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Use of Industrial Tea Leaf Waste for Cultivation of Oyster Mushrooms

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ABSTRACT: India is one of the largest tea (*Camellia sinensis*) producing countries in the world. A large quantity of tea leaf waste remains unutilized. An attempt was made to utilize waste from the tea industry for growing *Pleurotus* spp. Tea leaf waste alone and in different combinations with wheat straw (3:1, 1:1 and 1:3 w/w) were used for the mycelial growth of *P. flabellatus* and *P. sapidus* in Petri plates. Tea leaf waste + straw (3:1 and 1:1) showed the best mycelial growth followed by wheat straw in a 1:3 combination. Tea leaf waste alone showed poor mycelial growth. Subsequently the above substrate combinations were also used for growing both species in polypropylene bags. Tea leaf waste and wheat straw mixture (3:1 and 1:1) gave highest yield with *P. flabellatus* (96 and 90% BE, respectively) and *P. sapidus* (78 and 76% BE) followed by 1:3 mixture (68 and 60% BE) and wheat straw alone (60% and 50% BE). Unautoclaved tea leaf waste used alone did not produce mushrooms.

1 INTRODUCTION

Oyster mushrooms are lignocellulosic fungi that are cultivated mainly on non-fermented cereal straw. At present, India annually is producing around 2,000 tonnes of these mushrooms. Their cultivation in India is gaining momentum due to suitable climatic conditions, vast availability of raw materials and cheap labour. Due to lack of awareness among consumers their domestic consumption is localised in certain pockets. Moreover, there is no big export demand for oyster mushrooms from India. Due to the above reasons their production is limited and almost static. Cultivation of oyster mushrooms is largely confined to the southern and eastern regions of India where tea is cultivated on a very large scale.

India is one of the largest tea producing countries in the world with more than 28% of the total world production. During 1988 and 1989, the annual production was 7.0 and 6.9 lakh tonnes. A large quantity of waste from the tea leaf industry remains unutilized. An attempt was made, therefore, to develop techniques for utilization of industrial tea leaf waste for cultivation of oyster mushrooms at the National Centre for Mushroom Research and Training, Solan, India.

2 MATERIALS AND METHODS

2.1 *Mycelial growth in Petri plates*

Initially *in-vitro* studies were undertaken in Petri plates to observe the mycelial growth on tea leaf waste (TLW) and wheat straw (WS) alone and in different combinations (TLW+WS, 75:25, 50:50 and 25:5/5 w/w). The substrates were pre-soaked in water (16 hours) before filling in Petri plates and then sterilized (15lb p.s.i. for 1 hour). The moisture content in the tea leaves after autoclaving was 78 to 80% while it was 74 to 77% in all other treatments except wheat straw where it was 70 to 73%. Petri plates with sterilized substrates were inoculated with 10mm mycelial bits of *P. flabellatus* and *P. sapidus* (10-day-old culture). Inoculated plates were incubated at 24 to 26C to observe mycelial growth.

2.2 *Yield performance of Pleurotus species*

Tea leaf waste and wheat straw alone and in different substrate combinations as above in (2.1) were used for growing *P. flabellatus* and *P. sapidus*. Substrates in different treatments were thoroughly mixed and soaked overnight in water except wheat straw (alone) which was soaked in carbendazim solution (25 ppm) for 16 hours to avoid mould infection. After draining excess water, the substrates were filled in perforated polypropylene bags (250gm dry substrate/bag). From each treatment one set of four bags were autoclaved (15 lb.p.s.i. for one hour) before spawning while other four bags were spawned without autoclaving. Spawned substrate bags were kept in cropping rooms for mycelial growth and fructification. The temperature and humidity was 24 to27C and 65 to 75% RH throughout the cropping period. Standard cultural conditions for growing *Pleurotus* spp. were followed (Upadhyay 1989, and Zadrazil 1978). Yield data were recorded for 4 weeks and the % biological efficiency calculated as follows:

$$\frac{\text{Fresh wt of mushrooms harvested}}{\text{dry wt of substrate used}} \times 100$$

3 RESULTS

3.1 *Mycelial growth in Petri plates*

There was no significant difference in radial mycelial growth among treatments but colony morphology was different. The mycelial growth was profuse, dense and cottony in TLW+WS (1:1 and 3:1) while it was comparatively thinner and strandy in wheat straw alone and in TLW+WS(1:3). Tea leaf waste alone gave the poorest mycelial growth.

3.2 *Yield performance*

All treatments having autoclaved substrates supported mycelial growth and fructification except tea leaf waste alone. Among the unautoclaved treatment only the bags with wheat straw alone gave fructification and slight mycelial growth in TLW + WS in a 1:3 combination, while in other treatments there was no mycelial growth. Wheat straw (autoclaved) contained in bags became infected with *Trichoderma* sp. No mold infection was observed in tea leaf supplemented bags.

The highest yield was obtained in TLW+WS mixture in a 3:1 combination (96 and 78% BE) (Table 1). This was followed by a 1:1 mixture (90 and 76% BE) and wheat straw alone (60 and 50% BE) in the case of *P. flabellatus* and *P. sapidus* respectively, while there was no mycelial growth and fructification in bags with tea leaf alone.

Table 1. Comparative mycelial growth and yield performance of *Pleurotus flabellatus* and *P. sapidus* on a mixture of tea leaf waste and wheat straw.

