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The Novel Antibacterials from Two Edible Mushrooms: *Agaricus bisporus* and *Pleurotus sajor caju*

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Abstract: Two edible mushrooms (Basidiomycetes, a macrofungus), *Agaricus bisporus and Pleurotus sajor caju* were assayed *in vitro* for their antimicrobial activities using aqueous and organic solvents extracts. The present study showed that *Escherichia coli 390*, *Escherichia coli 739*, *Enterobacter aerogenes*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* were most sensitive to aqueous, ethanol, methanol and xylene extracts of these mushrooms. Thus indicated that the daily intake of mushroom can provide a natural covering of antibiotics to fight against the common pathogenic organisms.

Key words: Antimicrobial activities, *Agaricus bisporus*, *Pleurotus sajor caju*, mushroom, *Escherichia coli*, *Pseudomonas aeruginosa*

INTRODUCTION

Although most health care professionals skilled in the art of botanical medicine are aware of the antibacterial properties of certain mushroom and other fungi, few may realize that mushroom are rich source of natural antibiotics. The extra cellular secretions of mushroom mycelial are active and combat bacteria. The edible mushrooms (Basidiomycetes, a macrofungus), *Agaricus bisporus* and *Pleurotus sajor caju* have high nutritional value, enhance the immune system, potential of host mediated response and may be act as an antimicrobial agent (Hawks, 2001). Besides these mushroom have been used extensively in traditional medicine for curing various types of bacterial infections, gastro intestinal disorders, bleeding, high blood pressure etc. (Oso, 1977). The human being benefited from the natural defensive strategies of fungi (the mushroom) that produce antibiotics to fight against infections (Hardman *et al*., 2001; Jonathan and Fasidi, 2003, 2005). The antibacterial activities of some mushrooms were reported against number of Gram positive and Gram-negative bacteria (Sonar and Tambekar, 2005).

Smania *et al*. (2001) demonstrated antimicrobial activity of *Ganodermaapplanatum*against *Bacillus cereus*, *Staphylococcus aureus Escherichia coli*, *Pseudomonas aeruginosa* and *Pleurotus eryngii* and *Lactarius delicious*. Extracts of polypore mushroom were investigated for antibacterial properties against microorganisms (Suay *et al*., 2000). According to Bender *et al*. (2001) culture extracts of *A. bisporus* and other *Agaricus* sp. showed antibacterial activity against *Staphyloccocus saprophyticus*. Benedict and Brady (1972) reported antibacterial activities of some mushroom metabolites on Gram-positive bacteria. Oxalic acid and lentinamycin are responsible for the antimicrobial effect of *Lentinula edodes* against *Staphyloccocus aureus* and other bacteria (Komemushi *et al*., 1996). The objective of the present study is to high light the importance of the mushroom on its antibacterial activity against common bacterial pathogens.

MATERIALS AND METHODS

Mushroom: Two edible species of mushrooms, *Agaricus bisporus* (White button mushroom) *and Pleurotus sajor-caju* (Indian oyster mushroom) purchased from local market and used in the study.

Bacterial cultures: The standard pathogenic bacteria were procured from IMTECH, Chandigarh (India) and used in the study. The 0.1 mL of broth culture was inoculated in 10 mL sterile nutrient broth and incubated at 37°C for 3 h. Turbidity of culture was measured with the help of Nephlo-turbidometer. Viable count (10^5) was measured by standard plate and used in the study (Table 1).

Extract preparation: The prewashed and disinfected fruit body of mushroom were cut into pieces, crushed in mortar

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Table 1: Bacterial pathogens (From IMTECH, Chandigarh, India)

Enterobacter aerogenes 111	*Pseudomonas aeruginosa* 424
Escherichia coli 390	*Salmonella typhi* 733
Escherichia coli 739	*Salmonella typhimurium* 98
Klebsiella pneumoniae 109	*Staphyloccocus aureus* 96
Proteus vulgaris 426	*Staphyloccocusepidermidis*435

and pestle and filtered through muslin cloth and various dilutions of filtrate aqueous extract of 50, 20, 10 and 5% were made. The organic solvents extracts of ethanol, methanol, ether, xylene, benzene and acetone were made by standard methods. The extracts were evaporated to dryness and resulting powder dissolved in water or in DMSO. The 10 mm of Whatman filter paper discs soaked in various concentration of aqueous and organic solvent extracts were applied to bacterial lawn culture using disc diffusion method. After incubation of 24 h at 37°C zone of inhibition was measured. Rosacillin (Ampicillin 100 mg mL^{-1}) were used as control antibiotic in the present study.

