



13

MANAGEMENT OF SPENT SUBSTRATES AND WASTE DISPOSAL OF VARIOUS MUSHROOM

Spent mushroom substrate (SMS) is the material left after taking the crop of mushrooms. Spent substrate is high in organic matter. Hence, it can be used for various purposes. We have seen that substrate prepared specifically for growing mushrooms is a blend of ingredients like wheat straw, corn cobs, cottonseed hulls, poultry manure, cottonseed meal, gypsum, etc. Spent mushroom substrate still has some nutrients available for the mushroom. However, it is more economical to replace the substrate and start a new crop and use this SMS for other purposes. It may be possible to use fresh substrate for cultivation of some mushrooms whereas in other cases we may have to first compost it before use. Accordingly, the composition and thus the use of SMS of different mushrooms may also be different. As salt content in SMS is high, it may not be possible to use it in crops sensitive to salt concentration. We will discuss some of the uses of SMS and its management in this lesson.



OBJECTIVES

After reading this lesson you will be able to

- know the amount of SMS left after cultivation of mushroom;
- choose different options for its utilisation;
- state problems and limitations of its use.



13.1 WHAT IS SPENT MUSHROOM SUBSTRATE?

Mushroom growing is an eco-friendly activity as it utilizes the waste from agriculture, poultry, brewery, etc. and in turn produces a quality food. After production of mushrooms some compost/ substrate will still be there in bags and it may not be economical or possible to get more mushrooms from this remaining material. This is referred as Spent Mushroom Substrate (SMS). Every kg of mushroom produced results in generation of 5-6 kg of SMS. The quality of this by-product will vary with the mushroom species. For example, straw is well composted for cultivation of button; un-composted straw is used for oyster; saw dust is used for shiitake, wood ear mushroom, *Flammulina*, etc. Accordingly, the traits and composition of SMS will vary in different mushrooms.

As mushroom production is increasing, so is the SMS generation, which calls for management of this so-called waste. Fortunately, SMS has many positive attributes still left for its potential uses. The material has been found to be a good nutrient source for field and horticultural crops because of its nutrient-status. SMS can be used for organic-farming and can be processed into valuable products and we can earn benefit for ourselves and also for the environment.

SMS has, however, slightly higher salt content. You may be wondering that why it has more salts. The substrate shrinks during cultivation and salts of water that is sprayed regularly on the bags also stay there. The mechanism is similar to that occurs in sea. Here, when we keep on watering for 1-2 months, the water keeps on evaporating daily leaving the salts behind in the substrate. Further, a 10 kg bag after full crop production becomes a 5 kg bag in which the minerals already present in the compost get concentrated. Thus the major hurdle in SMS exploitation as organic manure comes from increase in salt concentration. This may require further compositing and leaching.

Mushroom cultivation offers a unique opportunity to recycle crop wastes for production of quality food followed by manure production or other modes of complete recycling of wastes. Thus, we do not only get quality health food using waste, but we also promote organic cultivation. The only drawback of SMS is that it has more salts and hence it may be used after leaching or may not be incorporated in the same field year after year when it is to be used as manure/soil amendment.

When the substrate is removed from the cultivation room, it may not be used immediately but we may compost or weather/leach for further improvement of the physical and chemical characteristics of the material.



13.1.1 Crop Production

Mushrooms are cultivated on various agrowastes and hence its residue is suitable for agricultural crops. In fresh SMS, however, salt content is more and hence may be used with caution and not be used in the same field year after year. Uses of SMS are summarized as below.

- **Greenhouse crops:** SMS can be used as a manure in various green house crops to promote organic production of vegetables. The SMS of button mushroom can be composted to prepare manure or vermicompost. Button mushroom SMS can also be used as potting soil for production of vegetables and flowers in green houses.
- **Field crops/Organic fertilizer:** SMS is rich in NPK and is a good substitute to Farm Yard Manure. *Agaricus* SMS is incorporated preferably after composting for an year or so and leaching for production of various crops and vegetables. *Pleurotus* SMS has also been used for cultivation of egg plant, tomato, zucchini, etc.
- **Soil improvement/reclamation/rehabilitation:** Addition of SMS in nutrient poor soil helps in improvement of soil health by improving soil properties like texture, water holding capacity and nutrient status and has also been reported to have bioremedial properties.
- **Horticulture:** If we decompose and leach the SMS for one or two years, it becomes suitable for cultivation of flowers, vegetables, fruits, saplings, ornamental shrubs and other horticultural plants. However, SMS has slightly higher salt content and hence may not be used for salt sensitive crops.
- **Nursery:** Decomposed SMS can be one of the ingredients of nursery/potting mixture and also in landscape activities.
- **Turf and Lawns:** We may Incorporate SMS into soil prior to turf establishment and do surface applications of SMS on established turf. Spent mushroom substrate is excellent to spread on top of newly seeded lawns. The material provides cover against birds eating the seeds and acts as mulch where it will hold the water in the soil while the seeds germinate.

13.1.2 Reuse in the Cultivation of Mushrooms

The SMS can be recycled and put to various uses in mushroom cultivation. For example, it can be used as casing. Some of the options for this are as below.

