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Packaging material's impression on banana worth and self-life: A Review

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Abstract
Various packing materials were used as treatments using high density polythene bag (HDPE), low density polythene bag (LDPE), paper bag and open condition. A three-day period was used to gather data from each packing material, fruit weight, width, TSS, and percentage of reduced sugar were measured on a sample of each treatment's bananas. From this research we observed that It that the optimum way to increase the shelf life and preserve the physiochemical quality characteristics of banana fruits during storage was to utilize bag packaging made of HDPE and LDPE. Fresh fruit and vegetable postharvest processing can benefit from the judicious application of MAP and associated technologies. By giving nitrogen atmosphere to banana increase the green life of banana.

Keywords: Banana, self-life, high density polythene bag, low density polythene bag, paper bag, packaging, green life

Introduction
Plantains and bananas (*Musu* sp.) are ancient crops that are deeply ingrained in Indian history and customs. The plants are regarded as a representation of "fertility and prosperity." The banana is known as 'Kalpatharu' (plant of virtues) due to its diverse applications and higher socio-economic significance. The diet and general health of individuals living throughout the world's tropical and subtropical areas are greatly influenced by *Musa* fruits. They provide farmers in their particular growing zones with a reliable source of income (Akinyemi *et al*., 2008) [2]. 11.13 million hectares are planted with bananas worldwide, yielding A total of 97.38 million tons of plantains and bananas. The world's largest banana grower is India, accounting for 24% of global production with a 19.19 million tonne production and 0.565 million hectares in total. After China, Ecuador, Indonesia, Philippines and Brazil. The Philippines is the world's second-largest banana grower (Singh). A staple of many diets, bananas are high in carbs, minerals, and vitamins. It helps people with heart conditions and excessive blood pressure. Additionally, it helps with gastroenteritis, ulcers, arthritis, and kidney disorders. The primary cause of banana rotting is poor harvesting at the wrong period of maturity. Damage to the body during transportation, resulting in fungal infections at the wrong stage and fungal disintegration after senescence (Rao, 2017) [15]. Many farmers and banana growers use improved techniques, treatments done after harvest to increase the shelf life of banana, to help them produce high-quality banana products. As a result, packaging is becoming a crucial and essential part of the commercial and industrial food supply chain. Modified environment packaging is the newest method becoming popular in the Indian food business. The banana fruits have a limited shelf life and ripen quickly in hot weather. Therefore, low-cost techniques for postponing ripening and prolonging the shelf life in ambient circumstances are required, without compromising the fruit's edible quality. Numerous issues, including inadequate storage facilities, incorrect handling, inadequate packaging, and poor refrigerated storage, contribute to the losses (Narayan *et al*., 2002) [11]. Gamma radiation is used to prolong the shelf life of bananas, which is healthy for human health in Bangladesh's agro climatic conditions. Bananas are very perishable and climacteric because of their increased respiratory activity and ethylene production throughout maturation. Under normal circumstances, fruits may only be kept fresh for up to eight days after being plucked. The fruit experiences ongoing physiological changes upon extraction. By limiting these changes, we can successfully extend the fruits' shelf life.

According to research on the conduct of Robusta and Dwarf Cavendish bananas stored in cold climates, it is advised that Dwarf Cavendish bananas be kept for extended periods of time at a temperature between 55 and 60 degrees Celsius14. The Rasthali banana's shelf life was increased to 22 days from 12 days in the control group with no loss of quality thanks to a report on the packing of banana hands in 400-gauge polythene bags using coir pith as a carrier (Mustafa *et al*., 2005) [10]. When farmers don't know how to manage and preserve fruits properly after harvest, they lose quality and suffer huge post-harvest losses. Soon after harvest, on-farm storage is essential to ensuring quality. In order to preserve and increase the shelf life of fruits, an on-farm storage study was carried out utilizing a large evaporative cool chamber created at the Indian Agricultural Research Institute in New Delhi (Waskar *et al*., 1999) [21].

