

PRELIMINARY RESULTS REGARDING THE POSTHARVEST PATHOLOGY OF PAWPAW (*ASIMINA TRILOBA* DUNAL) FRUITS

Elena Ștefania Ivan², Oana Alina Nițu¹, Ionuț Ovidiu JERCA², Florin STĂNICĂ¹

¹University of Agronomic Sciences and Veterinary Medicine of Bucharest,
59 Marasti Blvd, District 1, Bucharest, Romania

²Research Center for Studies of Food and Agricultural Products Quality, University of Agronomic
Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: elenamardare184@yahoo.com

Abstract

Asimina triloba, the pawpaw, is one of the few fruit tree species native to the United States. The plant is native to eastern North America, growing spontaneously from the Gulf of Mexico till the Great Lakes. The tree produces large fruits, yellow-green colour, sweet and flavored. In Romania, the first plants were introduced in Transylvania in 1926 and have been grown locally, remaining unknown to the rest of the country. Starting with the year 2000, within the Faculty of Horticulture from Bucharest, there were cultivated several varieties and hybrids of pawpaw, in order to determine the suitability of this species for the establishment of new plantations in Romania. The fruits were harvested manually and stored in controlled atmosphere rooms with 1.5% CO₂, at 4°C temperature and 90% relative humidity. During the 2 months storage period were identified several pathogens affecting the paw paw fruit. The micromycetes identification was carried out by isolation and successive subculture on PDA medium culture (Potato Dextrose Agar), followed by incubation at 22°C in the thermostated chamber.

Key words: *Asimina triloba*, storage pathogens, postharvest.

INTRODUCTION

The fruits are rich in active ingredients, vitamins and minerals. The fruits have an excellent exotic taste, that evolves during the storage from the taste of vanilla cream at crème brûlée, and finally, to chocolate cream taste.

Asimina triloba (L. Dunal), is part of the family *Annonaceae* being known in North America - its area of origin, as pawpaw (Stanica, F. et al., 2008). The genus includes the largest edible fruits originating in North America (Darrow, 1975). It is a large, thin, leathery fruit with two rows of almond-sized seeds. Its shape can vary from oval to elongated, peanut-shaped and can vary between 3 and 6 mm in length (McGrath M., 1994). Of the approximately 2300 species and 130 genera in the *Annonaceae* family, only the genus *Asimina* grows in temperate climates. All other genera of the family *Annonaceae* grow in the tropics. In south-eastern Florida and Georgia there are eight species of the genus *Asimina*: *Asimina angustifolia* Raf. - pawpaw with narrow leaves, *Asimina incana* (W. Bartram)- pawpaw with wool, *Asimina obovata* (Willd.) Nash - pawpaw with large flowers,

Asimina parviflora (Michx.) Dunal - pawpaw with small flowers, *Asimina pygmaea* (W. Bartram) Dunal - pawpaw dwarf, *Asimina reticulata* Shuttlw. ex. Chapman - Netted pawpaw, *Asimina tetramera* Small- pawpaw with four petals, *Asimina triloba* (L.) Dunal - Common pawpaw (Callaway, 1993).

Pawpaw grows at the edge of forests and is noted for its high frost resistance, surviving winters at -25-30°C, however, it is grown as an orchard crop in several states, including Alabama, California, Maryland, Michigan, Missouri., North Carolina, Kentucky, West Virginia, and Ohio. It has also been planted in Italy, China, Japan, Israel, Belgium, Portugal and Romania (Brannan, R. G et al., 2015). In Romania, it was introduced around 1900 in Pianu Nou, Alba County, by an emigrant returning from America. From there, some plants arrived in the locality of Geoagiu, where they are still found in the present of some locals (Stănică F. et.al., 2004).

In 2000, at the Faculty of Horticulture in Bucharest, 7 varieties and 3 hybrids of *Asimina triloba* (L.) Dunal imported from Italy were introduced, with which three collections were

established. One collection exists within the Bucharest Faculty of Horticulture, and the other two collections are in private gardens in Argeş and Ilfov counties (Stănică F., 2002; Stănică F. et al., 2004; Stănică F., 2012). Today, the northern banana is one of the most exotic plants that have been acclimatized in Romania with a huge potential on the domestic market, especially due to the special taste of vanilla and chocolate. Pawpaw fruits have a special taste, are rich in nutrients, dietary fiber, protein, minerals and vitamin C, they can be used as ornamental and medicinal species (Layne, D.R., 1996; Picchioni, G.A. et al., 2004; Pomper, K.W. et al., 2002; Pomper and Layne, 2005).

