Journal of Food and Nutrition Sciences
2026, Vol. 14, No. 5, pp. 327–334
https://doi.org/10.11648/j.jfns.20261405.16

Research Article

Phytochemical Screening and Antioxidant Activity of Pineapple (*Ananas comosus*) Grown in Côte d'Ivoire

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Abstract

Pineapple (*Ananas comosus* (L.) MD2) is a tropical fruit widely consumed in Côte d'Ivoire, recognized for its richness in bioactive compounds. This study aims to evaluate the antioxidant activity of pineapple pulp extracts of the MD2 variety from two major Ivorian production areas (Alepe and Bonoua). To this end, phytochemical screening, quantification of bioactive compounds, and determination of antioxidant activity using the DPPH method were carried out on extracts from these fruit pulps. The results revealed the consistent presence of flavonoids, saponins, condensed tannins, coumarins, quinones, alkaloids, and leuco-anthocyanins at both localities. These extracts showed total polyphenol contents ranging from 69.45 ± 0.76 to 102.21 ± 0.83 µg gallic acid equivalent (GAE)/mL and flavonoid contents ranging from 3.64 ± 0.16 to 8.83 ± 0.34 mg catechin equivalent (CE)/mL. Antioxidant activity revealed a 50% inhibitory concentration (IC_{50}) of 10.292 mg/mL for the Alepe pulp extract, versus 6.7264 mg/mL for that of Bonoua. These results confirm the existence of strong antioxidant potential in pineapple fruit from both major growing areas. Consumption of these fruits could therefore be of interest in preventing oxidative stress and, consequently, metabolic diseases.

Keywords

Ananas Comosus, Oxidative Stress, Polyphenols, Metabolic Diseases, Antioxidant Activity

1. Introduction

Plant resources occupy an important place in human nutrition and in the prevention of many diseases owing to their richness in bioactive compounds [21]. The oxidative stress resulting from excessive production of free radicals is now recognized as one of the central mechanisms involved in the development of many degenerative diseases such as cardiovascular disease, certain cancers, and metabolic disorders [27]. Dietary antioxidants, particularly phenolic compounds, play a major protective role by neutralizing these reactive species [9].

Among tropical fruits, pineapple (*Ananas comosus* L. MD2) constitutes an important source of substances of nutritional and therapeutic interest, owing to its richness in polyphenols, flavonoids, and other secondary metabolites [16]. In Côte d'Ivoire, this fruit occupies a strategic place in agriculture, representing 0.6% of national GDP and 1.6% of agricultural GDP, with about 70% of national production destined for export [13]. Cultivation is mainly carried out by about 2.500 small-

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Received: 1 September 2026; **Accepted:** 11 September 2026; **Published:** 29 September 2026

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holder farmers spread across the southeast of the country, notably in Bonoua, considered the "Ivorian pineapple capital," and in Alepe, two major production areas for the MD2 variety [22].

Although the general nutritional and functional properties of pineapple are well documented [31], to date few studies have been carried out in Côte d'Ivoire on the variability of the biochemical composition and antioxidant activity of MD2 pineapple pulp according to geographic growing origin. Yet pedoclimatic factors (soil type, rainfall, temperature) are known to significantly influence the accumulation of phenolic compounds and the biochemical quality of fruits [3].

The central question of this study is to assess the health value of pineapples grown in Côte d'Ivoire, with a view to their potential use in the prevention and treatment of metabolic syndromes. The general objective of this work is to evaluate the antioxidant activity of MD2 pineapple pulp extracts from these two localities, through (i) identification of the main phytochemical groups present, (ii) quantification of total phenolic compounds and flavonoids during storage, and (iii) evaluation of antioxidant activity using the DPPH test.

2. Material and Methods

2.1. Plant Material

The plant material consisted of pineapple fruits (*Ananas comosus*) *(Figure 1)* harvested at maturity on January 30, 2026, in two production areas of southeastern Côte d'Ivoire: Alepe (5°30' N, 3°41' W, about 66 km from Abidjan) and Bonoua (5°16' N, 3°36' W, about 45 km from Abidjan) *(Figure 2)*. For each region, 6 kg of fruit were collected from three growers (2 kg per grower). Analyses of the pulp were carried out at the Laboratories of Chemistry and Microbiology of the Swiss Centre for Scientific Research in Côte d'Ivoire (CSRS).

