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Original Article

Evaluation of Pineapple (*Ananas Coniosus*) Crown for Nutritional and Medicinal Applications

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Abstract

The pineapple (*Ananas comosus* L. Merr.) is a tropical fruit in the Bromeliaceous family, with a short stem and thin, stiff leaves that grow into medium- to large-sized fruit. The pineapple has special qualities, and only the fruits are eaten because of how sweet they are. The plant's other components are frequently discarded, representing a substantial loss of potential value. The purpose of this investigation was to evaluate the proximate and phytochemicals of pineapple crown to ascertain their compositions utilizing conventional analytical procedures. Proximate analysis revealed that the pineapple crown is a rich source of carbohydrates (52.45%) and dietary fiber (25.54%), alongside appreciable levels of protein (8.86%), ash (5.08%), and moderate fat content (4.63%), yielding an energy value of 286.91 kcal/100g. These findings show its suitability for nutritional applications, such as animal feed supplementation or as a functional food ingredient. The screening of phytochemicals showed that tannins, alkaloids, flavonoids and terpenoids were present while steroids, phenol and cardiac glycoside were absent. Quantitative analysis further elucidated significant concentrations of these compounds, with alkaloids at 6.23%, saponins at 4.68%, and flavonoids at 1.66%. The presence of these phytochemicals highlights the crown's promising medicinal attributes, including antioxidant, antimicrobial, and anti-inflammatory properties. The findings show that pineapple crown contains different levels of nutritional components. The presence of medicinally important bioactive constituents in the crown is a potential source of metabolites for pharmacological, functional dietary, and medicinal uses.

Keywords: Fruits, Proximate, Phytochemical Screening, Bioactive Constituents, Agro-Waste.

Introduction

Fruits are among the many different types of biowaste items that have been widely recycled into useful goods, such as citric acid synthesis, biofuel, pigments, bioactive compounds and agricultural compost [1-3]. An environmental imbalance can also be successfully corrected with this recycling technique. The pineapple (*Ananas comosus*), is an example of such a fruit. According to Amar *et al.* [4], pineapple is a premium hybrid variety that is consistent in size and ripeness and has a very sweet flavor and taste. Approximately, 60% of pineapple fruits are edible, and processing leftovers exceed 45% [4,5]. Before peeling, the pineapple's stem and crown are chopped off, and the center is removed during processing. About half of the overall weight of a pineapple consists of waste, such as the stem, leaves, peel, core, and crown [6,7]. Within the pineapple product zone, the fruit is processed using various techniques, including slicing, pulping, and juicing. Prior to processing, special measures are taken to remove the core and peels after the crown is removed [8]. At each stage, a unique amount of pineapple peel waste is produced. As a result, pineapple waste rises proportionately with increased pineapple production [9]. Waste disposal is becoming a bigger challenge since it typically leads to major environmental issues and microbial spoilage [10,11]. It is a clear example of the massive problem of disposing of pineapple waste, which, if not handled effectively, can further pollute the environment [5]. Pineapple has been effectively processed and marketed in addition to being consumed fresh because of its unique nutritional value, which includes vitamins, organic acids, an important mineral composition, and a total amount of polyphenols that have health benefits [12,13]. However, most of the inedible portions of are discarded, polluting the environment in the process. Because pineapple is typically rich in phenolic compounds, that act as antioxidants, initiatives for research have recently concentrated on discovering better uses for this type of waste [14,15]. Hence, this work is carried out to analyze pineapple crown, a waste from the pineapple plant so as to ascertain its nutritional and medicinal properties.

Materials and Methods

Sample Collection, Identification and Preparation

Pineapple crowns (Figure 1) were obtained from a local farmer on a farm in Ado-Ekiti. The plant materials were shipped in polythene bags to the Department of Science Technology, Department of Chemistry, The Federal Polytechnic Ado-Ekiti. There, they were identified by Dr. Oyeyemi B.F. (Biology and Microbiology Unit, The Federal, Polytechnic, Ado Ekiti) and Mr. Komolafe O.D. (an organic and natural product chemist). They underwent a clean water wash and a distilled water rinse. The material was cut, dried, and ground into powder. Until they were needed for analysis, these were kept in sealed containers. All chemicals and reagents used were of analytical grade and were used without any further purification.

