Diseases Caused by Fungi and Fungus-Like Organisms

First Report of *Mucor irregularis* Causing Postharvest Fruit Rot on *Garcinia mangostana* in China

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Mangosteen (*Garcinia mangostana* L.) is an evergreen fruit tree grown in Southeast Asia. The fruit of Mangosteen is spherical and dark purple with a diameter of 5 to 8 cm, a hard rind, and white flesh. The seeds and pericarps of the fruit have long been utilized as a traditional medicine in Southeast Asia (Ovalle-Magallanes et al. 2017). Surveys were conducted from March to April 2019 in fruit markets in Wujing Town, Shanghai (31°02'33" N, 121°28'04" E), and one noteworthy postharvest disease was observed. Overall, 116 fruit samples were collected from five different supermarkets; 10.3% (12) of the fruits were found infected with the same symptoms during cold storage. The infected fruits were subjected to pathogen isolation and characterization. The junction areas between diseased and healthy tissues were cut into small pieces 5 mm in diameter, which were surface sterilized with 0.5% NaClO solution for 3 min, followed by rinsing in sterile water three times, and then placed on sterilized potato dextrose agar (PDA) plates supplemented with 50 µg/ml streptomycin. The colony edges of the resulting fungal cultures were cut and moved to new PDA plates for purification after 2 days incubation at 28°C. After three rounds of subculture, a total of 19 purified isolates were obtained, which showed similar phenotypes in morphological characters. The fungal colonies were fast growing (25 mm per day at 28°C on PDA plates) and were circular with massive aerial hyphae, white to ochraceous in color. Nonseptate hyphae were hyaline and the septa were found only at the branching points. Sporangiophores arose from hyphae or from stolons.

Sporangiospores were hyaline, smooth-walled, mostly subspherical to ellipsoidal, and measured 1.34 to 2.73 µm (width) and 3.12 to 6.19 µm (length) ($1.98 \pm 0.36 \times 4.46 \pm 0.69$, $n = 100$) (Álvarez et al. 2011). Three independent isolates (GM-07, GM-16, GM-19) were selected for further genetic analysis and pathogenicity tests. The internal transcribed spacer (ITS) and the D1/D2 region of the nuclear large subunit ribosomal RNA gene (LSU) were amplified by primers ITS1/ITS4 and NL1/LR3, respectively (Walther et al. 2013). BLASTn analyses of ITS (MN081612, MN081613, MN087659) and LSU (MN080423, MN080422, MN080432) sequences exhibited 99 to 100% identity to *Mucor irregularis* strains HZ640, extr25, and CBS977.68 (accession nos. KC461926 and MH510278 of ITS and JX976214 of LSU). These morphological features and molecular identification indicated that the pathogen possessed identical characteristics as *M. irregularis* Stchigel, Cano, Guarro & Ed. Alvarez (Álvarez et al. 2011). To conduct a pathogenicity test (Al-Sadi et al. 2014), 20 µl of spore suspension (10^6 spores/ml) were inoculated into five healthy mangosteen fruits by sterile syringes, while another five healthy fruits were injected with sterilized water as controls. All inoculated fruits were kept in sealed plastic boxes at 28°C with a 12/12 h light/dark illumination cycle and 90% relative humidity. After about 3 to 7 days, the inoculated materials showed similar symptoms to those on the original diseased fruits, while control samples remained symptomless. *M. irregularis* was successfully reisolated from symptomatic fruits, fulfilling Koch's postulates. Only three plant species that can be infected by *M. irregularis* have been reported so far, including key lime from Oman (Al-Sadi et al. 2014), corn from China (Peng et al. 2015), and sorghum from Brazil (Lima et al. 2018). To our knowledge, this is the first report of *M. irregularis* causing postharvest rot on mangosteen fruit in China.

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