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Efficiency of Some Natural Plant Leaves in Improving Storage Stability of Okra Pods

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ABSTRACT

Background and Objective: Okra's high moisture content makes it susceptible to swift decay and fungal invasion, reducing its shelf life. This study investigates the efficacy of six plant leaves (*Thaumatococcus daniellii, Alchornea laxiflora, Xanthosoma sagittifolium, Musa paradisiaca, Colocasia esculenta* and *Artocarpus heterophyllus*) in improving okra storage stability. **Materials and Methods:** Freshly harvested okra pods were wrapped in sterilized plant leaves, with a control kept separately and monitored daily for fungal infections. Fungi from infected pods were cultured on PDA media at 25 °C for 5-7 days, subcultured for pure colonies and identified morphologically using a binocular microscope (X40). Fungal characteristics were compared to pictorial guidance and data were analyzed using one-way ANOVA to determine leaf performance at a 0.05 significance level. **Results:** At the end of the 21 days, the results obtained showed that *M. paradisiaca* had 28.75, *T. daniellii* 18.75, *C. esculenta* 11.25, *A. heterophyllus* 8.75, *X. sagittifolium* 7.50, *A. laxiflora* had 0% and control 0% survival rate. These findings show that the leaf of *M. paradisiaca* enhanced the shelf life of okra pods and reduced storage rot. **Conclusion:** *Musa paradisiaca* leaves significantly enhanced okra shelf life and reduced storage rot. This natural, eco-friendly method can support local farmers' traditional practices, provide alternative storage techniques during power outages and promote good health and environmental sustainability.

KEYWORDS

Storage stability, *Abelmoschus esculentus*, *Musa paradisiaca,* plant leaves, preservation

INTRODUCTION

The world's fruit and vegetable intake has skyrocketed in recent times as a result of growing knowledge of their possible health benefits but according to Krishnan *et al.*[1], these fruit and vegetables generally have a very short shelf life, thus requiring appropriate preservation technologies to extend their shelf life.

One of the most popular and commonly used vegetables is okra (*Abelmoschus esculentus*). Dantas *et al.*[2], describe it as an extremely perishable annual vegetable. It belongs to the Malvaceae family[3]. According to Ikechi-Nwogu *et al.*[4], okra is a versatile and profitable crop in Nigeria, with commercial value derived from the selling of fresh immature pods and fresh leaves. It is a low-calorie vegetable that is packed with protein, vitamins, minerals and dietary fibre[5].

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Okra is very perishable and prone to simple rotting due to its high water and mucilage content[2], which poses significant storage challenges for growers, distributors and consumers. The quantity of okra produced by indigenous farmers in Nigeria that is wasted due to improper storage is depressing, thus it is imperative to investigate traditional techniques of preserving okra in light of the country's economic downturn and rising food prices in the market[4].

One such emerging approach to extend the shelf life of fruits and vegetables is the utilization of leaves for preservation. The use of leaves for food preservation has been practiced for centuries in many cultures around the world. Some researchers have shown that leaves are used for food preservation. According to Oboh *et al.*[6] and Agha *et al.*[7] *T. daniellii* is traditionally used to cover food to increase the shelf life of the food. The leaves are said to give the food wrapped a unique taste, so they are preferred over banana leaves. Also In India, the leaves of a wide range of plants are used as food packaging materials, eating plates and wrapping for steam cooking, grilling and frying different foods[8]. The aims of the study, therefore, were to examine plant leaves to evaluate their efficacy in the long-term preservation of okra pods and study the phytochemical content of the leaves examined and the Identification of fungi associated with okra.

