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CHEMICAL COMPOSITION IN RELATION TO THE QUALITY OF WINES PRODUCED FROM NIGERIAN *SYZYGIUM MALACCENSIS* AND *EUGENIA OWARIENSIS* APPLES

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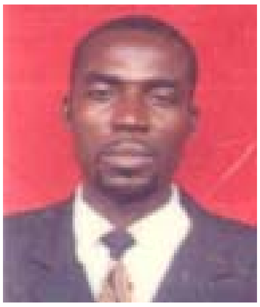

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ABSTRACT

Proximate composition, mineral and vitamin contents of *Syzygium malaccensis* (red) and *Eugenia owariensis* (green) apples obtained from Calabar, Nigeria were determined. Musts of the two apple species were fermented for six days into wines and allowed to age for twelve months. The fat, protein, tannin and total acidity were significantly low among the two apple species. There were significant differences ($p < 0.05$) in the proximate nutritive values of the edible parts of the two apples. Significant differences ($p < 0.05$) were also observed in calcium, iron, sodium, vitamin A and carotene contents among the two apples. Vitamin A and carotene contents were higher in *Syzygium malaccensis* and lower in *Eugenia owariensis*, while the contents of vitamin C for both apples were similar. The zinc contents were in trace levels for the two apple species. Among the minerals, calcium content was found to be higher in *S.malaccensis* (5.54 ± 0.03 mg/100g) than in *E. owariensis* (5.16 ± 0.03 mg/100g) while the sodium and iron contents were higher in *E. owariensis* (1.5 ± 0.03 mg/100g and 0.43 ± 0.02 mg/100g respectively). The aged wines were subjected to physical, chemical, mineral and organoleptic analyses. Physical properties such as appearance, color, flavor and taste were examined using taste panels. There were significant differences ($p < 0.05$) in the total acidity, residual sugar and ash contents of the wine samples but the alcohol content was similar averaging 11.0%. The amount of sodium and iron were higher in *E. owariensis* (18.85 ± 0.02 and 3.6 ± 0.04 mg/l respectively) than in *S. malaccensis* (14.4 ± 0.02 and 3.1 ± 0.04 mg/l). The composition of the wine produced from S. malaccensis had acceptable pH**,** titratable acidity, alcohol, chemical and slightly better mineral contents when compared with E. owariensis wine. Both apple wines were crisp, clear with distinct apple wine flavor. The overall results indicate that *S. malaccensis* apple species with slightly better wine characteristics has strong potential for the production of quality commercial wine.

Key words: Apple, proximate composition, fermentation, wine

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INTRODUCTION

It has been reported that fruits and nuts form an integral part of the African diet and are consumed as relishes and snacks [1]. They are found to be rich in vitamins especially vitamin C, minerals, fat and sugar [2]. Fruits are also used in the production of beverages [3]. Wine is an alcoholic beverage produced by the fermentation of the juice of various fruits. Chemical composition of edible parts of fruits which show higher contents of acid, vegetable tannins and strong aroma in quality wine production have been reported [4]. Also documented is the chemical composition of edible parts of several fruits such as apple, apricots, peaches, pears, berries, black berries, black currant, cherries, cow berries, goose berries, plumbs, raspberries, rose hips and straw berries used in wine making [5,6]. Apples, pears, plumb, cherries (*Ribes* sp) and the various types of berries are the most frequently used non-grape wine sources, although wine has been made from almost every type of fruit berry, herbs, roots and flowers [7]. When fruits other than *Vitis vinifera* L. (Common Grape Vine) are fermented to produce wine, the name of the fruit is included as in the case of peach wine, pear wine, pineapple wine, black berry wine and apple wine [8]. Wine is a commercial product, which can vary greatly in aroma and flavor according to the innumerable possible variations in its production. The term 'quality' and 'value' are consequently widely used in reference to wine. The International Standards Organization defines quality as the 'degree to which a set of inherent characteristics fulfils requirements' and it is worthwhile considering the meaning of this definition in relation to different elements involved in the wine production chain. The fulfilling requirements are associated with the 'intrinsic' sensory quality of the wine, which indicates how the wine tastes. Wine color has been shown to be dependent on basic composition such as wine pH and sulfur dioxide concentration and there is also the important factor of co-pigments from grapes that can enhance wine color [9]. It is reported that macro and micro climatic differences between regions and seasons manifest in grape aroma, composition and consequently in wine quality [10]. In aqueous solution, SO_2 forms sulfurous acid which is fairly effective as antioxidant in acid media especially at pH 3.0. Sulfur dioxide is used in food to prevent enzymic and non-enzymic browning as well as the growth of microorganisms. In dried fruits and vegetables it is used at concentration of up to 0.02 % w/w [11], but AOAC permitted limit is 350 mg/l maximum [12].