RESULTS AND DISCUSSION

The antibacterial properties of *Agaricus bisporus* (White button mushroom), *Pleurotus sajor-caju* (Indian oyster mushroom) were studies against common bacterial pathogens. The aqueous extract of *Pleurotus sajor-caju* (Indian oyster mushroom) were highly antibacterial against *Escherichia coli* 390, *Enterobacter aerogenes*, *Escherichia coli* 739 and *Pseudomonas aeruginosa. Klebsiella pneumoniae* and moderately against *Staphyloccocus aureus*, *Proteus vulgaris*, Salmonella typhi and least against *Staphyloccocus epidermidis* and *Salmonella typhimurium* (Fig. 1). The aqueous extract of *Agaricus bisporus* (White button mushroom), were highly antibacterial against *Escherichia coli* 390, *Enterobacter aerogenes*, *Escherichia coli* 739, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae* and moderately against *Proteus vulgaris*, *Staphyloccocus aureus* and least against *Salmonella typhi*, *Staphyloccocus epidermidis and Salmonella typhimurium* (Fig. 3). The antibacterial activities of aqueous extract of both edible, *Pleurotus sajor-caju* (Indian oyster mushroom) and *Agaricus bisporus* (White button mushroom) were significant up to 10% dilution against all tested pathogens (Table 2). Dulger *et al.* (2004) also observed antimicrobial activities of macrofungus *Cantharellus cibarius*. Ishikawa *et al.* (2001) reported antimicrobial activities of *Lentinus edodes* in liquid medium.

The present study showed that Escherichia *coli* 390, *Escherichia coli* 739, *Enterobacter aerogenes*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* were most sensitive to ethanol, methanol and xylene extracts of Indian oyster mushroom (*Pleurotus sajor caju*)

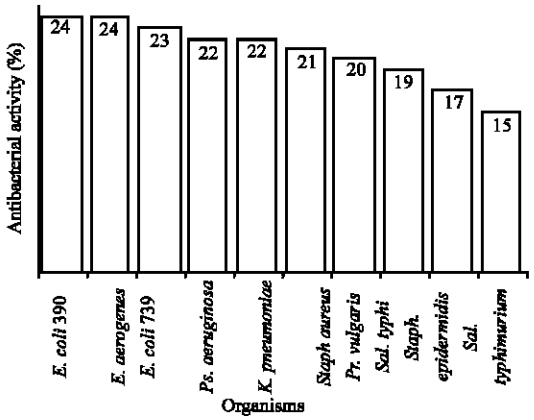

Fig. 1: Antibacterial activities of aqueous extract of *Pleurotus sajor-saju*

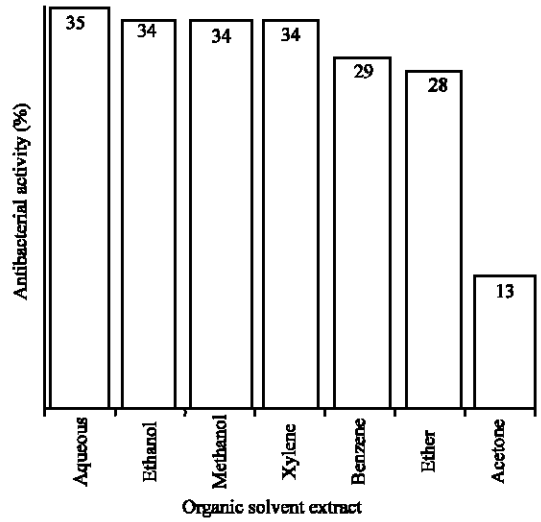

Fig. 2: Antibacterial activities of various organic extract of *Pleurotus sajor-caju*

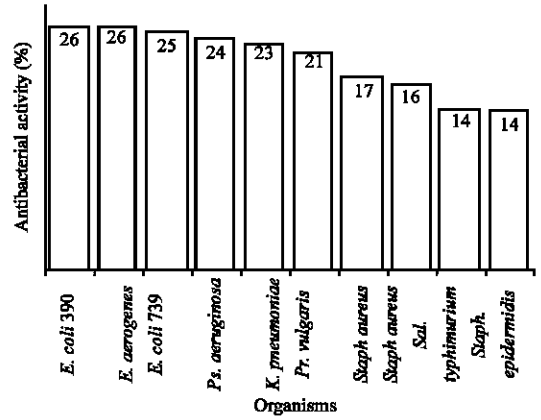

Fig. 3: Antibacterial activities of aqueous extracts of *Agaricus bisporus*

Table 2: Antibacterial effect of aqueous extract of mushroom on bacterial pathogens (zone of inhibition of growth in mm)

	Agaricus bisporus (dilutions in %) (Button mushroom)					*Pleurotus sajor caju* (dilutions in %) (White button mushroom)					
Pathogenic bacteria	100	50	20	10	5	100	50	20	10	5	Ampicillin
Enterobacter aerogenes	19	16	15	15	13	18	15	14	13	14	16
Escherichia coli 390	22	17	16	14	15	20	17	16	14	13	18
Escherichia coli 739	20	18	17	14	13	19	17	16	15	14	19
Klebsiella pneumoniae	21	18	16	17	13	19	17	14	15	12	15
Proteus vulgaris	18	15	15	13	13	16	17	15	14	13	16
Pseudomonas aeruginosa	18	15	16	14	12	18	17	16	15	13	15
Salmonella typhi	15	17	16	13	12	16	14	15	12	13	15
Salmonella typhimurium	14	16	15	15	13	17	15	16	14	15	17
Staphyloccocus aureus	15	16	14	14	12	16	15	13	14	13	16
Staphyloccocus epidermidis	16	15	16	14	14	14	16	15	13	12	16

