**B.Sc.Microbiology**

**2018-2019**

**Semester – VI**

**18MBU601A (4H – 4C)** **MUSHROOM CULTIVATION**

**Instruction Hours / week:L: 0 T: 0 P: 4** **Marks:** Internal: **40** External: **60** Total: **100**

**End Semester Exam:** 3 Hours

**COURSE OBJECTIVES**

To teach on classification, cultivation, diseases and health benefits of mushrooms.

**COURSE OUTCOME**

Provides knowledge on various mushrooms and its cultivation techniques

**Unit I**

Mushroom morphology: Different parts of a typical mushroom and variations in mushroom morphology. Key to differentiate edible from poisonous mushrooms. Mushroom Classification: Based on occurrence – Epigenous and hypogenous, Natural habitats – Humicolous, Lignicolous & Coprophilous, Color of spores – white, yellow, pink, purple brown and black. Ainsworth et al classification ($8^{th}$ edition) and Bisby's 'Dictionary of Fungi'.

**Unit II**

Biology of Mushrooms: Vegetative characters, general morphology, spore germination and life cycle of button mushroom (*Agaricus bisporus*), milky mushroom (*Calocybe indica*), oyster mushroom (*Pleurotus sajorcaju*) and paddy straw mushroom (*Volvariella volvcea*).

**Unit III**

Equipment and sterilization techniques.Isolation and culture of spores, culture media preparation. Production of mother spawn, multiplication of spawn – Inoculation technique – Cultivation technology – Substrates, composting technology, bed, polythene bag preparation, spawning – casing – cropping – Mushroom production – harvest – packing, storage and marketing.

**Unit IV**

Nutritional profile of Mushrooms: protein, amino acids, calorific values, carbohydrates, fats, vitamins & minerals. Medicinal Properties of Mushrooms: Antibacterial, antifungal, antiviral, anti-tumour effect and hematological value. Cardiovascular and renal effect, in therapeutic diets, adolescence, for aged persons and diabetes mellitus. Mushroom nutriceuticals.

**Unit V**

Problems in cultivation – diseases, pests and nematodes, weed moulds and their management strategies. Mushroom economics: economics of spawn and mushroom, cultivation, postharvest technologies. Processing and preservation of mushrooms. Mushroom research centres in India.

**SUGGESTED READINGS**

1. Alice, D., Muthusamy and Yesuraja, M. (1999). Mushroom Culture. Agricultural College, Research Institute Publications, Madurai.

2. Marimuthu, T. et al. (1991). Oyster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.
3. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
5. Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.

| LECTURE PLAN-UNIT-1 | | | |
|---|---|---|---|
| S.NO | Lecture duration hour | Topics | Supporting materials |
| 1 | 1 | Introduction | T1-1-8 |
| 2 | 1 | Mushroom morphology | T1 55-59 |
| 3 | 1 | Different parts of a typical mushroom and variations in mushroom morphology. Key to differentiate edible from poisonous mushrooms | T1 118-119 |
| 4 | 1 | Mushroom Classification: Based on occurrence | T1-59-61 |
| 5 | 1 | classsification-natural habitats | T1 61 |
| 6 | 1 | classsification-based n coloured spores | T1 61-70 |
| 7 | 2 | Ainsworth et al classification (8th edition) and Bisby's 'Dictionary of Fungi'.<br><br>Ainsworth et al classification (8th edition) and Bisby's 'Dictionary of Fungi'. | T1 85-89 |
| 8 | 1 | Unit Revision | |
| Textbooks: | | T1-mushroom cultivation-D.P.Tripathi | |
| Journals: | | - | |
| | | - | |
| Website: | | | |
| Reference books: | | | |
| Total number of hours | | 9 | |

| LECTURE PLAN-UNIT-2 | | | |
|---|---|---|---|
| S.NO | Lecture duration hour | Topics | Supporting materials |
| 1 | 2 | Life cycle of button mushrrom | T1-181-190 |
| 2 | 2 | life cycle of milky mushroom | T1 255-256 |
| 3 | 2 | life cycle of oyster mushroom | T 257 |
| 4 | 2 | life cycle of paddy straw mushroom | T1 258-260 |
| 5 | 1 | Unit Revision | |
| Textbooks: | | T1-mushroom cultivation-D.P.Tripathi | |
| Journals: | | - | |
| | | - | |
| Website: | | | |
| Reference books: | | | |
| Total number of hours | | 9 | |

| LECTURE PLAN-UNIT-3 | | | |
|---|---|---|---|
| S.NO | Lecture duration hour | Topics | Supporting materials |
| 1 | 1 | Equipment and sterilization techniques | T1-125-129 |
| 2 | 1 | Isolation and culture of spores, culture media preparation | T1 160-167 |
| 3 | 1 | Production of mother spawn, multiplication of spawn – Inoculation technique | T1 156-160 |
| 4 | 1 | Cultivation technology – Substrates, composting technology, bed, polythene bag preparation, | T1-137-153 |
| 5 | 1 | spawning – casing – cropping – Mushroom production – harvest | T1 154-156 |
| 6 | 1 | packing, storage and marketing | T1-298-305 |
| 7 | 1 | unit revision | |
| Textbooks: | | T1-mushroom cultivation-D.P.Tripathi | |
| Journals: | | - | |
| | | - | |
| Website: | | | |
| Reference books: | | | |
| Total number of hours | | 7 | |

| LECTURE PLAN-UNIT-4 | | | |
|---|---|---|---|
| S.NO | Lecture duration hour | Topics | Supporting materials |
| 1 | 1 | Nutritional profile of Mushrooms: protein, amino acids | T1-25-27 |
| 2 | 1 | Nutritional profile-calorific values, carbohydrates, fats, vitamins & minerals | T1 28-34 |
| 3 | 1 | Medicinal Properties of Mushrooms: Antibacterial, antifungal | T1 36 |
| 4 | 1 | antiviral, anti-tumour effect and hematological value | T1-37 |
| 5 | 1 | Cardiovascular and renal effect, | T1 38 |
| 6 | 1 | in therapeutic diets, adolescence, for aged persons and diabetes mellitus. | T1-39-41 |
| 7 | 1 | Mushroom nutriceuticals. | |
| Textbooks: | | T1-mushroom cultivation-D.P.Tripathi | |
| Journals: | | - | |
| | | - | |
| Website: | | | |
| Reference books: | | | |
| Total number of hours | | 7 | |

| LECTURE PLAN UNIT-5 | | | |
|---|---|---|---|
| S.NO | Lecture duration hour | Topics | Supporting materials |
| 1 | 1 | Problems in cultivation – diseases, pests | T1-284-293 |
| 2 | 1 | Problems in cultivation – nematodes, weed moulds and their management strategies | T1 293-296 |
| 3 | 1 | Mushroom economics: economics of spawn and mushroom | T1 25 |
| 4 | 1 | cultivation, postharvest technologies | T1-298-301 |
| 5 | 2 | Processing and preservation of mushrooms. | T1 301-305 |
| 6 | 1 | Mushroom research centres in India. | T1-306 |
| 7 | 1 | unit revision | |
| Textbooks: | | T1-mushroom cultivation-D.P.Tripathi | |
| Journals: | | - | |
| | | - | |
| Website: | | | |
| Reference books: | | | |
| Total number of hours | | 8 | |

**UnitI**

**Unit I**

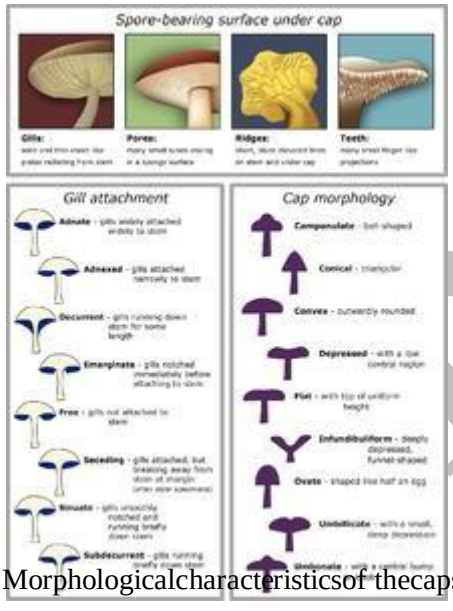
Mushroommorphology:Differentpartsofatypicalmushroomandvariationsinmushroommorphology. Keytodifferentiateediblefrom poisonousmushrooms.MushroomClassification:Basedonoccurrence–Epigenousandhypogenous,Naturalhabitats–Humicolous, Lignicolous&Coprophilous,Colorofspores–white,yellow,pink,purplebrownandblack.Ainsworthetalclassification(8th edition) andBisby's'DictionaryofFungi'.

A**mushroom**,or **toadstool**,is thefleshy, spore-bearingfruitingbodyofa fungus,typicallyproducedabove groundonsoiloronits foodsource.

Thestandardforthename"mushroom"is thecultivatedwhitebuttonmushroom,*Agaricusbisporus*;hencethe word"mushroom"ismostoftenappliedtothosefungi(Basidiomycota,Agaricomycetes)thathaveastem(stipe),a cap (pileus),andgills (lamellae,sing. lamella)ontheundersideofthecap."Mushroom" alsodescribes avarietyof othergilledfungi, withorwithoutstems,thereforethetermis usedtodescribethefleshyfruitingbodies ofsome Ascomycota.Thesegills producemicroscopicspores thathelpthefungus spreadacross thegroundorits occupant surface.

Forms deviatingfromthestandardmorphologyusuallyhavemorespecificnames,suchas "bolete","puffball", "stinkhorn",and "morel",andgilledmushrooms themselves areoftencalled"agarics"inreferencetotheir similarityto *Agaricus*ortheirorder Agaricales.Byextension,theterm"mushroom" canalsodesignatetheentire fungus wheninculture;the thallus(calledamycelium)ofspeciesformingthefruitingbodies calledmushrooms; orthespeciesitself.

