International Journal of Advancements in Research & Technology, Volume 7, Issue 4, April-2018
ISSN 2278-7763

Biochemical characterization of residues from the consumption of pineapple (*Ananas comosus* L.) in Côte d'Ivoire

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ABSTRACT

This study aimed to identify the biochemical parameters of two pineapple byproducts and propose ways of increasing their commercial value. The investigations concerned the pineapple skin and crown. The samples were gathered from sedentary saleswoman of 6 communes of Abidjan. The analyzes concerned the détermination of physicochemical parameters, nutritional and antinutritional compounds. The results showed that the skin was more acidic (4.92) than the crown. Nutritional compounds such as total sugars (13274.98 mg/100g), polyphenols (1054.07 mg/100 g), flavonoids (8.10 mg/100 g) and vitamin C (8.10 mg/100 g) were the highest into the skin. For the antinutritional compounds, the crown provided the highest phytate content (68.79 mg/100 g). However, tannins (200.25 mg/100 g) and oxalates (416.60 mg/100 g) contents were the most important into the skin. The results obtained showed that pineapple skin had huge nutritional and antinutritional potentialities. This will reduce recurrent food deficits in rural populations and contribute to food security in developing countries.

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Keywords : Pineapple, residues, nutritional and antinutional compounds, valorization.

1 INTRODUCTION

Pineapple (*Ananas comosus L.*) is a plant of the *Bromeliaceaes* family. Its fruit is grown in almost all tropical countries. In Côte d'Ivoire, the pineapple crop is very developed. Its annual production is more than 200.000 tons [1]. Pineapple is an economic and agricultural wealth for the population. The most popular variety is the *smooth Cayenne*. The pineapple is very appreciated by the population. Due to its sweet taste and nutritional properties, pineapple can be consumed fresh and processed [2]. Moreover, the industrial processing of pineapple and its domestic consumption produce large quantities of byproducts, in particular the skin, the heart and the crown. However, in Côte d'Ivoire, pineapple byproducts, during its marketing and consumption, are seen as not of interest. They constitute a source of environmental pollution and insalubrity. In addition, their decomposition is a source of foul odors which is a nest of flies that causes diseases such as cholera [3]. Previous studies have shown that pineapple byproducts can be used into soil fertilization and livestock feed [4]. For some countries, pineapple byproducts are recycled and used for economic purposes. However, in Côte d'Ivoire, they are piled up in dumping ground located near processing sites and homes. To overcome this situation, these different pineapple byproducts must be valorized in order to increase their profitability and fight the pollution. Thus, this study aimed to iden-

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tify the biochemical parameters of two pineapple byproducts to propose ways of increasing their commercial value.

2- MATERIALS AND METHODS

2-1 Sampling

The plant materials were consisted of mature pineapple skin and crown of the *smooth Cayenne* variety.

The sample was composed of the pineapple *smooth Cayenne* variety average weight of 1 kg collected on the 6 sites. Thirty (30) pineapples were purchased from sedentary sellers. These samples were coded according to their collection site and packed in collar. They were washed, peeled and cut to separate the skin and crown that formed the composite sample for each collection site.

2-2 Determination of physicochemical parameters

The dry matter content was measured in oven by the method described by [5]. The pH and titratable acidity were determined according to the methods of [6].

2-3 Determination of nutritional parameters

The contents of total soluble and reducing sugars were evaluated respectively with the methods of phenolsulphuric [7] and 3.5-dinitrosallicylic acid (DNS) [8] using a spectrophotometer. The fat content was determined by the Soxhlet extraction method from the dry matter according to [9] standards.

The proteins content was determined by the KJELDHAL method [5]. Vitamin C was determined according to the method of [5]. Phenol determination was performed according to the method of [10] using Folin-ciocalteu. The determination of tannins was carried out following the method described by [11]. The determination of flavonoid was performed according to the method described by [12].

2-4 Determination of antinutritional parameters

Phytates were quantified according to the method of [13]. Oxalates determination was carried out following the method of [14] using potassium permanganate.

2-5 Statistical analysis

The Data were subjected to an analysis of variance (ANOVA) using the software SPSS 16.0 for Windows operating system. Mean and standard deviation were calculated when F-values were significant at $p \leq 0.05$ level. The mean difference was separated using the Newman keul's test

3-Résults

3-1 Physicochemical characteristics of pineapple residues

The statistical analysis did not reveal a significant difference between the dry matter content of the skin and the crown. However, significant different was found between pineapple skin and crown regarding the pH and titratable acidity values (**Table 1**). Thus, the dry matter contents were 14.45% and 16.11% respectively for the skin and the crown. As for the pH values, the skin was more acidic (4.92) than the crown (5.60). Finally, the titratable acidity into the skin (103.26 meq/100 g) was higher.

Table 1: Dry matter. pH and titratable acidity contents of pineapple skin and crown

Parameters	**Sample**	
	Skin	**Crown**
Dry matter **(%)**	16.11 ± 1.06^a	14.35 ± 1.31^a
pH	4.92 ± 0.06^a	5.60 ± 0.11^b
titratable acidity **(meq/100 g)**	103.26 ± 14.90^a	81.22 ± 10.19^b

Values followed by the same letter in the same line are not significantly different for each parameter at the p ≤ 0.05 level

3-2 Nutritional compounds of pineapple residues

Statistical analysis revealed a significant difference for all nutritional compounds assessed into the skin and crown (Table

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2). Thus, the total sugars and reducing sugars content of the skin were statistically higher han the ones of the crown. These contents were 13274.91 mg/100g for total sugars and 1017.54mg/100g for reducing sugars. The skin provided the statistically highest protein, vitamin C, flavonoids and polyphenol total contents. These contents were respectively 11.28 mg/100g; 25.6 mg/100g; 8.10 mg/100g and 1054.07 mg/100g.

