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Nutritional Quality, Phenolic Compound Content and Radical Scavenging Potential of *Artocarpus altilis* of Benin

Cokou P. Agbangnan Dossa[1,*], Fifa. T. D. Bothon[1], Rose E. Kanfon[1], Seinde E. Medoatinsa[1], Gertrude Bahou[1], Valentin D. Wotto[2], Dominique. C. K. Sohounhloue[1]

[1]Laboratoire d'Etude et de Recherche en Chimie Appliquée, Ecole Polytechnique d'Abomey-Calavi, Université d'Abomey-Calavi, Bénin
[2]Laboratoire de Chimie Physique, Faculté des Sciences et Technique, Université d'Abomey-Calavi, Bénin
*Corresponding author: cokou2005@yahoo.fr, pascal.agbangnan@uac.bj

Abstract The aim of this study is to valorize the fruit of *Artocarpus altilis* by assessing the nutritional quality, phenolic compound content, and radical scavenging power of its flour and the possible transformation of the flour into porridge with acceptable organoleptic characteristics. The determination of the phenolic compounds was carried out by spectrophotometry and antioxidant activity by the DPPH method while the nutritional parameters were evaluated by Official methods of analysis of the AOAC. The results showed that breadfruit flour contained carbohydrates (78.74%), water (12.60%), fat (8.45%), low protein (0.17%) and total mineral (0.036 %) content. The production yield of the flour is of 21.65%, while the extraction of secondary metabolites showed that the aqueous ethanolic extract has the highest (3%) yield of extraction followed by the ethanolic and aqueous extracts which have 2% as a yield of extraction. The aqueous ethanolic extract has the highest total polyphenols content (74.92 mg GAE/g DM) while the ethanolic extract has the highest flavonoids content (100.16 mg CE/g DM) and better antiradical activity (IC50 = 0.16 g/mL) compared to other extracts. The highest content of condensed tannins (24.30 mg CE/g DM) was observed in the aqueous extract. The porridge most appreciated by the tasting panel is the one prepared with 15 g of flour and 0.25 L of water aromatized with citronella (*Cymbopogon citratus*) leaves. The flour of breadfruit tree fruit is a potential source of nutrients and phenolic compounds which can improve the health of Africa people often struck by under nutrition and many other ailments. Besides the uses made of this fruit, it can be ground into flour for better conservation and used against seasonal.

Keywords: *artocarpus altilis, nutrients, phenolic compounds, radical scavenging, porridge*

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1. Introduction

From a nutritional point, the world population is facing a double burden of malnutrition including both cases of under nutrition and overnutrition [1]. Food deficiencies in the developing countries, especially those located south of the Sahara, are a current affairs scourge. In Africa, despite substantial efforts in order to increase food production, malnutrition persists and cyclical or chronic food insecurity is affecting more and more households [2]. Food insecurity in Africa reveals three strong components. As a first step there is chronic malnutrition closely linked to poverty, poor post-harvest management underdevelopment; and then the "hunger riots" in urban areas and finally, we are seeing an increase in famine, particularly related to conflict, and a more general political instrumentalization of faim [3]. Dietary deficiency causes several serious diseases such as kwashiorkor (protein deficiency), beriberi (lack of vitamin B) and scurvy which is a deadly disease caused by a diet without fruit and vegetable source of vitamin C. Eating fruits and vegetables is considered by many authorities as a public health challenge and the subject of nutritional recommendations at the global level by FAO and WHO. According to [4] the average consumption of vegetables (excluding potatoes) and fruits highest in the European model (372 g/d, 212 g/d) than in Latin American (150 g/d, 271g/d) middle Eastern models (204 g/d, 233 g/d) Asia (179 g/d, 85 g/d) and Africa (77 g/d, 95 g/d). In view of these data, the consumption of fruits and vegetables in Africa is very low. This is due to: the lack of political will and industries for processing fruit and vegetables in order to acquire their derivatives in all seasons, as well as ignorance of values nutritional tropical fruits. Various epidemiological studies show that low consumption of fruit and vegetables increases the risk of chronic diseases in humans, and Africa does not escape this observation [5]. The beneficial effects of fruits and vegetables have frequently been attributed to vitamins C and the carotenoids present in these foods. However, fruits and vegetables contain a multitude of phenolic compounds that also act as natural antioxidants [6]. In order to make known and promote the consumption of certain vegetables and fruits in Benin, the present work on *Artocarpus altilis* has been done. Also known as breadfruit, this plant native to the Pacific, belongs to Moraceae family and is very suitable for hot and humidness regions [7]. In Benin, *Artocarpus altilis* is one of the ten woody food species on which sustained attention and priority actions must be carried out on the basis of their socio-economic importance [8,9] but the nutritional and medicinal properties of the fruits of this plant, remain well known. The aim of this study is to determine the nutritional quality, phenolic content and antiradical potential of *Artocarpus altilis* flour and the organoleptic characteristic of its porridge.

