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Effects of the PPO(Polyphenol oxidase) Activity and Total Phenolic Contents on Browning and Quality of Dried-Persimmon According to Maturity Degree of Astringent Persimmon (*Diospyros kaki* Thunb.)

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***Abstract*—Browning of fruit is affected by several elements such as environment, storage, each cultivar, each maturity degree, etc. This study was to review effects of the PPO(Polyphenol oxidase) activity and total phenolics contents on browning and quality of dried-persimmon according to maturity degree of astringent persimmon.**

Chromaticity value a in dried persimmon of ripe fruit and full ripe fruit were higher than unripe fruit. In case of soluble sugar contents, full ripe fruit was 50° Brix, the highest degree while unripe fruit was 40° Brix, the lowest degree.

PPO activation degree of unripe fruit was 4.7, which was higher than ripe fruit of 0.7 and full ripe of 1.0. There was no difference in PPO activation degree among treatment and PPO activation remained even while drying.

Total phenol contents of unripe fruit was 101.4, which was higher than ripe fruit of 57.5 and full ripe fruit of 67.4. Total phenol contents level was higher as drying period went by, which was based on fresh weight.

Hardness of unripe fruit and ripe fruit continued to decrease until three weeks while softening went on. After that, Hardness was high and it started drying. Hardness of full ripe fruit began to increase after two weeks. Softening of full ripe fruit was fastest during drying period and weight reduction rate was lower than unripe fruit and ripe fruit.

Keywords- astringent persimmon; dried persimmon; sulfur fumigation ; browning ; PPO; Sangju-Dungsi

I. INTRODUCTION

An astringent persimmon is difficult to be consumed as a fresh fruit due to its astringent taste, so it is changed into process food such as dried persimmon, mellowed persimmon, sliced and dried persimmon, persimmon vinegar, frozen soft persimmon, etc[1][3]. Since, in case of dried persimmon or semi-dried persimmon. Browning occurs on the surface of a persimmon while peeled and dried, most persimmon farmers conduct sulfur fumigation for prevention of browning or microorganism.

Food browning is divided into enzymatic and non-enzymatic browning, and browning that occurs in the tissue of plants has been known to have relation to creation of browning substances caused by enzymatic oxidization of phenolic compound. Enzymatic browning needs activated enzyme and oxygen, and fiber. If one of those factors is removed, enzymatic browning can be prevented[5].

Since browning occurred in agricultural products or food is an important element in loss of quality, so many scientist have been studied on browning of food. It was reported that there is no significant difference in the contents of phenolic compound or activity of phenol oxidase (PPO) between browning fruits and normal fruits in case of Fuji apples[6]. Browning of fruit juice occurring at sweet persimmons was assumed to generate in such a way that increase of PPO activation or of phenolic compound was ambiguous and discharge of phenolic compound existing in vacuole as well as increase of cell-membrane permeability make it easy to contact with phenol oxidase. In case of peeled garlic, it was reported that the browning degree of the specimen surface and the titer of PPO increased as storage period went by while the more browning degree of cut green pepper increased the less the titer of the enzyme reduced[4].

Browning of fruits was caused by several elements such as cultivating environment, storage, cultivar, degree of maturity, etc. This study was to review effects of the PPO(Polyphenol oxidase) activity and total phenolics contents on browning and quality of dried-persimmon according to maturity degree of astringent persimmon.

II. MATERIALS and Method

'Sangju-Dungsi', a cultivar of astringent persimmon, were harvested around the end of October at Sangju and made into dried persimmon. Determination of maturity as based on fruit skin. Unripe fruit showed green from center to fruit apex, table ripe fruit was all orange color, and full ripe fruit was scarlet, which were assorted by each color. Astringent persimmons were peeled and air-dried without sulfur fumigation.

Surface colors of persimmons were measured using Minolta CR-300 (Japan), hardness was using Compac-100, and № 25 was used as an adaptor.

PPO (Polyphenol Oxidase) was analyzed as follows; fruit flesh of 5g was frozen in liquid nitrogen and then triturated. And, sodium phosphate buffer liquid of 10ml (0.1M, pH 7.0, 0.25% Triton X-100 and 0.5g PVP) were added in and homogenized and centrifuged supernatant was used as an enzyme extract. The protein content of the enzyme extract was measured by Bradford method, and the enzyme extract of 200 ㎕ was mixed with assay Soln (12 mM 4-Methylcatechol in Sodium Acetate buffer, 0.1M and pH 5.0) of 3 ml. Absorbance was measured in 410 nm for 3 minutes in the interval of 30 seconds at spectrophotometer (25℃).

