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Physico-Chemical and Microbiological Study of Fresh Pineapple (Baronne de Guinée) Grown in the Sub-prefectures of: Maferinyah and Friguiagbé (Forécariah and Kindia Prefectures), Republic of Guinea

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Abstract: Pineapple fruit in the Republic of Guinea is currently less competitive in the West African sub-region due to the nutritional quality of the product. Thus, it is normal to review certain parameters such as: sensory, physico-chemical in order to improve this classification. To do this, instead of buying samples on the market, the aim is to analyze fresh samples harvested in the production fields and send them to the laboratory for analysis of certain physico-chemical and microbiological parameters. Analytical results showed that the Brix content in fields I and II at Maferinyah (Forécariah) was higher (14.35 and 16.5) than that found in fields I and II at Friguiagbé (Kindia) (14.2 and 12.4), The pH of fruit from both localities varies between 3.48 and 3.56, with the highest acidity value found in Field I at Friguiagbé (Kindia) 2.16 and the lowest value in Field II at Maferinyah (Forécariah) 0.46. Moisture contents for both localities ranged from 82.56 to 89.5, with the highest value found at Field I in Maferinyah (Forécariah) 89.5. Dry extract and ash in both localities would be in the range 10.54 to 17.45; 0.33 to 1.43 respectively. The highest values for dry extract and ash were found in Fields I and II Friguiagbé (Kindia) 17.45 and 1.43. The samples analyzed contained certain trace elements such as magnesium, sodium, iron and phosphorus. Microbiological analyses showed the presence of *Escherichia coli* (*E. coli*), yeast-molds, *Staphylococcus aureus* and the absence of salmonella.

Key words: Fresh pineapple, cultivated, physicochemical study, microbiology.

1. Introduction

Pineapple (*Ananas comosus* (L). M) is a monocotyledonous, herbaceous plant of the Bromeliaceae family [1]. It accounts for around 20% of the world's tropical fruit production and is the second most cultivated exotic fruit. According to the FAO (Food and Agriculture Organization), world pineapple production has doubled in 25 years, reaching over 25.5 million tonnes per year [2]. In West Africa, pineapple is the second most important tropical fruit in terms of production volume, just after banana and before mango [3, 4]. Pineapples are grown for consumption as fresh fruit, both locally and in temperate countries where they are imported. Most of the crop, however, is canned in producing countries, in the form of slices or cubes; or processed to produce juice, compote and concentrate, as it contains high levels of manganese, vitamins B1 and C and fiber [5]. The Republic of Guinea, a West African country, has an estimated cultivable area of 6 million ha, i.e. around 25% of the national territory. Pineapple is a major export [6, 7]. Pineapple cultivation is specific to lower Guinea, mainly Forécariah and Kindia on the coast, due to the average temperature of 25 to 30 °C, as

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too much or too little heat can disrupt development [8]. The cultivable area is estimated at 450 ha, i.e. 233 ha in Kindia and 217 in Forécariah, with an estimated yield of 40 tonnes/ha [9]. Despite the best environmental conditions for production and the existence of numerous production zones owned by cooperatives, the sector remains modest, with production ranging from 5 to 10,000 tonnes/year. However, over 50% of Guinean pineapple exported to Europe is rejected for non-conformity with standards. Out of production of 9,417 tonnes in 2017, only 8 tonnes of pineapple could be exported to Europe [10, 11]. The rest of the production is sold on local and regional markets, which are less demanding in terms of product quality, and at low prices [12, 13]. Recent studies, including our own, have been reported on the physico-chemical, microbiological and nutritional quality of pineapple sold on Guinean markets, and by our team on the quality of pineapple-growing soils in two localities [7, 8]. Following on from this study, we report on the physico-chemical analysis of freshly harvested pineapple fruits and compare them with those already sold on local markets after several exposures, with a view to resolving the problems associated with the rejection of Guinean pineapple on the international market.

2. Material and Method

This study involved the determination of certain physico-chemical (pH, acidity, Brix, ash, dry extract, potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), phosphorus (P), iron (Fe) and microbiological (*Escherichia coli* (*E. coli*), *Staphylococcus aureus*, Salmonella, yeasts and molds) parameters of freshly harvested pineapple.

