Antifungal compounds produce by *Rhodotorula glutinis* and applications as biocontrol

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**ABSTRACT**

Yeasts have been receiving great attention in science and industry for over one hundred years because they can produce many kinds of bioactive substances. However, little is known about the bioactive substances of yeasts. In recent years, it has been found that *Rhodotorula glutinis* yeast have wide applications as biocontrol and other fields. One of the main characteristics shared among *Bacillus* strains is the ability to produce a wide range of antimicrobial compounds active against bacteria and fungi. Even though microbial control exerted by these metabolites was demonstrated in plant environments, few reports focused their attention on how these compounds can interact with food microbiota. Therefore, *Rhodotorula glutinis* yeast, and the applications of yeasts themselves and the bioactive substances they produced are reviewed in this paper.

**Key words:**

**Introduction**

Biological control of plant pathogens by antagonistic microorganisms is a potential non-chemical means and is known to be a cheap and effective eco-friendly method for the management of crop diseases. The use of biological control agents as an alternative to fungicides is increasing rapidly in the present day agriculture due to the deleterious effects of chemical pesticides. Because yeasts can produce many bioactive substances, such as protein, amino acids, vitamin, polysaccharide, fatty acid, phospholipid, polyamine, astaxanthin, carotenoid, trehalose, glutathione, superoxide dismutase, chitinase, amylase, phytase, protease, killer toxin and so on, they have been receiving much attention for many decades. Red yeasts are ubiquitous microorganisms. They occur in soil, fresh and marine water, on plants, are commonly associated with animals and are also found frequently in man-made habitats such as foods [9]. The environment presents for yeasts a source of nutrients and forms space for their growth and metabolism.

*Rhodotorula* is a pigmented yeast, part of the Basidiomycota phylum, quite easily identifiable by distinctive orange/red colonies when grown on SDA (Sabouraud's Dextrose Agar). This distinctive colour is the result of pigments that the yeast creates to block out certain wavelengths of light that would otherwise be damaging to the cell. Colony colour can vary from being cream coloured to orange/red/pink or yellow.

Members of the genus *Rhodotorula glutinis* have long been known for their potential to reduce the plant disease caused by fungal pathogens and they have gained considerable importance as potential antagonistic microorganisms. Recently, an antagonistic yeast strain of *Rhodotorula glutinis* have been reported as an effective biocontrol agent (in vivo) against postharvest decay of fruits and vegetables [7,10]. *R. glutinis* 5 3 107 cells per ml in combination with 2% Silicon was the most effective among all treatments in controlling blue mold and black mold rot (caused by *A. alternata*) in jujube fruits stored at 20°C.

The potential of using *Rhodotorula glutinis* alone or in combination with salicylic acid (SA) for the control of postharvest Rhizopus rot of strawberries, and their effects on enzyme activities of fruits were investigated. The combination of *R. glutinis* (10-18 CFU ml-1) with SA (1 ug ml-1) resulted in a significant reduction in the disease incidence and lesion diameter of Rhizopus rot on the strawberry fruits at 2 Â°C and 4 Â°C, and more so than with SA or yeast alone. SA at the concentration of 1-1 ug ml-1 significantly inhibited spore germination of *Rhizopus stolonifer*. 1 ug ml-1 of SA. Moreover, the yeast strain of *Rhodotorula glutinis* and its autoploidy have been reported as an effective biocontrol agent (in vivo) and (in vivo) against grey mould of greenhouse sweet pepper [5].

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In a postharvest system, Calvente et al. [2,3] reported that iron sequestration by a siderophore, rhodotorulic acid, produced by the yeast *Rhodotorula glutinis*, is responsible for biocontrol of
**Penicillium expansum** on apples. The addition of the siderophore to the antagonist suspension further increased biocontrol of blue mold on apples, whereas the addition of iron reduced biocontrol. This study demonstrates that competition for iron can be an important biocontrol mechanism on fruit.

The production of rhotorularic acid, asiderophore, by the yeast **Rhodotorula glutinis** contributes greatly to biocontrol of bluemold on apples and the addition of some nutrients, e.g. proline or urea, and manipulating pH stimulated production of the siderophore in vitro [2]. Enhancing biocontrol using these manipulations may be possible if they do not benefit the growth of the pathogen and outweigh the benefits of higher siderophore production by the antagonist. Similarly, in systems where competition for limiting nutrients is the main mechanism, the addition of nutrients that stimulate antagonist growth may accelerate the removal of limiting nutrients by the antagonist, but the beneficial effect on the pathogen also must be considered. Carotenoid is a natural pigment widely distributed in organisms, such as red yeasts, some bacteria and plants, but can not be synthesized in animals. In industry, p-carotenoid and astaxanthin can be used as the additives of food and feed. p-carotenoid also can serve as the precursor of vitamin A in mammals. In recent years, many studies on enhanced production of ~carotenoids by mutants of **Rhodotorula** spp. and optimization of the fermentation processes for cultivation of **Rhodotorula** spp. were undertaken. For example, Bhosale and Gadre [1] found that mutant derived from R. glutinis NCIM 3253 produced 76-fold more ~carotene than the original. In the growth medium prepared with seawater, the total carotenoid content and dry cell mass were 86 mg L⁻¹ and 16 g L⁻¹, respectively, as compared to 70 mg L⁻¹ and 12 g L⁻¹ obtained with a medium prepared with distilled water.

Microbial exopolysaccharides have a lot of applications in the food, pharmaceutical, and other industries due to their diversity in composition, structure, and physical properties. Yeasts belong to different genres which produce exopolysaccharides, and these polymers include mannan, glucans, glucomannans, and phosphomannans. The exopolysaccharides produced from **R. glutinis** was a novel uronic acid, mannos-rich acidic heteropolysaccharide composed of neutral sugars (85%) and uronic acid (15%). The neutral sugar composition of this polymer was identified as mannone, fucose, glucose, and galactose in 6.7: 0.2: 0.1: 0.1 ratios, respectively. The molecular weight of purified polysaccharides was estimated to be 1.0±10⁵–3.8±10⁵ Da. **R. glutinis** produces an exocellular mannan containing (13)-β- and (14)-β-D-mannopyranose residues [4]. In addition, **R. glutinis** produce a heteropolysaccharide composed of L-fucose and D-galactose in an approximate molar ratio of 1:1. Bacterial exopolysaccharides have always been suggested to play crucial roles in the bacterial initial adhesion and the development of complex architecture in the later stages of bacterial biofilm formation. However, Escherichia coli group II capsular polysaccharide was characterized to exert broad-spectrum biofilm inhibition activity. The important characteristics of yeast cell wall are referred to as mannan, mannan conjugates, high water solubility, broad spectrum of biological activity, low toxicity, stability and anti-mutagenic effects via different modes of action. Beta-carotene is an excellent antioxidant and freeradical scavenger.

**References**