# CHEMICAL COMPOSITION OF TWO SPECIES OF A. COMOSUS

**O. Ovonramwen,** PhD, Lecturer
**M. Dauda,** Research student
[1]Department of Chemistry, Faculty of Physical Sciences, University of Benin, P.M.B. 1154, Benin City, Edo State, Nigeria.

https://doi.org/ 10.15673/fst.v18i3.2857

**Correspondence:**

O. Ovonramwen
*E-mail:* oluwaseyi.ovonramwenuniben.edu

**Cite as Vancouver style citation**

Ovonramwen O, Dauda M. Chemical composition of two species of A. ComosusFood science and technology. 2024;18(4):27-34. https://doi.org/10.15673/fst.v18i3.2857

**Цитування згідно ДСТУ 8302:2015**

Ovonramwen O., Dauda M. Chemical composition of two species of A. Comosus// Food science and technology. 2024. Vol. 18, Issue 4. P. 27-34. https://doi.org/10.15673/fst.v18i3.2857



**Abstract.** Pineapple is a very common fruit that is grown by individuals in gardens or in commercial agriculture to cater for taste satisfaction and nutritional requirements of the populace. It is recognised as second rank tropical and subtropical fruits in the world with Nigeria producing 1.508 million tonnes in 2022. The physiochemical, proximate analysis, mineral and vitamin C components of two pineapple species (black and queen pineapple) bought from New Benin Market in Benin City, Edo State, Nigeria and their juices manually extracted were used to run these analyses. The study was carried out on proximate analysis: % moisture content, % ash content, % crude fat, % crude fiber and % crude protein as well as some selected minerals: Na, Mg, K, Fe, Zn and Ca, vitamin C and physiochemical properties of both of freshly prepared pineapple juice viz temperature, pH, total solid and sugar content using standard methods. The results obtained showed that black pineapple juice had the following composition; moisture content (85.30%), ash content (0.50%), total solids (14.60%), crude fiber (0.20%), crude fat (0.16%), crude carbohydrate (13.31%) and crude protein (0.57). While the juice extracted from queen pineapple contained: moisture content (87.50%), ash content (0.99%), total solids (12.50%), crude fiber (0.13%), crude fat (0.13%), crude carbohydrate (10.70%) and crude protein (0.54%). The temperature at which black and queen pineapple were analysed were 29.50 ℃ and 28.50 ℃ with pH 3.95 and 4.20, vit C and sugar (31.22 and 39.38 mg/100g), (12.70 and 14.32 obrix) respectively. The potassium (K), sodium (Na), calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn), and copper (Cu) were (62.66 and 52.45), (4.18 and 1.18), (2.30 and 2.90), (0.96 and 0.97), (0.10 and 0.23), (0.34 and 0.28), (0.00 and 0.00) in mg/L respectively. The minerals K, Zn, Fe and vitamin C contributed the highest percentage of nutrients needed to meet the daily requirement for proper functioning and development of a healthy body. It can be used in food fortification. There is absence of Cu, high calories from carbohydrate. Hence, it is recommended to be safe for drinking especially for constipation but excessive intake of these pineapple juices can lead to overweight, dental decay, stomach problems (like diarrhea), vomiting and nausea.

**Keywords**: proximate, vitamin C, hidden hunger, daily contribution, calories

## Introduction. Formulation of the problem

Generally, fruits are considered as a healthy component of our daily diet and many global initiatives including WHO have encouraged consumption of at least, five portions (400 g) of fruits and vegetables per day to reap the health and nutritional benefits. More recently, a meta-analysis of 95 prospective studies reported a significantly reduced relative risk for cardiovascular diseases, stroke, total cancer incidence and all-cause mortality with fruit and vegetables intakes in excess of 200 g daily with consumption of 800 g of fruit and vegetables per day (10 portions) considered optimal. These fruits are known to contain certain phytochemicals (secondary metabolites) which act as antioxidants, antimicrobial agents, and provides other benefits essential to the survival of mankind. The nutritional composition varies from one type of fruit to another. The most common fruits in Nigeria are pineapple, the citrus family, water melon, cashew, cucumber, papaya, avocado pear, the native pear, banana, guava, mango, the pepper fruit, tomato, amongst others.

Pineapple is a very common fruit that is grown by individuals in gardens or in commercial agriculture to cater for taste satisfaction and nutritional requirements of the populace. It is recognised as second rank tropical and subtropical fruits in the world with Nigeria producing 1.508 million tonnes in 2022. According to Santos *et al.*, pineapple has potential in the fresh-cut form market due to its appreciated sensorial characteristics (flavour, juiciness, and taste) and the demand for immediate consumption [1]. In addition to this, the nutritional properties of pineapple also deserve interest since it is a good source of phenolic, and consequently, it is rich in antioxidant

activity. Pineapple fruit is known to possess a wide range of compounds which have more than one role, being involved both with immediate good health and with protection against disease that can develop over a long period of time, such as cancer, heart conditions, stroke, hypertension, birth defects, cataracts and diabetes. Thus, it is important to quantify these different compounds in the fruit produced locally. It is known to be a juicy fruit and it possesses a rich taste coupled with its availability all through the year. The nutritional value of pineapple fruits is usually assessed *via* proximate analysis, an analytical technique that quantifies the various components of food as documented by AOAC.