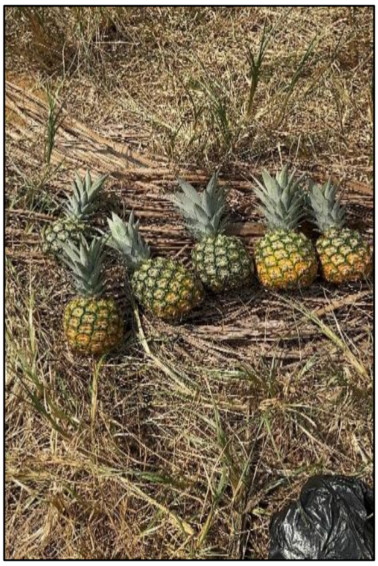

Figure 1. *Pineapple samples.*

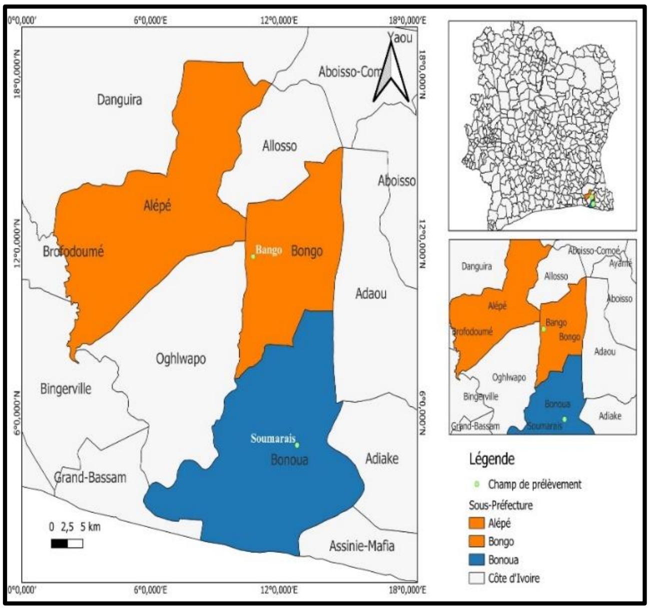

Figure 2. *presentation of the study area.*

2.2. Sample Preparation

After washing and peeling, the pulps were divided into two batches: one for physicochemical analyses, the other dried in an oven (50°C, 7 days), ground and then sieved to obtain a fine powder stored away from moisture. Extracts were prepared by macerating 10 g of powder in 100 mL of solvent (distilled water; ethanol-water 80/20 v/v; methanol-water 70/30 v/v) for 24 h under stirring at room temperature, followed by filtration and then evaporation to dryness in an oven (50°C), according to the method of Bougandoura and Bendimerad (2012) [10] modified. Analyses were carried out at three post-harvest storage dates: days 3, 12, and 22.

2.3. Physicochemical Analyses

Moisture, dry matter, ash, and crude fiber contents were determined according to the methods of AOAC (1990) [4]. pH and Brix degree were measured with a pH meter and a refractometer, respectively. Titratable acidity was determined by acid-base titration according to AOAC (2000) [5]. Reducing sugars and total sugars were determined according to the methods of Bernfeld (1955) [8] and Dubois *et al.* (1956) [12].

2.4. Phytochemical Screening

The main families of secondary metabolites (leuco-anthocyanins, polyphenols, flavonoids, quinones, alkaloids, catechic and gallic tannins, coumarins, saponins) were detected according to the method described by Békro *et al.* (2007) [7], on pineapple pulp extracts.

2.5. Determination of Total Polyphenols and Flavonoids

One gram (1 g) of the dry methanolic extract was dissolved in 10 mL of methanol (70% v/v) to obtain a stock solution at 100 mg/mL — this is the methanolic extract. This solution was diluted 10-fold to obtain a methanolic extract at 10 mg/mL, which was used to carry out the quantitative analyses. Total polyphenol content was determined by the Folin-Ciocalteu method described by Singleton and Rossi (1965) [32], with results expressed as gallic acid equivalents (µg GAE/mL). Flavonoid content was determined by the aluminum trichloride method described by Jia *et al.* (1999) [17], with results expressed as catechin equivalents (mg CE/mL).

2.6. Evaluation of Antioxidant Activity (DPPH Test)

Antioxidant activity was evaluated according to the method of Von Gadow *et al.* (1997) [33], based on the scavenging of the 2.2-diphenyl-1-picrylhydrazyl radical (DPPH•). The percentage inhibition was calculated from absorbance measured at 515 nm, and the 50% inhibitory concentration (IC_{50}) was determined from the regression line relating percentage inhibition to the logarithm of concentration.

2.7. Statistical Analysis

Data were subjected to one-way analysis of variance (ANOVA), followed by the Newman-Keuls mean comparison test (at the 5%, 1%, and 0.1% thresholds), using Statistica 7.1 software. Graphs were produced with GraphPad Prism 8.4.3.