## Identification




Morphologicalcharacteristicsof thecapsofmushrooms

Identifyingmushrooms requires abasicunderstandingoftheir macroscopicstructure.Mostare Basidiomycetes andgilled.Theirspores,called basidiospores,areproducedonthegills andfallinafine rainofpowderfromunder

thecaps as a result.Atthemicroscopiclevel,thebasidiosporesareshotoff basidiaandthenfallbetweenthegills inthedeadairspace.As a result,formostmushrooms,ifthecapis cutoffandplacedgill-side-downovernight,a powderyimpressionreflectingtheshapeofthegills (orpores, orspines,etc.)isformed(whenthefruitbodyis sporulating).Thecolorofthepowderyprint,calleda sporeprint,is usedtohelpclassifymushrooms andcanhelp toidentifythem.Sporeprintcolors includewhite (mostcommon),brown,black,purple-brown,pink,yellow,and creamy,butalmostneverblue,green,orred.[1]

Whilemodernidentificationofmushroomsis quicklybecomingmolecular,thestandardmethods foridentification arestillusedbymostandhavedevelopedintoafineartharkingbackto medievaltimes andtheVictorianera,combinedwithmicroscopicexamination.Thepresenceofjuices uponbreaking,bruisingreactions,odors,tastes, shades ofcolor,habitat,habit,andseasonareallconsideredbybothamateurandprofessionalmycologists.Tasting andsmellingmushrooms carriesits ownhazards becauseofpoisons and allergens.Chemicaltestsarealsousedfor somegenera.[2]

Ingeneral,identificationto genuscanoftenbeaccomplishedinthefieldusingalocalmushroomguide. Identificationto species,however,requiresmoreeffort;onemustremember thatamushroomdevelopsfroma buttonstage intoa maturestructure,andonlythelatter canprovidecertaincharacteristics neededforthe identificationofthespecies.However, over-maturespecimenslosefeatures andceaseproducingspores.Many novices havemistakenhumidwatermarks onpaperforwhitesporeprints, ordiscoloredpaperfromoozingliquids on lamellaedgesforcoloredsporedprints.

## Classification

Mainarticles: Sporocarp(fungi),Basidiocarp,andAscocarp

Amushroom(probably *Russulabrevipes*)parasitizedby *Hypomyceslactifluorum*resultingina"Lobstermushroom".

Typicalmushrooms arethefruitbodies ofmembers oftheorder Agaricales,whose typegenusis *Agaricus*andtype speciesis thefieldmushroom, *Agaricuscampestris*.However,inmodern molecularlydefined classifications,not allmembers oftheorderAgaricalesproducemushroomfruitbodies,andmanyothergilledfungi,collectively calledmushrooms,occurinotherordersoftheclass Agaricomycetes.Forexample, chanterellesareinthe Cantharellales,falsechanterelles suchas *Gomphus*areinthe Gomphales, milk-capmushrooms (*Lactarius*,*Lactifluus*) andrussulas(*Russula*),as wellas *Lentinellus*,areinthe Russulales,whilethetough,leatherygenera *Lentinus*and *Panus*areamongthe Polyporales,but *Neolentinus*isinthe Gloeophyllales,andthelittlepin- mushroomgenus, *Rickenella*,alongwithsimilargenera,areinthe Hymenochaetales.

Withinthemainbodyofmushrooms,intheAgaricales,arecommonfungilikethecommon fairy-ringmushroom,shiitake, enoki, oystermushrooms, flyagaricsandother Amanitas, magicmushroomslikespecies of *Psilocybe*,paddystrawmushrooms, shaggymanes,etc.

Anatypicalmushroomis the lobstermushroom,whichis adeformed,cooked-lobster-colored parasitizedfruitbodyofa*Russula*or*Lactarius*, coloredanddeformedbythemycoparasiticAscomycete*Hypomyceslactifluorum*.[3]

Othermushrooms arenotgilled,sotheterm"mushroom"islooselyused,andgivingafullaccountoftheir classificationsis difficult.Somehavepores underneath(andareusuallycalled boletes),others havespines,suchas the hedgehogmushroomandother toothfungi, andsoon."Mushroom" has beenusedforpolypores,puffballs, jelly fungi, coralfungi, bracketfungi, stinkhorns,and cupfungi.Thus,thetermismoreoneofcommonapplication to macroscopicfungalfruitingbodies thanonehavingprecisetaxonomicmeaning.Approximately14,000species ofmushrooms aredescribed.[4]

## Etymology


*Amanitamuscaria*,the mosteasilyrecognised"toadstool",isfrequentlydepictedin fairystories andongreeting cards.Itis oftenassociatedwith gnomes.[5]

Theterms "mushroom" and"toadstool" gobackcenturies andwereneverpreciselydefined,norwasthere consensus onapplication.Between1400and1600AD,theterms*mushrom,mushrum,muscheron,mousheroms, mussheron,or musserouns*wereused.[6]

Theterm"mushroom" andits variationsmayhavebeenderivedfromtheFrenchword *mousseron*inreferenceto moss(*mousse*).Delineationbetweenedibleandpoisonousfungiisnotclear-cut, soa"mushroom"maybeedible, poisonous,orunpalatable.

Culturalor socialphobiasofmushrooms andfungimaybe related. Theterm"fungophobia" was coinedby William DelisleHayofEngland,whonotedanational superstitionorfearof"toadstools".[7][8][9]

Theword"toadstool" has apparentanalogiesin Dutch*padde(n)stoel*(toad-stool/chair,mushroom) and German*Krötenschwamm*(toad-fungus, alt.wordfor panthercap). InGermanfolkloreandoldfairytales,toads areoften depicted sittingontoadstoolmushrooms andcatching, withtheirtongues,theflies thataresaidtobedrawntothe *Fliegenpilz*,aGermannameforthetoadstool,meaning"flies'mushroom".Thisishowthemushroomgotanother ofits names,*Krötenstuhl*(aless-usedGermannameforthemushroom),literallytranslatingto"toad-stool".

## Morphology

*Amanitajacksonii*buttonsemerging fromtheiruniversalveils

Theblue gillsof*Lactariusindigo*, amilk-capmushroom

Amushroomdevelopsfromanodule,orpinhead,less thantwomillimetersindiameter,calleda primordium, whichis typicallyfoundonornearthesurfaceofthe substrate.Itisformedwithinthe mycelium,themass of threadlikehyphaethatmakeupthefungus.Theprimordiumenlargesintoa roundishstructureofinterwoven hyphae roughlyresemblinganegg,calleda"button".Thebuttonhas acottonyrollofmycelium,the universalveil,thatsurrounds thedevelopingfruitbody.As theeggexpands,theuniversalveilruptures andmayremainas acup, or volva,atthebaseofthe stalk,oras wartsorvolvalpatches onthecap.Manymushroomslackauniversalveil, thereforetheydonothaveeitheravolvaorvolvalpatches. Often,asecondlayeroftissue,the partialveil,covers thebladelike gillsthatbear spores.As thecapexpands,theveilbreaks,andremnants ofthepartialveilmayremain as a ring,or annulus,aroundthemiddleofthestalkoras fragments hangingfromthemarginofthecap.The ring maybeskirt-likeasinsomespecies of *Amanita*,collar-likeasinmanyspecies of *Lepiota*,ormerelythefaint remnants ofacortina (apartialveilcomposedoffilaments resemblingaspiderweb),whichis typicalofthegenus *Cortinarius*.Mushroomslackingpartialveils donotformanannulus.[10]

Thestalk(alsocalledthestipe,orstem)maybecentralandsupportthecapinthemiddle,oritmaybeoff-center and/orlateral,asinspecies of *Pleurotus*and *Panus*.Inothermushrooms,astalkmaybeabsent,as inthepolyporesthatformshelf-likebrackets. Puffballslackastalk,butmayhaveasupportingbase.Othermushrooms,suchas truffles, jellies, earthstars,and bird's nests,usuallydonothavestalks,andaspecializedmycologicalvocabulary exists todescribetheirparts.

Thewaythegills attachtothetopofthestalkis animportantfeatureofmushroommorphology.Mushroomsinthe genera *Agaricus*, *Amanita*,*Lepiota*and *Pluteus*,amongothers,havefreegills thatdonotextendtothetopofthe stalk.Others have decurrentgills thatextenddownthestalk,asinthegenera *Omphalotus*and*Pleurotus*.Thereare agreatnumberofvariations betweentheextremes offreeanddecurrent,collectivelycalledattachedgills.Finer distinctions areoftenmadetodistinguishthetypes ofattachedgills:adnategills,whichadjoinsquarelytothe stalk;notchedgills, whicharenotchedwheretheyjointhetopofthestalk;adnexedgills, whichcurveupwardto meetthestalk,andso on.Thesedistinctions betweenattachedgillsaresometimes difficulttointerpret,sincegill attachmentmaychangeas themushroommatures, orwithdifferentenvironmentalconditions.[11]

**Microscopicfeatures**

*Morchellaelata*asciviewedwithphasecontrastmicroscopy

A hymeniumis alayerofmicroscopicspore-bearingcells thatcovers thesurfaceofgills.Inthenongilledmushrooms,thehymeniumlines theinnersurfaces ofthetubes ofboletesandpolypores, or coverstheteethof spinefungiandthebranches ofcorals.IntheAscomycota, spores developwithinmicroscopicelongated, sac-like cells calledasci, whichtypicallycontaineightsporesineachascus.The Discomycetes,whichcontainthecup, sponge,brain, andsomeclub-likefungi,developanexposedlayerofasci,as ontheinnersurfaces of cupfungior withinthepits of morels.The Pyrenomycetes,tinydark-coloredfungithatliveonawide rangeofsubstrates includingsoil,dung,leaflitter, anddecayingwood,as wellas otherfungi,produceminute,flask-shapedstructures calledperithecia, withinwhichtheascidevelop.[12]

IntheBasidiomycetes,usuallyfourspores developonthetips ofthinprojections called sterigmata,whichextend fromclub-shapedcells calleda basidia.Thefertileportionofthe Gasteromycetes,calleda gleba,maybecome powderyasinthepuffballs orslimyasinthe stinkhorns.Interspersedamongtheasciarethreadlikesterilecells called paraphyses.Similarstructures called cystidiaoftenoccurwithinthehymeniumoftheBasidiomycota. Many types ofcystidiaexist,andassessingtheirpresence,shape,and sizeis oftenusedtoverifytheidentificationofa mushroom.[12]

Themostimportantmicroscopicfeatureforidentificationofmushroomsis thespores. Theircolor,shape,size, attachment, ornamentation,andreactionto chemicaltestsoftencanbethecruxofanidentification.Asporeoften has aprotrusionatoneend,calledanapiculus,whichis thepointofattachmenttothebasidium,termedtheapical germpore,fromwhichthehyphaemerges whenthesporegerminates.[12]

## Growth

*Agaricusbitorquis*mushroomemergingthroughasphaltconcreteinsummer

Manyspecies ofmushrooms seeminglyappearovernight, growingorexpandingrapidly.This phenomenonis the sourceofseveralcommonexpressionsintheEnglishlanguageincluding"tomushroom" or"mushrooming" (expandingrapidlyin sizeorscope) and"topopuplikeamushroom" (toappearunexpectedlyandquickly).In realityall species ofmushrooms takeseveraldaystoformprimordialmushroomfruitbodies,thoughtheydo expandrapidlybytheabsorptionoffluids.

