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Full Length Research Paper

Determination of optimum seaweed concentration for mushroom cultivation and the ability of mushrooms to absorb iodine

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The optimum concentration of seaweed (*Laminaria schinzii)* in grass as substrate for cultivation of the Oyster mushroom *Pleurotus sajor caju* was observed to be 10%. This concentration supported growth of highest numbers and biomass of mushrooms. Concentrations of seaweed above 10% suppressed mushroom growth. No growth occurred above 25%. The Oyster mushrooms absorbed iodine from the growth substrates which increased with the increasing concentration of seaweed in the substrate mixtures. Incorporation of 10% seaweed (*L. schinzii)* in grass substrates for cultivation of the Oyster mushroom *P. sajor caju* is therefore likely to increase mushroom yield as well as iodine concentration in the mushrooms thus increasing food health benefits and reducing incidences of goiter and cretinism in the consumers.

Key words: Seaweed, *Laminaria schinzii, Pleurotus sajor caju,* mushrooms, substrates, iodine, goiter.

INTRODUCTION

Two basic problems which humans must make effort to solve are environmental pollution and the shortage of food due to the continuing population explosion. Food and nutrition problems are particularly severe in developing countries many of which are located in tropical regions. Mushrooms are palatable in their natural form and can be eaten directly. They produce a wide range of extracellular enzymes which degrade complex organic substrates into soluble substances which they absorb (Mshigeni and Chang, 2001). Thus, mushrooms can convert lignocellulosic materials and their organic wastes which have little or no market value and are inedible for humans, into valuable edible and nutritious food. Since there is an abundance of agricultural, forest and industrial lignocellulosic biomass in Africa, the cultivation of edible mushrooms can make important contributions to the nutrition and economic welfare of the growing human population, while simultaneously reducing environmental pollution. The protein level of some edible mushrooms for example *Pleurotus sajor caju* may range from 20 to 40% on dry weight basis. Although protein concentration in mushroom is slightly less than that in animal meat, it ranks well above that in milk and other foods such as vegetables and contains all the essential amino acids required in human diet including leucine and lysine which are often lacking in some of Africa's staple cereal crops, for example maize (Mshigeni and Chang, 2001; Chang and Mshigeni, 2004). Oyster mushrooms (*Pleurotus spp.*) display a high level of adaptability and can be grown on a wide range of substrates including seaweeds mixed with lignocellulosic materials (Molloy et al., 2003). Brown seaweeds contain a high amount of iodine and are also rich in

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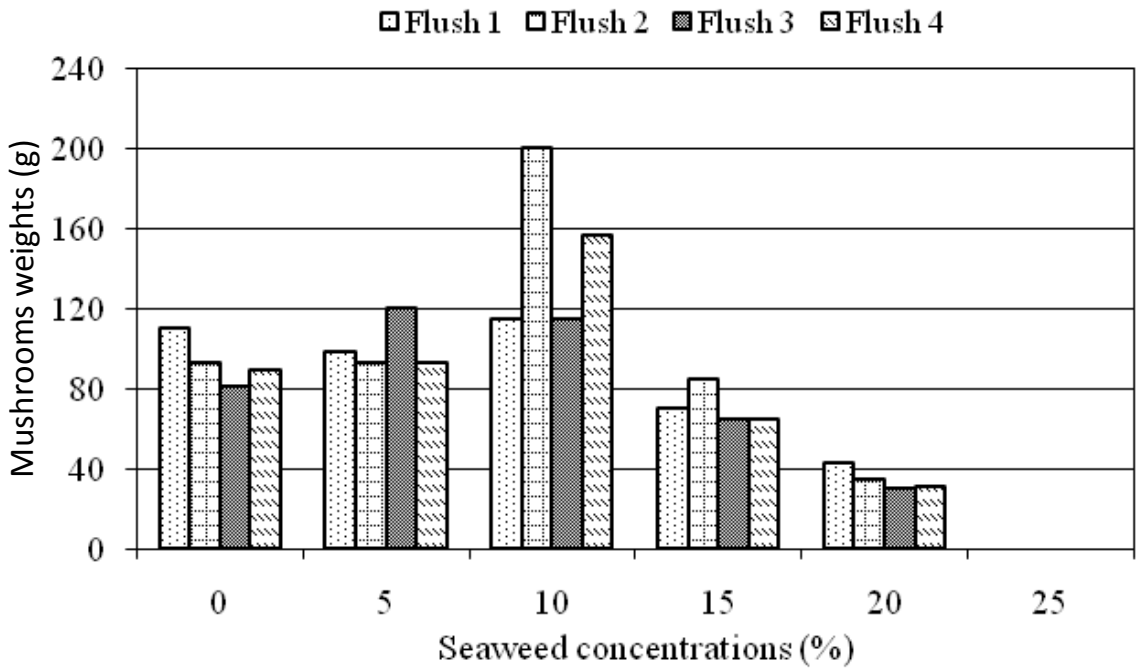

