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Preliminary Studies on the Quality Changes of Eggplant as Influenced by Active Packaging

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ABSTRACT

The effects of active packaging on the surface stiffness, mass, volume, density and weight changes of fresh as well as stored eggplant were studied at 11 and 25°C for 10 days with active packaging material Type 1 and 2 and control. Mass, volume, and surface stiffness of eggplant decreased linearly throughout the storage period regardless of storage conditions; while the mass density showed a reverse trend in the case of 11°C storage. Reduction rate of mass, mass density and weight was observed minimum at 25°C storage temperature with active packaging Type 1. The weight of eggplant decreased at a higher rate in the initial 4 days compared to that in the later period of storage regardless of storage temperature and type of packaging.

***Keywords** : corrugated fiberboard, active packaging, eggplant, stiffness, density*

1. Introduction

Eggplant (*Solanum melongena* L.) is a common vegetable available in retail outlets worldwide but has a very limited shelf life for freshness (1-3). It is also known as aubergine, guinea squash or brinjal and a good source of vitamins and minerals (particularly iron) making its total nutritional value comparable with tomato (4). Eggplant has been used in traditional medicine (5), for example, tissue extracts have been used for treatment of asthma, bronchitis, cholera and dysuria; fruits and leaves are beneficial in lowering blood cholesterol.

Eggplant belongs to a family of plants of tropical origin. Its fruit is a non-climacteric large berry and is chilling sensitive. Below 12°C but above their freezing point, eggplants suffer rapid physiological disorders manifested mainly by the appearance of surface injuries such as pitting, and seed browning, especially in the calyx (6). Therefore, chilling injury (CI) is a serious problem in storage and processing of these fruits (7). The texture of flesh and processed vegetable is one important quality aspect.

When the eggplant become mature, the tender

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texture characteristic is lost and becomes spongy. Successful marketing relies on increasing the shelf life of the fresh eggplant. A number of methods are available for increasing the shelf life including low temperature (8, 9), modified atmosphere (10) and gamma irradiation (11). These methods involve control of storage conditions, but still the quality of eggplant decreases appreciably. Recent development in packaging methods could be another answer to prolonged shelf life of eggplant.

The aim of this research was to study the effects of different types of active packaging materials which generate numbers of anion (Type 1 and Type 2) on the stiffness and density of eggplants which are the most important quality characteristics of eggplant, during storage at 11 and 25°C and correlate the density of the eggplant with storage period and temperature and packaging materials.

2. Experimental

2.1 Eggplant samples

Mature suitable eggplants were purchased from a local supermarket in 5 kg lots and directly used in experiment. The degree of maturation was decided based on the size of the eggplant usually preferred by consumer in supermarkets and street shops.

2.2 Treatment and storage conditions

Eggplants were randomly selected for each experiment. They were initially washed with 0.1% w/v NaClO for 1 min to prevent surface contamination and then air-dried for 30 min. The excess liquid was removed by hand with tissues, then put into two different active packaging boxes at two different temperatures (11 and 25°C) for up to 10 days. The samples without package were treated as control. Samples were evaluated in terms of several quality attributes listed below at different times of storage (0, 1, 3, 5, 7 and 10 days at 11°C and 0, 1, 4, 7, and 10 days at 25°C).

Samples placed in a corrugated fiberboard box coated with 15% of polyvinyl alcohol (PVA) and 10% of Monazite were treated as Type 1. Forty L of 15% PVA and 4 kg of Monazite were mixed at 1,000±100 rpm for 10 min in an agitator. Coating was done using a roller coating machine operating at 160℃ and 20 m/min. The coating thickness was approximately 30 μm. In case of Type 2 packaging, samples were placed in an uncoated fiberboard box. Numbers of anion generated by each types of packaging were 300-500/mL and 20-60/mL for Type 1 and Type 2, respectively. The fiberboard box was made of SK180/K200/K200 A type of corrugated fiberboard.

2.3 Mass, volume and density

The mass of the eggplant was measured on an electronic precision balance to within 0.01 g, while the volume was measured by a water displacement method using a graduated measuring cylinder having an inner diameter of 105 mm and a capacity of 3 L (3, 12). The minimum graduation of the cylinder was 5 cm^3. The whole eggplant was immersed, by holding its stem, into water and the differential volume minus the volume of the holder was noted as the volume of the eggplant. The density of the individual eggplant was computed by dividing its mass by volume and expressed in kg/m^3.