The cultivatedmushroomas wellas thecommon fieldmushroominitiallyformaminute fruitingbody,referredto as thepinstagebecauseoftheirsmallsize.Slightlyexpandedtheyarecalledbuttons,onceagainbecauseofthe relativesizeand shape.Oncesuchstages areformed,themushroomcanrapidlypullinwaterfromits myceliumandexpand,mainlybyinflatingpreformed cellsthattookseveraldays toforminthe primordia.

Similarly,thereareevenmoreephemeralmushrooms,like*Parasolaplicatilis*(formerly *Coprinusplicatlis*), that literallyappearovernightandmaydisappearbylateafternoononahotdayafterrainfall.[13]Theprimordiaformat groundlevelinlawnsinhumidspaces underthethatchandafterheavyrainfallorin dewyconditions balloonto fullsizeinafewhours, releasespores,andthencollapse.They"mushroom" tofullsize.

Notallmushrooms expandovernight; somegrowveryslowlyandaddtissuetotheirfruitbodies bygrowingfrom theedges ofthecolonyorbyinserting hyphae.For example, *Pleurotusnebrodensis*grows slowly, andbecauseof this combinedwithhumancollection,itisnowcriticallyendangered.[14]

Yellowflowerpotmushrooms(*Leucocoprinusbirnbaumii*)atvariousstatesofdevelopment

Thoughmushroomfruitingbodies areshort-lived,theunderlying myceliumcanitself belong-livedandmassive.A colonyof *Armillariasolidipes*(formerlyknownas*Armillariaostoyae*)inMalheurNationalForestinthe UnitedStatesis estimatedtobe2,400years old,possiblyolder,andspans anestimated2,200acres (8.9km$^2$).Mostofthe fungusis undergroundandindecayingwoodordyingtreeroots intheformofwhitemyceliacombinedwithblack shoelace-like rhizomorphsthatbridgecolonized separatedwoodysubstrates.[15]

Ithas beensuggestedtheelectricalstimulus ofalightningboltstrikingmyceliainlogs accelerates theproduction ofmushrooms.[16]

**Ediblemushrooms**

Mainarticles: Edible mushroom,Mushroomhunting,and Fungiculture

The*Agaricusbisporus*,one of the mostwidely cultivatedandpopularmushroomsinthe world


Culinarymushrooms areavailableinawide diversityofshapes and colorsatthismarketstandatthe San FranciscoFerryBuilding

Mushrooms areusedextensivelyin cooking,inmany cuisines(notably Chinese, Korean, European,and Japanese). Thoughneithermeatnorvegetable,mushrooms areknownas the"meat"ofthevegetableworld.[21]

Mostmushrooms soldin supermarketshavebeencommerciallygrownon mushroomfarms.Themostpopularof these, *Agaricusbisporus*,is consideredsafeformostpeopletoeatbecauseitis grownincontrolled,sterilized environments.Severalvarieties of *A.bisporus*aregrowncommercially,includingwhites,crimini,andportobello. Othercultivatedspecies availableatmanygrocersinclude *Hericiumerinaceus*, shiitake, maitake(hen-of-the- woods), *Pleurotus*,and enoki.Inrecentyears,increasingaffluenceindevelopingcountries hasledtoa considerablegrowthininterestinmushroomcultivation,whichis nowseenas apotentiallyimportanteconomic activityforsmallfarmers.[22]

Chinais amajorediblemushroomproducer.[23]Thecountryproduces abouthalfofallcultivatedmushrooms,and around2.7kilograms (6.0lb)ofmushrooms areconsumedperpersonperyearbyoverabillionpeople.[24]In2014, Polandwas theworld'slargestmushroomexporter,reportinganestimated194,000tonnes(191,000longtons; 214,000shorttons)annually.[25]

Separatingediblefrompoisonous species requires meticulous attentiontodetail;thereis nosingletraitbywhich alltoxicmushrooms canbeidentified,noronebywhichallediblemushrooms canbeidentified.Peoplewho collectmushroomsforconsumptionareknownas mycophagists,[26]andtheactofcollectingthemforsuchis knownas mushroomhunting,orsimply"mushrooming".Evenediblemushroomsmayproduceallergicreactions insusceptibleindividuals,fromamildasthmaticresponsetosevere anaphylacticshock.[27][28]Eventhecultivated *A.bisporus*contains smallamounts ofhydrazines,themostabundantofwhichisagaritine(amycotoxinand carcinogen).[29]However, thehydrazinesaredestroyedbymoderateheatwhencooking.[30]

Anumberofspecies ofmushrooms arepoisonous;althoughsome resemblecertainediblespecies,consumingthem couldbefatal.Eatingmushrooms gatheredinthewildis riskyand shouldonlybeundertakenbyindividuals knowledgeableinmushroomidentification.Commonbestpracticeisforwildmushroompickers tofocus on collectingasmallnumberofvisuallydistinctive,ediblemushroomspecies thatcannotbeeasilyconfusedwith poisonous varieties.

**Toxicmushrooms**
Mainarticle: Mushroompoisoning

Young *Amanitaphalloides*,"death cap"mushrooms

Manymushroomspecies produce secondarymetabolitesthatcanbetoxic,mind-altering,antibiotic,antiviral,or bioluminescent. Althoughthereareonlyasmallnumberof deadly species,severalothers cancauseparticularly severeandunpleasantsymptoms.Toxicitylikelyplays a roleinprotectingthefunctionofthebasidiocarp:the myceliumhas expendedconsiderableenergyandprotoplasmicmaterialtodevelopastructuretoefficiently

distributeits spores.Onedefenseagainstconsumptionandprematuredestructionis theevolutionofchemicals that renderthemushroominedible, eithercausingtheconsumertovomitthemeal(see emetics),ortolearntoavoid consumptionaltogether. Inaddition,duetothepropensityofmushrooms toabsorb heavymetals,includingthose thatare radioactive,Europeanmushroomsmay, as lateas 2008,includetoxicityfromthe1986 Chernobyldisasterandcontinuetobestudied.[31][32]

**Psychoactivemushrooms**

*Psilocybezapotecorum*,ahallucinogenicmushroom

Mushrooms withpsychoactivepropertieshavelongplayeda roleinvarious nativemedicinetraditionsincultures allaroundtheworld.Theyhavebeenusedas sacramentinrituals aimedatmentalandphysicalhealing,andto facilitatevisionarystates.Onesuchritualis the *velada*ceremony.Apractitioneroftraditionalmushroomuseis the *shaman*or *curandera*(priest-healer).[33]

Psilocybinmushroomspossesspsychedelicproperties.Commonlyknownas "magicmushrooms" or"'shrooms", theyareopenlyavailableinsmartshopsinmanypartsoftheworld,orontheblackmarketinthosecountries that haveoutlawedtheirsale.Psilocybinmushroomshavebeenreportedas facilitatingprofoundandlife-changinginsights oftendescribedasmysticalexperiences.Recentscientificworkhas supportedtheseclaims, as wellas the long-lastingeffects ofsuchinducedspiritualexperiences.[34]

Thereareover100psychoactive mushroomspeciesofgenus*Psilocybe*nativetoregions allaroundthe world.[35]

Psilocybin,anaturallyoccurringchemicalincertain psychedelicmushroomssuchas *Psilocybecubensis*,isbeing studiedforits abilitytohelppeoplesufferingfrompsychologicaldisorders,suchas obsessive–compulsivedisorder.Minuteamounts havebeenreportedtostop clusterand migraineheadaches.[36]Adouble-blindstudy, donebytheJohns Hopkins Hospital,showedpsychedelicmushrooms couldprovidepeopleanexperiencewith substantialpersonalmeaningandspiritualsignificance.Inthestudy,onethirdofthesubjects reportedingestionof psychedelicmushrooms was thesinglemostspirituallysignificanteventoftheirlives. Overtwo-thirds reportedit amongtheirfivemostmeaningfulandspirituallysignificantevents.Ontheotherhand,one-thirdofthesubjects

reportedextreme anxiety.However, theanxietywentawayafterashortperiodoftime.[37]Psilocybinmushrooms havealsoshowntobesuccessfulintreatingaddiction,specificallywithalcoholandcigarettes.[38]

Afewspeciesinthegenus *Amanita*,mostrecognizably *A.muscaria*,butalso *A. pantherina*,amongothers,contain thepsychoactivecompound muscimol.The muscimol-containingchemotaxonomicgroupof*Amanitas*contains no amatoxinsor phallotoxins,andas sucharenot hepatoxic,thoughifnotproperly curedwillbenon-lethally neurotoxicduetothepresenceof ibotenicacid.The*Amanita*intoxicationis similarto Z-drugsinthatitincludes CNSdepressantand sedative-hypnoticeffects,butalsodissociationand deliriuminhighdoses.