Total Phenolics were analysed as follows; fruit flesh of 5 g was frozen in liquid nitrogen and triturated. 1% Hcl/MeOH of 10ml was added in the frozen specimen powder of 1 g, was covered up and stored overnight in refrigerator of 4℃, and centrifuged supernatant was used as a phenol extract. 7.5% carbonate of 400 ㎕, folin-ciocalteu reagent of 500 ㎕ and 1% Hcl/MeOH of 50 ㎕ were vortexed in phenol extract of 50 ㎕, which was left at a room temperature for 30 minutes. Absorbance was measured at 765 nm and the content of total phenolics was indicated as mg/g fresh weight.

III. Results AND Discussion

Chromaticity value a of dried persimmons

Value a was reduced as drying period went by in every process, and that of dried persimmons made of rather ripe fruit and full ripe fruit than unripe fruit was high to show a red persimmon skin.

Climacteric fruits such as tomato, banana, pineapple, etc, are processed with ethylene, coloring is facilitated, ethylene dissolved chlorophyll existing in fruit peel of persimmons and synthesized lycopene to create a red color[5]. In the same context, in case of ripe fruit and full ripe fruit, ethylene has a strong influence on maturity. Since fruit color changed to yellow or red according to kind and amount of carotinoid as persimmon matured, its dried persimmon surface is more red and better than unripe fruit[2].

Soluble solid contents of dried persimmon

The soluble solid contents increased as drying period went by in every process, and the soluble solid contents of ripe and full ripe fruit was higher than that of unripe fruit. It was consistent with the report of that the concentration of soluble sugar occurs with evaporation of moisture to increase the soluble solid contents gradually as drying period goes by[1]. The reason of more content than unripe fruit was allegedly that unripe fruit had much starch while starch of ripe fruit was rapidly was reduced as maturity went on and content of sugar increased.

PPO(polyphenoloxidase) activation

PPO activation degree of unripe fruit was 4.7, which was higher than ripe fruit of 0.7 and full ripe of 1.0. Browning of unripe fruit was stronger than that of ripe fruit and full ripe fruit when dried persimmons were made with unripe fruit, and as a result, the effect of PPO (oxidase) on browning of dried persimmon was shown.

PPO activation degree in dried persimmon of ripe fruit increased a little but activation degree did not make a significant difference. Since PPO activation remained even while drying, PPO was regarded as quite a stable enzyme. The reason that PPO activation degree increased a little during drying period was that water evaporated and enzyme was concentrated during drying period. It is assumed that PPO activation is deactivated during drying.

Total phenol contents

Total phenol content of unripe fruit was 101.4, which was higher than ripe fruit of 57.5 and full ripe fruit of 67.4. Browning in dried persimmon of unripe fruit was stronger than that of ripe fruit and full ripe fruit. The result showed the effect of total phenol content on browning of dried persimmon according to maturity degree of astringent persimmon. Since total phenol content is the substrate of PPO enzyme, the higher the content of the substrate was the higher the activation of the enzyme was. Therefore, it is assumed that browning of unripe fruit was stronger than that of ripe fruit and full ripe fruit.

Total phenol contents was higher as drying period went by, which was based on flesh-weight. Phenol was concentrated as drying went on to show its higher content. However, it was hard to regard it increased because cells died and then total phenol could not generate.

Hardness of dried persimmon

Hardness of dried persimmon decreased during its softening period in every treatment. Since moisture continued to evaporate and then hardness increased. Hardness of full ripe fruit was lower than that of unripe fruit and ripe fruit. Protopectin changed into soluble pectin by maturity and then pectic acid decreased. Consequently, some of cell walls were melted to make fruit flesh soft. Softening speed while drying became fast when dried persimmons were made of full ripe fruit.

Reduction rate in weight

The reduction rate in weight of unripe fruit was higher than that of ripe fruit and full ripe fruit. It is because free water of ripe fruit and full ripe fruit was less than that of unripe fruit. So these make it easy that moisture evaporated well in unripe fruit.