Figure 1 Image of pineapple (*Ananas comosus*) crown

Determination of Proximate Composition

The proximate parameters such as moisture, ash, fiber, protein, and fat of the sample were evaluated following the

procedure as described by AOAC [16]. Carbohydrate was calculated by difference.

Determination of Moisture Content

A clean and well labeled weight was taken of an oven-dried dish (W_1). After adding the sample to the dish, it was weighed (W_2). Afterward, moved to the thermostated oven at 105 °C for 3 hours. The dish from oven was transferred to desiccator, cooled, and W_3 was weighed. This was repeated until constant weight. Moisture content was calculated as follows equation 1:

$$\% \text{ Moisture} = \frac{W2 - W3}{W2 - W1} \times 100 \quad (1)$$

Where,

w_1 = weight of empty dish

w_2 = weight of empty dish + sample

w_3 = weight of empty dish + sample after drying

Determination of Ash Content

A silica dish was heated to 350 °C in a muffle furnace for approximately fifteen minutes. After being removed and allowed to cool in a desiccator for approximately an hour, the crucible was weighed (W_1). The crucible was weighed (W_2) after 2 g of sample was added. Once the crucible was placed in the muffle furnace, the temperature gradually rose from 200 to 450 °C. After being taken out of the furnace and placed in a desiccator, the crucible was allowed to cool to room temperature. Both the content and the crucible were reweighed (W_3). The ash content was calculated as equation 2:

$$\% \text{ Ash} = \frac{W3 - W1}{W2 - W1} \times 100 \quad (2)$$

Where,

w_1 = weight of empty crucible

w_2 = weight of empty crucible + sample

w_3 = weight of empty crucible + sample after ashing

Determination of Protein Content

Kjeldahl flasks were filled with 1 g of the sample. As a standard blank, tyrosine was weighed into a different Kjeldahl flask. As a catalyst, a mixture of potassium and copper sulfate (10:150) was added to the samples, K_2SO_4 and $CuS0_4.5H_2O$. A few anti-bumping granules were added to the solutions to prevent bumping of the flask by the acid. The samples were digested by adding 10 ml of concentrated H_2SO_4 acid. Until the samples were clear, the digestion flasks were kept in the digester at 400 °C for a while. To capture the ammonia vapor from the digest, 15 ml of boric acid (H_3BO_3) was placed in a 200 ml conical flask, which served as the receiving flask. Two drops of a mixed indicator (methylene blue + methyl red) were added to the boric acid, and was combined by 10 ml of digested sample was combined with 10 ml of distilled water in a digestion flask. The conical flask and the Kjeldahl flask were then positioned in the nitrogen/protein determinator, and the Kjeldahl flask was filled with NaOH until the color changed. The sample was then steamed and distilled into the conical flask. The distillate was titrated with 0.05 M HCl. The nitrogen content was calculated as follows in equation 3 and 4:

$$\% \text{ Nitrogen} = \frac{(V2 - V1) \times C \times 0.0140 \times V \times 100}{W \times Vo} \quad (3)$$

Where,

V_1=blank volume

V_2= sample volume

C= molarity of acid

V= digested solution volume (ml)

W= sample weight

Vo=Volume of distillate (ml)

Crude protein = % Nitrogen × Conversion factor (6.25) (4)

Determination of Crude Fiber

2 g of the dried sample was weighed, placed in the flask, and 200 ml boiling sulfuric acid

solution was added. The extraction was boiled with petroleum ether for 1 hour with 200 ml of 1.25% of sodium hydroxide solution**.** The mixture was filtered through a filter paper and washed with distilled water**.** The residue was transferred into a weighed crucible (W_1) and oven dried at 105 °C, and then cooled in a desiccator and weighed as (W_2). The crucible was placed in a muffle furnace at about 500 ˚C for approximately 30 minutes, then cooled inside a desiccator, and weighed as (W_3). The crude fiber content was calculated as follows in equation 5:

$$\% \text{ Crude fiber} = \frac{W3 - W1}{W2 - W1} \times 100 \quad (5)$$

Where,

w_1 = weight of empty crucible

w_2 = weight of empty crucible + sample after drying

w_3 = weight of empty crucible + sample after ashing

Determination of Crude Fat

2 g of the sample was weighed and wrapped in a weighed filter paper. The round bottom flask was filled up to 2/3 of the mark with n-hexane. The Soxhlet extractor was set up with a reflux condenser. It was heated with heating mantle at a temperature of 40-60 °C for 6 hours and removed. The residue was transferred into the oven and oven dried for 1 hour. It was transferred to a desiccator and allowed to cool. The residue was weighed and calculation for fat content is as follows in equation 6-8:

$$\% \text{ Crude fat} = \frac{\text{Weight } of \text{ the residue}}{Weight \ of \ the \ sample} \times 100 \quad (6)$$