**MushroomPoisoningandtreatments**
Eatingpoisonousmushroomsmaycausedifferenttypes ofreactions whichcanbroadlybeclassifiedasfollows :

1. **Gastricdisorder:**Thepoisoncauses serious gastricdisturbance,itchieflyacts byexcitingandthen paralysingthecentralnervous systemas by*Amanitamuscaria*orpoisoncontainingirritantwhichcause gastricenteritis bydirectactiononthemucousmembraneofthedigestivesystem.e.g*Gyromitraesculenta.*
2. **Nervous disorder:**Itcauses degenerationofcells,especiallyofthenervous systemandgrandularparenchymatoustissueslikeliverasincaseof *Amanitaphalloides.*
3. **Musculardisorder:**Theremaybeexcitingofthemuscularsystem,especiallythesmoothmuscularfibreasitis thereintheuterus , vessels etc.
4. **Haemolyticdisorder:**Therecanbedestructionofbloodorhaemolysisasincaseof*Amanitarubescens*

**Treatments :**

- Allthecollectorsofwildmushrooms shouldbecarefulaboutmushroompoisoningandhavesome knowledgeofthefirst–aidremediesincaseofmushroompoisoningandthenthepatientshould immediatelybetakentoadoctor.
- Thepatientshouldbemadetocoverhisbodywithablanket,liedowncalmlyandgiventhefirst–aid treatmenttillthearrivalofthedoctor.
- **Removalofpoisonfromthestomach**:Thepatientmaybemadetovomitbyputtinghisfingersinsidethe mouthorthroatorbygivingwarmwaterwithonetablespoonfulofmustardseeds orapomorphine.The stomachshouldbecompletelywashedbymeans ofastomachtube.Onecanalsogivesomesedativeslike warmwater,4--5tablespoonfulofwarmmilk,twotablespoonfulofoliveoilbeatenwiththeyolkof an eggetc.
- **Eliminationofthetoxin**:Theingestedpoisoninthestomachcanbe removedbyputtingcharcoalpowder inthestomachandifithas alreadybeenabsorbedinbloodthensubcutaneousinjections ofatropineor otherantidotes canhelpinremovingtheeffectofpoisoning.

**Mushrooms Cultivation:procedureformushrooms cultivation!**

***Directutilization offungi asfood:***

ManyAgaricalesandHelvellalesaredirectlyusedasfood. Thereis anon-poisonous edibletoadstool,i.e., Coprinussp.foundinlawnsinthe rainyseason.Agaricuscampestrisis ediblemushroomandcultivatedforits fructifications.Thefruitingbodies arequitefleshyandeatendirectlyasvegetableorwithriceas ‘pulao’.

ImageCourtesy:upload.wikimedia.org/wikipedia/commons/4/41/Mushroom-IMG_3304.JPG

ADVERTISEMENTS:

Thesemushrooms arebeingsuccessfullycultivatedinSouthIndia.Morchelaesculentais anotherimportantedible fungus.ItisfoundinKashmirandPunjabplains.Its localnameis ‘guchi’andsoldverycostly.Torulopsisutilis,is usedforthelarge-scaleproductionofyeastforfoodpurposes.Saccharomyces cerevisiaeis usedinbreadmaking industry.

Ofthemanymushrooms thatcanbecultivated, onlythreekindsnamelybuttonmushroom(Agaricusbisporus), strawmushroom(Volvariellavolvacea)andoystermushroom(Pleurotussajorcaju)aresuitableforgrowingin Indiawheresuitableenvironmentalconditions exist. Thefollowingaccountdeals withcultivationofButton Mushroom(Agaricusbisporus).

***Growing Season:***

Agaricusbisporusbeingatemperatemushroomgrows bestduringwinterthroughouttheplains ofNorthIndia.It canhowever,begrownthroughouttheyearinhills.Themostsuitabletemperatureforthespreadofmyceliumis 24-26°C.Temperatureranging from16-18°Cis essentialfortheformationoffruitbodies. Highertemperatures are harmfulbutthelowertemperature retardsthedevelopmentofbothmushroommyceliumandfruitbodies.

***MushroomHouse:***

ADVERTISEMENTS:

Themushroomhousecanbeanyavailable room,shed,basement,garage, etc. Thegrowinghouseshouldbewell ventilatedandnotstuffy.

***Compost:***

Thecultivatedmushroomis grownonspecialcompost. Twotypes ofcomposts, naturaland syntheticareusedfor growingthismushroom.

***Composting Yard:***

Thecompostshouldbepreparedonwellcleanedconcreteorpuccafloor,whichshouldbeonahigherlevel sothat the run-offwaterdoes notcollectneartheheap.Compostingis usuallydoneintheopen,butithas tobeprotected fromrainbycoveringitwithpolythenesheet. Itcanalsobedoneinashedwithopensides ora largeroomto shelteritfromrain.

***SyntheticCompost:***

Thefollowingingredients are required:

Wheatstraw(chopped8-20cm.long)–250kg.

Wheat/Ricebran –20kg.

Ammoniumsulphate/calciumammoniumnitrate–3kg.

Urea–3kg.

Gypsum–20kg.

ADVERTISEMENTS:

This willmakecompostsufficientfor15-16trays ofsize1m×l/2m×15cm.

Tenkgmolasses and/or60kgchickenmanurecanalsobeusedifavailable.

***Procedure for Long Method:***

Mixingthematerials andmakingpile:Day-0.

Thestrawis uniformlyspreadoverthecompostingyardinathinlayer andwetted(thoroughlybysprinkling water).Allingredients suchas wheatbran,fertilizers,etc.,exceptgypsumaremixedthoroughlyinthewetted straw,whichisfinallyheapedintoapileaboutonemetrehigh,onemetrewideandaslongas toholdtheentire quantityofstrawmixture.Thepilecanbemadewithhandorstackmould.Thestrawshouldbefirmlybutnot compactlycompressedintothemould.

Itis essentialtoopentheentirepileandremakeitanumberoftimes accordingtothefollowingschedule:

1stturning–4thday

2ndturning–8thday

3rdturning-

12thday,add10kg.gypsum.

4rdturningfinalturning-16thday,add10kg. gypsum.

Finalturning–20thday,spray10mlMalathionin5litrewater(anyotheravailablepesticidelike,DDT,BHC, Lindanecanalsobeused).

Ateachturningwatershouldbesprinkledtomakeuptheloss ofwaterduetoevaporation.Ifitis desiredtoadd molasses, then10kgmolasses diluted20times withwatershouldbepouredoverthestrawmixtureduringthefirst turning.Sixtykgchickenmanureifavailablecanalsobeaddedatthetimeofstartofpile,i.e.,0-daytoimprove thequalityofthecompost. NaturalCompost

Itis preparedfromhorsedungwhichmustbefreshlycollectedandnothavebeenexposedtorain.Itshouldnot containadmixtureofdungofotheranimals.Choppedwheatstraw(1/3, ormoreofweightofhorsedung)ismixed withthehorsedungtowhich3kgureaand/or100-110kgpoultrymanurepertonneis usuallyadded.

Horsedungandstrawmixtureis uniformlyspreadoverthecompostingyardandsufficientwateris sprinkledover itsothatthestrawbecomes sufficientlywetsothatittakes nomorewater. Themanureis thenheapedinapileas forsyntheticcompost.

After3days whenthemanureintheheapgets heatedupduetofermentationandgives offanodourofammonia,it is openedupandrepeated3or4times afteranintervalof3-4days.Twenty fivekggypsumpertonneis addedin twoinstalments at3rdand4thturning.Atthefinalturning20mlMalathiondilutedin10litresofwateris sprayed intothemanure.

***Filling:***

Thecompostwhenreadyforfillingandspawninghas adarkbrowncolourandnotraceofammonia.Thereisno unpleasantodourbutitsmellslikefreshhay.ThepHis neutralornearneutral.Thecompostshouldnotbetoodry ortoowetatthetimeoffillinginthetraywhichcanbedeterminedbythepalmtest. Forthis purposeasmall quantityofcompostis takenintothehandandpressedlightly,ifafewdropsofwateroozeofthefingers thenitis ofrightconsistency.

Ifrelativelydrythenthewatershouldbeaddedbysprinkling.Iftoowet,theexcess watermaybeallowedto evaporate. Thepreparedcompostisnowfilledintrays,whichmaybeofanyconvenientsizebutits depthshould be15-18cm.Astandard sizeoftray1m×½m×15cm.Thetrayshouldbemadeofsoftwoodandprovidedwith thepegs atthefourcomers sothattheycanbestackedoneovertheotherleavingsufficientspacebetweenthetwo traysforvarious operations.Thetrayis completelyfilledwiththecompost,lightlycompressedandthesurface levelled.

***Spawning:***

Spawningmeans sowingthebeds withthemycelium(spawn)ofthemushroom.Spawncanbehadfrom mushroomLaboratoryCollegeofAgriculture,Chambaghat,Solanatanominalcost. Smallquantityofspawnis alsoavailablefromtheDivisionofMycology,IndianAgriculturalResearchInstitute, NewDelhi.

Thegrainspawnis scatteredonthesurfaceofthetraybedwhichis coveredwiththethinlayerofcompost. Spawningcanalsobedonebymixingthespawnwithcompostbeforefillingitintrays.Fivehundredgramspawn (two1/2litbottles/polypacks)is sufficientforfivetrays ofstadard size.Afterspawningthecompostsurfaceis coveredwitholdnewspapersheet, whichis wettedbysprinklingwatertoprovidethehumiditybutnotwateris directlyaddedtothecompostduringspawnrunning.

Thetrays afterspawningarestackedverticallyoneovertheotherin4-5tiers.Onemetreclearspacemaybeleftin betweenthetoptrayandceiling.Thereshouldbeabout15-20cmspacebetweenthetwotrays.

The roomshouldbemaintainedat25°C ornearabout. Thehumidityshouldbebuiltupbyfrequentlywateringthe floorandwalls.The roommaybekeptclosedas nofreshairisneededduringthespawnrun.Whitecottony mycelium spreads andpermeates throughthecompost.

Eventuallythecompostsurfacegets coveredwiththemycelium.Ittakes 12-15daysforcompletespawnrun.Low temperatureprolongs thespreadofthemycelium.

