INTRODUCTION

Mushroom mycelium contains several minerals. In general, they contain P, Na, K, Ca, Mg, and Fe. Anderson and Fellers (1942) and Esselen and Fellers (1946) have obtained 12% ash in sporophores of *Agaricus campestris* whereas Humfeld and Sugihara (1949) have got 4.59 percent ash, 0.12 percent Ca, and trace Fe in white variety and 5.24 percent ash, 1.05 percent Ca, and trace of Fe in brown variety of *A. campestris*. Jennison et al. (1957) have made a comprehensive study on 17 wood-rotting basidiomycetes of which white rots generally produce maximum ash. Litchfield et al. (1963) have reported 18.2 percent ash in *Morchella crassipes* grown in submerged culture. Watt and Merril (1963) have obtained 63 mg of Ca, 8.3 mg of Fe, and 135 mg of Mg per 100 g dry mycelium of *A. bisporus*. It has been found that there are 10.7 percent ash in *Pleurotus sp* (Zakia et al. 1963), 9.3 percent ash in *Termiomyces sp* and 12.1 percent in *Lepiota sp* (Zakia et al. 1964). Kaeic et al. (1967) have analysed ash for mineral contents in some mushrooms. In *A. bisporus*, 23 mg of Ca, and 0.2 mg of Fe per 100 g dry mycelium has been obtained by Altamura et al. (1967). Zakia et al. (1971) have also reported the presence of 11.5 percent ash, 58 mg of Ca, and 17.7 mg of Fe per 100 g dry mycelium of *Volvariella diplasia*. Mukhiibi (1973) has shown 23.3 percent ash in *Agaricus sp* and 8.9 percent ash in *Tricholoma sp*. In *Lentinus edodes* 7 percent ash has been obtained (Sugimori et al. 1971).
Zhuk et al. (1973) have worked on some mushrooms in this aspect. Guha and Banerjee (1973) have reported that *A. campestris* S12 culture is rich in Fe and Mg content but low in Ca content. Fe content of mycelium has been studied in basidiomycetes by Horovitz et al. (1974). Stetsenko and Bakayeva (1975) have studied the Ca, Mg, Fe and other mineral contents of mushrooms. Lee and Chang (1975) have obtained 12.6 percent ash in *Volvariella volvacea*. Drbal et al. (1975) have reported 5-15 percent ash contents in 15 species of common edible mushrooms. Mineral content of mushrooms has also been studied by Parent and Daniel (1977). Mutsch et al. (1979) have estimated Fe and other mineral contents in 87 basidiomycetes and Fe content has been found to be comparatively low. Estimation of Ca, Mg, Fe and other elements has also been done by Stetsenko et al. (1979) in eight mushroom species. Tyler (1980) has studied the Ca, Mg, Fe and other mineral contents in sporophores of 130 basidiomycetes. Vogt and Edmonds (1980) have found during working on nutrient content of a few mushrooms that, Ca and Mg are concentrated at levels less than 1% of the dry wt. Kosaric and Nabuo (1981) have obtained 8.5 percent ash in morel mushroom.

In the present study, the ash and mineral contents of mycelia of *G. chrysomycetes*, *L. birnbaumii* and *L. cepaestipes* grown in basal medium and in their respective optimum media were estimated.

**MATERIALS AND METHODS**

**Test Organisms:**

Tissue cultures of *Gymnopilus chrysomycetes* (Berk.)·acc. *Leucocy-
prinus birnbaumii (corda) sing, and Leucocoprinus cepaeestipes (Sow, ex Fr.) Pat. were used for study. Cultures were maintained in 3% malt-extract agar medium at 25°C in complete darkness.

Cultural Procedure:

Two types of media, basal and optimum, were prepared for each test-fungus. Glucose-asparagine synthetic medium of Lilly and Barnett (1951) was used as basal medium with the following composition:

- glucose-30 g
- asparagine-2 g
- MgSO$_4$, 7H$_2$O- 500 mg
- KH$_2$PO$_4$ - 1 g
- FeSO$_4$, ZnSO$_4$- 0.2 mg each
- MnSO$_4$- 0.1 mg
- thiamine hydrochloride-100 ug
- biotin-5 ug and distilled water to make the volume 1 litre.