3. Results

3.1. Physicochemical Parameters of Pineapple Pulps

1) *Changes in some physicochemical parameters of Alepe and Bonoua pineapple pulps (days 3, 12, and 22)*

Table 1 presents the water, fiber, ash, and dry matter contents of pineapple pulps (*Ananas comosus*) from the Alepe and Bonoua production sites, analyzed at 3, 12, and 22 days after harvest.

On day 3, the results show that the Bonoua samples had a markedly higher water content than those of Alepe, at 91.77 ± 0.75% and 87.94 ± 0.14%, respectively. Bonoua pulps were distinguished by higher fiber and ash contents from the start of storage. Indeed, the fiber content on day 12 in Bonoua (13.8 ± 0.14 g/100 g DM) was significantly different from that of Alepe on day 12 (10.4 ± 0.14 g/100 g DM), at the 5% significance threshold.

On day 22, water content values remained stable for fruit from both sites (87.36% for Alepe and 88.14% for Bonoua). These results are not significantly different at the 5% significance threshold.

Bonoua's ash content remains slightly higher than Alepe's at the end of the period (day 22). These results are significantly different at the 5% significance threshold.

Table 1. *Changes in some physicochemical parameters of Alepe and Bonoua pineapple pulps (days 3, 12, and 22).*

	Alepe			Bonoua		
	Day 3	Day 12	Day 22	Day 3	Day 12	Day 22
Water content%	87.94 ±0.14 ^{a}	889.91 ±0.17 ^{b}	87.36 ±0.03 ^{a}	91.77 ±0.75 $^{b, c}$	89.98 ±0.06 ^{b}	88.14 ±0.05 $^{a, b}$
Fiber (g/100g DM)	13.95 ±0.78 ^{b}	10.4 ±0.14 ^{a}	14.8 ±0.14 $^{b, c}$	14.05 ±0.35 $^{b, c}$	13.8 ±0.14 ^{b}	14.6 ±0.14 $^{b, c}$
Ash (g/100g DM)	0.38 ±0.09 ^{c}	0.16 ±0.02 ^{a}	0.23 ±0.01 ^{b}	0.29 ±0.01 ^{c}	0.37 ±0.05 ^{c}	0.33 ±0.08 ^{c}
Dry matter%	12.06 ±0.14 ^{c}	10.09 ±0.17 $^{a, b}$	12.64 ±0.03 ^{c}	8.23 ±6.75 ^{a}	10.02 ±0.06 $^{a, b}$	11.86 ±0.05 $^{b, c}$

These results are the mean ± standard deviation of 3 trials. Values with the same letters on the same row are not significantly different at the 5% threshold ($p > 0.05$).

2) *Changes in pH and titratable acidity*

Figure 3 presents the changes in the pH of juice from pineapple pulps at the two production sites over the three analysis periods. The results show that pH follows a V-shaped curve for juices from pineapple at both sampling sites. A marked acidification is observed on day 12 of storage.

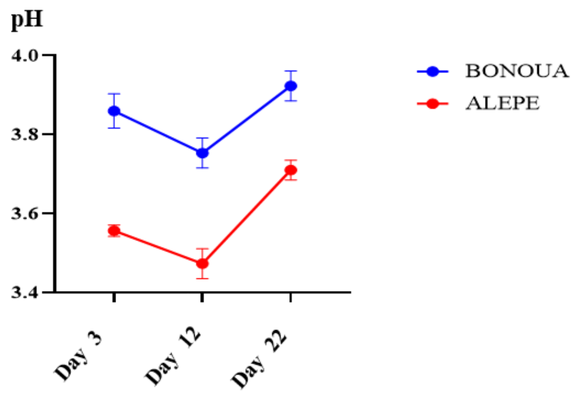

***Figure 3**. Changes in pH of Alepe and Bonoua pineapple pulps during storage.*

3) *Changes in titratable acidity*

Figure 4 presents the changes in titratable acidity, expressed as milliequivalents of citric acid, of pineapple pulps from the two production areas.

The results reveal that titratable acidity is higher in Alepe pulps on days 3 and 12, with values rising from 2.08±0.16 g/L to 2.29 ± 0.09 g/L citric acid, followed by a progressive drop in acidity during storage to stabilize at 1.36±0.14 g/L.

In Bonoua, titratable acidity remains relatively stable between day 3 (1.65 g/L) and day 22 (1.73 g/L).

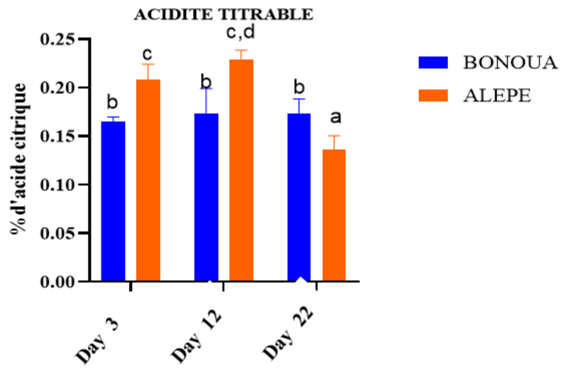

***Figure 4**. Changes in titratable acidity (% citric acid) of Alepe and Bonoua pineapple pulps during storage (days 3, 12, and 22).*

These results are the mean ± standard deviation of 3 trials. Values with the same letters are not significantly different at the 5% threshold ($p > 0.05$).