***Casing:***

Afterthespawnrunis completeasis evidentbywhitemouldygrowth, thesurfaceofthecompostis coveredwith 3cmlayerofcasingsoil.Asuitablecasingsoilcanbepreparedbymixingequalpartofwellrottencowdung (finelycrushedandcoarselysieved)andgardensoil.Thecasingmaterialshouldpossesshighwaterholding capacity,goodporespaceandpH shouldnotbelowerthan7.4. Thecasingmaterialis sterilizedtokillinsects, nematodes andmolds.Sterilizationcanbeaccomplishedeitherbysteamingorbytreatingwithformalinsolution. Foronecubicmetreofcasingsoil,half litreofformalindilutedwith10litreofwateris sufficient.

Thecasingsoilisspreadoveraplasticsheetandtreatedwithformalinbysprinkling.Thetreatedsoilis piledupin aheapandcoveredwithanotherplasticsheetfor48hours. Thesoilis turnedfrequentlyforaboutaweekto removealltraces offormalinwhichcanbetestedbysmellingit.Aftercasing,thetemperatureofthe roomis maintainedforfurtherthreedays, afterwhichitmustbeloweredtobelow18°C.Atthis stagelotoffreshairis neededandtherefore, thegrowingroomshouldbeventilatedbyopeningwindows,etc.

***Cropping andHarvesting:***

Thefirstflushofthepinheads becomesvisible15-20days aftercasingorsayabout35-40days afterspawning. Smallwhitebuttons develop5-6days afterpinheadstage. The rightstageofharvestis whenthecapis stilltight overtheshortstem.Incasethebuttons areallowedtomature, themembranebelowthecapwillruptureandthe capwillopenupinumbrella-likeshape.

Suchmushrooms areconsideredtobetheinferior. Harvestingis donebyholdingthecapwithforefingers slightly pressedagainstthesoil.Thesoilparticles andmycelialthreads clingingtothebaseofthestalkarechoppedoff. Mushroomcanalsobeharvestedbycuttingoffwithasharpknifeatsoillevel.

***Yield:***

Theaverageyieldof3-4kgper trayis considerednormal.However,ifcompostis carefullyprepared,spawn reliableandfavourabletermperatureprevailingduringthegrowingperiod, thenayieldof5-6kgpertrayis possible.Partialorcompletefailuremayalsohappenduetonegligence.

***Storage:***

Themushrooms arebestconsumedfresh.Storageinrefrigeratorforafewdaysis possible.Themushrooms should beplacedbetweenmoistpapertowelforstoringina refrigerator.

**Classificationof Mushrooms**

- Mushroomis afleshyfruitingbodyofsomefungiarisingfromagroupofmyceliumburiedinsubstratum. Mostofthemushroomsbelongtothe Sub-Division:BasidiomycotinaandafewbelongtoAscomycotinaofKingdom-Fungi.
- Itis reportedthattherearеabout50,000knownspecies offungiandabout10,000areconsideredas edible ones.Ofwhich,aboutonehundredandeightymushrooms canbetriedforartificialcultivationandseventy arewidelyacceptedas food.Thecultivationtechniques wereperfectedforabouttwentymushrooms and aboutdozenofthemhavebeenrecommendedfor commercialcultivation.However, onlysixmushrooms arewidelypreferredforlarge-scalecultivation.Theyare:

1. Paddystrawmushroom-*Volvariellaspp.*
2. Oystermushroom-*Pleurotusspp.*
3. Buttonmushroom-*Agaricusspp.*
4. Milkymushroom-*Calocybespp.*
5. Shiitakemushroom_*Lentinullaspp.*
6. Jew's ear mushroom- *Auriculariasp.*

**MUSHROOM CULTIVATION - 17MBU601A**
**Possible Questions – Unit I**

1. What is a mushroom?

2. Write the general morphology of button mushroom?

3. Write about mother spawn?

4. What is mushroom Nutraceuticals?

5. How to preserve the mushroom?

6. Write about the variations in mushroom morphology.

7. Explain Ainsworth et al classification of mushroom.

8. Explain the spore germination & life cycle of Agaricus bisporus.

# KARPAGAM ACADEMY OF HIGHER EDUCATION

**CLASS:III B.Sc MB COURSE NAME: MUSHROOM CULTIVATION PRACTICAL**

**COURSE CODE: 17MBU601A UNIT-1 BATCH-2017-2020**

| SINO | unit-1 | Option A | Option B | Option C | Option D | Answer |
|---|---|---|---|---|---|---|
| 1 | Mushroom consist of _____ portions | 1 | 2 | 3 | 4 | 2 |
| 2 | Two portions of Mushrooms are _____ | Fruiting bodies and mycelium | mycelium and thread like structures | stalks and fruiting bodies | stalk and mycelium | Fruiting bodies and mycelium |
| 3 | Many mushrooms have | Fruiting bodies and mycelium | mycelium and thread like structures | stalks and fruiting bodies | caps and mycelium | stalks and caps |
| 4 | _____ supplies nutrients from substrate to fruiting bodies | Stalks | chlorophylls | caps | mycelium | mycelium |
| 5 | How many species of mushrooms are cultivated in india? | 10 | 25 | 23 | 35 | 25 |
| 6 | A ring is formed around the stipe is called as | annulus | veil | gills | pileus | annulus |
| 7 | The _____ covers the gills and extend from the margin of the cap to the stalk. | annulus | veil | gills | pileus | veil |
| 8 | Gills are also called as_____ | annulus | veil | gills | lamellae | lamellae |
| 9 | In many varieties, fruiting bodies remain covered by a | annulus | veil | gills | pileus | veil |
| 10 | The stalk arises from a cuplike structure known as | volva | veil | gills | pileus | volva |
| 11 | The _____ and _____ are supported by the stipe(Stalk) | pileus and gills | annulus and lamellae | veil and cap | none of the above | pileus and gills |
| 12 | The genus _____ has a funnel shaped fruiting body with folds | Cantharellus | hymenium | Schizophyllum | volverella | Cantharellus |
| 13 | _____ is the example of stripe less mushroom. | Cantharellus | hymenium | Schizophyllum | volverella | Schizophyllum |
| 14 | Forming fruiting bodies entirely above the | Substratum | tuber | truffles | tuberaceae | Substratum |

| | | | | | | |
|---|---|---|---|---|---|---|
| | surface of _____ | | | | | |
| 15 | On the basis of the occurrence of fruiting bodies, mushrooms may be classified into two groups called _____ | Epigenous | hypogenous | epigenous and hypogenous | pizza species | epigenous and hypogenous |
| 16 | Gilled fungi have been further divided into _____ categories. | 3 | 1 | 5 | 8 | 5 |
| 17 | Pore fungi is characterized by absence of | gills | tubes | tubes or pores | pores | gills |
| 18 | Pore fungi is characterized by presence of | gills | tubes | tubes or pores | pores | tubes or pores |
| 19 | Pore fungi is characterized by _____ gills. | absence | presence | absence or presence | none of the above | absence |
| 20 | Pore fungi is characterized by _____ Tubes or pores. | absence | presence | absence or presence | none of the above | absence |
| 21 | Pore fungi is characterized by _____ Tubes or pores | Very hard and irregular | Woody and irregular | Regular and irregular | Very hard and woody | Very hard and woody |
| 22 | Pores mating the context in an _____ and _____ | Very hard and irregular | Woody and irregular | Regular and irregular | Irregular and uneven line | Irregular and uneven line |
| 23 | In *Boletaceous* whose many species can be distinguished among them only by _____ characteristics | Microscopic | naked eye | macroscopic | none of the above | microscopic |
| 24 | In *Clavaria cinerea* fruit bodies are _____ in colour. | Pale violet | pale yellow | ashgrey | red | ashgrey |
| 25 | In *Clavaria flava* flesh of pileus and its branches turning _____ brushed | Pale violet | pale yellow | ashgrey | red | red |
| 26 | In *Clavaria amethystnia* fruit bodies are _____ in colour | Pale violet | pale yellow | ashgrey | red | Pale violet |
| 27 | In *Clavaria aurea* flesh not turning _____ when brushed | Pale violet | pale yellow | ashgrey | red | red |

| | | | | | | |
|---|---|---|---|---|---|---|
| 28 | In *Clavaria pistillaris* fruit bodies _____ in colour. | Pale violet | pale yellow | ashgrey | tan | tan |
| 29 | The most widely cultivated mushroom is | *Agaricus bisporus* | *Volvariella volvacea* | *Pleurotus ostreatus* | Both A and B | Agaricus bisporus |
| 30 | Pleurotus ostreatus commonly called as | Oyster mushroom | Button mushroom | Paddy straw mushroom | Magic mushroom | oyster mushroom |
| 31 | *Morchella* species are _____ mushrooms. | Ascomycetous | Myceteous | gastromycetous | none of the above | Ascomycetous |
| 32 | *Morchella* species are also called as _____ | morels | corals | sponge | none of the above | morels |
| 33 | *Hydnum caputursi* fries mushroom is also known as _____ | Bear's head | Hydunum | both a and b | edible | both a and b |
| 34 | Poison mushroom is classified by_____ | 8 | 6 | 5 | 2 | 5 |
| 35 | Muscarine poisoning is known to be caused by the eating of _____ | *Amanita muscaria* | *Amanita pantherina* | *Amanita vaginata* | none of the above | *Both A and B* |
| 36 | Haemolytic poisoning is known to be caused by the eating of _____ | *Amanita muscaria* | *Amanita rubescens* | *Amanita pantherina* | *Amanita vaginata* | *Amanita vaginata* |
| 37 | Psychotropic poisonous mushroom affects | UTI | heart | kidney | nervous system | nervous system |
| 38 | Coprine poisonous mushroom affects | UTI | heart | kidney | nervous system | nervous system |
| 39 | What is the other name of Mushroom? | Funaria | agaricus | dryopteris | fern | Agaricus |
| 40 | Mushroom is: | Saprophytic fungus | Autotrophic Algae | Heterotrophic fungus | none of the above | Saprophytic fungus |
| 41 | The scientific name of paddy straw mushroom is | volvariella volvaceae | Calocybe indica | Agaricus bisporus | Pleurotus sojarcaju | volvariella volvaceae |
| 42 | The nutritive value of paddy straw mushroom is %protein. | 90 | 40 | 6 | 35 | |
| 43 | Agaricus bisporus can grow in _____ | tropical region | temperate region | any type | desert | temperate region |

| | | | | | | |
|---|---|---|---|---|---|---|
| 44 | Mushroom is a | Saprophytic fungus | halophyte | parasite | autotroph | Saprophytic fungus |
| 45 | Which of the following statement is true? | normal soil is suitable | in any types of soil | grown in particular types of soil in temperate region | cannot be cultivated in south india | grown in particular types of soil in temperate region |

**Unit II**

BiologyofMushrooms:Vegetativecharacters,generalmorphology,sporegerminationandlifecycleofbuttonmushroom(*Agaricusbisporus*),milkymushroom (*Calocybeindica*),oystermushroom (*Pleurotussajorcaju*)andpaddystrawmushroom (*Volvariella volvcea*).

