The Effect of Pineapple Syrup Immersion on Antioxidant Properties of Fresh-cut ‘Fuji’ Apples

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**Abstract.** Antioxidant capacity are studied on fresh-cut ‘Fuji’ apple slices pretreatment with four various pineapple juice solutions (pineapple original syrup; pineapple syrup pH3.6; pineapple syrup pH4.5; pineapple syrup dilution 1:1; Control group) during storage at 5 \textdegree C for 9 days. Apple slices samples dipped with pineapple syrup retarded browning compared with the check, especially the pineapple juice pH4.5 is the best. The reducing powers of all the fresh-cut apple samples with the immersion with pineapple syrups comparing (with the absorption value at 700nm from 1.438 to 1.758) were higher than the control sample (from 1.325 to 1.403). Scavenging rate of apple slices samples dipped with pineapple juice showed higher value than the control samples.

**Introduction**

As the consumption of fresh-cut apple increases, ready to use apple has become more popular. Available fresh-cut apple in the market is already cut and bagged in polypropylene films. It is important to take into account that cutting may affect antioxidant properties. The antioxidant activity of apples has been widely investigated in several studied [1, 2, 3]. However, few data are available on antioxidant activity of processed apple products during processing and storage with the exception of juices [4, 5, 6]. Pineapple contains considerable calcium, potassium, fiber and vitamin C. It is low in fat and cholesterol. Pineapple juice helps those suffering from high blood pressure due to the low amounts of sodium and high amounts of potassium. This helps in regulating the pressure.

The objective of this study was to minimize the degradation of these antioxidant metabolites, it is essential to know the variation during storage of the fresh-cut apples. The purpose of the present work was to investigate physicochemical changes, such as colours, firmness, antioxidant capacity in minimally processed apple slices pretreated with four different pineapple syrup solutions and to explore the feasibility of pineapple syrup immersion preservation the surfaces of fresh-cut apples.

**Materials and Methods**

**Preparation of Apple Slices**

Apples (Fuji) were purchased from a local wholesale distributor at commercial maturity. Apples were selected for uniform size and appearance. These fruits were rinsed gently with tap water by hand and dried naturally. Then apples were peeled, cored and cut into 1×1×1cm thick cubes (average weight at 1\pm0.3 g) with a sharp stainless steel knife at room temperature. The knife and cutting board were washed with deionized water and rinsed with 200\mu L/L sodium hypochlorite solution prior to use.
Dipping and Storage Conditions of Apple Slices

Preparation of Pineapple Juice. Fresh pineapple was procured locally. The crown and stem portions were removed and the skin was peeled using knife. After that, the fruit was sliced and crushed into pineapple syrup, then kept in a cold room at 5°C. Pineapple juices were then prepared into the fourth solution: the original pineapple syrup, pineapple syrup pH3.6, pineapple syrup pH4.5, pineapple syrup dilution 1:1. The pH was adjusted with sodium hydroxide and citric acid, and they were diluted with distilled water.

Apple Cubes Immersion. The apple cubes were first dipped into the four solutions immersed by using forceps for 2 min. Residual solutions of slices were dripped off for 1 min. The samples were kept at 5°C until the excess of water was drained. Then these apple slices were placed on plastic-coated wire racks inside plastic containers in the conditions of 9 days at 5°C before testing. The color, firmness, reducing power and scavenging rate were determined every two days and repeated 3 times.

Measurement of Color

The color of apple slices was measured with a Minolta Chroma Meter Model CR-300 (Minolta, Tokyo, Japan) every other days. The degree of browning was expressed as L-value and a value. The results were expressed as a mean L-value.

Measurement of Firmness

Firmness determination was performed at room temperature (20±2°C), about 1 h after removing samples from 4°C during penetration of a 6mm diameter stainless steel cylinder for 6mm into the apple cubes, using a Texture analyser. Test speed was 0.5mms⁻¹ and data were expressed in newtons (N).

Reducing Power Assay

A method developed by Oyaizu [7] was employed for the determination of reducing power. Weigh 3.0g pulp tissue, add a small amount of cold 1% HCl-methanol solution, grind in an ice bath, transfer to 20ml test tube scale, and then use 1% HCl-methanol solution, wash mortar, transfer to the test tube too. Set it in the dark at 4 °C for 20min for extraction, shaking several times during the period, and then filtered to collect the filtrate. Samples was added to 2.5 ml of 0.2 M phosphate buffer (pH 6.6) and 2.5 ml of 1% potassium ferricyanide (2.5 ml distilled water in place of the sample solution as the blank). The mixture was incubated at 50°C for 20 min, after which 2.5 ml of 10% trichloroacetic acid (TCA) was added, and the reaction mixture was centrifuged at 6,000×g for 10 min. The 2.5 ml of upper layer obtained after centrifugation was mixed with 2.5 ml of distilled water and 0.5 ml of 0.1% ferric chloride in a 10 ml test tube and left to stand for 10 min. Absorbance at 700 nm was used as the indicator of reducing power.