The harvest season for pawpaw fruit is from mid-August to the end of September. A color change often occurs later in the ripening period. On the other hand, a decrease in fruit firmness is relatively obvious and a detectable indicator of maturity (Pomper et al., 2008). It is also recommended to harvest the fruits during the early ripening period, in order to increase the storage time (Archbold et al., 2003; Pomper & Layne, 2005; Szilagy B.A., 2015).

In Bucharest, the fruits of *Asimina triloba* (L.) Dunal ripen only at the beginning of October (Cepoiu N. et al., 2003).

During ripening, the loss of firmness is extremely fast, the fruits soften quickly, at ambient temperature and this can be an obstacle in the development of a wider development market (Galii et al., 2008).

Monilinia spp. is the plant pathogen responsible for the occurrence of grey mold and fruit rot in stone fruits species, and it is present in all cultivated areas (Cristea S. et al., 2017)

Agricultural production is vulnerable to contamination and infection with various microorganisms during storage and the safety of agri-food products can be achieved by maintaining climatic factors in the stored areas, thus limiting the population level of contaminating microorganisms. The most common genera of fungi identified in storage room are *Aspergillus*, *Penicillium* and *Fusarium* (Dudoiu, R. et al., 2016)

Micromycetes' development on storage room is conditioned by temperature and atmospheric humidity present in stored areas and by its fluctuations in time (Cristea S., 2004)

The results showed that Romanian natural conditions are suitable for growing this species as one of the most exotic plants that were ever acclimated in Romania. The pawpaw has an huge potential on the domestic market.

MATERIALS AND METHODS

The present paper presents the results of research conducted between 2016-2017, a period in which no phytosanitary treatments have been applied, the plants proving their suitability to the organic production systems. Research has sought to identify the presence of mycoflora on the fruits of *Asimina triloba* (L.). The biological material consisted of samples of pawpaw fruit, stored in the room with a controlled atmosphere, from which samples were taken for analysis. The fruits were harvested by hand and stored in rooms with a controlled atmosphere with 1.5% CO₂ at 4°C and a relative humidity of 90%.

The samples were taken immediately after collection and stored for 60 days. The batch sampling was performed on three levels, respectively the base, the middle and the upper surface, then a sample of 100 fruits was constituted (Chira L., 2008).

PDA culture medium was used to isolate and identify microorganisms associated with the disintegration of pawpaw fruits.

The fruits were washed from the ground with tap water and finally rinsed with sterile water. No pesticides have been used as they can also affect pathogenic fungi. Since the aim was to isolate the fungi that spore on the surface, the introduction of the samples in the humid chamber was preceded by a day or two (Severin, V et al., 2009).

Segments of 1-2 mm of tissue from the edge of the affected area are passed, with the help of a sterile scalpel and a repeating needle, in Petri dishes with a diameter of 70 mm, on the PDA culture medium. The vessels were incubated at 22°C for 9 days. Observations were made at 3, 6 and 9 days. The Euromex stereo microscope and the Euromex Ox Range microscope were used to identify fungi, based on the scientific literature (Raicu C., 1978; Hulea A., et al., 1986; Hulea A., 1969)

RESULTS AND DISCUSSIONS

Studying the spectrum of pathogens on the fruits of the "northern banana" it was found that the mycoflora present in the analyzed samples was composed of fungal species belonging to the genera *Alternaria* spp., *Verticillium* spp., *Penicillium* spp., *Fusarium* spp. and *Monilinia* spp. (Table 1).

The analysis of the 2016 samples shows that the fruits from the studied genotypes showed fructifications of the micromycetes *Alternaria* spp., *Verticillium* spp., *Penicillium* spp., *Fusarium* spp. and *Monilinia* spp.

In the samples of pawpaw fruits, from the 2016 harvest, micromycetes belonging to the genera *Alternaria* spp., *Verticillium* spp., *Penicillium* spp., *Fusarium* spp. and *Monilinia* spp. Were identified were detected on the analyzed genotype R2P3, and the fungus *Alternaria* spp. was present on the skin of genotype R1P2, R2P3. The pathogen *Penicillium* spp. was identified on the genotypes R1P8, R2P1, R2P3, 10344, 10836. The fungus *Fusarium* spp. was present on the genotypes R2P1, R2P3, 10836 (Table 2).

