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INDIGENOUS FOOD SYSTEMS AS ECONOMIC CATALYSTS: UNLOCKING THE NUTRITIONAL AND MARKET POTENTIAL OF HAEMATOSTAPHIS BARTERI IN THE UPPER WEST REGION OF GHANA

Saan, R.[1], Saan, R.[2], Kaburi, S. A.[3], and Donani, M.[4]
[1]*Department of General and Liberal Studies, Dr. Hilla Limann Technical University, Wa, Ghana.*
[2] *Department of Language and International Relations, Tamale Technical University, Tamale, Ghana.*
[3]*Department of Food Sciences and Postharvest Technology, Cape Coast Technical University, Ghana.*
[4] *Department of Mechanical Engineering, Dr. Hilla Limann Technical University, Wa, Ghana.*
[1]*rhodasaan@gmail.com*

ABSTRACT

Purpose: The purpose of this study is to investigate the nutritional, economic, and microbial properties of *Haematostaphis barteri* (zimberima), an underutilised indigenous fruit in Ghana's Upper West Region, and to evaluate its potential as a raw material for wine production.

Design/Methodology/Approach: Ripe *Haematostaphis barteri* fruits were harvested in 2023 and processed to extract juice, which was fermented to produce "Jimb Wine". Proximate and mineral compositions were analysed using standard Association of Official Analytical Chemists (AOAC) methods. A microbial test was conducted to assess the presence of Enterobacteriaceae, yeast, and mould to ensure safety. The alcohol and Vitamin C contents were also measured to determine the wine's nutritional value. The data were subjected to analysis of variance (ANOVA). The statistical package used was the Student Edition of Statistix 9.0

Research Limitation: The study was conducted within a single harvest season and a specific geographic location within Ghana's Upper West Region, which may not capture variations in fruit composition due to climate, soil, or seasonal changes. Consumer sensory evaluation and long-term storage stability were not assessed.

Findings: *Haematostaphis barteri* wine (Jimb Wine) possesses high nutritional value, with carbohydrate, fibre, and protein contents of 59.4%, 12.05%, and 8.8%, respectively. Mineral analysis revealed significant levels of potassium (970.81 mg/l), calcium (192.08 mg/l), and phosphorus (111.49 mg/l), which contribute to the wine's flavour and stability. Microbial testing confirmed the absence of Enterobacteriaceae, indicating product safety, while the presence of yeast and mould supported its natural fermentation potential. The final wine contained 9.46% alcohol and retained 78% of its original Vitamin C, highlighting its potential as a nutritious, locally made beverage.

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Practical Implication: *Haematostaphis barteri* can be effectively used to produce a safe, nutritious, and marketable fruit wine, offering a viable opportunity for food diversification and value addition.
Social Implication: Promoting this indigenous fruit supports rural innovation, encourages sustainable use of local resources, and helps combat poverty through income diversification.
Originality/Value: It highlights the underexplored value of an indigenous fruit traditionally used by the Dagaba people. The findings provide a foundation for further research, commercialisation, and policy support to promote indigenous crops for sustainable livelihoods and food security.
Keywords: *Extinction. food. haematoataphis barteri. nutrition. socio-economic*

INTRODUCTION

Indigenous Fruits and vegetables play a very crucial role in the livelihood of rural people in developing countries (Chatepa & Masamba, 2020; Uusiku et al., 2010; Zemede & Mesfin, 2001). In the developing world, many rural areas have limited food resources, resulting in a deficiency of essential nutrients (FAO et al., 2012; Tanumihardjo & Yang, 2005). According to Chatepa and Masamba (2020), rural poor people depend on locally available indigenous fruits and vegetables for income and food (Ebert, 2014; Zemede & Mesfin, 2001).

Many of these vegetables and fruits also serve as raw materials for the processing of beverages for families and commercial purposes. They constitute an indispensable constituent of the human diet in Ghana, generally, and the Upper West region in particular. The varieties of fruits utilised are diverse, ranging from fruits of annuals and shrubs to fruits of trees.

Fruit beverages are generally good sources of nutrients. They are important protective foods and highly beneficial for maintaining health and preventing diseases, as they contain valuable food ingredients that can be utilised to build up and repair the body.

