COMPARATIVE STUDY ON THE EFFICACY OF SOME PLANT AQOEUOUS EXTRACTS AND WAXES IN THE PRESERVATION OF SOME FRUITS AND FRUIT VEGETABLES

By

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ABSTRACT

The preservative effect of waxes (paraffin and ester) and aqueous extracts (*P. biglobosa* pod, *G. senegalensis* and *B. aeyptiaca* leaves) were comparatively studied. The preservative effects of the waxes was determined by treating fresh ripe tomatoes, peppers and oranges with buffer (pH 9, 10) for 2 minutes and wax for 3 minutes using the dipping method and for extracts, washing daily with 5mg/ml and 10mg/ml for 3 minutes respectively. Control experiments (untreated and unwaxed) were also set up for comparison. Number of days taken by the fruits and fruit vegetables to deteriorate was recorded and compared. The results showed that waxing was highly effective on pepper (30 days), moderately effective on orange (26 days) and fairly effective on tomato (15 days). Among the waxes, paraffin was more effective (9 – 30 days) in increasing the shelf life than ester (9 – 14 days) and the control (6-8 days). *P. biglobosa* extract application proved more effective (17 - 26 days) than *Guera senegalensis* (13 – 14 days), *Balanites aegyptiaca* (8 - 13 days) and the control (9-11 days) in terms of extending the shelf life of the test fruits and fruit vegetables. Statistically, significant difference ($p < 0.05$) exist between shelf life of tomato, orange and pepper used as control and those subjected to treatments. Overall in terms of preservative activity, paraffin wax > *P. biglobosa* > *G. senegalensis* > *B. aegyptiaca* > ester wax. Application of waxes and plant aqueous extracts to preserve seasonally available fruits and vegetables could provide a cheap and economically viable method of preservation that could be adopted by farmers in Nigeria, where storage facilities for such products are insufficient or electricity – driven, which is epileptic in supply.

Keywords: Wax, Fruits, Efficacy, Nigeria, Storage

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INTRODUCTION

It is estimated that 20% of all fruits and vegetables harvested for human consumption are lost through microbial spoilage [1]. The high water content of fruits and vegetables favours growth of spoilage bacteria, molds and yeasts and consequently spoil the fruits and vegetables [2].

Fresh fruits and vegetables offer the most rapid and lowest cost method of providing adequate supplies of vitamins, minerals, and fibre to man [3]. In the tropics, fruits and vegetables are very abundant immediately after the early rains but become scarce late in the rainy season and more so in the dry season [4]. To curtail the effect of the scarcity and make it available all year round, farmers resort to sun drying of fruits and vegetables. The consequent is that certain vitamins and minerals are lost due to sun drying for example about 33 -50% of the thiamine, ascorbic acid and vitamin A in fruits and vegetables are also lost due to drying [5]. Therefore there is need to have a preservative method that will guarantee the supply of these vitamins and minerals in fresh fruits and vegetables even for a short – term duration.

The use of plant materials in the preservation of fruits and vegetables is a method currently under research. In a preliminary investigation to determine the efficacy of plant extracts as preservatives, Bukar and Magashi [6] screened *Guera senegalensis, Lepidium sativum, Balanite aegyptiaca* and *Parkia biglobosa* used in ethnomedicine for preservative effect on tomatoes, green leaf and fresh meat. The results obtained show a preservative effect of the powdered suspension of *Lepidium sativum,* leaves of *Balanite aegyptiaca, Guera senegalensis* and pods of *Parkia biglobosa* on tomatoes, lettuce but not on the fresh meat.

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Another method also under investigation is the use of wax material to preserve fruits and vegetables. Waxes serve as physical barrier to spoilage microorganisms and by preventing their entry preserves the fruit and vegetables by increasing their shelf life [7]. Waxes could be natural waxes such as candelia wax, carnauba wax, Japan wax, rice oil wax, sugar cane wax, shellac wax, bees wax and paraffin wax etc, chemically modified waxes (hard waxes) such as ester wax, sasol wax, hydrogenated jojoba wax, montan ester wax; and synthetic waxes such as polyalkylene wax, polyethylene glycol wax etc [8]

Fruit wax could be considered as ingredient rather than a handling aid for a variety of reasons. The wax is often visible to consumers. Shellac wax is used as polish and dessert topping, confectionary glaze in candy as excipient in pharmaceuticals, a coating for supplements. Beeswax is used for vegetable and fruit coatings, in candy and confection to make candles and a sealant [9]. Waxes impart flavours in fruits whose peels are eaten and even in those with peels that are ordinarily not eaten such as citrus [10]. It can also be considered as a preservative, because it prolongs shelf life [11]. The aim of this research is to comparatively evaluate the preservative activities of some selected waxes and plant aqueous extracts with a view to discovering their potentials as fruit and vegetable preservatives.