MATERIALS AND METHODS

Collection of materials: Frehly harvested okra pods were harvested from farmland at Omuoko Aluu, Rivers State, Nigeria in May, 2023. Fresh and matured leaves of *Thaumatococcus daniellii* (Miracle berry), *Alchornea laxiflora* (Lowveld bead string), *Xanthosoma sagittifolium* (Arrowleaf elephant ears), *Musa×paradisiaca* (Plantain), *Colocasia esculenta* (Cocoyam) and *Artocarpus heterophyllus* (Jackfruit) were collected from farmland in Omuetche Village Aluu, Rivers State, Nigeria and the leaves were authenticated by a Taxonomist, Dr. C. Ekeke, in the Herbarium Unit, Department of Plant Science and Biotechnology, University of Port Harcourt, Nigeria. These leaves were chosen based on their history of previous use in preservation, medicinal properties and rural availability from local farmers around Rivers State, Nigeria.

Selection of okra: After selecting healthy-looking okra fruits from the gathered bulk, damaged pods were removed and the bulk was divided into four equal halves, each containing eighty (80) fresh okra.

Preparation of leaves for preservation: To make sure there were no insects or any other pathogens on the various leaves, they were examined. They were then completely cleaned using sterile cotton wool and 70% ethanol.

Lining of baskets with leaves: The pods were wrapped in the leaves of *T. daniellii*, *X. sagittifolium*, *M. paradisiaca*, *C. esculenta* and *A. heterophyllus* tied with string to provide support and kept in different baskets. Owing to its small surface area, *A. laxiflora* leaves were neatly stacked in baskets with no gaps and the pods were arranged inside. Fresh okra without leaves was placed in a different basket for the control group.

Preservability of independently wrapped okra pods under ambient circumstances: Every two days, the okra pods were checked for deterioration, color changes, wilting and rotting. The leaves were taken out of the wrap after seven (7) days and the wilted, soft and rotting ones were tallied before being replaced with fresh ones. A gentle, dry paper towel was used to wipe away any remnants of the decaying fruits from the remaining pods. The pods that were soft, rotted and wilted comprised those with lesions, dehydration and all forms of rots (soft and dry). The okra pods' appearance and physical state were also observed.

Data analysis: The data for each treatment was collected weekly- the numbers of rotten and healthy fruits were taken note of. "The data collected was analyzed statistically using One-way Analysis of Variance (ANOVA) techniques to determine the performance of each leaf and their significant differences, with a significance level set at 0.05".

RESULTS AND DISCUSSION

The result of the performance of leaves of *Thaumatococcus daniellii* (Miracle berry), *Alchornea laxiflora* (Lowveld bead string), *Xanthosoma sagittifolium* (Arrowleaf elephant ears), *Musa paradisiaca* (Plantain), *Colocasia esculenta* (Cocoyam) and *Artocarpus heterophyllus* (Jackfruit) in the preservation of okra pods is displayed in Table 1.

Performance of the leaves: The okra pods were observed visually and the results obtained showed that the pods wrapped in the *Alchornea laxiflora* (Lowveld bead-string) leaves and the ones in the control basket without leaves had the lowest survival rate of 0 and 3.75%, respectively, by the end of the 21 days treatment. The pods wrapped in *Xanthosoma sagittifolium* (Arrowleaf elephant's ear) had a 7.5% survival rate, jackfruit leaves had a survival rate of 8.75% and then the ones wrapped in Cocoyam leaves with a survival rate of 11.25%. *Thaumacoccus daniellii* (Miracle berry) had an 18.75% survival while the plantain leaves had the lowest number of spoils with a survival rate of 28.75%.

The okra pods were seen to have been preserved longer when wrapped in *M. paradisiaca* and *T. Daniellii* leaves. From the observation and result, the okra pods in the above-mentioned leaves had a higher number of survived pods at 21 days.

The leaves have some antimicrobial properties so were able to reduce the rate of microbial activities on the fruits causing less infestation. Leaves of *X. sagittifolium* and *T. daniellii* have relatively low moisture content in comparison to *A. laxiflora*. Hence, it can be concluded that, in the case of *A. laxiflora,* the moisture of the leaves aided the microorganisms in attacking the pods and leading to 100% loss at 21 days.

Furthermore, this study backs up the claims of local farmers that use leaves; especially plantain leaves to preserve their produce that is being carried from the farm to market with the belief that it keeps the produce fresh till they get to their destination.

