# Proximate, micronutrient compositions and shelf life of juice and concentrate of hog plum *(Spondias mombi), a* wild fruit in Nigeria


## ABSTRACT

**Aims: T**o process hog plum fruits (*Spondias mombin* L.) into juice and concentrate, study their proximate and micronutrient composition and evaluate the shelf life of these products.
**Study design:** Matured and ripe fruits were processed into juice and then, concentrate. The products were analyzed for physicochemical, proximate and micronutrient compositions. Shelf life of the products was evaluated. All experiments were replicated three times and data subjected to descriptive statistics.
**Place and Duration of Study:** Department of Food, Nutrition and Home Sciences, Prince Abubakar Audu University, Ayingba, Kogi State, Nigeria, between 01/01/2022 and 30/08/2023.
**Methodology:** Hog plum fruits were harvested and processed into fruit juice and then, fruit concentrate by evaporation of water. Physicochemical and proximate compositions were determined using standard methods. Mineral and Vitamin C analyses were done by suitable Spectroscopy methods, while HPLC was used to determine B vitamins. Changes in physicochemical properties were studied to determine shelf life. Data were subjected to statistical analyses.
**Results:** Mean values of the physicochemical parameters of juice were pH, 2.43± 0.01; TA, 0.17±0.01 and °Bx, $23.05^{a}$± 007. °Bx of concentrate, $63.50^{b}$± 2.12, differed significantly (*P=.05*) from that of the juice. Proximate analyses showed a high moisture and protein concentration (relative to other fruits) in hog plum fruit juice. Concentrate was significantly (*P=.05*) lower in moisture and protein content. Fruit juice contained micronutrients; Ca, 261.00±4.0; Fe, 44.97±2.1; K, 99.30±2.9; Zn, 0.88±0.1 and Vitamin C, $57.79^{a}$±0.04. Concentrations of these substances, except for K and Zn were significantly (*P=.05*) higher in the fruit concentrate. Fruit concentrate had a shelf life of up to six months.
**Conclusion:** Hog plum fruit juice and concentrate are rich in many macronutrients, especially protein, Ca, Fe, K, Zn and Vitamin C. Processing fruit juice into concentrate prolongs the shelf life of product for up to six months.



*Keywords: Hog plum fruit juice, concentrate, nutrients, shelf life*


## 1. INTRODUCTION

The intake of vegetables and fruits is associated with reduced risk of mortality due to Non - communicble diseases, such as cancer, cardiovascular diseases, and diabetes. Certain vegetables and fruits appear to have greater benefits than others, implying that substances found in these species are responsible for the benefits [1].
Hog plum (*Spondias mombin* L.) also known as “yellow mombin” is a wild, but exotic fruit from a small deciduous tree belonging to the Anacardiaceae family [2]. It grows wild in Nigeria and is thus considered a lesser known fruit. The apple has a unique blend of sweet-sour taste with a pleasant astringent flavor [3]. The plant has varying local identity names and uses among the major Nigerian tribes; Hausa- [Tsadarmasar]; Yoruba – [Iyeye]; and Igbo [Isikala or uvuru].
Ayoka *et al*. [4] and Ojo *et al*. [5] have reported that studies on *Spondias mombin* tree reveal that it has high medicinal value. The decocted fruits can be drunk or be served as diuretic

and febrifuge drink while drinking the decocted bark and leaves can be used as emetic, anti-diarrhea and in the treatment of dysentery. A few studies have focused on its nutrients and biochemical substances [3; 6; 7]. All these studies find that the fruit is a rich source of vitamins A and C, minerals such as potassium and phosphorus, and certain health-promoting phytochemicals. The importance of health benefits derivable from the consumption of this fruit has long been known in Brazil, where there is a legislation about the composition of its commercial products [6]. However in Nigeria, as a lesser known fruit, hog plum has not received sufficient attention in terms of studies of its nutrients and biochemical substances. Further studies are necessary to determine the substances present in this fruit and subsequently evaluate their potentials to provide health benefits to its consumers as described by Brandt [1].

