Why Post Harvest Management is Important in Mushroom?

- High moisture content
- Delicate texture
- Highly respiration rate

Low shelf life

- Enzymatic reactions
- Microbial action

Spoilage
- Browning
- Wilting
- Liquefaction
- Loss of texture, aroma, flavor
<table>
<thead>
<tr>
<th>Class</th>
<th>Range at 5 °C</th>
<th>Commercies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>mg CO₂ kg⁻¹ h⁻¹</em></td>
<td></td>
</tr>
<tr>
<td>Very Low</td>
<td>&lt;5</td>
<td>Nuts and dates</td>
</tr>
<tr>
<td>Low</td>
<td>5 to 10</td>
<td>Apple, citrus, grape, kiwifruit, onion, potato</td>
</tr>
<tr>
<td>Moderate</td>
<td>10 to 20</td>
<td>Apricot, banana, cherry, peach, nectarine, pear, plum, fig, cabbage, carrot, lettuce, pepper, tomato</td>
</tr>
<tr>
<td>High</td>
<td>20 to 40</td>
<td>Strawberry, blackberry, raspberry, cauliflower, lima bean, avocado</td>
</tr>
<tr>
<td>Very High</td>
<td>40 to 60</td>
<td>Artichoke, snap bean, Brussels sprouts, cut flowers</td>
</tr>
<tr>
<td>Extremely high</td>
<td>&gt;60</td>
<td>Asparagus, broccoli, mushroom, pea, spinach, sweet corn</td>
</tr>
<tr>
<td>Temperature °C (°F)</td>
<td>ml CO₂/kg.hr.</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------</td>
<td></td>
</tr>
<tr>
<td>0 (32)</td>
<td>14-22</td>
<td></td>
</tr>
<tr>
<td>5 (41)</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>10 (50)</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>15 (59)</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>20 (68)</td>
<td>132-158</td>
<td></td>
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<tr>
<td>25 (77)</td>
<td>&gt;210</td>
<td></td>
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</table>
Losses at farm and postharvest channels

**On farm**
- Improper handling, diseases and insects
- Improper harvesting technique

**Postharvest channels**
- Improper sorting and grading
- Poor handling and packaging
- Transportation losses
Postharvest Management Practices of MUSHROOM

HARVESTING

GRADING

PRE COOLING (1.7°C -7.2°C)

FRESH

PROCESSED (CANNING, DRYING, PICKLING, I.Q.F)

PACKING

POLYPOUCHES

CARTONS

TRANSPORTATION

BY ROAD (ORDINARY, REFRIGERATED)

BY AIR

MARKETING

DOMESTIC TRADE

MAJOR MARKETS (DELHI, PUNE, CHANDIGARH, MUMBAI)

EXPORT

MAJOR MARKETS (U.S.A, SWITZERLAND, FRANCE, GERMANY, NETHERLAND)
Post harvest handling of Button Mushroom
Harvesting is done at button stage and caps measuring 2.5 to 4 cm. Mushrooms are harvested by light twisting without disturbing the casing soil.
Quality indices for white button mushrooms
- White in color
- Uniform, well rounded cap with a smooth glossy surface
- Fully intact veil
- Stipes are straight and glossy in appearance
- Cleanliness and absence of browning
- No visible or open gills

Grading of mushroom
- Small: (1.9 – 3.2 cm / 0.75-1.25 inch)
- Medium: (3.2 – 4.5 cm / 1.25 – 1.75 inch)
- Large: (>4.5 cm / 1.75 inch)
Flow Sheet for the harvesting and packaging of White button mushroom (*Agaricus bisporus*)
Washing

• Done to remove soil particles
• But can lead to decline in shelf life and spoilage by bacteria
• Antimicrobial and reductant compounds used in washing to extend the shelf life
  • 0.05 % Potassium meta bisulphite (KMS)
  • 0.5 % Calcium chloride
• Selling clean, unwashed properly packed mushroom may be a better option
Precooling

• Temperature of mushroom at picking varies between 15-18°C
• Should be brought down to 4-5°C
• For local markets- retail packs of 200g or 400g in polythene or polypropylene packs of less than 100 gauge thickness with 0.5 % vent.

• For long distance transportation of large quantity of mushrooms (400 g to 5.0 kg) – polythene or pulp-boards punnets overwrapped with differentially permeable PVC or polyacetate films- remain fresh for 3 days at 18 °C

• Packaging of mushroom in polypropylene bags with moisture absorber (e.g. silica gel) could be better option
Button mushroom in a punnet
Packing material
Freshly harvested mushrooms should be immediately processed by any of the following methods.

