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NUTRITIONAL AND BIOCHEMICAL ANALYSIS OF LOCALLY PRODUCED WINE FROM A BLEND OF BANANA (MUSA SAPIENTUM) AND DATE PALM FRUIT (PHOENIX DACTYLIFERA L.)

Silas Verwiyeh Tatah[1], Philip Shadrach[2], and Moses Adondua Abah[3*]
Federal University Wukari, Taraba State, Nigeria
m.abah@fuwukari.edu.ng

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Abstract

Background: Wine is a low-alcohol beverage made from fresh grapes or grape juice through partial or complete fermentation. Wine contains many nutrients necessary for the human body, such as sugar, vitamins, amino acids, mineral elements, polyphenols etc. Objective: This project aimed at analysing the nutritional and biochemical composition of locally produced wine from a blend of banana and dates palm fruit. The study includes determining the proximate, phytochemical, mineral, physicochemical, and amino acid profiles. Methods: The method involves heating a crucible dish to eliminate moisture, determining fat content, defatting the sample, determining ash, and determining crude protein. The phytochemical analysis includes tests for saponin, flavonoid, alkaloid, and tannin. Mineral analysis was carried using an atomic absorption spectrophotometer, while physicochemical analysis includes alcohol, pH, and temperature measurements as well as determination of amino acid profile analysis of banana-date palm wine. Results: The proximate analysis revealed high moisture content (97.87%), suggesting a good source of fruit wine production. The wine contains low crude fibre (1.01%), low crude

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protein (0.14%), Ash content (0.49%) and low crude lipid (0.58%). The wine also contains antioxidant and anti-inflammatory properties. Physicochemical analysis revealed an average pH of 4.62 to 4.71, with sugar concentration decreasing daily over four days and two mineral elements were reveal which are potassium and phosphorus. The amino acid profile analysis of banana-date palm wine reveals that it contains both essential and non-essential amino acids. The essential amino acids include isoleucine, methionine, histidine, and phenylalanine, non-essential amino acids include glutamic acid, asparagine, proline, and cysteine. Conclusion: The findings of this study suggest that a blend of Banana (musa sapientum) and date palm fruit (Phoenix dactyliferal) wine has a unique pleasant aroma, and may have the potential to provide both essential and non-essential amino acids, provide other nutrients that are important for normal physiological function of the body.

Keywords: Phytochemicals, Proximate composition, Amino acid profile, Local wine, Banana, Date palm

INTRODUCTION

Wine is a low-alcohol beverage made from fresh grapes or grape juice through partial or complete fermentation (He *et al.*, 2023). Wine contains many nutrients necessary for the human body, such as sugar, vitamins, amino acids, mineral elements, polyphenols etc. These nutrients are combined with alcohol, organic acids, and aroma components to make the wine form a more unique sensory flavor and higher nutritional value (Giovinazzo and Francesco, 2019). Proper drinking of wine is beneficial to human health, and plays an important role in preventing atherosclerosis, kidney stones cancer and protecting ski (Acaroz *et al.,* 2019). According to statistics, the global wine productions in 2020 have reached 26 billion liters, an increase of 1 % compared with 2019. Hence, there is need for search of indigenous strain that could be used as an alternative.

Fruits such as banana, cucumber, pineapple, dates palm fruit and other fruits are used in wine production (Selli and Kelebek, 2015). Wine and dates palm fruit production is challenging in which marketable product can be obtained, but the processes involved in its production are relatively straight forward (Archibong *et al.*, 2015). Highly acceptable wines can be made from practically all fruits. Wine can be fermented with yeast that occurs naturally in grape which is the main organism responsible for alcoholic fermentation which belongs to the genus *Saccharomyces* (Saranraj *et al.,* 2017*).* Although, many genera and

species of yeast are found in must, *Saccharomyces cerevisiae* is the main yeast strain that is commonly reported to be responsible for alcoholic fermentation and in other countries where grape is not produced, emphasis is usually placed on other fruits for wine making (Saranraj *et al.,* 2017*)*. There are some soft fruits from both temperate and tropical regions whose pigment stability and flavor profiles match those of any wine from grapes, but suffer from the lack of intensive research and development given to grape wine (AOAC, 1990).