MATERIALS AND METHODS

Collection and Processing of Plant Materials and Wax

The leaves of *Guera senegalensis, Balanites aegyptiaca* and Pods of *Parkia biglobosa* were collected fresh from their parent plants around Old campus, Bayero University, Kano. Paraffin and Ester waxes were purchased from Toteil Nigeria Limited, Kano.

The plants were first identified at the field using standard keys and descriptions of Dalziel [12]. The plants were further confirmed and authenticated in a Herbarium of the

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Department of Biological Sciences, Bayero University, Kano, Nigeria. The plant materials were air dried and ground into powder using mortar and pestle in the laboratory as described by Mukhtar and Tukur [13].

Sourcing of Test Fruits and Vegetables

For the purpose of this research, Oranges, peppers and tomatoes were used as test fruits and vegetables. Arrangement was made with a fruit seller to purchase the fruits and vegetables immediately their bags were opened before they were washed, as washing will reduce or eliminate the microorganism on the surface of the fruits and vegetables. Visually unbruised fruits were sorted out and transported in sterile polythene bags to the laboratory for investigation as set out by Refai [14].

Grade of fruits and fruit vegetables used for the research

Ripe = fully ripe (red in colour) [Ripe tomatoes, pepper and oranges were used]

Unripe = unripe (green in colour) [Unripe tomatoes and pepper only were used]

Preparation of Aqueous Extract of Plant Materials

The aqueous extracts were prepared using the procedure described by Olamifihin [15]. Fifty grams (50g) of each of the dried, powdered leaves of *Guera senegalensis, Balanites aegyptiaca* and pods of *Parkia biglobosa* was percolated in 500ml of sterilized distilled water at 60°C in a 1-litre capacity round bottom flasks. The flasks were corked, shaken for 1 minute and left to stand for 7 days with shaking at regular intervals. The solutions were filtered using Whatman N0. 1 filter paper. The filtrates were evaporated in a hot oven at 40°C to obtain aqueous extracts of the various test plants. The extracts were stored in a refrigerator at 4°C for future use.

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Preparation of Different Concentrations of Aqueous Extracts

Concentrations of the aqueous extracts (5mg/ml and 10mg/ml) were prepared for evaluation of antimicrobial activity and preservative effect. To prepare 5mg/l of each of the extracts, 5 gram of each of the extract was weighed and dispensed into sterilized bottles containing 1000ml of sterile distilled water. While for 10mg/ml, 10gram of each of the extracts was dispensed into sterilized bottles containing 1000ml of sterilized distilled water [16].

The solutions of the extracts were then kept in a refrigerator for daily use.

Buffer preparation

Buffers of pH 9 and 10 were prepared for fruit and vegetable treatment prior to wax application. Buffer solution of pH 9 was prepared by dissolving 2 sachet of pH 9 powder into 200ml of sterilized distilled water. One hundred millilitres (100ml) of this buffer (pH 9) was dispensed into a separate conical flask, which was adjusted to pH 10 by adding more 1N NaOH with the help of pH meter Jenway model (UK).

Wax Preparations

The procedure for wax preparations was carried out according to the manufacturer's instructions on the packets. Paraffin wax (Raymond A. Lamb, London) was prepared by melting about 200g in a stainless steel container on a hot plate at 60°C. When the wax had melted completely, the container was left on the hot plate to equilibrate at 50°C prior to wax treatment on the fruits and vegetables.

For ester wax (BDH Chemicals Ltd, England), the same procedure for melting paraffin wax was applied, the only difference was the melting temperature used, at 80°C.

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Determination of shelf life of Wax and plant extract treated fruits and vegetables

The fruits and vegetables were also divided into 3 groups (containing two fruits and vegetable fruits); first set was dipped into buffer solution at pH 9 for 2 minutes, then treated with wax at 50°C for 3 minutes, it was removed and allowed to dry. It was kept in open plastic containers in a cupboard. The number of days taken for the fruit and vegetable to spoil or decay was recorded. The second set was also dipped into buffer at pH 10 for 2 minutes, then dipped into wax at 50°C for 3 minutes and allowed to dry and kept until it show signs of spoilage or deterioration. The last set which was the control was not treated with either the buffer or wax but was kept unwaxed for a period of time until it spoilt.

For shelf life determination of extract treated tomatoes, peppers and oranges, the fruits and vegetables were also divided into 3 groups (each containing two fruits and vegetable fruits each); first set was surface washed daily with the aqueous extract of 5mg/ml concentration for 3 minutes duration, dried and kept in plastic containers in a cupboard for shelf life determination. The second set was also treated with the aqueous extract of 10mg/ml concentration for 3 minutes duration, dried and kept also in plastic containers in a cupboard for shelf life determination. The last set which was the control was daily washed with sterilized distilled water for 3 minutes also and kept in a cupboard until it deteriorated.

Temperature Monitoring during the research

The room temperature was monitored daily throughout the period of the research. To take the temperature reading, a thermometer was removed from its jacket and held in air for few minutes. When the mercury level stabilizes, the reading was taken in ^{o}C. The average reading was taken and recorded.

