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ESTUDIO POSTCOSECHA DE LA CIRUELA MEXICANA (*Spondias purpurea* L.) DURANTE EL ALMACENAMIENTO.

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Palabras clave: Spondias purpurea L., hongos postcosecha, ciruela mexicana

RESUMEN

La demanda del fruto de la ciruela mexicana se ha incrementado tanto a nivel Nacional como Internacional. El incremento en las áreas de producción de esta fruta junto con un interés en los mercados extranjeros prevé la necesidad de llevar acabo estudios relacionados con el comportamiento postcosecha de esta fruta. El objetivo de este trabajo fue el de evaluar algunos aspectos físico-químicos de la ciruela durante el almacenamiento, junto con la identificación de los microorganismo presentes en esta fruta, con la finalidad de iniciar un manejo postcosecha adecuado para este cultivo. Los experimentos se llevaron a cabo en fruta cosechada en el estado de Morelos, México. Las evaluaciones en la fruta se llevaron a cabo en dos estados de madurez. Verde: entre un 25 y 75% de la superficie de la fruta presentaba color verde y Maduro: menos del 25% del color de la fruta era verde. Los resultados indicaron pérdida de masa durante los cuatro días de almacenamiento a 20°C. Se observaron diferencias en el contenido de sólidos solubles totales, firmeza, pH y color de acuerdo a los dos estados de madurez. El contenido de sólidos solubles totales y pH se incrementaron mientras la firmeza y la acidez descendieron después del periodo de almacenamiento. El color fue principalmente verde en el primer estado de madurez, cambiando de verde a naranja-rojo a medida que la madurez avanzaba. En general, los cambios físico-químicos fueron más drásticos en la fruta del estado de madurez 'verde' que en el 'maduro'. Los principales microorganismos aislados fueron *Rhizopus stolonifer* y *Alternaria* spp. Para diseñar un sistema postcosecha adecuado en esta fruta se hace necesario otros estudios como la evaluación de diferentes combinaciones de temperatura-humedad relativa, control de enfermedades postcosecha, empaques etc.

POSTHARVEST STUDY OF RED-MOMBIN (*Spondias purpurea* L.) FRUIT DURING STORAGE.

Key words: Spondias purpurea L.; postharvest fungi, red-mombin

ABSTRACT

The red-mombin (ciruela) fruit (*Spondias purpurea* L.) has increased in popularity among local and overseas population. Hectares increasing among the growing regions of Mexico and interests on export marketing foresee that is necessary to evaluate the postharvest behaviour of this fruit. The objective of this study was to evaluate some postharvest characteristics of red-mombin fruit to aid to initiate a sound postharvest system. Experiment was carried out in fruit harvested in the state of Morelos, Mexico. Studies of fruit were carried out in two ripening stages: "Turning" fruit surface between 25 to 75% green and "ripe" less than 25% green. Results indicated that percentage mass loss decreased during the four days storage period at 20°C. Fruit had differences in total solid solubles levels, firmness, pH, acidity and colour according to ripening stage. Total solid solubles and pH increased while firmness and acidity decreased after storage period at both ripening stages. Colour was predominately green in turning fruit, changing from green to orange-red as maturity increased. In general physical-chemical changes of red-mombin fruit were more dramatic in fruit harvested green than in fruit harvested ripe. The main postharvest pathogens present were *Rhizopus stolonifer* and *Alternaria* spp. To design a sound postharvest handling to export markets further study will be required considering aspects such as storage temperature and relative humidities, control of postharvest diseases, fruit packing and others.