One such fruit is *Haematostaphis barteri* (zimberima or jimbrima). It is an annual tree fruit commonly used as a sweetener in porridge and for producing wine in the Upper West region, especially among the Dagaba tribe. However, *Haematostaphis barteri* is underutilised. The *Haematostaphis barteri* tree, which usually grows in the wild, most often has lots of fruits which are not harvested and end up drying on the trees. Many of these trees are felled by farmers to make room for farming or to be used as firewood or charcoal making.

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This tree, with the potential to significantly contribute to nutrition and food security as well as the economic well-being of rural communities, especially in the Upper West Region of Ghana, is prone to extinction due to persistent yearly bushfires and indiscriminate felling.

Haematostaphis barteri is a tree belonging to the Anacardiaceae family. Its fruit is a red-purple drupe with a thin, acidic pulp and a resinous flavour (Kubmarawa, Andenyang, & Magomya, 2009). It is an endemic plant species with a high economic potential that mostly grows on rocky soils in the savanna zone in Ghana, especially in the Northern, Upper East and West Regions and in Borno and Adamawa States of Nigeria (Bokhari & Ahmed, 1979) as cited in Kubmarawa, Andenyang, and Magomya, (2009). It has several uses by the local populations, but very little knowledge is documented on its uses and how these uses potentially can impact the socio-economic and nutritional food dynamics of the region.

This study explored the economic and nutritional benefits of *Haematostaphis barteri* in Ghana based on the assessment of its indigenous uses as an alcoholic and non-alcoholic beverage in the Upper West Region of Ghana.

LITERATURE REVIEW

Under-utilised fruits constitute an essential yet often neglected aspect of agricultural biodiversity, offering significant socio-economic and nutritional opportunities for rural communities. In Ghana, many indigenous fruits remain largely unexploited despite their potential nutritional and economic benefits. Among these, Haematostaphis barteri, popularly known as pink grapes, remains notably under-researched, although local communities in the Upper West Region acknowledge its beneficial uses.

Socio-economic Significance of Under-utilised Fruits

Increasingly, under-utilised fruits are recognised for their potential to alleviate poverty, enhance food security, and improve rural livelihoods (Schreckenberg et al., 2021; Leakey & Simons, 2020). Indigenous fruit trees substantially contribute to household incomes, particularly benefiting rural women and youth involved in harvesting, processing, and marketing these fruits (Maroyi, 2022). Typically, such fruits are sold locally or regionally, providing an important supplementary income source and strengthening the economic resilience of rural households.

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Dovie et al. (2020) highlighted that under-utilised indigenous fruits significantly support rural livelihoods by diversifying income sources, reducing vulnerability to economic uncertainties, and generating employment opportunities. Specifically, in Ghana, Owusu-Amankwah et al. (2021) indicated that promoting indigenous fruit trees could alleviate rural poverty, encourage local entrepreneurship, and reduce rural-urban migration.

Nutritional Potential of Under-utilised Fruits

Under-utilised fruits are nutritionally dense, containing essential nutrients and bioactive compounds that enhance dietary diversity and nutritional security (Fraikue et al., 2024; Bvenura & Sivakumar, 2017). Fruits such as Haematostaphis barteri are reported to be rich in vitamins, minerals, antioxidants, and dietary fibres, contributing significantly to improved health outcomes by reducing the prevalence of chronic diseases and malnutrition (Leakey & Akinnifesi, 2017).

Awodoyin et al. (2015) emphasised the nutritional value of indigenous fruits, documenting their high content of vitamins C and E, carotenoids, flavonoids, and phenolic compounds with anti-inflammatory and antioxidant properties. Similarly, Anhwange et al. (2019) noted that indigenous fruits, including Haematostaphis barteri, possess significant nutritional benefits surpassing those of many commonly consumed fruits.

Overview Haematostaphis barteri (Pink Grapes)

Haematostaphis barteri is part of the Anacardiaceae family and is indigenous to sub-Saharan Africa, particularly in semi-arid regions. Traditionally, these fruits are consumed fresh or processed into juices, jams, or alcoholic beverages (Maroyi, 2022). Despite their substantial cultural and dietary importance, they remain under-explored scientifically and commercially.

Akinnifesi et al. (2018) highlighted that insufficient research, inadequate market structures, and limited consumer awareness significantly impede the full exploitation of fruits like Haematostaphis barteri. These challenges simultaneously present opportunities for promoting these fruits as viable economic and nutritional resources.