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Statistical Analysis

The results of the preservative effect (Shelf life) of the *P. biglobosa*, *G. senegalensis* and *B. aeyptiaca* extracts, paraffin and ester waxes on test fruits and vegetables was statistically analysed using Analysis of variance (ANOVA) at 5% level of significance to determine whether significant difference exist among the various treatments applied.

RESULTS

Figure 1 shows the result of shelf life determination of paraffin waxed and control tomato, pepper and orange. It can be observed that unwaxed unripe tomato, pepper (control) took 15 and 11 days to deteriorate. The paraffin waxed unripe tomato and pepper at pH 9 took 19 and 24 days to deteriorate while paraffin waxed unripe tomato and pepper at pH 10 took 30, 35 days to deteriorate respectively. For unwaxed ripe tomato, pepper and orange it took 8, 6, 6 days to spoil, paraffin waxed ripe tomato, pepper and orange at pH 9 took 9, 18 and 15 days to spoil , while paraffin waxed ripe tomato, pepper and orange at pH 10 took 15, 30 and 26 days to spoil respectively (Plates 1 and 2).

Figure 2 shows the result of shelf life determination of Ester waxed and control tomato, pepper and orange. It was observed that unwaxed unripe tomato and pepper (control) took 15 and 11 days to deteriorate, the ester waxed unripe tomato and pepper at pH 9 took 12 days and 8 days to deteriorate, while ester waxed unripe tomato and pepper at pH 10 took 19 days and 15 days to deteriorate respectively. For unwaxed ripe tomato, pepper and orange it took 8, 6, 6 days to spoil, ester waxed ripe tomato, pepper and orange at pH 9 took 7, 6 and 10 days to spoil while ester waxed ripe tomato, pepper and orange at pH 10 took 14, 9 and 14 days to spoil respectively.

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Figure 3 shows the result of shelf life determination of aqueous extract of *Parkia biglobosa* treated and control tomato, pepper and orange. It can be observed that untreated unripe tomato and pepper (control) took 18 and 13 days to deteriorate, the *Parkia biglobosa* treated unripe tomato and pepper at 5mg/ml took 26 days and 19 days to deteriorate while *Parkia biglobosa* treated unripe tomato and pepper at 10mg/ml took 32 days and 23 days to deteriorate respectively. For untreated ripe tomato, pepper and orange it took 9, 10, 11 days to spoil, *Parkia biglobosa* treated ripe tomato, pepper and orange at 5mg/ml took 20, 15 and 11 days to spoil while *Parkia biglobosa* treated ripe tomato, pepper and orange at 10mg/ml took 24, 17 and 26 days to spoil respectively.

Figure 4 shows the result of shelf life determination of aqueous extract of *Guera senegalensis* treated and control tomato, pepper and orange. It can be observed that untreated unripe tomato and pepper (control) took 18 and 13 days to deteriorate, the *Guera senegalensis* treated unripe tomato and pepper at 5mg/ml took 18 days and 16 days to deteriorate while *Guera senegalensis* treated unripe tomato and pepper at 10mg/ml took 28 days and 19 days to deteriorate respectively. For untreated ripe tomato, pepper and orange it took 9, 10, 11 days to spoil, *Guera senegalensis* treated ripe tomato, pepper and orange at 5mg/ml took 11, 10 and 10 days to spoil while *Guera senegalensis* treated ripe tomato, pepper and orange at 10mg/ml took 14, 13 and 14 days to spoil respectively.

Figure 5 shows the result of shelf life determination of aqueous extract of *Balanites aegyptiaca* treated and control tomato, pepper and orange. It can be observed that untreated unripe tomato and pepper (control) took 15 and 11 days to deteriorate, the *Balanites aegyptiaca* treated unripe tomato and pepper at 5mg/ml took 22 days and 14 days to deteriorate while *Balanites aegyptiaca* treated unripe tomato and pepper at 10mg/ml took 32

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days and 16 days to deteriorate respectively. For untreated ripe tomato, pepper and orange it took 9, 10, 11 days to spoil, *Balanites aegyptiaca* treated ripe tomato, pepper and orange at 5mg/ml took 10, 9 and 14 days to spoil while *Balanites aegyptiaca* treated ripe tomato, pepper and orange at 10mg/ml took 14, 13 and 18 days to spoil respectively.

Result of temperature monitoring indicated it to be within the range of 19°C to 32°C with mean of 23°C.

There was a statistically significant difference ($p > 0.05$) between all the treatments on the tomato, orange and pepper.

