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Investigation on the effect of nano zeolite and potassium permanganate on the shelf life extending and quality of red delicious apple

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Key words: apple, Nano zeolite, acidity, Brix, pH, weight loss.

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Abstract

In the present study the extended storage life of apples (Red Delicious) examined using nano zeolite particles and potassium permanganate. Titratable acidity, total soluble solids, pH and weight loss was measured .Visual observations of fruits during storage were investigated. The results showed that pH, soluble solids and fruit weight loss has increased during storage. The acidity of fruits stored with nano zeolite was less decreased as compared with potassium permanganate. The growth of moulds on preserved fruit with nano zeolite was much less after 45 days of storage as compared with potassium permagenate.

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Introduction

In recent years there has been a considerable increase in demand for high quality fruits and vegetables, coupled with convenience and safety. Consumers are indicating a strong preference for fresh fruits and vegetables over their processed counterparts (Perera *et al.*, 2003). Minimal processing includes operations such as washing, sorting, peeling, coring and cutting, although the product is still unavoidably wounded and its shelf life greatly diminished compared to the intact fruit (Rocha and Morais, 2003). Because of removal of the protective peel, microbial proliferation and desiccation are accelerated. Quality is reduced because of associated degradative processes, and even under ideal storage conditions, the shelf life of these products is limited (Perera *et al.*, 2003). The physiology of these fruits is essentially the physiology of wounded tissue. Physiological and biochemical changes in such products occur at a faster rate than in intact fruits. Mechanical injury sets off a complex series of events which result in loss of quality (Rocha and Morais, 2003).

One major challenge is to develop techniques that will effectively extend the shelf life of these products while ensuring product quality and safety. The gaseous plant hormone ethylene induces synthesis of enzymes that lead to fruit ripening, senescence, and degradation. Therefore, one strategy to retard deterioration and senescence of fruit would be to remove this hormone and/or block its effects (Perera *et al.*, 2003).

The development of flavor and fruit eating quality is determined in large part by the relative amounts of sugars and acids. Both sugars and acids in apple serve as respiratory substrates. Malic acid is the major organic acid in apples and can be reduced by 50% during the life of the fruit (Perera *et al.*, 2003).

Murata and others (1995) showed that TA of Fuji apples was reduced during the ripening period, and ethylene is known to increase this acidity loss in apples that are in the preclimacteric state (Murata *et al.*, 1995). Mohajan (1994) showed that TA of Red Delicious apples was reduced and Brix was increased during storage (Mohajan, 1994). Cheves and others (2007) also showed that potassium permanganate caused to increase of shelf life apples (Cheves *et al.*, 2007).

Ganji moghadam and Nikkhah (2005) studied the effects of plant oils on extending the storage life of two kinds of Red Delicious and Golden Delicious apples. They showed that during storage, pH and Brix were increased and acidity was decreased (Ganji moghadam and Nikkhah, 2005).

Zomorodi (2005) used potassium permanganate and other packaging for extending the shelf life apples. The results showed that in storage time Brix, pH and weight loss were increased and acidity and firmness were decreased. So uses of potassium permanganate prevent the decay of apples (Zomorodi, 2005).

Visai and others (1986) kept apple in cold storage controlled temperature of 2° C without ethylene absorber and using 3% potassium permanganate and 1% sulfuric acid. They showed that the treatments without ethylene absorbent fruits are firmness and Brix and weight loss were increased. The result showed that potassium permanganate caused to increase shelf life of fruit (Visai *et al.*, 1986). Toivonen and others (2001) were researched on the effect of a natural clay adsorbent on quality retention in modified atmosphere packaged raspberries. The clay is a raw, unrefined product that is classified as an XY natural zeolite. Fruit packaged with the natural clay adsorbent was much firmner, had less decay, and had fewer dark red overripe fruit after 14 days than those packaged without any adsorbent. So uses of zeolite prevent the decay fruits (Toivonen *et al.*, 2001).

The use of zeolite as adsorbent started in 1930s followed by Milton, who synthesized zeolite for air separation and purification (Binti Kamarudin, 2006).

Zeolites are nanoporous crystalline alumina silicates. They have tetrahedral and trihedral compounds (Auerbach *et al.*, 2003). They have large vacant spaces or cages in their structure that provide space for cation or large molecules such as water and ammonia. Zeolites have a rigid, three dimensional crystalline structure consisting of a network of interconnected channels and cages. Water moves freely in and out of these pores, but the zeolite framework remains rigid (Binti Kamarudin, 2006). In nano zeolite structure the size of pores are reduced to the level of nano sizes .The Nano pores are capable of capturing the gases molecules and water vapor more strongly than zeolite due to increase in surface area.

