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Use of *Moringa oleifera* in the Preservation of Fresh Tomatoes

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Abstract: *The ability of the powder from the leaf, stem bark, seed and root of Moringa oleifera plant to preserve tomatoes from early spoilage was evaluated in this study. Mixed cultivars of tomatoes obtained from a retail outlet in Kano, North Western Nigeria, were treated with the powder of the Moringa oleifera plant parts and observed for preservation or spoilage for 42 days. The plant powders from leaf and stem bark gave better preservation results ($p<0.05$) when compared to the seed powder. The mean preservation rate of the leaf and stem bark in 42 days were 66.07% each as against 37.5% and 52.7% for the seed and root respectively. Fresh tomatoes were also infected with Bacillus species and Pseudomonas aeruginosa earlier isolated from spoilt tomatoes and then treated with the plant parts and observed for preservation or spoilage. The results obtained did not show any significant difference ($p>0.05$) in preservation between the infected and the non infected tomatoes when treated with the Moringa oleifera plant parts. The findings therefore indicate that powder from the leaf and stem bark of Moringa oleifera which is reported to have antimicrobial properties can be used as a preservative for enhancing the shelf life of fresh tomatoes.*

***Key words*:** *Tomato, Moringa oleifera, Preservation, Spoilage*

I. Introduction

The process of drying, freezing or treating foods with substances to prevent the proliferation of microorganisms such as bacteria and fungi in order to retard or stop spoilage is known as preservation. The primary aim of food preservation is to extend the shelf life of the produce and this may involve processes for the complete elimination or slowing down the oxidation of fats which usually cause rancidity [1]. Other processes that will inhibit visual deterioration, including enzymatic changes such as browning of fruits also constitute food preservation. In recent times, more and more attention has been paid to the use and application of natural organic by-products and plant extracts as preservatives and as antioxidants in foods. Some of these preservatives include Activin from grape seed, a known potent antioxidant [2, 3]

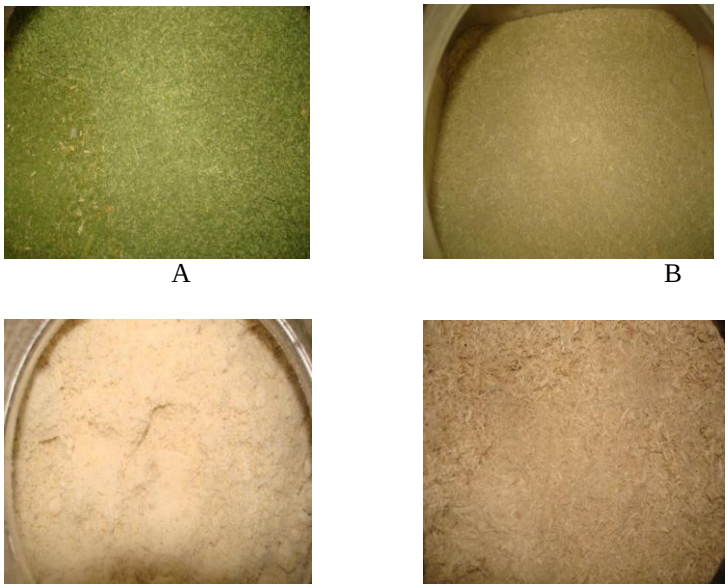
Ultimately, the use of plant materials as food preservatives apart from extending the shelf life of foods, are less toxic to humans and animals than synthetic or chemical preservatives. These attributes of plant materials in food preservation enhances the economic value of such foods. Tomato (Lycopersicon esculentum Mill), which is a berry, is often regarded as one of the most important vegetable crops grown universally. It is a very important source of minerals, vitamins and health acids. This vegetable crop, classified as fruit, is highly sensitive to several biotic and non-biotic stresses. Fungal, bacterial and viral diseases in tomatoes are a serious problem in several countries. In Nigeria, about one million hectares total land area is used for its cultivation and this crop makes up about 18% of the average daily consumption of vegetables in Nigerian homes [4]. Nigeria ranks second to Egypt in Africa and fourteenth globally in tomato production [5]. Though the quantum of tomatoes produced in Nigeria is relatively small compared to China the largest producer, yet, about 70% of this may always be lost to spoilage.

Its preservation and storage is important to the economy of individual homes, farmers and the country considering the vital role tomato play in the health of people and food security. Most methods of preserving tomatoes like drying, freezing and canning often lead to the loss of the freshness of the tomatoes. Little or no attempt has been made in the use of plant parts or extracts to preserve the fruit. We therefore, seek in this study to evaluate the preservative potentials of the powder of the *Moringa oleifra* plant parts; a multi-purpose plant that is easily grown locally and one that has found tremendous use in food and medicine, for use by local individuals and farmers to curtail tomato wastages.