**OYSTERMUSHROOMCULTIVATIONPROCESS**

**MATERIAL REQUIREMENT**

**Substrate:**

Alargenumberof agriculture,forestandagro-industrialbyproductsareusefulforgrowingoystermushroom. Substratesshouldbefresh,dry andfreefrommouldinfestation.Oystermushroom canutilizealargenumberof agro-wastesincluding strawofwheat, paddyand ragi, stalksand leavesofmaize, jowar, bajra, and cotton, sugarcane bagasse, jute and cotton waste, peanut shells, dried grasses, sunflower stalks, used tea leaf and discardedwastepaper.Itcanalsobecultivatedusingindustrialwasteslikepapermillsludge,coffeeby-products, tobaccowasteetc.About1.5-2.0kgofgoodsubstrate willbe requiredperbagof80cmx40cmsize.

**MushroomSpawn**

Threetofourweekoldnon-contaminatedspawn@10%ofdryweightofthesubstrateis required forthepurpose. Spawnofgoodqualityshouldbecollectedfrom areliablesource.Further,thespecies/variety shouldbechosen basingonthetemperatureandrelativehumidityofthecroppingseasonofthelocality.Justpriortousethe200gm Spawnis extractedfromthebottlewithhookedironrodanddividedintofourparts.

**SubstrateSupplementation**

Someofthecommonsupplementsarewheatbran,ricebran,soybeancake,groundnutcake,maizemeal,horse grampowder,cottonseedmealetc.wheatbranandricebran shouldbeusedattherateof10%,whileothershould betried@3-6%ondry weightbasisofthesubstrate.Supplementsafterpasteurizationarethoroughlymixedwith strawwhilespawning.Additionofsupplementsincreases thesubstratetemperatureandhence,itis riskyduringthe workperiodtosupplementthesubstrate.

**Paddystrawmushroom-Bedpreparationandcropping**

Thecultivationofpaddystrawmushroomcanbedoneinathatchedhouseandalsoundertheshadeofatree. Fresh,diseasefreepaddystrawis theideal substrate. Ten–fifteenkgpaddystrawisnecessaryforpreparingone

bed.Inrecentyears, itis cultivatedinsideplasticfilmhouses tomaintainthetemperatureofaround25-35°C and relativehumidityof75-80%.

**PaddyStrawbundlemethod**

Procedure

- PrepareraisedplatformofaboutImlengthand0.75mbreadthwithadealwood flanks andkeepitovera supportby arrangingbricksonallfourcorners.
- Thepaddystrawisbundledintotoweighaboutkgeach.
- Soakthestrawbundlesinwaterfor12-18hr.
- Tenbundles aretakenout anddrainthe excesswater
- Placethebundlesovertheplatform withtheirbuttendononeside.
- Buildthesecondlayerbyplacingthebuttendtowardsthe otherdirection.(These8bundlesmakeone layerofbed)
- Placetheasmallquantityofspawn8-12cminsidethe margin atanintervalof10-15cmallalongtheperiphery.
- Applyaspoonfulofcoarselypowdereddhalpowderbeforeplacingspawn.
- Placethestrawbundles at right anglestothepreviouslayerincris-crossfashiontomakethethirdlayer.
- Placethestrawbundleswithoppositebuttendstomakefourthlayer.
- Spawnthislayerasstatedabove.
- Placeanotherlayerofstrawbundlesoverthis anddonot applyspawn.
- Pressurethebedtomake it ascompact aspossibleandcoveritwithatransparentpolythenesheet.
- Keepthebedsundisturbedforfora fewdays.

Note: Usuallythebedwillhavethe necessaryhumidity,if thestrawbundles areproperlysoaked.Ifmoisture is foundtobeless,itmaybe wateredusinga rosecan.Onthe otherhand,if the moisture isfoundtobe excess, polythene coveristobepartlytoregulatethe moisture. Thesuccessofcultivationdependsuponthetemperatureand moisture inthebed. Theoptimumtemperatureof30-35° Cisnecessary fordevelopingbuttons.

Themushrooms startappearingfromallsidesin6-10days as tinybuttons,whichcanbeharvestedinanother4-5 days.Theharvestingis tobedoneatthebuttonstageitself,sincetheopenedsporocarpwillbemorefibrous. Usually,1-2kgofmushroomcanbeharvestedfrom10kgsubstrate.

**Paddystrawtwistmethod**

Insteadofbundledstraw,twistedpaddystrawcanalsobeusedforcultivation

**Procedure**

- Makethestrawintotwistsofabout5-8mlongand5-10cmdiameter.
- Immersethetwistsinwaterfor12hr.
- Takeoutthestrawanddrainthe excesswater.
- Placetheplacethemlengthwiseoveraplatformonazigzagmanner.
- Placeasecondoverthisinanoppositedirection.(Thisformsthefirstlayerof thebed)
- Sprinklethe coarselypowdereddhalandplacesmallbitsofspawnallalongtheperipheryasabove.
- Buildanotherlayerasdescribedaboveandspawnthelayer.
- Buildup4-5layers andspawnasusual.
- Compactthebedbypressingand coveritwithapolythenesheet.

ButtonMushroom

## Taxonomy

Thecommonmushroomhas acomplicated taxonomichistory.Itwas firstdescribedbyEnglishbotanist MordecaiCubittCookeinhis 1871*HandbookofBritishFungi*,as a variety(var.*hortensis*)of *Agaricuscampestris*.[4][5]DanishmycologistJakobEmanuel Langelaterrevieweda cultivarspecimen, anddubbedit*Psalliotahortensis*var. *bispora*in1926.[6]In1938,itwas promotedto speciesstatus andrenamed*Psalliotabispora*.[7]EmilImbach(1897–1970)impartedthecurrentscientificnameofthespecies,*Agaricusbisporus*, afterthegenus*Psalliota*was renamedto*Agaricus*in1946.[3]The specificepithet*bispora*distinguishes thetwo-sporedbasidiafromfour-sporedvarieties.

## Description

The pileusor capoftheoriginalwildspeciesis apalegrey-brownincolor,withbroad,flatscales onapaler backgroundandfadingtowardthemargins.Itisfirsthemisphericalin shapebeforeflatteningoutwithmaturity, and5–10centimetres(2–4inches)indiameter.Thenarrow,crowded gillsarefreeandinitially,pink, thenred-brownandfinallyadarkbrownwithawhitishedgefromthecheilocystidia.Thecylindrical stipeis upto6 cm (2⅓in)tallby1–2cmwideandbears athickandnarrow ring,whichmaybestreakedontheupperside.Thefirm fleshis white, althoughstains apalepinkish-redonbruising.[8][9]The sporeprintis darkbrown.Thespores are ovaltoroundandmeasureapproximately4.5–5.5µm× 5–7.5µm,andthe basidiausuallytwo-spored,although two-tetrasporicvarietieshavebeendescribedfromtheMojaveDesertandtheMediterranean, withpredominantly heterothallicand homothalliclifestyles,respectively.[10][11]

Thismushroomis commonlyfoundworldwideinfields andgrassyareasfollowingrain,fromlatespringthrough toautumn,especiallyinassociationwithmanure.Itis widelycollectedandeaten,evenbythosewhowouldnot normallyexperimentwithmushroom hunting.[9]

### Similar species

Thecommonmushroomcouldbeconfusedwithyoungspecimens ofthedeadlypoisonous destroyingangel(*Amanita*sp.), butthelattermaybedistinguishedbytheir volvaor cupatthebaseofthemushroomandpurewhite gills (as opposedtopinkishorbrownof*A.bisporus*).Thus itis alwaysimportanttoclearawaydebrisandexamine thebaseofsuchsimilarmushrooms,as wellas cuttingopenyoungspecimens tocheckthegills.Furthermore, the destroyingangelgrowsin mossywoods andlives symbioticallywith spruce.

Amorecommonandless dangerous mistakeis toconfuse*A.bisporus*with *Agaricusxanthodermus*,aninedible mushroomfoundworldwideingrassyareas.*A.xanthodermus*has anodorreminiscentof phenol;itsfleshturns yellowwhenbruised.Thisfungus causes nauseaandvomitinginsomepeople.

Thepoisonous Europeanspecies *Entolomasinuatum*has apassingresemblanceas well,buthasyellowishgills, turningpink,anditlacks aring.

## Cultivationhistory

*A.bisporus*being cultivated

Theearliestscientificdescriptionofthecommercialcultivationof*A.bisporus*wasmadebyFrenchbotanist JosephPittondeTournefortin1707.[12]FrenchagriculturistOlivierdeSerresnotedthattransplantingmushroom myceliawouldleadtothepropagationofmoremushrooms.

Originally,cultivationwas unreliableasmushroomgrowers wouldwatchforgoodflushes ofmushroomsinfields beforediggingupthemyceliumandreplantingtheminbeds ofcompostedmanureorinoculating'bricks'of compressedlitter, loam,andmanure.Spawncollectedthis waycontainedpathogens andcrops commonlywould beinfectedornotgrowatall.[13]In1893,sterilized, orpureculture, spawnwas discoveredandproducedbythe PasteurInstituteinParis,forcultivationoncompostedhorsemanure.[14]

Today's commercialvarietyofthecommonmushroomoriginallywas alightbrowncolor. In1926, a Pennsylvaniamushroomfarmerfoundaclumpofcommonmushrooms withwhitecapsinhismushroombed.As withthe receptionofwhitebread,itwas seenas amoreattractivefooditemandbecameverypopular.[15]Similartothe commercialdevelopmenthistoryofthenaveloranGeandRedDeliciousapple,cultures weregrown fromthe mutantindividuals, andmostofthecream-coloredstoremushroomsmarketedtodayareproductsofthis 1926 chancenaturalmutation.

