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Effect of zinc on uptake and biological efficiency of oyster mushroom

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Zinc is a heavy metal, which is less toxic than other heavy metals, particularly required by other higher organisms for various metabolic activities. Three salts of zinc, viz. chloride, nitrate and sulphate, were tested on the uptake and productivity of oyster mushroom, *Pleurotus sajar-caju*. At a concentration of 10 µg/ml. the treatment of zinc chloride showed an increase of 12.16% in mycelial growth, that account for 12.32 µg/g dry wt. of zinc. For zinc nitrate and sulphate treatment, the mycelial growth was reduced by 14.23% and 22.21% and an uptake of 4.55 and 2.68 µg/g dry wt. of zinc respectively were noted. Treatment of 10% $ZnCl_2$ after one week of spawning, increased the biological efficiency of sporocarp production by 4.9%, though a distinct reduction in productivity was noted for the other two salts. This was primarily due to the anionic effect, which drifted the pH towards the acidic side. Hence it can be concluded that zinc chloride at a low concentration can be an effective additive to increase the biological efficiency of *Pleurotus sajar-caju,* which can safely by used with other additives like dal powder or cornmeal.

Key words : *Pleurotus sajar-caju*, heavy metal, zinc, anionic effect

INTRODUCTION

Amongst the different types of edible mushrooms, the oyster mushrooms are most easily cultivated and can be grown for maximum time in a year. For this reason, it has gained much popularity particularly in the plains. The conventional substrates used include chopped paddy straw and dal powder, particularly for this easy availability, but along with it other non-conventional additives, including heavy metals can also be used to increase the biological efficiency of sporocarp production (Mitra, 2003). This investigation was undertaken with the following objectives :

i. To estimate the mycelial growth at a low concentration (10 µg/ml.) of zinc salts like $Zncl_2$, $Zn\ (NO_3)_2$ and $ZnSO_4$.
ii. To estimate the mycelial uptake of zinc, during submerged growth at the above mentioned concentration.
iii. To study the effect of the above mentioned zinc salts (10%) on the biological effciency of sporocarp production.

MATERIALS AND METHODS

Preparation of fungal culture : The culture of *Pleurotus sajar-caju* was prepared from sporocarps collected from local market. The hyphal tip cultures were prepared on petriplate and the culture was maintained in 2% potato dextrose agar medium.

Estimation of mycelial growth in liquid medium : The mycelial growth of *Pleurotus sajar-caju* ws estimated in 2% glucose asparagine medium containing 10 µg/ml zinc salts after it was freed from trace elements using CaCO3 as per modified Steinberg, 1939 adopted by Purkayastha *et al.* 1994. This concentration was denoted on the basis of pilot experiments. The mycelial cultures were maintained for 10 days at 30°C, followed by harvesting and the mycelial mass was dried at 90°C for 96 hours.

Estimation of mycelial uptake of zinc : The mycelial uptake of zinc was estimated after drying and processing of the mycelia as per Adrian, 1973 and modified by Mitra and Purkayastha, 1995 using

atomic absorption spectrophotometer, Parkin Elmar, 2380 with deuterium background corrector.

Spawning and preparation of mushroom bed : Wheat grains spawn of *Pleurotus sajar-caju* was prepared using 2% $CaSO_4$ and 6% $CaCO_3$. Three-week spawn was used (after spawning) for the preparation of mushroom bed. The bed included chopped paddy straw (1Kg wet wt.) taken in wooden trays and thoroughly mixed with spawn and covered with a thin layer of wet c.p.s. Ten percent zinc salt solutions (20g in 200 ml) was added to the mushroom bed after 7 days of spawning. The sporocarps start appearing 18-22 days of spawning and are collected in 3 flushes within the next fortnight.

RESULTS

Effect of zinc salts on mycelial growth of *Pleurotus sajar-caju* : The mycelial growth of *Pleurotus sajar-caju* was tested in presence of 10 µg/ml concentration of various zinc salts, viz. $ZnCl_2$, Zn $(No_3)_2$ and $ZnSO_4$. There was an increase of 12.16% in mycelial mass compared to control noted in case of $ZnCl_2$, but there was a reduction of 14.23% and 22.2% noted in case of the other 2 salts and the results and expressed in Table 1.

