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Mushroom: Post-harvest processing and marketing

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In general, mushroom should be harvested while the partial veil is still intact or before they open. Mushrooms are usually enjoyed fresh, but this can be problematic as most species should be consumed within three to four days of harvesting in order to avoid spoilage. Where infrastructure permits, harvesting and immediately selling to an end consumer, local market or regional wholesaler on the same day ensures a better price. In larger enterprises, cold rooms can be used to store the mushrooms before they are sent to market. Optimum storage temperature varies between 5 and 8°C. Processing can assist marketing, by extending shelf-life for small scale producers until they need to sell their product, and in some cases adding value. Some infrastructural investment may be needed to undertake processing effectively and once processed, mushrooms need to be packaged and stored carefully. Mushrooms may be frozen and placed in airtight containers; however, unprocessed mushrooms take up a lot of room and this can be a costly way of preserving them. Mushrooms are also suitable for drying, enabling them to be stored for long periods without deteriorating. A successful marketing programme means that growers increase their income status, which in turn creates condence in their ability to grow mushrooms protably. The details of post-harvest activities and marketing strategies in mushroom enterprise are given under.

Grading, packing and storage : Soon after harvest, mushrooms have to be cleaned, graded and packed before sending to the market or stored in a cool atmosphere. The grading and sorting is done according to their colour (pure white, slightly brown, damaged), size, stage of the cap or partial veil (Intact, slightly open, open), length of the stem etc. Mushrooms are highly perishable and get spoiled due to browning, wilting, liquefaction, loss of texture, aroma, flavor etc., making it unsaleable. Mushrooms are best consumed as fresh. However, in actual practice this is may not be possible. The storage at high temperature results in browning. Mushrooms have a high rate of respiration and hence proper attention should be given for storage. Some of the commonly adopted methods for storage/ enhancement of shelf life of mushrooms are described hereunder:

***Refrigeration*:** Freshly harvested mushrooms are packed in 25-gauge polythene bags without making any holes. Immediately after packing they are stored at 5°C in a refrigerator. This process extends the storage life for 3-5 days. This process helps in reducing the respiratory rate and minimizing the water loss. In addition, it reduces browning of mushroom and off flavour development.

***Washing of mushrooms is normally done to remove soil particles*:** It leads to decline in shelf life and spoilage by bacteria. Washing with Oxine (50 ppm) or with sodium hypochlorite (100 ppm) and calcium chloride (0.55%) resulted in increased antibacterial effectiveness. Washing with 0.05% potassium meta-bisulphite improves the initial whiteness. However, unwashed properly packed mushroom is better option.

***Modified atmosphere packaging* (*MAP*):** MAP is a method by which a modified atmosphere is created in a sealed package of a fresh product by respiratory gas exchange, namely oxygen (O_2) intake and carbon dioxide (CO_2) evolution.

***Controlled atmospheric storage*:** In this method, the oxygen and carbon dioxide concentrations are altered inside the package and respiration rate gets altered. It reduces brown discolouration (enzymatic browning) and the shelf life is extended.

***Vacuum cooling*:** In vacuum cooling, the water in cell walls and inter hyphal spaces of mushrooms is evaporated

under low pressure and the evaporative cooling lowers the temperature from ambient to 2ºC in 15 to 20 minutes.

***Ice-bank cooling*:** In this, a stack of mushrooms is passed through forced draft of chilled but humidified air from the ice-bank.

***Irradiation*:** Irradiation with gamma rays (Cobalt 60) just after harvest can be used to reduce the contamination and extend the shelf-life of mushrooms.

***Freeze-drying*:** The mushrooms are sliced and immersed in 0.05 per cent sodium meta-bisulphite and 2 per cent common salt solution for 30 minutes. They then blanched in boiling water for 2 minutes, followed by cooling and frozen for one minute at -12°C and store at –20°C. This process extends the storage life for 3-4 months.

Dehydration: This treatment involves three steps *viz.,* Pretreatment, drying and storage.

– Pre-treatment : Clean the mushroom and blanch it in boiling water for 2 minutes and immerse it in cold water for 2 minutes. Dip the mushroom in water containing 0.2 per cent potassium meta-bisulphite and 1 per cent citric acid and use for drying.