The aim of this study was to determine and compare the effects of nano zeolite and potassium permanganate on the quality attributes of apple, and further to determine the potential of using this compound as a treatment to extend the shelf life of apples.

Materials and method

Sample preparation

Red delicious apples were purchased from local market. Apples were washed. Two apples packed in a container (1620mL volume). All containers which include two apples were divided in to three groups. The First group called control group contains no fruits preservative material. In each container of second group, one pouch of nano zeolite (8gram) was placed. In third group, one pouch of potassium permanganate (5gram) was placed. Pouches of nano zeolite and permanganate potassium were prepared with paper and perforated with needle point.

The nano zeolite powder was supplied by Nafez co. and potassium permanganate produces by Kimia Mavad co.

Quality and physiological evaluations

All fruits were stored in laboratory at a fixed temperature and humidity condition. Samples for several tests were collected and examined after 1, 10, 20, 30 and 45 days and Parameters: Titratable acidity (TA), total soluble solids (TSS), pH and weight loss were measured and the visual observations of fruits during storage were also investigated.

Titratable acidity (TA)

Three containers of each control, nano zeolite and permanganate potassium along with apples were taken. The apples of each container were cut and squeezed. Approximately 5cc distilled water was added to the 5 to 10gram juice of apple and then manually titrated (AOAC, 1990). Titration was conducted with 0.1*N* NaOH and the of percentage malic acid equivalents were determined (Perera *et al.*, 2003). Measurements were carried out in triplicate and mean value was taken as final value.

Total soluble solid (TSS)

Total soluble solids (TSS; 0Brix) were determined with hand refractometer. 2 or 3 drops of juice to be analyzed for TSS using a Atago Refractometer (Model DR-A1, Atago, Tokyo, Japan). Measurements were carried out in triplicate.

PH

The pH was measured in the juice of the crushed apple prior to pH determination, using a pH meter (Model Metrohm 827, Switzerland) which had been previously standardized to pH 2 and pH 7. Measurements were carried out in triplicate.

Weight loss

Weight loss was calculated by weighting samples before and after storage days and Measurements were carried out in triplicate.

Visual observations

Three containers including control, nano zeolite and permanganate potassium were prepared. Each container contains three apples. Visual observations of fruits during storage, were investigated.

Results and discussion

Titratable acidity (TA) and pH

The overall results showed that the titratable acidity of fruits decreased (similar observation by Mohajan and others (1994)), but reduction of TA with nano zeolite was much less as compared with that of potassium permanganate and control (Fig. 1). Increase in pH value was observed (Fig. 2), which was obviously correlated, to the decrease in acidity. The increased in pH of apples with nano zeolite were less than with potassium permanganate and controls.

Less change in pH reduces microbiological development which will contribute to the preservation of the apple. On the other hand, it is also desirable from the sensorial point of view, since a variation in pH value would most certainly imply a negative change in flavor (Rocha and Morais, 2003). After harvesting fruit, breathing and fruit physiology activities were continued. The fruit metabolism causes the acidity of fruit to decrease and thereby the pH value increases. One of the most important features of nano zeolites are effective adsorption of gases such as oxygen, carbon dioxide and ethylene, and water vapors due to presence of pores with nano in sizes. Nano zeolite causes the adsorption of these gases and thus reducing the breathing and advances of metabolism in fruits. The reduction in acidity by potassium permanganate (similar observation by Cheves and others (2007)) being as a strong oxidizer is due to destruction of only ethylene gas and to some extend of adsorption of water vapors, therefore its effect in decreasing acidity of fruits is less as compares with nano zeolite.

