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ISSN: 2322-4789
Asian Journal of Medical and Pharmaceutical Researches
Asian J. Med. Pharm. Res. 4(1): 46-52, 2014

AJMPR

# Baobab Fruits (with\without Shell) Affected by Wrapping and Type of Packaging Materials during Storage Period

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**ABSTRACT:** Baobab fruit pulp is derived from the fruits of the Baobab tree (Ad Ansonia digitata), also known as the 'upside down tree 'The applicant proposes to market a baobab fruit pulp as a novel food ingredient for use in a range of food products namely beverages, smoothies, cereal bars and other similar food products. In this study baobab fruits pulp was analyzed for proximate composition and effect of wrapping material on fruits during storage. Seventy seven samples of raw Baobab fruit as well as market samples were studies for chemical composition. Moisture content%, pH, treatable acidity %, TSS, Ascorbic acid content ml/100g, total sugars content%, Reducing sugars content% and ash content % were evaluated ,the pulp contain substantial quantities of treatable acidity 6.30%, TSS 7.00, total sugars 13.00%, Reducing sugars 5.70% and high amount of Ascorbic acid content (392.00 mg/100g of fruit pulp). Baobab contains naturally dehydrated fruit pulp, which contains five times or more the vitamin C content present in oranges (53mg/100g of fruit pulp). The study proved that packaging materials have a significant impact in reducing the nutritional value generally and vitamin c in particular. The study revealed that Poly ethylene bags the best one.

**Key words:** Baobab, Dehydrated Fruit Pulp, Vitamin C.

ORIGINAL ARTICLE

Received 04 May. 2013
Accepted 23 Dec. 2013

## INTRODUCTION

The baobab fruit pulp is probably the most important foodstuff. It can be dissolved in water or milk. The liquid is then used as a drink, a sauce for food, a fermenting agent in local brewing, or as a substitute for cream of tartar in baking (Sidibe and William, 2002).

The baobab fruit is composed of an outer shell (epicarp) (45%), fruit pulp (15%) and seeds (40%) (Shukla et al., 2001). The woody epicarp or pod contains the internal fruit pulp (endocarp) which is split in small floury, dehydrated and powdery slides that enclose multiple seeds and filaments, the red fibres that subdivide the pulp in segment (Nour et al., 1980). The baobab fruit pulp is dry, acidulous and mealy, and rich in mucilage, pectins, tartarate and free tartaric acids. The presence of the tartarate gives rise to the name 'cream of tartar tree' (Shukla et al., 2001; Ajayi and Fagade, 2003). Pulp sweetness is provided by fructose, saccharose and glucose contents. Fruit pulp is also acidic and this is due to the presence of organic acids including citric, tartaric, malic, succinic as well as ascorbic acid (Shukla et al., 2001). When eaten raw, the pulp is a rich source of calcium and vitamins B and C (Burkill, 1995).

It contains sugars but no starch, and is rich in pectins. The fruit pulp has very high vitamin C content; almost ten times that of oranges. However, the vitamin C content of the bulk fruit pulp reportedly varies from 1623 mg/kg in one tree to4991 mg/kg in another (Sidibe et al., 1996; Sidibe et al., 1998; Gebauer et al., 2002). Citrus fruit are non-climacteric, with persistently low respiration and ethylene production rates, do not undergo any major softening or compositional changes after harvest therefore, can normally be stored for relatively long periods (Kader, 2002). Poly ethylene bags maintained good organoleptic properties of melon study the storage in a modified atmosphere (Rodov et al., 2002).

## MATERIALS AND METHODS

### Fruit collection

Dry Gongolase fruits Adansonia digitata were purchased from the local market of Nyala in Western Sudan in March 2006-2007, chemicals materials were obtained from laboratories materials shops and some from Sudanese Arab Company for Oil Seeds Ltd.

### Extraction of fruit (Adansonia digitata) pulp powder:

The hard woody shells of the fruits were opened by hand using machaete to obtain seeds, embedded in a whitish powdery soft pulp. The seeds were then ground using mortar and pestle to separate the pulp from the seeds. The mixture was sieved through a 0.09 micron sieve to obtain a fine powder. The powder was immediately analyzed.

To cite this paper: Adam Eldoom E., Elmubarak Ali A. and Awad Abdel-Razig K. 2013. Baobab Fruits (with\without Shell) Affected by Wrapping and Type of Packaging Materials During Storage Period. *Asian J. Med. Pharm. Res.*, 4 (1): 46-52.