3.2. Phytochemical Screening

Table 2 presents the results of the qualitative phytochemical screening carried out on aqueous, methanolic (70%), and ethanolic (80%) extracts of pineapple pulps from the two production areas, at the three sampling dates.

***Table 2**. Summary table of secondary metabolite detection in Alepe and Bonoua pineapple pulp extracts (days 3, 12, and 22).*

	Alépé									**Bonoua**								
	Day 3			**Day 12**			**Day 22**			**Day 3**			**Day 12**			**Day 22**		
	Water	**Meth**	**Etha**	**Water**	**Meth**	**Etha**	**Water**	**Meth**	**Etha**	**Water**	**Meth**	**Etha**	**Water**	**Meth**	**Etha**	**Water**	**Meth**	**Etha**
Polyp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flavo	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sapo	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tannins Cat	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tannin Gal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Quin	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Alkaloids	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Leu	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Polyp.: Polyphenols, Flavo.: Flavonoids, Leu.: Leuco-anthocyanins, Cat.: Catechic, Gal.: Gallic, Sapo.: Saponins, Quin.: Quinones, Coum.: Coumarins, + = Present, - = Absent. Meth. = 70% methanol, Etha = 80% ethanol.

Analysis of the table reveals a very similar phytochemical profile between the two sites (Alepe and Bonoua) and the three analysis periods. Flavonoids, saponins, condensed tannins, coumarins, quinones, alkaloids, and leuco-anthocyanins are present in extracts from fruit of the different localities regardless of the extraction solvent used (water, 70% methanol, or 80% ethanol).

In contrast, phenolic compounds and hydrolyzable tannins are consistently absent from all the extracts analyzed, regardless of geographic origin or analysis period.

3.3. Total Polyphenol and Total Flavonoid Contents

1) Quantitative determination of total polyphenols

As shown in Figure 5, total polyphenol contents were higher in Bonoua pulps on days 3 and 22, with values of 102.21 µg GAE/mL and 88.92 µg GAE/mL of extract, respectively, versus 80.92 µg GAE/mL and 69.45 µg GAE/mL of extract for Alepe. Total polyphenol contents decreased progressively over time for extracts from Alepe fruit, whereas an intermediate decrease was observed on day 12 in Bonoua, followed by a rise on day 22.

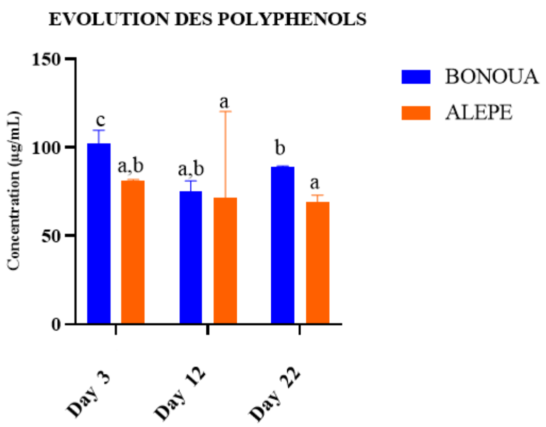

Figure 5. *Changes in total polyphenol contents (µg GAE/mL) of Alepe and Bonoua pineapple pulps during storage (days 3, 12, and 22).*

These results are the mean ± standard deviation of 3 trials. Values with the same letters are not significantly different at the 5% threshold ($p > 0.05$).

2) Quantitative determination of total flavonoids

Total flavonoids, in contrast, show a trend opposite to that of total polyphenols. Alepe pulps show markedly higher concentrations that increase continuously during storage, with a maximum value of 8.83 mg CE/mL on day 22. Bonoua pulps, on the other hand, show a peak on day 12 (5.65 mg CE/mL) followed by a decrease on day 22 (3.64 mg CE/mL). (Figure 6).