Determination of Carbohydrate Content

It was calculated as:

$$\% \ carbohydrate = 100 - (\% \ moisture + \% \ protein + \% \ fat + \% \ fiber + \% \ ash) \quad (7)$$

Caloric value was measured as follows:

Energy(kcal/100g) = (Crude protein×4) + (carbohydrate ×4) +(crude fat×9) (8)

Procedure for Qualitative Phytochemical Analysis

A conical flask was filled with 100 ml of distilled water, 10 g of the powder, and cotton wool plugs. The samples were shaken periodically while being allowed to stand at room temperature for the entire night. Whatman No. 1 filter paper was used to filter each sample, and a rotary evaporator (Model: RE2000B) was used to concentrate the filtrate (Figure 2).

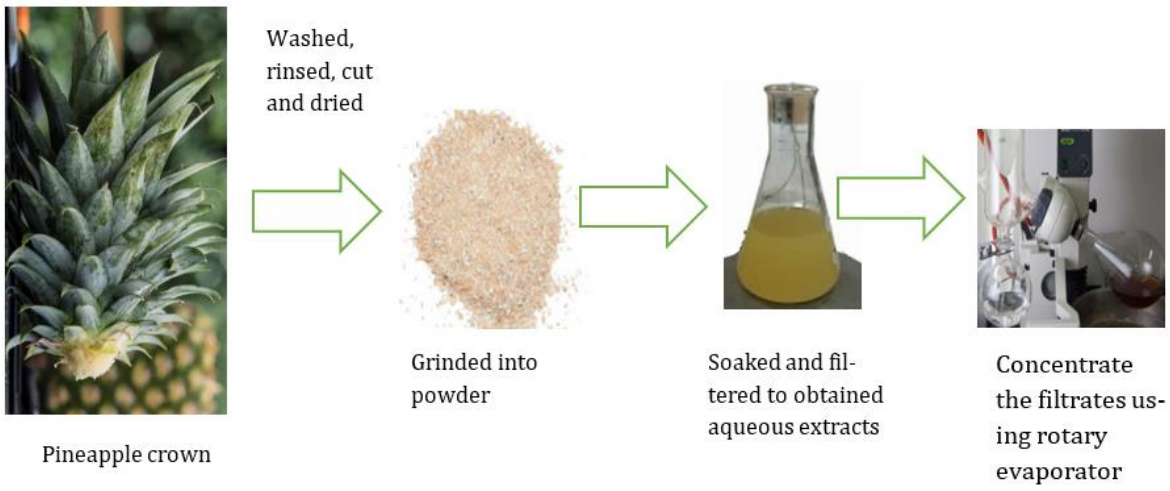

Figure 2 Extracts preparation flow chart

The standard protocols were used to perform phytochemical screening on the extracts of the pineapple crown as described by Abegunde and Ayodele-Oduola [17]. The test was conducted in duplicates under same conditions as follows:

Wagner's Test for Alkaloids

Three drops of Wagner's reagent were added to a portion of the extract. The appearance of a reddish-brown precipitate indicated the presence of alkaloids.

Alkaline Reagent Test for Flavonoids

A few drops of 20% NaOH solution were added to 2 mL of extract. Formation of a bright yellow coloration that turns colorless when diluted HCl was added indicated the presence of flavonoids.

Foam Test for Saponins

2 mL of the extract were mixed with 6 mL of distilled water in a test tube and shaken vigorously. The display of a stable, tenacious froth shows the presence of saponins.

Braymer's Test for Tannins

10% alcoholic $FeCl_3$ solution was treated with 2 mL of extract. The development of a greenish or blue coloration was indicative of tannins.