Bananas (*Musa sapientum*) are an important staple starchy food in Nigeria. It is a seasonal and highly perishable fruit, which can be available all year round (Shiru, 2023). The large quantity of bananas and plantains provides the potential for industrial use (Robinson and Charles, 2010). In addition, any application to produce a marketable, value-added product will improve banana farming economies and eliminate the large environmental problem presented by banana waste. Banana could then compete in the market, either as banana juice or as mixtures with other juices because of its flavor and aroma (Lee *et al.*, 2006). Bananas are considered to be a valuable dietary component due to their high content of dietary fiber, essential vitamins, and minerals. Banana peel makes up around half of the total mass of the fruit (35%–50%) out of all by-products of the banana such as pseudo-stems, leaves, and blossoms (Kumari *et al.*, 2023). Medicinal uses of banana have positive contribution towards successful treatment of anemia, heartburn, temperature control, ulcer, overweight (Bakrhu, 1995). Banana juice can also be applied to wine production; however, banana juice is turbid, gray in color, very viscous, tends to settle during storage and, therefore must be clarified prior to commercialization (Lee *et al.*, 2006). The turbidity and viscosity of banana wine are caused mainly by the polysaccharides in banana juice such as pectin and starch and therefore make the clarification process harder (Ramadan, 2019).

A member of the palm family, Arecaceae, the Phoenix dactylifera, more commonly known as the date palm, is a flowering plant mostly grown for its edible fruit. Even if its origin is still up for question, date fruits are a mainstay in the diets of people in the MENA region. Today, many tropical and subtropical areas across the globe primarily grow it for its fruit. A lot of people around the world, particularly in Europe, eat it presently (Tengberg, 2012). The maximum length of a date tree can reach 21–23 metres, while its leaves can reach 4-6 metres in length and contain about 150 leaflets. Native to the area, these trees typically sprout from a single trunk or a cluster of trunks. Dates are a good source of dietary fibre (6.5%-11.5% total; 10% soluble, 90% insoluble), along with a small amount of fat (1%), protein (2%),

and ash (2%). Ghimi et al. (2017) also found that it is abundant in phenolic antioxidants. Similarly, most of the sugar in soft dates is fructose and glucose, with very little sucrose, but most of the sugar in dry dates is sucrose. Since date fruits are packed with beneficial nutrients and antioxidants, researchers have tried to include them into functional diets (Selim et al., 2012).

Because of the high volume and great distances it must travel, the flavour and freshness of industrially made wine often diminishes. Because of the high energy and resource requirements of transportation, industrially produced wine is also bad for the environment. Since locally made wine is said to have a more sustainable production method and a greater feeling of local identity, these problems have prompted the need to improve the rate of locally produced wine. Some have even said it's more locally sourced, has a stronger flavour, and is fresher than the competition. Improving the quality and promoting the cultural and economic importance of locally produced wine from a blend of Banana and Date palm was the goal of this study, which attempted to analyse the nutritional and biochemical properties of the wine.

METHODS

Sample Collection

Banana and Date palm fruits were both obtained at the school gate of Federal University Wukari, Taraba State. Wine sample used for this project work was fermented using yeast extract in the Central Laboratory at Federal University Wukari, Taraba State. The wine sample was locally prepared and stored in a refrigerator.

Proximate Analysis

Determination of moisture content

A crucible dish was heated in a carbonate oven at 105 degrees Celsius for approximately 5 minutes to eliminate any residual moisture. The dish was then allowed to cool in a desiccator. The weight of the dish was recorded, and 10 ml of the wine sample was poured into the dish and reweighed. The dish with the sample was placed in the oven at 105 degrees Celsius for 24 hours. After cooling in a desiccator, the dish with the dried sample was weighed (Zhang *et al.,* 2020). The moisture content was calculated as follows: *Weight of*

moisture = (weight of sample and dish) (weight of dried sample and dish) % weight of dried sample = 100 % weight of moisture Dry matter = 100 - % weight of moisture