2.1 Plant Material

Fresh pineapple fruits of the Baronne variety from Guinea were used as raw materials.

2.2 Equipment

The equipment used in this study is as follows:

pH meter, refractometer, oven, mixer, desiccator, muffle furnace, gloves, analytical balance, knives, Petri dishes, beakers, tweezers, UV-Visible spectrophotometer.

2.3 Methods

A subsequent study randomly identified the various sampling fields. A total of six (6) samples were purchased at random from the fields during harvest, wrapped in polyethylene plastic and sent to the Office National de Contrôle de Qualité laboratory in Matoto for sensory, physico-chemical and microbiological analysis (Fig. 1).

2.4 Experimental Protocol

Sensory analysis was used to visually assess the physical quality of the fruit in terms of color, crown shape, presence of sunburn, insect holes, deformations, cracks and scales. Fruit size was determined by weighing them on a precision balance. The fruit was peeled and sliced. They were then put through a blender to obtain the extract to be analyzed (Fig. 2).

Fig. 1 Pineapple samples collected in growing areas for analysis.

(a) (b)

Fig. 2 (a) peeling and (b) pineapple juice extraction.

2.5 Physico-Chemical Analysis

2.5.1 Determination of pH

Take a test sample in a beaker, rinse the pH meter lens with distilled water, immerse the pH meter in the beaker, wait a while for the value to stabilize, then proceed with the reading [14].

2.5.2 Determination of Acidity and Brix

After rinsing the refractometer lens with the test sample, pour a few drops onto the lens, then switch on to read the Brix value. For acidity, weigh 1 g of the test sample into a beaker, make up the volume with distilled water to weigh 50 g of solution, rinse the refractometer lens with the weighed solution, pour 1 to 2 drops onto the lens, press the button for the second time and read the acidity value [14].

2.5.3 Determining Humidity

Weigh 5 g of the test sample into a pre-weighed Petri dish, place in an oven at 105 ℃ for 3 h, remove and place in a desiccator for partial cooling, then proceed to final weighing and calculate the moisture content using the following formula:

$$\%\mathrm{H} = \frac{\mathrm{Pe} - \mathrm{Ms}}{\mathrm{Pe}} \mathrm{x}\ \ 100$$

where

Pe: Test sample;

Ms: Dry matter;

H: Moisture.

The quantity of dry matter is calculated using the following formula: Ms = (100 - H%) [14].

2.5.4 Ash Determination

From the dry matter of the moisture, take 0 to 0.2 g of the test sample in a crucible, place in a muffle furnace at a temperature of 800 to 900 ℃ for a few minutes, remove and place in a desiccator for partial cooling, make the final weighing and calculate using the formula [14]:

$$\%\mathrm{C} = \frac{\mathrm{C1} - \mathrm{C2}}{\mathrm{Ce}} \times\ \ 100$$

C1: Weight of crucible and ash;

C2: Weight of empty crucible after drying;

Ce: Test sample;

C: Ash.

2.5.5 Determination of Mineral Elements: Potassium (K), Calcium (Ca), Magnesium (Mg) Sodium (Na), Phosphorus (P) and Iron (Fe)

According to the laboratory of the national quality control office in Matoto Conakry (Republic of Guinea), the UV-Visible Spectrophotometry technique following the standards: ISO 9964-3; 7980; 9964-3; 6878; 6332 was used.

2.6 Determination of Microbiological Parameters

2.6.1 Salmonella Enumeration

(1) Pre-enrichment

This consists in revitalizing the cells to facilitate culture in the enrichment broths. The stock solution is incubated at 37 °C for 24 h.

(2) Enrichment

Aseptically transfer 0.1 mL of the pre-enrichment solution into tubes containing 10 mL of rapapport broth. After homogenization, tubes are incubated at 37 °C for 18 to 24 h.

(3) Isolation

Isolation is achieved by streaking solid SS (Salmonella-Shigella) selective medium from the enrichment broth. Plates are incubated at 37 °C for 18 to 24 h, and sometimes even for 48 h in the absence of characteristic colonies. Proceed to reading.