Salkowki's Test for Terpenoids

1 mL of chloroform was combined with 2 mL of each extract, with the addition of few drops of concentrated H_2SO_4. The development of a reddish-brown coloration at the interface was indicative of terpenoids.

Liebermann-Burchard Test for Steroids

After treating 1 mL of the extract with acetic anhydride and chloroform, strong sulfuric acid was carefully added. The presence of steroids was confirmed by the development of a dark pink or red hue.

Keller Killiani's Test for Cardiac Glycosides

2 mL of glacial acetic acid with a single drop of $FeCl_3$ solution was added to 5 mL of extract. After that, 1 mL of sulfuric acid concentrate was cautiously added down the test tube's side. The formation of a brown ring at the interface revealed the presence of deoxysugars characteristic of cardenolides.

Test for Carbohydrate (Molisch's Test)

2 mL of the extract were mixed with several drops of Molisch's reagent, and then 2 mL of concentrated H_2SO_4 was added along the test tube's side. An interphase ring that is either red or violet confirms the presence of carbohydrates.

Procedure for Quantitative Phytochemical Analysis

All experimental analyses were conducted in triplicate and the mean value taken.

Determination of Alkaloids

This was estimated following the procedure adopted by Ejikeme *et al.* [18]. A 2.50 g portion of each powdered pineapple crown sample was transferred into a 250 mL beaker containing exactly 200 mL of 10% acetic acid in ethanol. The mixture was left at room temperature for 4 hours to facilitate alkaloid extraction. Afterward, the solution was filtered, and to the filtrate drops of concentrated ammonium hydroxide were added until complete precipitation of alkaloids was observed. The resulting mixture was then concentrated in a water bath to 25% of the original volume. The precipitated alkaloids were allowed to settle for 3 hours, after which they were cleaned using 0.1 M ammonium hydroxide solution (20 mL) to remove impurities. The residue was gathered

by filtering, and the supernatant was disposed of. Finally, the residue was dried, cooled, and weighed to determine the alkaloid content. The percentage alkaloid was calculated mathematically as in equation 9:

$$\% \text{ Alkaloid} = \frac{Weight\ of\ alkaloid}{Weight\ of\ sample} \times 100 \quad (9)$$

Determination of Flavonoid

This was estimated following the procedure adopted by Ejikeme *et al.* [18]. 2.50 g each powdered pineapple crown sample was placed in a 250 mL beaker and extracted with 80% aqueous methanol (50 mL). The beaker was covered and left at ambient temperature for 24 hours to facilitate flavonoid extraction. The residue was extracted again after the supernatant was decanted three additional times using of 80% methanol to ensure complete recovery of flavonoid compounds. The combined extracts were filtered, and the resulting filtrate was placed in a pre-weighed crucible. The solvent was removed by evaporation over a water bath. The dried residue was then cooled and weighed repeatedly until a consistent weight was recorded.

The percentage flavonoid was calculated mathematically as follows in equation 10:

$$\%\text{Flavonoid} = \frac{Weight\ of\ flavonoid}{Weight\ of\ sample} \times 100 \quad (10)$$

Determination of Saponin

This was estimated following the procedure adopted by Ejikeme *et al.* [18]. A 5.00 g portion of each powdered pineapple crown sample was placed into a 250 mL flask containing 20% aqueous ethanol (100 mL). In a water bath, the mixture was heated to 55 °C for four hours while being constantly stirred and filtered. The residue was subjected to a second extraction with an additional 20% aqueous ethanol (100 mL) under identical conditions. The two filtrates were combined and concentrated over a water bath at 90 °C until the volume was reduced to approximately 40 mL. The concentrates were transferred into a separatory funnel and partitioned with diethyl ether (20 mL). The mixture was vigorously shaken, and the ether layer was discarded. The aqueous layer was then extracted with 60 mL of n-butanol, followed by two successive washes with 10 mL of 5% sodium chloride solution to remove impurities. The sodium chloride wash was discarded, and the remaining butanol extract was heated in a water bath for 30 minutes. The resulting solution was transferred to a pre-weighed crucible, oven-dried, and cooled in a desiccator to a constant weight. The percentage saponin was calculated mathematically as in equation 11:

$$\% \text{ Saponin} = \frac{Weight\ of\ saponin}{Weight\ of\ sample} \times 100 \quad (11)$$

All experimental analyses were conducted in triplicate and the mean value taken. The results were expressed as mean ± standard deviation (SD). Reagent blanks (without extract) served as negative controls, to confirm the specificity of the observed reactions.