2. Materials and Methods

2.1. Collection of Plant Sample

Artocarpus altilis fruit was collected in the market of Ouando (Porto-Novo, Benin). The fruit was peeled, cut into thin slices, dried in an oven at 40 ° C for 72 hours and then ground in a blender to obtained the *A. altilis* flour. The flour was used to determine the different parameters defined in this study.

2.2. Physicochemical Analysis

2.2.1. Determination of Water Content

The water content was determined by the oven method [10].

2.2.2. Determination of Nitrogen

The determination of nitrogen was carried out using the Kjeldahl method [10]. Protein was calculated by multiplying the total nitrogen value by [11].nitrogen conversion factors.

2.2.3. Determination of Total Lipids

Total lipids of the sample were determined by the Soxhlet method after acid hydrolysis [11,12,13].

2.2.4. Calculation of Carbohydrates

The carbohydrate content was determined by calculation using the different method [14]:

$$\text{Total carbohydrates} = 100 - \%\left(\text{Protein} + \text{Fats} + \text{Moisture} + \text{Ash}\right).$$

2.2.5. Determination of Energy Value

The energy value of a food compound is the sum of the products of carbohydrates, proteins, lipids and its thermal coefficient of Atwater correspondent. [14]. The energy value per 100 g of the sample was then obtained by the formula:

$$\textbf{Energy value} = \left[\textbf{Protein}(\%)\,\textbf{x4}\right] + \left[\textbf{carbohydrates}(\%)\,\textbf{x4}\right] + \left[\textbf{lipids}(\%)\,\textbf{x9}\right].$$

2.2.6. Total Phenolic Compounds

A. altilis flour was macerate for 24 hours at room temperature (25°C) with magnetic stirrer in various solvents: water, ethanol, and the mixture water/ethanol (30:70). Samples were analyzed for phenolic content using the modified Folin-Ciocalteu method [15].

2.2.7. Flavonoids Content And Tannins Content

The total flavonoids content was determined using $AlCl_3$ [16]. This method is based on the formation of a flavonoid-aluminum complex with maximum absorbance at 510 nm. The tannins contents were determined using the modified Vanillin-HCl method [17] with and without blank subtraction. Catechin was used as a standard.

2.3. Radical scavenging Activity

Free radical scavenging activity was determined using 2,2-diphenyl-1-picrylhydrazil (DPPH) [18]. 3800 µL of DPPH and 200 µL of the plant extract at different concentrations were added. The reaction mixture was shaken and incubated in the dark for 1 hour. The absorbance was read at 517 nm against blank. DPPH radical scavenging activity (I) was calculated according to the formula:

$$I(\%) = \frac{A_{blank} - A_{sample}}{A_{blank}} * 100$$

IC50 (Concentration required to decrease the reaction to 50%) value for each sample was calculated from the non-linear regression curve.

2.4. Sensory Evaluation

Six porridges were prepared at various proportions: 10, 15 and 20 grams of flour in 0.25 mL of water with or without sheets citronella. After the preparation of the porridge, sensory test was carried out by employing 40 untrained panelists. They were asked to score their preferences for sensory attributes (colour, aroma, taste, mouth feel, and overall), using questionnaire sheets.

3. Results and Discussion

3.1. Phytochemical Analysis

The different physico-chemical parameters values are shown in Table 1.

Table 1. Results of physico-chemical analysis

Nutritional characteristics (%)	*A. Altilis* flour
Water content	12.6
Dry matter content	87.4
Fat	8.45
Protein	0.17
Carbohydrate	78.74
Ash	0.036
Caloric value	391.69 Kcal/g

It appears that *Artocarpus altilis* flour in this study is more energetic than bananas (89 kcal) avocado (139 kcal), durian (126 kcal) and dried fruit (260-340 kcal [19].