Increasing self life

Fruits can have their shelf life extended by a variety of techniques, one of which is appropriate packaging. Paper packaging-both tissue and brown paper-is becoming more and more common these days. It's extremely perishable fruit can cause post-harvest losses of up to 30-40%. Generally speaking, cold storage facilities are not located close to production centers. Furthermore, because of power shortages and the cost of pricey devices, cold storage facilities are not readily available in a country like India to handle all perishable commodities. Therefore, keeping in mind the aforementioned challenges, a low-cost structure that farmers can readily access and that can store these perishable goods for a brief period of time must be built (Singh *et al*., 1987) [17]. Ethiopia produces bananas on a variety of scales, from small commercial plants to homesteads. Research on bananas concentrated on developing varietals, choosing disease-resistant varieties, testing fertilizers, clump management techniques, and irrigation studies. Postharvest losses are a big concern in many developing countries, thus even though these pre harvest procedures are mandatory, they must be combined with postharvest management practices. Applying fungicide (prochloraz 250 ppm) and treating banana fruit with hot water at 50 degrees Celsius both greatly decreased the severity of the illness, and the latter treatment also decreased the incidence of the disease. Banana shelf life could be greatly increased by using a variety of advanced techniques. It has been demonstrated that eucalyptus leaf extract-derived nano particles can boost the duration of storage of bananas by up to 32 days by controlling ripening processes and decay (Nayab *et al*., 2023) [12]. Active packaging technologies, such as using ethylene absorbers, have also proven effective in extending the shelf life of bananas, with fruits remaining fresh for up to 72 days when stored at lower temperatures (Suresh and Kumar, 2023) [19]. Encapsulating ethylene inhibitors in nano carriers has been demonstrated to inhibit ethylene production in bananas, leading to prolonged freshness and reduced spoilage (Sarp *et al.,* 2023) [16]. Additionally, treatments involving shrink wrapping, sanitization, and fungicide application have successfully extended the shelf life of bananas to 45 days, making them suitable for long-distance transportation and export markets (Gomez *et al.,* 2023) [6]. Herbal edible coatings, like corn starch combined with papaya or mint leaf extracts, shown the potential to increase the duration of storage of bananas by as long as nine days, reducing spoilage and maintaining quality (Chithra *et al*., 2022) [5].

Using packaging material: A specific procedure has been used. The TSS, reducing sugar, non-reducing sugar, and total sugar content of the LDPE polythene bag containing fruits treated with silica gel increased gradually and steadily over the course of storage in Treatment T_2 [LDPE (40 micron) polythene bag + Silica gel sachet (2 g)], but a rapid boost was seen in the Control group. To improve storability and/or shelf life, Often, creating an atmosphere with very little oxygen and/or abundant carbon dioxide is ideal. This can affect the way that bananas are packaged or the activity of organisms that cause decomposition. Apart from altering the environment, MAP significantly enhances moisture retention. Additionally, packing keeps the product isolated from the outside world and contributes to maintaining conditions (Beaudry, 2000) [4]. The banana fruit treated by polyethylene bag show the longest shelf life than followed by carton (Zerga and Tsegaye, 2020) [20]. Banana leaf using as packaging material show lowest weight loss than uncontrolled condition whereas the weight loss recorded from the polyethylene bag was less than the banana leaf this is because the polyethylene bag has high relative humidity, low respiration rate and low concentration of temperature. Zeolite-LDPE composite bags infused with chlorine or silver are effective packaging materials for banana storage, enhancing shelf life by reducing respiration rate and maintaining biochemical properties (Kumar *et al.,* 2020) [9].

Control atmosphere storage

Bananas kept in a controlled environment were firmer and had less soluble solids during the ripening process, but the colour of the peel remained same. Fruits suffer a significant post-harvest loss in addition to losing quality due to inadequate knowledge about proper post-harvest handling and farm storage (Ahmad *et al*., 2006) [3]. In the immediate aftermath of harvest, farm storage is essential to quality preservation. In order to preserve and increase the shelf life of fruits, an on-farm storage study was carried out utilizing a large evaporative cool chamber created at the Indian Agricultural Research Institute (Waskar *et al*., 1999) [21]. Quality of a fruit has a major impact on both how long it will last before going dire and what buyers will decide to buy. In this experiment, TSS, reducing sugar, non-reducing sugar, and total sugar all rise with fruit ripening across all regimens. Initial growth was primarily attributable to the conversion of starch to soluble carbohydrates (Reboucas *et al*., 2013) [14]. Low temperature, heat treatment, and modified atmosphere are often used extensively throughout the world to reduce postharvest losses in banana. In addition to low temperature storage, bananas with a green life (from harvest to yellow with green tips) can also be treated with small-period nitrogen treatments. Applying nitrogen atmospheres for three days straight after harvest can increase the green life by 42%. This treatment is economical and not so tough to use for large quantities of fruit. Atmosphere provide by nitrogen will reduce the level of oxygen available to the fruit, this will create barrier for ethylene which inhibit ripening (Klieber *et al.,* 2002) [8].