Table 3: Antibacterial effect of organic solvents extract of mushroom on bacterial pathogens (zone of inhibition of in mm)

	Agaricus bisporus (Button mushroom)						*Pleurotus sajor caju* (White button mushroom)					
Pathogenic bacteria	Ethanol	Methanol	Ether	Benzene	Xylene	Acetone	Ethanol	Methanol	Ether	Benzene	Xylene	Acetone
Enterobacter aerogenes	22	22	15	15	20	13	18	19	17	18	19	13
Escherichia coli	21	18	16	13	18	15	18	19	17	16	19	13
Escherichia coli	20	19	16	15	19	14	18	18	17	17	18	12
Klebsiella pneumoniae	18	19	16	13	20	12	19	18	16	15	18	12
Proteus vulgaris	19	18	15	14	18	12	17	17	16	17	19	13
Pseudomonas aeruginosa	20	20	17	15	19	13	19	18	15	17	18	12
Salmonella typhi	15	17	17	14	16	13	16	17	17	15	16	14
Salmonella typhimurium	16	16	15	15	13	12	15	15	15	16	15	12
Staphyloccocus aureus	17	17	16	15	16	13	16	17	18	16	17	14
Staphyloccocus epidermidis	15	17	14	14	13	13	17	16	15	16	14	15

whereas *Enterobacter aerogenes* was highly sensitive to benzene extract. The moderate antibacterial activity was recorded for benzene and ether extracts of Indian oyster mushroom whereas acetone extract was least sensitive to the all tested bacterial pathogens. Ether and xylene extracts showed highest antibacterial activity against *Staphyloccocus aureus* and *Proteus vulgaris*, whereas ethanol, methanol, benzene and acetone extract of Indian oyster mushroom showed moderate sensitivity. *Salmonella typhi, Salmonella typhimurium* and *Staphyloccocus epidermidis* were recorded as moderate sensitive to all the solvent extracts used in present study. *Salmonella typhimurium* was least sensitive to acetone extracts of Indian oyster mushroom (Table 3).

The various extracts of white button mushroom (*Agaricus bisporus)* also showed the varied degree of antibacterial activity. Ethanol and methanol extracts of button mushroom were highly; xylene and ether extracts were moderately while benzene and acetone extracts least antibacterial to all tested organisms. *Escherichia coli* 390, *Escherichia coli* 739 and *Klebsiella pneumoniae* were highly sensitive to the aqueous extract of button mushroom. Ethanol, methanol and aqueous extract of button mushroom showed highest antibacterial activity against both the species of *Escherichia coli*, *Enterobacter aerogenes and Pseudomonas aeruginosa* and moderately against *Klebsiella pneumoniae*, *Proteus vulgaris*, *Staphyloccocus aureus* and *Salmonella*

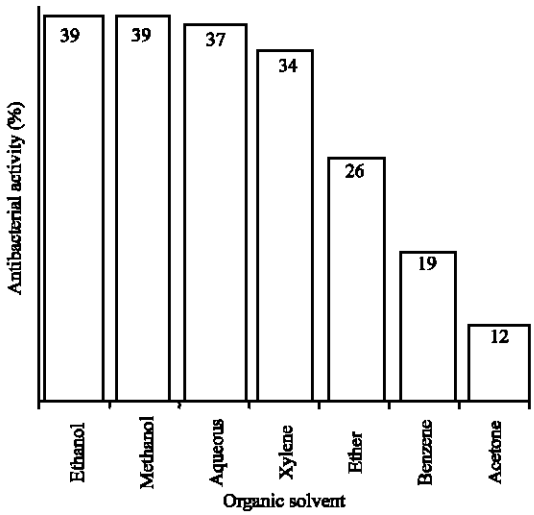

Fig. 4: Antibacterial activities of various solvents extracts of *Agaricus bisporus*

typhimurium and least against *Staphyloccocus epidermidis* and *Salmonella typhi* (Fig. 2). The methanol extract of button mushroom was moderately antibacterial against all the tested organisms except *Enterobacter aerogenes* and *Pseudomonas aeruginosa whereas x*ylene extract was least antibacterial against *Escherichia coli* 390, *Escherichia coli* 739, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Staphyloccocus aureus* and *Salmonella*

typhi, *Enterobacter aerogenes*, *Klebsiella pneumoniae*. Ether, benzene and acetone extracts of button mushroom were least antibacterial against all tested pathogens (Fig. 4).

The indiscriminate use of antibiotics has developed antibiotics resistance common bacterial pathogens, which created immense clinical problems in the treatments of diseases. Therefore, there is a need to search for non-antibiotic, nontoxic plant based alternative. The present study showed that, the aqueous, ethanol, methanol and xylene extracts of Agaricus *bisporus* and *Pleurotus sajor caju* mushroom were antibacterial and the daily intake of them as diet helpful in combating common bacterial infections and also strengthening the immune system and improve the nutritional status. Thus the study indicated that the daily intake of mushroom could provide a natural covering of antibiotics to fight against the common pathogenic organisms.

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