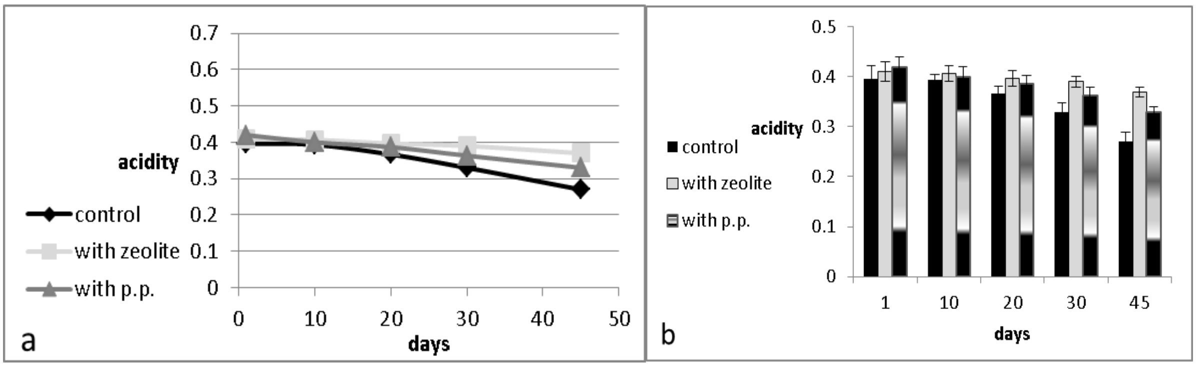

Fig. 1. (a) Titratable acidity of apple during storage. (b) Error bar standard deviation of the mean values of results from triplicate experiments. [control apples, apples with potassium permanganate, apples with zeolite].

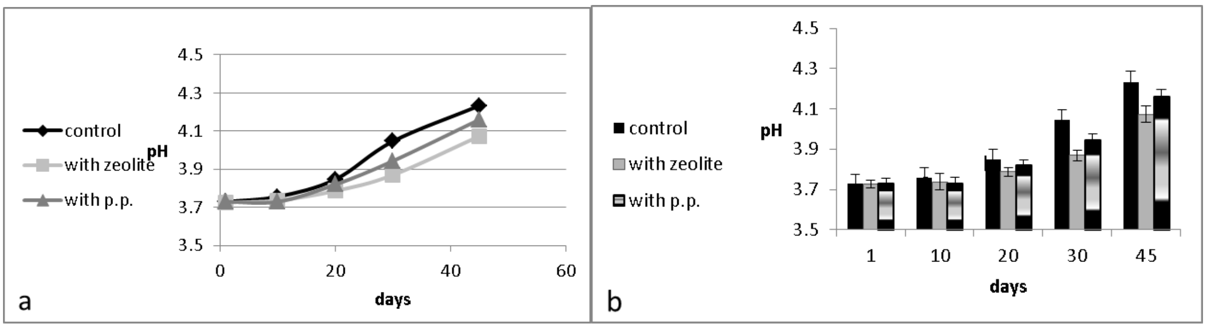

Fig. 2. (a) pH of apple during storage. (b) Error bar standard deviation of the mean values of results from triplicate experiments. [control apples, apples with potassium permanganate, apples with zeolite].

Total soluble solid (TSS)

In Fig. 3, Brix index values are reported. As the results indicates, during the first 10 days, the increase in Brix index values of apples with nano zeolite and that of potassium permanganate were similar. In the 20th day of storage the increase of brix values of apples with nano zeolite were less than control apples and apples with potassium permanganate. (similar observation by Zomorodi (2005)). As mentioned earlier, after harvest, the fruit continues to breathe and most physiological fruits change, effect of oxidative metabolism. Respiratory causes the starch to hydrolysis and therefore increases the Brix. Nano zeolite with adsorbing oxygene, carbon dioxide and ethylene can prevent increase in Brix value.

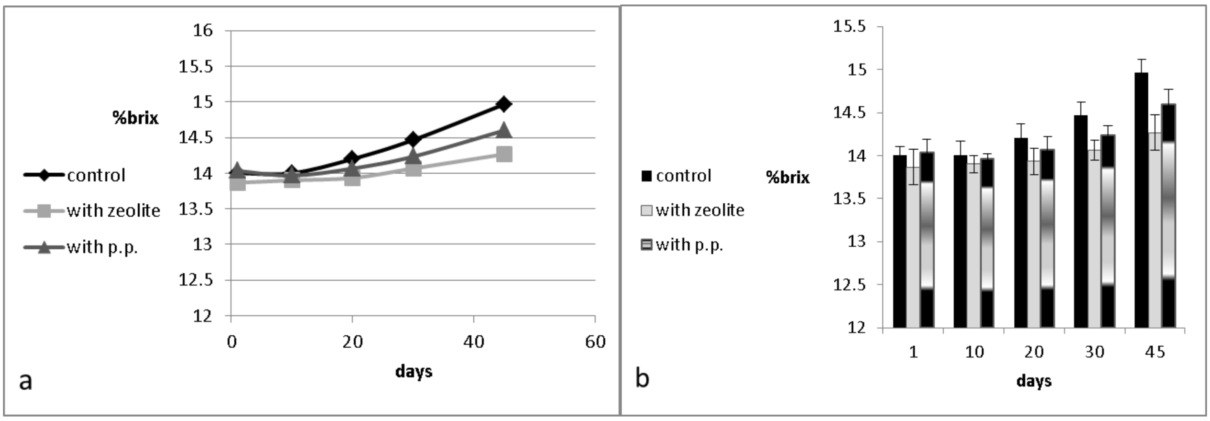

Fig. 3. (a) Brix of cut apple during storage. (b) Error bar standard deviation of the mean values of results from triplicate experiments. [control apples, apples with potassium permanganate, apples with zeolite].