There is also a problem of supply of hog plum fruit to consumers. Because it is seasonal, its availability as a fresh fruit is limited only for a specific period of the year. The need for the preservation of this fruit for consumption outside its season is imperative if its numerous potential health benefits will be made available to consumers.

Mishra *et al*. [8] has proposed a method employing spray drying to preserve hog plum fruit pulp as spray dried powder. Processing and preservation as juice has been proposed by Adeboyejo *et al*.[9] and Oladunjoye *et al*.[10] using techniques involving refrigeration and sonication, respectively. However, these technologies may not be available to rural communities. Fruit concentrates are juices with water removed and Rehman [11] has reported studies using this process to preserve fruit juices of mango, apple, guava and peach.

The aim of this study is to process hog plum fruits into juice and concentrate, study their proximate and micronutrient composition and evaluate the shelf life of these products. These simple techniques can be employed in the rural areas to make the fruit available for off season consumption.

## 2. MATERIAL AND METHODS

### 2.1 Hog Plum Fruit Samples

Matured and ripe hog plum fruits (*Spondias mombin* L.) (Plate 1) were harvested from the trees in Anyigba, Dekina Local Government Area of Kogi State and brought to the Laboratory at Food Nutrition and Home Sciences Kogi State University in crates containing ice. The fruits were sorted manually to remove spoilt ones and then rinsed with tap water, pH 7. They were blanched (75°C for 10 -15 min) to remove the bacterial load on the epicarp and soften it for peeling.

### 2.2 Preparation of Fruit Juice

The fruits were manually peeled and the pulp scraped from the seed using a sterile steel knife. The pulp was thereafter fed into a locally fabricated squeezer press and the juice sieved out through a muslin cloth. The product was packaged in glass bottles with screw caps, pasteurized at 85° C/5 seconds to inactivate enzymes and then stored in the laboratory fridge at a temperature of 18°C during the period of study. Sodium benzoate was added at recommended concentrations (0.1 % of total weight of product), to serve as preservative.

### 2.3 Preparation of Fruit Concentrate

Hog plum fruit concentrate was prepared by further heating juice in an open pan at 85°C for ten minutes with continuous stirring.

### 2.4 Physicochemical analysis, pH, TSS, TA parameters

These parameters were determined using the standard methods described in AOAC [12]. The pH values of samples were determined using pH meter (Model Basic 2°; Crison

Instrument, Barcelona, Spain) at 20 °C. Total soluble solids (TSS, °Bx) was determined by measurement of refractive index at 25 ± 1 °C using a digital Abbe Refractometer (Atago Co. Ltd., Tokyo, Japan).Titratable acidity (TA) was determined by diluting 10 mL of each juice sample with 10 mL of distilled water, and concentrate with 20 mL of distilled water and titrating against 0.1 N NaOH up to 8.1 pH value using phenolphthalein as an indicator. The titration was done in triplicate and calculated as percentage citric acid. The specific gravity of the samples produced was determined by measuring 250 mL of the sample into the measuring cylinder and a hydrometer was inserted into it and the reading was taken [12].

## 2.5 Proximate analysis

Proximate analysis of the juice and concentrate samples, Moisture, Carbohydrates, Protein, Fat, ash and fiber were determined using the standard methods described in AOAC [12].

## 2.6 Micronutrient Analyses

### 2.6.1 Mineral Analysis

Mineral elements (Zn, Mg, Ca, Na, Fe, and K) were determined using Thermo Fisher Scientific (iCE 3000) Atomic Absorption Spectrophotoscopy (AAS), with the appropriate hollow cathode lamp and wavelength of each of the metals. Atomic Absorption Spectrophotometer standard solutions were purchased from Merck. Appropriate quality assurance procedures and precaution were carried out to ensure reliability of the result.

The dry ashing method was used for sample preparation. All glass wares were washed with demineralised water and 1% Nitric acid. Portions of 25 mL of fruit juice and concentrate were appropriately homogenized before samples were taken directly into crucible and evaporated completely by placing on water bath at 100°C. The thick mass was charred on hot plate & kept in muffle furnace (450 °C) till it became complete ash. The crucible with ash was put in dessicator for cooling. The ash was dissolved in 2 mL Nitric acid & demineralised water & finally made up to 30 mL.