INTRODUCTION

The red-mombin fruit (ciruela) is a widely distributed tropical tree in Mexico. A wide variety and forms of ciruela trees can be found in this country (Popenoe, 1974). The fruit, leaves and wood of this tree are utilized in many ways. Among the great diversity of genotypes of red-mombin existing in Mexico, those fruit harvested in September-November are about 5 cm long, oval to roundish and have a thin skin that can be from green to dark red depending on the ripening stage (Popenoe, 1979). The fruit is commonly consumed as fresh produce or as liquid beverages such as liquors and wines, having medicinal properties as well (Leon and Shaw, 1990). The pleasant flavour (sweet to acid) and attractive appearance when ripe suggest a potential for export marketing. In the growing areas (Morelos, Sinaloa, Nayarit and Guerrero) cultivation of this fruit has extended up to 50% (Carbajal *et al*., 1981). However, before any postharvest handling system can be implemented it is necessary to evaluate those physiological fruit attributes and pathological features that may influence fruit quality and postharvest life. The objective of this investigation was to evaluate some postharvest physical-chemical characteristics of ciruela together with microorganisms identification to initiate the establishment of an adequate postharvest system for this fruit.

MATERIALS AND METHODS

Fruit Harvesting

Fruit were collected from different commercial orchards in the state of Morelos, Mexico.

Fruit transportation

Fruit were taken to the laboratory in wooden boxes that were padded with wet paper to avoid excessive fruit transpiration. In the laboratory, fruit were classified visually in two ripening stages: 'Turning': colour green was present in more than 75% of fruit surface and 'ripe': less than 25% remained green.

Evaluation of physical-chemical attributes

Thirty fruits per stage of ripeness were selected at harvest and marked to determine mass loss during a period of four days storage at 20°C.

Firmness was measured by fruit compression (no skin removed) of each side fruit using a Chantillon penetrometer (Mod. LTC, John Chatillon & Sons Inc. New York USA). Total soluble solids (TSS) were measured on undiluted fruit juice with a hand refractometer (Model Atago N-1E 0-32%). The pH was determined with a pH meter (Corning, pH/ion Analyzer 350). Fruit acids were titrated to pH 8.2 with 0.1N NaOH and expressed as percent citric acid. Surface colour, was measured in the L* a* b* colour system with a Milton Roy Colorimeter (Colour Mate, Colour Analyzer, Milton Roy, New York USA). Measurements were taken at two side points equally spaced at the equator of each fruit. Colour values were reported as Hue angle (Hue = Tan-1 (b/a) (Tijskens and Evelo, 1994).

Assessment period

Evaluations of firmness, TSS, pH, acidity and colour were carried out in sixty fruits per ripening stage, at harvest and after four days storage period at 20°C. For all parameters averages and standard deviations were calculated. Duncan's multiple range test (P =0.05) was calculated for percentage mass loss.

Evaluation of postharvest diseases

Thirty ripen fruit were randomly selected and placed on polyurethane trays wrapped with wetting paper and enclosed in plastic bags. Fruit remained in trays at ambient temperature 20-25°C until disease symptoms were visualized (development of mycelium). To obtain pure cultures, small portions of fruit mycelium were re-isolated and subcultured in Petri plates containing Potato Dextrose Agar (PDA) (Bioxon, Becton Dickinson) and incubated (Lab-line Biotron) at 25°C. Identification was carried out once conidia developed onto the Petri plate (4-10 days). Portion of the mycelium was fixed in lactophenol acid fucsin. Optical microscope (Mod. Carl Zeiss) was used for microscopic identification.

RESULTS AND DISCUSSION

Evaluations of physical-chemical attributes

The postharvest behaviour of red-mombin fruit varied according to the ripening stage, and storage period. At both ripening stages, percentage daily