Hydroxyl Radical Scavenging Assay

The scavenging capacity of apple slices dipped with pineapple juice on hydroxyl radicals was evaluated according to the reaction of salicylic acid and residual hydroxyl radicals. Hydroxyl radical scavenging assay was performed according to the method of Smirnoff and others [8] with a few modifications. Hydroxyl radicals were generated by the Fenton reaction. The reaction mixture (4.0 mL) containing 2 mL FeSO₄ (9 mM), 2 mL H₂O₂ (8.8 mM), 2.0 mL of apple slice samples extraction of ethanol solution and 2 mL salicylic acid (9 mM) was incubated at 37 °C for 0.5 h and then the absorbance was recorded at 510 nm. Scavenging assay, the reaction solution was colorless at first, and then changed into light yellow and blue-violet with the addition of H₂O₂ and salicylate. Ascorbic acid was used as the positive control. The scavenging activity was calculated using the
following Equation: Scavenging rate (%) = \[1 - (A_1 - A_2)/A_0\] × 100 where A_0 is the absorbance of the control group (without apple slices samples), A_1 is the absorbance of the test group and A_2 is the absorbance without salicylic acid.

Results and Discussion

Color Changes for Storage

In the five treatment conditions, L* value is decreased with the extending of storage period (Fig 1). Apple slices dipping with four various pineapple syrups retarded browning compared with the blank, especially the pineapple juice pH4.5, which is much better.

![Figure 1. Effects of Various Pineapple Juice Treatments on Color.](image)

In general, the enzymatic browning of apple pieces during storage was accompanied by a decrease in lightness L*. Fig. 1 shows effects of pineapple syrup dipping on L* of apple pieces. Comparing to control sample, pineapple syrup immersion samples almost remained stable L* values at 5°C for 9 d. L* values of control sample decreased rapidly for 1 d at 5°C. This indicated that pineapple syrup immersion samples retarded browning of apple pieces. L* values of apple pieces the original Pineapple syrup, Pineapple syrup pH3.6, Pineapple syrup pH4.5, Pineapple juice dilution 1:1, control samples were 73.74, 72.17, 71.73, 68.08 and 65.2 on 1 d at 5°C, respectively, which were 98.58%, 96.48%, 95.90%, 90.98% and 87.16% of L* values of control sample on 0 d at 5°C. L* values of apple pieces were 64.47, 65.32, 66.11, 63.63, 60.3 on 9 d, respectively, which were 86.18%, 87.32%, 88.38%, 85.07% and 80.61% of L* values of control sample on 0 d at 5°C. These results showed that pineapple juices inhibited effectively browning of apple pieces and ascorbic acid and citric acid increased inhibitory efficiency of browning.

Firmness

The hardness of the fresh-cut apples decreased with the longer storage time. Hardness decrease of fresh cut fruit and vegetable is a very common phenomenon, and it also affects the quality of fresh-cut apple. In this study, The firmness of all the treatments are at a downward trend during 9 days (Fig. 2). Apple cubes pretreated with pineapple juice dilution 1:1 immersion can maintain good hardness of the situation. While there was no significant difference in apple cubes softening with the treatment of other four various pineapple syrups immersion.
Reducing Power

The reducing powers of fresh-cut apple slices dipping with four different pineapple syrups are shown in Fig. 3, during storage, the reducing powers of all the fresh-cut apple samples with the immersion with pineapple syrups comparing (with the absorption value at 700nm from 1.438 to 1.758) were higher than the control sample (with the absorption value at 700nm from 1.325 to 1.403). The reducing power of samples treated with pineapple original juice and pineapple juice pH4.5 and pH3.6 showed higher reducing power than the control sample at 9 days. The reducing power of samples treated with pineapple original juice and pineapple juice pH4.5 and pH3.6 might be due to their hydrogen-donating ability. These bioactive compounds, including ascorbic acid, total phenolics, flavonoids, lycopene, and other hydrophilic or hydrophobic antioxidants from pineapple juice are good electron donors and could terminate the radical chain reactions by converting free radicals to more stable products.

Hydroxyl Radical Scavenging Rate

Figure 2. Effects of Various Pineapple Juice Treatments on Firmness.

Figure 3. Effects of Various Pineapple Juice Treatments on Reducing Power.

Figure 4. The Scavenging Effects of Apple Slices with Various Pineapple Juice Treatments on Hydroxyl Radicals.
Fig. 4 shows the percentage hydroxyl radical scavenging effects of apple slices with various pineapple juice treatments. In general, scavenging rate of apple slices samples treated with pineapple original juice, pineapple juice pH3.6 and pineapple juice pH4.5 showed higher value than the samples treated with pineapple juice dilution 1:1 and control group. Apple slices samples treated with pineapple original juice, pineapple juice pH3.6 and pineapple juice pH4.5 showed a gradual decrease in scavenging capacity (from the first day 22.2%, 26.8% and 23.2%, respectively to the 7th day 21.2%, 19.7% and 19.5%, respectively) and then a gradual increase (at the 9th day 21.8%, 23.9% and 24.2%, respectively), while apple slices samples treated with pineapple juice dilution 1:1 and control group showed a gradual decrease in scavenging capacity (from the first day 16.4%, 18.6%, respectively to the 9th day 11.3%, 13.9%, respectively), so sample treated with pineapple juice can retain the antioxidant properties of apples.

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Summary

Apple slices samples dipped with pineapple syrup retarded browning comparing to the control, there was no significant difference in inhibition of apple cubes softening. The reducing powers of all the fresh-cut apple samples with the immersion with pineapple syrups comparing (with the absorption value at 700nm from 1.438 to 1.758) were higher than the control sample. Scavenging rate of apple slices samples treated with pineapple original juice, pineapple juice pH3.6 and pineapple juice pH4.5 showed higher value than the samples treated with pineapple juice dilution 1:1 and control group. Pineapple syrup treatment consistently produced higher antioxidant capacity and antioxidant enzyme activity in apples.

References


