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Development of manufacturing method for the honey coating semi-dried mulberry fruit using hot air dryer

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Abstract

Semi-dried mulberry fruit can be distributed at room temperature and maintained its chewy texture and shape. It can be used for its own itself or food materials. We develop the honey coating semi-dried mulberry fruit manufacturing method through hot air dryer. After extracting the moisture from the thawing process, honey was coated and dried. Drying time for semi-dried mulberry fruit was shortened by manufacturing on the day of work without going through aging process. The first the mulberry fruit juice was separated from the frozen mulberry fruit at room temperature of the laboratory or in the dryer of 60~90°C, then the first dried by a hot air drier at 60°C for 3 to 4 h. Next, it is coated with honey, which is equivalent to 20% weight of the first dried mulberry fruit, and then the second dried at a temperature of 38°C for 20 ~ 30 h. The honey coating semi-dried mulberry fruit by above method was shiny on the surface and retained its shape. The moisture content was about 15% and it was confirmed that it could be stored at room temperature.

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Introduction

Recently, as a result of continuous publicity through the media, attention about the sericultural products has been increased as a health functional food resource and medicine material. Especially, as the results of various physiological activities about mulberry fruit such as inhibition of aging (Hong *et al*., 1997), treatment of diabetic retinopathy (Scharrer and Ober, 1981), improvement of vision (Politzer, 1977; Timberlake and Henry, 1988; Lee *et al*., 2014), antioxidant activity (Tamura and Yamagami, 1994; Yoshiki *et al*., 1995; Rice-Evans *et al*., 1995, 1996; Sichel *et al*., 1991; van Acker *et al*., 1995), neuroprotective effect (Kang *et al*., 2006) and immunomodulating activity (Lee *et al*., 2013) have been reported, the number of farmer and cultivation area has increased significantly since 2007. Consumption of mulberry fruit was the highest peak in 2014, but it declined somewhat. Last year, the number of farmhouses was 4,182, and the cultivation area was 1,309ha (MAFRA, 2018).

The National Institute of Agricultural Sciences has analyzing the functional ingredient content of mulberry fruit according to the mulberry variety / strain and developing food processing technology using it since 2002. As a result, many studies on the functional components of mulberry fruit have been reported that mulberry fruit contained a large amount of various functional

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ingredients such as cyanidin-3-glucoside (C3G) (Kim and Kim, 2003), rutin (Kim and Kim, 2004), γ-aminobutyric acid (GABA) (Kim *et al*., 2004), unsaturated fatty acid (Kim *et al*., 2003), resveratrol (Kim *et al*., 2005) and so on.

In the field of processing, a variety of high-value added products manufacturing technology such as natural food coloring, jam, juice, semi-dried mulberry fruit, beer etc. has developed that can be easily applied at the farm site.

However, the harvested mulberry fruit from mid to late June are highly moisture content and are easily squishy or decayed, so it must shipped immediately or stored frozen. This long-term storage of frozen mulberry fruit is costly for farmers because of the storage and distribution costs until it is sold.

As a way to solve these problems and expand the use of mulberry fruit, semi-dried mulberry fruit is being considered. Semi-dried mulberry fruit refers to dried mulberry fruit which is made to dry at the full dry level of moisture content of frozen mulberry fruit to be able to distribute at room temperature, and to maintain its chewy texture and shape. It can be used for its own itself or food materials.

National Institute of Agricultural Sciences has attempted to manufacture semi-dried mulberry fruit using the hot air dryer, vacuum freeze dryer and far infrared ray dryer etc. As a result, a method of simultaneously producing extraction juice, jam, and semi-dried mulberry fruit by mixing mulberry fruit, sugar and citric acid using a hot air drier (Kim, 2013), and a vacuum freeze dryer method (Kim, 2014; Kim *et al*., 2015) of producing a semi-dried mulberry fruit which retains the functional ingredients, taste, aroma and shape of the fruit were developed. In addition, in order to solve the problem of rejection due to the use of sugar in the hot air drying method and to solve the problem of lowering the preference degree due to the relatively low sugar content of the vacuum freeze drying method, a method of manufacturing semi-dried mulberry fruit by far infrared ray dryer (Kim, 2016; Kim *et al*., 2017) was studied

At present, the dryer which is the most in the farmhouse in Korea is a hot air dryer, and it is required to develop a method of processing the mulberry fruit by using it instead of far infrared ray dryer. Therefore, this study was conducted to contribute to the improvement of farm household income by expanding the sales of various processed foods using high quality honey coating semi-dried mulberry fruit and selling them.