Malnutrition was divided into three key strands *via* hunger and undernourished, overweight or over-nourishment and micronutrient deficiencies or malnutrition (hidden hunger). Of these strands, the hidden hunger is most caused by poor nutrition and poor eating habits. Micronutrients malnutrition is the deficiencies of essential vitamins and minerals required in small amounts for metabolism, proper growth and development. Micronutrients includes; iron, zinc, calcium, vitamin C, vitamin B, vitamin A, iodine, etc. Micronutrients malnutrition is a global health issue which are not always visible and can be devastating. The World Health Organization (WHO) has estimated that more than two billion people suffer from micronutrient malnutrition worldwide. From a report documented by UNICEF, children (< 5 years) and pregnant ladies are most affected by malnutrition and the adverse effects are most observed in preschool children [2]. The major poor health conditions associated with hidden hunger are scurvy, rickets, oxidative stress, poor immunity, and even deaths. These conditions are mostly rampant in Africa and Asia continents with people of low socioeconomic, restricted diets, pregnant and lactating mothers. There's need for the consumption of natural products which consists of fruits and vegetables in order to curb these conditions. Food fortification and supplementation strategies have been successful in enhancing the status of certain micronutrients. Although there have been advanced ways of addressing micronutrient malnutrition, areas like excess micronutrient should be considered. It is imperative that funding bodies and policy makers prioritise micronutrient malnutrition and work with the scientific community to ultimately improve the health of our population [3] and increase the production and consumption of fruits and vegetables.

## Analysis of recent research and publications

Pineapple contains some other nutrients that are essential for man's health, growth, tissue repair, and energy *viz* carbohydrates, proteins, some fat fractions, and crude fibre. The physicochemical constituents and nutritional values has been documented by [4]. Whereas, Chaudhary et al. had reviewed on different end products pineapple has been preserved into vegetables, jams, fruit juice, candy, wine etc [5]. Another researcher, compared nutritional and physiochemical properties of Giant Kew and Honey Queen in Chittagong [6]. In another study in Ogun State Nigeria, different fruit mixtures samples D (40% Soursop, 30% Orange and 30% Pineapple), C (50% Soursop and 50 %Orange), B (50% Soursop and 50% Pineapple) and A (100% Soursop) were compared with the sample D being the best in terms of flavour, sweetness, aroma taste and nutrition [7]. Likewise, pineapple has been added to some fruit juice [8]. Agomuo et al. studied proximate, sensory, vitamin A and C of soybean seeds, fresh ripe orange and pineapple fruits processed into soymilk, and fruit juices respectively [9]. In the work of Ajibade et al., incidence of Saccharomyces cerevisiae, proximate composition and single cell protein produced from fruit wastes was conducted in Abuja including pineapple wastes [10]. In southwest Ethiopia, there was a study on physico-chemical composition and sensory characterisation of varieties of pineapple [11]. Pineapple has also been blended to soybean drink in Edo State, Nigeria in order to improve nutritional quality of the components [12]. In Kerala, physiochemical, proximate and mineral constituents in different commercial Curtivars and Local Varieties of Ananas comosus have been analysed [13]. Likewise, the physiochemical and proximate analysis of pineapple fruits sold in the various markets of Abidjan has been reported [14]. Ogunmefun et al. carried out works on nutritional values, chemical compositions, sensory evaluation and antimicrobial activities of pasteurised and non-pasteurised pineapple, coconut juices and their blends. They reported the blends to have good antimicrobial activities with a longer storage period [15].

Fruits and vegetables are important sources of vitamins, dietary minerals, fibres, and anti-oxidative compounds. They are a rich source of biologically active compounds, known as phytochemicals, which are an essential and beneficial part of the human diet. The fruit consumption following the recommended daily intake (RDI) of 400 g and above helps to improve the health and wellbeing of humans. While some researchers have keyed into the nutritional constituent of pineapple, recent literature contain just little documentation of the nutritional value of the fruit especially those sourced locally from Nigeria. Thus, determining the physiochemical, proximate composition, minerals and ascorbic acid of pineapple will provide an aid in curbing the adverse effects associated with hidden hunger.

This research **aims** at determining and documenting the physiochemical, proximate composition, minerals and ascorbic acid content of two species of locally sourced fresh pineapple fruit juice.

To achieve this aim, the following **objectives** were set to:

- purchase of two species of locally sourced pineapple fruits from new Benin market, Benin City, Edo State followed by the extraction and separation of the fresh fruit juice,
- determine physicochemical properties of the fresh pineapple juice extracts *viz* temperature, pH and sugar content,
- quantify water, crude protein, crude fat crude fiber, minerals and carbohydrate fractions of the fresh juice extracts,
- quantify the ascorbic acid content of the fresh juice extracts,
- determine the mineral content of each juice extract *viz* copper, sodium, zinc, iron, calcium, magnesium, and potassium.

## Research materials and methods

All analytical procedures were carried out following standard procedures with some modifications. All glass wares were thoroughly washed and rinsed with distilled water followed by drying prior to use. Analytical grade sulphuric acid, Kjeldahl's catalyst (potassium sulphate + copper (II) sulphate + selenium dioxide), petroleum ether, NaOH, HCl and $KMnO_4$ were used.

*Source of Material (Pineapples).* The queen pineapple and its hybrid black pineapple were bought from New Benin Market, Benin City, Edo State, Nigeria on postal code 300271, and 6.3448°N, 5.6340° E. The pineapples were identified by Dr. H. N. Akinnibosun of the Department Plant Biology and Biotechnology, University of Benin, Benin City with the voucher number, UBH-A234 (Figure 1).