2.4 Moisture content and weight of eggplant

Moisture content of the eggplant samples was measured as an indicator of water loss during storage using an oven drying method (13, 14). A certain amounts of samples (c. 5 g) were weighed onto aluminum weighing dishes. After 24 h in the drying oven (105°C), the samples were reweighed and percent moisture was calculated.

Weight measurement of the eggplant was carried out at 0, 1, 3, 5, 7, and 10 days using an electronic precision balance.

2.5 Surface stiffness ratio

Texture characteristics were evaluated with a computer controlled Advanced Universal Testing System (model LRXPlus, Lloyd Instrument Limited, Fareham, Hampshire, UK) at room temperature. A 100 Newton (N) load cell and a 5 mm diameter stainless steel cylinder probe were used and the cross head speed was 10 mm/min. Each treatment was repeated 3 times, and their mean values were compared. Results were expressed as the maximum force Newton (N) from 30% compression of individual the eggplant fruit (15). From the typical force deformation curve, stiffness was derived using the following relationship:

$$\text{Stiffness } (N/mm^2) = [F/A_0]/[D/L]$$

where F is the maximum force (N), A_0 is the area of cross section (mm^2), D is the maximum deformation (mm), and L is the original length (mm). The surface stiffness ratio was calculated by dividing the stiffness at a given time of storage by the stiffness of the fresh eggplant.

3. Results and Discussion

3.1 Mass, volume and density

Mass of the eggplant at all storage conditions, without exception, decreased linearly with storage period, which are obvious due to loss of moisture during storage (Fig. 1). The slope of curves indicate the rate of decreases. In all conditions, the slope of curves are the almost same regardless of active packaging type at 11°C storage. But the rate of decrease differs with storage conditions at 25°C. The slopes of curves of packaging Type 1 and 2 are lower than that of the curve of control. But the rate of decrease at 11°C was still lower than that of at 25°C. The similar results were reported elsewhere (3).

The volume of eggplants decreased at a higher rate and slowed down for all conditions (Fig. 2). The decrease in volume is also due to moisture

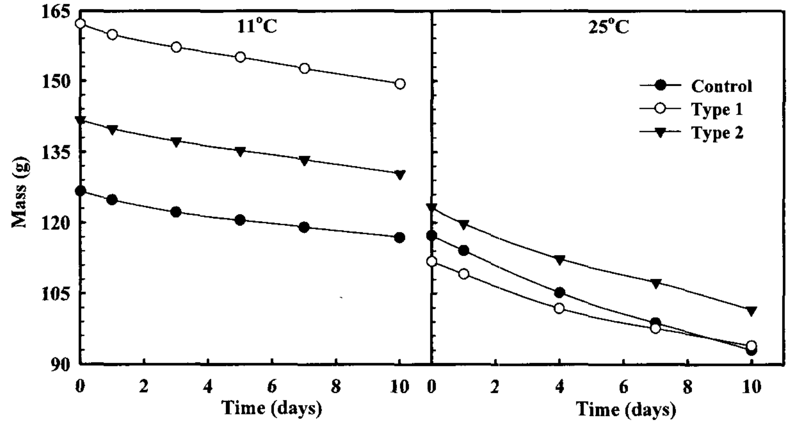

Fig. 1. Changes in mass of eggplant as influenced by active packaging conditions.

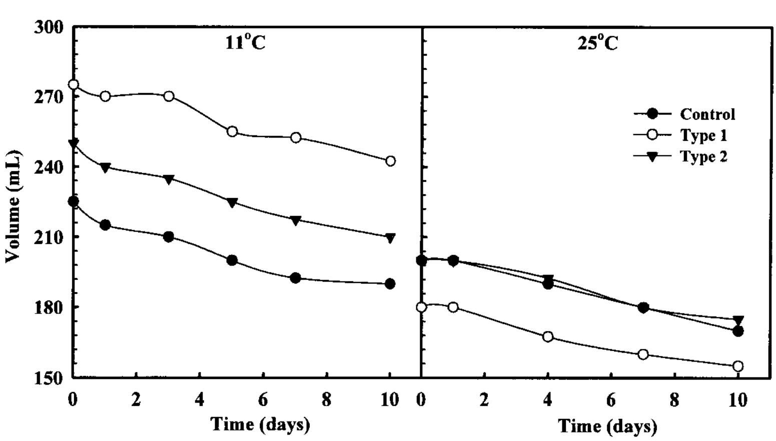

Fig. 2. Changes in volume of eggplant as influenced by active packaging conditions.

loss with storage time. The rate of decrease is higher for the first day at 11°C and decreased steadily until 10th days regardless of packaging type, whereas the volume did not change for the first day at 25°C and decreased until 10th days regardless of packaging type.