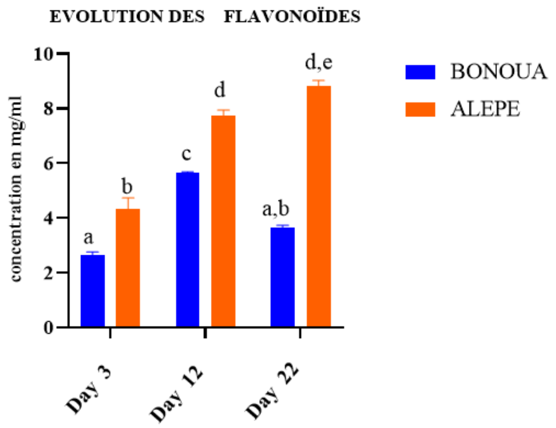

Figure 6. *Changes in total flavonoid contents (mg CE/mL) of Alepe and Bonoua pineapple pulps during storage (days 3, 12, and 22).*

These results are the mean ± standard deviation of 3 trials. Values with the same letters are not significantly different at the 5% threshold ($p > 0.05$).

3.4. Results of the Antioxidant Activity of Pineapple Extracts (Dpph Test)

Figures 7 and 8 show, respectively, the 50% inhibitory concentration (IC_{50}) of aqueous pineapple extracts from Alepe and Bonoua, determined by the 2.2-diphenyl-1-picrylhydrazyl (DPPH) test.

Analysis of these curves reveals that the IC_{50} of the aqueous pineapple extract from Alepe is 10.292 mg/mL (Log IC_{50} = 1.0125). That of the extract from Bonoua is 6.7264 mg/mL (Log IC_{50} = 0.82778). The Bonoua extract therefore has the lowest IC_{50} of the two localities studied.

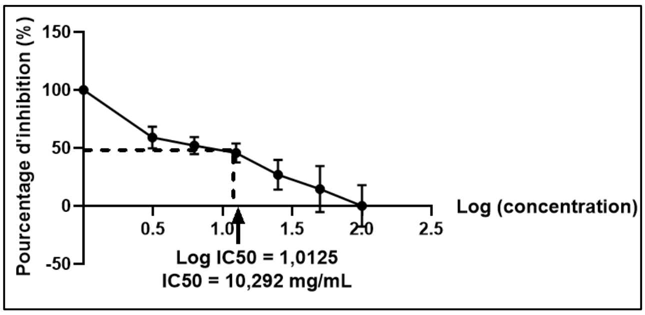

Figure 7. *Inhibitory concentration curve of pineapple extracts from the locality of Alepe.*

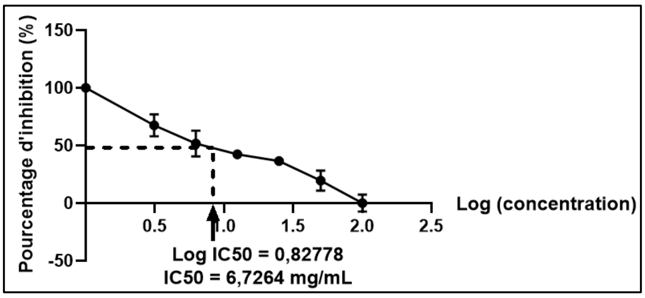

Figure 8. *Inhibitory concentration curve of pineapple extracts from the locality of Bonoua.*

4. Discussion

On day 3 and day 12, the water content of the pulps varied between 87.94±0.14% and 91.77±0.75% this content eventually stabilized around 88% by day 22 of storage. Conversely, dry matter stabilized around 12% after day 22. This stabilization of water and dry matter contents around day 22 reflects a homogenization of water balances linked to post-harvest evapotranspiration. These results are consistent with those reported by Adabe *et al.,* (2021) [1], who report water contents in MD2 and Cayenne pulps of between 85% and 92%.

The clay-loam soils of Alepe, which tend to be more acidic, favor preferential accumulation of soluble and insoluble matter in the fruit, in line with the observations of Rani *et al.* (2024) [29] who establish a direct relationship between soil properties, growing technique, and the dry matter composition of MD2 fruit. The relative stability of water content around day 22 of storage indicates good ambient-temperature storage capacity over the study period. These results are consistent with the observations of N'guessan (2022) [23] who report dehydration limited to less than 5% over 25 days under similar conditions.

Crude fiber contents range from 10.4 to 14.8 g/100 g DM, as indicated in Table 1. These values are close to those reported by Arampath and Dekker (2019) [6] who report differential degradation kinetics of structural fibers depending on storage temperature and humidity. The drop in fiber content in Alepe between day 3 (13.95 g/100 g DM) and day 12 (10.4 g/100 g DM) reflects rapid enzymatic depolymerization of parietal polysaccharides (pectins, hemicellulose) under the action of cellulases and polygalacturonases activated in the post-harvest phase. The dietary fiber present in the pulps studied constitutes a recognized nutritional asset for the consumer, contributing to the regulation of intestinal transit and to reducing the risk of metabolic diseases, as shown by Sharma *et al* (2024) [31] in their comprehensive review of the nutritional and pharmacological properties of *Ananas comosus.*

Ash contents, ranging from 0.16 to 0.38 g/100 g DM, indicate the presence of minerals in the pineapple pulps. The work of Kouadio *et al.* (2023) [19] confirms this trend, with ash contents between 0.2 and 0.4 g/100 g DM. These micronutrients present in the ash of the pineapple pulps studied could be beneficial to the consumer insofar as they play an essential role in the proper functioning of the body [31].