**Figure 1. Pineapples used (right: Queens Pineapple (B), left: Black pineapple (A))**

*Determination of pH value.* To a clean 250 mL beaker, 30 mL of the pineapple juice was dispensed and the pH probe was inserted into the juice and the pH was determined with a previously standardised meter. The pH was calibrated using phosphate buffer solution of pH 4.0 and 7.0 and the reading was recorded.

*Determination of sugar content.* The refractometer was used for the measurement of percent brix or relative sugar concentration. Depending on the amount of sugar in the sample, the refractometer gives a reading on the index.

*Proximate Analysis.* The proximate parameters assessed were moisture content, ash content, crude fat, crude fiber and crude protein using [16].

*Determination of moisture content***.** Oven dried clean and well labelled crucible ($W_1$), 2 g of pineapple juice was added and weighed ($W_2$). The sample was transferred to a thermostatic oven at about 105 $^oC$ for 3 h, this was repeated to a constant weigh ($W_3$). Moisture content was calculated using equation 1 below:

$$\%\ moisture\ = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \quad .(1)$$

*Determination of total solids.* From the moisture content obtained the total solids was calculated using equation 2 below:

$$\%\ Total\ solid\ = \frac{W_3 - W_1}{W_2 - W_1} \times 100 \ldots\ldots\ldots (2)$$

*Determination of ash content.* A crucible was placed in a muffle furnace for about 15 min at 350 $^oC$. It was removed and cooled in a desiccator for about one hour and weighed ($W_1$). 2 g of pineapple juice was added to the crucible and weighed ($W_2$). The sample was pre-dried using a thermostatic oven since the sample is wet. Thereafter, the crucible was moved to a muffle furnace and the temperature was slowly increased from 200 to 450 $^oC$ to avoid incomplete ashing. The crucible was removed and cooled in a desiccator. The crucible and content were reweighed ($W_3$). The ash content was calculated using equation 3 below:

$$\%\ ash\ = \frac{W_3 - W_1}{W_2 - W_1} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

*Determination of crude fat.* A previously oven dried thimble was weighed ($W_1$). 40 g of pineapple juice was added to the thimble and weighed again ($W_2$). 500 mL round bottom flask was weighed ($W_3$). The flask was filled to two-third with petroleum ether. The soxhlet extractor was fitted up with a reflux condenser with a heat source attached, it was allowed to boil and siphon over 5–6 h. The petroleum ether is siphoned over the barrel, the condenser is detached and the thimble removed. The petroleum ether was distilled from the flask and the flask containing the fat residue is placed in a water bath at 100 $^oC$ for 5 min, it was cooled in a desiccator and weighed ($W_4$). The crude fat was calculated using equation 4 below:

$$\%\ Crude\ fat\ = \frac{W_4 - W_3}{W_2 - W_1} \times 100 \ldots\ldots\ldots (4)$$

*Determination of crude fibre.* 2 g of pineapple juice was weighed in a dried crucible ($W_1$) and placed in a 1 L conical flask. (200 mL 1.25% (v/v)) of hot sulfuric acid was added to the flask, digested for 30 min with constant swirling and filtered. The residue was rinsed three times with hot water and transferred to a clean and dried conical flask. The digestion procedure was repeated with washed residue using NaOH (200 mL, 1.25% (v/v)), sulfuric acid. The

obtained residue was dried at 105 $^{o}$C and cooled to a constant weight ($W_2$) [17]. The crude fibre was obtained using equation 6 below;

$$\%\ crude\ fibre\ = W_1 - W_2\ \times 100 \ldots\ldots\ldots (6)$$

*Determination of crude protein*. One boiling stone was added to a kjeldahl digestion flask, 1 g of kjeldahl catalyst as well as 10 mL of pineapple juice was added, 25 mL of sulfuric acid was added and digested till a clear solution was seen. The solution was allowed to cool and distilled water was added and allowed to cool again. The solution was filtered and the filtrate was made up to 100 mL and transferred to a sample bottle. 5 mL of the filtrate was pipetted out, 2.5 mL of alkaline phenate solution was added and shook well. 1 mL of sodium tartrate was added and shook, 2.5 mL of sodium hypocholrite was added and shook (as bleach). At 620 nm the solution was read with a UV-VIS spectrometer. The obtained value was multiplied with 6.25 to get the crude protein (MERL).

*Vitamin C determination using UV- Visible spectrophotometry*. 10 mL of pineapple juice was transferred into a test tube, mixed and homogenized with 1.0 mL of $KMnO_4$ (100 µg/ml) and allowed to stand for 5 min. The absorbance of the sample was read in the UV-Visible spectrophotometer in a glass cuvette at 521 nm. From the calibration curve the concentration of ascorbic acid was calculated. In each analysis, the same reaction system was utilised to calculate blank of the apparatus by the substitution of the sample containing vitamin C by one containing the same amount of distilled water.

*Mineral Analysis.* The mineral content is the amount of specific inorganic components within a sample. The ash obtained from the proximate analysis was digested with HCl (5 mL, 2 M), cooled and filtered. The filtrate was made up to 100 mL in a volumetric flask with distilled water. The solution was transferred to a plastic bottle and labelled accurately. The Zn, Fe, Ca, Mg, and Cu were analysed using atomic absorption spectrometry (AAS) and the Na and K were analysed using flame emission spectrometry (FES). All according to the standard methods [16].