The proximate composition of all the leaves is presented in Table 1 below. The protein content in *A. Laxiflora* were higher than those in the other leaves[9] and protein in food or drinks enables water retention. This probably is the reason for the zero survival rate of pods wrapped with the leaves. As the leaves may have expel lots of moisture that affected the pods and caused decay. Also, research done by Farombi *et al.*[10] suggests that *A. laxiflora* contains potent natural antioxidants and may therefore be relevant in the preservation of lipid food products, which are prone to oxidation.

The result of the moisture content analysis as given in Table 2 with *X. sagittifolium* leaves having the highest moisture content, explained why among the 6 studied leaves, the pods wrapped in the leaves of *X. sagittifolium* were soggy and extremely rotten when spoilt. They are the most prone to microbial attack during storage but according to Aovi *et al.*[11], *X. sagittifolium* is used in folk medicine as there claims that it possesses antioxidant and antibacterial properties.

It was also observed that the mineral composition of phosphate and potassium in plantain are higher and according to Ritz *et al.*[12], phosphate additives play an important role in the food industry, where they are used as preservatives. This explains why the plantain leaves with the highest level of phosphate and potassium preserved best.

Table 1: Performance of the leaves of *Thaumatococcus daniellii* (Miracle berry), *Alchornea laxiflora* (Lowveld bead string), *Xanthosoma sagittifolium* (Arrowleaf elephant's ears), *Musa paradisiaca* (Plantain), *Colocasia esculenta* (Cocoyam) and *Artocarpus heterophyllus* (Jackfruit) in the preservation of okra pods in storage

	Number of days					
Treatment	7	14	21	Total losses	Survival	Survival (%)
Control	17	47	16	80	0	0
Plantain leaves	4	25	28	57	23	28.75
Cocoyam leaves	18	23	30	71	9	11.25
Jackfruit leaves	18	37	18	73	7	8.75
Arrowleaf elephant's ear	30	32	12	74	6	7.50
Miracle berry	17	30	18	65	15	18.75
Lowveld bead-string	45	25	10	80	0	0

Number of fruits per treatment = 80, Total losses: Includes all wilted, rotten, soft and discolored fruits, Survival: The number of fruits remaining after 21 days of treatment and observation

Table 2: Proximate and mineral composition of *Thaumatococcus daniellii, Alchornea laxiflora, Xanthosoma sagittifolium, Musa paradisiaca, Colocasia esculenta* and *Artocarpus heterophyllus*

Parameters	*A. laxiflora*	*X. sagittifolium*	Jackfruit	Plantain	Cocoyam	Jackfruit
Protein (%)	23.090	18.193	20.853	17.548	12.073	13.688
M.C (%)	3.163	5.220	3.937	4.494	3.752	5.121
Ash (%)	0.261	0.351	1.499	7.191	6.004	8.194
K (%)	0.599	0.452	0.333	0.613	0.584	0.477
P (%)	0.418	0.315	0.232	0.428	0.407	0.333
Vit E (%)	0.068	0.051	0.038	0.070	0.066	0.054
Vit K (%)	0.007	0.007	0.006	0.006	0.009	0.009
Phytate (%)	4.624	4.923	3.951			
Tanin (%)	2.642	2.813	2.258			
Oxalate (%)	5.725	6.095	4.892			
Saponin (%)	3.435	3.657	2.935			
Trypsin-inhibitor (%)	1.674	1.782	1.430			
Total titratable acidity g/100 g	0.012	0.012	0.010			
Turbity g/100 g	13.462	14.331	11.503			
Total soluble solute (%)	10.657	11.345	9.106			
Specific gravity	0.670	0.714	0.573			
Viscosity	7.085	7.542	6.054			
Original gravity	0.896	0.953	0.765			
Glucose (%)	41.089	62.812	39.990			
Sucrose (%)	7.757	4.019	4.346			
Fructose (%)	9.234	4.316	1.349			
Malstriose (%)	1.802	2.425	10.342			
Total FAN g/100 g	8.519	9.229	8.790			
Total alkaloids profile g/100 g	0.8713	0.9277	1.2897			
Total glycosides profile g/100 g	13.5481	15.1815	25.1612			
Total flavonoids profile g/100 g	71.376	68.048	77.311			
Total phenolic profile g/100 g	61.3672	47.6287	59.2258			
Total amino acids profile (%)	11.691	25.043	17.532			
Total organic acids profile (ppm)	0.6042	1.0865	1.6155			
Total fatty acids profile g/100 g	10.947	9.847	10.399			