– Drying: Drying is the process of removal of moisture from the product to such a low level that microbial and biochemical activities are checked due to reduced water activity, which makes the products suitable for safe storage and protection against the attack by microorganisms during the storage. Mushroom dried at higher temperature loose texture, flavor, color along with reduced rehydrability. Dehydrated mushrooms are used as an important ingredient in several food formulations including instant soup, pasta, snack seasonings, casseroles, and meat and rice dishes. Dried mushrooms can be easily powdered and used in soups, bakery products, etc. Mushrooms can be dried with following measures.

– Sun-drying: mushrooms are spread over the trays or sheets and kept in open under the sun (25 ^{0}C, >50% RH, high velocity, 2-3 days @ 4 hrs per day) and may be covered by a thin cotton sheet. Sun dried product contains more than 10-12 % moisture and should therefore be oven dried at 55-60^{0}C for 4-6 h to further reduce the moisture to 7-8 % to avoid any spoilage during storage. The dried product regains to a large extent its flavour and texture after rehydration. The technique has however, been not used for the button mushroom. Other mushrooms are generally sun-dried by resource-poor growers. Sun drying of mushroom is done till it reaches 1/10th weight of the fresh product. After drying, it can be stored for 3 months, however color may turn to brown and appearance of the final product is not good.

– Drying in flow drier : Dry the pre-treated mushroom at 60°C with heated air for 6-8 hr. This process lead to bring the final moisture level to 3-5%.

– Vacuum drying : Dry the pre-treated mushroom at 40°C under vacuum condition instantly. This process yields a very good quality mushrooms but cost of processing is heavy.

Now-a-days apart from sun drying, bigger and sophisticated Mechanical Dehydrators *viz.,* fluidized bed drying, dehumidified air- cabinet drying, osmo-air drying, freeze-drying, cabinet drying and microwave drying are available in the market.

Canning: Canning is adopted on a very large scale, especially for preservation of button mushrooms. For canning purpose, the mushrooms should be harvested at an early stage. The mushrooms of uniform size are selected and stalks are cut before processing. The procedure of canning is given under.

– Wash the mushroom in clean water to remove dirt and other foreign materials.

– Dip the mushroom in boiling water for 2 minutes, take it out and dip in cold water for 2 minutes.

– Fill the mushrooms in the specially made cans upto ¾ capacities. (Approximately 220-g mushrooms are filled in 1-lb cans)

– Add salt solution consisting of 2 per cent common salt, 2 per cent sugar and 0.3 per cent citric acid just to fill up to the brim. Before adding, the salt solution should be boiled and filtered through muslin cloth. About 125 ml solution is needed for 1 lb can.

– Place the lid on the can and keep the cans in boiling water or steam till the temperature in the centre of the cans reaches 80-85°C.

– Seal the can on a seamer to get an air tight seam.

– Sterilize the cans in an autoclave at 10 lb. pressure for 20-25 minutes.

– Keep the cans immediately after sterilization in clean cool water for cooling.

– Wipe the cans with a dry cloth and store in a cool dry place. This process extends the storage life upto 12 months.

***Steeping preservation*:** Mushrooms can be preserved for short period by steeping them in solution of salt or acids. The common practice is that cleaned mushrooms are washed in water or chemical added water and filled in large plastic containers. Blanching in brine solution for 5 minutes is generally done before filling them in cans. Brine solution is then added into the cans or containers. Steeping of water blanched mushrooms in 1% potassium meta

bisulphite (KMS) along with 2% citric acid (overnight), before drying improves colour, texture and reconstitution properties. Solution consisting of 2% sodium chloride, 2% citric acid, 2% sodium bicarbonate and 0.15% KMS is used for steeping preservation of blanched mushrooms for 8-10 days at 21-28ºC.

Refrigerated transport **:** To keep the mushrooms, cool during transport to short distances, the polypacks of mushrooms can be stacked in small wooden cases or boxes with sufficient crushed ice in polypacks (over-wrapped in paper). For long distance, transport of large quantities in refrigerated trucks is essential though it is costlier. Once they reach in the market, they must be immediately transferred to the deep freezer.