**Chemical analysis:**

Moisture and ash content of each fruit sample were determined according to AOAC standard method (AOAC, 1990) by accurately weighing 5 g of the sample and drying in an oven at 105C to constant weight.

Acidity (expressed as total titratable acidity; TTA) was determined according to AOAC standard method by titrating 10 ml of the pulps and juices against 0.1 M NaOH standard solution using phenolphthalein indicator (AOAC, 1990).

Ascorbic acid content was estimated as method described by (Ranganna, 2001). The total soluble solids of the fruits pulp were determined using a hand refractometer (0 to 32% Brix, Model DIGT 0-32ATC for the pulp. The pH was measured using pH meter (Wagtech, Model 3305, Jenway Ltd, and UK).

**Acceptability tests**

Sensory evaluation was carried out; along with the different tests' using a 5-point hedonic scale ranging from excellent (Abdel-Muti, 1991) to unacceptable (Association of Official analytical Chemistry, 2000) ten panelists were used to evaluate the color, taste and general acceptance of the samples. Panelists were aged between 25 and 45 years. For each sample, 10 g or more of baobab fruit samples were served in white disposable plate. The plates were coded with six digit random numbers and randomized between panelists. The panelist assessed baobab fruit samples and allowing the panelists to write their comments on the assessment form. The evaluation took place at 12.00 Am every day for a period of 3 days.

**Statistical analysis**

Data were subjected to statistical analysis using (statistical software for Windows). The general linear model (GLM) was used to determine the differences ($p<0.05$) of means between the dry fruit for each attribute. Means were compared using Duncan's multiple range test at $p<0.05$.

## RESULTS AND DISCUSSION

**Changes in titratable acidity**

Table 1 and Chart 1 shows the changes in titratable acidity of dry Gangolase fruits. The significant ($p<0.01$) decrease in acidity of all samples during storage periods in all three packaging materials tested .It decreased from 9.6 to 8.00% in Jute with shell after one year of storage; From 7.71 to 5.45% in Jute without shell; from 9.6to 6.23% in polyethylene with shell; from 7.71to 5.40% in polyethylene without shell; from 9.60to 8.00% in basket with shell; from 7.71to 7.05% in basket without shell. The results further indicated that amongst the various packages tested, Jutes were the less affected. The interaction between storage and packaging materials were found to be significant ($p<0.01$) .Similar trend of decrease in acidity of all samples in the three different packaging materials were noted.

The differences in acid decreasing of samples in different packages were due to varied rates of growth and action of lactic acid producing by microorganisms. In market Samples the acidity did not show the same trend. This may be due to difference in samples during collection time (may be new or old), difference in environmental condition during purchasing or may be due to both factors.

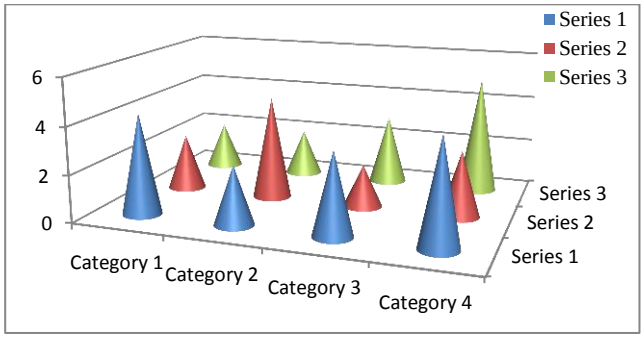


**Chart 1.** Changes in titratable acidity of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

**Changes in Moisture content**

Moisture content of dry gongolase fruits similar to what has been reported by Arnold et al. (1985) and after storage at (35C°±5) was decreased. The decreasing in moisture content was highest in samples packed in baskets and minimum in polyethylene (Table 2 and Chart 2). This could be explained on the basis that polyethylene pouch had better moisture barrier properties than other two types of package material tested.