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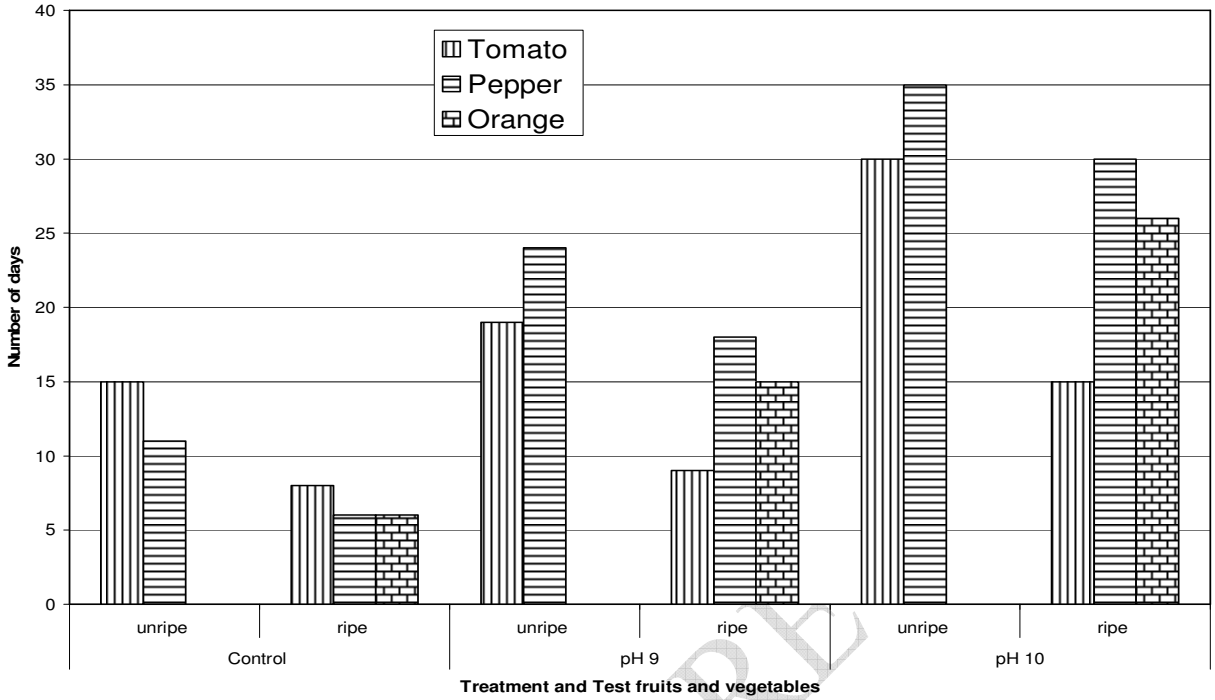

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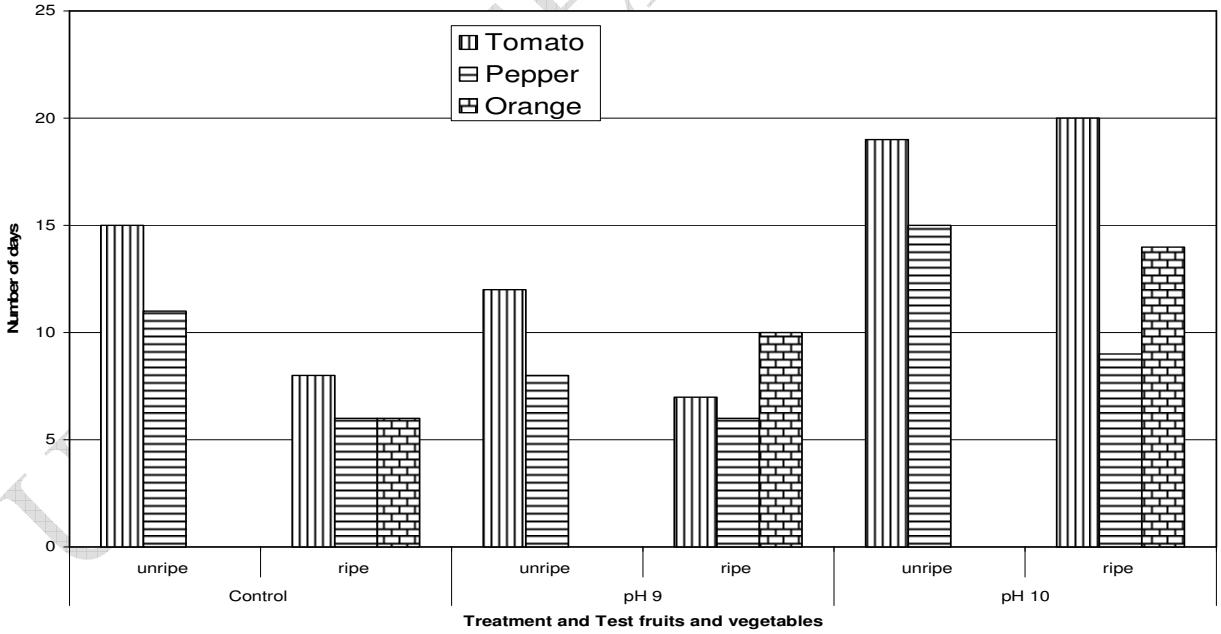
225 **Figure 1: Comparison of shelf life of paraffin waxed and unwaxed, ripe and unriped**
226 **(control) fruits and vegetables**



