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# Shelf-Life Evaluation of Freshly Harvested and Sodium Benzoate - Treated Hog Plum (*Spondia mombin*) Stored for a Period of Three Weeks at Tropical Ambient Temperature (29.0±2$^0$C)

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**Abstract:** ***Fresh fruits of Spondia mombin were harvested and treated with 0.2% sodium benzoate (SB) solution. The treated fruits were package in perforated high density polyethylene bags and stored at room temperature (29.0±2$^0$C) for a period of three week. Microbiological and physicochemical analysis were carried out using standard methods. The mineral contents were analyzed using atomic absorption spectrophotometer. Ascorbic acid content of the sample was determined by titration with 2,6-dichlorophenol-indophenol solution while other vitamins were determined using chromatography method. Microorganisms isolated from the control sample were Escherichia coli, Staphylococcus aureus, Bacillus subtilis and species of Klebsiella, Streptococcus, Aspergillus, Penicillium, Mucor and Rhizopus while only two genera (Bacillus and Aspergillus) were isolated from SB treated sample. The total viable count (Bacteria) for control sample ranged from 4.2 × 10$^3$ – 6.3 × 10$^8$ cfu/g while that of sample treated with 0.2% SB was 2.1 ×10$^1$ – 1.3 × 10$^2$ cfu/g during the storage period. The fungal count ranged from 1.6 × 10$^2$ - 1.42 × 10$^6$ cfu/g for the control and 1.30 × 10$^1$ -6.6 × 10$^3$ cfu/g for the treated sample. A decrease in pH was observed in both control and treated samples. For the control sample, the pH decreased from 3.2 – 2.75 while for the treated, it decreased from 4.15 - 3.01. There was a corresponding increase in % titratable acidity (%TA), with the control sample ranging from 0.0018 ± 0.02 to 0.0075 ± 0.01% and 0.0016± 0.03 to 0.0028 ± 0.04% in sample treated with 0.2% SB. The mineral and vitamin analysis of the fresh fruits revealed the presence of the minerals - Na (3.501± 0.01), K (202.68± 0.16), Ca (3.65± 0.24), Mg (22.05± 0.03), Zn (0.0024±0.000), Fe (0.24± 0.006), Cu (0.063±0.001) and Mn (0.104±0.004) mg/100g. The vitamins obtained were vit A (11.05±0.02), Vit. B (0.12±0.001), Vit.C (54.06± 0.015), Vit K (0.15±0.001) and Vit D(0.015± 0.000) mg/100g. There was slight decrease in the mineral and vitamin contents at the end of the storage period in both control and treated samples. The fruit contains appreciable quantities of vitamin A and C also the preservative was able to extend the shelf life of the treated fruits from 2 to 21 days.***

**Keywords:** *Spondia mombin*, sodium benzoate, shelf-life

## 1. Introduction

*Spondia mombin* Linn is a fructiferous tree that belongs to the family Anacardiaceae. It grows in the costal areas and in the rain forest into a big tree of up to 15-22mm in height. The tree thrives in the rainforest and coastal areas of Africa and also it is widely distributed in Southern America, Asia and West Indies but grow to a limited extent in the Indian subcontinent and Indonesia (Morton, 1987). It is readily common in Nigeria, Brazil and has high genetic variability among populations (Ayoka *et al*., 2008). It is commonly known as Hog plum or yellow mombin. In Nigeria, it is known by various names: Tsardamasar (Hausa), Ichikara (Ibo), Akika etikan (Yoruba), chabbli (Fulani) and nsukakara (Efik) (Gill, 1992). The fruits are yellow in colour with a length of about 4cm long, hanged in numerous clusters and are aromatic and ovoid in shape. The edible fruit is said to have a sour-sweet taste (Bosco *et al*., 2000).

The leaves bark and fruit juices of the plant have been widely used for medicinal and non- medicinal purposes. The fruits are edible. Frozen pulp of the fruit is one of the most prized in Brazilian market due to its exotic flavor beside its excellent nutritional quality (Julia *et al*., 2011). It is used for the preparation of ice cream, yogurts and jams (Janick and Paull, 2008). In Amazon, the fruit is used mainly to produce wine sold as 'Vinho de Taperiba', while in Guatemala, it is made into a cider-like drink: however, excessive indulgence in the fruit is said to cause dysentery (Morton, 1987). It is used in Panama, Peru and Mexico in fairly large quantities as jams (Igwe *et al* 2010). It has been evaluated as an unconventional source of vitamins A and C (Keshinro, 1985).