*A.bisporus*is nowcultivatedinatleastseventycountries throughouttheworld.[3]Globalproductionintheearly 1990s was reportedtobemorethan1.5millionshorttons(1.4billionkilograms),worthmorethanUS$2billion.[16]

## Nutritionalprofile

Agaricusbisporus,whiteraw

**Nutritionalvalue per 100g(3.5oz)**

| | |
|---|---|
| **Energy** | 93kJ(22kcal) |
| **Carbohydrates** | 3.26g |
| Sugars | 1.98g |
| Dietaryfiber | 1g |
| **Fat** | 0.34g |
| **Protein** | 3.09g |

| **Vitamins** | **Quantity** | **%DV†** |
|---|---|---|

| | | |
|---|---|---|
| Thiamine(B1) | 7% | 0.081mg |
| Riboflavin(B2) | 34% | 0.402mg |
| Niacin(B3) | 24% | 3.607mg |
| Pantothenic acid(B5) | 30% | 1.497mg |
| VitaminB6 | 8% | 0.104mg |
| Folate(B9) | 4% | 17µg |
| VitaminB12 | 2% | 0.04µg |
| VitaminC | 3% | 2.1mg |
| VitaminD | 1% | 0.2µg |

| **Minerals** | **Quantity** | **%DV†** |
|---|---|---|
| Iron | 4% | 0.5mg |
| Magnesium | 3% | 9mg |
| Phosphorus | 12% | 86mg |
| Potassium | 7% | 318mg |
| Sodium | 0% | 3mg |
| Zinc | 5% | 0.52mg |

| **Other constituents** | **Quantity** |
|---|---|
| Water | 92.45g |

LinktoUSDADatabaseentry

- Units
- µg= micrograms• mg= milligrams
- IU= Internationalunits

†Percentagesareroughlyapproximatedusing

USrecommendationsforadults.

Source:USDANutrientDatabase

Ina100-gramserving,rawwhitemushrooms provide93kilojoules (22kilocalories)of foodenergyandarean excellentsource (>19%ofthe DailyValue,DV)ofthe Bvitamins, riboflavin, niacin,and pantothenicacid(table). Freshmushrooms arealsoagoodsource (10–19%DV)ofthe dietarymineralphosphorus(table).

WhilefreshA.*bisporus*onlycontains 0.2micrograms (8IU)of vitaminDas ergocalciferol(vitaminD2), the ergocalciferolcontentincreases substantiallyafterexposuretoUVlight.[17][18]

**PolytheneBag**

Transparentpolythenetubeof125-150gaugewithadimensionof80cmx40cmissuitableforoystercultivation. Bags of60cmx40 cmmayalsobeusedforthepurpose.Thebagscanbereusedforthesecondcropafterproper cleaning.

**CULTIVATIONPROCEDURE**

**SubstrateProcessing**

Freshlyprocuredgoodqualitysubstrateischoppedto4-5cmsizeby achaffcutterandsteepedinachemical solutionof carbendazim50%WP(75ppm)andformaldehide(500ppm)foraperiodof6hours.Thenthestrawis takenoutandexcesswateristobedrained.Nintylitersofwatermixedwith7.5gcarbendazim50%WPand125 mlformaldehide(37-40%)willbeappropriateforthepurpose.Howeverseamandhotwatertreatmentmethodsare preferredastherearereportsofphytotoxicityassociatedwithchemical treatment.Here,thepre-wettedsubstrate afterchoppingissoakedinhotwater(65-70$^0$C )foroneour.Incaseofsteampasteurization,thepre-wettedstraw issteam pasteurizedat60-70$^0$Cforonehour,cooledatroom temperatureandthenseededwithspawn.Through pasteurization,thecompetitormouldsareeitherkilledortheirgrowthis suppressedfor25-40days afterspawning.

Thesubstrateisdriedinshadeforfewhoursinordertomaintainthemoisturelevelof 55-60%.Thesubstrate necessaryforraisingonebagmaybedividedintofourlots afterdrying.

**Raisingofbag**

Oneendofthepolythenetubeistiedwitharubberbandandthemoistenedsubstrateisputinsidetoaheightof15 cm.Substrateis thengentlypressedandoneparteachofspawn(50g)andsupplement(50g)spreadattheperiphery closetopolythene(SeetheVideo).Likewise,foursuchlayersaremade andthebagisclosedattheupperendafterpressingthesubstrate.Forabagoutof2kgofdrystraw,200geachspawnandsuppleme ntwillbeused.15-
20smallholes(0.5cm diameter)shouldbemadeon allsidestofacilitategasexchange.Insteadoflayerspawning, mixedspawningmay alsobefollowedwheretherequiredquantity ofspawnismixedwiththeprepared substrate(soakedstraw)andincorporatedintothebag.Thebagsarethenincubatedinawellventilatedroomat250 C.Duringthemycelialgrowthbags shouldnotbeopened.

**AfterCare**

Oncethe myceliumhas fullycolonized thesubstrateforming athick mycelialmat, it isreadyfor fruiting. Contaminatedbagswithmouldmay bediscardedwhilebagswith patchy myceliagrowth may beleftforfewmore daysforcompletionof themyceliagrowth.Thesebagsareopenedafter15-16days.ButincaseofP.eousandP. djamorevar.areopenedafter12daysasfruitingcomesoutwithinthese.Thebundlesafteropeningarearranged onshelves atadistanceof20cmbetweeneachbaginthetierorhangedwithplastic rope.Appropriatetemperature (20-30$^0$C),humidity(70-80%)andlight(200lux)withgoodventilationshouldbemaintainedinthecroppingroom.
Bags arewateredtwicedailydependinguponthe weathercondition.

**Harvesting**

Primordia(smalleggs)appearswithin4-5days ofopeningthebagthatcametotheharvestablestage3-4dayslater. The mushroomsshould beharvested whenthecap beginsto fold inwards. Picking isdonebytwisting the mushroomgentlywithoutdisturbingthesurroundingfruitbodies.Cropshouldnotbewateredbeforeharvesting. Thesecondcrop appearsafter7-10days.Hence within45dayscropperiod,3-4cropsareexpected.With exception,undersuitablegrowingcondition,abiologicalefficiencyof100%is achievedincommercialfarms.

**Directutilizationoffungiasfood:**

ManyAgaricalesandHelvellalesaredirectlyusedasfood. Thereis anon-poisonous edibletoadstool,i.e., Coprinussp.foundinlawnsinthe rainyseason.Agaricuscampestrisis ediblemushroomandcultivatedforits fructifications.Thefruitingbodies arequitefleshyandeatendirectlyasvegetableorwithriceas 'pulao'.

Thesemushrooms arebeingsuccessfullycultivatedinSouthIndia.Morchelaesculentais anotherimportantedible fungus.ItisfoundinKashmirandPunjabplains.Its localnameis 'guchi'andsoldverycostly.Torulopsisutilis,is usedforthelarge-scaleproductionofyeastforfoodpurposes.Saccharomyces cerevisiaeis usedinbreadmaking industry.

Ofthemanymushrooms thatcanbecultivated, onlythreekindsnamelybuttonmushroom(Agaricusbisporus), strawmushroom(Volvariellavolvacea)andoystermushroom(Pleurotussajorcaju)aresuitableforgrowingin Indiawheresuitableenvironmentalconditions exist. Thefollowingaccountdeals withcultivationofButton Mushroom(Agaricusbisporus).

***GrowingSeason:***

Agaricusbisporusbeingatemperatemushroomgrows bestduringwinterthroughouttheplains ofNorthIndia.It canhowever,begrownthroughouttheyearinhills.Themostsuitabletemperatureforthespreadofmyceliumis 24-26°C.Temperaturerangingfrom16-18°Cis essentialfortheformationoffruitbodies. Highertemperatures are harmfulbutthelowertemperature retardsthedevelopmentofbothmushroommyceliumandfruitbodies.

***Mushroom House:***

Themushroomhousecanbeanyavailable room,shed,basement,garage, etc. Thegrowinghouseshouldbewell ventilatedandnotstuffy.

***Compost:***

Thecultivatedmushroomis grownonspecialcompost. Twotypes ofcomposts, naturaland syntheticareusedfor growingthismushroom.

***CompostingYard:***

Thecompostshouldbepreparedonwellcleanedconcreteorpuccafloor,whichshouldbeonahigherlevel sothat the run-offwaterdoes notcollectneartheheap.Compostingis usuallydoneintheopen,butithas tobeprotected

fromrainbycoveringitwithpolythenesheet. Itcanalsobedoneinashedwithopensides ora largeroomto shelteritfromrain.

***SyntheticCompost:***

Thefollowingingredients are required:

Wheatstraw(chopped8-20cm.long)–250kg.

Wheat/Ricebran –20kg.

Ammoniumsulphate/calciumammoniumnitrate–3kg.

Urea–3kg.

Gypsum–20kg.

Thecasingsoilisspreadoveraplasticsheetandtreatedwithformalinbysprinkling.Thetreatedsoilis piledupin aheapandcoveredwithanotherplasticsheetfor48hours. Thesoilis turnedfrequentlyforaboutaweekto removealltraces offormalinwhichcanbetestedbysmellingit.Aftercasing,thetemperatureofthe roomis maintainedforfurtherthreedays, afterwhichitmustbeloweredtobelow18°C.Atthis stagelotoffreshairis neededandtherefore, thegrowingroomshouldbeventilatedbyopeningwindows,etc.

***CroppingandHarvesting:***

Thefirstflushofthepinheads becomesvisible15-20days aftercasingorsayabout35-40days afterspawning. Smallwhitebuttons develop5-6days afterpinheadstage. The rightstageofharvestis whenthecapis stilltight overtheshortstem.Incasethebuttons areallowedtomature, themembranebelowthecapwillruptureandthe capwillopenupinumbrella-likeshape.