2.6.2 Enumeration of Staphylococcus aureus

The culture medium of choice was BP (Baird-Parker), supplemented with a mixture of egg yolk and potassium tellurite. Using a sterile pipette, 0.1 mL of each dilution was transferred to the surface of agar plates. The deposited inoculum was spread carefully and as quickly as possible on the surface of the agar medium, avoiding touching the edges of the plate with the spreader. The plates were left to dry, with their lids in place, for approximately 15 min at room temperature, then turned upside down and incubated for 24 ± 2 h, then re-incubated for a further 24 ± 2 h in the 37 ℃ ovens. After 24 h and 48 h incubation, black or grey, shiny, convex colonies surrounded by an aureole of lightening are characteristic. After at least 24 h incubation, an opalescent ring may appear in contact with the colonies. Proceed to reading [15].

2.6.3 Enumeration of Yeasts and Moulds

Using the decimal dilutions selected (1/1,000 to 1/10), aseptically apply 4 drops per dilution to the corresponding Sabouraud dish, then spread with a sterile rake, starting with the highest dilution. In the same way, make a “Diluent Control” dish using 4 drops of the diluent used, and a “Medium Control” dish incubated as is. Take the reading [15].

2.6.4 Enumeration of Escherichia coli (E. coli)

From the stock solution and decimal dilutions, 0.1 mL is aseptically taken using a Pasteur pipette, and streaked onto Petri dishes (containing cast and gelled Mac Conkey medium). Incubate at 37 ℃ for 24 to 48 h then proceed with reading [15].

3. Results

The physico-chemical parameters determined are summarized in Tables 1 and 2 for samples from Friguiagbé in Kindia and Maferenya in Forécariah.

Table 1 Physico-chemical parameters of pineapples from Friguiagbé (Kindia).

Parameters	Friguiagbé (Kindia)			
	Unit	Field I	Field II	Criteria
pH	-	3.48	3.5	3.2-4
Acidity	g/L	2.16	0.52	0.1-1
Brix	%	14.2	12.4	12-15
Moisture	%	82.56	86.52	
Dry extract	g/L	17.45	13.08	
Ash	%	1.28	1,43	0.2-0.4
Potassium (K)	%	17.66	17.03	12-18
Calcium (Ca)	%	1.54	1.50	1-2
Magnesium (Mg)	%	1.48	1.51	1.5
Sodium (Na)	%	0.1	0.2	0.1-0.3
Phosphorus (P)	%	0.79	0.62	0.5-1
Iron (Fe)	%	0.01	0.01	0.01-0.03

Table 2 Physico-chemical parameters of pineapples from Maferinyah (Forécariah).

Parameters	Maferinyah (Forécariah)			
	Unit	Field I	Field II	Criteria
pH	-	3.49	3.56	3.2-4
Acidity	g/L	1.45	0.46	0.1-1
Brix	%	14.35	16.5	12-15
Moisture	%	89.5	82.76	
Dry Extract	g/L	10.54	17.24	
Ash	%	1.09	0.33	0.2-0.4
Potassium (K)	%	16.66	15.02	12-18
Calcium (Ca)	%	1.60	1.40	1-2
Magnesium (Mg)	%	1.38	1.41	1.5
Sodium (Na)	%	0.2	0.1	0.1-0.3
Phosphorus (P)	%	0.69	0.59	0.5-1
Iron (Fe)	%	0.02	0.01	0.01-0.03

Table 3 Microbiological parameters of pineapples from Maferinyah (Forécariah).

Germs	Friguiagbé (Kindia)			
	Unit	Results		Criteria
		Field I	Field II	
Escherichia coli (*E. coli*)	UFC	Presence	Presence	Abs/25 g
Staphylococcus aureus	UFC	147	143	<100/g
Salmonella	UFC	Absence	Absence	Abs/25 g
Yeast and mold	UFC	287	266	10^5/g

Table 4 Microbiological parameters of pineapples from Maferinyah (Forécariah).