Determination of Tannin

This was estimated using the procedure adopted by Ejikeme *et al.,* [18]. 50 g of sodium tungstate (Na_2WO_4) was dissolved in 37 mL of distilled water to create the Folin-Denis reagent. 10 g of phosphomolybdic acid ($H_3PMo_{12}O_{40}$) and 25 mL of orthophosphoric acid (H_3PO_4) were added to this mixture. After 2 hours of reflux, the mixture was allowed to cool to room temperature and was diluted with distilled water to reach a final volume of 500 mL. After weighing 1 g of each powdered pineapple crown sample, it was added to a 250 mL conical flask containing 100 mL of distilled water. An electric hot plate was used to gently boil the mixture for 1 hour. Following cooling, the extract was filtered into a 100 mL volumetric flask and distilled water was used to make up the difference. For

tannin quantification, 10 mL of the extracts was measured into a 100 mL flask, and 50 mL of distilled water was added. Subsequently, 10 mL of saturated Na_2CO_3 solution and 5 mL of the prepared Folin-Denis reagent were added. The mixture was thoroughly agitated and incubated the mixture in a water bath maintained at 25 ± 2 °C to allow for color development. The resulting blue-colored complex absorbance was measured at 700 nm using a UV spectrophotometer (Bibby Scientific Jenway 7305 Model). A standard tannic acid solution was prepared by dissolving 0.20 g of tannic acid in distilled water and diluting it to a final volume of 200 mL (1 mg/mL). From this stock solution, aliquots corresponding to 0.2-1.0 mg/mL concentrations were pipetted into different test tubes. After adding 10 mL of saturated Na_2CO_3 solution and 5 mL of Folin-Denis reagent to each test tube, the volume was adjusted with distilled water to reach 100 mL. These standard solutions were also incubated in a water bath at 25 ± 2 °C for 30 minutes. The absorbance values were measured at 700 nm and used to construct a standard calibration curve for tannin quantification. The tannin content was calculated mathematically as follows in equation 12:

$$\text{Tannic acid (mg/100g)} = \frac{C \times \text{extract volume} \times 100}{\text{Aliquot volume} \times \text{Weight of sample}} \quad (12)$$

Where, C is the tannic acid concentration as indicated by the graph.

Determination of Terpenoids

100 mg (0.1 g) of dried plant extract was steeped in 9 mL of ethanol for 24 hours [19]. Following filtration, the extract was removed using a separating funnel and 10 mL of petroleum ether. After being separated into glass vials that had been previously weighed, the ether extract was allowed to completely dry. After evaporating the ether, the yield (%) of the total terpenoids was computed mathematically as in equation 13:

$$\text{Terpenoid (\%)} = \frac{\text{Weight of sample} - \text{weight of sample after drying}}{\text{Weight of sample}} \times 100 \quad (13)$$

Results and Discussion

Table 1 indicates the proximate composition of the dried pineapple crown. The pineapple crown contained 8.86% of crude protein. Particularly for the less fortunate people in developing nations such as Nigeria, plant proteins are a source of essential nutrients. One macromolecule that can be used as a backup energy source when other energy sources are scarce is protein. Proteins serve as building blocks, and food protein is essential for the production of vital hormones, critical brain chemicals, antibodies, digestive enzymes, and DNA. While certain proteins are involved in movement throughout the body or in defense against bacteria, others are engaged in structural support [20]. For a plant-based byproduct, the pineapple crown offers a noteworthy source of protein. Even though it's not as high as protein-rich legumes, this level makes a substantial contribution to the nutritional profile overall, especially given that it is usually discarded. Significant protein content has also been found in studies on other pineapple byproducts, such as peels and rinds, indicating their value in nutrient recovery and byproduct utilization techniques [21]. However, legumes hold a unique position in global agricultural systems due to their significant agronomic and nutritional qualities [22]. The investigation of the pineapple crowns as a substitute protein source supports waste-to-wealth conversion and the circular economy, which advances environmental sustainability and food

security. The pineapple crown contained crude fiber value of 25.54% (Figure 3).