Table 2: Content of some nutritional compounds of the pineapple skin and crown

parameters	**Samples**	
(mg/100g)	**skin**	**crown**
Total sugar	13274.98±2812.01[a]	10523.68±1118.98[b]
Reducing sugar	1017.54±122.70[a]	580.37±30.16[b]
Proteins	11.28± 0.01[a]	8.70± 0.2[b]
Lipids	0.19± 0.051[b]	0.31± 0.90[a]
polyphenol total	1054.07±55.59[a]	748.70± 132.17[b]
flavonoids	8.10±1.38[a]	3.64± 1.68[b]
Vitamin C	25.6± 0.02[a]	4.97± 0.1[b]

Values followed by the same letter in the same line are not significantly different for each parameter at the p≤0.05 level

3-3 Antinutritional compounds of pineapple residues

Statistical analysis revealed a significant difference for all antinutritional compounds measured into the skin and crown (Table 3). Thus, the contents of tannins (200.25 mg/100 g) and oxalates (416.60 mg/100 g) into the skin were statistically the highest. However, crown had the highest phytate content, statistically (68.79 mg/100g).

Table 3: Content of some antinutritional compounds of the pineapple skin and crown

parameters	**Sample**	
(mg/100g)	**skin**	**crown**
Tannins	200.25 ± 15.90[a]	114.11 ± 34.21[b]
Oxalates	416.60 ± 18.20[a]	330.15 ± 15.30[b]
Phytates	60.26 ± 12.35[b]	68.79 ± 13.45[a]

Values followed by the same letter in the same line are not significantly different for each parameter at the p ≤0.05 level

4- Discussion

The pineapple skin and crown have low dry matter content because they are important water reserves. Thus, the consumption of fruits rich in water allows to drink and hydrate. This water allows the chemical exchanges which occur into the body. It also eliminates the waste and toxins which encumber the body [15]. Indeed, the water proportions contained into the pineapple skin and crown are greater than 80%. This high water content into the residues explains the rapid deterioration of these constituents. These results are similar to those obtained by [16]. Pineapple skin and crown had acidic pH. This result confirmed those of [17]. Indeed, pH is an indicator of fruit maturity [18]. It varie with area, crop, time of harvest, maturity, and other factors which affect the fruit [19]. pH plays an important role in fruit processing and fermentation reactions [20]. lipid content were very low into the two residues types. This low lipid content is similar to that found into apples and bananas [21]. The protein contents of the residues were also low. The protein content was however higher into the skin. The results of this study are similar with those of [21]. Carbohydrates were the major compounds into the two pineapple residues with higher values into the skin. Indeed, the pineapple samples being from the same variety and the same stage of maturity, this difference would be due to the action of micro-

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organisms and their activities. Enzymes and microorganisms degrade complex sugars in reducing sugars and their actions depend on several intrinsic parameters [20]. Otherwise, pineapple byproducts are composed of glucose, fructose, sucrose, galactose and xylose [17; 22]. Carbohydrates are important for their energy contribution into the body. Thus, pineapple residues are real byproducts because they are good sources of energy due to their high sugar content. This justifie their use into animal feed [23]. The nutritional value of pineapple crown and skin was reported by [24]. Furthermore, since sugar is used by some industries for fermentation reactions [25]. These pineapple byproducts would be useful in fermentation processes [26 ;27]. Pineapple byproducts are potential sources of polyphenols, which have antioxidant power. They are trappers of radicals which protect the human body against free radicals. These are potential sources of many diseases, such as cancer, and contribute to the aging process [28]. This study revealed the presence of phytochemicals such as flavonoids and tannins i pineapple skin and crown. These results, therefore, corroborate those of [29]. Indeed, these molecules are secondary metabolites present in plant. Their abundance in the byproducts makes them very important in the pharmaceutical and cosmetic industry [30]. The vitamin C content is higher into the pineapple skin. Vitamin C is an important advantage for the food and pharmaceutical industries. Indeed, vitamin C is an antioxidant which promotes the formation of collagen into bones, blood vessels, cartilage and muscles. It delays the development of urinary tract infections during pregnancy and reduces the risk of the stomach, esophagus and colon cancer [31]. These results revealed the presence of antinutritional factors such as phytates, tannins and oxalates into pineapple byproducts. Indeed, antinutritional compounds are substances which reduce or prevent the nutrients absorption by the body. Oxalates can bind to calcium into foods. This makes it inaccessible to physiological and biochemical roles [32]. However, phytic acid found into vegetable materials has a chelating effect on some essential minerals such as Ca, Mg, Fe and Zn to form insoluble phytate salts [33]. Phytate content found into pineapple skin and crown are lower than those found into cowpea and chickpea [34]. Thus, for the valorization of pineapple skin and crown, the antinutritional substances must undergo fermentation reactions or heat treatment to reduce their content. This could increase the bioavailability of mineral elements and contribute to the reduction of mineral deficiencies in rural populations [35].

5- Conclusion

The pineapple skin and crown considered as waste after fruit flesh consumption are very important. They have important nutritional properties with high sugars, polyphenols and vitamin C content. Compared to the pineapple flesh, the analyzes revealed lower content in the studied parameters. However, the nutritional and antinutritional compounds observed into the skin and crown are very important. Thus, these byproducts will be useful for fermentation reactions and can be valorized in nutraceutical and bioactive compounds in the pharmaceutical industry.

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