

## Soft Rot of Tomato Caused by *Mucor racemosus* in Korea

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A soft rot of fruits caused by *Mucor racemosus* occurred on cherry tomato collected in Agricultural Products Wholesale Market in Jinju, Korea. The disease infection usually occurred wounded areas after cracking of fruits. At first, the lesions started with water soaked and rapidly softened and diseased lesion gradually expanded. Colonies were white to brownish to gray in color. Sporangia were 32–54  $\mu\text{m}$  in size and globose in shape. Sporangioophores were 8–14  $\mu\text{m}$  in width. Sporangiospores were 5–12  $\times$  4–8  $\mu\text{m}$  in size, ellipsoidal to subglobose in shape. Columella was 27–42  $\mu\text{m}$  in size, obovoid, ellipsoidal, cylindrical-ellipsoidal, slightly pyriform in shape. Chlamydospores were numerous in sporangioophores and barrel-shaped when young, subglobose in old cultures. Optimum growth temperature was about 25°C. The fungus was identified as *M. racemosus* Fres.. This is the first report of soft rot on cherry tomato caused by *M. racemosus* in Korea.

**KEYWORDS:** Cherry tomato, *Mucor racemosus*, Soft rot

*Mucor* mainly occurs during sale after harvest, transports, market shelf and storage when moisture conditions are favorable. The soft rot on the succulent, fleshy fruits and vegetables, cut flowers, bulbs and corms are often affected by postharvest diseases (Agrios, 1997). *Mucor* is omnipresent as a saprophyte and sometimes as a weak parasite on stored organs of plants. When the epidermal cells are collapsed, the fungus emerges through the wounds, fruit drop, step on fruits and cracks of matured fruits of cherry tomato, and produces aerial sporangioophores and sporangia.

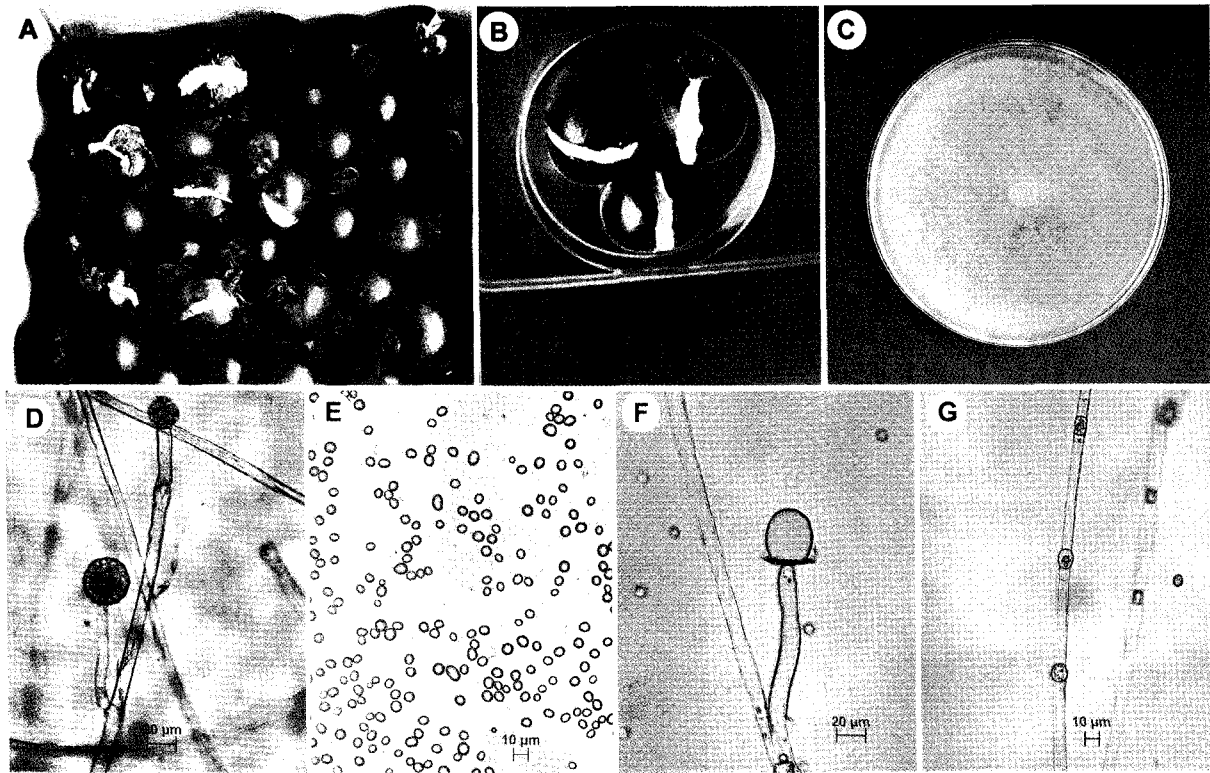
**Disease occurrence.** Diseased fruits were collected from cherry tomato (cv. Pepe) in the containers in the spring of 2002. A disease suspected as *Mucor* soft rot occurred on cherry tomato (*Lycopersicon esculentum*) in Agricultural Products Wholesale Market in Jinju. Recently, the fungus was occurred from cherry tomato (cv. Suncherry) in the box after postharvest in the April of 2005. The fungus attacked only dropping fruits in the field or cracks of matured fruits of cherry tomato (Fig. 1A), but not occurred young and immature ones. The infected parts of cracks on matured fruits appeared water soaked at first, then became soften. White hyphae grew from the site where the fungus invaded primarily and covered the affected portions by producing tuft brownish to gray sporangioophores and sporangia. The infected tissues finally were broken down and disintegrated in watery rot. The bush growth of the fungus often extends to the surface of the healthy portions of affected fruits and even to the sur-