Utilisation Haematostaphis barteri in Ghana

In Ghana's Upper West Region, the usage of Haematostaphis barteri remains informal, predominantly characterised by subsistence-level harvesting with limited market connectivity. The fruit’s seasonal availability and perishability further restrict its market potential, necessitating investments in post-harvest handling technologies and preservation methods (Owusu-Amankwah et al., 2021).

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Moreover, a general lack of awareness regarding the fruit's nutritional and economic advantages among stakeholders and consumers poses significant barriers. Typically, local consumption of Haematostaphis barteri occurs without awareness of its wider nutritional and economic potential (Asante & Kwame, 2020).

The socio-economic and nutritional potential of under-utilised fruits like Haematostaphis barteri remains considerable yet largely unexploited. Addressing these gaps through enhanced knowledge dissemination, consumer education, improved market access, and investment in post-harvest technology is essential for sustainably harnessing these resources. Prioritising these under-utilised fruits through targeted research and policy interventions can significantly enhance nutritional security and socio-economic stability in Ghana's Upper West Region.

METHODOLOGY

Preparation of Pink Grapes Wine

Haematostaphis barteri fruits were harvested in June 2023, sorted, and washed, and a two-kilogram worth of it was crashed into a paste. The paste is then added to a fifty-litre drum of water. Refined sugar was then added to facilitate the fermentation process. The mixture was allowed to stand for 21 days in air-tight plastic drums, with the storage duration split into a fourteen-day block and a seven-day block. At the end of the first fourteen days, the content is sieved out and stored for the remaining seven days to get an appreciable alcoholic content. This process produced a fruit drink called "Jimb Wine" (the name offered by the authors of this paper).

On the other hand, the non-alcoholic version follows the same procedure but is not stored to ferment; instead, it is utilised the same day or preserved and stored in a refrigerator.

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Plate 1: Pink grapes

Plate 2: fermentation process

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Plate 3: Finished product of bottled Jimbwine

Laboratory Analysis of Pink Grapes and Wine

Proximate Analysis
The proximate analysis was conducted using (AOAC, 2008)

Moisture Determination
Ceramic crucibles underwent washing, drying, and weighing. A 10–12 g sample was placed into crucibles, cleaned, and dried in the oven. The crucibles holding the sample were spread over the oven's base to guarantee a uniform heat distribution. Afterwards, they were held at 105°C for 48 hours in an oven with a thermostat. The samples were taken out after the time, weighed, and allowed to cool in a desiccator. Each sample was replicated three times. The proportion of water lost by the sample was then used to compute the moisture content.

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Ash Determination

The dried samples were heated gradually for approximately an hour at 105°c in an oven, and then they were placed in an overnight furnace set at 550°c. The heating process was continued until all of the carbon particles had been burned off. After being taken out of the furnace, the ash in the dish was weighed after cooling in a desiccator. After that, the ash content was computed as a percentage of the initial sample.

Oil/Fat Determination

A 50 × 10 mm Soxhlet extraction thimble was filled with 10–12g of the ground materials. This was moved to a soxhlet extractor with a 50 ml capacity. Weighing was done on a dry, clean 250 ml round-bottom flask. A heating mantle was used as a source of heat during the six-hour extraction process, which involved adding 150 millilitres of petroleum spirit and connecting it to the soxhlet extractor. The flask was taken out after six hours and put in an oven set to 60℃ for two hours. Once taken out, the round-bottom flask was weighed and allowed to cool in a desiccator. The following formula was used to get the fat/oil percentage.

Calculation

Crude Fat (%) = $\frac{\text{W (g)} \times 100}{\text{Sample (g)}}$,
where W is the Weight of Oil

Protein Determination

Protein was determined using the Kjeldahl technique, which consists of three steps: digestion, neutralisation or distillation, and titration.

Digestion

A 100 ml Kjeldahl flask was filled with around 0.2g of the sample. After adding 4.4 ml of the digestion reagent, the samples were digested for two hours at 360 °C. A blank was ready. The same procedure was used for digesting the mixture without a sample. Following digestion, the digests were quantitatively transferred and volumetrically reconstituted into 100 ml flasks.

Distillation

An apparatus for steam distillation was assembled. For approximately twenty minutes, distilled water was used to clean the distillation apparatus. Following equipment cleaning, a 100 ml conical flask was filled with 5 ml of boric acid indicator solution and placed beneath the distillation apparatus's condenser, with the condenser's tip fully submerged in the boric acid solution. Using

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the trap funnel, an aliquot of the sample digest was moved to the reaction chamber. To initiate the distillation process immediately, 10 ml of the alkali mixture was added, and 50 ml of the distillate was collected.