Weight loss and sugar loss after harvest

A decrease in the physiological weight loss % is closely correlated with the firmness of bananas. Fruit tissue is mostly hard at harvest time due to the physical characteristics of the individual cell walls and the central lamella, which contains the pectic substance that cements the cell walls together. Its quality and quantity losses after harvest are higher, which makes it less appealing to customers. In many places, bananas lose a large portion of their nutritional content due to poor post-harvest management techniques, which causes huge financial losses

(Santosa *et al*., 2010) [18]. Throughout the storage process, the reducing sugar amplified in all treatments, and under both storage circumstances at ambient temperature and in a cool chamber-it increased substantially more quickly. After three days of storage, the treatment Open control had the most decreasing sugar, which was measured at 6.02%. In comparison to a cool chamber, the rate of sugar reduction rose significantly faster at ambient temperature. The amount of reducing sugars increased dramatically during storage. Fruit reducing sugar was shown to be noticeably better in cold storage circumstances, even after three days of storage, as reducing sugar grew more gradually in cool storage settings than in ambient ones. After three days of storage, i.e. treatment, it was discovered that the fruit's sugar content had decreased to 4.45% in treatment CC + Tissue paper, 3.72% in treatment CC + Brown paper and 5.52% in treatment CC + Open control, in treatment AT + Tissue paper 4.38%, in treatment AT + Brown paper 3.88% and in treatment AT + Open control 6.02% respectively (Prasad *et al.*, 2015) [13].

Post harvest loss in open condition

From harvest to final consumption, a significant quantity of bananas is wasted and their quality is diminished. By utilizing packaging materials to enhance postharvest handling techniques or by refining conventional packing practices, this loss can be minimized. Thus, the intention of this study was to make longer the shelf life of bananas by selecting suitable packing materials. Despite these facts, postharvest losses in terms of quantity and quality between harvest and consumption hamper the marketing of fresh food, especially bananas. In charge to keep the maximum value of fruit upon harvest, proper monitoring of postharvest management during harvesting, shipping and storage is necessary. This applies to both fresh and processed fruit. Ethiopian farmers are sometimes compelled to discard their goods quickly because of the country's rain-fed agricultural system, inadequate storage facilities, limited transportation options, and potential for significant losses. This results in an economic loss of horticultural crops in general and fruits in particular. There are significant postharvest losses of bananas throughout the nation. From harvest to final consumption, a significant quantity of bananas is wasted and their quality is diminished. By using packaging materials to improve postharvest handling techniques or by enhancing conventional packing processes, this loss can be minimized. Inadequate handling lack of packaging techniques and in sufficient cold storage facilities have been identified as key issues leading to post harvest losses in banana. To mitigate these losses there is call of increased awareness, education and training on proper post harvest handling practices as well as the adaptation of better management operations and careful handling throughout the supply chain.

Conclusion

The importance of bananas and plantains in Indian agriculture and global food supply chains cannot be overstated. These fruits, deeply rooted in cultural significance, serve as symbols of prosperity and nutrition. However, despite their economic and nutritional value, significant postharvest losses occur due to inadequate handling, storage, and packaging techniques. Various innovative methods, including modified atmosphere packaging, active packaging technologies, and controlled atmosphere storage, have demonstrated encouraging outcomes in increasing the shelf life of bananas and reducing postharvest losses. Additionally, advancements in packaging materials, such as polyethylene bags infused with silica gel or zeolite, offer low-cost solutions for improving storage conditions. Addressing these challenges is crucial for minimizing waste, sustaining agricultural livelihoods, and ensuring food security for communities reliant on these vital crops. Efforts to optimize postharvest management practices and packaging technologies are essential for maximizing the economic and nutritional benefits of bananas and plantains while minimizing environmental impact.

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