face of the containers. The fungus emerged through the wounds and produces aerial sporangioophores sporangia. The causal organism was isolated from mycelial tips on the diseased fruits.

**Mycological characteristics.** The fungal colonies grown on potato dextrose agar at 25°C were white at first to brownish to gray with age, and became heavily speckled with the appearance of sporangia (Fig. 1C). Sporangia were 32–54  $\mu\text{m}$  in size and became brownish to gray at maturity. The sporangia contained thousands of ellipsoidal to subglobose sporangiospores. Sporangioophores were 8–14  $\mu\text{m}$  in size and short branches sometimes recurved, with encrusted walls, globose in shape (Fig. 1D). Sporangiospores were 5–12  $\times$  4–8  $\mu\text{m}$  in size and broadly ellipsoidal to subglobose, smooth walled, grayish in color (Fig. 1E). Most of the sporangiospores were appeared to be readily dispersed in the air. Numerous sporangiospores were produced on the diseased fruits. Columella was 27  $\times$  42  $\mu\text{m}$  variable in size and obovoid, ellipsoidal, cylindrical-ellipsoidal, slightly pyriform, usually with truncate base and light brown in color (Fig. 1F, Table 1). Chlamydospores were numerous in sporangioophores and barrel-shaped when young, subglobose in old cultures, yellowish in color and 8–18  $\mu\text{m}$  in size (Fig. 1G). Zygosporangia were not measured on potato dextrose agar media culture. The maximum temperature for mycelial growth of the fungus was 30°C, minimum temperature was 5°C, optimum growth temperature was 25°C (Fig. 2).

Most characteristics of the fungus examined in this study were almost identical to *M. racemosus* described by the previous workers (Gobayashi, 1992; Lunn, 1977;

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**Fig. 1.** Symptoms of soft rot on cherry tomato and mycological characteristics of the pathogenic fungus *Mucor racemosus*. A: Symptoms started from the cracks of fruits in the box postharvest, B: Artificially inoculated fruits after 3 days inoculation, C: Mycelial growth on PDA after 7 days, D: Sporangium and sporangiophore, E: Sporangiospores, F: Columella, G: Chlamydospores.