The sample's high fiber content indicates that it can support the maintenance of a healthy and functional digestive tract. Fiber helps accelerate the body's removal of waste and toxins, preventing them from accumulating in the colon or bowel for an extended period of time, which can result in a number of illnesses. Consuming enough dietary fiber can reduce blood sugar levels, constipation, hypertension, cholesterol, the risk of coronary heart disease, and colon cancer [23].

Table 1 Result of proximate analysis of the pineapple crown

Parameters (%)	Pineapple crown
Moisture	3.44 ± 0.07
Ash	5.08 ± 0.10
Fibre	25.54 ± 0.30
Protein	8.86 ± 0.20
Fat	4.63 ± 0.10
Carbohydrate	52.45 ±0.50
Energy (kcal/100g)	286.91 ± 2.00

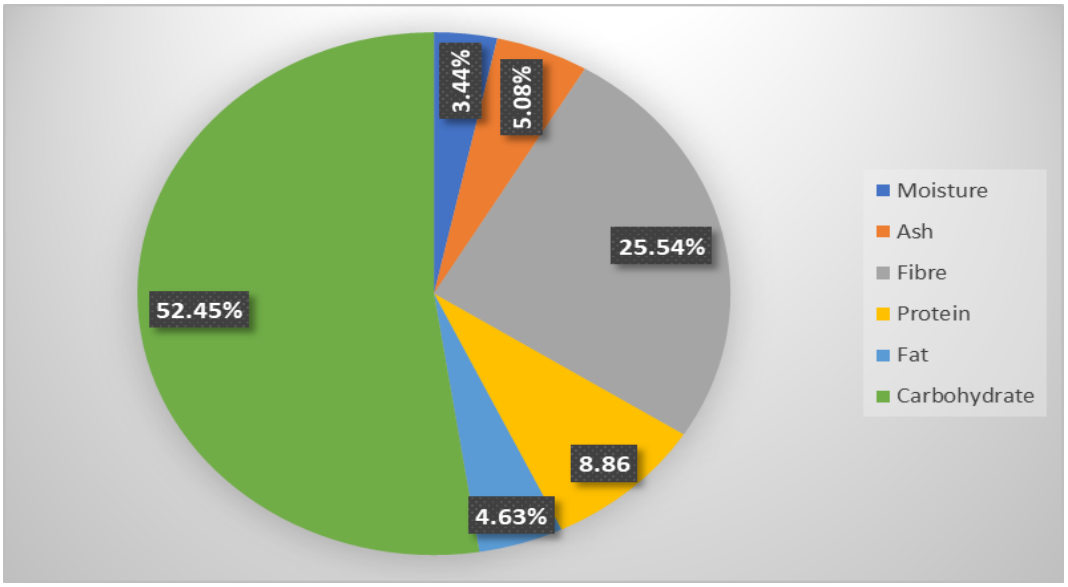

Figure 3 Proximate composition of pineapple crown

Additionally, food waste with a high fiber content has a great deal of potential for value addition to animal feed or as a functional food ingredient in human diets [15]. The pineapple crown may, therefore, be a good source of nutritional fiber. The pineapple crown has ash value of 5.08%. The amount of minerals retained in the plants is reflected in the ash content. The results on the pineapple byproduct report significant ash content, indicating the presence of minerals like potassium, calcium, and magnesium, which are vital for various physiological functions [24]. The results, therefore, suggest an appreciable mineral elements' deposit in the sample. The pineapple crown has a carbohydrate value of 52.45% (Figure 3). This high carbohydrate content, makes it a suitable

candidate for fermentation processes to produce biofuels or other value-added products, or as a carbohydrate supplement in animal feeds. Thus, the contribution of carbohydrate content is vital to the survival of both plants and animals, serving as raw material for numerous businesses such as food, textiles, and biofuel production [25].

The pineapple crown had a crude fat value of 4.63%. Dietary fat absorbs and retains flavors, making food more palatable [26]. The presence of fats can also influence the sensory properties and palatability when utilized in food formulations. The moisture content value is 3.44%. The low moisture content indicates good stability and a prolonged shelf life for the dried pineapple crown. This is consistent with findings for other dried fruit byproducts, which exhibit reduced water activity to inhibit microbial growth and enzymatic reactions [27].