Determination of fat

The fat content was determined using method of Association of Official Analytical Chemists (Thiex, 2009). 10 ml sample of the wine was collected in a beaker and transferred to a thimble, which was then placed in the extractor chamber. Approximately 50 ml of petroleum ether was added to the beaker, and the thimble with the sample was positioned over it. The machine was powered on, and boiling and extraction were allowed to occur for 10 minutes. The thimble was raised for rinsing down the extracted fat into the beaker, followed by the removal of used petroleum ether for an additional 10 minutes. After removing the used petroleum ether, the beaker with the extracted fat was placed in an oven to evaporate the remaining petroleum ether. It was then cooled in a desiccator and weighed. The weight obtained was used to calculate the fat content as follows:

Weight of fat = (weight of sample and beaker) - (weight of empty beaker) % weight of fat =

(weight of fat/weight of sample and beaker) × 100

Determination of crude fiber

Crude fiber was determined using method of Association of Official Analytical Chemists (Thiex, 2009). A 10ml portion of the defatted sample was weighed and placed in a glass container. Then, 50ml of glacial acetic acid were added to the sample, which was heated at 200-400 ^{0}C in a fume cupboard for 45-60 minutes to facilitate digestion. After digestion, the sample was thoroughly filtered using pre-weighed filter paper and dried in an oven at 100 ^{0}C for 24 hours. The dried residue was weighed and recorded. The residue was further ached in a crucible at 580-600^{0}C for 4-5 hours in a furnace and weighed.

The calculation for fiber content was as follows:

Weight of residue = weight of filter paper + residue - weight of filter paper Weight of ash = weight of ash + crucible - weight of empty crucible

Weight of crude fiber = weight of ash - weight of residue

Determination of ash

Ash content was determined According to method described by Association of Official Analytical Chemists (Thiex, 2009), an empty crucible was weighed and recorded. Then 10ml of the sample were added to the crucible and ashes in a furnace at 500-600 ^{0}C for 2-4 hours. After ashing, the crucible was removed, cooled in a desiccator, and weighed.

The calculation for ash content was as follows:

Weight of Ash = (Weight of crucible + ash) - (Weight of crucible)

Percentage Weight of Ash = (Weight of ash / weight of sample) × 100

Determination of crude protein

The crude protein content was determined using the Kjeldahl method (Thiex, 2009). Approximately 10ml of the wine sample were weighed into a micro Kjeldahl digestion flask, and a selenium catalyst tablet was added. The mixture was digested on an electro thermal heater until a clear solution was obtained. After cooling, it was diluted with distilled water to a volume of 50ml. Five (5) milliliters of the diluted solution were transferred to a distillation apparatus. In a separate 100ml conical flask (receiver flask), 5ml of 2% boric acid and four drops of screened methyl red indicator were added. Approximately 50% NaOH was added to the digested sample until the solution turned cloudy, indicating alkalinity. Distillation was then carried out into the boric acid solution in the receiver flask, with the delivery tube placed below the acid level. As distillation proceeded, the pink-colored solution in the receiver flask turned blue, indicating the presence of ammonia. Distillation continued until the flask content reduced to about 50ml, and the delivery tube of the condenser was rinsed with distilled water. The resulting solution in the conical flask was titrated with 0.1M HCl (Thiex, 2009)

Phytochemical Analysis

Saponin determination

Saponin quantitative determination was carried out using the method reported by Ekpo *et al.* (2022). Exactly 100 cm^3 of 20% aqueous ethanol was added to 5 grams of wine sample in a 250 cm3 conical flask. The mixture was heated over a hot water bath for 4 hours with continuous stirring at a temperature of 55 ^{0}C. The residue of the mixture was reextracted with another 100 cm^3 of 20% aqueous ethanol after filtration and heated for 4 hours at a

constant temperature of 55 ^{0}C with constant stirring. The combined extract was evaporated to 40 cm^3 over water bath at 90 ^{0}C. 20 cm^3 of diethyl ether was added to the concentrate in a 250 cm^3 separator funnel and vigorously agitated from which the aqueous layer was recovered while the ether layer was discarded. This purification process was repeated twice. 60 cm^3 of n-butanol was added and extracted twice with 10 cm^3 of 5% sodium chloride. After discarding the sodium chloride layer the remaining solution was heated in a water bath for 30 minutes, after which the solution was transferred into a crucible and was dried in an oven to a constant weight. The saponin content was calculated as a percentage:

$$\% \quad \text{Saponin} = \frac{weight\ of\ saponin}{weight\ of\ sample} \times 100$$

