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Wrapping Materials and Cold Storage Durations Effect on Water Content of Plum

[1]Majid Rashidi, [1]Mahdi Hosseini Bahri, [2]Fariborz Naserzaeim, [2]Jafar Abdi and [2]Amirhossein Ahmadbeyki

[1]Department of Agricultural Engineering Research, Tehran Province Agricultural and Natural Resources Research Center, Tehran, Iran
[2]Department of Agricultural Machinery, Takestan Branch, Islamic Azad University, Takestan, Iran

Abstract: Three wrapping materials (kraft paper + straw, kraft paper and news paper) and five cold storage durations (0, 8, 16, 24 and 32-day) were investigated for water content of plum (cv. Shablon) during cold storage at -1°C temperature and 98% relative humidity. The experiment was laid out in Factorial Completely Randomized Design (FCRD) with four replications for each one of factors. The data collected were subjected to Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT) at 1% probability was performed to compare the means of different treatments. The statistical results of the study indicated that wrapping material and cold storage duration significantly ($P \leq 0.01$) affected water content. Results of the study also indicated that water content decreased by increasing cold storage duration. In addition, kraft paper was the best wrapping materials for conserving water content.

Key words: Plum · Wrapping material · Cold storage duration · Water content

INTRODUCTION

A plum (*Prunus domestica*) is a drupe fruit of the genus *Prunus*. The commercially important plum trees are medium sized, usually pruned to 5-6 meters height. Fruits are usually of medium size, between 1 to 3 inches in diameter, globose to oval. The flesh is firm, juicy and mealy. The fruit's peel is smooth, with a natural waxy surface that adheres to the flesh. The fruit has a single large seed. Plum fruit tastes sweet and/or tart; the skin may be particularly tart. It is juicy and can be eaten fresh or used in jam-making or other recipes. Plums come in a wide variety of colors and sizes. Some are much firmer-fleshed than others and some have yellow, white, green or red flesh, with equally varying skin color [1]. Plums are produced around the world and China is the world's largest producer. The ten largest producers of plums are China, Romania, USA, Serbia, Chile, France, Iran, Turkey, Italy and India. Iran products nearly about 269,139 tons of plum and is ranked 7th in the world [2]. But, Iranian plums are not exported because of variability in size and shape and lack of suitable packaging [3].

Methods that are being used to preserve whole fruits and vegetables during storage and marketing are generally based on refrigeration with or without control of composition of the atmosphere [4, 5]. However, temperature, atmosphere, relative humidity and sanitation must be regulated to maintain quality of them [6, 7]. In this direction, several methods that have been used are refrigeration, controlled atmosphere packaging, modified atmosphere packaging and chemical preservatives [8-10]. The most prevalent method is rapid cooling at a low temperature with high relative humidity [11]. However, low temperature storage is not economically feasible in most developing countries [5, 12].

Fungicides control postharvest decay of whole fruits, but they leave residues that are potential risks to humans and the environment [12]. In addition, many consumers are suspicious of chemicals in their foods, especially in fruits and vegetables [9]. Sulfites were effective chemical preservative as they were both inhibitors of enzymatic browning and antimicrobial. But their use has been banned due to adverse reaction in consumers [9, 13]. Moreover, chemical preservatives affect the flavor of fruits and vegetables [14].

Corresponding Author: Dr. Majid Rashidi, Department of Agricultural Engineering Research, Tehran Province Agricultural and Natural Resources Research Center, Tehran, Iran. E-mail: majidrashidi81@yahoo.com - m.rashidi@aeri.ir.

Coatings, films and wrapping materials are also effective in reducing desiccation (moisture loss), but are subject to microbial growth and disposal problems [10, 15]. Many years of research are conducted to develop a material that would cover fruit so that an internal modified atmosphere would develop [16, 17].

In this paper, the effect of wrapping material and cold storage duration on water content of plum (cv. Shablon) during cold storage at -1°C temperature and 98% relative humidity is reported.

MATERIALS AND METHODS

Plant Materials: Plums (cv. Shablon) were purchased from a local market in Karaj, Iran. They were visually inspected for freedom of defects and blemishes. Plums were then wrapped in different wrapping materials (kraft paper + straw, kraft paper and news paper), placed in plastic boxes and stored in cold storage at -1°C temperature and 98% relative humidity for 0, 8, 16, 24 and 32 days.