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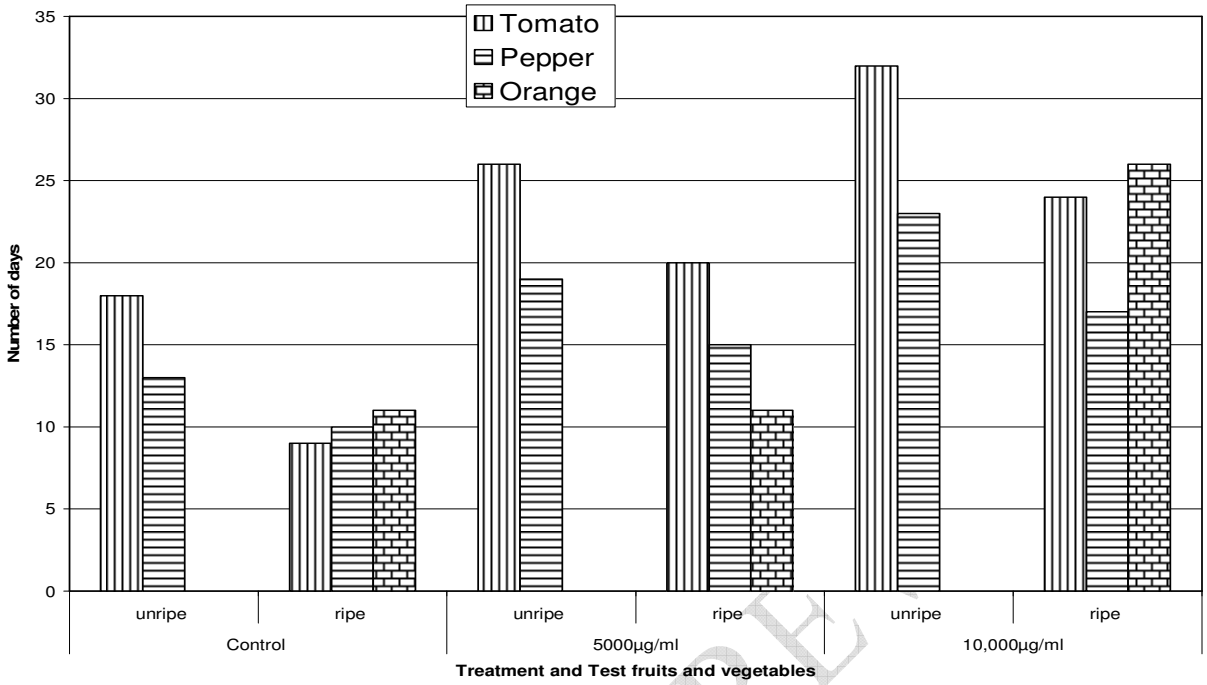
228 **Figure 2: Comparison of shelf life of ester waxed and unwaxed, ripe and unripe**
229 **(control) fruits and vegetables**



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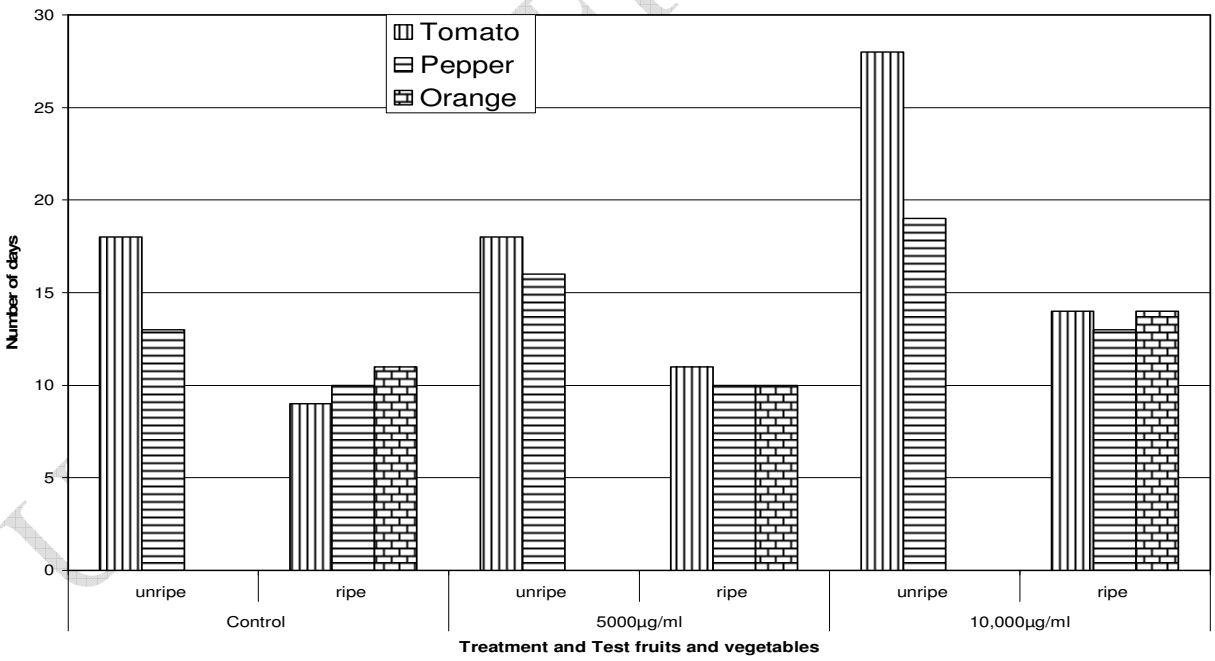
231 **Figure 3: Comparison of shelf life of *Parkia biglobosa* extract treated and untreated,**
232 **ripe and unripe (control) fruits and vegetables**