- Short term storage
- Long term storage
## Short term storage by Refrigeration

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Harvesting</strong></td>
<td>• Cut the mushrooms at the soil line</td>
</tr>
<tr>
<td><strong>Washing</strong></td>
<td>• Washing in a antimicrobial solution</td>
</tr>
<tr>
<td><strong>Draining</strong></td>
<td>• Remove excess of water</td>
</tr>
<tr>
<td><strong>Packing</strong></td>
<td>• Packed in perforated poly bags (250-500 g)</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>• Storage in polyethylene bag at 4-5°C for 7-10 days</td>
</tr>
</tbody>
</table>
Preservation in Steeping Solution

Fresh mushrooms
↓
Wash
↓
Cut the stock
↓
Immerse in KMS Solution (0.5%)
↓
Blanch in citric acid solution
(3 min., 0.1% CA)
↓
STEEPING PRESERVATION (Cont.d)

Cool

↓

Prepare Steeping Solution
(15% salt + 0.05% citric acid + 100ppm SO₂).

↓

Fill the mushrooms in Glass bottles

↓

Put Steeping Solution

↓

Put caps and seal air tight

↓

Labeling and storage

RT: 3-4 months
• Straw adhered to mushroom is removed
• No washing
• Packing in polyethylene bags of less than 100 gauge thickness with perforation having vent area of 5%
• Storage under cooling with ventilation is desirable i.e. cold air should be directed through the packed produce
• Transportation in trays or baskets or polythene packs with crushed ice packs
Post Harvest Handling of Milky Mushroom

• Seasonal growers
• Highly localized market
• **Very good shelf life of 3-4 days** without loss of color and appearance
• Washing, packaging, pre-cooling and refrigeration, transport and storage is **same as button mushroom**
Bulk Packing of milky mushroom
Packing of milky mushroom
Bumper harvest of milky mushroom

Packing of milky mushroom in progress
Post Harvest Handling of Paddy Straw Mushroom

- **Shelf life is very less** and mushrooms are sold on the day of harvest
- **Low temperature causes** frost injury and deterioration in quality
- **Storage at** 10-15 °C in polythene bags with perforation
- **Transportation in** bamboo baskets (in Taiwan) and wooden cases (in China)
Dedicated cool chain
Temperature management is essential for quality retention

- Temperature of button mushroom after picking varies between 15-18°C and rises during storage.
- Maintenance of low temperature in different stages of handling by means of a cold chain results in reduction of losses and retention of quality of products.
- It is yet to become popular owing to several difficulties such as high cost, lack of abundant uninterrupted power supply etc.
- Instead of mechanical refrigeration we should try some other alternative cooling system viz. evaporation cooling, hydro-cooling, ice bank or vacuum cooling etc.
- In this respect the advantages of evaporative cooling can be utilized and a cool chain based on the principle of evaporative cooling can be established.
Processing

Drying

Canning

Pickling

Hot air oven drying

Canned Mushroom
Drying of Mushroom

- Sun drying
- Mechanical drying
**Drying**

- Drying refers to the removal of water by heat to such a level that the biochemical and microbial activity is checked due to reduced water activity ($a_w$) in the produce.

- **Pre-treatments:** Water blanching of mushroom (*Agaricus bisporus*) for 5 minutes along with 0.5 per cent citric acid and 0.05 per cent KMS to improve colour and texture of mushroom slices.

- **Drying in cabinet-air drier at** 55-60 ± 2°C **results in high per cent of yield**
Cabinet dryer

Trays loaded with material
Canning is the most common process for preserving mushrooms, particularly *Agaricus* mushroom.

Canning is divided into six operations; cleaning, blanching, canning, sterilization, cooling, labeling and packing.

Use of tomato juice is better as canning medium for retaining the mushroom quality than the brine solution.
Canning of mushrooms

Button mushroom
↓
Wash
↓
Cut the stock
↓
Immerse in KMS Solution (0.05%)
↓
Blanch in citric acid solution and cool
(Blanching time 5 min., 0.1-0.2% CA, improves colour)
↓
Fill in plain cans
Add hot brine solution
(1-2% salt + 0.1% citric acid)

Exhaust
(heating at 80°C temperature, 3-5 min.)

Seaming

Pressure processing
(Autoclave/Retort, 118 °C, 10-15lbs, 15-20 min.)