*Determination of Carbohydrate.* Total carbohydrate was calculated by the addition of other constituents of the proximate and then subtracted from 100.

$$(TC) = 100 - (\%CP + \%CFE + \%CF + \%CTA + \%\ moisture) \quad (7)$$

*Estimaton of the calorific value*. The calorific energy was calculated using the constant described by the United Kingdom Department of Health [18] as shown in equation 8.

$$(CE) = (CP \times 4.00) + (CFE \times 9.00) + (TC \times 3.75) \quad (8)$$

*DV percent daily value (DV) of minerals*. The percent daily value (%DV) of minerals is shown in equation 9.

$$\%\ DV\ of\ minerals = \frac{Amount\ of\ minerals\ in\ 100g\ sample}{Recommended\ daily\ value} \times 100 \ldots\ldots\ldots (9)$$

## Results of the research and their discussion

The experiment was conducted to compare the physiochemical, proximate, mineral and vitamin C compositions of black and queen pineapple with temperature 29.50 and 28.50 ℃ and pH 3.95 and 4.20 respectively (Table 1). Bio-deterioration of fruit juice is influenced by factors like temperature, pH and chemical composition. Pineapple juice can undergo fermentation there by leading to an increase in pH. The pH of the two pineapples differs significantly. The pineapple A is more acidic than the pineapple B. The values are higher than fresh pineapple reported but was within the treated values [19-20]. The differences in pH was because of different varieties, maturity and the environmental condition. The high pH is responsible for a slight burning sensation on consumption of the juice due to its acidity and can causes tooth decay. Total sugar level of fresh pineapple juice B (14.32 ± 0.03 °Brix respectively) was higher than pineapple juice A (12.70 ± 0.00 °Brix). These were in line with reported value of pineapple and mango juice juices ratio of 100P: 0M, 70P:30M, 50P:50M and 30P:70M, TSS were 12.93 ± 0.100, 13.67 ± 0.201, 13.9 ± 0.100, and 14.23 ± 0.251 °Brix respectively [8]. The sugar contents were directly proportional to pH but inversely proportional to total solid. This indicates that the more the organic acids of juices the lower the sugar contents. Hence, the higher the total solid. The range of total solid values (12.50–14.60%) was significantly higher than those varieties reported at the first day of different temperature [21].

The juice extracted from black pineapple contained: moisture content (85.30%), ash content (0.50%), total solids (14.60%), crude fiber (0.20%), crude fat (0.16%), crude carbohydrate (13.31%) and crude protein (0.57). while the juice extracted from queen pineapple contained: moisture content (87.50%), ash content (0.99%), total solids (12.50%), crude fiber (0.13%), crude fat (0.13%), crude carbohydrate (10.70%) and crude protein (0.54%) (Table 2).

**Table 1 – Physiochemical Analysis of Samples A and B**

| Parameters | A | B |
|---|---|---|
| pH | 3.95 ± 0.01 | 4.20 ± 0.00 |
| Sugar Level (Brix) | 12.70 ± 0.00 | 14.32 ± 0.03 |
| Total solid (%) | 14.60 ± 0.58 | 12.50 ± 0.00 |

**Table 2- Proximate composition of black and queen pineapple juice (%)**

| S/N | Proximate | Black Pineapple | Queens Pineapple |
|---|---|---|---|
| 1. | Moisture content | 85.30 ± 0.58 | 87.50 ± 0.00 |
| 2. | Ash content | 0.50 ± 0.01 | 0.99 ± 0.00 |
| 4. | Crude fiber | 0.20 ± 0.03 | 0.13 ± 0.03 |
| 5. | Crude fat | 0.16 ± 0.02 | 0.13 ± 0.01 |
| 6. | Crude protein | 0.57 ± 0.02 | 0.54 ± 0.01 |
| 7. | Crude carbohydrate | 13.31 ± 0.65 | 10.70 ± 0.03 |

In this experiment, the moisture content of both species was found to be high (85.30% to 87.50%). These findings are within the range of 84.93 to 90.35% for pineapple fruit varieties MD2, Josapine, and Morris juice of pre-treated storage stage at different temperature reported [21]. The queen pineapple had the same value as reported [19]. In another work, 87.40% was reported for a pasteurised pineapple juice at 75 $^{o}$C [12]. The high moisture indicates that routinely consumption of pineapple juice can increase the body's water there by leading to easy absorption, transportation and digestion. It will be good for constipation. The high content of moisture in both species suggested that they have short shelf life.

Crude fat content in both species was very low (0.13 to 0.16%) which is common for fruits as they are not good sources of fat. This was higher than 0.10% reported [12].

Crude fiber contributes to the bulkiness needed for digestion in the large intestine. The crude fibre content observed ranged from 0.13 to 0.20%. This value was low compared to other treatments, as fruit are usually good source of dietary fibre but higher than the 0.12% of 75 $^{o}$C pasteurised [12]. The total dietary fibre obtained of black pineapple was in line with 0.2% USDA nutrient database.

Studies have shown that crude protein content in fruits are lower as compared to other foods. Pineapple A contained 0.57 % of protein while Pineapple B contained 0.54% of protein. The pineapple A had similar value with *Ananas comosus* cv. Amritha ACE bracteatus red [13] but lower than 0.59% of 75 $^{o}$C pasteurised [12]. Fruit juices are not good sources of protein rather they are very good source of vitamins and minerals.