Table 1 : Estimation of mycelial growth of *P. sajar-caju* in liquid medium containing zinc salts.

Treatments	Mycelial growth* (mg)	% Reduction in mycelial growth
Control©	96.0 ± 07.81	—
© + $ZnCl_2$	107.67 ± 4.33	+ 12.16
© + $Zn(NO_3)_2$	82.33 ± 4.33	– 14.23
© + $ZnSO_4$	74.67 ± 3.53	– 22.21

* Average of 3 replicates/treatment.
Mycelia dried at 90°C for 96 hours.
Incubation Time 10 days.

Table 2 : Estimation of zinc uptake by of *P. sajar-caju.*

Treatments	Mycelial uptake of zinc*	
	Fresh wt. (µg/g)	Dry wt. (µg/g)**
Control©	3.35 ± 0.19	22.45 ± 1.27
© + $ZnCl_2$	5.19 ± 0.39	34.77 ± 2.61
© + $Zn(NO_3)_2$	4.03 ± 0.42	27.00 ± 2.81
© + $ZnSO_4$	3.75 ± 0.14	25.13 ± 0.94

* Average of 3 replicates/treatment.
** 1g dry wt. ≡ 6.7g fresh wt.

Uptake of zinc by mycelial of *Pleurotus sajar-caju* : The mycelial uptake of zinc by *Pleurotus sajar-caju* during submerged growth in liquid medium was estimated at 10 µg/ml concentrations of zinc salts, (Table 2). In all the three cases, viz. chloride, nitrate and sulphate, the uptake of zinc was noted ; it was maximum in case of $ZnCl_2$ (12.32 µg/g dry wt.) and minimum in case of $ZnSO_4$ (2.68 µg/g dry wt.)

Effect of zinc salts on production of sporocarps : The three different zinc salts as mentioned above were sprayed directly on the mushroom bed, 7 days after spawning at 10% concentration. An increase of 4.9% in sporocarp production was noted in case of $ZnCl_2$, but a marked reduction in biological efficiency was noted in case $Zn(NO_3)_2$ and $ZnSO_4$. The results are summarized in Table 3.

Table 3 : Effect of zinc salts on the production of sporocarps.

Nature of Substrate	Number of Sporocarps*	Production of Sporocarps* Fresh wt. (g)	Dry wt. (g)**	% Increase /decrease in productivity
Control (c.p.s)	46.00±2.30	675.00±16.07	93.75±2.33	–
© + $ZnCl_2$	63.33±1.76	708.33±11.67	98.38±1.62	+4.89
© + $Zn(NO_3)_2$	42.33±1.20	461.67±20.28	64.12±2.82	–31.70
© + $ZnSO_4$	37.00±3.28	519.33±27.09	72.1±3.76	–23.11

* Results on the basis of 3 replicates/treatment.
Sporocarps in each replicate collected in 3 flushes.
**1g dry wt. ≡ 7.2g fresh wt.

DISCUSSION

The nutritional importance of *Pleurotus sajar-caju* has long been established ; Bano *et al.* 1981, denoted the mineral content. Chandra and Purkayastha (1976) effectively used it as a dietary supplement for laboratory animals. The presence of heavy metals in edible mushrooms was denoted by earlier workers like Yu and Zhao, 1984, Jain *et al.*, 1988, Purkayastha and Mitra, 1992 and Purkayastha *et al.*, 1994. In the present investigation, three different salts of zinc (viz. chloride, nitrate and sulphate) were considered and their effect on mycelial growth, uptake and productivity of an oyster mushroom, *Pleurotus sajar-caju* was denoted. Starling and Ross, 1991 has shown the affinity of *Penicillium notatum* towards zinc. Since zince is a non-toxic heavy metal, it can be safely used in the substrate for edible mushrooms. During submerged growth, the mycelia of *P. sajar-caju,* showed a reduction of 12.16 to 22.2% at 10 µg/ml concentration of zinc salts. At the same

concentration, maximum uptake was observed incase of zinc chloride (12.32 µg/g dry wt.). The same salt increased sporocarp production by 4.9%, though the other two salts viz. nitrate and sulphate reduced the biological effciency, this reduction is purely due to anionic effect, as there was a decrease in the pH level. Thus it is evident from this investigation that the mushroom has an affinity towards zinc that binds with the mycelia and increases the biological efficiency.

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