Free alpha amino nitrogen (FAN), which is the nitrogenous compound in must that is metabolically available to yeast aids fermenting wine to completion. Thus, slow or incomplete fermentations are often linked to FAN deficiency. Nitrogen gas which is relatively insoluble (14 mg/l) in wine is used effectively in low concentration to strip other volatile gases such as CO_2 with solubility of 1,500 mg/l in wine and O_2 which promotes growth of microorganisms in wines [13]. Titratable acidity (TA) is a measure of the organic acid content of the juice, must or wine sample which include the non-volatile (malic and tartaric) and volatile acids. A measure of volatile acidity is used routinely as an indicator of wine spoilage. In the USA, the legal limits for volatile acidity in wine are 1.20 for red wine and 1.10 for white and dessert wines [10]. The production of dry wine from cocoa pulp juice by fermentation process and

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its analysis by physical, chemical and organoleptic methods has been reported [14]. Apple wine refers to the fermented beverage obtained from apple, and its production, including cider brewing, constitute an important industry in the world [15, 16]. It is the most common fermented apple beverage in the United States of America, Canada and Europe [6].

Wines have been characterized by color, flavor, alcohol content and aroma and also classified as still, sparkling, fortified, aromatized and sweet wines [4]. The primary characterization of apple wine is a "spicy aromatic, apple- like note" [17, 18]. The results of the chemical composition of twelve different wine brands produced locally in Iraq showed high pH (3.4 - 4.2) and residual sugar (0.118 – 10.05 g/100 ml) with low fixed acidity (0.095 – 0.504 g/100 ml) and total sulfur dioxide (21 – 95 mg/L) and alcohol level that ranged from 7.9 – 14.6 % [19]. The trends in the composition of some Australian wines had been reported by Godden and Gishen [20]. Although wine produced from star apple has been reported [21], most of the apple wines found in the Nigerian markets are made from temperate apple fruits such as *Eugenia owariensis* and imported into the country. Little information is available on the use of locally produced apple such as *Syzygium malaccensis* for the production of wine even though the fruit is in abundant supply in the country. This paper reports on the proximate nutrient and mineral compositions of the locally available *Syzygium malaccensis* (red) and the imported *Eugenia owariensis* (green) apples along with the chemical and mineral composition of wines produced from the two apples in order to determine the suitability of *Syzygium malaccensis* apple for the commercial production of quality wine.

MATERIALS AND METHODS

Fruit samples

Two species of apples, namely *Syzygium malaccensis* and *Eugenia owariensis* were obtained from Akpabuyo and Calabar Municipal markets in Cross River State, Nigeria.

Extraction of juice

Juices of the two apple samples were extracted according to the method of Amerine, Berg and Cruess [4]. The must was processed using the method of A.O.A.C. [22]

Compositional Analysis

Moisture content, crude protein, fiber, fat, ash, caloric value, acidity and tannin contents of the apple samples were determined using A.O.A.C. method [22].

Mineral Analysis

Ten grams of wet pulp of each sample of *Syzygium malaccensis* and *Eugenia owariensis* were digested with 20 ml of acid mixture (650 ml conc.HNO_3, 80 ml $HClO_4$ and 20 ml conc. H_2SO_4) using AOAC method [22]. The digested sample was taken into 100 ml volumetric flask and diluted to the mark with distilled water. Calcium and sodium were determined using Gallenkamp Flame photometer (CL 378-

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ELICO) while zinc and iron were determined using Atomic Absorption Spectrophotometer (UNICAM 919 model).

Vitamin and Cyanide content Analysis
Method of Scharffert and Kingsley was used for the determination of vitamin C [23]. Vitamin A and cyanide contents of the apples were determined using A.O.A.C. method [24].

