiber for tubers that received high doses of nitrogen. The fiber content of pulps obtained is higher than that of Medoua (2005) which were 4.1%. The low lipid levels of "Assawa" and "Krenglè" peelings are consistent with those obtained by Soro *et al.* (2013) for the "beet-beta" (0.87%), with the exception of the pulp of "Assawa", "Krenglè", "Kponan" and "Kponan" peelings which are twice higher. The protein content of the pulp and peel of the yam varieties remains within the range defined by Comoé (2002), which is 5.7 to 7.07%. These same results were confirmed as well Wu *et al*. (1970) in the food composition table for use in Africa and Agbor-Egbe and Trèche (1995).

According to these authors, the protein content of the varieties *Dioscore acayenensis rotundata*could range from 5.7 to 9.9 g /100g yam. The results obtained in total sugars and reducing sugars show that the pulps are richer in sugars than the peelings. This result could be explained by the fact that during storage, the effect of hardening would cause the hydrolysis of the starch into sugar. The energy values of the pulps are greater than those of the peelings. The properties of the pulp to metabolize the energy more easily would be at the origin of this result. The results obtained are consistent with those of Agbor-Egbe and Trèche (1995) on cultivars of *Dioscorea* of Cameroon, whose values are defined from 370.4 to 388 g/100 g of yams. The low total polyphenol contents of the yam varieties are twice as low as those found by Medoua (2005) with *Dioscorea dumetorum*, but remain much higher than those of Soro *et al*. (2013) on the "beta-beet" which was (58.5 mg /100g). These variations are due to storage conditions as shown by Medoua (2005). According to this author, there would be about 22-28% decrease in phenolic compounds under the conditions prevailing in tropical environment. Polyphenols are bitter, astringent or sweet substances. They are also flavoring of choice. Several studies have demonstrated their ability to limit oxidation in vivo and in vitro and have suggested several beneficial effects on health (Moure *et al.,* 2001). Tannins are a set of phenolic polymers that, depending on their concentration in a food product, develop a positive or negative organoleptic note when their astringency and bitterness become excessive. On a nutritional level, they tend to inhibit enzymatic digestion because of their affinity with proteins. The amounts of tannins of the "Assawa", "Krenglè" and "Kponan" peels are higher than that found by Medoua, (2005) with *D. dumetorum* which is 21.8 mg/100g. Oxalic acid forms, with alicano-earths, strictly insoluble salts which cannot be dissociated during digestion and therefore lack nutritional efficiency. Oxalic acid thus has demineralizing properties. Moreover, if it remains in the digestive tract in the form of soluble alkali oxalates, the absorbed fraction is toxic especially at the renal level.

In particular, cooking degrades oxalates (Adrian *et al.,* 1998). The results showed low levels of oxalates in the different varieties of yams studied. In fact, calcium oxalate raphites and notable amounts of oxalic acid are present in most yams (Udoessien and Ifon, 1992), but are three times less abundant than in cassava roots. Thus, the values obtained would be higher than those of Bradbury *et al.* (1988), which varied from 12.7 to 17.6 mg / 100 g fresh weight. These oxalate contents are lower than those of fresh tubers (501.7 to 510.9 mg / 100g DM) found in the species *D. dumetorum* par Medoua (2005). Also, the oxalate contents of the yam varieties are lower than those of Akindahunsi and Oboh, (1998). which obtained tannin contents in the range of 486 to 581.9 mg / 100 g fresh weight *D. bulbifera* and *D. mangeonotiona*. The absence of hydrogen cyanide in the yam varieties is due to the fact that the yam tubers studied were dried prior to the determination of this compound. In fact, hydrocyanic acid (HCN) is a volatile compound. It evaporates rapidly in the air at temperatures above 28 ° C and dissolves easily in water. It can easily be lost during transport, storage and analysis of samples. But also because the edible yam, mature and cultivated does not contain a toxic principle. However, bitter principles tend to accumulate in the tissues of the still green tubers of *Dioscorea rotundata* and *D. cayenensis.* These may be polyphenols or tannin-like compounds (Coursey, 1979).