II. Methods

2. 1 Moringa oleifera Plant Material

Fresh leaves, root, stem bark and seeds of *Moringa oleifera* plant were collected from rural farms in Omu-Aran (8° 8' 0" North, 5° 6' 0" East) Kwara State and Egbe (8° 13' 0" North, 5° 31' 0" East) in Kogi State, Nigeria. The plant parts were air-dried in a dust-free room for 7 days, away from direct sunlight. The plant parts were ground into fine powder first with an electric miller and then with a Warren blender (Fig.1). The powders were stored in well covered clean jars and kept away from direct light in a dust-proof locker.



A B C D

Figure 1: Powders of the *Moringa oleifera* (A - Leaf); (B - Stem bark (C - Seed); (D - Root)

2. 1. 2 Tomatoes

Mixed cultivars of tomatoes were purchased from retail outlets in Kano (11° 59' 47" North, 8° 31' 0" East), in the north western part of Nigeria. The cultivars represented include; Royal, Tecnesium, Top harvest, Stike Ayse and Rio grade. Records of the retail source indicate the tomatoes had been with the sellers for a minimum period of 7 days post harvest. They were then transported to Omu-Aran in Kwara State Nigeria in 48 hours while selection and preparation of eligible fruits lasted another 24 hours before commencement of experiment.

2.1.3 Selection of Tomatoes

The tomatoes used were ensured to be brightly coloured and firm. All the tomatoes selected were fully ripe and red in color. Those with deformity, pigmentation, wrinkle (with a thumb slide), darkened or with bruised areas on or under the skin of the tomatoes, were rejected.

2.2.1 Treatment and Storage of Tomatoes using the Plant Part Powders of *Moringa oleifera*
Briefly:

Firm, smooth and healthy tomatoes were selected and washed in clean water to remove dirt, rinsed again in water and kept to air-dry before treatment. The treatments were grouped into four. Group 1 comprised the fresh tomatoes covered with the *Moringa oleifera* powders. Group 2 was made up of fresh tomatoes inoculated with bacteria isolated from spoilt tomatoes and thereafter covered with the *Moringa oleifera* powders. Groups 3 and 4 were the controls for uninfected and infected tomatoes both of which were not treated with the plant parts powders. Each group had a total of sixteen (16) tomato fruits. The tomatoes were arranged on wooden racks in baskets and kept at 25^{o}C - 28^{o}C (room temperature) in an airy-room protected from pests.

2.2.2. Experimental infection of tomatoes

Tomatoes in Group 2 were inoculated with 0.1ml of 10^{6}CFU/ml cultures of *Pseudomonas aeruginosa* and Bacillus spp. The tomatoes were infected by inoculating the mix of the cultures in a slit made on the stem scar and left for 24hours to absorb into the tomatoes before coating with the plant materials.

All the fruits were stored away from direct sunlight with the stem scar facing up; to avoid softening and darkening of the fruit.

2.2.3. Controls

The control Group comprised fresh non-bacteria inoculated tomatoes numbering 16 and another 16 that were infected. These were left untreated with the plant parts and served as control. Daily monitoring was carried out to observe physical changes such as shrinking, pigmentation, microbial growth or spoilage (Table 1).

All the tomatoes treated with the powders of *Moringa oleifera* Leaf, Seed, Root and Stem bark and controls were observed for 42days.

Table 1
Treatment of Fresh non-infected and Infected Tomatoes with *Moringa oleifera* Plant Parts

	Powder Treatment				
Tomatoes	**Leaf**	**Seed**	**Root**	**Bark**	**NT**
Fresh Uninfected tomatoes	16	16	16	16	
Infected Tomatoes	16	16	16	16	
Controls					
1	Fresh Tomatoes with no Plant Part treatment				16
2	Infected Tomatoes with no Plant Part treatment				16

NT: No Powder Treatment

III. Results

Results of the preservation potentials of *Moringa oleifera* on tomatoes in this study were based entirely on organoleptic test of the tomatoes that include; visual observations, touch, taste and smell. Tomatoes were considered spoilt if there was evidence of softening, wrinkle, tear or microbial growth. The powders of the different plant parts of the *Moringa oleifera* showed varying degrees of preservation property. At the minimum, ten (10) days had elapsed from time the fruits were with the retailers, collection from the retailers, selection, washing and drying of the tomatoes to start of the study.