[20] showed that Breadfruit flour contained 0.75% of Ash, 94.5% of dry matter and and 4.35 % of Proteins, those value were higher than those of this work. This difference in can be related to the fact that the studied fruits are produced in different agro-ecological environments or are harvested in different seasons. The water content of the flour is not too high it can be stored order to have other derivatives of fruit against the season. Its carbohydrate content value was lightly superior to 18.9 % obtained by [21]. Human dietary intake of these carbohydrates is important because of their diverse biological roles, the most important of which is the provision of energy [22].

3.2. Extraction Yield

The aqueous ethanol has the highest extraction yield (3%), closely followed by aqueous and ethanol extracts, each with 2% as the extraction efficiency.

3.3. Total Phenolic Compounds, Flavonoids and Tannins Content

Figure 1 presents: total polyphenols, flavonoids and condensed tannins of aqueous, ethanolic and hydroethanolic extracts of the fruit from the breadfruit. The aqueous ethanolic extract has the highest total polyphenols content, while the aqueous and ethanol extracts showed the highest levels of condensed tannins and flavonoids respectively.

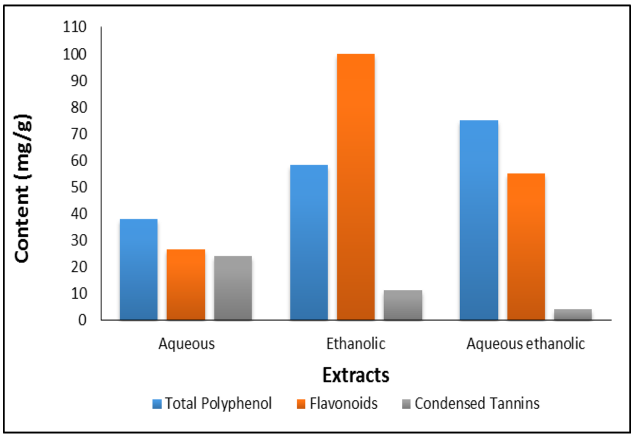

Figure 1. Total phenolic compounds, flavonoids and tannins contents

Starting at those results, *Artocarpus altilis* fruit is richer in total polyphenols as dates (56.60 mg/g) considered one of the richest plant species in phenolic compounds [23]. Several studies have demonstrated the likely involvement of phenolic compounds in the prevention of various diseases associated with oxidative stress, such as cancer, neurodegenerative diseases or cardiovascular diseases [23,24,25]. Thus the consumption of the fruit of the breadfruit tree is beneficial to health.

3.4. Radical Scavenging Activity

The anti-radical activity of *A. altilis* fruit is due to its chemical composition rich in polyphenols, mainly flavonoids [26]. The antiradical potential of the extracts was expressed here through the determination of their IC50. Although the aqueous extract is richer in tannin than the other two extracts, its IC50 could not be determined in the ranges of concentration studied. While the ethanol extract richer in flavonoids than the other two extracts has a more interesting IC50. Then comes IC50 of hydroetanolic extract, with an average content of flavonoids but greater than that of the aqueous extract. The flavonoids are well known for their antioxidant properties by neutralizing free radicals and limiting certain oxidative damage. They are the source of beneficial physiological effects on the human body and deserve the growing making research interest.

Table 2. Results of radical scavenging activity of the extracts

Extract	IC50 (g/ml)
Water Extract	-
Ethanolic extract	0.16
Hydroethanolic extract	0.19

3.4. Sensory Evaluation

The porridge most appreciated by the tasters is that made with 15 grams of flour in 0.25L of water with citronella aroma and accompanied by sugar and milk.

4. Conclusion

This study on *Artocarpus altilis* from Benin show that the fruit is a good source of nutritional intake, polyphenols content and have a radical scavenging potential. It is very rich in carbohydrates and consumed in Benin after steaming or fried. It can also be transformed into flour because of its low water content and to make a very nutritious and organoleptic quality appreciable porridge for both children and the elderly. This study opens a way of preserving the nutritional values of this fruit in benefit of consumers and allows its availability in all seasons.

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