Njoku and Akumefula, 2007 reported the chemistry of this plant. Wide ranges of antibacterial and antifungal properties have been reported (Castner *et al*., 1998; Okwu, 2001). Other reported pharmacological activities include anti-malarial (Caraballo *et al*., 2004), anti-helmintic (Ademola et al., 2005), anti-diarrhoea (Akubue *et* al., 1983) and anti-free radical, anti-aging and reduces glutathione synthesis (Pauly and Fleury, 2002). It has also been reported to have blood lipid-lowering activity (Igwe *et al*., 2008). The reported effects observed with the plant's extract has been attributed to its phytochemical compounds such as phenol, tannin, anthraquinones, flavonoids, alkaloids, proanthocyanins and saponins (Edeoga and Eriata, 2001; Ayoka *et al* ., 2008).

Work has been carried out on the nutritional, phytochemical and antimicrobial properties of both the fruit and leaves of *Spondia mombin*, however, there is a dearth of information on method of extending the shelf-life. The fruits are seasonal and perishable; it last for only 1-2 days after harvest. Thus, it is imperative to identify the post harvest microorganisms associated with the spoilage of the fruits.

This study investigates the effect of 0.2% sodium benzoate on the shelf stability of freshly harvested hog plum during storage at tropical ambient temperature (29.0±2°C).

## 2. Materials and Methods

**Collection and Preparation of samples**

Freshly harvested fruits (1500g) were collected in sterile high density polyethylene (HDPE) bags from Ambrose Alli University, Ekpoma, Edo State, Nigeria. The sample was divided into two sub-groups and packaged (10g/pack) using perforated HDPE bags. A set of pack was treated with 0.2% solution of sodium benzoate (SB) while the other set (control sample) was not treated. Both samples were stored in the laboratory at tropical ambient temperature (29.0 ± 2°C) for a period of 21days.

**Isolation of Microbial strains**

Samples were aseptically weighed, homogenized, diluted serially and analyzed microbiologically at intervals of 7days for a period of 21days. Diluted samples were plated and enumerated. For identification of bacteria and fungi, colonies were isolated and sub-cultured in nutrient agar and potato dextrose agar (supplemented with chloranphenicol) respectively.

**Physico-chemical, Mineral and Vitamin content analyses**

The pH of the sample was analyzed using pH meter (Jenway, Model 302) as described by Njoku and Okemadu (1989). Titratable acidity (as % lactic acid) was determined by method of AOAC (2001). The mineral contents were evaluated using atomic absorption spectrophotometer. The ascorbic acid content of the sample was determined by titration with 2, 6-dichlorophenol-indophenol solution while the other vitamins were analyzed using chromatographic method. All analyses were performed in duplicate.

## 3. Results

The result showed the microbiological, physicochemical, vitamin and mineral contents of *Spondia mombin* treated with 0.2% sodium benzoate (Tables 1-5).

Steady increases were recorded for total viable bacterial and fungal counts in the control samples throughout the storage period (Tables 1 and 2). For the sample treated with 0.2% SB, gradual decreases in counts were observed. Fungal count ($6.6 \times 10^3$ cfu/g) was higher than the bacterial count ($1.3 \times 10^2$ cfu/g) at the end of three weeks. Microorganisms isolated were *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis* and species of *Klebsiella*, *Aspergillus*, *Penicillium*, *Mucor* and *Rhizopus* from controlled samples while two genera (*Bacillus* and *Aspergillus*) were isolated from SB treated samples

The pH of the controlled sample decreased gradually from 3.2± 0.01 to 2.75 ± 0.21 while the treated sample increased to 4.15 ± 0.02 after processing and thereafter remained fairly stable (3.01 ± 0.13) till the end of storage (Table 3).

Table 4 revealed the titratable acidity (TA) values of both the controlled and treated samples. The values increased from 0.0018 ± 0.02 to 0.0075 ± 0.01 and 0.0016 ± 0.03 to 0.0028 ± 0.04 respectively at the end of storage.

The mineral and vitamin contents (Table 5) of fresh, controlled and preserved samples indicated that the fresh sample contains appreciable amounts of sodium (3.501mg/100g), potassium (202.68mg/100g), magnesium (22.05mg/100g) and calcium (3.65mg/100g). Four micro minerals were quantified: these include manganese (0.104mg/100g), iron (0.24mg/100g), copper (0.063mg/100g) and zinc (0.24mg/100g). Noticeable decrease changes were observed in the mineral contents of the control sample at the end of the storage period. Values obtained from treated samples were comparable with fresh samples with the exception of sodium which had an increased value (4.154 ± 0.03 mg/100g). Vitamin C, A, B. K and D contents of the fresh fruit were 54.06 ± 0.015, 11.05 ± 0.02, 0.12±0.001, 0.15 ±0.001 and 0.015 ±0.000 mg/100g respectively. The preserved sample had slightly lower values of vitamin C (52.78 ±0.03 mg/100g) and A (10.37 ±0.004 mg/100g) at the end of storage compared with nutrient status prior to preservation.