Materials and methods

Experimental material

The mulberry fruit species used for this experiment was 'Iksuppong' (Morus alba L.), which was purchased in Sang-ju city, Gyeongbuk province. The samples were stored at -80°C in a deep freezing cryocooler (Ilshin Lab Co., Ltd, Korea) until in the experiment.

The honey was purchased acacia honey (25 kg, domestic) from Korea Apicultural Cooperative Federation for the production of honey coating semi-dried mulberry fruit. The acacia honey used in the test was passed through 22 test items such as moisture content 18.9%, free sugars (fructose and glucose) 72.2%.

Hot air dryer

The hot air dryer used in this experiment was commissioned and manufactured by Hanbaek Scientific, Korea. Dimension of the dryer (HB-503LF) is 1200 x 800 x 1200 (H) mm and the temperature range is 40 ~ 120°C.

Moisture content measurement

Moisture content of honey coating semi-dried mulberry fruit was measured 10 times randomly for each treatment using a simple type moisture meter (SK-840A, SATO, Japan) and the average value was used.

Observation of mulberry fruit's characteristics according to drying time

The condition of the semi-dried mulberry fruit was observed by visual observation, and the presence of fungi during drying and storage and the occurrence of odor were investigated.

Taste and palatability evaluation

The taste and palatability of the honey coating semi-dried mulberry fruit by hot air dryer was evaluated. Considering age and gender, 10 persons were selected for each age group. Each item was evaluated using a 9-point scoring method.

Results and discussion

Characteristics of thawing and juice separation of frozen mulberry fruit

It is difficult to apply honey coating to frozen mulberry fruit, so thawing should be done first. We conducted preliminary the process of thawing and juice separation in order to manufacture the honey coating semi-dried mulberry fruit (Fig. 1). We took out the frozen mulberry fruit from the cryogenic freezer and spread it evenly on the wire tray which put with drying entanglement. In order to collect the juice dropping down from the thawing process, a water container was placed under the wire tray. Three treatments such as room temperature(non-heat treatment) and heat treatment at 60°C and 90°C in a dryer were carried out. The frozen mulberry fruit weight of each treatment was 1 kg, and the thawing time was stopped when the juice did not fall under the wire tray. It took 8 h at room temperature thawing (RT-8), 3 h at 60°C (60-3), and 2 h at 90°C (90-2) based on 1 kg of frozen mulberry fruit. The weights of mulberry fruit of RT-8, 60-3, 90-2 were 709 g, 688 g, 655 g respectively, and the collected juice in the water container of RT-8, 60-3, 90-2 were 220 mL, 105 mL, and 100 mL respectively after the thawing (Table 1). The weight of mulberry fruit and the amount of juice separated was small in the case of heat treatment than room temperature thawing because it was thawed and dried simultaneously in the dryer due to heat treatment.

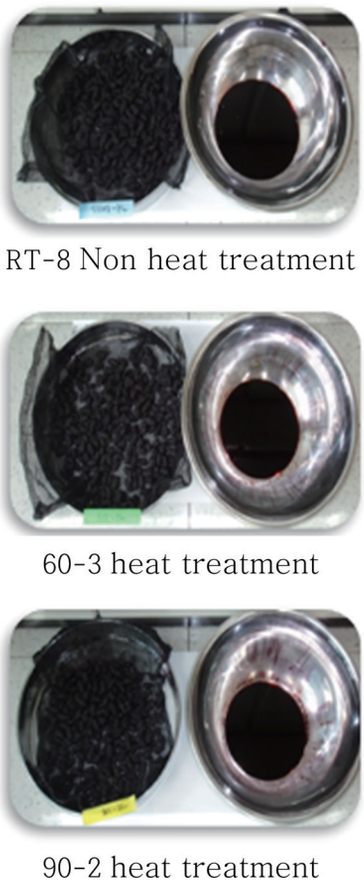


Fig. 1. Thawing and separation from frozen mulberry fruit

Table 1. Characteristics of thawing and juice separation of frozen mulberry fruit

Item	RT-8 Non heat treatment	60-3 heat treatment	90-2 heat treatment
The weights of mulberry fruit(g)	709	688	655
Collected juice in the water container(mL)	220	105	100

From this result, we concluded that thawing of frozen mulberry fruit takes long time at room temperature, and there can be a risk of occurrence of fungi or decay due to surroundings environment such as high temperature or contaminant, so it is preferable to heat treatment in a dryer for a short time.