Water Content: The water content of plums was determined using the equation (1):

$$\text{Water content (\%)} = 100 \times (M_1 - M_2)/M_1 \quad (1)$$

where:
M_1 = Mass of sample before drying, g
M_2 = Mass of sample after drying, g

Statistical Analysis: The experiment was laid out in Factorial Completely Randomized Design (FCRD) with three wrapping materials (kraft paper + straw, kraft paper and news paper) and five cold storage durations (0, 8, 16, 24 and 32-day) at -1°C temperature and 98% relative humidity with four replications for each one of factors. The effect of the factors on water content was determined by analysis of variance (ANOVA) using SPSS 12.0 (Version, 2003). Also, Duncan's Multiple Range Test (DMRT) at 1% probability was performed to compare the means of different treatments.

RESULTS AND DISCUSSION

Wrapping material and cold storage duration significantly ($P \leq 0.01$) affected water content of plum (Table 1). The highest water content of 85.86% was observed in kraft paper and lowest (85.05%) in news paper and wrapping material affected water content in the order of kraft paper > kraft paper + straw > news paper. Also, the highest water content of 87.20% was observed in 0-day and lowest (83.83%) in 32-day and water content decreased with increased cold storage duration (Table 2). Moreover, interaction of wrapping material × cold storage duration had no significant effect ($P \leq 0.01$) on water content (Table 1). The study of wrapping material and cold storage duration combinations on water content indicated that in each wrapping material, water content

Table 1: Analysis of variance for water content of plum (cv. Shablon)

Source of variation	Degree of freedom	Mean square
Wrapping material	2	3.02**
Cold storage duration	4	19.2**
Wrapping material × Cold storage duration	8	0.28^{ns}
Error	45	0.24
C.V. (%)	---	0.58

** = Significant at 0.01 probability level
ns = Non-significant

Table 2: Means comparison for water content of plum (cv. Shablon) for different studied treatments using DMRT at 1% probability

	Treatment	Water content (%)
Wrapping material	Kraft paper + straw	85.39 b
	Kraft paper	85.86 a
	News paper	85.05 c
Cold storage duration	0-day	87.20 a
	8-day	86.47 b
	16-day	85.20 c
	24-day	84.47 d
	32-day	83.83 e

Means in the same column with different letters differ significantly at 0.01 probability level according to DMRT

Table 3: Means comparison for water content of plum (cv. Shablon) for combinations of wrapping material and cold storage duration using DMRT at 1% probability

Wrapping material ×	Cold storage duration	Water content (%)
Kraft paper + straw	0-day	87.20 a
	8-day	86.48 ab
	16-day	85.15 de
	24-day	84.43 efg
	32-day	83.70 gh
Kraft paper	0-day	87.20 a
	8-day	87.03 a
	16-day	85.73 cd
	24-day	84.85 ef
	32-day	84.50 ef
News paper	0-day	87.20 a
	8-day	85.90 bc
	16-day	84.73 ef
	24-day	84.13 fg
	32-day	83.30 h

Means in the same column with different letters differ significantly at 0.01 probability level according to DMRT had the highest value in 0-day and the lowest value in 32-day. In addition, the maximum mean value for water content (87.20%) was observed in 0-day of three wrapping materials and the minimum mean value for water content (83.30%) was observed in 32-day of news paper. Furthermore, water content in each wrapping material decreased with increased cold storage duration (Table 3). These results are in agreement with those of Mahmoud and Savello [18], Avena-Bustillos *et al*. [19], Rashidi *et al*. [20] and Rashidi *et al*. [21] who concluded that coatings, films and wrapping materials significantly conserved water content. These results are also in line with the results reported by Smith and Stow [4], Baldwin *et al*. [9], Rashidi *et al*. [20], Rashidi *et al*. [21], El Ghaouth *et al*. [22], Bahri *et al*. [23] and Niari *et al*. [24] that water content significantly decreased with increased cold storage duration.

CONCLUSION

Wrapping material and cold storage duration significantly ($P \leq 0.01$) affected water content of plum. Also, water content decreased by increasing cold storage duration. In addition, kraft paper was the best wrapping materials for conserving water content.

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