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234 **Figure 4: Comparison of shelf life of *Guera senegalensis* extract treated and untreated,**
235 **ripe and unripe (control) fruits and vegetables**
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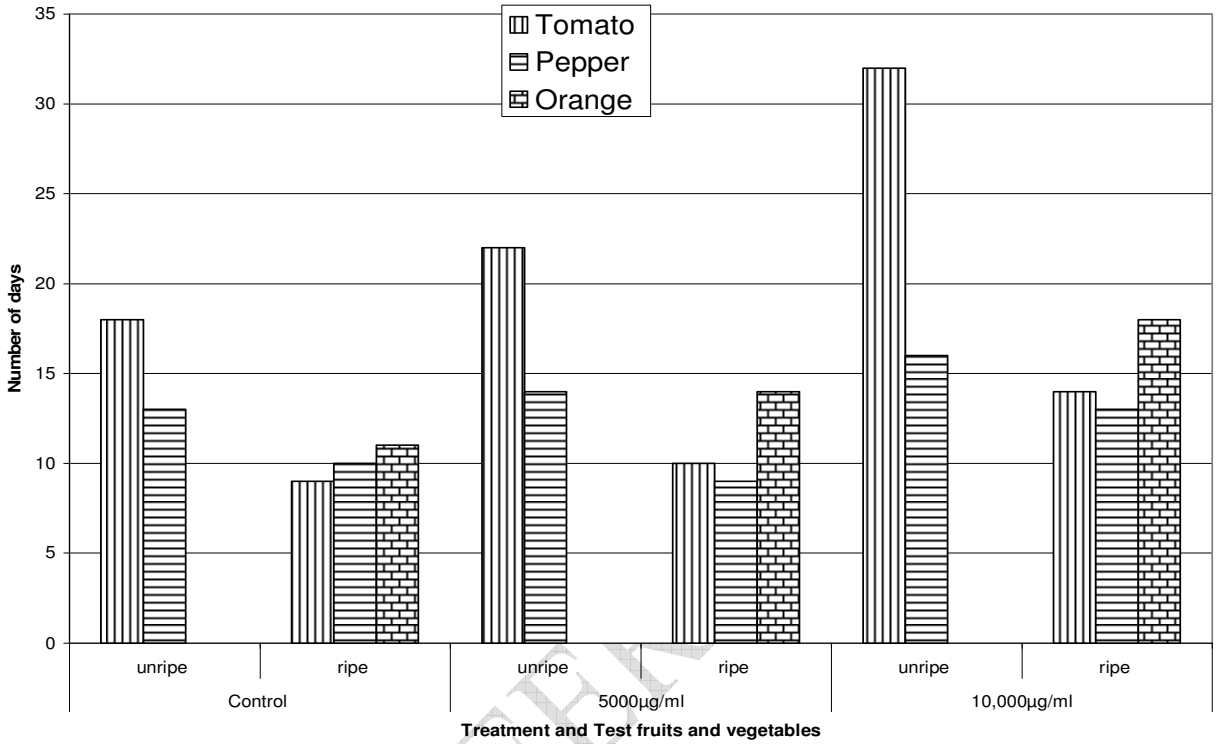