Determination of Acidity and specific gravity of the Must
Titratable acidity was determined by titration against 0.1N NaOH and the acidity was expressed as malic acid. The specific gravity was determined at 20 ºC using hydrometer.

Fermentation, Aging and Pasteurization
The musts were fermented in separate bottles fitted with air-locked corks that contained 1% sodium metabisulphite solution to ensure sterility. Attenuation points were determined by ceasation in carbon dioxide production and specific gravity determination using hydrometer. The wine samples were aged by the addition of 0.2 g/l sodium metabisulphite and 0.05 g/l of ascorbic acid and stored in bottles plugged with sterilized cork at 15 ºC for 12 months. After the 12 months aging period, the wine samples were filtered and pasteurized in water bath at 65 ºC for 60 minutes.

Analysis
The wines obtained from *Syzygium malaccensis* and *Eugenia owariensis* were subjected to physical, chemical and organoleptic analysis. Physical properties such as appearance, color, flavor and taste were examined using taste panel. Percent alcohol was obtained by conversion of specific gravity values using U.S. Bureau of Standards method [25]. Chemical properties such as residual sugar, nitrogen, tannin, sulphur and ash contents were determined using standard methods. Wine acidity was obtained by titration**.** Data on chemical composition determined for the two wine samples were subjected to Chi-square analysis. Significance was accepted at 5% probability level. Data for proximate nutrient, mineral and vitamin composition of the edible part of the two apple species and the mineral composition of the wine products were reported as the mean ± standard deviation (SD) for five determinations.

RESULTS

The proximate analysis of the edible parts of Syzygium *malaccensis* (red) and *Eugenia owariensis* (green) apples are shown in Fig. 1. There were significant differences ($p < 0.05$) in moisture, total sugar, fiber and caloric values among the two apple species. Moisture, total sugar and energy values were higher in *Syzygium malaccensis* and lower in *Eugenia owariensis* while the fiber content was slightly higher in *Eugenia owariensis* than in *Syzygium malaccensis*. The fat, protein, tannin and total acidity were significantly low among the two apple species.

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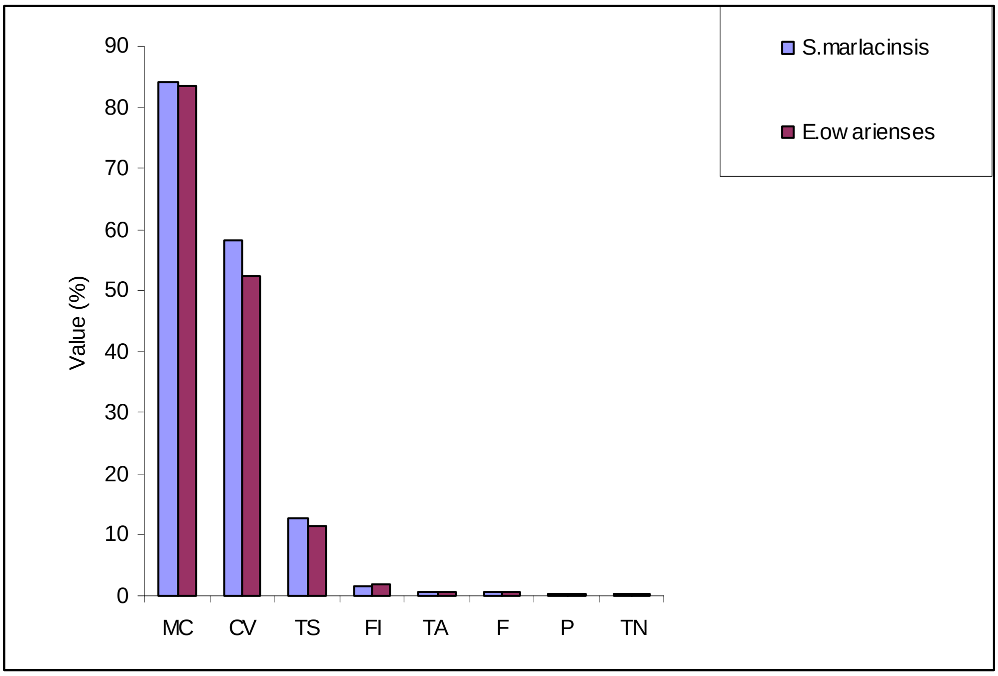