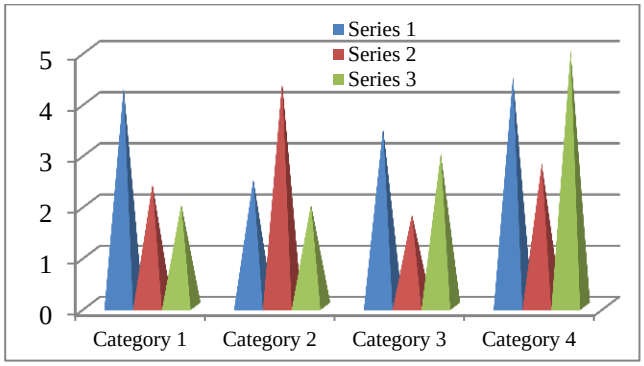


**Chart 2.** Changes in moisture content of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

During autumn the moisture content of all samples increased with high rate in samples without shell due to high relative humidity (R.H).The basket samples had a highest rate (3.58%) and the polyethylene was the lowest

rate (1.30%) of increasing. This agreed with what reported by Kader (2002) who found that polyethylene layer provided better protection against losses of moisture.

**Changes in Ash content**

At initial analysis the ash content was not similar to what had been showed by Abdel-Muti (1991) and Arnold et al. (1985) that may be due to fact that the time of analysis, place of original sample and type of trees are not the same, and after 6 months the ash content increased similar to that reported by Abdel-Muti (1991) and Arnold et al. (1985). All Packaging Materials had a significant ($p<0.01$) effect on ash content of the samples. The ash content of fresh samples was 0.90%, which increased to 6.00% after one year in jute with shell and a relative increase has recorded in other Packaging materials. The minimum change occurred in samples packed in Polyethylene (3.10%) and the highest reported in samples collected from the market (25.53%) that may be due to contamination of samples from the surrounded environmental conditions such as dust, filths, foreign matters insects etc. (Table 3 and Chart 3).

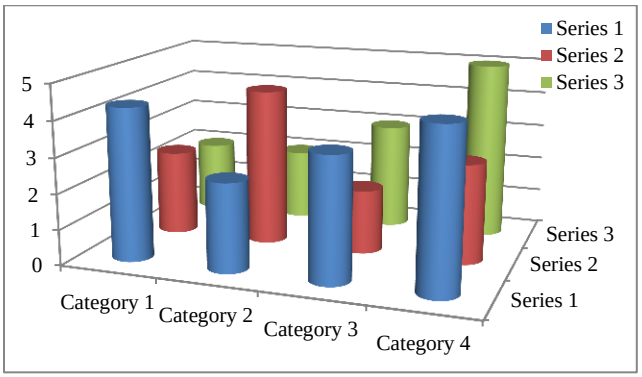


**Chart 3.**Changes in ash content of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging material

**Changes in Vitamin C content**

Initial analysis revealed that the content of vitamin C in Baobab fruit pulp (392mg/100g) higher than that 337mg reported by Lghodalo et al. (1991) Ascorbic acid /100g pulp for fruits in Nigeria.

Vitamin C content of dry gongolase fruits samples affected significantly ($p<0.01$) during storage. This effect was highly influence with the type of packaging materials used as well as with the condition of samples (with /without shell) (Table 4 and Chart 4) showed that a decrease in vitamin C content with extended storage period. Vitamin C value of fresh fruits of powder gongolase was 392 mg / l00g of fruits powdered and it decreased progressively upon storage for one year at room temperature (35C°±5). The maximum changes in vitamin C were in sample packaged in basket (317.43 mg) .The decrease in vitamin C content during storage may be as a result of high atmospheric oxygen.

Atmosphere oxygen is an essential element in the losses of vitamin C during long-term storage, Salunkhe et al. (1991). The minimum changes in vitamin C in Samples packaged in polyethylene may be as a result of layer provided better protection against penetration of oxygen.

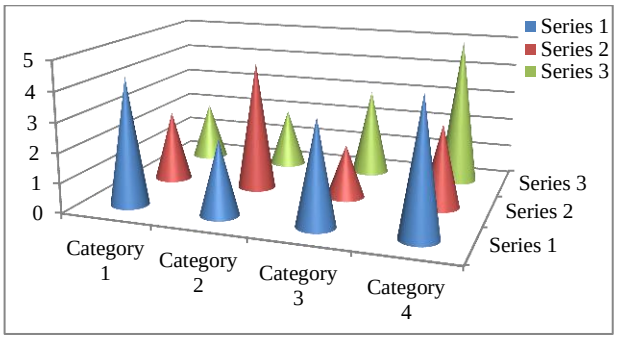


**Chart 4.** Changes in Ascorbic acid content of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

**Changes in Total and reducing sugar content**

Total and Reducing sugar content of dry gongolase fruits samples decreased significantly ($p<0.01$) with increase in storage period in all three packaging materials (Table 5 and Chart 5) .The initial reducing sugar content was 5.70% that deceased to 1.75% after one year of storage. The maximum relative decrease 1.75% was observed in sample packed in basket especially in samples without shell as it did not provided better protection against contamination and growth of micro-organisms, or due to non-enzymatic browning that had taken place.