3.1 Non Infected Tomatoes Treated with Powder of Moringa oleifera

The controls for the uninfected tomatoes recorded a 100% spoilage by the 18^{th} day with only 2 out of 16 (12. 5%) of the controls still not spoilt on the 15^{th} day from start of the experiment. On the other hand, the tomatoes coated with the powder from the seed did not show good or appreciable preservation beyond the 21^{st} day while the powder from the root showed 25% preservation by the 30^{th} day post treatment. The powders from the leaf and stem bark showed better and higher degree of preservation property; 62.5% and 75% respectively or on the average for the leaf and stem bark, a preservation rate of 68.75% up to the 30^{th}day of the experiment.

Overall, the leaf and the stem bark powders showed greater ability to preserve the tomatoes from spoilage with more than 60% of the tomatoes still preserved 30 days post treatment (Table 2).

The mean preservation rate of the powder from the leaf, stem bark, seed, root and control for the non infected tomatoes for the period of study was 66.07%, 66.07%, 37.5% and 52.7% respectively (Table 2).

Table 2

Preservation Rate (%) of Fresh Tomatoes Coated with *Moringa oleifera* Leaf, Stem Bark, Seed and Root Powders.

Time in Days	Leaf	Stem bark	Seed	Root	Control. No powder Treatment
3	16 (100)	16 (100)	16 (100)	16 (100)	16 (100)
6	16 (100)	16 (100)	16 (100)	16 (100)	8(50)
9	16 (100)	14(87.5)	14(87.5)	16 (100)	5(31.25)
12	16 (100)	14(87.5)	14(87.5)	14(87.5)	2(12.5)
15	16(100)	14(87.5)	12(75)	14(87.5)	2(12.5)
18	12 (75)	14(87.5)	8 (50)	12 (75)	0
21	10 (62.5)	12(75)	4(25)	12 (75)	0
24	10(62.5)	12 (75)	0	10 (62.5)	0
27	10(62.5)	12(75)	0	4(25)	0
30	10 (62.5)	12(75)	0	4(25)	0
33	6 (37.5)	6 (37.5)	0	0	0
36	4(25)	6 (37.5)	0	0	0
39	4 (25)	0	0	0	0
42	2(12.5)	0	0	0	0
Mean preservation rate	66.07	66.07	37.5	52.7	-

3.2 Infected Tomatoes Treated with Powder of *Moringa oleifera*

The control for the infected tomatoes which were not treated with the *Moringa oleifera* powders showed evidence of spoilage beginning from the 6th day post-infection. All the tomatoes in the control group became spoilt on the 18thday. At least 25% of the tomatoes infected but coated with the powder from the stem bark and root remained preserved up to the 33rd day post infection while the leaf powder preserved 25% of the infected tomatoes for up to 36 days.(Table 3).

The mean preservation rate (%) in 42 days of the powder from the leaf, stem bark, seed and root for the infected tomatoes was 71.43%, 50%, 33.93% and 46.43% respectively (Table 3).

Table 3

Preservation Rate (%) of Infected Tomatoes Coated with *Moringa oleifera* Leaf, Stem Bark, Seed and Root Powders

Time in Days	Leaf	Stem bark	Seed	Root	Control. No powder Treatment
3	16 (100)	16 (100)	16 (100)	16 (100)	16 (100)
6	16 (100)	16 (100)	16 (100)	16 (100)	7 (43.75)
9	16 (100)	16 (100)	16 (100)	16 (100)	7 (43.75)
12	16 (100)	12 (75)	8 (50)	16 (100)	3 (18.75)
15	16 (100)	12 (75)	8 (50)	8 (50)	2 (12.5)
18	16 (100)	12 (75)	8 (50)	8 (50)	0
21	16 (100)	12 (75)	8 (50)	8 (50)	0
24	16 (100)	4 (25)	0	4 (25)	0
27	12 (75)	4 (25)	0	4 (25)	0
30	12 (75)	4 (25)	0	4 (25)	0
33	4 (25)	4 (25)	0	4 (25)	0
36	4 (25)	0	0	0	0
39	0	0	0	0	0
42	0	0	0	0	0
Mean preservation rate	71.43	50	33.93	46.43	-

3.2 Organoleptic Result

At the end of the experiment (42 days), the preserved tomatoes were washed and examined for organoleptic properties. The tomatoes remained firm to the touch, bright; maintaining the usual red colouration. The cut tomatoes when tasted still maintained the usual flavour but with less fluid (Fig. 2).