Titration

With a 0.1 N HCl solution, the distillate was titrated until the solution turned from green to the original colour of the indicator, which was wine red. The sample titre value was reduced by treating the digestion blanks in the same manner. The protein content and nitrogen were determined using the titre values that were obtained. 6.25 was the conversion factor applied.

$$\%\text{Total Nitrogen } (\%N) = \frac{(\text{Sample titre value} - \text{Blank titre value}) \text{ X } 0.1 \text{ x}0.01401 \text{ x } 100}{sample\ weight\ X\ 10}$$

$$\%\text{ Protein} = \%N \text{ x } 6.25$$

Crude Fibre Determination

Reagents:-

- Sodium hydroxide, 1.25%

1.25%. Dissolve 12.5g NaOH in 700 ml distilled water in a 1000 ml volumetric flask and dilute to volume.

- Sulphuric Acid, 1.25%

Add 12.5g concentrated Sulphuric acid to a volumetric flask containing 400 ml of distilled water and dilute to volume.

Procedure

After weighing and adding 1g of the sample to a boiling flask, 100 ml of the 1.25% sulphuric acid solution was added, and the mixture was allowed to boil for 30 minutes. Filtration was carried out in a numbered sintered glass crucible following the boiling. After returning the residue to the boiling flask, 100 ml of the 1.25% NaOH solution was added, and the mixture was allowed to boil for 30 minutes. Following the boiling, the residue was rinsed with hot water and methanol, and the filtration process resumed. After being dried overnight at 105 degrees in the oven, the crucible was weighed. For approximately four hours, the crucible was kept in a furnace set at 500°c. In a desiccator, the crucible was gradually cooled to room temperature before being weighed.

Calculation

$$\%\text{ Crude fibre} = \frac{\text{weight loss thro ashing}}{\text{Sample weight}} \times 100$$

Carbohydrate

The total carbohydrate was determined by difference.

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Mineral Analysis

The mineral analysis was done using the method used by Kaburi et al. (2022). Using atomic absorption spectrophotometry and a flame photometer (GBC Scientific Equipment Ltd., Dandenong, Australia), the mineral content of the samples was ascertained following AOAC (1990).

Microbial Analysis

Three samples of the already prepared wine were randomly selected, and 1 ml of wine was aseptically drawn from each sample and serially diluted in sterile water to 106. The presence of Enterobacteriaceae was determined by the pour plate method, where 0.1 ml of each dilution was added to 20 ml of molten MacConkey agar and thoroughly mixed. The mixed agar was poured into a sterile petri dish and allowed to solidify. The solidified agar was then incubated at 37 °C for 24 hours. The same procedure was used to test for yeasts and moulds using Saboroud Dextrose Agar (SDA). The SDA was incubated at 28 °c for seven days to ensure the total growth of all yeast and moulds (Bassey et al., 2023). The results are indicated in Table 1.

Statistical Analysis

The means were calculated and subjected to analysis of variance (ANOVA). The statistical package used was the Student Edition of Statistix 9.0

RESULTS AND DISCUSSION

Nutritional Composition of Pink Grapes

The nutritional composition of the pink grapes used for the wine is shown in Table 1 below. The results of the nutritional composition of the pink berries (*Haematostaphis barteri*) that were used for the wine were carbohydrate (59.40 %), fibre (12.05%), protein (8.80%), oil (4.90%), ash (4.05%) and with a moisture content of (10.80%). The nutritional composition of pink berries (Haematostaphis barteri) indicates a rich and diverse profile suitable for wine production and potentially other food products. The berries have high carbohydrate content, which is beneficial for wine production as carbohydrates (especially sugars) are essential for fermentation. Yeasts convert these sugars into alcohol and carbon dioxide, making the high carbohydrate level favourable for producing an alcoholic beverage (Walker & Stewart, 2016). The relatively high fibre content suggests that the pink berries can contribute to digestive health when consumed (Yahia et al., 2017).