Figure 1: Proximate nutrient composition of edible parts of *Syzygium malaccensis* and *Eugenia owariensis* species of apples

The mineral and vitamin constituents of the apple varieties are presented in Table 1. Significant differences ($p < 0.05$) were observed in calcium, iron, sodium, vitamin A and carotene contents among the two apples. The zinc contents were in trace levels for the two apple species. Among the minerals, the quantities of calcium were higher in *Syzygium malaccensis* and lower in *Eugenia owariensis*, while sodium and iron quantities were higher in *Eugenia owariensis* and lower in *Syzygium malaccensis*. Vitamin A and carotene contents were higher in *Syzygium malaccensis* and lower in *Eugenia owariensis*, while the contents of vitamin C for both apples were similar. Table 2 shows some physical properties and alcohol contents of the wine samples. The pH, specific gravity, and alcohol contents of both wines were similar.

Results of the chemical analysis of the wine samples are presented in Fig.2. There were significant differences ($p<0.05$) in total acidity and ash contents among the two wine samples. Total acidity and residual sugar were slightly higher in *Eugenia owariensis* and lower in *Syzygium malaccensis* while the ash content in *Syzygium malaccensis* was higher than that of *Eugenia owariensis*. Both wine samples contained similar amounts of nitrogen with trace amounts of total sulfur and tannin.

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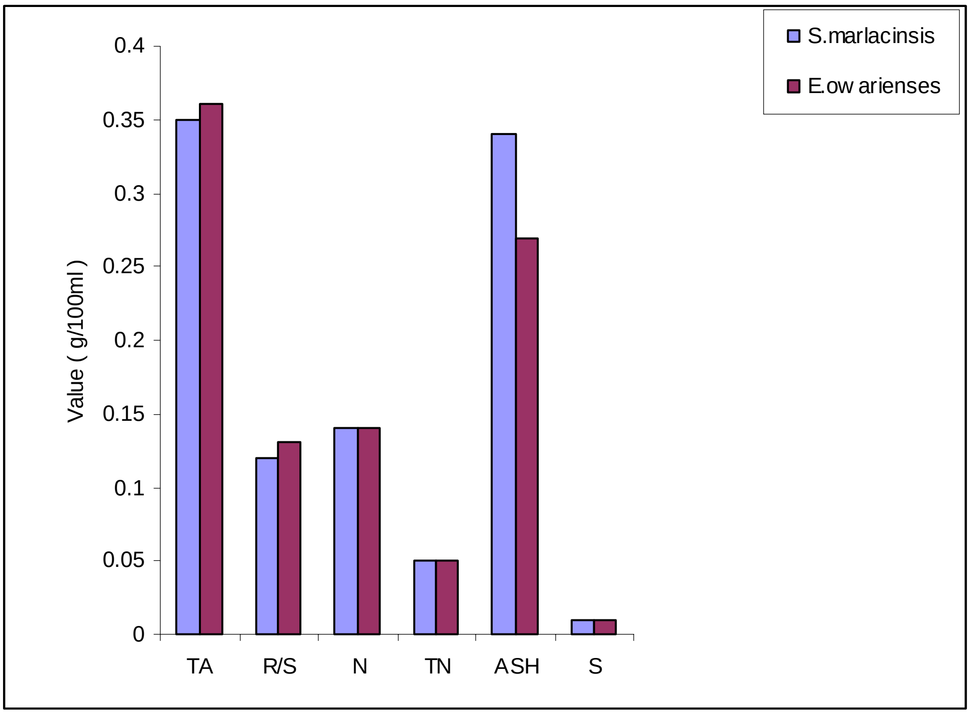

Figure 2: Chemical composition of the wine samples

The mineral composition of the wine samples is presented in Fig.3. There were significant differences ($p<0.05$) in calcium and sodium contents among the two wine samples. The amounts of sodium and iron in *Eugenia owariensis* were higher than that of *Syzygium malaccensis* while the amount of calcium was higher in *Syzygium malaccensis* than in *Eugenia owariensis*. The zinc content in both wines was similar.