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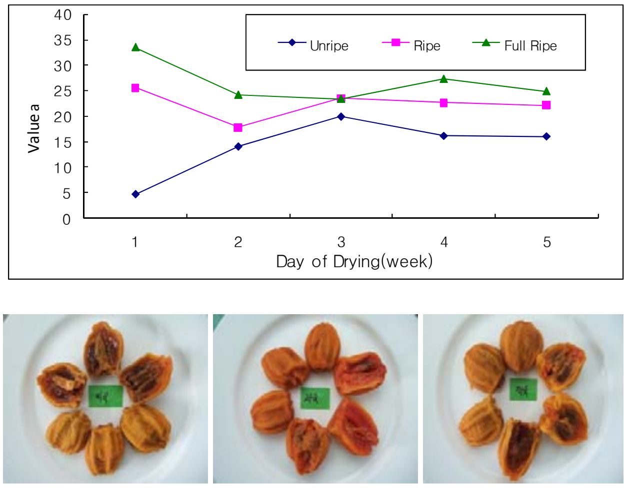

Unripe Ripe Full Ripe

Fig. 1. The chromaticity value a according to maturity degree of astringent persimmon.

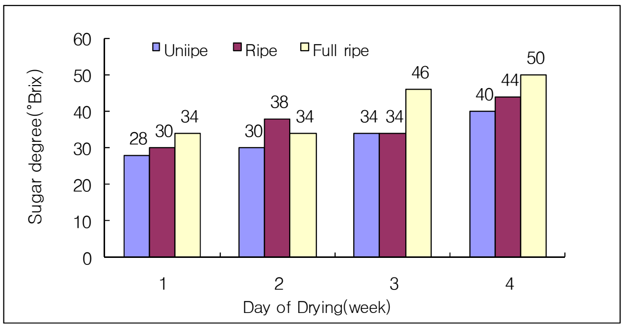

Fig. 2. Soluble solid contents of dried persimmon by each maturity degree of astringent persimmon

TABLE 1. PPO ACTIVATION BY EACH MATURITY DEGREE OF ASTRINGENT PERSIMMON

Maturity Degree	PPO Activation Degree (A410/min/mg protein)
Unripe	4.7
Ripe	0.7
Full Ripe	1.0

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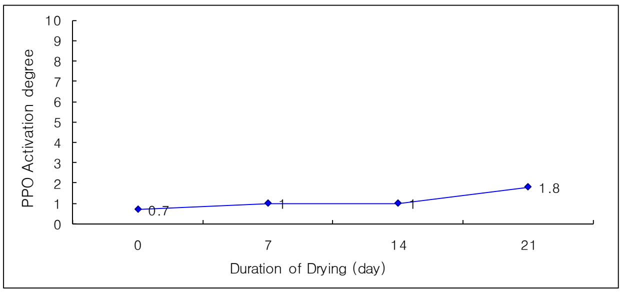

Fig. 3. PPO activation degree in dried persimmon of ripe fruit.

TABLE 2. TOTAL PHENOL CONTENT IN DRIED PERSIMMON BY EACH MATURITY DEGREE OF ASTRINGENT PERSIMMON

Maturity Degree	Total Phenol Content (mg/g fresh wt)
Unripe	101.4
Ripe	57.5
Full Ripe	67.4

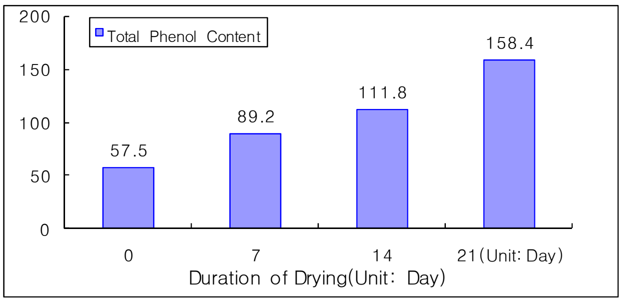

Fig. 4. Total phenol content in dried persimmon of ripe fruit.

TABLE 3. HARDNESS BY EACH MATURITY DEGREE OF ASTRINGENT PERSIMMON

(Unit: cm²)

Days of Drying / Maturity Degree	0	1	2	3	4	5
Unripe	2949.7	497.4	194.7	178.4	236.4	318.1
Ripe	2597.8	342.2	235.9	208.1	243.7	356.8
Full Ripe	1546.4	255.4	104.4	210.2	315.1	396.3

TABLE 4. REDUCTION RATE OF WEIGHT.

Class / Maturity Degree	Weight (g)		Reduction Rate of Weight (%)
	Fresh Persimmon	After 5 weeks' drying	
Unripe	150.8	35.1	76.7
Ripe	147.9	37.4	74.7
Full Ripe	148.4	43.2	70.9