Low moisture also implies a higher concentration of dry matter [28], making the pineapple crown a more potent source of nutrients per unit weight. The calculated energy content of 286.91 kcal/100g reflects its rich composition of carbohydrates, protein, and fat. This energy value demonstrates its potential as a caloric source, particularly in animal feed formulations or as a component in functional foods. When compared to the report by Oweye *et al.* [29], the pineapple crown in this study exhibited markedly higher dietary fiber (25.54%) and protein (8.86%) compared to the peel (fiber 4.10%; protein 5.78%) indicating its potential as a nutrient rich byproduct. The crown also showed elevated ash content (5.08%) relative to peel (3.78%), suggesting greater mineral content. In contrast, carbohydrate content and calorific value were lower in the crown (52.45%; 286.91 kcal/100 g) compared with the peel by making the peel better suited for energy-boosting formulations, while the crown is more aligned with digestive health and nutrition applications. Given its low moisture and high fiber/protein profile, the pineapple crown appears particularly promising for incorporation into functional foods, dietary supplements, or nutraceutical formulations. Its high mineral content further adds value for mineral fortification applications. However, consumer nutritional needs and product knowledge, greatly influence food product purchasing decisions [30]. The results of qualitative and quantitative phytochemical analyses are presented in Tables 2 and 3, respectively. The phytochemical screening analysis revealed that alkaloids, tannins, terpenoids, flavonoids, and saponins are present, while steroids, cardiac glycosides, and phenols were absent. Similar findings have also been reported in other waste parts of the pineapple waste [31,32]. Additional examination of the findings revealed that alkaloids recorded the highest value of 6.23%. Moreover, saponins at 4.68%, tannins at 3.52 mg/100 g, terpenoids at 2.34%, and flavonoids at 1.66% (as shown in Figure 4) were recorded in the pineapple crown sample analyzed. Plant foods contain components that have been evaluated for their biological effects, such as flavonoids and saponins [32].

Alkaloids have been shown to be effective pain relievers, antipyretics, stimulants, and topical anesthetics in ophthalmology [33]. Their high presence in the pineapple crown suggests significant medicinal potential. Antiviral, antibacterial, and antitumor effects are well established for tannins [34]. According to Huang *et al.* [35], terpenoids and steroids are known to exhibit antibacterial and antitumor effects. Flavonoids are polyphenolic compounds widely recognized for their antioxidant, anti-inflammatory, and anticarcinogenic effects [36]. Even a slight presence indicates some level of protective capacity against oxidative stress [37]. Antioxidant substances that can efficiently counteract free radicals include carotenoids, phenolics, flavonoids, anthocyanins,

unsaturated fatty acids, vitamins, enzymes, and cofactors. As a result, there is now more interest in using plants for phytotherapy, which is both curative and preventive [38]. The terpenoid content is relatively low but still contributes to the crown's complex phytochemical profile. Terpenoids are known for diverse biological activities, including anti-inflammatory, antiseptic, and potentially anticancer properties [39], making their presence valuable. Because the pineapple crown contains secondary metabolites, using it may help prevent illness and treat related conditions by offering certain benefits.

Table 2 Result of phytochemical screening of the pineapple crown

Phytochemicals	Test	Pineapple crown
Alkaloid	Wagner's test	++
Flavonoid	Alkaline reagent test	+
Saponin	Frothing test	++
Tannin	Ferric chloride test	+
Terpenoid	Salkowski test	+
Steroid	Liebermann-burchard test	-
Cardiac glycoside	Keller's test	-
Carbohydrate	Fehling test	++

Note: -: Absent, ++: Highly present, and +: Slightly present.