### 2.6.2 Ascorbic acid content

The ascorbic acid (AA) content was determined according to a method of Rahman *et al*. [13]. The mixture containing hog plum juice and concentrate were treated with 1 mL of 2, 4-dinitrophenyl hydrazine at 37 °C for 3 h, and the resulting solution was further treated with $H_2SO_4$ acid (1.0 mol·dm$^{-3}$) to produce red color complex. Absorbance was measured at 521 nm using a spectrophotometer (UV–VIS spectrophotometer, UV-VIS Spectronic). AA content was calculated and expressed as milligram per 100 mL of juice (mg/100 mL) using a calibration curve of standard ascorbic acid.

### 2.6.3 Determination of B Vitamins

Ten grams of each sample were extracted and analyzed using the HPLC (Shimadzu Corporation, Japan) and the conditions described by Zohora *et al*. [14] for the estimation of B-vitamins. All chemicals and reagents were of recommended analytical grade. Standard solutions of thiamine hydrochloride for vitamin B1(thiamine), riboflavin for vitamin B2 (riboflavin) and niacin for B3 (nicotinamide) were also prepared and used as described by these authors.

Four different concentrations (5 µg/mL, 10 µg/mL, 20 µg/ mL and 40 µg/mL) were prepared from standard solutions of each by diluting with HPLC water. Then, 20 µl from each diluted solution was injected into HPLC using auto-sampler and the analyses were monitored at 210 nm and repeated three times. The average peak areas were plotted against concentrations. The linearity of the method was evaluated using calibration curves to calculate coefficient of correlation, slope and intercept values. The content of B-vitamins (x) was calculated by using the plotted peak areas (y) of three samples of the each sample slope (m) and intercept (c) from the calibration curves of B-vitamin standards in

this equation, y = mx+c, Then result was multiplied by dilution factor, as described by Zohora *et al*. [14]

### 2.7 Shelf life Studies

The products were packaged in glass bottles with screw caps, pasteurized at 85 °C/5 seconds and stored at ambient conditions (25 – 30 °C and 60 – 85 % RH). Samples were analyzed for their physicochemical properties, Titratable acidity, °Bx, Specific gravity and pH over a period of six months using methodologies described earlier.

### 2.8 Statistical Analyses

All experiments were replicated three times and simple descriptive statistics and t test for difference of means were used to validate data. All data analyses were done at the 95% confidence level. Results are expressed as Means ±Standard Deviation.

## 3. RESULTS AND DISCUSSION

### 3.1 Hog plum Juice and Concentrate

Hog plum Juice is a golden yellow color with a smooth consistency. Processing into Concentrate resulted in a paste of a light brown color. The taste and aroma of the products were characteristic of the fruit, which has been described by Owolarafe *et al*. [3].

**Plate 1. Hog Plum fruits**

### 3.2 Physiochemical properties of Hog plum fruit juice and Concentrate

The physicochemical properties of the juice and concentrate products are given in Table 1. Observations about the pH and titratable acidity of this juice are consistent with previous reports by Oladunjoye *et al*. [10] and Adeboyejo *et al*. [9]. Both soluble solids and Specific Gravity showed high values in this study and differed from the reports of these authors. These values are dependent on the extent of dilution adopted during preparation, which in turn affects dissolved sugar content of juice.

Processing of juice into concentrate or water removal, which was achieved by evaporation during this study, resulted in significant changes (*P=.05*), in physicochemical properties. Particularly notable is the increase in concentration of sugar in the product as defined by °Brix. Increased sugar concentration in the product will suggest lower water activity and hence a desirable improvement in shelf life.