- **Additional crop** after reversal and recasing the bags: In button mushroom it is possible to get an additional crop by reversal and recasing the bags. This is more useful when there is crop failure due to biotic and abiotic factors and some nutrition to support the crop is still left in the compost.



- There are reports where different supplements have been added to SMS and good crop has been obtained.
- **Partial replacement of straw:** Upto 20 % SMS can be added as a replacement of straw while preparing compost of button mushroom. This reduces the cost of cultivation and helps in disposal of SMS.
- **Casing material for *Agaricus bisporus*:** Two year old anaerobically composted SMS of *Agaricus bisporus* can be used as casing material. This is a good replacement of peat moss which is used as casing in other countries and is not easily available in our country.
- **Cultivation substrate for other mushrooms :** SMS of Shiitake, *Hypsizygus*, *Flammulina* can be used for growing oyster mushroom after supplementation with bran, lime, etc

13.1.3 Food for Animals and Fish

SMS of some of the mushrooms like oyster mushroom can be used as animal feed or even in aquaculture as discussed below.

- **Animal feed:** SMS of oyster and other mushrooms grown on un-composted substrates can be used as animal feed or to prepare animal feed supplements. *Pleurotus* spp SMS has been evaluated extensively as a feed stock. There are limited studies on *Agaricus* SMS. As mushrooms act on celluloses, hemi-celluloses and lignin, the digestibility of SMS is high. It may be possible to add 20-30% SMS of oyster grown on wheat straw in the normal feed. We may further ferment the SMS of oyster or shiitake to increase protein content of the feed.
- **Aquaculture:** Some experiments have evaluated *Agaricus bisporus* SMS as a component in the diet of Carp.

13.1.4 Pest Management

SMS, in addition to improving soil quality, has also been reported to be effective in checking many soil borne diseases. *Agaricus bisporus* SMS has been assessed against various plant diseases like apple scab, damping-off disease of Tomato, Fusarium wilt, rot and other soil borne diseases of many crops.

13.1.5 Bioremediation

Bioremediation is the use of living organisms such as bacteria, fungi, or green plants, to remove or neutralize unwanted contaminants in air, soil, or water. SMS has been assessed as a partial solution to environmental contaminations.



Notes

Management of Spent Substrates and Waste Disposal of Various Mushroom

- **Air:** *A. bisporus* substrate after mixing with other materials has been used for removal of H₂S and organic volatiles
- **Water:** Waste water generated from many industries is contaminated with heavy metals, dyes used in textile or plastic industries, or pesticides from agricultural operations. Spent substrate from *Agaricus bisporus*, various *Pleurotus* species have been investigated for the removal of heavy metals and number of other contaminants successfully.
- **Soil:** Various industrial sites can be reclaimed and got rid of negative effects (like heavy metals, dangerous chemicals, etc) by filling these with SMS.
- **Pesticides:** SMS of *Agaricus*, *Pleurotus*, *Lenntinula* has been extensively evaluated for degradation of various pesticides with successful results.

13.1.6 Other Uses

Other miscellaneous uses are:

- **Renewable Energy:** SMS can be used for direct burning after drying (biofuel)/ or can be converted to briquettes for use in boiler, etc.
- SMS of button has been used for production of biogas.
- SMS of many mushrooms can be an important source of different lignocellulase enzymes.
- SMS after drying and processing can also be used as carrier material for bioinoculants and may be also for nano particle production.
- In addition to preparing manure, SMS can also be used for vermiculture/ vermicompost and making various other types of compost.
- SMS can be dumped directly in mined areas for rehabilitation of the mining sites.



INTEXT QUESTIONS 13.1

Fill in the blanks

- (i) Every kg of mushroom produced leaves behind kg spent mushroom substrate.
- (ii) SMS may not be repeatedly put in the same field as it has high content of



- (iii) SMS of is more useful for making manure.
- (iv) SMS of is more useful for using as animal feed or making food supplements.
- (v) During cropping of button mushroom, 2-year old decomposed SMS can be used as material.



WHAT YOU HAVE LEARNT

Let us recapitulate the important points we have learnt in this lesson:

- That mushroom cultivation is a way for complete recycling of agro-wastes.
- As SMS has more salts, it should not be put in the same field every year
- It is better to compost SMS before use.
- Decomposed SMS can be used as manure for various crops, in greenhouse, nursery or in lawns.
- Incorporation of SMS improves soil quality.
- SMS of button can be reused as casing material.
- SMS of some mushrooms can be used for cultivation of other mushrooms.
- SMS of oyster and some other mushrooms can be used as animal feed.
- SMS is reported to control some soil borne diseases and is a suitable material for bioremediation.
- SMS can be used to make vermicompost, can be burnt, used for making biofuel, etc.



TERMINAL EXERCISE

1. Waste of which mushroom can be used as animal feed?
2. Why the SMS should not be put in the same field year after year?
3. Describe some of the uses of compost for use in fields, green house, nursery or lawns
4. How SMS can be reused for cultivation of mushrooms? Describe three options.
5. Describe some of the areas where SMS can be used for bioremediation.



Notes



ANSWERS TO INTEXT QUESTIONS

13.1

- (i) 5-6 (ii) salts (iii) button mushroom
(iv) oyster mushroom (v) casing

Key Learning Outcomes

- Manage bio waste of mushroom industry.