Table 3 Result of quantitative phytochemical analysis of the pineapple crown

Parameters	Pineapple crown
Alkaloid (%)	6.23 ± 0.08
Flavonoid (%)	1.66 ± 0.03
Saponin (%)	4.68 ±0.05
Tannin (mg/100g)	3.52 ±0.03
Terpenoid (%)	2.34 ± 0.02

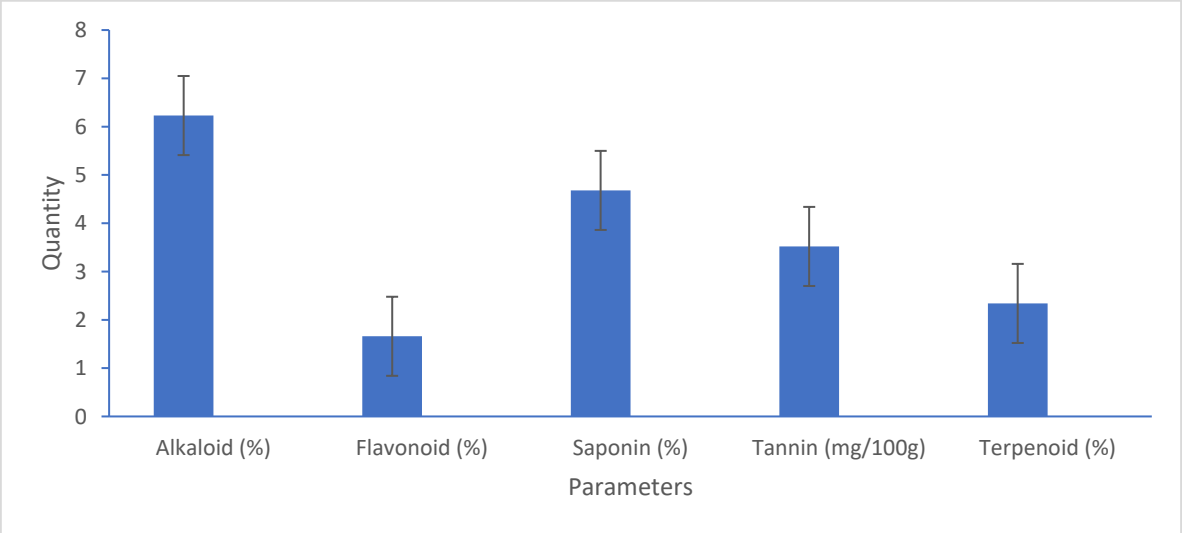

Figure 4 Result of quantitative phytochemical analysis of the pineapple crown

When compared with other pineapple byproducts, the crown shows appreciable variations. For example, pineapple peel has been reported to contain lower alkaloid levels (~3–4%) but higher flavonoids and phenolic compounds, contributing to stronger

antioxidant activity. Similarly, the pineapple stem, which is rich in bromelain, often exhibits comparatively lower flavonoid concentrations than the peel but higher tannins and saponins [40]. The values obtained in this study suggest that the crown accumulates higher alkaloid and saponin content than both peel and stem, which may enhance its potential in nutraceutical and medicinal applications. This distinct composition may improve its potential in specific nutraceutical and medicinal applications where these particular compounds are desired. Studies on other fruit byproducts such as mango peel, show low content of alkaloids, tannins, and saponins when compared to those obtained in this study, with predominantly higher values of phenols and flavonoids [41]. The relatively high alkaloid (6.23%) and saponin (4.68%) content observed in the pineapple crown indicates its possible use in pharmaceutical formulations, especially in antimicrobial and cholesterol management [42].

Conclusion

The nutritional makeup of pineapple crown was examined in this study. The phytochemical screening revealed that alkaloids, tannins, terpenoids, flavonoids, and saponins were present. Proximate composition revealed concentrations of carbohydrates, fiber, protein, ash, fat, and moisture in descending order of abundance. Its high fiber and carbohydrate content, coupled with appreciable levels of protein and minerals, make it suitable for nutritional applications, particularly in animal feed formulations or as a functional food ingredient. The findings of this investigation demonstrated that pineapple crown contains different levels of nutritional components. Hence, pineapple waste such as pineapple crown can be utilized as a nonpharmacological treatment in processed foods and instant beverages. The presence of medicinally important bioactive constituents in the crown is a potential source of metabolites for pharmacological, functional dietary, and medicinal uses. However, anti-nutritional factors, safety concerns, processing challenges, and lack of clinical validation are key limitations that must be carefully addressed. Future research should focus on toxicity studies, standardization of bioactive content, and controlled clinical trials to ensure safe and beneficial large-scale utilization.

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Conflict of Interest

The authors had no relevant financial or non-financial interests to disclose.

Ethical Considerations

Not applicable, as no animals were used in this study.

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