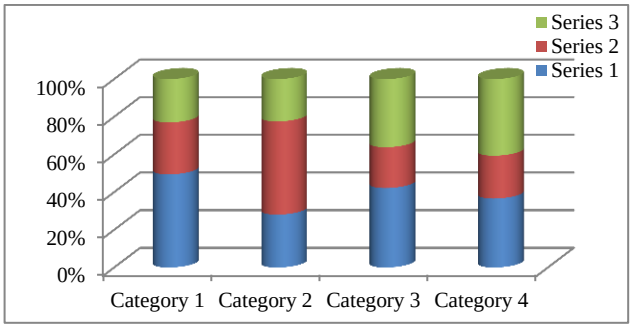


**Chart 5.** Changes in total sugars content of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

**Changes in Ph**

Table 6 and Chart 6 showed a significant ($p<0.01$) degrease in pH in both samples during storage period in all three packaging materials tested. It decreased in Jute from 3.57% to 3.10%with shell; from 3.40% to 3.11% without shell after one year of storage, from 3.30% to 3.02% in

poly ethylene with shell; from 3.35% to 3.01% in polyethylene without shell; from 3.54% to 3.09% in basket with shell and from 3.39% to 3.01% in Basket without shell. The result further indicated that the growth of microorganisms producing acids was lowered due to lowering of nutrients.

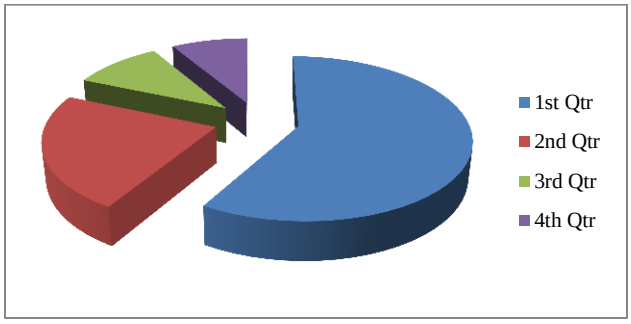


**Chart 6.** Changes in reducing sugars content of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

### Changes in Total Soluble Solid Content

Total soluble solid content changed in all samples significantly ($p<0.01$) except in samples packed in polyethylene with shell which was constant during period of storage (Table 7).

Polyethylene protects samples against environmental condition such as dryness, moisture, microorganisms act.