Determination of flavonoids

Flavonoid determination was by the method reported by Ekpo *et al* (2022). Exactly 50 cm^3 of 80% aqueous methanol added was added to 2.50 g of sample in a 250 cm^3 beaker, covered, and allowed to stand for 24 hours at room temperature. After discarding the supernatant, the residue was re-extracted (three times) with the same volume of ethanol. Whatman filter paper number 42 (125 mm) was used to filter whole solution of wine sample. Wine sample filtrate was later transferred into a crucible and evaporated to dryness over a water bath. The content in the crucible was cooled in a desiccator and weighed until constant weight was obtained. The percentage of flavonoid was calculated as:

$$\% \quad \text{Flavonoid} = \frac{weight\ of\ flavonoid}{weight\ of\ sample} \times 100$$

Alkaloid determination

Quantitative determination of alkaloid was according to the methodology by Harborne (1998). Exactly 200 cm^3 of 10% acetic acid in ethanol was added to wine sample (2.50 g) in a 250 cm^3 beaker and allowed to stand for 4 hours. The extract was concentrated on a water bath to onequarter of the original volume followed by addition of 15 drops of concentrated ammonium hydroxide dropwise to the extract until the precipitation was complete immediately after filtration. After 3 hours of mixture sedimentation, the

supernatant was discarded and the precipitates were washed with 20 cm^3 of 0.1 M of ammonium hydroxide and then filtered using Gem filter paper (12.5 cm). Using electronic weighing balance Model B218, the residue was dried in an oven and the percentage of alkaloid is expressed mathematically as;

$$\% \quad \text{Alkaloid} = \frac{weight\ of\ alkaloid}{weight\ of\ sample} \times 100$$

Tannin determination

Analytical method for quantitative determination of tannin was according to method described by Ejikeme *et al.* (2014). By dissolving 50 ml of sodium tungstate (Na_2WO_4) in 37 cm^3 of distilled water, Folin-Denis reagent was made. To the reagent prepared above, 10 g of phosphomolybdic acid ($H_3PMo_{12}O_{40}$) and 25 cm^3 of orthophosphoric acid (H_3PO_4) were added. Two-hour reflux of the mixture was carried out, cooled, and diluted to 500 cm^3 with distilled water. One-gram wine sample in a conical flask was added to 100 cm^3 of distilled water. This was boiled gently for 1 hour on an electric hot plate and filtered using number 42 (125 mm) Whatman filter paper in a 100 cm^3 volumetric flask. Addition of 5.0 cm^3 Folin-Denis reagent and 10 cm^3 of saturated Na_2CO_3 solution into 50 cm^3 of distilled water and 10 cm^3 of diluted extract (aliquot volume) was carried out after being pipetted into a 100 cm^3 conical flask for colour development. The solution was allowed to stand for 30 minutes in a water bath at a temperature of 25°C after thorough agitation. With the aid of a Spectrum Lab 23A spectrophotometer optical density was measured at 700 nm and compared on a standard tannic acid curve. Dissolution of 0.20 g of tannic acid in distilled water and dilution to 200 cm^3 mark (1 mg/cm^3) were used to obtain tannic standard curve. Varying concentrations (0.2–1.0 mg/cm^3) of the standard tannic acid solution were pipetted into five different test tubes to which Folin-Denis reagent (5 cm^3) and saturated Na_2CO_3 (10 cm^3) solution were added and made up to the 100 cm^3 mark with distilled water. The solution was left to stand for 30 minutes in a water bath at 25°C. Optical density was ascertained at 700 nm with the aid of a Spectrum Lab 23A spectrophotometer. Optical density (absorbance) versus tannic acid concentration was plotted. The following formula was used in the calculation:

Tannic acid ($\frac{mg}{100g}$) = C× extract volume × 100 Aliquot volume × weight of sample

Determination of phenols

Analytical method for quantitative determination of phenols was done according to method described by Ejikeme et al. (2014). Defatting of 2 g wine sample was carried out for 2 hours in 100 cm_3 of ether using a soxhlet apparatus. The defatted sample (0.50 g) was boiled for 15 minutes with 50 cm^3 of ether for the extraction of the phenolic components. Exactly 10 cm^3 of distilled water, 2 cm^3 of 0.1 N ammonium hydroxide solutions, and 5 cm^3 of concentrated amyl alcohol were also added to 5 cm^3 of the extract and left to react for 30 minutes for colour development. The optical density was measured at 505 nm. 0.20 g of tannic acid was dissolving in distilled water and diluted to 200 mL mark (1 mg/cm^3) in preparation for phenol standard curve. Varying concentrations (0.2–1.0 mg/cm^3) of the standard tannic acid solution were pipetted into five different test tubes to which 2 cm^3 of NH_3OH, 5 cm^3 of amyl alcohol, and 10 cm^3 of water were added. The solution was made up to 100 cm^3 volume and left to react for 30 minutes for colour development. The optical density was determined at 505 nm.

Determination of Minerals: Phosphorus And Potassium

The minerals in the wine sample (Phosphorus and Potassium) were analyzed using the spectrophotometer. 2 ml of the wine sample was collected in a 50 cm volumetric flask followed with 2 ml of perchloric acid, 1 ml of H_2SO_4 and 5ml of HNO_3. The mixtures were placed on a water bath and evaporated almost to dryness. The solution was cooled and filtered into 100 ml standard flask.

Physicochemical Analysis

Sugar

The alcohol content of the wine sample was estimated using a refractometer. Two drops of the wine sample were placed on the refractometer's prism, and the alcohol percentage was directly viewed and recorded.

pH

The pH meter used for the analysis was calibrated using distilled water. 2ml of the wine sample were accurately weighed and dissolved in 25ml of distilled water in a conical flask. The pH meter's electrode was inserted into the beaker containing the solution, and the reading was directly taken from the meter's screen.

Temperature

The temperature of the wine sample was measured using a laboratory thermometer. 2ml of the wine sample were mixed with 20ml of distilled water in a 100ml beaker, and the thermometer was directly inserted into the solution.

Amino acid profile

The amino acid composition of the wine was analyzed using HPLC and a colorimeter (Lu *et al.,* 2015). The different amino acids present in the sample were separated based on their charges and collected in separate containers by eluting with a sodium extract buffer. Each amino acid was identified by calculating the volume of buffer required for elution and determining its pH, comparing it with a standard. A fixed volume of each identified amino acid was collected in test tubes, and ninhydrin solution was added to each. The test tubes were covered with aluminum foil and placed in a boiling water bath for 15 minutes. After cooling in cold water, 50% ethanol was added to each test tube and mixed thoroughly. The concentration of each amino acid was determined using colorimetric method

RESULTS

Proximate Composition of a Blend of Banana and Date Palm Wine

The results of the nutritional composition revealed that banana with blend of date palm fruit wine is rich in proximate nutrient as shown in Table 2. The wine was shown to have moisture of 97.87 %, ash content of 0.49 %, fat of 0.58 %, crude fiber of 1.01 % and protein of 0.14 %.

Table 1. Proximate composition of a blend of banana and date palm wine

Parameter	Concentration (%)
Moisture content	97.87
Ash content	0.49
Crude fibre	1.01
Crude lipid	0.58
Crude protein	0.14

Phytochemical Composition of a Blend of Banana and Date Palm Wine

Table 2 shows the phytochemicals that were identified from the wine. The quantities of the various phytochemicals were also shown in the table. The most abundant phytochemicals present in the wine and their concentration are; Tannin (12.38 mg/100 ml), Flavonoid (6.81 mg/100 ml), Saponin (3.06 mg/100 ml) phenolic (14.21 mg/100ml) and Alkaloid (12.38 mg/100 ml).