Storage of oyster mushroom at very low temperatures especially in non-perforated polypacks results in condensation of water with increased sliminess and softening of the texture. Cooling with positive ventilation is desirable i.e. cold air should be directed through the packed produce. Milky mushroom has very good shelf life of 3-4 days without loss of colour and appearance. Its storage is almost same as for the button mushroom. Paddy straw mushroom may be stored at 10-15ºC in polythene bags with perforations. In general, the shelf life of this mushroom is very less and it sold on the day of harvest.

Value addition of mushrooms : In India, mushroom industry is focusing predominantly on trade of the fresh produce rather than the real value-addition. Almost entire domestic trade is in the fresh form while most of the export is in the preserved form (canned or steeped). As mushrooms contain high moisture and are delicate in texture, these cannot be stored for more than 24 hours at the ambient conditions of the tropics. This leads to weight loss; veil opening, browning, liquefaction and microbial spoilage of the product making it unsaleable. Effective processing techniques will not only diminish the post-harvest losses but also result in greater remuneration to the growers as well as processors. Value can be added to the mushrooms at various levels, right from grading to the readymade snacks or the main-course item. Value-added products of mushrooms are the mushroom soup powder, biscuits, nuggets, noodles, papad, ketch-up, candies, chips, preserve and readymade mushroom curry. Attractive packaging of the value-added products is also very important get the optimum price.

Marketing of mushrooms : Since mushrooms are highly sensitive and early perishable products, these should reach to the market as early as possible, immediately after the harvest. The white colour is preferred by the consumers; hence to increase the whiteness and shelf life, most of the growers wash their button mushroom produce in 0.05 per cent KMS or Potassium meta-bisulphite solution for 1 minute (5 g in 10 litre water). In India mushrooms are sent to the market either in loose packing or in poly packets of different weights and sold through auction in vegetable markets or through vegetable vendors. Mushrooms packed in attractive boxes and covered with attractive papers are known to fetch higher price as compared with the mushrooms in ordinary packings.

The market for mushrooms continues to grow due to interest in their culinary, nutritional, and health benets. Many specialty mushrooms can be cultivated, but the market, though growing, is still limited. If you are thinking about starting a commercial mushroom enterprise, begin at the end: to whom will you sell them? You cannot make money in any business if you don't have buyers for your product. Learn who buys mushrooms, what kinds they want, and where they shop. You must thoroughly investigate the demand for each mushroom species or product - as well as the available marketing outlets - before committing large amounts of capital to the enterprise. Check the local situation on your own. Some common methods for conducting initial research include observation of buyers, surveys of stores, personal interviews with growers, and test marketing (once you have an experimental product). Another function of market research is to evaluate the competition. This will help you determine what market already exists and identify any niches you could ll. To nd out more about your competitors, use their products. Talk to them. You may be surprised how much information they will share.

If you can sell your mushrooms or mushroom products directly to an end user, you will naturally receive a better price than if you sell to a wholesaler. Direct marketing of mushrooms at local farmers' markets, to restaurants, or in supermarkets is possible in many locations. When competing in local markets, excellent service, top quality, and consistent supply, rather than the lowest price, might win the sale, particularly with gourmet chefs. Some chefs specialize in locally grown foods and may be interested for that reason. Others are willing to pay for fresh, premium produce. In any case, establishing a relationship with the buyer and reliably delivering a quality product are essential for this type of marketing. Local grocery stores are another potential buyer of fresh mushrooms. Any chef or grocer will require assurances of both quality and regular supply before switching from established wholesale sources. Although the wholesaler with an established account

Fig. 1: Value added products of mushroom: A-Button mushroom pickle, B-Oyster mushroom papad and C-Oyster mushroom powder

creates stiff competition, the small, efcient producer might still have an advantage in some niche markets. Find the buyer to whom quality matters, and you will have found a market for your product. Selling fresh mushrooms to a wholesaler will mean a lower price than if you market directly. However, for growers who choose not to involve themselves in direct sales, there are wholesale markets for mushrooms. Wholesalers advertise in produce industry periodicals. Your local librarian or an Internet search can help you locate other such magazines. Small-scale commercial production of white button mushrooms is not recommended for the beginner, except on a small scale for direct marketing. Drying mushrooms is another way to add value and avoid the low prices of the peak season.

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