It is common practice to utilize tocopherols or vitamin E, to stop oils and fats from oxidizing meaning it is a popular antioxidant used in food processing to stop oxygen-sensitive components from deteriorating and discoloring. The amount of vitamin E in plantain is higher than in other leaves which may have aided their preservative potential. From this study, it has been demonstrated that using these organic antioxidants can extend the shelf life of food.

This study supports the claims of Adeogun *et al.*[13] that, *Thaumatococcus daniellii* can be used as potential preservatives against the fungi responsible for food spoilage. The leaf extract of this plant has been documented to possess antimicrobial properties[14] and a study by Wilson *et al.*[15] substantiated the function of *T. daniellii* leaves as antioxidants as such, they contribute to the preservation of nutrient levels, as well as the texture, color, flavor and freshness of food products. The study demonstrated the plant's capacity to avert degenerative illnesses linked to oxidative stress, indicating that this antioxidant effect can be employed as a practical means of food preservation.

The result of the phytochemical analysis of the leaves, showed appreciable levels of organic acids (1.6155), alkaloids (1.2897 g/100 g), flavonoids (77.311 g/100 g) and glycoside (25.1612 g/100 g) in *T. daniellii* which are essential for food preservation, this supports the study of Oboh *et al.*[6] that quantitative phytochemical analysis of extracts of its fruit, leaf and root revealed the presence of alkaloids, tannins, saponin, flavonoids, phlorotannins, anthraquinones, phytate, phenol and terpenoids in high quantities.

Furthermore, this backs up the claims of local farmers that use leaves; especially *T. daniellii* to preserve their produce that is being carried from the farm to market with the belief that it keeps the produce fresh till they get to their destination.

Isolation of organisms: Pure culture of *Geotrichum candidum*, *Aspergillus niger*, *Mucor irregularis*, *Fusarium* sp. and *Penicillium* sp. organisms were isolated and identified from diseased *Abelmoschus esculentus* following the isolation method described by Ikechi-Nwogu and Egba[16], while the fungal cultures identified were confirmed using reference materials[17]. The organisms associated with the storage rot of okra fruits agree with the earlier work[15], that organisms isolated from apparently healthy and diseased okra fruits include *Fusarium moniliforme*, *A. flavus*, *A. niger*, *Penicillium* sp. and a bacterium species *Corynebacterium* sp.

CONCLUSION

The findings show that plants with high antibacterial and antifungal capabilities can be utilized to preserve fresh produce as an alternative for rural residents, who cannot afford the luxury of having storage facilities like refrigerators/freezers, provided the produce are free from visible wounds or rot and the plant being used is healthy. According to the study, *Thaumacoccus daniellii* and *Xanthosoma sagittifolium* are effective in the preservation of fresh produce, additional tests or physiochemical analysis can be done to identify the chemical constituents or metabolites in the leaves that obtained this result. Since plants are entirely healthy organic and devoid of any synthetic and manmade chemicals that may cause sicknesses in humans, this study recommends employing this preservation method not just in current rural areas but also in urban areas.

SIGNIFICANCE STATEMENT

This study offers important new information on the possibility of natural plant leaves-*Musa paradisiaca* in particular-as an efficient and ecological way to prolong the shelf life of okra pods. The results of this study have significant ramifications for lowering post-harvest losses, advancing food security and aiding in the creation of sustainable food preservation methods. Additionally, this study adds to the body of information regarding the use of natural plant leaves as a substitute for artificial preservatives and emphasizes how local farmers and communities may implement this technique to enhance the handling and storage of perishable crops, including okra.

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