ISSN: 0975 -8542

Journal of Global Pharma Technology

Available Online at: www.jgpt.co.in

RESEARCH ARTICLE

Modified Atmosphere Packaging on Physico-Chemical Characteristics of Star Apple (*Chrysophyllum cainito*) Fruit during Post-harvest Storage

Minh Phuoc Nguyen

Faculty of Biotechnology, Ho Chi Minh City Open University, Ho Chi Minh City, Vietnam.

Abstract

Star apple (*Chrysophyllum cainito*) is popularly cultivated in Mekong region. Its pulp has strong sweet taste with antioxidant constituents contributing to various phytochemical and functional advantages. However this fruit has a short shelf life due to its perishable nature. It's necessary to have appropriate way to extend its commercial distribution. Modified atmosphere packaging can be considered as a proper alternative to store this perishable fruit. Purpose of this research focused on the application of modified atmosphere packaging (MAP) to prolong shelf-life of star apple fruit. Weight loss (%), firmness (N), total soluble solid (^{0}Brix), and vitamin C (mg/100g) were the main variables applied to observe this valuable fruit during 21 days of storage. Under MAP (30% CO_2, 15% O_2, 55% N_2), star apple fruit could be extended to 18 days regarding to the weight loss, firmness, total soluble solid, and vitamin C values. Our finding contributed a basic foundation for more further studies on other tropical fruits and vegetables.

Keywords: *Chrysophyllum cainito, Modified atmosphere packaging, Weight loss, Firmness, Soluble solid, Vitamin C.*

Introduction

The star apple fruit (*Chrysophyllum cainito*) is delicious as a fresh dessert fruit by creamy white pulp with several small seeds. Its sweet pulp contains excellent source of nutrient and phytochemicals such as vitamins and minerals [1]. This fruit has great potential as an antimicrobial agent for chemotherapeutic medicine [2]. Star apple (*Chrysophyllum cainito*) has a smooth and waxy skin [3]. It is very susceptible to weight loss so they are easily shrinkage and fruit softening during storage, resulting in the decrease of their commodity value. The major postharvest losses of star apples are due to fungal infection, physiological disorders, and physical injuries [4].

Modified atmosphere packaging (MAP) was a food packaging technique in which the ratio of CO_2, O_2 and N_2 in a sealed bag were different from those in the ambient environment to improve the food stability [5]. Ie depended on the alteration of the air inside the bag, achieved by two pathways, the product respiration and the air movement through the bag that caused the air richer in CO_2 and poorer in O_2; and it also relied on the properties of commodity and packaging material [6]. It slowed down respiration rate, ethylene emission, maturity, ripening, firmness, nutritional composition, decay, oxidation and overall acceptance [7, 8]. It's proven to be useful to reduce postharvest quality losses in highly perishable fruits [9, 10] such as strawberry [11, 12], mango [13], tomato [14], peach, grape, banana [15]. The price of star apple fruit dropped down quickly during harvesting period owing to its perisibility as well as lack of proper preservation technique limiting it from word wide marketing distribution. Several notable studies mentioned to the storage of star apple fruit. Star apple fruits which were coated with 2.75% agar and 6.8% glycerol still maintained good quality until 30 days of preservation [16].Nguyen Phuoc Minh et al [17].Used chitosan as edible coating on storage of star apple (*Chrysophyllum Cainino*) fruit.

During harvesting season, commercial price of star fruit decreased quickly because it's

highly perishable by high respiration rate and attack of harmful pathogen. Objective of our study focused on the utilization of modified atmosphere packaging to preserve star apple fruit for an extended shelf-life during post-harvest to enhance its commercial value in the international distribution chain.

Materials and Method

Material

Star apple fruits were collected from Soc Trang province, Vietnam. After collecting, they must be immediately transfered to laboratory for experiments. They were subjected to air blasting to separate foreign matters before packing in MAP bags.

Researching Procedure

Star fruits were packed in MAP in three conditions: group A (35% CO_2, 15% O_2, 50% N_2); group B (30% CO_2, 15% O_2, 55% N_2), group C (25% CO_2, 15% O_2, 60% N_2) and kept under 18±2°C. Weight loss (%), firmness (N), total soluble solid (°Brix), vitamin C (mg/100g) was periodically examined in 5 day-interval for 25 days in preserved samples.

Physico-chemical and Statistical Analysis

Weight loss (%) was estimated by weight comparison before and after storage. Firmness (N) was measured by penetrometer. Total soluble solid (°Brix) were measured by hand-held refractometer. Vitamin C (mg/100g) was evaluated by using 2, 5-6 dicholorophenol indophenols' method. The experiments were run in triplicate with three different lots of samples. Statistical analysis was performed by the Stat graphics Centurion XVI.

Result & Discussion

Weight loss (%) of Star Apple Fruits Preserved by MAP

Respiration rate was the main cause resulting to weight loss of fruit [18]. The firmness of fruits and vegetables became soft from crisp. Their taste decreased, and their resistant capacity against physical and microbial pathogen also came down [19]. In our research, weight loss (%) of treated samples was carefully monitored within 25 days of storage. Our results showed that fruit weight decreased as the storage duration increased. Star apple fruits kept under group B (30% CO_2, 15% O_2, 55% N_2) had the lowest weight loss (see Table 1). MAP slowed down the weight loss rate, which would decrease the undesirable changes in appearance, such as wilting, shriveling and color changes [20].