Functional properties of yam varieties studied: The functional properties of foods are defined as the physico-chemical properties reflecting the complex interactions between the composition, structure, conformation and physicochemical properties of the components (Oulaï *et al.,* 2014). Yam varieties studied showed significant differences between pulp and peel data respectively in terms of clarity, wettability and dispersibility. The clarity of gels is a desirable property of starches used as thickeners in the food industry because it directly influences the brightness and opacity of food (Mweta *et al.,* 2008). The clarity of yam peelings studied is similar to that of Amon (2008) on taro flours (4.05% to 5.375%). Concerning the pulp, they are three times lower than the results of Tetchi *et al*., 2007 on the starch of the yam << Bétè-Bètè >>. But our results on are within the range of result obtained by Amani *et al.* (2004) on ginger (1.4% to 11.5%). The wettability times obtained are high. These results make it possible to classify them into three classes according to their wettability time. Because, according to Pohl et al. (2004) [43], if the wettability time is less than 30 seconds, the flour is said to be very wettable. If the time is between 30 and 60 seconds, the flour is said to be wettable. If the time is greater than 120 seconds, the flour is said to be non-wettable. Thus, none of our studied flours is very wettable, because their wettability time is greater than 30 seconds. By cons, all peelings are wettable because their wettability time less than 60 seconds. For pulps whose wettability times greater than 60 seconds, but less than 120 seconds could take the term of wettable. These differences in wettability are due, on the one hand, to the composition of flours and the affinity between its components and water and, on the other hand, to the accessibility of water in terms of structure (porosity and capillarity) to flour constituents (Schuck *et al*., 2007).

The wettable capacity of the flours gives them an ability to swell when handling pasta. The high water absorption capacity of the peelings compared to that of the pulps could be explained by the presence of hydrophilic compounds. Flours with high water absorption capacity would contain more hydrophilic constituents. The difference in the values observed would also be due to the content of the different flours in amino acids, as well as the availability of the functional groups of the proteins in the flours. The availability of functional groups of proteins in flours is governed by the water absorption capacity which according to Collinlaw *et al*. (2009) is an important property of flour used in pastry. Nevertheless, the results obtained agree with those of Medoua, (2005) ranging from (182, 3 ± 4.1%) to (390.7 ± 4.4%) for hardened tuber flours. The results obtained show a significant solubility of the "Assawa" and "Krenglè" flours compared to that of "Kponan". However, no significant difference between pulp flours and their peelings was observed. The solubility of flours also increases with temperature. Starch with a crystalline structure is insoluble in cold water. During gelatinization, between 60-65 ° C, there is a destruction of the crystalline structure and a beginning of swelling. The swelling continues with increasing temperature until the granules burst, thus releasing their contents, some of which dissolves (Doublier, 2009). A high temperature therefore denatures the starch granules of the flour by improving the solubility. Solubility could involve the amount of amylose (soluble fraction of starch) released from the starch granules during swelling. Therefore, the increase in solubility is explained by an increase in released amylose (Hathaichanock and Masubon, 2007). According to these same authors, for the food flours, the solubility would be also due to the soluble proteins but also to the concentration of hydrophobic amino acids. Hydrated density is important in separation processes such as sedimentation and centrifugation (Lewis, 1987). The results of high dispersibility of the pulps compared to peelings testify important hydrophobic characters, but also the very fine structure of the flours of these pulps compared to those of their peelings. The results obtained from the studied yam flours are similar and are in the range of the values obtained by Otebgayo *et al.* (2013) from 63 to 87%. It is a measure of the degree of reconstitution of flour in water. The higher it is, the more the flour has a great capacity of reconstitution in the water to give a fine and coherent paste.

Conclusion

The flours from "Assawa", "Kponan" and "Krenglè" peels have good physicochemical and functional characteristics enabling them to provide nutrients, such as mineral elements, proteins, sugars capable of participating in major part of meeting the nutritional needs of the organization. The energy value of these peelings thus testifies to their ability to cover the energy needs of the body. It would therefore be possible to offer African households generally low monthly incomes, the peel flours that combine the characteristics of quality, availability and accessibility. Thus, in order to value the peelings, they could be recycled to regain the human food and even that of the production of infant flours. These important physicochemical and functional characteristics would be a plus for the agro-food industries in the manufacture of food products derived from yam tubers. Also, they could be the object of a protein and lipid enrichment.

Abbreviations

EVA: Peelings of the variety "Assawa"
EVKr: Epluchures of the variety "Krenglè"
EVKp: Epluchures of the variety "Kponan"
PVA: Pulp of the variety "Assawa"
PVKr: Pulp of the variety "Krenglè"
PVKp: Pulp of the Kponan variety

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