Carbohydrate has been reported to be high in fruit juice (11–16%) compared to the oral electrolyte solutions of 2.5 to 3% which may exceed the small intestine's ability to absorb carbohydrate, resulting in carbohydrate malabsorption [22]. In this research pineapple A had: 13.31% while Pineapple B had: 10.70%. The carbohydrate was in between 11.35% and 12.9% reported of 75 $^{o}$C pasteurised [12] and USDA database respectively.

The amount of ash present translates to the quantity of minerals present in the juices. Ash content is the measure of minerals present in food, it is required for metabolic processes. The ash content for pineapple B (0.99%) was higher than pineapple A (0.50%). The ash content obtained was closer to the values reported of two varieties of pineapple (Giant Kew and Honey Queen) of 0.6 and 0.9 % respectively [6]. These results were significantly higher than 0.20 to 0.28% [14], 0.28% USDA nutrient database and 0.44% of 75 $^{o}$C pasteurised [12].

The calories contribution is presented (Table 3). The appropriate calorific values from carbohydrate, protein and fat help to reduce the risk of chronic diseases. The two species have high calorific values contribution from carbohydrate, low from protein and fat so should be consumed moderately to avoid chronic health diseases. The total calorific value of the two pineapples were higher than 41.04 Kcal/100 reported [15].

Macro minerals are essential minerals required in amounts greater than 100 mg per day whereas trace or micro minerals are required in trace quantities about less than 100 mg/day for normal metabolic activities. The results obtained from minerals and vitamin C are presented in Table 4. Sodium is found in low concentrations and has little metabolic function compared to potassium concentration found in both species. Sodium is needed to maintain blood and fluid volume in the body. Na has been related to hypertension, high blood pressure, stroke, and cardiovascular disease when taken than the normal. Fruit juices are characteristically low in Na content and its replacement of fruits in children's diets may result in the onset of hypernatremia [22]. Na found in pineapple A was higher (4.18 mg/L) than pineapple B which was (1.18 mg/L). USDA nutrient database reported 2 mg of sodium levels in pineapple juice. Potassium helps in neurotransmission, regulation of blood pressure, muscle contraction, and activation of enzymes. Potassium is most abundant minerals observed in the two varieties compared to other minerals. This is similar to other studied [13,23]. The potassium has been related to iron utilisation when it is higher its shows it will bring more of iron absorption. The values obtained 62.66 and 52.45 of black and queen pineapple respectively, was lower than 130 mg reported in USDA nutrient database. The values were higher than the two species reported [6]. The ratio of K to Na should be higher than 2 in food to prevent or manage the risk of high blood pressure [24] (Table 5). The studied pineapples fall within the ideal ratio with far more potassium than sodium (NHANES). Sodium/potassium ratio from this study is showing more potassium so can be consumed by hypertensive patient.

**Table 3-Calories contribution of Black and Queens Pineapple**

| Nutrients | Black Pineapple | | Queens Pineapple | |
|---|---|---|---|---|
| | Calories Kcal/100g | % Calorific value | Calories Kcal/100g | % Calorific value |
| Carbohydrate | 52.57 | 87.25 | 42.27 | 92.70 |
| Protein | 2.28 | 3.79 | 2.16 | 4.74 |
| Lipid/fat | 5.40 | 8.96 | 1.17 | 2.56 |
| Total | 60.25 | 100.00 | 45.60 | 100.00 |

Macro minerals are essential minerals required in amounts greater than 100 mg per day whereas trace or micro minerals are required in trace quantities about less than 100 mg/day for normal metabolic activities. The results obtained from minerals and vitamin C are presented in Table 4. Sodium is found in low concentrations and has little metabolic function compared to potassium concentration found in both species. Sodium is needed to maintain blood and fluid volume in the body. Na has been related to hypertension, high blood pressure, stroke, and cardiovascular disease when taken than the normal. Fruit juices are characteristically low in Na content and its replacement of fruits in children's diets may result in the onset of hypernatremia [22]. Na found in pineapple A was higher (4.18 mg/L) than pineapple B which was (1.18 mg/L). USDA nutrient database reported 2 mg of sodium levels in pineapple juice. Potassium helps in neurotransmission, regulation of blood pressure, muscle contraction, and activation of enzymes. Potassium is most abundant minerals observed in the two varieties compared to other minerals. This is similar to other studied [13,23]. The potassium has been related to iron utilisation when it is higher its shows it will bring more of iron absorption. The values obtained 62.66 and 52.45 of black and queen pineapple respectively, was lower than 130 mg reported in USDA nutrient database. The values were higher than the two species reported [6]. The ratio of K to Na should be higher than 2 in food to prevent or manage the risk of high blood pressure [24] (Table 5). The studied pineapples fall within the ideal ratio with far more potassium than sodium (NHANES). Sodium/potassium ratio from this study is showing more potassium so can be consumed by hypertensive patient.

Ca is required in the body for strong bones, teeth, hormone secretion, blood clotting, heartbeat, muscle and for proper functioning of the nervous system. Although, Ca levels facilitate many body physiological processes, very low levels may affect body weight and fat levels, two risk factors for cardiovascular diseases [25]. Results of this study showed that the calcium in pineapple B was slightly higher (2.90 mg/L) than pineapple A (2.30 mg/L). These were lower than reported of [6,12].