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240 **Figure 5: Comparison of shelf life of *Balanites aegyptiaca* extract treated and untreated,**
241 **ripe and unripe (control) fruits and vegetables**
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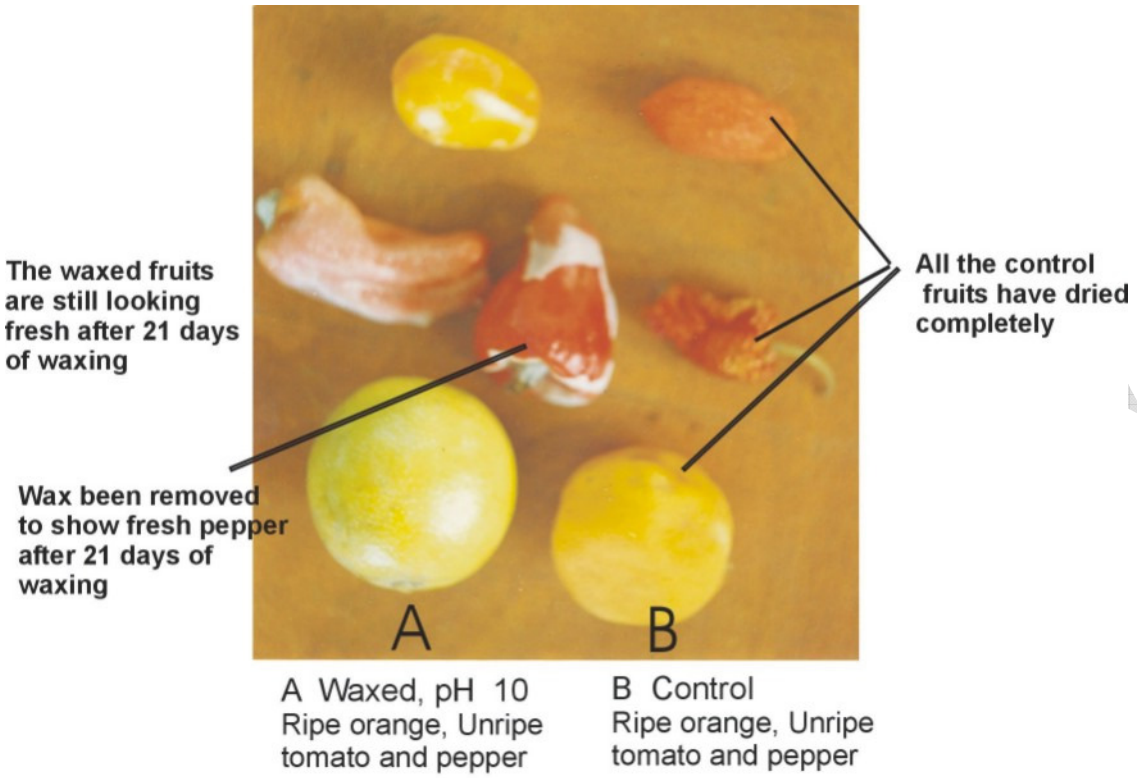

Plate 1: Paraffin waxed and unwaxed tomato, orange and pepper after 21 days of treatment

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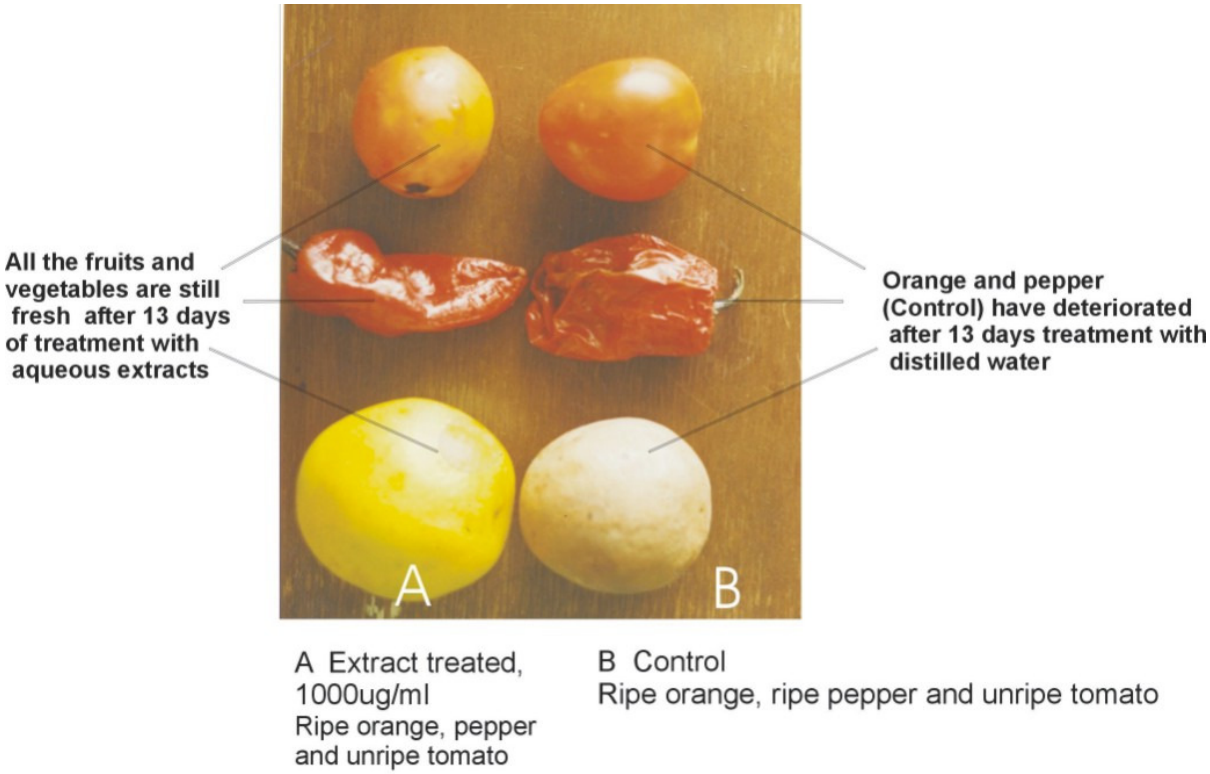