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Table 1: Nutritional Composition of Pink Grapes

Proximate Composition	Pink Grapes (%)
Moisture	10.80
Ash	4.05
Protein	8.80
Oil	4.90
Fibre	12.05
Carbohydrate	59.40

Source: Laboratory Analysis (2024)

In wine, while the fibre may not directly influence the fermentation process, it may provide additional health benefits when consumed in moderation. The moderate protein content in the berries indicates a potential source of amino acids, which can have various functional roles, including influencing flavour and texture. However, proteins are generally not the primary focus in wine production, and they may be filtered out during the winemaking process (Claus & Mojsov, 2018). The presence of oil in the berries, although relatively low, suggests a contribution to the flavour profile of the wine. Oils can add complexity and mouthfeel to the beverage. However, excessive oil content might affect clarity, which would need to be managed during wine production.

The ash content represents the total mineral content in the pink berries. Minerals are important for fermentation as they can act as nutrients for yeast (Maicas, 2020). This mineral richness may support a balanced fermentation process and contribute to the overall nutritional profile of the wine. The moisture content indicates that the berries have relatively low water content, which may be advantageous in wine production as it implies a higher concentration of fermentable solids. Low moisture also helps preserve the berries before processing and might reduce the risk of spoilage.

Mineral Composition of Pink Grapes

The profile of the mineral composition of the pink grapes used in the preparation of the wine is shown in Table 2. The pink grapes contained a high amount of Potassium (4276.38 µg/g), followed by Phosphorus (2927.19 µg/g). The most prevalent mineral in these grapes, potassium, is crucial for preserving ionic balance and enhancing fruit ripening. It affects the grape's acidity and controls water retention in the cells, which enhances the flavour and stability of the wine (Conde et al., 2007). However, excessive potassium levels can also harm the colour of the juice during storage (Morris et al., 1983).

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This high phosphorus concentration supports robust growth and fruit development in grapevines, ultimately affecting the grape's flavour, sweetness, and quality (Conde et al., 2007)

High potassium and phosphorus levels are crucial, as they affect the acidity, flavour, and maturity of the fruits and the wine. Moderate levels of iron (93.12 µg/g), zinc (334.10 µg/g), and copper (282.97 µg/g) also quietly support flavour development and general vine health. In wine production, controlled copper content is beneficial, as it influences fermentation, stability, and shelf life by acting as a natural antioxidant (Pretorius, 2006).

Table 2: Mineral Composition of Pink Grapes

Mineral Composition	Pink Grapes (ug/g)
Phosphorus(P)	2927.19
Potassium(K)	4276.38
Sodium (Na)	1304.72
Calcium (Ca)	1.10
Magnesium (Mg)	0.21
Iron (Fe)	93.12
Zinc (Zn)	334.10
Copper (Cu)	282.97

Source: Laboratory Analysis (2024)

Mineral Composition of Pink Grape Wine

After the grapes had been turned into wine, the highest mineral present in the wine was Potassium (K) (970.81 mg/L), followed by Calcium (192.08mg/L) and Phosphorus (P) (111.49 mg/L) as shown in Table 3. Potassium is the most abundant mineral in pink grape wine produced and is necessary for balancing acidity (Conde et al., 2007). This mineral influences the pH level, enhancing the wine's flavour and smoothness, which are essential attributes for a pleasant mouthfeel (Kodur, 2011). Phosphorus levels in pink grape wine contribute to enzymatic reactions during fermentation, supporting yeast activity. Its presence is significant for wine quality as it can subtly affect flavour stability and preservation. Calcium contributes to the prevention of crystal formation, particularly during storage, ensuring the wine remains clear and sediment-free (Rossi et al.,2022). A refined end product is ensured by minerals such as magnesium, iron, zinc, and copper, which also improve fermentation efficiency and provide subtle yet significant aspects to the wine's flavour and clarity (Rossi et al., 2022).

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Table 3: Mineral Composition of Pink Grapes Wine

Mineral Composition	Pink Grapes Wine (mg/L)
Phosphorus (P)	111.49
Potassium (K)	970.81
Sodium (Na)	78.75
Calcium (Ca)	192.08
Magnesium (Mg)	14.56
Iron (Fe)	45.08
Zinc (Zn)	10.39
Copper (Cu)	13.18

Source: Laboratory Analysis (2024)