Magnesium (Mg) is an important component which is necessary for energy production and nucleic acid synthesis. Mg concentration found in pineapple A was 0.96mg/L and that of pineapple B was 0.97 mg/L. Mg plays role in calcium absorption as its stimulates calcitonin and suppresses parathyroid hormone. The Ca/Mg ratio was slightly higher. This has been reported to associate with the risk of cancers and other chronic health disease [26-27]. Therefore, is not ideal for metabolic processes.

Copper and zinc are two essential trace minerals required in optimal health maintenance. They help to improve both internal and external wound elasticity and resistance. Zinc is involved in the functioning of the immune system, growth, brain development, behavioural response, bone formation, and wound healing [28]. Its deficiency can lead to stunt growth. The zinc (0.34 mg/L) of pineapple A was higher than that of pineapple B (0.28 mg/L). USDA nutrient database reported 0.11 mg, was lower than the two pineapples. The reported of [6] (0.169 and 0.179) was lower than the studied pineapples. Copper helps to reduce atherosclerosis, inflammation, maintain cardiovascular function and fat metabolism [29]. This research showed the absence of copper which indicates that the pineapples are not a source of Cu. Hence, there will be disruptions in iron and zinc metabolism.

Iron is a mineral that is needed for growth and development by the body. It is vital in the functioning of immune system and oxygen transportation. This study shows that black pineapple contained 0.10 mg/L while pineapple B contained 0.23 mg/L whereas, USDA nutrient database reported 0.25 mg for raw traditional varieties. The minerals Zn, K and Fe had the highest percentage contributions of micronutrients needed to meet the daily requirement for proper functioning of a healthy body (Table 6). Therefore, they are good sources of hidden hunger micronutrients K, Zn, Fe and vitamin C. The variations in the constituents of pineapples of different varieties from place to place depends on the soil, cultural practices, the type of manuring employed, environmental conditions, and some certain human activities.

**Table 4 – Mineral and Vitamin C composition of Black and Queens Pineapple juice**

| S/N | Minerals | Unit | Black Pineapple | Queens Pineapple |
|---|---|---|---|---|
| 1. | Zn | mg/L | 0.34 ± 0.04 | 0.28 ± 0.01 |
| 2. | Fe | mg/L | 0.10 ± 0.00 | 0.23 ± 0.06 |
| 3. | Ca | mg/L | 2.30 ± 0.12 | 2.90 ± 0.00 |
| 4. | Mg | mg/L | 0.96 ± 0.02 | 0.97 ± 0.06 |
| 5. | Cu | mg/L | 0.00 ± 0.00 | 0.00 ± 0.00 |
| 6. | Na | mg/L | 4.18 ± 0.47 | 1.18 ± 0.41 |
| 7. | K | mg/L | 62.66 ± 15.28 | 52.45 ± 6.58 |
| 8. | Vitamin C | mg/100g | 31.22 | 39.38 |

**Table 5 – Nutrient ratio of Black and Queen Pineapples**

| No | Micronutrient ratio | Ratio | | Ideal ratio |
|---|---|---|---|---|
| | | A | B | |
| 1 | Potassium: Sodium | 14.99 | 44.45 | >2 |
| 2 | Calcium: Magnesium | 2.40 | 2.99 | 1.70 – 2.00 |
| 3 | Zinc: Copper | 0.00 | 0.00 | 8-12 |
| 4 | Iron: Copper | 0.00 | 0.00 | 10-15 |
| 5 | Iron: Zinc | 0.29 | 0.82 | 2 |
| 6 | Calcium: Protein | 4.04 | 5.37 | 20 |

**Table 6 – Percent Daily value of the proximate and minerals in 100 g of Sample A and B**

| Minerals | 4-8years | | 9-13years | | 14-18 years | | 19-30years | | 31-50years | | 51+ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B | A | B | A | B |
| Carbohydrate | 10.23 | 8.22 | 10.23 | 8.22 | 10.23 | 8.22 | 10.23 | 8.22 | 10.23 | 8.22 | 10.23 | 8.22 |
| Protein | 3.00 | 2.84 | 1.68 | 1.54 | 1.10-1.24 | 1.04-1.17 | 1.02-1.24 | 0.96-1.17 | 1.02-1.24 | 0.96-1.17 | 1.02-1.24 | 0.96-1.17 |
| Vit C | 124.88 | 157.52 | 69.38 | 87.51 | 41.63-48.03 | 52.51-60.58 | 34.69-41.63 | 43.76-52.51 | 34.69-41.63 | 43.76-52.51 | 34.69-41.63 | 43.76-52.51 |
| Zn | 6.80 | 5.60 | 4.25 | 3.50 | 3.09-3.77 | 2.55-3.11 | 3.09-4.25 | 2.55-3.50 | 3.09-4.25 | 2.55-3.50 | 3.09-4.25 | 2.55-3.50 |
| Fe | 1.00 | 2.30 | 1.25 | 2.88 | 0.67-0.91 | 1.53-2.09 | 0.55-1.25 | 1.28-2.88 | 0.55-1.25 | 1.28-2.88 | 1.25 | 2.88 |
| Ca | 0.23 | 0.29 | 0.18 | 0.22 | 0.18 | 0.22 | 0.23 | 0.29 | 0.23 | 0.29 | 0.19-0.23 | 0.24-0.29 |
| Mg | 0.74 | 0.75 | 0.40 | 0.40 | 0.23-0.27 | 0.24-0.27 | 0.24-0.31 | 0.24-0.31 | 0.23-0.30 | 0.23-0.30 | 0.23-0.30 | 0.23-0.30 |
| Cu | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Na | 0.22 | 0.06 | 0.19 | 0.05 | 0.18 | 0.05 | 0.18 | 0.05 | 0.18 | 0.05 | 0.18 | 0.05 |
| K | 1.65 | 1.38 | 1.39 | 1.17 | 1.33 | 1.12 | 1.33 | 1.12 | 1.33 | 1.12 | 1.33 | 1.12 |