Titratable acidity, expressed as a percentage of citric acid (Figure 4), decreases progressively in Alepe (from 2.08±0.16 g/L on day 3 to 1.36±0.14 g/L), whereas it remains stable in Bonoua (from 1.65 g/L on day 3 to 1.73 g/L on day 22). The stability of acidity in Bonoua suggests a slower degradation kinetics of organic acids, linked to the high rainfall of this area (>1.500 mm/year), which more effectively inhibits oxidative enzymes. Day 22 is marked by a reversal of the acidity trend (Bonoua acidity higher than Alepe's); this reversal reflects differential fermentation processes between the two study areas [34].

Phytochemical screening of Alepe and Bonoua pineapple pulp extracts, carried out on days 3, 12, and 22, reveals the consistent presence of flavonoids, saponins, condensed tannins, coumarins, quinones, alkaloids, and leucoanthocyanins in all the extracts analyzed (water, 70% methanol, 80% ethanol). These results are consistent with those reported by Castro *et al.* (2025) [11], and by Sharma *et al.* (2024) [31] in their comprehensive pharmacological review of *Ananas comosus*, who confirm the presence of these metabolite families in different parts of the fruit.

Moreover, the absence of phenolic compounds and hydrolyzable tannins in our pulp extracts is fully consistent with the results of Helen *et al.* (2019) [14] who did not observe these phytochemical compounds for this test in leaf, stem, and fruit extracts of *Ananas comosus.*

This observation is explained by a preferential orientation of the phenylpropanoid pathway toward the synthesis of flavonoids and condensed tannins, in line with the biosynthetic pathway described by Rahim *et al.* (2023) [28] in their editorial on phenylpropanoid biosynthesis in plants.

The remarkable persistence of all the secondary metabolites detected on day 22 of storage, regardless of the extraction solvent used, indicates a high chemical stability of these compounds under ambient-temperature storage conditions. This observation is similar to that reported by Leneveu-Jenvrin *et al.* (2020) [20], who report a comparable relative stability of bioactive compounds in *'Queen Victoria' pineapple* over a period of 45 days.

Total polyphenol contents of pineapple pulp extracts range from 69.45±0.76µg (GAE)/mL to 102.21±0.83µg (GAE)/mL, depending on origin and analysis period. These results are close to those of Kouadio *et al.* (2023) [19] for Ivorian MD2 pulps, who obtained phenolic compound contents of between 80-120 µg/mL.

The high total polyphenol levels of the pulps could be explained by the mineral and water richness of the soils. This mineral and water richness would stimulate the phenylpropanoid pathway by increasing the activity of key enzymes such as PAL, C4H, and 4CL, which are involved in the biosynthesis of phenolic compounds, thereby favoring the accumulation of polyphenols in the pulps [28]. The presence of polyphenols in significant amounts in the pineapple pulps studied is beneficial to the consumer, as these molecules are recognized for their protective role against the oxidation of low-density lipoproteins (LDL) and, consequently, against cardiovascular disease [31].

Total flavonoid contents, expressed in (CE)/mL, range from 3.64±0.16 mg CE/mL to 8.83±0.34 mg CE/mL. These results are consistent with the data from Hossain and Rahman (2011) [15] which confirm that flavonoids constitute a major fraction of the antioxidant potential of tropical pineapple pulps. Also, these results are consistent with the data of N'zi *et al.* (2022) [24] (4-10 mg/mL) for West African pulps, linking the late accumulation of flavonoids to the acidic, nitrogen-poor soils characteristic of Alepe.

The increasing accumulation of flavonoids during storage could be explained by the pedoclimatic conditions of environmental stress (acidic soils, variable rainfall, intermittent water stress) characteristic of this area [34]. Indeed, Akhtar *et al.* (2026) [2] demonstrate that flavonoids accumulate preferentially in plant tissues in response to abiotic stress (drought, salinity, soil acidity) *via* activation of the phenylpropanoid pathway. This high flavonoid content gives the pulps a first-rate anticancer and antimicrobial potential, as flavonoids are recognized for their ability to induce apoptosis in tumor cells and to inhibit the growth of pathogenic microorganisms [31].

The antioxidant activity of pineapple extracts is generally attributed to the presence of numerous bioactive compounds, notably polyphenols and flavonoids. These compounds contribute significantly to the overall ability of the extracts to scavenge free radicals.