Germs	Maferinyah (Forécariah)			
	Unit	Results		Criteria
		Field I	Field I II	
Escherichia coli (*E. coli*)	UFC	Presence	Presence	Abs/25 g
Staphylococcus aureus	UFC	138	134	<100/g
Salmonella	UFC	Absence	Absence	Abs/25 g
Yeast and mold	UFC	287	283	10^5/g

4. Discussion

Analysis of the results in Tables 1 and 2 for pineapple samples from fields I and II at Friguiagbé in Kindia and Maferinyah in Forécariah showed moisture content ranging from 82.56% to 89.5% respectively. However, the highest moisture value was found at 89.5% in field I of Friguiagbé (Kindia) and the lowest value at 82.56% in field I of Maferinyah (Forécariah). These results are close to those of the Baronne de Guinée pineapple sample purchased at the market by Saa et al. [7], with a difference of 3.7% in Field I and 0.26% in Field II (Friguiagbé in Kindia), which is 86.26%. These differences are probably due to the fruit being exposed to the open air before being drained. The values: Brix (14.2%), acidity (2.16%), dry extract (17.45 g/L) of field I are higher than those of field II (12.4%, 0.52%, 13.08 g/L) respectively at Friguiagbé in Kindia. These values are higher than those found by Saa et al. [7], which are 0.89% and 14.26%. On the other hand, the pH (3.5) and ash (1.43%) values for field II are slightly higher than those for field I (3.48, 1.28%) respectively. Compared with the value found by Saa et al. [7], the pH of field I (3.8) is higher and that of field II (3.5) is lower. Ash contents, with the exception of field II in Maferinyah, all other values are higher than its values. For dry matter, its value found in Maferinyah (27.73%) is clearly higher than our values (Tables 1 and 2). But comparing its dry matter value found at Friguiagbé (14.26%) this value is lower than our values at Friguiagbé and Maferinyah (17.45% and 17.24%) respectively (Tables 1 and 2). The values: pH (3.56), Brix (16.5%), dry extract (17.24 g/L) of field II are higher than those of field I (3.49, 14.35%, 10.54 g/L) respectively at Maferinyah in Forécariah. These values are lower than those found by Saa et al. [7], which are: 4.08 and 27.73 g/L. This increase in dry matter may be due to the length of time the fruit which has been exposed to the open air and sun by the vendors, which would cause evaporation of the water content. Acidity (1.45 g/L), moisture (89.5%) and ash (1.09%) values for field I are higher than those for field II (0.46 g/L, 82.76%, 0.33%) respectively (Table 2). The moisture contents of pineapple fruit from fields I and II (89.5%) and (82.76%) are higher than those found by Saa et al. [7], which can be explained by the fact that the harvested fruit was sent directly to the laboratory for analysis. The pH values found in this study are lower than those found by Azonkpin et al. [5], which are: 3.76-4.62. This can be explained by the growing medium, variety and climate. However, chemical analysis shows the presence of certain trace elements in the various field samples (Maferenya and Friguiagbé): potassium, calcium, magnesium, sodium, phosphorus and iron, with values ranging from 0.01 to 17.45 respectively (Tables 1 and 2). Tables 3 and 4 show the results of microbiological analysis of pineapple peel. These tables show the presence of Escherichia (*E. coli*) and the absence of Salmonella in the samples analyzed. The presence of this micro-organism is probably due to the conditions under which the fruit was stored and handled. *Staphylococcus aureus* values, however, varied in a sawtooth pattern: 147, 143, 138 and 134 CFU/100 mL (Field I and Field II of Friguiagbé and Maferenya). Yeast and mold values are: 287, 266 and 283/g. These values are significantly higher than those found by Abdoulaye et al. [6].

5. Conclusion

In the present work, we studied certain physico-chemical characteristics of pineapple samples taken in two localities, Friguiagbé and Maferinyah (Kindia and Forécariah), with a view to reducing the rejection of pineapple fruit imported from the Republic of Guinea. The following instruments were used: pH-meter Testo, France; portable refractometer (Sopelem 9596, France) graduated from 0 to 30 °Brix; standard NF V 08-051; NF-V08-022, etc. These methods showed that the four pineapple samples harvested in the various fields of Kindia and Forécariah have sensory and physico-chemical qualities that meet the requirements of the DPQC (2005) and the UNECE FFV-49 standard issued by the United Nations on November 12, 2012. Microbiological analysis of the samples showed the presence of micro-organisms. Further studies are recommended, as this document can be used by the Ministry of Agriculture and Livestock to improve cultivation, fruit preservation and export of fresh pineapple (Baronne) in the Republic of Guinea.

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