Vitamins C plays an important role in collagen biosynthesis, iron absorption, immune response activation, wound healing and osteogenesis. It acts as a protective antioxidant that operates in the aqueous phase both intra- and extra-cellular [30]. In this case when Fe and Cu are reduced, the reduction of hydrogen peroxide occurs and the product such as reactive hydroxy radical destroys cancerous cells [30]. The vitamin C of black and queen (31.22 and 39.38 respectively) were significantly different from varieties reported [31] at different ripening stages. In a similar work, Ogunmefun et al. reported 38.9 [15]. The recommended daily intake of vitamin C for children above 4 years and adult are 25–75 and 75->90 mg. The vitamin C in both species contributed about half of daily requirement of adult's need and more than what is needed in children 4-8 years. Therefore, pineapple can be used in food fortification especially for children and adult with low iron availability as vitamin C increases iron absorption.

## Conclusion

Conclusively, from the findings of this research carried out on Black Pineapple and Queens Pineapple fruit juice obtained from New Benin Market in Benin City were observed to possess their proximate, mineral contents and vitamin C. They are good sources of hidden hunger micronutrients K, Zn, Fe and vitamin C. Hence, recommend to be safe for consumption as they aid in digestion and provision of essential minerals needed for proper function and development of the body. It can be used in food fortification. Although,

excessive intake of these pineapple juices can lead to overweight, dental decay, stomach problems (like diarrhea), vomiting and nausea.