Table 1. Mycoflora detected on pawpaw fruits

Genotypes	The pathogen agent				
	<i>Alternaria</i> spp.	<i>Verticillium</i> spp.	<i>Monilinia</i> spp.	<i>Penicillium</i> spp.	<i>Fusarium</i> spp.
R1P2	+	+	+	-	-
R1P8	-	-	-	+	-
R2P1	-	-	+	+	+
R2P3	+	+	+	+	+
10344	-	-	+	+	-
10836	-	-	+	+	+

Table 2. Incidence of mycoflora detected on pawpaw fruits expressed as a percentage (2016)

Genotypes	The pathogen agent (after 9 days)				
	<i>Alternaria</i> spp.	<i>Verticillium</i> spp.	<i>Monilinia</i> spp.	<i>Penicillium</i> spp.	<i>Fusarium</i> spp.
R1P2	70	10	20	-	-
R1P8	-	-	-	100	-
R2P1	-	-	45	20	35
R2P3	10	4	66	17	3
10344	-	-	56	44	-
10836	-	-	35	48	7

Micromycetes of the genus *Monilinia* spp. were identified on genotypes R1P2, R2P1, R2P3, 10344 and 10836.

Observations made on the incidence of mycoflora detected on "northern banana" fruits in 2016 show that the micromycete *Alternaria* spp., present on genotypes R1P2, R2P3, had the highest frequency value, in the variety R1P2 with F = 70%.

Pathogens of the genus *Monilinia* spp, showed the highest incidence values in the variety R2P3 with 66%, 10344 (56%) and R2P1 with 45%. The lowest incidence value was noted in the R1P2 genotype (20%).

In the analyzed samples, the micromycete *Penicillium* spp. was identified on the genotypes R1P8, R2P1, 10836, 10344, R2P3, with frequency values of 100%, 48%, 44% and F = 17%, respectively.

The results showed that *Alternaria* spp., *Verticillium* spp., *Penicillium* spp., *Fusarium* spp. and *Monilinia* spp. were found with pawpaw fruits studied. All five isolated organisms were confirmed to be pathogenic on pawpaw fruits, but in different percentages. Gupta and Pathak (1986) previously reported that pathogens were responsible for post-harvest pawpaw losses in southwestern Nigeria.

CONCLUSIONS

Research has shown that fruit rot and the development of pathogens depend on various factors. The optimum temperature range for the development of pathogenic fungi was 22° C. Isolation of these pathogens confirmed the studies of Baiyewu and Amusa (1999),

Baiyewu et al. (2007), Gupta and Pathak (1986).