Figure 1. Weights of Oyster mushrooms produced in 4 individual flushes by substrate containing various concentrations of seaweed.

polysaccharides (Mshigeni et al., 2000). Thus, growing mushrooms on enriched seaweed substrates can boost the iodine content in the mushroom (Mshigeni et al., 2003).

Goitre is one of the commonest iodine deficiency syndromes in large parts of Africa. Since seaweed biomass is one of the most underutilized natural resources in Namibia, this research was designed to investigate the performance of the seaweed *Laminaria schinzii*, as a suitable component of substrate for growth of Oyster mushrooms and enhancing the iodine content of mushrooms.

MATERIALS AND METHODS

Determination of optimum ratios of seaweed in mushroom cultivation substrates

P. sajor caju was chosen as a representative oyster mushroom for the study. The seaweed *L. schinzii* collected from Luderitz was crushed into small pieces and soaked in tap water overnight. It was further blended into smaller pieces to increase the surface area to optimise the action of mushroom fungal enzymes. Cultures grown on Potato Dextrose Agar were multiplied on pearl millet (*Pennisetum americanum)* grain to make spawn for inoculation into substrates consisting of a mixture of grass and seaweed plus 1% agricultural lime to bring the pH to 8.4. Substrates were prepared and sterilised in the autoclave at 121°C and 21 pa pressure for 15 min. The treatments consisted of 5, 10, 15, 20 and 25% seaweed. Each treatment had 6 replicates in a randomised complete block design. Substrates were inoculated with 2% grain spawn by volume. The inoculated substrates in plastic bags were incubated in a dark room at 22 to 27°C and 70 to 80% Rh during vegetative phase and later increased to 98 to 100% Rh in the fruiting room. Mushrooms were harvested in four flushes and the total yields for each flush recorded.

Determination of iodine concentrations in mushrooms

Mushroom culture, spawn and substrate preparation were done as explained earlier using seaweed concentrations of 10, 20 and 30%. Harvested mushrooms were oven-dried to constant weight and their iodine concentrations determined. Mushrooms were blended into fine pieces and mixed with K_2CO_3 at a ratio of 1g mushroom/5 g of K_2CO_3. The mixtures were then heated in the oven at 600°C for 8 min and ashed. About 0.06 g of each sample was then dissolved in 50 ml of deionized water and titrated with 0.005N $Na_2S_2O_3$ using starch solution as an indicator. Starch was added when the solution became pale-yellow to determine both iodide and iodate concentrations from mushrooms pooled from 2 flushes.

Statistical analysis

Post-Hoc test for multiple comparisons at 5% level of significance was used.

RESULTS

The optimum concentration of seaweed (*L. schinzii)* in the substrate mixture for the cultivation of the Oyster mushroom *P. sajor caju* was observed to be 10%. It supported growth of more mushrooms than the other concentrations (Figures 1 and 2). The greatest weight of