**References**


1. Santos DI, Martins CF, Amaral RA, Brito L, Saraiva JA, Vicente AA. Moldão-Martins M. Pineapple (*Ananas comosus* L.) By-Products Valorization: Novel Bio Ingredients for Functional Foods. *Molecules.* 2021*;* 26 (3216):1-17. https://doi.org/10.3390/molecules26113216.
2. UNICEF. *Children, Food and Nutrition, Growing Well in a Changing World*. 2019; 1: 36-46.
3. Magee P, McCann M. Micronutrient deficiencies: current issues. Medicine, Environmental Science. *Proceeding of the Nutrition Society*. 2019; 78 (2): 147 – 149. https://doi.org/10.1017/S0029665118002677.
4. Hossain F, Shaheen A, Mustafa A. Nutritional Value and Medicinal Benefits of Pineapple. *International Journal of Nutrition and Food Sciences*. 2015; 4 (1): 84-88. https://doi.org/10.11648/j.ijnfs.20150401.22.
5. Chaudhary V, Kumar V, Sunil, Vaishali, Singh K, Kumar R, Kumar V. Pineapple (Ananas cosmosus) product processing: A review. *Journal of Pharmacognosy and Phytochemistry* 2019; 8(3): 4642-4652.
6. Kader A, Hossain FMJ, Ismail MM, Kabir G, Sarkar SK, Absar N. A comparative analysis on the nutritional contents of two varieties of pineapple of Chittagong region*. Chittagong University Journal of Biological Sciences*. 2010; 5(1&2):105-112. https://doi.org/10.3329/cujbs.v5i1.13375
7. Ani IF, Ajuzie NC, Adeoye BK, Ngozi EO, Bassey VE. Comparative Nutritional Quality and Sensory Properties of Pure Soursop Juice and its Blend with Orange and/or Pineapple, *Global scientific journal*. 2019; 7 (6): 470-479.
8. Kamarul ZAA, Shamsudin R, Mohd AN. Effect of blending ratio on quality of fresh pineapple (*Ananas comosus* L.) and mango (Mangifera indica L.) juice blend. *International Food Research Journal* 2016; 23(Suppl): S101-S106.
9. Agomuo JK, Ehirim FN, Akajiaku LO. Effect of Orange and Pineapple Fruit Juice Replacement on Proximate and Sensory Attributes of Soymilk Mixed Fruit Juice Drink. *Asian Journal of Agriculture and Food Sciences*. 2014; 02 (06): 469-477.
10. Ajibade HY, Ayegba SO, Abdallah HF, Egbi TK. Incidence of Saccharomyces cerevisiae, Proximate Composition and Single Cell Protein Produced from Fruit Wastes. *Researcher* 2022; 14 (6): 26-33. https://doi.org/10.7537/marsrsj140622.04.
11. Mulualem T, Semman N, Etana G. Physico-chemical and sensory characterization of pineapple (*Ananas comosus* (L.) Merr) varieties in Southwest Ethiopia. *Agrotechnology*. 2021; 10: 219.
12. Ebabhamieghebho PA, Evive SE, Izekor C. Nutritional quality of Pinasoy: a pineapple and soybean blend drink. *ADAN J. Agric*, 2020; (1): 191-200.
13. Nisha AP, Radhamany PM. Evaluation of proximate and mineral constituents in Different Commercial Curtivars and Local Varieties of *Ananas comosus* (L.) Merr. From Kerala. *Int. J. fruit Sci*. 2019; 20 (3): 620-634. https://doi.org/10.1080/15538362.2019.1628683.
14. Koffi YF, Traore M, Deffan KP, Ban Koffi L, Alloue-Boraud MWA. Assessment of the Physicochemical and Nutritional Parameters of Pineapple Fruits (*Ananas comosus* L.) and Post-harvest Bioconservation Test. *American Journal of Food Science and Technology*. 2021; 9 (2): 53-61. https://doi.org/10.12691/ajfst-9-2-4.
15. Ogunmefun TO, Asoso SO, Olatunji BP. Nutritional values, chemical compositions and antimicrobial activities of fruit juice from pineapple (*Ananas comosus* L.) and coconut (*Cocos nucifera* L.) blends. *J. Food Sci Nutr*. 2018; 1 (2): 40-46. https://doi.org/10.35841/food-science.1.2.40-46.
16. AOAC (Association of Official Agricultural Chemists). *Official Methods of Analysis of the AOAC*. 18th ed. Gaithersburg, M. D., The Association 2005.
17. Ovonramwen OB. Proximate and Mineral composition of vegetable salad without dressing. *Malaysian journal of Applied Sciences*. 2021; 6(2): 1-8. *https://doi.org/10.37231.myjas2021.6.2.272.*
18. UKDH, (United Kingdom Department of Health). *Nutrient analysis of fruit and vegetables.* Institute of Food Research, Norwich Research Park, Colney, Norwich, NR4 7UA, Independent Nutritionist, Surrey, UK. 2013; 14.
19. Kundu A, Mostofa R, Hassain A, Dina PR, Esrafil M, Uzzaman MA, Zubair MA. Development of Pineapple Juice and Observation of Shelf Stability Using Various Degrees of Preservative in Several Storage Condition, *Science Frontiers*. 2021; 2 (4): 50-60. https://doi.org/ 10.11648/j.sf.20210204.12.
20. Zzaman W, Biswas R, Hossain MA. Application of immersion pre-treatments and drying temperatures to improve the comprehensive quality of pineapple (*Ananas comosus*) slices. *Heliyon*. 2021; 7 (1): e05882. https://doi.org/10.1016/j.heliyon.2020.e05882.
21. Mohd Ali M, Hashim N, Abd Aziz S, Lasekan O. Shelf Life Prediction and Kinetics of Quality Changes in Pineapple (*Ananas comosus*) Varieties at Different Storage Temperatures. *Horticulturae* 2022; 8, 992. https://doi.org/10.3390/horticulturae8110992.
22. Heyman MB, Abrams SA, Heitlinger LA, Cabana MC, Gilger MA, Gugig R, Hill ID, Lightdale JR, Daniels SR, Corkins MR, de Ferranti SD, Golden NH, Magge SN, Schwarzenberg SJ. Fruit Juice in Infants, Children, and Adolescents: Current Recommendations. *Pediatrics.* 2017; 139 (6): e20170967. https://doi.org/10.1542/peds.2017-0967.
23. Sahu P, Sushma, Srivasatava SK, Lal N. Nutraceuticals profiling of queen and king varieties of pineapple (*Ananas comosus*) (Pineapple). *International Journal of Chemical Studies.* 2017; 5(3): 25-31.
24. Park J, Kwock CK, Yang YJ. The Effect of the Sodium to Potassium Ratio on Hypertension Prevalence: A Propensity Score Matching Approach. *Nutrients*. 2016; 8 (8): 482, http://dx.doi.org/10.3390/nu8080482.
25. Alomaim H, Griffin P, Swist E, Plouffe LJ, Vandeloo M, Kumar A, Bertinato J. Dietary Calcium affects body composition and lipid metabolism in rats. *PLoS ONE* 2019; 14 (1): e0210760, https://doi.org/10.1371/journal.pone. 0210760.
26. Costello RB, Rosanoff A, Dai Q, Saldanha LG, Potischman N. A. Perspective: Characterization of Dietary Supplements Containing Calcium and Magnesium and Their Respective Ratio-Is a Rising Ratio a cause for concern. *Adv Nutr*. 2021; 12 (2): 291-297, (2021). https://doi.org/10.1093/advances/nmaa160.
27. Barrado E, Parodi J, Escobedo-Monge Ma, Marcos-Temprano M, Marugan-Miguelsanz JM. Magnesium Status and Calcium/ Magnesium Ratios in Aseries of Cyctic Fibrosis Patients. *Nutrients*. 2022; 14 (9): 1793. https://doi.org/10.3390/nu14091793.
28. Hojyo S, Fukada T. Roles of Zinc Signaling in the Immune System. *J. Immunol. Res.* 2016; 2016: 6762343, https://doi.org/10.1155/2016/6762343.
29. Kerkadi A, Alkudsi DS, Hamad S, Alkeldi HM, Salih R, Agouni A. The Association between Zinc and Copper Circulating Levels and Cardiometabolic Risk Factors in Adults: A Study of Qatar Biobank Data. *Nutrients*. 2021; 13 (8): 2729.
30. Shilpi S, Shivvedi R, Singh A. Vitamin-C: Properties, Function and Application in Cancer Therapy. *J Cancer Prev. Curr. Res.* 2018; 9 (6): 331-334.
31. Rashima SR, Maizura M, Hafzan WNWM, Hazzeman H. Physicochemical properties and sensory acceptability of pineapples of different varieties and stages of maturity. Food Research. 2019; 3 (5): 491 – 500. https://doi.org/10.26656/fr.2017.3(5).060