Table 2. Phytochemical composition of a blend of banana and date palm wine

Parameter	Concentration (mg/100ml)
Saponin	3.06
Flavonoid	6.81
Alkaloid	7.11
Tannin	12.38
Phenolic	14.21

Mineral Composition of A Blend of Banana With Date Palm Wine

The mineral composition of banana-date palm wine is shown in the table below. The presence and concentration of Potassium and Phosphorus in the wine were both analyzed. The results of the mineral composition of a blend of banana with date palm wine were revealed in the Table 3. It contains potassium (2.19 ppm) and phosphorus (3.51 ppm)

Table 3. Mineral composition of a blend of banana with date palm wine

Parameter	**Concentration (ppm)**
Potassium	2.19±0.002
Phosphorus	3.51±0.002

Physicochemical Composition of a Blend of Banana and Date Palm Wine

The Table 4 shows that the hydrogen ion concentration of the wine determines it acidity. It also shows the temperature of the wine it density and sugar content

Table 4: Physicochemical composition of a blend of banana and date palm wine

Day	**Temperature**	**P^H**	**Density**	**Acidity**	**Sugar**
1	27.7	4.62	0.883	4.5	5.00
2	26.2	4.69	0.985	5.2	4.00
3	27.8	4.64	0.920	5.7	4.50
4	27.5	4.71	0.884	2.9	4.10

Amino Acid Profile of Banana and Date Palm Wine

The wine contains both essential and non-essential amino acids as demonstrated in Table 5. Four essential amino acids were revealed, they include; iosleucine, methionine,

phenylalanine and histidine. The non-essential amino acids revealed were glutamic acid, asparagine, proline, cysteine

Table 5. Amino acid profile of banana and date palm wine

Compound name	Amount (%)	Amount (μL)
Asparagine	1.6	11.266
Methionine	1.4	9.768
Histidine	8.0	56.147
Phenylalanine	6.0	42.075
Proline	8.2	57.689
Glutanic acid	21.7	157.701
Isoleucine	51.6	362.494
Cysteine	1.6	11.001

DISCUSSION

Wine, traditionally produced by fermenting blend of banana and date palm, has shown to have significant health benefits when consumed in moderation. Recently, there has been growing interest in producing wine from fruits other than grapes. However, the scientific literature suggests that limited research has been conducted on banana commonly known as *Musa sapientum* and *Phoenix dactyliferal*, commonly known as the date fruit. In this study, we conducted a comprehensive analysis of the nutritional and biochemical properties of locally prepared wine from *Musa sapientum* and *Phoenix dactyliferal*. This analysis includes amino acid profiling, physicochemical characterization, phytochemical composition, proximate composition, sugar alcohol content, and mineral composition.

The result of proximate analysis shows that the wine has high moisture content (97.87%) which shows the wine has high moisture content, which make sense giving that it is made from fruit. The wine contains (0.49%) ash content, which suggests that there are few minerals present in the wine. It also content low crude fiber (1.01%), which means that the wine is low in dietary fiber and low in crude protein (0.58%), which means that there is

low amount of protein in the wine. The wine also contains low amount of crude lipid (0.14%), suggesting that the wine is relatively low in fat. The result obtained was slightly similar to that of Tatah et al. (2023). The phytochemicals constituent of locally produced wine from *phoenix dactylifera,* but the result observed has higher amount of moisture content, ash, crude fiber and low amount of protein and fat.

Phytochemical analysis of banana-date palm wine shows that bioactive compounds were present in the banana-date palm wine. The wine contains saponin, alkaloid, tannin, flavonoid and phenolic compound, which accounts for the antimicrobial, anticancer and anti-diabetic properties. These were the phytochemicals present in the wine and their concentration; saponin 3.06 mg/100ml, flavonoid (6.81mg/100ml), alkaloid (7.11mg/100ml), tannin (12.38mg/100ml) and phenolic compound (14.21 mg/100ml).The result obtained in this analysis were slightly higher than that of Tatah *et al.* (2023). The phytochemical constituents of the locally produced wine from *phoenix dactyliferal* indicate that the wine has moderate or high amount of bioactive compounds. This reveals that the wine may have antioxidant, antimicrobial, antiviral, anticancer and anti-inflammatory properties.