Drying characteristics of thawed mulberry fruit according to dry time

Drying temperature is a key factor for agricultural products. According to some researchers, drying temperature over 70°Ccaused rapid drying but destroyed nutritional component of sweetpotato and marine products (Kim, 2011; Jeong *et al*., 2015a, 2015b). Mulberry fruit could not dried at low temperature from 40 to 50°C but molded (Kim, 2011; Kim, 2016). Drying temperature was fixed at 60°C to inhibit nutrient destruction and to maintain the quality of mulberry fruit. Mulberry fruit was dried as follows; after the defrosting process was completed, juice in the water container was removed from the dryer and then mulberry fruit was dried in a dryer. After drying for 2 h, the weight of mulberry fruit of RT-8, 60-3, 90-2 was 560 g, 544 g, and 486 g, respectively, and after 3 h of drying, 504 g, 493 g, and 442 g, respectively (Table 2). No difference in the shape according to treatment was observed (Fig. 2). By the way, mulberry fruit which was thawed at 90°C (90-2) stopped primary drying and applied honey coating. Room temperature thawing (RT-8) and 60°C thawing (60-3) were performed for 4 h and then

Table 2. Drying characteristics of thawed mulberry fruit according to dry time

Item	Drying time	RT-8 Non heat treatment	60-3 heat treatment	90-2 heat treatment
The weights of mulberry fruit(g)	2 h	560	544	486
	3 h	504	493	442
	4 h	444	426	-

Fig. 2. The shape of first dried mulberry fruit in the dryer at 60°C after thawing

coating with honey. At that time, the weight of the mulberry fruit of RT-8 and 60-3 was 444 g and 426 g, respectively.

From this, it was found that the time for primary drying was different before the honey coating treatment according to the thawing temperature. That is, in the case of room temperature thawing (RT-8) and 60°C thawing (60-3), 4 h is needed and in the case of 90°C thawing (90-2), 3 h is preferable to dry at 60°C.

Honey coating treatment

In order to improve the taste of the mulberry fruit which was the primary dried, honey was added and coated. And then transferred to a separate container to add 20 % honey to the weight of the mulberry fruit. This reference was made to Kim *et al*. (2017) and RDA report (2016), a method for honey coating semi-dried mulberry fruit by far-infrared ray dryer. In other words, honey coating semi-dried mulberry fruit was prepared by varying the content of honey added after the separation of mulberry fruit's juice by 10 % and 20 %, respectively. The shape maintained regardless of the honey adding volume. But it was not preferable to add more than 20 % because the drying time was too long and the moisture content was too high, which lowered the drying efficiency and increases the cost of honey input, which was not economical.

Also we confirmed that the addition of dextrin, a food additive, as an excipient was able to shorten the drying time by 3 to 10 h compared with the dextrin free treatment, as well as shape stability and glossy surface effect of the thawed mulberry fruit (data not show).

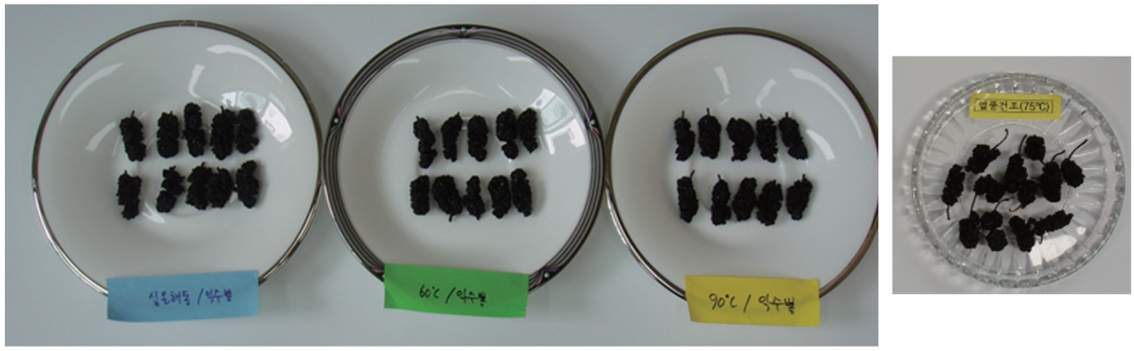
Drying of Honey-coated mulberry fruit

The honey-coated mulberry fruit was transferred to a new tray, spread evenly on, placed in a hot air dryer at 38°C, and dried for 20 to 30 h until no mulberry fruit juice came out. The control (75°C constant temperature drying) showed that the volume of the mulberry fruit was significantly reduced and crushed, while the honey coated mulberry fruit remained in the form (Fig. 3). The moisture content was about 15 % which was considered to be suitable for long-term room temperature distribution.

