Penicillium albocoremium, a new taxon from tulip bulbs in Iran

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In recent years, tulip flowers have been grown extensively in parks and green spaces of Urmia city (NW Iran). During the surveys in a period from 2014–16, characteristic symptoms of the blue mold rot were observed on both planted and stored tulip bulbs, as the bulbs were covered with a white to bluish-green mycelia and spores. In order to determine the fungi associated with tulip bulbs (*Tulipa gesneriana* L.), the bulbs with characteristic rot symptoms or signs (Fig. 1a-c) were collected from different green spaces and municipal greenhouses. The fungi were isolated in two ways: First, small pieces of fungal colonies were taken with a sterile fine needle and a suspension of spores was prepared in sterile distilled water. A small aliquot of suspension was spread all over the PDA medium amended with streptomycin sulfate. Second, the bulbs were washed thoroughly under tap water, then surface sterilized in 0.5% sodium hypochlorite solution for 10 minutes and washed for three times again with sterile distilled water. The outer parts of the bulbs were removed and small pieces were taken from the inner parts and put on PDA medium (Kim *et al*. 2006, Valdez *et al*. 2009). Petri dishes were incubated at 25±2° C in dark. The isolated fungi were purified using single spore method and the purified isolates were stored on PCA slants at 4° C. From the 40 obtained isolates, except three which were belonged to the genus *Rhizopus*, the remaining isolates had typical characteristics of the genus *Penicillium*. For morphological characterization, the purified isolates were three points inoculated onto malt extract agar (MEA), Czapek's agar (CZ), Czapek yeast autolysate agar (CYA) and yeast extract sucrose agar (YES), and incubated for seven days in dark at 25° C. Colony colors were determined based on Rayner's (1970) color chart. Lactic acid was used as a mounting fluid and a drop of 75% ethanol was added to remove excess conidia. Measurements of all parameters were made at ×1000 magnification using Olympus AF1 microscope, with 30 measurements per structure.

Based on morphological studies, all the isolates were identified as *Penicillium albocoremium* (Frisvad) Frisvad (Visagie *et al*. 2014, Houbraken & Samson 2011, Kim *et al*. 2006, Overy *et al*. 2005, Frisvad & Samson 2004, Overy & Frisvad 2003). To the best of our knowledge, this is the first report of this species from Iran. A representative isolate (Pen081), was deposited under IRAN 2425C in the Iranian Fungal Culture Collection at the Iranian Research Institute of Plant Protection (Tehran, Iran). A description of the fungus is given bellow:

Colony on CZ reaching 34 mm diam., with fasciculate growth, center umbonate and with 8–11 radially sulcae; margin entire, mycelium white; sporulation dense, in bluish-green shades; exudates abundant, pure yellow; soluble pigments present, apricot in color; sclerotia absent; reverse scarlet. Colony on CYA reaching 45 mm diam., lanose to fasciculate, with 9–14 radially sulcae; mycelium white; sporulation dense; in dark green shades; exudates sparse, sulphur yellow; soluble pigments absent; sclerotia absent; reverse apricot in center and pale luteus at margins. Colony on MEA reaching 43 mm diam., lanose to fasciculate; mycelium white, plane, without radial sulcae, center umbonate; sporulation dense, in greenish shades, giving a granular appearance to the colony surface; exudates moderate, orange; soluble pigments absent; sclerotia absent; reverse light orange in center and yellow at margins. Colony on YES reaching 40 mm diam., lanose to fasciculate; with 16–21 radial sulcae; mycelium white; sporulation dense, in greenish-green shades; exudates mainly produced at center, clear sulphur yellow; soluble pigments absent; sclerotia absent; reverse brownish-yellow at center to pale yellow at margins (Fig. 1 d-k). Conidiophores treverticillate, rarely quarterverticillate, more or less aggregated into definite fascicles; phialides flask-shaped, with short necks, smooth-walled, (7–)8–11(–25) (1.5–)2–2.5(–4) µm; metulae cylindrical, apically inflated, rough- or smooth-walled, (2–)9.5–11.5(–16) × 3–4 µm; ramuli cylindrical, apically inflated, rough-walled, (10–)15–18(–32) × (2–)2.5–3(–4) µm; rami cylindrical, rough-walled, 20–28 × 3–4 µm; stipes rough-walled, 3.5–4.5 × 170–2000 µm; conidia smooth-walled, globose to subglobose, 2–3(–5) µm (Fig. 1 l-n).

This species has been reported from edible and/or ornamental bulbs such as *Allium* spp., *Chrysanthemum* sp., *Iris* × *hollandica*, *Lilium longiflorum* Thumb., and *Tulipa* sp., mainly as a pathogen, from the roots of *Apium graveolens* L., *Petroselinum crispum* Mill., *Zingiber officinale* Roscoe, and on *Glycyrrhiza* sp., *Brassica oleracea* L., *Fragaria vesca* L., *Helianthus tuberosus* L., cake, salami, indoor air and in a saltern in Denmark, Germany, Korea, the Netherlands and USA (Overy & Frisvad 2003, Frisvad & Samson 2004, Kim *et al*. 2006, Dugan *et al*. 2017).

Penicillium albocoremium has micro-morphological resemblance especially in dimensions of conidia, phialides, metula, ramuli, rami and stipes as well as conidiophore branching pattern with *Penicillium tulipae*, and *P. radicicola*, but it could be distinguished based on wall ornamentation of the stipes, fasciculation, colony reverse color on CYA and YES media and also abundant sporulation on YES (Frisvad & Samson 2004).

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