**Table 1:** Total viable count of bacteria (cfu/g) of *Spondia mombin* fruits preserved with 0.2% sodium benzoate during storage for 21days at tropical ambient temperature (29.0± 2°C).

| Period of storage (days) | Samples Control | 0.2% SB |
|---|---|---|
| 0hr | $4.2 \times 10^3$ | $2.1 \times 10^1$ |
| 1 | $4.8 \times 10^3$ | $2.6 \times 10^1$ |
| 2 | $4.6 \times 10^4$ | $3.2 \times 10^1$ |
| 7 | $5.2 \times 10^4$ | $3.4 \times 10^1$ |
| 14 | $3.1 \times 10^6$ | $1.0 \times 10^2$ |
| 21 | $6.3 \times 10^8$ | $1.3 \times 10^2$ |

**Table 2:** Total fungal count (cfu/g) of *Spondia mombin* fruits preserved with 0.2% sodium benzoate during storage for 21days at tropical ambient temperature (29.0± 2°C).

| Period of Storage (days) | Samples Control | 0.2% SB |
|---|---|---|
| 0hr | $1.6 \times 10^2$ | $1.3 \times 10^1$ |
| 1 | $1.8 \times 10^2$ | $1.7 \times 10^1$ |
| 2 | $2.0 \times 10^3$ | $3.2 \times 10^2$ |
| 7 | $2.7 \times 10^4$ | $1.9 \times 10^2$ |
| 14 | $3.6 \times 10^5$ | $2.5 \times 10^3$ |
| 21 | $1.42 \times 10^6$ | $6.6 \times 10^3$ |

**Table 3:** Changes in pH of *Spondia mombin* fruits treated with 0.2% sodium benzoate (SB) during storage for 21 days at tropical ambient temperature (29.0 ± 2°C).

| Period of Storage days | Samples Control | 0.2% SB |
|---|---|---|
| 0hr | 3.20 ± 0.01 | 4.15 ± 0.02 |
| 1 | 3.15 ± 0.02 | 3.38 ± 0.04 |
| 2 | 3.12 ± 0.01 | 3.27 ±.0.02 |
| 7 | 3.10 ± 0.04 | 3.15 ± 0.01 |
| 14 | 3.00 ± 0.02 | 3.05 ±0.03 |
| 21 | 2.75 ± 0.02 | 3.01 ± 0.13 |

**Table 4:** Changes in Titratable acidity (% lactic acid) of *Spondia mombin* fruits treated with 0.2% sodium benzoate (SB) during storage for 21 days at tropical ambient temperature (29.0 ± 2°C).

| Period of Storage Days | Samples Control | 0.2% SB |
|---|---|---|
| 0hr | 0.0018 ± 0.02 | 0.0016 ± 0.03 |
| 1 | 0.0022 ± 0.01 | 0.0019 ± 0.03 |
| 2 | 0.0035 ± 0.04 | 0.0021 ± 0.01 |
| 7 | 0.0051 ± 0.03 | 0.0023 ± 0.04 |
| 14 | 0.0068 ± 0.01 | 0.0027 ± 0.01 |
| 21 | 0.0075 ± 0.01 | 0.0028 ± 0.04 |

**Table 5:** Mineral and Vitamin contents (mg/100g) of fresh, controlled and treated samples of *Spondia mombin* at the end of storage for 21 Days at tropical ambient temperature (29.0 ± 2°C)

| Parameters (mg/100g) | Fresh fruit | Control | 0.2% SB |
|---|---|---|---|
| Sodium (Na) | 3.501 ± 0.01 | 3.301 ± 0.05 | 4.154 ± 0. 03 |
| Magnesium (Mg) | 22.05 ± 0.03 | 18.89 ± 0.01 | 19.814 ± 0.01 |
| Potassium (K) | 202.68 ± 0.16 | 190.12 ± 0.08 | 200.09 ± 0.04 |
| Calcium | 3.65 ± 0.24 | 3.50 ± 0.001 | 3.61 ± 0.01 |
| Manganese (Mn) | 0.104 ± 0.004 | 0.101 ± 0.000 | 0.103 ± 0.001 |
| Iron (Fe) | 0.24 ± 0.006 | 0.201 ± 0.002 | 0.231 ± 0.001 |
| Copper (Cu) | 0.063 ± 0.000 | 0.062 ± 0.000 | 0.063 ± 0.000 |
| Zinc (Zn) | 0.0024 ± 0.001 | 0.0023 ± 0.000 | 0.00233± 0.000 |
| | | | |
| Vitamin C | 54.06 ± 0.015 | 35.42 ± 0.04 | 52.78 ± 0.03 |
| Vitamin A | 11.05 ± 0.02 | 6.50 ± 0.02 | 10.37 ± 0.04 |
| Vitamin B | 0.12 ± 0.001 | 0.081 ± 0.000 | 0.11 ± 0.000 |
| Vitamin K | 0.15 ± 0.001 | 0.08 ± 0.000 | 0.12 ± 0.000 |
| Vitamin D | 0.015 ± 0.000 | ND | ND |