IC50 values determined for pineapple extracts from Alepe (IC50 = 10.292 mg/mL) and Bonoua (IC50 = 6.7264 mg/mL) indicate the presence of bioactive molecules with antioxidant power in these fruits. The lower this value, the higher the antioxidant power of the extract [18, 26]. Both pineapple extracts studied therefore show measurable antioxidant activity.

These results are consistent with those of several authors who have demonstrated the ability of pineapple extracts to scavenge free radicals. Indeed, Ong *et al* (2023) [25] reported an IC50 of 0.63 mg/mL for MD2 pineapple peel extract in the DPPH test, confirming that the different parts of the fruit and extraction methods considerably influence the IC50 value. Similar values, though variable depending on the fruit part studied and the solvent used, have been reported by other authors, with IC50 values ranging from less than 1 mg/mL to more than 233 mg/mL depending on the fruit part and extraction method [30].

5. Conclusion

Bonoua and Alepe pineapple fruits are endowed with strong antioxidant power. Consequently, regular consumption of these pineapples could therefore contribute to the prevention of diseases linked to oxidative stress, notably cardiovascular disease, cancer, and metabolic diseases. Further work is needed to deepen these results, particularly through fine molecular characterization (HPLC-MS) of the polyphenols specific to each growing area, in vivo evaluation of the protective effects of these extracts, and extension of the study to other Ivorian production areas (Dabou, Tiassale, Adiake, Aboisso) in order to establish a national map of the phytochemical and antioxidant variability of pineapple grown in Côte d'Ivoire.

Abbreviations

GDP	Gross Domestic Product

Author Contributions

Dembele Syndoux: Conceptualization, Resources, Writing – review & editing

Tie Bi Gotre Felicien: Writing – original drafting

Tchumou Messou: Methodology

Coulibaly Founzegue Amadou: Validation, Visualization

Anin Atchibri Anin Louise: Validation, Visualization

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Adabe, K. E., Kouassi, K. N., & Yao, K. A. (2021). Growing pineapple well in Côte d'Ivoire [Technical sheet]. National Center for Agronomic Research.

[2] Akhtar, M. T., Noor, M., Lin, X., Lu, Z. & Jin, B. (2026). Flavonoids in plant salt stress responses: Biosynthesis, regulation, functions, and signaling networks. Plants, 15(1), 171.

[3] Alothman, M., Bhat, R. & Karim, A. A. (2009). Antioxidant capacity and phenolic content of selected tropical fruits from Southeast Asia. Food Chemistry, 115(1), 785-788.

[4] AOAC (1990). Official Methods of Analysis (15th ed.). Association of Official Analytical Chemists.

[5] AOAC (2000). Official Methods of Analysis (17th ed.). Association of Official Analytical Chemists.

[6] Arampath P. C. & Dekker M. (2019). Kinetics of polyphenol degradation in pineapple pulp during storage under ambient and refrigerated conditions. Food Chemistry, 271, pp. 150-157.

[7] Békro, Y. A., Jana, A., Mamyrbekova, B., Boua, B., Fézan, H. T. B. & Ehile, E. E. (2007). Ethnobotanical study and phytochemical screening of Caesalpina benthamiana (Bail) Herend and Zarucchi (Caesalpiniaceae). Science of Nature, 2, 217-225.

[8] Bernfeld, P. (1955). Amylases, alpha and beta. Methods in Enzymology, 1, 149-158.

[9] Bjorklund, G. & Chirumbolo, S. (2017). Role of oxidative stress and antioxidants in daily nutrition and human health. Nutrition, 33, 311-321.

[10] Bougandoura, N. & Bendimerad, N. (2012). Evaluation of the antioxidant activity of aqueous and methanolic extracts of Satureja calamintha ssp. Nepeta (L.) Briq. Nature et Technologie, 7, 45-51.

[11] Castro A. C. L., Lubido A. C. C., Balderas A. K. A., Gonzales R. K. P. & Saldo I. J. P. (2025). Phytochemical Analysis and Antibacterial Assessment of Pineapple (Ananas comosus) Peel Extract. South Asian Research Journal of Natural Products, 8(1), Article 188.

[12] Dubois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. & Smith, F. (1956). Colorimetric method for determination of sugars and related substances. Analytical Chemistry, 28(3), 350-356.

[13] FAO (2024). FAOSTAT: Quantities produced - Crops - Pineapple. Food and Agriculture Organization of the United Nations.

[14] Helen, P. A., Teena, D. S., Godwin Jacob, J. G., Jinto James, J. & Anitha, C. (2019). Preliminary phytochemical screening and antioxidant activity of leaves, stems and fruits of Ananas comosus. World Journal of Pharmaceutical Research, 8(5), 1407-1416.