Labeling and storage
Canning unit for processing of 50 tonnes mushroom/year

Area required: Hall (50’x25’) and boiler room (8’x8’)

Equipments:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Approximate cost (Rs.)</th>
</tr>
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<tbody>
<tr>
<td>Can reforming unit with flanger</td>
<td>1.50 lakhs</td>
</tr>
<tr>
<td>Flange rectifier</td>
<td>50,000</td>
</tr>
<tr>
<td>Lid embossing machine</td>
<td>50,000</td>
</tr>
<tr>
<td>Double seaming machine</td>
<td>1.5 lakhs</td>
</tr>
<tr>
<td>Washing tank (2 Nos.)</td>
<td>20,000</td>
</tr>
<tr>
<td>Steam jacketed double wall kettle (2 Nos.)</td>
<td>2.50 lakhs</td>
</tr>
<tr>
<td>Cooling tank</td>
<td>10,000</td>
</tr>
<tr>
<td>Exhaust box (18 ft)</td>
<td>1.50 lakhs</td>
</tr>
<tr>
<td>Canning retort with two crates</td>
<td>1.50 lakhs</td>
</tr>
<tr>
<td>Stainless steel working tables (2 Nos.) of 3’x8’</td>
<td>40,000</td>
</tr>
<tr>
<td>Boiler with necessary fittings</td>
<td>1.50 lakhs</td>
</tr>
<tr>
<td>Miscellaneous small instruments including aluminium trays</td>
<td>50,000</td>
</tr>
<tr>
<td>Total</td>
<td>12.20 lakhs</td>
</tr>
</tbody>
</table>
Pickling

- Pickling of mushroom is also a popular method of preserving.

- It is more economically viable way during the surplus periods.

- Sweet chutney from edible mushroom having a shelf life of over a year with better sensory qualities.

- Pickle prepared from paddy straw mushroom was also reported with better quality.

Recipe for Mushroom Pickles

- Oil: 10%
- Red chilly: 2.5%
- Mustard Seeds: 3.0%
- Mustard Powder: 0.5%
- Methi Seeds: 1.6%
- Cumin: 1.5%
- Clove: 0.3%
- Cinnamon: 0.2%
- Pepper: 0.6%
**Button Mushroom Pickle**

1. **Wash** harvested mushrooms in water (containing 300 ppm KMS)
2. **Blanch** mushrooms in hot water at 85 °C for 5 min and then dip immediately in cold water
3. **Cut** in halves or quarters according to the desired size
4. **Salt** mushroom 90 g salt/kg mushrooms and **keep overnight**
5. Drain excess and accumulated water and **surface dry mushrooms** for 2-3 hours
6. **Add salt and spices** as per the given recipe and mix with hands
7. **Add** **vinegar** to the pickle mix
8. **Add** **heated mustard oil** from the top to the mix and blend with both hands
9. **Leave overnight** for balancing of spices and flavor development
10. **Fill** in plastic/glass jars and again top-fill with mustard oil
11. **Storage**
Oyster Mushroom Pickle

1. Fresh mushrooms
2. Wash
3. Cut in to 1” cubes/Pieces
4. Remove Excess moisture by heating in oil
5. Oil
6. Heat
MUSHROOM PICKLES (Cont.d)

Add chilly powder
↓
All other spices (Heated and powdered)
↓
Mix with Prepared and heated Mushrooms
↓
Add salt
↓
Cool
↓
Add Acetic acid
↓
Store for balancing of spices
Individual quick freezing (IQF) is another popular processing method.

After that, blanched and water cooled mushroom are subjected to tunnel freezing stage. At this stage are cooled in a system having temperature around -40°C and core areas of mushroom pieces acquire a temperature of around -18°C.

Subsequently packed in multi-layer poly-bags and stored in a cold storage having temperature – 20°C to -35°C.

Vacuum freeze drying (V.F.D) is a further development in mushroom processing. In this process the original shape, quality, colour, size, texture, freshness properties of thermal produce are retained.
Other Value added Products of Mushroom
Mushroom soup powder

Plate: 3  Mushroom tikki mix
Plate: 1  Mushroom noodles
Plate: 2  Instant mushroom soup powder

Standard recipes of valued-added products of mushroom

Plate: 2  Instant mushroom soup powder
Mushroom biscuits
Mushroom Biscuits

Mix wheat flour with mushroom powder in 80:20 ratio

↓

Mix the fat in high speed mixer

↓

Add sugar to the fat in mixer in 2-3 parts

↓

Blend for 2 min

↓

Mix wheat flour: mushroom with this mix

↓

Add milk powder, flavor and water to make dough

↓

Make thin sheets of uniform thickness

↓

Cut biscuits

↓

Bake at 180 °C for 20 minutes

↓

Let the biscuits cool and Pack
## Ingredients for Mushroom Biscuits

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maida</td>
<td>80 g</td>
</tr>
<tr>
<td>Mushroom powder</td>
<td>20 g</td>
</tr>
<tr>
<td>Sugar</td>
<td>30 g</td>
</tr>
<tr>
<td>Fat</td>
<td>45 g</td>
</tr>
<tr>
<td>Baking powder</td>
<td>0.6 g</td>
</tr>
<tr>
<td>Ammonium carbonate</td>
<td>0.3 g</td>
</tr>
<tr>
<td>Salt</td>
<td>0.6 g</td>
</tr>
<tr>
<td>Vanilla essence</td>
<td>0.02 g</td>
</tr>
<tr>
<td>Milk powder</td>
<td>1.5 g</td>
</tr>
<tr>
<td>Glucose</td>
<td>1.5 g</td>
</tr>
<tr>
<td>Water</td>
<td>12-22 ml</td>
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</tbody>
</table>
Mushroom cake
Mushroom chips
Mushroom Chips