For *G. chrysomycetes*, the maltose-peptone optimum medium of the composition, maltose-40 g, peptone-3 g, MgSO$_4$, 7H$_2$O-500 mg, KH$_2$PO$_4$-1 g, FeSO$_4$, ZnSO$_4$, MoO, CuSO$_4$- 0.2 mg each, MnSO$_4$-0.1 mg, thiamine, pyridoxine, ascorbic acid-100 mg each, inositol-5 mg, biotin and riboflavin-5 ug each and distilled water to make the volume 1 litre, was used.

For *L. birnbaumii*, glucose-yeast extract optimum medium was prepared with the following composition:

- glucose-30 g
- yeast extract-2 g
- MgSO$_4$, 7H$_2$O-500 mg
- KH$_2$PO$_4$-1 g
- FeSO$_4$, ZnSO$_4$, MoO, CuSO$_4$ and CaSO$_4$-0.2 mg each
- pyridoxine, ascorbic acid and PABA- 100 mg each
- inositol-5 mg
- biotin and riboflavin-5 ug each
- distilled water to make the volume up to 1 litre.

For *L. cepaeestipes*, starch-yeast extract optimum medium of the following composition was prepared:

- starch-40 g
- yeast extract-
3 g; MgSO₄, 7H₂O-500 mg; KH₂PO₄ - 1 g; ZnSO₄, MnO, CuSO₄, CaSO₄-0.2 mg each, MnSO₄-0.1 mg; Pyridoxine, thiamine and PABA-100 mg each; inositol-5 mg; biotin and riboflavin-5 ug each; distilled water to make the volume 1 litre. The pH of the glucose-yeast extract medium was adjusted to 6.0 and that of basal medium, maltose-peptone and starch-yeast extract medium was adjusted to 5.5 with the help of 0.2 M Phosphate buffer. 50 ml of each medium was distributed in each of 250 ml Erlenmeyer flasks, plugged and sterilized at 10 p.s.i. for 20 minutes. Each sterilized flask was then inoculated with 1 ml cell suspension of each test-fungus separately and incubated in a shaking incubator (120 r.p.m.) at 30°C(+0.5°C) in complete darkness. Flasks for G. chrysosmyces were incubated for 20 days and those for L. birnbaumii and L. cepaestipes were incubated for 16 days according to the optimum period obtained in previous experiments. After incubation period, mycelium was harvested by filtration through a tarred sintered funnel (Jena IG-3), filtered mycelium was washed repeatedly with distilled water to make it free from adherent medium and dried to constant weight at 60°C.

Dry mycelium was used for analytical studies.

Analytical Procedures:

A. Estimation of ash contents;

2 g of dried mycelium of each test-fungus was taken separately in a previously weighed silica crucible and ignited in a muffle furnace at about 450°C for 2 hours (A.O.A.C., 1960). The crucible
was then cooled in a dessicator and weighed.

B. Determination of mineral contents:

i) Estimation of Calcium and magnesium:

250 mg of ash residue was digested with 5 ml of conc. HCl in
a steam bath till the acid was boiled off. The digested residue
was dissolved in a definite volume of dilute HCl and distilled
water was added to make up the volume up to 50 ml for estimation
of minerals. 5 ml aliquot from ash solution was taken to estimate
calcium titrimetrically with 0.01 M EDTA solution using Solochrome
dark blue as indicator (Vogel, 1961). Similarly magnesium was measu­
red titrimetrically in 5 ml ash solutions with 0.01 M EDTA solution
using Eriochrome black T as indicator (Vogel, 1961). In both the
cases NH$_4$Cl- NH$_4$OH buffer of pH 10 was used. Each estimation was
done in triplicate.

ii) Estimation of iron:

Iron content was estimated colorimetrically following the thio­

In this method 100 mg of ash was dissolved in 2.5 ml of conc.
HCl, evaporated to dryness and then total volume was made up to 25
ml with distilled water. Then 2.5 ml of potassium thiocyanate solu­
tion and 1.5 ml of 4 N HCl was added to it successively. A blank
set was prepared by adding 25 ml distilled water instead of ash
solution. The colour development was observed immediately in photo­
electric colorimeter (Model AE-11, Tokyo Erma Optical Works Ltd,
Japan) at 470 m/μ. Iron content was estimated from standard graph made by using ferrous-ammonium-sulphate. Estimation was done in triplicate.