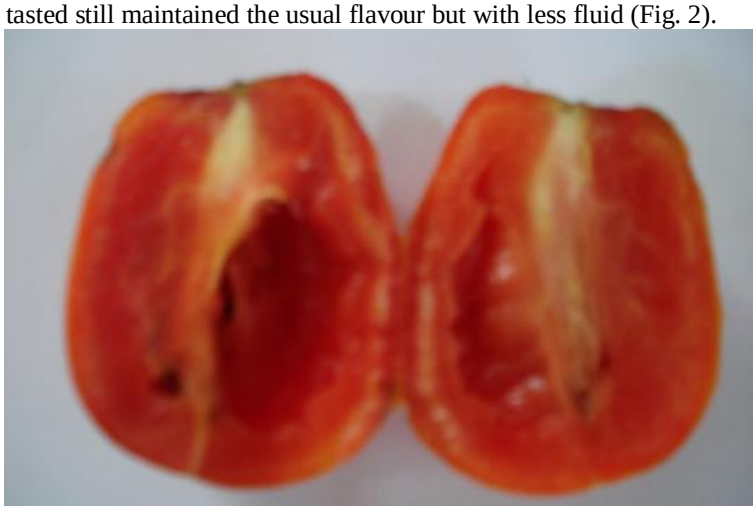


Figure 2. Tomatoes preserved with *M. oleifera* leaf powder for 42 days

IV. Discussion

Tomato wastages in Nigeria and elsewhere, especially in developing countries continue to be a source of economic loss to farmers, households and the countries. Any means by which these losses can be curtailed is therefore, very welcome. In a recent local news report in Nigeria, titled "Waste market: In Mararaba Fruits Depot, Farmers Lose Fortunes Daily to Rotten Products", an attempt was made to paint the picture of daily recurring wastages of fruits, vegetables and other perishable fresh foods in the country; a situation attributed to

poor unhygienic environments and lack of basic infrastructure needed for preserving such foods [6]. Usually, tomatoes purchased from retail outlets retain best eating qualities for 2 to 3 days when stored at room temperature of 25^{o}C to 28^{o}C while under-ripe tomatoes can be held for up to 5 days [7]. Since it is not recommended that tomatoes be stored under refrigeration if the original flavor must be maintained, it therefore becomes necessary to seek alternative preservation methods that can be easily adapted by people such as local farmers and rural dwellers that lack basic infrastructure for storage and preservation for enhancing the shelf life of the vegetable fruit. Various methods have been suggested especially in climes that experience frost and freezing temperatures. Some of these include collecting and placing mature green (unripe) fruit in a nursery flat or on newspaper on a shelf. These may keep for up to 70 days from transplanting. These methods are more valuable for individuals who farm tomatoes in their backyards and not for commercial purposes. It is in the light of this that this study seeks to recommend for use, both for commercial and as an indigenous measure, the powder from the leaf and stem bark of *Moringa oleifera* in the preservation of ripe tomatoes purchased from retail outlets. The number of days the tomatoes may have stayed after harvest before they are taken for retail may not always be known. From our findings, it is suggestive that fresh unripe tomatoes treated with the powder from the *Moringa oleifera* Leaf and Stem bark can keep and retain their flavor and form beyond the 42 day period adopted in this study. This is however subject to further investigation.

At the minimum however, losses due to various forms of spoilage were cut down by 50% for tomatoes purchased from retailers and stored for at least 30days considering that up to 62.5% and 75% of tomatoes in this study was preserved using the leaf and stem bark powders respectively for 30 days. Earlier, it was reported that best eating qualities of tomatoes can be retained for 2 to 3 days when stored at room temperature of 25^{o}C. This study however shows that ripe tomatoes already on retail can be stored covered with the powder from the leaf and stem bark of *Moringer oleifera* for up to 30 days while still retaining the flavor, texture and firmness.

V. Conclusion

Plant materials have been used in food as preservatives in extending the shelf life of foods. *Allium sativum* and *Aframomium melegueta* extracts are reported to possess significant sanitizing effect and so can inhibit the growth of *Rhizopus stolonifer*, *Penicillium digitatum* and *Mucor mucido* in cashew and pawpaw juices [8]. *Moringa oleifera* contain useful compounds such as saponins, cardiac glycosides, terpanoids, steroids and alkaloids; compounds that are known to posses many therapeutic antimicrobial properties [9, 10].

The fact that the leaf and stem bark of the *Moringa oleifera* were able to significantly extend the shelf life of the tomatoes indicate the plant may have played an active role in the preservation. In addition, an appreciable antibacterial activity was recorded in this work: 100% and 75% of the infected tomatoes treated with the *Moringa oleifera* leaf and stem bark powders respectively remained unspoilt for 21 days. The preservation and storage of tomatoes using powder from the leaf and stem bark of *Moringa oleifera*, which does not require any form of refrigeration or additional application of chemicals makes its use for tomatoes preservation very convenient for low income earners and rural dwellers, either for market or for consumption. It is possible that the keeping quality of *Moringa oleifera* may be related to the variety of the tomatoes being preserved. In this study however, the role of tomato strain or variety was not considered as a factor since the intent was to mimic the general mixture of tomatoe varieties often observed among tomato retailers in Nigeria.

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