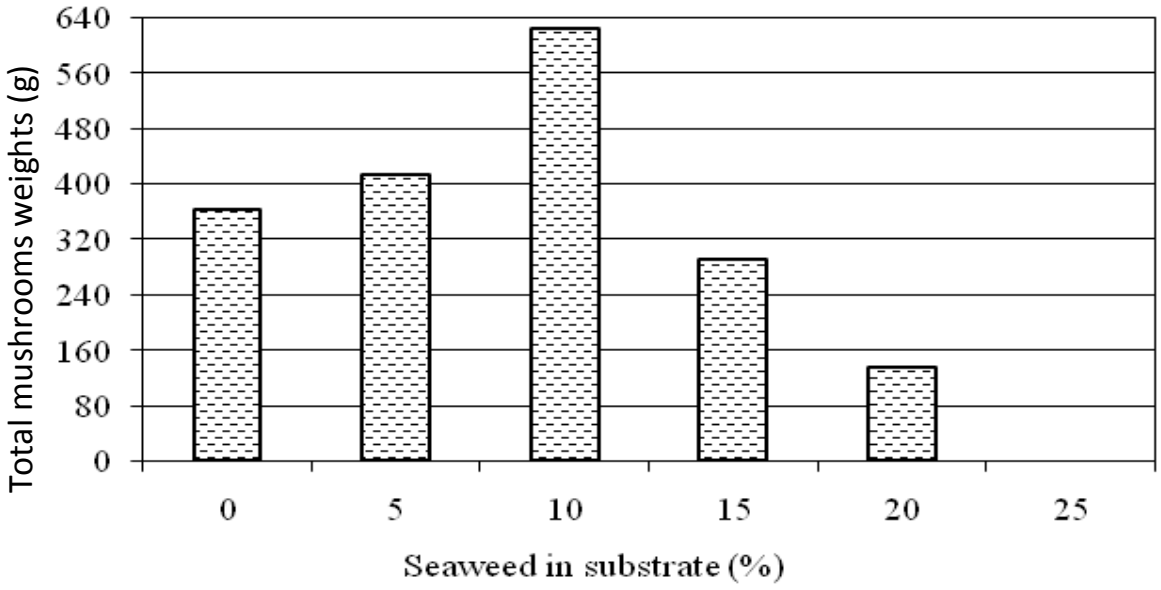

Figure 2. Combined weights of Oyster mushrooms produced by 4 flushes by substrate containing various concentrations of seaweed.

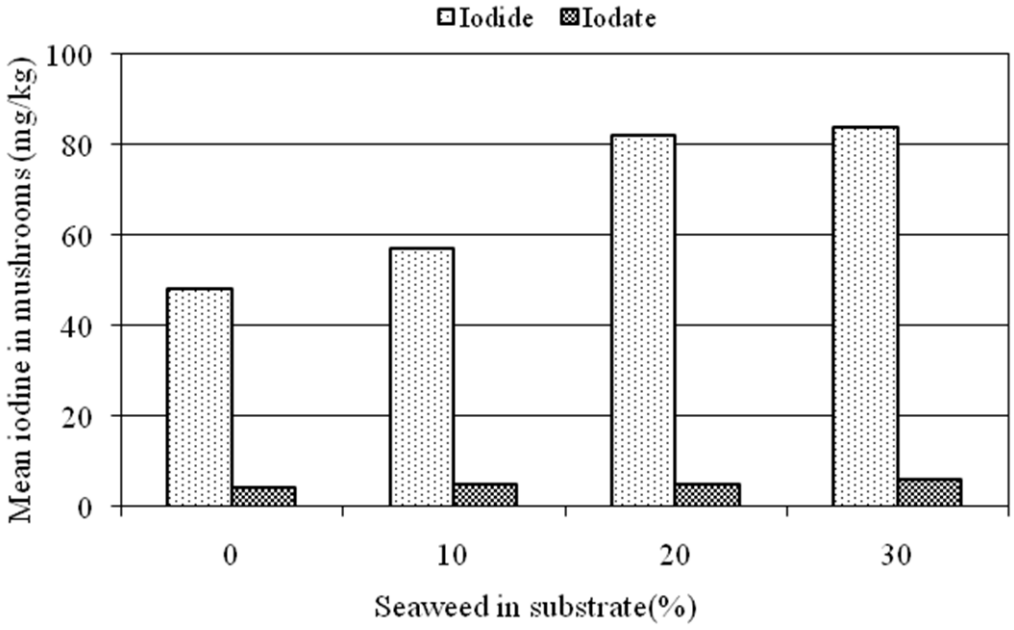

Figure 3. Iodide and iodate concentrations in Oyster mushrooms cultivated on substrate containing seaweed at various concentrations.