mass loss decreased over the storage period (Table 1) Turning fruit, stored for one day at ambient temperature, had the highest mass loss (P £ 0.05) while ripe fruit stored for the first three days had similar mass loss. However, in any case fruit showed severe symptoms of shrivelling. Firmness values decreased and the content of TSS increased during fruit storage of both ripening stages (Table 2). Similarly, as for many other fruits such as kiwifruit, apples, pears and others, ripe fruit compared with unripe had less firmness and higher TSS following a storage period (Crisosto *et al*., 1984; Drake 1977; Chen *et al*., 1997). pH increased after storage period at both maturity stages. Titratable acidity of the fruit showed little changes among maturity stages and storage time. pH increased from 4.5 to 5.2 in turning fruit and from 4.8 to 5.5 in ripe fruit while acidity slightly decreased from 0.8 to 0.5 and 0.5 to 0.4. Green colour was predominately present in turning fruit. During storage, turning and ripe fruit increased the Hue values remaining within ranges of 100 - 38°. As ripening and storage period proceeded fruit turned from green to orange-red. In general, in this study, the physical and chemical changes of ciruela were more dramatic in fruit harvested mature green and stored for four days than in fruit harvested ripe with similar storage period.

Evaluation of postharvest diseases

In this study, fifty percent of the fruit were rot after one week storage. *Rhizopus stolonifer* and *Alternaria* sp. were the main postharvest fungi isolated from this commodity. During storage period, both fungi spread rapidly covering the whole fruit, developing white mycelium. *Rhizopus* bearing minute spherical black spore heads, while *Alternaria*, conformed by conidia black with cross and longitudinal septa (Barnett and Hunter, 1972; Streets, 1984). The presence of these two microorganisms during transport and storage has been reported on various tropical fruits such as papaya (*Carica papaya*) and soursop (*Annona muricata*) and temperate fruits such as soft fruits and berry fruits (Snowdon, 1990; Sommer *et al*., 1992; Bautista *et al*., 1997). Associated these fungi most of the times with injuries sustained during harvesting and handling.

Table 1 Daily percentage mass loss of ciruela fruit during storage at 20°C

Ripening stage	Storage period (days)	Mass loss (%)*
Turning	1	4.07 ± 0.4[a]
	2	3.47± 0.2[b]
	3	3.08 ± 0.3[bc]
	4	2.11 ± 0.2[d]
Ripe	1	365 ± 0.3[a]
	2	3.59 ± 0.5[a]
	3	3.44 ± 0.4[a]
	4	3.00 ± 0.6[b]

*Average of 30 fruits per ripening stage. Letters a, b, c and d refer to Duncan t test (P £ 0.05)

CONCLUSIONS

Further studies are still required to achieve the objective of designing a postharvest handling system. Red-mombin fruit presented a shorter storage life when harvested ripe and kept at 20°C as indicated in the high values of solid solubles and the low firmness since fruit harvest. Results of high percentage mass loss indicate the necessity of future studies related to different storage temperatures and relative humidities. The harvesting ripening stage might depend on the fruit destiny; ripe for local markets and turning for overseas market. Mexican growers will have to adopt simple sanitation methods such as cleaning and sanitation of harvesting tools and containers to avoid such a high contamination by fungi. The proper design of harvesting tools and containers will minimize the opportunity of bruising as well and therefore less fungi infection during storage. Selection studies of various ciruela genotypes tending to reunite the best preharvest and postharvest characteristics of ciruela will be of great importance.

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Table 2 Postharvest physical-chemical characteristics of ciruela fruit harvested in two ripening stages and kept at 20°C for four days

Ripening stage*	Firmness (N)	TSS (%)	pH	Titratable acidity (%)	Hue°
Mature green:					
at harvest	30.1 ± 4.2	10.4 ± 1.6	4± 0.2	0.84 ± 0.1	100.4 ± 3.2
four days storage	9.8 ± 0.9	24.2 ± 0.9	5.6 ± 0.3	0.52 ± 0.1	59.5 ± 6.9
Ripe:					
at harvest	7.7 ± 2.3	22.7 ± 1.2	4.8 ± 0.1	0.52 ± 0.1	46.2 ± 5.6
four days storage	5 ± 0.2	25.9 ± 0.8	5.5 ± 0.2	0.44 ± 0.1	38.3 ± 5.8

*Average of 60 fruits per ripening stage
Hue°: 0 = red, 90° = yellow, 180° = green, 270° = blue

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