Weight loss

The weight loss during 45 days of storage was increased (Fig.4). As it is shown in fig. 4, the increase of weight loss for apples with potassium permanganate and control were more than apples with nano zeolite. The respiration and metabolism by which the fruit losses water and cause the weight loss is advanced by the adsorption of gases that rises in breathing. In presence of nano zeolite much more gases are adsorbed from fruits environments and thereby breathing is controlled and less losses of water and less reduction in weight occurs.

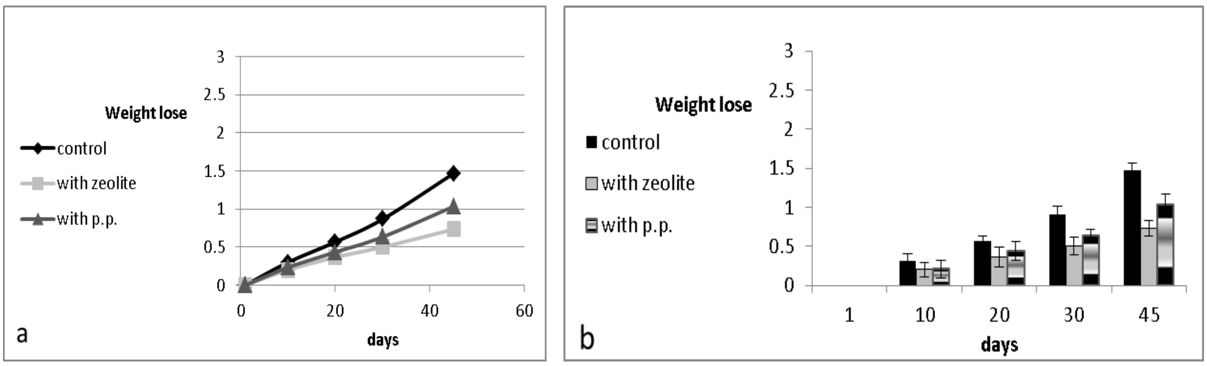

Fig. 4. (a) Weight loss of cut apple during storage. (b) Error bar standard deviation of the mean values of results from triplicate experiments. [control apples, apples with potassium permanganate, apples with zeolite].

Visual observations

In fig. 5, visual observations after 45 days of storage of apples showed that the apples with nano zeolite powder (fig.5-b.) are be more fresh than both control and potassium permanganate apples (fig.5-a,c).

(a) (b) (c)

Fig. 5. The apples after 45 days of storage. (a) control, (b) with zeolite, (c) with potassium permanganate.

Murata and others (1995) showed that TA of Fuji apples was reduced from 0.64 to 0.34 g/100 g during the ripening period, and ethylene is known to increase this acidity loss in apples that are in the preclimacteric state (Murata *et al.*, 1995).

Mohajan (1994) showed that TA of Red Delicious apples was reduced and Brix was increased during storage (Mohajan, 1994). This was also observed in present study.

Cheves and others (2007) also showed that potassium permanganate caused to increase of shelf life apples (Cheves *et al.*, 2007). The results of the present study are similar.

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Conclusions

The changes in physiological and quality characteristic of apples have been examined. The results produced in this study infer that the nano zeolite could extend the shelf life of apples, potassium permanganate could extend the shelf life of apples too but nano zeolite had better effect comparison with potassium permanganate. This is probably because changes in respiration rate and ethylene production are maturity-dependent.

Objective quality evaluations of apple were considered highly correlated in terms of colour and flavour, especially with respect to total soluble solid, and moderate correlations were found with respect to TA and pH.

Data obtained from correlation between the selected sensory modalities showed that these were good indicators of overall fruit quality.

To be able to extend apple shelf life future research is still required focusing on the effect of nano zeolite on bacterial growth on fruit. Also consider effect of different temperature and humidity on efficiency of nano zeolite to extending the shelf life of fruits.

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