mushrooms was produced by the substrate containing 10% seaweed. Concentrations of seaweed above 10% were observed to suppress mushroom growth. No growth was observed at seaweed concentrations of 25% and above. Mushrooms were observed to be capable of absorbing iodine from the growth substrates. The absorption increased with the increasing concentration of seaweed in the substrate mixtures (Figure 3).

DISCUSSION

In this investigation, it was observed that addition of 10% seaweed (*L. schinzii*) to grass significantly enhanced mushroom yield. Concentrations of 25% and above, however, inhibited mushroom growth, probably due to high concentration of salt which was difficult to eliminate by soaking and washing. The increase in mushroom yield

at the seaweed concentration of 10% was higher than that of the grass alone suggesting that the seaweed might have provided some additional micronutrients to the substrate mixture. This yield enhancement might also be due to enhanced moisture retention capacity of the seaweeds. Mushrooms are a good source of nutrients and minerals for example proteins, fats, carbohydrates, potassium, phosphorus, iron, sodium, calcium and vitamins such as thiamine, riboflavin, niacin, biotin and ascorbic acid (Mshigeni and Shu-Ting, 2001; Chang and Mshigeni, 2004). Unlike animal fatty acids which are mostly saturated, those from mushrooms (up to 78%) are unsaturated (Chang and Mshigeni, 2004). Seaweeds which are regarded as wastes at the Namibian coast can be used by coastal communities for growing mushrooms to increase their food security. Oyster mushrooms (*Pleurotus* spp.) are by far the easiest and least expensive to grow. For small cultivators with limited budgets, they are the clear choice for gaining entry into the mushroom industry (Miles and Chang, 1997). Few other mushrooms demonstrate such adaptability, aggressiveness and productivity as the *Pleurotus* species (Quimio, 1986). Iodine is an essential micronutrient for all animal species including humans because it is necessary for thyroid hormone synthesis which regulates cell oxidation (Delange, 2000). This hormone plays an important role in cellular metabolism in the process of early growth and development of most organs especially the brain (Delange, 1998). Iodine is absorbed as iodides by the thyroid gland and this is controlled by the thyroid-stimulating hormone from the pituitary gland in direct response to the level of thyroxine circulating in the blood (Williams, 1995). The daily requirement for iodine is 150 μg/day for adults in both sexes and rapidly growing adolescents. However, pregnant and breastfeeding women need more iodine for both themselves and their babies, about 175 μg/day during pregnancy and 200 μg/day during lactation (Williams, 1995). The amount of iodine in natural food varies considerably depending on the iodine content of the soil. Seafood is known to provide a good amount of iodine. People with goitre lack the ability to produce normal amount of thyroxine hence, the large amounts of Thyroid stimulating hormone continually stimulate their non-productive thyroid glands causing it to increase greatly in size (Williams, 1995). About 90% of the Goiter sufferers are women, especially pregnant and nursing mothers (Mshigeni et al., 2000). During pregnancy, iodine is diverted from mother to foetus. Iodine prevents cretinism in the baby which often results in the baby being physically and mentally retarded.

In this research, it was observed that mushrooms grown on a substrate containing seaweed absorb iodine from the substrate. Consumption of such mushrooms will therefore provide consumers with iodine thus preventing incidences of goiter and cretinism. Most members of the brown seaweed have been reported to contain high iodine levels in their tissues (Molloy et al., 2003). The progressive increase in iodine concentrations in the mushrooms cultivated on substrates containing high concentrations of seaweed indicates that mushrooms are capable of absorbing iodine from substrates. Incorporation of 10% seaweed (*L. schinzii)* in grass substrates for cultivation of the Oyster mushroom *P. sajor caju* will therefore increase mushroom yield as well as iodine concentration in the mushrooms thus increasing food security and reducing incidences of goiter and cretinism.

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