ND = Not detected

## 4. Discussion

The effect of sodium benzoate (SB) treatment on the Total Viable Count (TVC) of bacteria and fungi associated with fruits of *S. mombim* during storage at room temperature are as shown in Tables 1 and 2. In general, microbial counts increased in the control sample throughout the storage period. However, negligible growth was detected in the SB treated samples till the end of storage period. This might be due the effect of the preservative on the spoilage organisms; the inhibitory properties of SB may have created unfavourable micro environment situation which may have distorted the physiological, homeostatic and metabolic activities of the organisms. Further stress might be created as the organisms struggle to overcome the hostile environment thus leading to metabolic exhaustion and gradual death with subsequent decrease in the viable counts of the microorganisms. This finding is in agreement with previous work (Ogiehor, 2002). The slight increase in bacterial count detected at the end of storage suggests slow recovery and survival of injured cells. Similar findings have been reported for foods preserved by combination of preservative factors (Leistner, 1994; Efiuvwevwere and Isaiah, 1998).

Only *Aspergillus niger* and *Bacillus subtilis* were isolated from the preserved sample. This reduction from eight genera in the control to two in SB treated sample demonstrated the beneficial effect of SB on the microbial stability of *S. mombin* during storage

The slight increase in the pH observed in SB treated samples may be due to influence of the preservative that exhibits slight basic characteristics. However the decrease recorded in the control sample may be related to microbial activities; utilization of carbohydrate and subsequent production of organic acid.

Fruits generally have in their composition a great variety of vitamins and minerals which make them a rich contribution to our diet (Julia *et al*., 2011). The fruits of *S. mombin* contain adequate concentration of vitamin C and A. The noticeable decreases recorded in mineral and vitamin contents of *S. mombin* in the control sample during storage could be attributed to the proliferation of the microorganisms and the associated activities (Tables 1and 2). However, the stability observed and recorded in the treated sample may be due to the antimicrobial properties of SB. Ogiehor *et al*. (2003) reported the application of SB to control microbial growth and also enhance stability of food.

Vitamin C has anti-infection properties, promotes wound healing, boost immune system and help to ward off infection. Vitamin A helps to maintain good sight and prevents certain eye diseases. Also, both vitamins have antioxidant properties and may protect against some forms of cancer (Wright, 2002; Ayoka *et al*., 2008). High content of vitamin A and C may help essentially in controlling physiological oxidative stress (Wright, 2002).

Minerals are inorganic elements that remain in the ash when food is incinerated. They are classified as either essential or non- essential depending on whether or not they are required for human nutrition and have metabolic roles in the body (Reilly, 2002). From the result obtained, *S. mombin* fruit contains more concentration of potassium, magnesium calcium and sodium than other minerals determined.

Regarding the macro-minerals determined; the fruit showed low levels of sodium and calcium. However, there were high contents of magnesium and potassium. Albino *et al*.(1999) confirmed the yellow mombin as a fruit with a high content of potassium along with jackfruit, soursop, jenipapo (*Genipa americana*) and mangaba (*Hancornia speciosa*). The magnesium content was higher than the one found by Leterme *et al*. (2006), 12mg/100g but lower than that found by Mattieto (2005), 24.33mg/100g. The differences could be attributed to the origin of the fruit. Julia et al. (2011) stated that the mineral composition is dependent on the fertility conditions of the region since minerals are absorbed from the soil, also it is dependent on genetic factors and use of fertilizers. The essential micro- minerals quantified include manganese, iron and copper. The fruit indicated significant amounts of iron and manganese but low copper content. Values obtained for copper was below those found by Julia *et al*.(2011) and Mattieto (2005).

## 5. Conclusion

The study has shown that *Spondia mombin* fruits contain high levels of potassium, magnesium and also it has high content of vitamin A and C which are associated with the prevention of various diseases. Treating *S. mombin* with

sodium benzoate improved the microbial quality and extended the shelf stability for up to three weeks.

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