**Table 1. Physiochemical properties of Hog plum fruit juice and Concentrate**

| Physiochemical Property | Fruit Juice | Concentrate |
|---|---|---|
| **pH** | 2.43± 0.01 | 3.40±0.28 |
| **Titrable acidity (mg/g)** | 0.17±0.01 | 0.46±0.05 |
| **°Brix** | $23.05^{a}$± 007 | $63.50^{b}$± 2.12 |
| **Specific gravity** | 1360.0± 0.14 | 1420 ± 0.71 |

**Different superscripts in rows indicate significant differences (P = .05)*

### 3.3 Proximate Composition of Hog plum fruit juice and Concentrate

The proximate composition of hog plum fruit juice reveal a high level of moisture and good concentrations of desirable nutrients that can be derived from its consumption (Table 2). Findings from this study when compared with the earlier reports [6] on fruit pulp show similarities in moisture and carbohydrate compositions. They however differ in most of the other parameters. Tiburski*et al*. [6] had noted that both climate and geographical region affects the nutrient composition of this fruit.

In order to evaluate the quality of hog plum fruit juice we compared its composition with those of apple (*Malus domestica*) reported by Okokon & Okokon [15] and sweet orange (*Citrus sinensis*), in another publication by Chuku & Akani [16].

Ash in hog plum juice averaged 0.23± 0.04 %, which is comparable with 0.3 in apple juice[15], but lower than 0.6 % in orange juice[16]. Ash in our hog plum juice was lower than values reported for the fruit by Olaoye *et. al*. [17]. These authors suggest that stage of ripening of fruit and method of processing would affect ash content.

The hog plum fruit juice is considerably high in protein. At a concentration of 2.21+0.09 %, it is much higher in this nutrient than the juice from apple 0.5 % [15] and orange (*Citrus sinensis*), 1.56 % [16]. Orange juice is generally acknowledged as comparatively higher in protein content than most fruit juices

The hog plum fruit juice is lower in fat, 0.10± 0.00 % than apple, 0.13 % [15] and orange 0.25 % juices [16]. It is also lower in Carbohydrates, 12.53± 0.09 % than orange juice 14.56 % [16]. These are desirable properties in terms of worries about calories from fruit juices. Hog plum fruit juice, however, compares unfavorably in fiber content with orange juice at 2.5 % [15; 16].

The composition of the fruit concentrate (Table 2), is derived from that of the juice, taking into consideration water lost and the effect of heat on some nutrients during the evaporation process. Thus a lower and desirable moisture, in terms of its shelf life, is observed for this product and a significant loss ($P = .05$) recorded for a nutrient like protein.

**Table 2. Proximate Composition of Hog plum fruit juice and Concentrate**

| Composition | Fruit Juice | Concentrate |
|---|---|---|
| **Moisture %** | $84.84^{a}$ ±0.09 | $75.55^{b}$ ± 0.07 |
| **Ash (%)** | 0.23± 0.04 | 0.17± 0.35 |
| ***Protein (%)** | $2.21^{a}$+0.09 | $1.60^{b}$ ± 0.03 |
| **Fat (%)** | 0.10± 0.00 | 0.10±0.00 |
| **Fiber (%)** | 0.09± 0.04 | 0.11±0.014 |
| **Carbohydrate%** | 12.53± 0.09 | 22.45±0.12 |

**Different superscripts in rows indicate significant differences (P = .05)*

## 3.4 Micronutrient Composition

### 3.4.1 Mineral Composition

Adepoju [7], in a study of the pulps of three wild fruits obtained in Nigeria had reported that *S. mombim* was high in magnesium, sodium and potassium; and can be good sources of these minerals. These authors however, found the fruits low in calcium, phosphorus, zinc, manganese, and copper. These findings do not seem to be in agreement with earlier reports on mineral composition of hog plum pulp obtained from Northeast of Brazil [6]. Both Tiburski*et al*. [6] and Adepoju [7], however, agree that climate and other edaphic factors affect the nutritional composition of this fruit.

The results of mineral analyses of hog plum fruit juice during this study is provided in Table 3. Contrary to the findings of Adepoju [7], all minerals studied showed high concentrations. We compared the mineral content of hog plum fruit juice with those of fruit juices prepared from orange and mango in Nigeria [18] and found it higher in concentrations, particularly in Ca, 261.00±4.0; Mg, 104.40±4.7 and K, 99.30±2.9. Expectedly, concentration of the juice results in an increase in mineral composition (Table 3). The fruit juice and concentrate of the hog plum may thus serve its consumers as a good source of nutrient minerals.