The mineral composition of banana-date palm wine that was examine are potassium and phosphorus, the concentration of the mineral are as follows; potassium (2.19 ± 0.002) and phosphorus (3.51±0.002), This shows that the wine contain (2.19ppm) which is a moderately high concentration of potassium, this suggest that the wine is a good source of potassium, which play an important role in muscle concentration and maintaining normal blood pressure, it also contain (3.51ppm) phosphorus, which is moderately high. This indicates that the wine sample is a good source of phosphorus and rich in the two important minerals. The result obtained was slightly similar to that of Tatah *et al* (2023).

Physicochemical composition of banana-date palm wine observed from the analysis carried out indicates that the wine has an average pH within 4.62 to 4.71 which is slightly acidic, while the sugar concentration of the wine gradually decreases in a daily basis occur at the space of four days from 5.0 to 4.10, temperature of 27.5°C sugar content of 4.1 According to Tatah *et al.,* (2023) Physicochemical properties of locally produced wine from *Cucumis melo L* wine revealed a pH of 3.60, temperature of 23.0°C, and total sugar of 2.8 ± 0.28 %. Comparing the result of this study to that of Tatah *et al* (2023) show that the wine has high sugar content compares to that of Tatah *at el* (2023). The result of temperature

obtained from this study showed slight difference to that of Tatah *et al* (2023). This difference could be due to the difference in raw material used or due to difference in season the analysis was carried out.

Amino acid composition of banana-date palm wine shown in table 5 was found to contain both essential and non- essential amino acid. Isoleucine methionine, histidine, phenylalanine are some essential amino acid found in banana-date palm wine. Banana-date palm contain (51.6%) of isoleucine, methionine (1.4%), phenylalanine (0.6%), histidine (0.8%). Non-essential amino acids in banana-date palm wine include glutamic acid (2.7%), asparagine (1.6%) proline (8.2%) and cysteine (1.6%). According to Tatah et al. (2023) Nutritional and biochemical analysis of wine locally produced from phoenix, contain essential amino acids like isoleucine, leucine, histidine, lysine, and threonine, as well as non-essential amino acids like glutamine, glutamic acid, serine, alanine, proline, and aspartic acid, were identified from the study. Some amino acids such as asparagine, glutamine, serine, and glutamic acid were found in higher concentrations: 132.4±7.3mg/100ml, 122.5±5.5mg/100ml, 117.9±1.4mg/100ml, and 260.4±11.0mg/100ml, respectively. Various minerals including lead, aluminum, calcium, zinc, phosphorus, sulfur, and iron were detected in the wine, with concentrations falling within the recommended daily allowance by WHO. For example, the estimated concentrations of potassium, phosphorus, and zinc were 4.90mg/100ml, 2.60mg/100ml, and 0.09mg/100ml, respectively, while the WHO recommended daily allowances for these minerals are 3500mg, 1000mg, and 15mg, respectively

CONCLUSION

Based on the findings of this study, several conclusions can be drawn regarding the nutritional and biochemical aspects of the banana-date palm fruit wine: The nutritional profile showed that essential minerals, vitamins, and antioxidants properties can be provided by both banana and date palm fruit. These nutrients may contribute to the wine's potential health benefits, such as improve antioxidant status and micro nutrients intake. The biochemical analysis revealed important parameters such as alcohol contents, acidity levels, phenolic compounds, sugar content. These properties not only influence the sensory characteristics of the wine but also contribute to its overall quality and shelf life. The presence of bioactive compounds in the wine, including phenolic and antioxidants,

suggests potential health benefits such as antioxidant activity, anti-inflammatory effects, and cardiovascular protection. Further studies are needed to explore these health promoting properties in detail.

Author Contributions

Tatah Verwiyeh Silas: Research idea conceptualization, supervised laboratory work and Manuscript proofreading.

Philip Shadrach: Developed and proofread the manuscript

Moses Abah Adondua: Manuscript editing and proofreading.

Conflict of Interest

All contributing authors declared no conflict of interest

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