Slice mushrooms to average slice of thickness of 2.5 mm each
↓
Blanch in hot water (2 min) and dip immediately in cold water
↓
Spread the mushroom for drying (sun or tray drying)
↓
Pack the chips in PE bags
↓
Store in cool and dry place
↓
Fry for consumption at 170 °C for 1.5 min
Mushroom preserve
Mushroom candy
Mushroom Preserve and Candy

1. Wash Mushrooms
2. Blanch in hot water and dip immediately in cold water
3. Cut mushrooms in candy size (2 x 2 cm)
4. Prepare sugar solution of 50 % by heating
5. Dip cut mushrooms in hot sugar solution
6. Place the container till it reaches room temperature and then refrigerate overnight
7. Strain the mushrooms out of sugar solution
8. Add more sugar to sugar solution and heat to attain strength of 60 %
9. Add Citric acid @0.1% to sugar solution
Dip the mushrooms in this and place in refrigerator overnight

↓

Repeat with 70% and 75% sugar solution

↓

Strain the mushrooms out of sugar solution

↓

Spread them on drying tray

↓

Leave for 3-4 h till the surface in dried

↓

Pack the candy in polyethylene bags

↓

Store in clean dry place
Mushroom Ketch-up
Mushroom Ketchup/Sauce

Fresh mushrooms
↓
Washing
↓
Slicing
↓
Cook in 50% water for 20 min
↓
Making of paste
↓
Addition of ingredients
↓
Cooking till 1/3rd in volume
↓
Filling in sterilized bottles
↓
Store

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Parts (%)</th>
</tr>
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<tbody>
<tr>
<td>Salt</td>
<td>10</td>
</tr>
<tr>
<td>Sugar</td>
<td>25</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>1.5</td>
</tr>
<tr>
<td>Sodium benzoate</td>
<td>.065</td>
</tr>
<tr>
<td>Onion</td>
<td>10</td>
</tr>
<tr>
<td>Garlic</td>
<td>0.5</td>
</tr>
<tr>
<td>Ginger</td>
<td>3</td>
</tr>
<tr>
<td>Cumin</td>
<td>1</td>
</tr>
<tr>
<td>Black pepper</td>
<td>0.1</td>
</tr>
<tr>
<td>Red chilly powder</td>
<td>1</td>
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</table>
Mushroom Papad
Mushroom Papad

Wash Mushrooms

Blanch in hot water and dip immediately in cold water

Cut mushrooms and make a paste in grinder

Mix with boiled potato paste in 50:50 ratio and add spices (Salt, chilli powder/black pepper, cumin etc.)

Add KMS powder to the blend @300ppm

Spread the papad batter on a polythene sheet in drying tray (10 cm diameter and 1-2 mm thickness)

Keep the trays in sun or in tray drier at 50 °C for 5-6 h

Peel off the papad and pack a set of 10-20 in PE bag

Store in cool and dry place
Mushroom nuggets
Mushroom Badi/ Nuggets

Mushroom powder ↓
Mix with Dhal powder ↓
Make paste by adding water ↓
Blend for 2 min ↓
 Mixing of ingredients and spices ↓
Make round ball of 2-4 cm dia ↓
Spread on steel tray ↓
Sun drying ↓
Mushroom badi/Nuggets

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Parts (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mushroom powder</td>
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<tr>
<td>Urad dhal powder</td>
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</tr>
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<td>Salt</td>
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<tr>
<td>Red chilly powder</td>
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</tr>
<tr>
<td>Sodium bicarbonate</td>
<td>0.01</td>
</tr>
<tr>
<td>Water</td>
<td>7</td>
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</tbody>
</table>
Mushroom Jam

Fresh mushrooms ↓
Washing ↓
Blanching ↓
Grinding into paste ↓
Heating on low flame with addition of
Sugar (1:1 to paste) ↓
Pectin 1 % of paste ↓
Citric acid 1 % of paste ↓
Till it reaches to 68 °Brix (Sheeting test) ↓
Hot filling in sterilized bottle leaving 0.8 to 1.0cm headspace ↓
Sealed and stored cold and dry place
Mushroom noodles and pasta
Mushroom Snack bar

Ingredients:
Mushroom powder
Rolled oats
Puffed rice
Jaggery
Honey
Nuts
Mushroom Multigrain Bread

Ingredients:
Mushroom powder, Refined Wheat flour, Whole wheat flour, Rolled oats, Ragi flour, Flaxseeds, Sugar, Salt, Yeast, Fat
Thanks