According to the Kim (2016) and Kim *et al*. (2017), when the moisture content of the semi-dried mulberry fruit was 21%, mold was formed during storage. However, no mold during storage in case of 14 ~ 16%.

Sensory evaluation

Sensory evaluation was performed on the shape, taste, and overall acceptability of the semi-dried mulberry fruit. As a result, the control which was dried at a high temperature of 75°C, had a low score on taste and preference, but all of the honey coating semi-dried mulberry fruit showed high score regardless of the pretreatment (Table 3). However, because there are individual differences in preference for sweetness, we decided that it would be better to control the addition of honey in the range of 10 ~ 20 % (RDA, 2016).



Honey coating semi-dried mulberry fruit (38℃) Control (75℃)

Fig. 3. The shape of honey coated mulberry fruit (dried at 38°C, hot air dryer)

Table 3. Sensory evaluation of semi-dried mulberry fruit according to thawing method

Item	RT-8 Non heat treatment	60-3 heat treatment	90-2 heat treatment	Control (75℃)
Shape	8.0	8.2	8.2	5.3
Taste	8.5	8.4	8.2	3.2
Overall acceptability	8.8	8.3	8.5	5.2

*9-point scoring method

Conclusion

The temperature of the hot air dryer was adjusted step by step to develop a semi-drying method of frozen mulberry fruit (Fig. 4). After extracting the juice from the thawing process, honey was coated and dried. Drying time of the semi-dried mulberry fruit is shortened by manufacturing semi-dried mulberry fruit on the day of work without going through a separate aging process. First, frozen mulberry fruit was taken out and thawed in a drier with heat-treatment (60-3, or 90-2) to separate the mulberry fruit juice and then subjected to primary drying (3 ~ 4 h) with a hot air drier at 60°C. Next, it was coated with the addition of honey which was equivalent to 10 ~ 20 % of the weight of the primary dried mulberry fruit, followed by secondary drying (38°C for 20 ~ 30 h), which can be stored at room temperature for a long time.

The method of manufacturing honey-coating semi-dried mulberry fruit using the hot-air dryer described above is to maintain the shape of the mulberry fruit after drying and add honey instead of sugar to prepare semi-dried mulberry fruit,

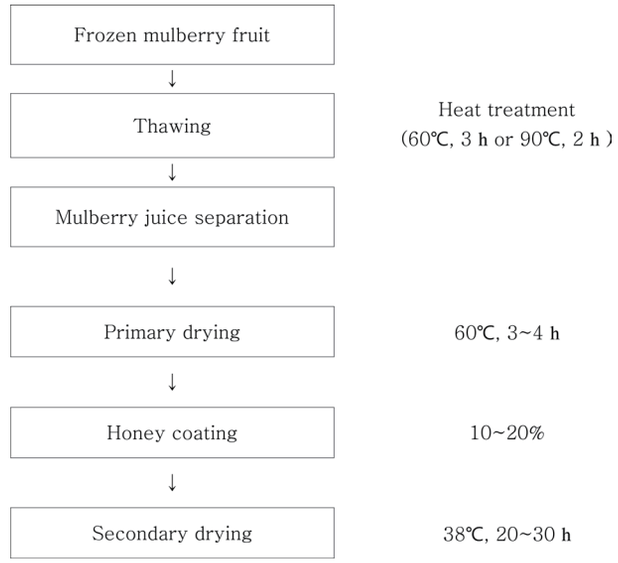


Fig. 4. Manufacturing process of honey coating semi-dried mulberry fruit using hot air dryer

thereby increasing the visual satisfaction of the consumers. In addition, since semi-dried mulberry fruit can be cooked or processed by adding them to various foods, it can contribute to promoting consumption of mulberry fruit by increasing the expectation of use of mulberry fruit. Further, semi-dried mulberry fruit can be stored at room temperature, so that the convenience of transportation and distribution can be increased, the mulberry fruit can be manufactured in a short time without aging process.

We expect the stable income growth of the farmers and processors through the rapid dissemination of semi-dried mulberry fruit manufacturing technology.

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