		Mycelial growth		Average yield (g)/250g substrate	
Strain	Substrate ratio used (%)	*P. flabellatus*	*P. sapidus*	*P. flabellatus*	*P. sapidus*
1	TLW+WS (1:3)[a]	good	good	170	150
2	TLW+WS (1:1)	excellent	excellent	225	190
3	TLW+WS (3:1)	excellent	excellent	240	195
4	TLW	no growth	no growth	nil	nil
5	WS	good	good	150	125

[a]TLW = tea leaf waste; WS = wheat straw

4 DISCUSSION

Oyster mushrooms are gaining popularity among throughout the world. Their production has increased from 169,000 tonnes (1986) to 909,000 tonnes (1989-90), an increase of almost 438% (Chang and Miles 1991).

In India, oyster mushrooms are cultivated mainly on wheat and paddy straw-based substrates. These substrates have various other industrial and domestic uses such as cattle feed, paper making, thatching mud houses etc. In past years, these materials were easily available at cheaper rates but day by day they are becoming more costly. Use of costly substrates for growing oyster mushrooms increases their cost of production. Various agricultural and industrial by-products are available in plenty with little or no other use. We have to search and utilize such substrates for better recycling through mushroom production. A number of agricultural and industrial by-products and non-conventional plants including cotton waste, cotton seed hulls, coffee by-products, citrnonella bagasse, tobacco medium, waste tea leaf, pea nut shells, lawn grass, water hyacianth, and apple pomace have been successfully utilized by different workers for growing oyster and paddy straw mushrooms (*Volvariella volvacea*) (Miller 1987, Singh *et al.* 1989, Leon *et al.* 1983, Cho *et al.* 1981, Tolentino 1986, Upadhyay and Sohi 1988). Tea leaves are rich in nitrogen and lignin, with a low C/N ratio and waste tea leaves can be used as a nitrogen supplement for spawn and compost preparation. (Fung *et al.* 1981). Tea leaf waste contains various phenolic substances like catechins. Catechins are known to have antioxidative and antibacterial actions against food borne carcinogenic or phytopathogenic bacteria (Yukihika 1994). When tea leaf waste was mixed with wheat straw it gave early and higher crop yields than the wheat straw alone and there was no mould infection on the substrate. It may be due to increased nitrogen content in the substrate and antimicrobial properties of tea leaf waste. Fung *et al.* (1981) have reported non-suitability of tea leaf waste as a sole carbon source because it is poor in cellulose (19 to 39%) and hemicellulose (9 to 16%). The present finding also indicates that tea leaf waste alone is not a suitable substrate for growing oyster mushroooms. It can be used after mixing with other substrates having high carbon and low nitrogen contents. It is in agreement with earlier findings.

Failure of mycelial growth in unautoclaved substrates (TLW+WS) indicates that tea leaf waste requires heat treatment before spawning for mycelial growth. Heat treatment may help to release different phenolics for their metabolic conversion. Balazs (1978) has also reported heat treatment of corn cobs and straw for getting better yields in *P .ostreatus* and *P. florida.* Bisht and Harsh (1983) could cultivate *P. ostreatus* on unautoclaved used tea leaves. This may be because most of the tea, polyphenols get leached away during tea preparation while tea leaf waste still contain various polyphenolics which are known to be antifungal (Khare *et al.* 1994).

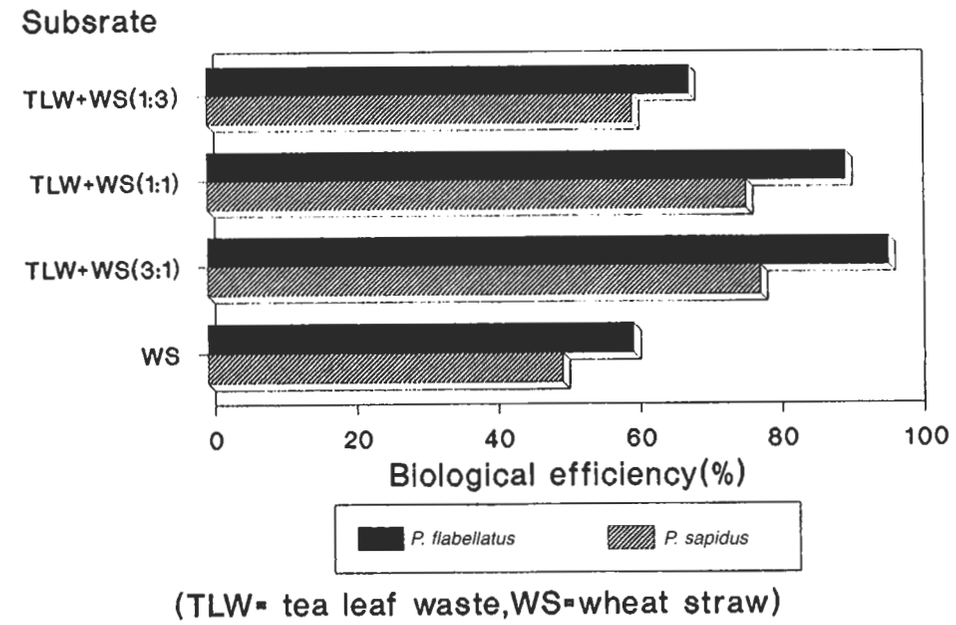

Fig. 1. Biological efficiency of *Pleurotus* spp. on tea leaf waste and wheat straw.

5 CONCLUSION

It could be concluded that wastes from the tea leaf industry can be utilized for growing oyster mushrooms after mixing with some lignocellulosic substances. The substrates, therefore, must be autoclaved before spawning. It will help for efficient utilization of industrial tea leaf waste for producing microbial protein through mushrooms in a country where protein deficiences is a nutritional problem among the people.

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