Density of eggplant increased significantly during the storage period studied in general at 11°C for all active packaging materials in contrast with mass and volume (Fig. 3). Density increased over 5 days in the case of packaging Type 1 and 7 days in the case of control, after reaching the peak, these fell gently. The increase in density may be due to a higher rate of decrease in volume in comparison to that of mass. The mass decreased at a lower rate than that of volume for the corresponding periods of storage of eggplant (Fig. 1 and 2). The considerable difference in density was found in the case of storage at 25°C, density of eggplant decreased significantly over 1 day of storage for all conditions showing the mass decreased at a higher rate than that of volume (Fig. 1 and 2).

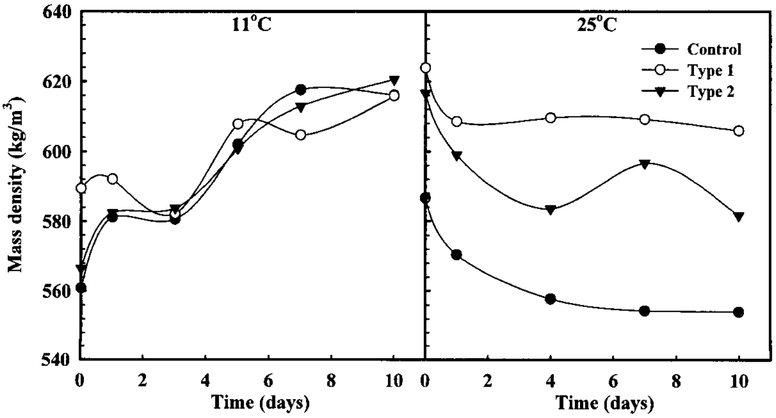

Fig. 3. Changes in mass density of eggplant as influenced by active packaging conditions.

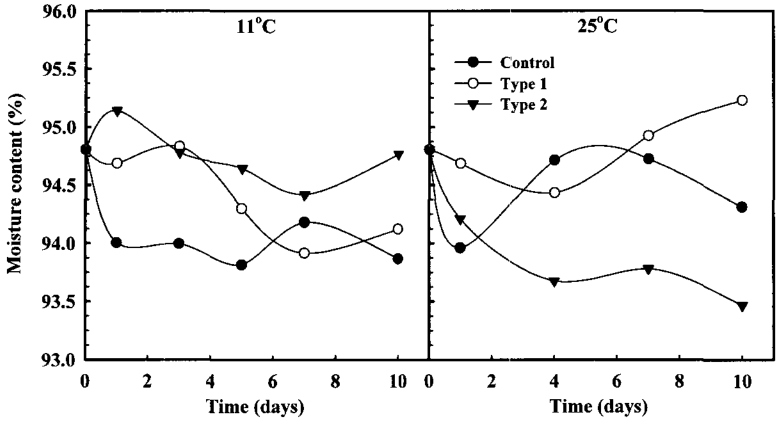

Fig. 4. Changes in moisture content of eggplant as influenced by active packaging conditions.

3.2 Moisture content and weight of eggplant

Figure 4 shows the moisture content of eggplant. In the case of storage at 11°C, the moisture content of control sharply decreased during the first day of storage, whereas that of packaging Type 1 and 2 decreased slowly. For 25°C, the moisture content of control and packaging Type 2 sharply decreased for the first day, whereas that of packaging Type 1 slowly decreased.

The weight of eggplant decreased at a higher rate in the initial 4 days compared to that in the later period of storage (Fig. 5). The loss of weight with storage period is obvious due to loss of water by continual transpiration of eggplant during storage. The weight of eggplant during storage could best be predicted by the equation presented in Fig. 5. These data were nicely fit to the linear equations. The rates of weight loss (express as the slope) were similar at 11°C storage regardless of active packaging materials and even for control. In the case of storage at 25°C, the slopes were

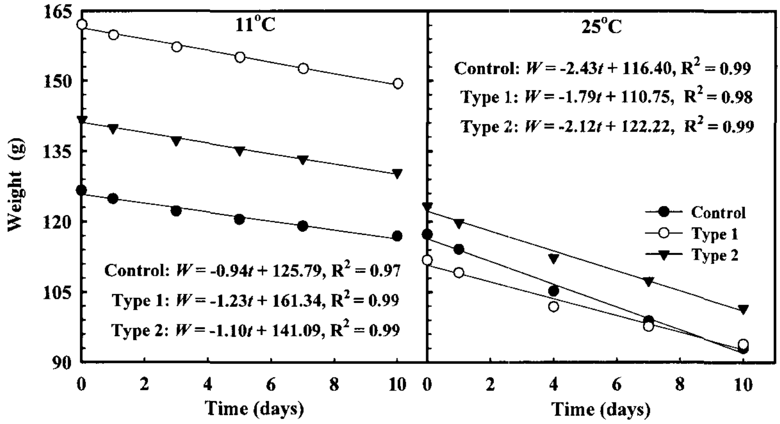

Fig. 5. Changes in weight of eggplant as influenced by active packaging conditions. *W*, weight at any time; *t*, storage time in day.