Table 1: Weight loss (%) of star apple fruits preserved by MAP

Storage days	5	10	15	20	25
MAP (group A)	$3.38±0.03^{c}$	$4.54±0.00^{bc}$	$6.18±0.01^{b}$	$7.05±0.00^{ab}$	$8.26±0.02^{a}$
MAP (group B)	$1.39±0.01^{c}$	$2.07±0.01^{bc}$	$3.11±0.02^{b}$	$3.86±0.01^{ab}$	$4.03±0.01^{a}$
MAP (group C)	$4.17±0.00^{c}$	$5.33±0.02^{bc}$	$7.01±0.00^{b}$	$8.47±0.02^{ab}$	$9.55±0.00^{c}$

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Firmness of Star Apple Fruits Preserved by MAP

The fruit firmness was strongly related overall acceptance. Fruits became soft during storage duration; their crispness gradually decreased and then disappeared. This phenomenon could be explained by moisture evaporation, pectin degradation, nutrient depletion [21]. In our research, firmness (N) of treated samples was carefully observed within 25 days of preservation. Results demonstrated that firmness of the fruit samples decreased throughout the storage periods across all of the various treatments. Star apple fruits kept under group B (30% CO_2, 15% O_2, 55% N_2) had stable firmness until the 20th day of storage (see Table 2). This formula had a good capacity for retaining the firmness of the star apple fruit for a longer period of time.

Table 2: Firmness (N) of star apple fruits preserved by MAP

Storage days	5	10	15	20	25
MAP (group A)	$1.84±0.01^{a}$	$1.67±0.02^{ab}$	$1.41±0.01^{b}$	$1.25±0.00^{bc}$	$1.09±0.02^{c}$
MAP (group B)	$2.09±0.00^{a}$	$1.95±0.03^{ab}$	$1.81±0.03^{b}$	$1.74±0.01^{bc}$	$1.62±0.03^{c}$
MAP (group C)	$1.37±0.02^{a}$	$1.22±0.03^{ab}$	$1.06±0.00^{b}$	$0.97±0.00^{bc}$	$0.80±0.01^{c}$

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Total Soluble Solid of Star Apple Fruits Preserved by MAP

Total soluble solids in pulp of star apple fruit was approximately 11.2°Brix [22]. The depletion of total soluble slid in fruits and vegetables caused by transpiration and the substrate metabolism of respiration [23].Total soluble solid (°Brix) of treated samples were carefully observed within 25 days of storage. Our results noticed that star apple fruits kept under group B (30% CO_2, 15% O_2, 55% N_2) still preserved their soluble solid until the 20th day of preservation (see Table 3).

Table 3: Total soluble solid (°Brix) of star apple fruits preserved by MAP

Storage days	5	10	15	20	25
MAP (group A)	10.86±0.03^{a}	9.47±0.00^{ab}	8.54±0.02^{b}	6.42±0.00^{bc}	5.06±0.03^{c}
MAP (group B)	11.92±0.01^{a}	11.39±0.03^{ab}	11.04±0.01^{b}	10.83±0.02^{bc}	10.56±0.01^{c}
MAP (group C)	9.75±0.00^{a}	8.21±0.02^{ab}	7.49±0.00^{b}	6.03±0.03^{bc}	4.93±0.00^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Vitamin C of Star Apple Fruits Preserved by MAP

The Vitamin C content in pulp of star apple (*Chrysophyllum cainito*) was around 10 mg/100g [2]. Vitamin C served as antioxidant to eliminate free radicals during preservation [24]. In our research, vitamins C (mg/100g) of treated samples were carefully observed within 25 days of preservation. Our results proved that star apple fruits kept under group B (30% CO_2, 15% O_2, 55% N_2) still kept their vitamin C content until the 20th day of preservation (see Table 4). In another research, there was significantly higher compared to 55.17 and 51.53 mg/100 mL vitamin C for MAP packed and unpacked mango fruits [25, 26].

Table 4: Vitamin C (mg/100g) of star apple fruits preserved by MAP

Storage days	5	10	15	20	25
MAP (group A)	9.13±0.00^{a}	9.01±0.02^{ab}	8.74±0.01^{b}	8.29±0.02^{bc}	7.81±0.03^{c}
MAP (group B)	9.85±0.03^{a}	9.63±0.00^{ab}	9.35±0.03^{b}	9.17±0.00^{bc}	9.04±0.01^{c}
MAP (group C)	9.06±0.01^{a}	8.90±0.01^{ab}	8.61±0.00^{b}	8.13±0.03^{bc}	7.48±0.02^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Conclusion

Star apple fruit had an excellent source of vitamins, irons, flavours to diets with high antioxidant capacity, high nutritional and health potential. However it also had a short shelf-life limited it from international marketing. Bio deterioration of star apple fruit limited its commercial value in distribution.

A proper preservation method was essential to prolong its quality during post harvest. Modified atmosphere packaging could be considered as an excellent alternative to maintain physico-chemical attributes of this valuable throughout distribution. Further extensive studies for other tropical fruits and vegetables would be urgent and essential to improve their commercial value in food chain.

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