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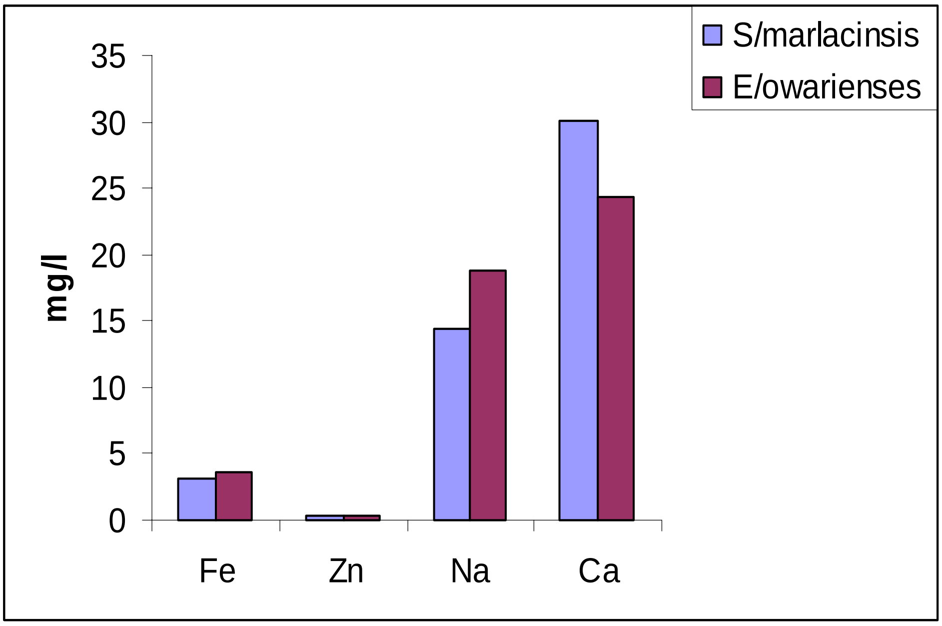

Figure 3: Mineral composition of the wine samples

DISCUSSION

The chemical composition of the edible part of apple determines its nutritional value. It differs according to species but also depends on the atmospheric conditions and the various conditions of storage after harvesting [5, 6]. The results summarized in Fig.1 and Table 1 showed nutrient, mineral and vitamin compositions of the edible parts of the two apple species. The nutrient compositions were similar for both apples. The fat, protein and tannin contents were slightly higher in *Eugenia oweriensis* than in *Syzygium malaccensis*. It is important to consider moisture content, since all of the nutrients are contained in the dry matter. The moisture contents which averaged 83.69% in both apples agree with the reported value of 84.50% [26]. The high moisture content of the two apple species indicates that they are highly perishable. High moisture content has been reported to promote susceptibility to microbial growth and enzyme activity which accelerates spoilage [6]. In terms of energy value, the results indicated that the two apple species are low in caloric contents and their energy values varied according to species. The mean caloric value was higher in *Syzygium malaccensis* (58.20 ± 0.57 kcal/100g) and lower in *Eugenia owariensis* (52.48 ± 0.82 kcal/100g). However, the caloric values obtained in this study are consistent with published reports of 49.20 kcal/100g [1, 5, 21].

Vitamin content is an important factor in the overall nutritional value of food. Because of its antioxidant and therapeutic properties, ascorbic acid (vitamin C) is a valuable food component [27]. In the present study, the values of vitamin A varied between the two apples with 25.10 IU for *Syzygium malaccensis* and 18.0 IU for

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Eugenia owariensis, but were within the reported value of 18.0 IU. Also, the amounts of vitamin C for both apples were higher than the reported value of 6 mg/100g [26]. This could be attributed to the type of apple species and the climatic differences between regions and seasons [10]. There are many minerals that are essential for a normal healthy body. Significant differences were observed in the mineral contents of the two apple species. Calcium was predominant in the macro-elements measured, while iron was predominant in the trace minerals analyzed [Table 1]. However, both calcium and iron contents were slightly higher than reported values of 3 and 0.1mg/100g, respectively. The sodium contents for the two apple species were also lower than the reported value of 3 mg/100g [26].