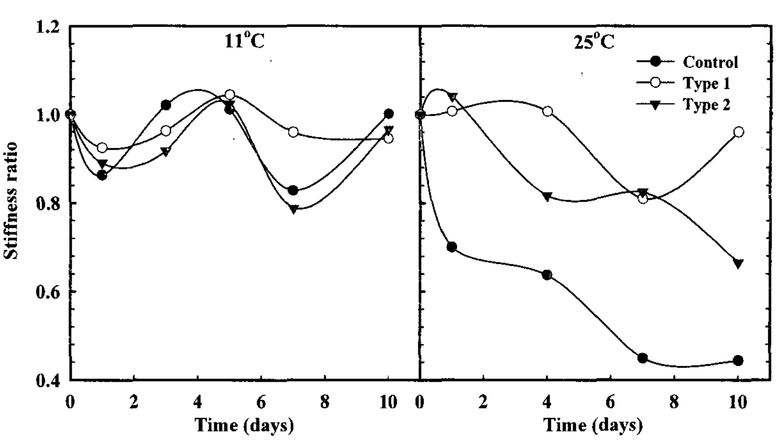

Fig. 6. Changes in stiffness ratio of eggplant as influenced by active packaging conditions.

much steeper than those of storage at 11°C, showing the highest slope in control sample.

3.3 Surface stiffness ratio

Figure 6 shows the changes in surface stiffness ratio of fresh eggplant as influenced by storage conditions. All three texture parameters including hardness, stiffness and firmness, decreased with an increase in the time and storage temperature (data not shown). It can also be observed that the three texture parameters (hardness, stiffness, and firmness) behaved similarly in describing the textural qualities, so that any of them may be effectively considered as a representative parameter for texture evaluation of eggplant. Nourian et al. (16) also showed very similar behaviors of texture parameters with cooked potatoes. The rate of decrease in stiffness ratio was initially high till 4 days storage in packaging Type 2 and 1 day storage in control at 25°C. In the case of storage temperature at 11°C, the rate of decrease in stiffness ratio with storage time was slow for all conditions. These are due to the shrinkage of the eggplant during storage. The upper layer (epidermis) of the eggplant became loose during storage and thus had minimal resistance to compression. In both temperatures, packaging Type 1 showed the minimum changes in texture and thus could be successfully used in high temperature storage while maintaining the stiffness which was the advantage of cold storage.

Jha and Matsuoka (3) showed the increased stiffness after some time during storage. And these phenomenon was explained by the loss of epidermis' firmness during storage followed by contact with the inner surface which resist the compression result in increased stiffness temporarily. And indicated that the eggplant could be safely stored up to that period. Figure 6 did not show clear trend but still showing high stiffness ratio over 0.6 except the control at 25°C. And the stiffness ratio was found to be lower at higher storage temperature than at lower temperature, which indicated that the stiffness of eggplant decreases more rapidly at higher temperature than at the lower one.

No scientific evidence yet exists to support the notion that anions offer positive benefits to human health. Kim et al. (17) reported that low dose ionizing radiation increased germination rate, growth and yield of soybean cultivar. Kim et al. (18) showed stimulating effects of low dose gamma-radiation on the seed germination, early growth and physiological activity in the gourd.

And Baek et al. (19) investigated the promoting effects of low dose gamma-radiation on germination and early growth of vegetable crops. Our experiment of active packaging with anion generating materials on quality characteristics of fresh as well as stored eggplant at 11 and 25°C for 10 days showed reduction rate of mass, mass density and weight was observed minimum at 25°C storage temperature with active packaging Type 1.

4. Conclusions

The following conclusions may be drawn from the results:

(1) Mass, volume, density, moisture content, and surface stiffness of eggplants changes appreciably with storage time ranging between 0 and 10 days at 11 and 25°C.

(2) Mass, volume, and surface stiffness decreased linearly throughout the storage period regardless of storage conditions.

(3) The effectiveness of active packaging material was very clear, specially with package Type 1 showing minimum changes in texture, mass density, moisture content and weight during storage at 25°C.

Acknowledgements

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