[15] Hossain, M. A. & Rahman, S. M. M. (2011). Total phenolics, flavonoids and antioxidant activity of tropical fruit pineapple. Food Research International, 44(3), 672-676.

[16] Ignat, I., Volf, I. & Popa, V. I. (2011). A critical review of methods for characterisation of polyphenolic compounds in fruits and vegetables. Food Chemistry, 126(4), 1821-1835.

[17] Jia, Z., Tang, M. & Wu, J. (1999). Determination of flavonoid content of blackberry and its superoxide radical scavenging effects. Food Chemistry, 64, 555-559.

[18] Kanatt, S. R., Chawla, S. P. & Sharma, A. (2018). Antioxidant and antimicrobial activity of plant extracts. Food Bioscience, 21, 1-7.

[19] Kouadio, Y. J., Bamba, Y. & Biego, G. H. M. (2023). Valorization of by-products from the processing of Ananas comosus L. Merril: A review. African Scientific Journal, 4(2), 45-56.

[20] Leneveu-Jenvrin, C., Quentin, B., Assemat, S., Hoarau, M., Meile, J.-C. & Remize, F. (2020). Changes of quality of minimally-processed pineapple (Ananas comosus, var. 'Queen Victoria') during cold storage: Fungi in the leading role. Microorganisms, 8(2), 185.

[21] Liu, R. H. (2013). Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. American Journal of Clinical Nutrition, 78(3), 517S-520S.

[22] Ministère du Commerce et de l'Industrie & Deloitte Côte d'Ivoire (2024). Opportunity sheets - Côte d'Ivoire: Agro-industry, pineapple sector [Report]. Restructuring and Upgrading Fund.

[23] N'guessan, K. A. (2022), Réponse de l'ananas à la fertilisation azotée et potassique en Côte d'Ivoire (145 pages) [Thèse de doctorat]. Université Nangui Abrogoua.

[24] N'zi, K. C., Kouadio, Y. J., & Bamba, F. (2022). Qualité biochimique des pulpes de fruits tropicaux ouest-africains: Cas de l'ananas (15 pages). European Scientific Journal, 18(4), 78-89.

[25] Ong, E. S., Tan, J. J., Rosli, N. A. & Ahamad, M. N. (2023). Comparison of phenolic and volatile compounds in MD2 pineapple peel and core. Foods, 12(11), 2233.

[26] Phuyal, N., Jha, P. K., Raturi, P. P. & Rajbhandary, S. (2020). Total phenolic, flavonoid contents, and antioxidant activities of fruit, seed, and bark extracts of Zanthoxylum armatum DC. Scientific World Journal, Article ID 8780704.

[27] Pisoschi, A. M. & Pop, A. (2015). The role of antioxidants in the chemistry of oxidative stress: A review. European Journal of Medicinal Chemistry, 97, 55-74.

[28] Rahim, M. A., Zhang, X. & Busatto, N. (2023). Editorial: Phenylpropanoid biosynthesis in plants. Frontiers in Plant Science, 14, 1230664.

[29] Rani S. M. A., Beng L. B., Elias N. H., Ya'kub M. K., Suntudprom J. & Kasim K. F. (2024). Physicochemical and Phytochemical Properties of MD2 Pineapple. Dans Proceedings of the 3rd International Conference on Biomass Utilization and Sustainable Energy (ICoBiomasSE 2023). Springer, Singapore. https://doi.org/10.1007/978-981-99-91648_8

[30] Saptarini, N. M., Mustarichie, R. & Rahayu, D. (2020). Antioxidant activity of crude bromelain of pineapple (Ananas comosus (L.) Merr) crown from Subang District, Indonesia. Journal of Advanced Pharmaceutical Technology & Research, 11(1), 28-32.

[31] Sharma, A., Kumar, L., Malhotra, M., Singh, A. P. & Singh, A. P. (2024). Ananas comosus (Pineapple): A comprehensive review of its medicinal properties, phytochemical composition, and pharmacological activities. Journal of Drug Delivery and Therapeutics, 14(5), 148-157.

[32] Singleton, V. L. & Rossi, J. A. (1965). Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. American Journal of Enology and Viticulture, 16, 144-158.

[33] Von Gadow, A., Joubert, E. & Hansmann, C. F. (1997). Comparison of antioxidant activity of aspalathin with that of other plant phenols of rooibos tea (Aspalathus linearis), α-tocopherol, BHT and BHA. Journal of Agricultural and Food Chemistry, 45, 632-638.

[34] Yapo, A. V., N'zi, K. C., & Kouadio, Y. J. (2024). Diversité des métabolites secondaires dans l'ananas de Bonoua (Ananas comosus) (11 pages). Journal Africain de Botanique, 7(1), 34-42.