**Table 1.** Comparison of morphological characteristics of the pathogenic fungus isolated from soft rot of cherry tomato with *Mucor racemosus* described previously

Characteristics	Present isolate	Sarbhoy (1966)	Schipper (1976)
Colony			
color	brownish to gray	yellowish brown	white to brownish-grey
Sporangiophores			
shape	short branches, recurved, encrusted walls	branched irregularly in group	short branches, recurved, encrusted walls
size	8~14 $\mu\text{m}$	10~20 $\mu\text{m}$	-
Sporangia			
color	brownish to gray	yellow to yellowish brown at maturity	brownish to grey
shape	globose	globose	-
size	32~54 $\mu\text{m}$	18~70 $\mu\text{m}$	70~80 $\mu\text{m}$
Columella			
shape	obovoid, ellipsoidal, cylindrical-ellipsoidal, slightly pyriform, truncate base	globose to ovoid or cuneate to campanulate	obovoid, ellipsoidal, cylindrical-ellipsoidal, slightly pyriform, truncate base
size	27~42 $\mu\text{m}$	14~60 $\times$ 10~30 $\mu\text{m}$	37~55 $\mu\text{m}$
Sporangiospores			
shape	ellipsoidal to subglobose	oval to elliptical	ellipsoidal to subglobose
size	5~12 $\times$ 4~8 $\mu\text{m}$	5.5~7.5 $\times$ 4.5~9 $\mu\text{m}$	5.5~8.5 $\times$ 4~7 $\mu\text{m}$
Zygosporos			
shape	not measured	globose	globose or subglobose
size	not measured	70~85 $\mu\text{m}$	110 $\mu\text{m}$

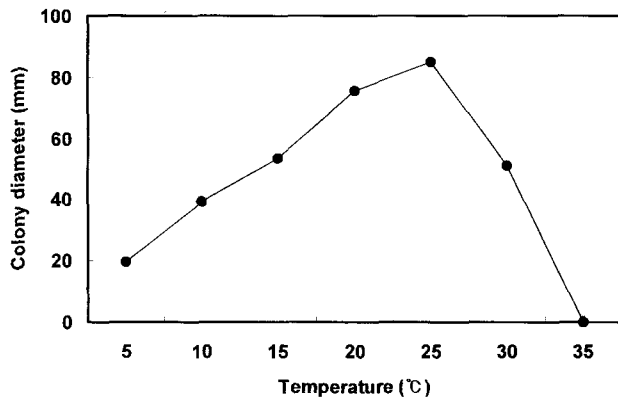


Fig. 2. Effect of temperature on the mycelial growth of *Mucor racemosus*, the causal organism of soft rot of cherry tomato. Linear mycelial growth was measured 50 hours after incubation on PDA. Data are means of three replications.

Samson *et al.*, 2000; Sarbhoy, 1966; Schipper, 1976). Accordingly, we identified the causal fungus of soft rot of cherry tomato as *M. racemosus* Fresenius.

**Pathogenicity test.** The conidial suspension of 100 ml was sprayed to cracked fruits in matured. Inoculated fruits were placed in a humid chamber with 100% relative humidity at 25°C for 24 hours. The typical symptoms on cherry tomato (cv. Suncherry) were appeared at 3 days after inoculation in plastic fruit container (29 × 22 × 14 cm) (Fig. 1B). The disease infection usually started from cracked parts of matured fruits. The symptoms were identical to those of naturally infected tomatoes. Morphological characteristics of conidia and mycelia of the fungi that were reisolated from inoculated fruits were same as those of naturally infected fruits confirming Koch's postulation. Farr *et al.* (1995) have reported *M. circinelloides*, *M. hiemalis*, and *Mucor* sp. on tomato.

The soft rot disease caused by *Mucor* sp. has been reported in *Panax ginseng* in Korea (The Korean Society of Plant Pathology, 2004), but no records in tomato. Generally, cherry tomato is cultivated by forcing culture or semi-forcing culture in greenhouses near to urban area where normal temperature and humid condition were kept. Such environments are favorable for occurring *Mucor* soft rot of cherry tomato. Many of the postharvest diseases of fruits, vegetables, grains, and legumes are the results of infection by the pathogens in the field (Agrios, 1997). The world-wide distribution of *Mucor* was ranged in soil, dung, food, seeds of wheat, barley, rice, tomatoes, tea, groundnuts and animals (Schipper, 1976).

The type culture of the fungus is stored at the Korean Agricultural Culture Collection (KACC No. 41012), National Institute of Agricultural Biotechnology, Rural Development Administration, Suwon, Korea.

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