Microbial load of wine

The absence of *Enterobacteriaceae* in the fermented *Haematostaphis barteri* wine aligns with established microbiological standards, indicating good hygiene and safety in food and beverage processing. According to AuWerter (2021), *Enterobacteriaceae* are commonly used as indicator organisms to assess the sanitary quality of food and water; their absence typically reflects effective hygiene and low risk of pathogen presence. This finding is consistent with the work of Kort, et al. (2015), who observed that well-fermented indigenous beverages in Nigeria exhibited no detectable *Enterobacteriaceae*, underscoring the role of controlled fermentation in microbial safety. Furthermore, the presence of yeast and mould, particularly at low levels, supports natural fermentation and is beneficial in beverage production. As reported by Malfeito-Ferreira, & Silva, (2019), yeast, especially *Saccharomyces cerevisiae*, is central to wine fermentation and contributes not only to alcohol production but also to microbial stability by inhibiting the growth of spoilage organisms. Similarly, Legras et al. (2016) emphasised that native yeast strains can enhance both fermentation efficiency and the sensory profile of traditional wines. These findings confirm the suitability of *Haematostaphis barteri* for safe, hygienic, and effective wine production using its native microbiota.

Table 3: Microbial load of wine

Dilution factor	Enterobacteriaceae	Yeast and moulds	CFU/ml
10^1	0	7	$7\times10^1\pm3.11$
10^2	0	2	$2\times10^2\pm0.89$
10^3	0	3	$3\times10^3\pm1.33$
10^4	0	0	0
10^5	0	0	0
10^6	0	0	0

Source: Laboratory Analysis (2024)

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Presence of metals, Alcohol, and vitamin C

Table 4, shown below, also indicates a 9.46% alcohol and 78% vitamin C level presence in the wine. The detection of 9.46% alcohol and 78% Vitamin C in *Haematostaphis barteri* wine supports existing evidence on indigenous fruits' nutritional and functional potential in beverage production. The alcohol content falls within the typical range for naturally fermented fruit wines, as reported by Saranraj et al. (2017), who found alcohol levels ranging from 6% to 12% in tropical fruit wines such as pineapple, orange, and cashew. High Vitamin C retention in fresh and processed tropical fruits suggests that indigenous fruits like *Haematostaphis barteri* can serve as excellent sources of ascorbic acid in functional beverages (Sarkar et al., 2023). The high Vitamin C content also emphasises the antioxidant capacity of Vitamin C-rich tropical fruits and their potential to improve public health and immune response.

In terms of mineral composition, the presence of essential metals like potassium, calcium, and phosphorus aligns with the results of Sulieman & Mariod (2019), who noted that underutilised fruits such as *Spondias mombin* and *Tamarindus indica* contain significant levels of essential minerals needed for metabolic functions and beverage stability. These findings reinforce the view that indigenous fruits are not only nutritionally competitive with imported fruits but also possess economic value for rural-based agro-industrial development. On the contrary, the mineral and vitamin content can significantly diminish with poor handling or prolonged fermentation, underscoring the need for optimised processing techniques (Singh et al.,2023).

Table 4: Presence of metals, Alcohol, and vitamin C

Test Code	Test Conducted	Unit	Results	Test Method
Pb	Lead	Mg/L	<0.01	BS: EN
Hg	Mercury	Mg//L	<0.01	15763:2009
Av	Alcohol volume	%	9.46	-
	Vitamin C	%	78	

Source: Laboratory Analysis (2024)

CONCLUSION

Haematostaphis barteri, also known as pink grapes, hold significant nutritional, economic, and health potential for rural communities in Ghana. This indigenous fruit is used in the preparation of alcoholic and non-alcoholic beverages due to its high carbohydrate content, mineral composition, and high levels of potassium, phosphorus, and trace minerals. Its diverse nutritional profile, including fibre, protein, and essential minerals, makes it suitable for human consumption. The

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fruit's moderate alcohol content and high vitamin C content make it a valuable raw material for local and commercial beverage industries.

Practical and Social Implications

Haematostaphis barteri can be effectively used to produce a safe, nutritious, and marketable fruit wine, offering a viable opportunity for food diversification and value addition. Its high nutrient content and natural fermentation properties make it suitable for small-scale processing and commercialisation. Promoting the use of this underutilised indigenous fruit can enhance rural livelihoods, support local economies, and contribute to improved food and nutrition security. The utilization of *Haematostaphis barteri* in wine production can enhance community well-being by creating employment opportunities, especially for women and youth involved in harvesting, processing, and marketing. Promoting this indigenous fruit supports rural innovation, encourages sustainable use of local resources, and helps combat poverty through income diversification.

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