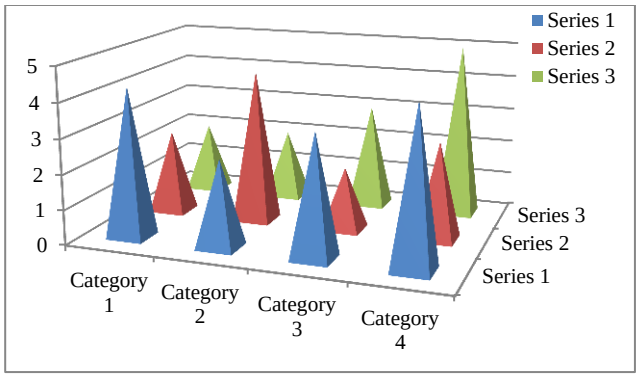


**Chart 7.**Changes in PH of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

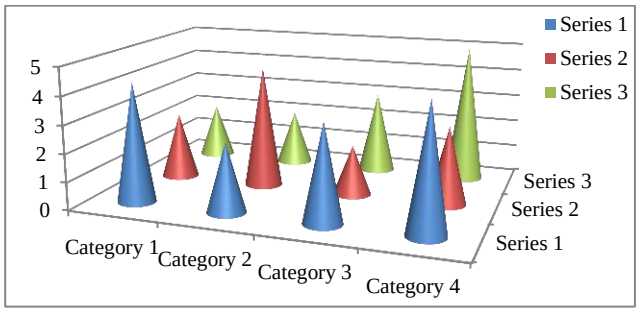


**Chart 8.** Changes in TSS of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

**Table 1.** Changes in titratable acidity of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials**.**

| M<br>P | Jute | | | | Polyethylene | | Basket | | Market |
|---|---|---|---|---|---|---|---|---|---|
| | w. | | | | w.o | w. | w.o | w. | w.o | w.o |
| 0 | 9.60 | | | | 7.71 | 9.60 | 7.71 | 9.60 | 7.71 | 5.76 |
| 2 | 9.52 | | | | 7.62 | 11.27 | 10.56 | 10.24 | 10.56 | 10.88 |
| 4 | 9.45 | | | | 7.71 | 8.24 | 8.40 | 9.13 | 9.05 | 7.71 |
| 6 | 8.65 | | | | 6.78 | 7.71 | 7.70 | 8.95 | 8.27 | 9.45 |
| 8 | 8.45 | | | | 5.73 | 6.78 | 5.99 | 8.75 | 8.01 | 8.50 |
| 10 | 8.40 | 5.64 | 6.57 | 5.52 | 8.30 | | | 7.47 | | 11.83 |
| 12 | 8.01 | 5.45 | 6.23 | 5.40 | 8.10 | | | 7.05 | | 13.27 |

W: With shell, W.O: Without shell, P: Packaging materials, M: Month

**Table 2.** Changes in moisture content of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

| P<br>M | Jute | | Polyethylene | | Basket | | Market |
|---|---|---|---|---|---|---|---|
| | w. | w.o | w. | w.o | w. | w.o | w.o |
| 0 | 6.30 | 5.61 | 6.30 | 5.61 | 6.30 | 5.61 | 4.20 |
| 2 | 5.61 | 4.84 | 6.23 | 4.42 | 4.30 | 4.00 | 2.43 |
| 4 | 8.53 | 9.50 | 6.53 | 4.57 | 4.50 | 13.11 | 2.32 |
| 6 | 4.26 | 4.00 | 6.10 | 4.03 | 3.93 | 5.73 | 5.51 |
| 8 | 3.91 | 3.97 | 5.95 | 3.91 | 8.70 | 4.25 | 7.19 |
| 10 | 3.32 | 3.21 | 5.00 | 3.79 | 2.01 | 2.03 | 6.40 |
| 12 | 3.09 | 3.00 | 5.00 | 3.66 | 2.00 | 1.95 | 9.53 |

W: With shell, W.O: Without shell, P: Packaging materials, M: Month

**Table 3.** Changes in ash content of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging material

| P<br>M | Jute | | Polyethylene | | Basket | | Market |
|---|---|---|---|---|---|---|---|
| | w. | w.o | w. | w.o | w. | w.o | w.o |
| 0 | 0.90 | 1.33 | 0.90 | 1.33 | 0.90 | 1.33 | 29.56 |
| 2 | 3.83 | 3.80 | 4.42 | 4.00 | 4.07 | 5.02 | 6.42 |
| 4 | 4.51 | 4.54 | 4.60 | 4.50 | 4.41 | 5.56 | 7.07 |
| 6 | 5.00 | 5.00 | 4.54 | 4.63 | 4.53 | 5.78 | 8.51 |
| 8 | 5.00 | 5.56 | 4.82 | 4.89 | 5.00 | 5.93 | 4.03 |
| 10 | 5.37 | 6.23 | 4.93 | 5.13 | 5.13 | 6.32 | 9.06 |
| 12 | 6.00 | 6.93 | 4.93 | 4.98 | 0.90 | 6.73 | 11.04 |

W: With shell, W.O: Without shell, P: Packaging materials, M: Month

**Table 4.** Changes in Ascorbic acid content of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

| P<br>M | Jute | | Polyethylene | | Basket | | |
|---|---|---|---|---|---|---|---|
| | w. | w.o | w. | w.o | w. | w.o | w.o |
| 0 | 392.00 | 343.50 | 392.00 | 343.50 | 392.00 | 343.50 | 280.00 |
| 2 | 196.70 | 168.00 | 271.18 | 255.24 | 239.93 | 230.97 | 148.00 |
| 4 | 190.00 | 119.70 | 168.00 | 175.00 | 175.00 | 58.65 | 127.50 |
| 6 | 59.1 | 56.12 | 76.50 | 74.57 | 73.95 | 58.65 | 127.50 |
| 8 | 56.13 | 53.55 | 68.85 | 64.00 | 66.30 | 53.75 | 94.35 |
| 10 | 49.08 | 32.46 | 62.07 | 51.80 | 50.19 | 30.22 | 235.30 |
| 12 | 47.13 | 31.01 | 57.26 | 50.97 | 43.09 | 26.45 | 359.05 |