Plate 2: *Parkia biglobosa* extract treated and untreated tomato, orange and pepper after 13 days of treatment

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DISCUSSION

Results of shelf life determination of tomatoes, pepper and oranges showed that waxing is highly effective on ripe pepper (30 days), moderately effective on ripe orange (26 days) and fairly effective on ripe tomatoes (15 days). Among the waxes however, paraffin wax proved more effective (9-30 days) by increasing the shelf life than ester wax (7-14 days). This might be because ester wax was observed to inflate by trapping air and also had a crack, which might facilitate entry and proliferation in numbers and activities of the spoilage microorganisms [5]. Small amount of moisture was observed after peeling of ester wax from surface of the fruits and vegetables studied. On the other hand, this was not observed on

256 surfaces of fruits and vegetables treated with paraffin wax rather they appeared fresh and
257 glossy looking after peeling.

258 The surface washing of the tomatoes, pepper and oranges with the aqueous extracts
259 was observed to be effective in extending their shelf life. This may be as a result of the
260 antimicrobial components (alkaloids, tannins, saponins, etc) extensively reported to be
261 present in plant tissues (roots, leaf, stem bark, etc) [17; 18; 19]. This finding agrees with the
262 findings of Bukar and Magashi [6] who reported on the preservative effect of aqueous
263 suspension of *Parkia biglobosa* pods, and leaves of *Guera senegalensis,* and *Balanites*
264 *aegyptiaca* on tomatoes and oranges.

265 Other factors that might have aided in increasing the shelf life of aqueous extract
266 treated tomatoes, pepper and oranges is the duration of treatment and the vehicle used in
267 applying the extracts. In the present research, the fruits and vegetables were daily washed
268 with 20 ml of the extracts for 3 minutes and then kept in containers with lid almost closed.
269 The water on the surface of the fruits and vegetables might have helped in increasing the
270 relative humidity, thereby reducing the temperature of the microenvironment on the surface
271 of the fruits and vegetables [2], which helps to reduce transpiration and rate of enzyme
272 activity that hasten ripening and decay [20].

273 On comparison, extract application at both 5 and 10mg/ml has proven to be more
274 effective on ripe tomato (24 and 24 days), while paraffin wax at pH 9 and 10 was more
275 effective on both pepper (18 and 30 days) and orange (15 and 26 days). The least effective of
276 all is ester wax. Overall, in terms of increasing shelf life of fruits and fruit vegetables,
277 paraffin wax > *Parkia biglobosa* > *Guera senegalensis* > *Balanites aegyptiaca* > ester wax.

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The preservative effect of the buffer and aqueous extract does not increase significantly even when the pH was increased from 9 to 10 and the concentration from 5 to 10mg/ml, even though Ajaiyeoba [19] reported that increasing the concentration of extracts should naturally increase the antimicrobial activity.

The shelf life of unripe fruits and vegetables under investigation was observed to take longer time to spoil than the ripe ones. This might be because unripe fruits and vegetables take some days to ripe before actually starting to deteriorate [4] compared with ripe ones which are ripe already, therefore undergo deterioration only.

The average temperature of the room during the conduct of this research (23°C) did not significantly affect the shelf life of the test fruits and vegetables as result show an increase of several days (in some cases up to 20 days) over the control despite the fact that fruits and vegetables have been reported to stay longer at temperature of below 10°C and relative humidity of 95% [2]. Desrosier and Desrosier [21] reported that the generalized storage life of fruit and vegetables at 21°C is 1 – 7. The treatment by both waxing and aqueous extract application can serve in increasing the shelf life of tomato, pepper and orange as well as reduce or eliminate on the surface potentially pathogenic and spoilage causing organisms.

Conclusion

The present research has shown that paraffin wax, ester wax and aqueous extracts of *Guera senegalensis, Parkia biglobosa* and *Balanites aegyptiaca* possess varying degrees preservative effects on tomato, pepper and orange kept at room temperature compared to

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control test fruits and vegetables. This was achieved by shelf – life extension of treated fruits and fruit vegetables compared to the untreated.

Recommendation

Based on the results of this research, I suggest that further research should be carried out to corroborate the findings of this research so that the objective of the research will be achieved which is to make available waxes and plants extracts, which are available and cheap for preservation of fruits and vegetables at room temperature.

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