REFERENCES

- Archbold, D. D., Koslanund, R., & Pomper, K. W. (2003). Ripening and postharvest storage of pawpaw. *Hort Technology*, 13(3), 439-441.
- Baiyewu, R. A., & Amusa, N. A. (1999). Biochemical Changes in pawpaw fruits infected with fungi. *Bioscience Research Communications*, 11(3), 257-261.
- Baiyewu, R. A., Amusa, N. A., & Ayoola, O. A. O. (2007). Survey of the post harvest diseases and aflatoxin contamination of marketed pawpaw fruit (*Carica papaya* L.) in South Western Nigeria. *Afr. J. Agric. Res.*, (2), 178-181.
- Brannan, R. G., Peters, T., & Talcott, S. T. (2015). Phytochemical analysis of ten varieties of pawpaw (*Asimina triloba* [L.] Dunal) fruit pulp. *Food chemistry*, 168, 656-661.
- Brannan, R. G., Peters, T., & Talcott, S. T. (2015). Phytochemical analysis of ten varieties of pawpaw (*Asimina triloba* [L.] Dunal) fruit pulp. *Food chemistry*, (168), 656-661.
- Callaway, M. B. (1992). Current research for the commercial development of pawpaw [*Asimina triloba* (L.) Dunal]. *Hort Science*, 27(2), 90-191.
- Cepoiu, N., Roșu, A., Dănăilă-G, S., & Păun, C. (2003). *Asimina* o specie pomicolă de viitor pentru români. *Agricultorul roman*, (10), 58.
- Chira L., 2008. Controlul calității fructelor. (Fruit quality control). Editura Ceres, București, pp. 95.
- Constantinescu O. (1974). Metode și tehnici în micologie (Methods and techniques in mycology). Ed. Ceres, București.
- Cristea S., Oprea M., Cristea M.C., Braileanu B. (2004). Cercetari privind parametrii biologici ai ciupercii *Fusarium graminearum* izolate de pe semintele de porumb. *Lucrari stiintifice, Seria A, Vol. XLVII, Agronomie*, p. 291-294.
- Cristea, S., Manole, M. S., Zala, C., Jurcoane, S., Dănăilă-Guidea, S., Matei, F., ... & Olariu, L. (2017). *In vitro* antifungal activity of some steroidal glycoalkaloids on *Monilinia* spp. *Romanian Biotechnological Letters*, 22(5), 12972.
- Darrow, G. M. (1975). Minor temperate fruits. *Advances in Fruit Breeding*. J. Janick & JN Moore, eds.
- Dănăilă-Guidea, Silvana (2004). Paw-paw (*Asimina triloba* L. Dunal) o specie pomicolă cu reale perspective pentru România. *Hortinform*, 11(147), 25-28
- Dudoiu, R., Cristea, S., Lupu, C., Popa, D., & Oprea, M. (2016). Micoflora associated with maize grains during storage period. *Agrolife Scientific Journal*, 5(1), 63-58.
- Galli, F., Archbold, D. D., & Pomper, K. W. (2008). Loss of ripening capacity of pawpaw fruit with extended cold storage. *Journal of agricultural and food chemistry*, 56(22), 10683-10688.
- Gupta, A. K., & Pathak, V. N. (1986). Survey of fruit markets for papaya fruit rots by fungal pathogens. *Indian Journal of Mycology and Plant Pathology*, 16(2), 152-154.
- Hulea A. (1969). Ghid pentru laboratoarele de micologie și bacteriologie. Ed. Agrosilvică, Bucuresti.
- Hulea A., Iliescu P. (1986). Determinator pentru identificarea mucegaiurilor potential toxigene (A guide for toxicigen molds determination). Societatea de Medicină Veterinară din R.S. România, București.
- Layne, D. R. (1996). The pawpaw [*Asimina triloba* (L.) Dunal]: A new fruit crop for Kentucky and the United States. *HortScience*, 31(5), 777-784.
- McGrath, M. J., & Karahadian, C. (1994). Evaluation of physical, chemical, and sensory properties of pawpaw fruit (*Asimina triloba*) as indicators of ripeness. *Journal of Agricultural and Food Chemistry*, 42(4), 968-974.
- Picchioni, G. A., Graham, C. J., & Ulery, A. L. (2004). Gypsum effects on growth and macroelement uptake of field-grown *Asimina triloba* (pawpaw) irrigated with low-saline, sodic water. *HortScience*, 39(5), 1104-1109.
- Pomper, K. W., & Layne, D. R. (2005). The North American pawpaw: botany and horticulture. *Horticultural Reviews*, 31, 351-384.
- Pomper, K. W., & Layne, D. R. (2005). The North American pawpaw: botany and horticulture. *Horticultural Reviews*, 31, 351-384.
- Pomper, K. W., Crabtree, S. B., Layne, D. R., & Peterson, R. N. (2008). Flowering and fruiting characteristics of eight pawpaw [*Asimina triloba* (L.) Dunal] selections in Kentucky. *Journal of the American Pomological Society*, 62(3), 89-97.
- Pomper, K. W., Layne, D. R., Jones, S. C., & Kwantes, M. G. (2002). Growth enhancement of container-grown pawpaw seedlings as influenced by media type, root-zone temperature, and fertilization regime. *HortScience*, 37(2), 329-333.
- Raicu Cristina, Baciui Doina (1978). Patologia seminței. Editura Ceres, București, pp.105-106.
- Severin, V., & Cornea, C. P. (2009). Ghid pentru diagnoza bolilor plantelor. Editura Ceres, București, pp. 195-196.
- Stănică F., (2012). *Asimina triloba* (pawpaw) germplasm in Romania. Scientific Papers, Series B. Horticulture. (LVI), 267-272.
- Stănică, F., Cotrut, R., & Zuccherelli, G. (2008). New selections of pawpaw (*Asimina triloba* (L.) Dunal). *Acta horticulturae*.
- Stănică, Fl. (2002). Banana nordului o nouă specie pomicolă în România, Rev. Căminul, Casa de vacanță, nr. 4. Editura Casa Lux Ltd., București.
- Stănică, Fl., Ghena, N., Dănăilă-Guidea, Silvana and Cotruț, Ramona (2004). Preliminary results regarding the propagation by grafting of Northern banana *Asimina triloba* (L.) Dunal, Scientific Papers USAMV, B Series, Horticulture, (XLVII), Invel Multimedia, București.
- Szilagyí Beatrice Agneta, Roșcan Mare Oana, Dănăilă-Guidea, Silvana Mihaela (2015). Potențialul ecopeisagistic al spațiilor verzi intravilane din municipiul Baia Mare Maramureș - Editura Ex Terra Aurum - București Editura Invel-Multimedia-Otopeni.

Szilagyı, B. A., Mare-Roşca, O., Dumitru, Z., Dănăilă-Guidea, S. M., Marian, M., Mihalescu, L., & Voşgan, Z. (2015). The Culture Of *Asimina Triloba* (L.) Dunal Seedlings With A View Toward Their Development As Planting Material. *Current Trends in Natural Sciences*, Vol. 4(7), 23-31.

Szilagyı, B., & Marian, M. (2011). Morphological And Physiological Features Of The Species *Asimina Triloba* (L.) Dunal, Introduced As An Ornamental Plant In Baia Mare (Maramureş County, Romania). *Analele Universitatii din Oradea, Fascicula Biologie*, 18(2).