W: With shell, W.O: Without shell, P: Packaging materials, M: Month

**Table 5.** Changes in total sugars content of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials.

| P<br>M | Jute | | Polyethylene | | Basket | | Market |
|---|---|---|---|---|---|---|---|
| | w. | w.o | w. | w.o | w. | w.o | w.o |
| 0 | 13.00 | 12.41 | 13.00 | 12.41 | 13.00 | 12.41 | 11.80 |
| 2 | 12.78 | 12.38 | 7.80 | 12.06 | 12.70 | 12.26 | 11.60 |
| 4 | 11.68 | 12.14 | 7.40 | 11.61 | 11.72 | 12.10 | 13.40 |
| 6 | 5.68 | 4.80 | 4.89 | 4.42 | 4.19 | 4.32 | 4.40 |
| 8 | 5.37 | 4.38 | 4.30 | 3.56 | 3.91 | 3.50 | 4.59 |
| 10 | 5.21 | 4.26 | 3.76 | 3.11 | 3.43 | 3.00 | 12.60 |
| 12 | 5.09 | 3.93 | 3.11 | 2.98 | 3.00 | 2.87 | 10.19 |

W: With shell, W.O: Without shell, P: Packaging materials, M: Month

**Table 6.** Changes in reducing sugars content of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

| P<br>M | Jute | | Polyethylene | | Basket | | Market |
|---|---|---|---|---|---|---|---|
| | w. | w.o | w. | w.o | w. | w.o | w.o |
| 0 | 5.70 | 5.50 | 5.70 | 5.50 | 5.70 | 5.50 | 4.30 |
| 2 | 5.40 | 4.34 | 5.55 | 4.65 | 5.31 | 5.26 | 3.70 |
| 4 | 5.01 | 3.98 | 5.08 | 4.17 | 2.90 | 2.34 | 2.08 |
| 6 | 3.80 | 3.38 | 3.74 | 3.89 | 2.77 | 2.24 | 3.12 |
| 8 | 3.56 | 3.03 | 2.92 | 2.33 | 2.49 | 2.16 | 2.89 |
| 10 | 3.13 | 2.93 | 2.30 | 2.16 | 2.00 | 2.07 | 4.80 |
| 12 | 3.04 | 2.12 | 1.97 | 1.89 | 1.75 | 1.94 | 9.30 |

W: With shell, W.O: Without shell, P: Packaging materials, M: Month

**Table 7.** Changes in PH of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

| P M | Jute | | Polyethylene | | Basket | | Market |
|---|---|---|---|---|---|---|---|
| | w. | w.o | w. | w.o | w. | w.o | w.o |
| 0 | 3.57 | 3.4 | 3.3 | 3.35 | 3.54 | 3.09 | 3.5 |
| 12 | 3.1 | 3.11 | 3.02 | 3.01 | 3.09 | 3.01 | 4.62 |

W: With shell, W.O: Without shell, P: Packaging materials, M: Month

**Table 8.** Changes in TSS of Baobab fruits during storage period as affected by wrapping with\without shell and type of packaging materials

| P M | Jute | | Polyethylene | | Basket | | Market |
|---|---|---|---|---|---|---|---|
| | w. | w.o | w. | w.o | w. | w.o | w.o |
| 0 | 7.00 | 5.00 | 5.50 | 7.00 | 5.50 | 5.50 | 5.80 |
| 12 | 6.00 | 5.00 | 6.00 | 5.00 | 5.00 | 5.00 | 6.30 |

W: With shell, W.O: Without shell, P: Packaging materials, M: Month

**Table 9.** Sensory Evaluation of dry Gongolase fruits packed in three different packaging materials and stored for one year.

| Character | Jute | | Polyethylene | | Basket | | Market |
|---|---|---|---|---|---|---|---|
| | w. | w.o | w. | w.o | w. | w.o | w.o |
| Texture | 3.40 | 3.90 | 1.20 | 1.50 | 4.00 | 4.40 | 2.90 |
| Flavour | 2.20 | 2.65 | 1.20 | 1.45 | 3.45 | 3.80 | 3.95 |
| Appearance | 3.10 | 3.55 | 1.05 | 1.55 | 2.85 | 3.85 | 3.05 |
| Overall acceptability | 2.50 | 3.00 | 1.03 | 1.70 | 3.20 | 4.70 | 3.50 |
| Texture | 3.40 | 3.90 | 1.20 | 1.50 | 4.00 | 4.40 | 2.90 |

W: with shell, W.O: without shell, 1: excellent, 2: V good, 3: good, 4: acceptable, 5: unacceptable

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