**Table 3. Mineral Composition of Hog Plum fruit Juice Concentrate**(mg/100 mL**)**

| | Juice | Concentrate |
|---|---|---|
| **Ca** | 261.00±4.0 | 747.30±3.1 |
| **Fe** | 44.97±2.1 | 93.74±2.8 |
| **Mg** | 104.40±4.7 | 301.50±6.2 |
| **Na** | 43.00±3.0 | 44.25±4.3 |
| **K** | 99.30±2.9 | 92.50±7.0 |
| **Zn** | 0.88±0.1 | 0.684±0.3 |

### 3.4.2 Vitamin Composition

Analyses of B vitamins in hog plum juice reveal low concentrations of these substances (Table 4). Even though Chanson-Rolle *et al*. [19] has also reported low levels of folate in orange juice, fruits are not generally considered good sources of B vitamins.

The ascorbic acid (AA) content of hog plum juice (Table 4) found in this study is higher than concentrations of 24.10 and 45 mg/100 mL reported for this juice by Oladunjoye et al. [10] and Adeboyejo *et al*. [9], respectively. Sources of raw materials and processing methods may be responsible for these differences.

When compared with juices from other fruits, hog plum juice is richer in Vitamin C than apple juice, which contains 22.15 mg/100 mL [15] but inferior to orange juice, which contains a high 125.4 mg/100 mL [16].

Values observed for Vitamin content of concentrate were probably a combination of the effects of evaporation of water and the partial lability of Vitamin C to heat.

**Table 4. Vitamin composition of Hog plum fruit juice and Concentrate (mg/100 mL)**

| | Juice | Concentrate |
|---|---|---|
| **Vitamin C** | $57.79^{a}$ ±0.04 | $221.5^{b}$ ±0.05 |
| **Vitamin B1** | 0.22±0.02 | 0.65±0.04 |
| **Vitamin B2** | 0.39±0.03 | 0.73±0.03 |
| **Vitamin B3** | 0.36±0.01 | 0.83±0.02 |

**Different superscripts in rows indicate significant differences (P = .05)*

### 3.4.2 Shelf Life Studies

Table 5 gives some characteristics of the hog plum juice and concentrate after they had been stored at ambient conditions for six months. The results reveal that the juice was stable for one month in all the studied parameters but that significant changes ($P$ = .05) were observed in the pH of the fruit juice as well as in its titratable acidity after six months. The concentrate on the other hand appeared stable during the entire six months of storage. Water is essential for biochemical reactions and the reduced water content of this product would have contributed to its stability.

## 4. CONCLUSION

Findings from this study have shown that hog plum fruit juice and concentrate, relative to many popular fruit juices, are rich in many macronutrients, especially protein. Hog plum fruit juice and concentrate were also found to contain high concentrations of Ca, Fe, K, Zn and Vitamin C, micronutrients. Processing of fruit juice into fruit concentrate increased the concentration of most nutrients, reduced moisture and enabled extension of shelf life of product for up to six months. Findings from this study will contribute towards the effort to make fruits and vegetables that provide health benefits to their consumers available to Nigerians, particularly those living in rural areas, during all seasons of the year.

**Table5. Physiochemical properties of Hog plum juice and Concentrate during storage**

| | Fruit Juice | | | Fruit Concentrate | | |
|---|---|---|---|---|---|---|
| **Months of Storage** | **0** | **1** | **6** | **0** | **1** | **6** |
| **pH** | 3.37[a]±0.03 | 3.39[a]±0.17 | 2.90[b]±0.03 | 3.43±0.15 | 3.40±0.03 | 3.30±0.14 |
| **Titratable Acidity** | 0.314[a]±0.14 | 304[a]±0.03 | 0.28[b]±0.08 | 0.46+0.05 | 0.455±0.03 | 0.470±0.06 |
| **°Brix** | 23.05[a]± 0.07 | 19±0.73 | 23±0.14 | 53.50±0.03 | 43.5±0.14 | 51.0±0.05 |
| **Specific gravity** | 1360.0[b]±0.14 | 1360±0.09 | 1360±1.53 | 1420±0.71 | 1420±1.01 | 1421±0.13 |

**Different superscripts in rows indicate significant differences (P = .05)*

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