The difference in the mineral contents of both apple species may be as a result of soil and geographical location of the planting areas. There was no carotene concentration data available in the literature for *Eugenia owariensis* apple species for comparison. Wines have been characterized by color, flavor, alcohol content and aroma and also classified as still, sparkling, fortified, aromatized and sweet wines [4]. There were no significant differences between the pH, specific gravity and alcohol contents of the wines produced from *Syzygium malaccensis* and *Eugenia owariensis*, and the alcohol contents (averaging 11%) were within the reported levels of 3-21 % for cider and fruit wines [6] and 7.9 -14.6 % for the Iraqi apple wines [19]. Both wines were crisp and clear, which could be attributed to the low tannin and nitrogen contents, with the distinct harmony of tart wine with fruit flavor of the apples. The golden yellow and light green tint colors observed in *S. malaccensis* and *E. owariensis*, respectively could be attributed to co-pigmentation that can enhance wine color [9].

From the chemical analysis of the wine samples, the 0.01g/100 ml (100mg/l) of soluble sulfur in the present studies is significantly lower than the AOAC set limit and does not affect the wine color [10]. The effect of nitrogen on quality can be both direct and indirect. The level of nitrogen, present as free amino nitrogen (FAN) in the wine samples is quite low (0.14) compared to the acceptable level of 14 mg/l but should be sufficient to strip any other volatile gas including CO_2 and O_2 that may be present but does not cause any haziness as can be seen by the clear appearance of the wines [12, 13]. The titratable acidity which includes the non-volatile (malic and tartaric) and volatile (acetic) acids is higher in *Eugenia owariensis* and lower in *Syzygium malaccensis*. Although the measure of volatile acidity is used as an indicator of wine spoilage, the amount of titratable acidity in both wine samples is within the legal limits for volatile acids in wines (red, white or desert) [10] and would not affect the quality.

Generally, the presence of minerals such as calcium and iron at acceptable levels will contribute to the normal functioning of the body. From the mineral analysis of both wines, sodium and iron contents were higher in *Eugenia owariensis* and lower in *Syzygium malaccensis*, but the iron contents were within the range 1-5 mg/l while the sodium content was significantly lower than the reported value of 60 mg/l [28]. The zinc content (0.3 ± 0.02 mg/l) for both wine samples was found to be much lower than the 5 mg/l reported [29]. However, the amount of calcium found was significantly

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higher in *Syzygium malaccensis* than in *Eugenia owariensis*. Although both were within the reported range (6-165 mg/l) [30], the higher value for *Syzygium malaccensis* wine is an indication of its higher nutritional value.

CONCLUSION

The proximate composition of the edible parts of apples (*Syzygium malaccensis* and *Eugenia owariensis*) showed high moisture and sugar contents with acceptable levels of acidity, fat and tannin. The composition of the wine produced from *Syzygium malaccensis* showed an acceptable pH**,** titratable acidity, alcohol, chemical and slightly better mineral contents when compared to *Eugenia owariensis* wine. The apple wines were crisp, clear with distinct fruit flavor of the apples. The overall results indicate that *Syzygium malaccensis* apple species with slightly better wine qualities than *Eugenia owariensis* apple has strong potentials for the production of quality commercial wine.

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Table 1: Minerals and vitamins content of the edible parts of *Syzygium malaccensis and Eugenia owariensis* species of apple (mg/100g)*

Minerals	***Syzygium malaccensis***	***Eugenia owariensis***
Sodium	1.20±0.03	1.5±0.03
Calcium	5.54±0.03	5.16±0.02
Iron	0.21±0.04	0.42±0.04
Zinc	0.002±8.16	0.001±7.11
Vitamins		
Vitamins A IU	25.10±0.04	18.80±0.04
Vitamin C (mg/100g)	10.23±0.02	10.07±0.02
Carotene (μ g/100g)	375.96±0.02	229.77±0.02

Values are mean ± SD for five determinations

Table 2: Some physical properties and alcohol content of the wine samples

Properties	***Syzygium malaccensis***	***Eugenia owariensis***
pH	3.68	3.79
Specific gravity	0.9854	0.9880
Appearance	clear	clear
Color	golden yellow	greenish tint
Flavor	vinous	vinous
Taste	dry	dry
Alcohol (%)*	11.0±0.04	10.50±0.03

*Values are mean ± SD for five determinations

List of Abbreviations: MC = Moisture content, CV = Caloric value, TS =Total sugar, FI = Fiber, TA =Titratable acidity, F = Fat, P = Protein, TN = Tannin, R/S = Residual sugar, N= Nitrogen, ASH= Ash, S =Total sulfur, Na = Sodium, Ca = Calcium, Fe = Iron, Zn = Zinc

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