**RESULTS AND DISCUSSION**

The experimental data are given in Tables 16 and 17.

<table>
<thead>
<tr>
<th>Mushroom species</th>
<th>Ash Content (%)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mycelium from OM</td>
<td>Mycelium from BM</td>
<td></td>
</tr>
<tr>
<td><em>G. chrysomyces</em></td>
<td>6.00 ±0.10</td>
<td>5.80 ±0.13</td>
<td></td>
</tr>
<tr>
<td><em>L. birnbaumii</em></td>
<td>7.00 ±0.17</td>
<td>6.10 ±0.13</td>
<td></td>
</tr>
<tr>
<td><em>L. cepaes-tipes</em></td>
<td>5.50 ±0.25</td>
<td>4.50 ±0.17</td>
<td></td>
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</tbody>
</table>

* Averages of three replicates under identical conditions.
Table-17. Data showing the mineral contents (mg/100 g of dry mycelia) of *G. chrysomyces*, *L. birnbaumii* and *L. cepaestipes* grown in their respective optimum media (OM) and basal medium (BM) under submerged conditions.

<table>
<thead>
<tr>
<th>Mushroom Species</th>
<th>Calcium (Ca) Content (mg/100g dry mycelium)</th>
<th>Magnesium (Mg) Content (mg/100g dry mycelium)</th>
<th>Iron (Fe) Content (mg/100g dry mycelium)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mycelium from OM</td>
<td>Mycelium from BM</td>
<td>Mycelium from OM</td>
</tr>
<tr>
<td><em>G. chrysomyces</em></td>
<td>108.68 ± 0.05</td>
<td>93.30 ± 0.03</td>
<td>60.12 ± 0.05</td>
</tr>
<tr>
<td><em>L. birnbaumii</em></td>
<td>138.04 ± 0.04</td>
<td>130.82 ± 0.03</td>
<td>95.34 ± 0.03</td>
</tr>
<tr>
<td><em>L. cepaestipes</em></td>
<td>98.82 ± 0.05</td>
<td>74.88 ± 0.03</td>
<td>60.46 ± 0.03</td>
</tr>
</tbody>
</table>

* Averages of three replicates under identical conditions.

The data reveal that in case of *G. chrysomyces*, 100 g dry mycelium from optimum medium (OM) contains 108.68 mg, 60.12 mg and 0.9 mg of Ca, Mg and Fe respectively, whereas 100 g dry mycelium from basal medium (BM) contains 93.3 mg, 58.38 mg and 0.6 mg of Ca, Mg and Fe respectively. Ash content of OM-mycelium is 6% and that of BM-mycelium is 5.8%.

In case of *L. birnbaumii*, 100 g dry mycelium from OM contains
138.04 mg, 95.34 mg and 1.61 mg of Ca, Mg and Fe respectively. 100 g dry mycelium from BM is found to contain 130.82 mg, 78.0 mg and 0.68 mg of Ca, Mg and Fe respectively. Ash content of OM-mycelium is 7% and that of BM-mycelium is 6.1%.

In case of L. cepaestipes, ash content is 5.5 and 4.5% in mycelium from OM and that from BM respectively. 100 g dry OM-mycelium contains 98.82 mg of Ca, 60.46 mg of Mg and 1.48 mg of Fe. and 100 g dry mycelium from BM containing 74.88 mg of Ca, 49.06 mg of Mg and 0.52 mg of Fe.

The experimental data show that the ash and mineral contents are more in the mycelia grown in OM than that grown in BM. 5.5-7.0 percent ash content is obtained in mycelia from OM. Similar percentage has been obtained in other mushrooms (Humfeld and Sugihara, 1949; Sugimori et al, 1971;). High percentage of ash (23.3%) has been reported in Agaricus sp (Mukibi, 1973). In the test-fungi, Fe content is comparatively low. Low Fe content has been reported in other mushrooms (Altamura et al, 1967; Mutsch et al, 1979;). But reports of high content of Fe has been observed in some other mushrooms (Zakia et al, 1971; Guha and Banerjee, 1973;).
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