Suchmushrooms areconsideredtobetheinferior. Harvestingis donebyholdingthecapwithforefingers slightly pressedagainstthesoil.Thesoilparticles andmycelialthreads clingingtothebaseofthestalkarechoppedoff. Mushroomcanalsobeharvestedbycuttingoffwithasharpknifeatsoillevel.

***Yield:***

Theaverageyieldof3-4kgper trayis considerednormal.However,ifcompostis carefullyprepared,spawn reliableandfavourabletermperatureprevailingduringthegrowingperiod, thenayieldof5-6kgpertrayis possible.Partialorcompletefailuremayalsohappenduetonegligence.

***Storage:***

Themushrooms arebestconsumedfresh.Storageinrefrigeratorforafewdaysis possible.Themushrooms should beplacedbetweenmoistpapertowelforstoringina refrigerator.

Milkymushroom

**White milky mushroom(Calocybeindica)**

Milkymushroom(Calocybeindica)canbegrownonwiderangeofsubstratesasincaseofoystermushroom. It canbegrownonsubstratescontaininglignin,celluloseandhemicelluloses.Substrateshouldbe fresh and dry.Substratesexposedtorainorharvested premature(greencolor)arepronetovariousweedmouldswhichmayresultinfailureofthecrop.Itcanbegrownonstraw ofpaddy,wheat,ragi,maize/bajra/cotton stalksandleaves, sugarcanebagasse, cotton andjutewastes, dehulledmaizecobs,tea/coffeewasteetc., Howevercerealstraw(paddy/wheat)easilyavailable inabundance, isbeingwidelyused.

Strawischoppedinsmallpieces(2-4cmsize)andsoakedinfresh waterfor8-16hours.Thisperiodcanbe reduced when pasteurizationisto bedonebysteam.Mainpurposeofsoakingistosaturate thesubstrate withwater.It iseasiertosoakifstrawisfilledingunnybaganddippedinwater.

**Pasteurization**

Thepurposeofpasteurizationistokillharmfulmicrobes. Thiscanbeachievedintwoways.

**Hotwater treatment**

Waterisboiledinwidemouthcontainerandchopped wetstrawfilledingunnybagissubmersedinhotwater for40minutesat80-90Cto achievepasteurization.This isverypopularmethodparticularlywithsmall growers.

**Steampasteurization**

Wetstrawisfilledinside insulatedroomeither inperforatedshelvesorinwoodentrays.Steamisreleased underpressurefroma boilerandtemperatureinsidesubstrateisraisedto65C andmaintained for5-6 hours.Air insidetheroomshouldbecirculatedtohave uniformtemperatureinthesubstrate.

**Sterilization**

Substrateisfilledin polypropylenebags(x45cm,holding2-3kgwetsubstrate)andsterilized at15lbpsi for 1hour. Oncepasteurization/sterilizationisoverstrawisshiftedtospawningroomforcooling,bag fillingand spawning.

**Spawningandspawn running**

Spawningmethodsaresimilartothatmentionedincaseofoystermushroom.Incaseofsterilizationofppbagsinautocl aveeithersurfaceorthroughspawningshouldbedone. Higherspawn dose4-5%ofwet substrateisused.Afterspawningbagsareshifted tospawnrunningroomandkeptin dark where temperature 25-35C andrelativehumidityabove80% aremaintained.It takesabout20dayswhen substrateisfullycolonisedandbagsarereadyforcasing.Bagsareshiftedtocroppingroomforcasingand

cropping.

**Casing**

Casingmeanscoveringthetopsurfaceofbagsafterspawnrunisover,with pasteurizedcasingmaterialin thicknessofabout2-3cm.Casingprovidesphysicalsupport,moistureandallowsgasestoescape from the substrate. Casingmaterial(soil75% + sand25%)with pH adjustedto7.8-7.9withchalkpowderis pasteurizedin autoclaveat151bpsi foroneourorchemicallytreatedwithformaldehydesoln(4%)abouta weekin advanceofcasing. Solutionshouldbeenoughtosaturate thesoil.It iscoveredwithpolythenesheet to avoidescapeofchemical andataintervalof2dayssoilis turnedso that atthe timeofcasingsoilisfree fromformalinfumes. Bag'stopismadeuniform byrufflingtopsurfaceofthesubstrateandsprayed with solutionofcarbendazim(0.1%)+formaldehyde(0.5%).Casingmaterialisspreadinuniformlayerof2-3cm thicknessandsprayedwithsolutionofcarbendazimandformaldehydetosaturationlevel.Temperature30-35C andR.H.80-90%aremaintained.

**Cropping**

**I**ttakesabout10daysformyceliumtoreach ontopofcasinglayerwhenfreshairisintroducedwhile maintainingtemperatureandR.H.asabove.Lightshouldbeprovided inlongtime. Thechanges thusmade inenvironment,resultintheinitiationoffruitingbodieswithin3-5days inthe formofneedleshapewhich mature inaboutaweek.Mushrooms7-8cmdiam.areharvested bytwisting,cleanedandpackedin perforatedpolythene/polypropylenebagsformarketing.Mushroomscanalso bewrappedinkilnfilmfor longerstorage.

## MUSHROOM CULTIVATION-17MBU601A

## POSSIBLE QUESTIONS

1. Write a detailed note on production of mother spawn & its multiplication.
2. Explain the harvesting, packaging, storage and marketing of mushrooms.
3. What are the different parts of a typical mushroom?
4. What is milky mushroom?
5. How to isolate & culture the spores for mushroom cultivation?
6. Write about the anti-tumor effect of mushroom.
7. Write the steps involved in post harvest technologies of mushroom cultivation.
8. Explain the vegetative characters & life cycle of milky mushroom.
9. Explain the vegetative characters & life cycle of paddy straw mushroom.

| SL.NO | unit-2 | Option A | Option B | Option C | Option D | Answer |
|---|---|---|---|---|---|---|
| 1 | The presence of sporo bearing layer known as | mycelium | hymenium | rhizomorph | sporangium | hymenium |
| 2 | The hyphae of secondary mycelium twist together to form wide hyphal cords called, | mycelium | hymenium | rhizomorph | sporangium | rhizomorph |
| 3 | Rhizomorphs are visible in which stage | red hyphal strands | white hyphal strands | green hyphal strands | none of the above | green hyphal strands |
| 4 | The hyphal Swelling or ovoid body called | button stage | mycelial aggregation | chymatous | sporophore | button stage |
| 5 | Which type of genera the young button is covered by a universal veil | Amanita | button mushroom agaricus | Paddy straw | milky mushroom | Amanita |
| 6 | the central part of gill which is made up of ____ | mycelium, hyphea | trema,mycelial threads | hymenium, sub hymenium | trema, basidia | trema,mycelial threads |
| 7 | Basidia are _____ cells which are arranged parall | long club shaped | short club shaped | long chain shaped | short chain shaped | long club shaped |
| 8 | White button mushroom known as | agaricus bisporus | lentinus edodes | agaricus campestris | basidiospores | agaricus bisporus |
| 9 | Agaricus biaporus is grown on | cereal straw | animal manure whea | cereal straw, animal manure | none of the above | cereal straw, animal manure |
| 10 | Most extensively cultivated mushroom in the world is | agaricus bispours | milky mushroom | oyster mushroom | button mushroom | agaricus bispours |
| 11 | The cropping period of Lentinus edodes | 3 to 5 years | 4to 6 | 2 to 5 | 4 to 8 | 3 to 5 years |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 | Oyster mushroom also known as | flammulina velutipes | volvariella volvacea | pleurotus sps | pleurotus cystidus | pleurotus sps |
| 13 | Fruiting structure can be produced by | single monosporous mycelium | monosporous mycelium | polysporous mycelium | disporous mycelium | single monosporous mycelium |
| 14 | Pezizales order contains approximately _____ species and ____ families. | 102 species, 16 families | 1125 specices , 16 familie | 16 species,225 families | 1025 species, 16 families | 1125 specices , 16 familie |
| 15 | _____ mushrooms contain self-fertile and self-sterile species | Edible mushrooms | Ascomycetes | discomycetes | basidiocarp | Edible mushrooms |
| 16 | which mushroom is grown in high tempertature and tropical regions | pleurotus species | Volvariella volvacea | flammulina velutipes | Agaricus bisporus | Volvariella volvacea |
| 17 | which mushroom is contain the high amount od pro- vitamins and vitamin D | pleurotus species | Volvariella volvacea | flammulina velutipes | Agaricus bisporus | flammulina velutipes |
| 18 | Truffle belong to | Ascomycetes | eumycota | basidiomycete | discomycetes | Ascomycetes |
| 19 | Black cup fungus is | truffles | plectania campylospora | morchellaceae | pithya vulgaris | plectania campylospora |
| 20 | Poisonous mushrooms may be identified based on | morphology | colour | Shape | having swollen stacks | having swollen stacks |
| 21 | which is the highly toxic mushroom | Amanita virosee | Gyromitra esculenta | A.phalloids | Agaricus | A.phalloids |
| 22 | which mushroom toxin is Water soluble | Gyromitra esculenta | amanita phalloides | A.muscaria | A.verna | Gyromitra esculenta |
| 23 | A.muscuria is toxic cause | mycetomuscarine | muscardine | Diarrhoea | Mycetomuscarine and muscardine | Mycetomuscarine and muscardine |
| 24 | what is the Elimination of | the toxin is mixed | it caues | the toxin | .the toxin is absorbed in | .the toxin is absorbed in |

| | | | | | | |
|---|---|---|---|---|---|---|
| | toxin | in the blood | vomitting | disturbances respiratory track | blood and eliminated by subcutaneous injection of atropin | blood and eliminated by subcutaneous injection of atropin |
| 25 | Pleurotus mushroom is _____ depandent | water | temperature | Nutrient | light | light |
| 26 | Tetrapolar mating system, the mating competence is determined by incopatibiliy factors are | factor A and B | A and c | factor AB | none of the above | factor A and B |
| 27 | Winter mushroom known as | pleurotus species | Volvariella volvacea | flammulina velutipes | Agaricus bisporus | flammulina velutipes |
| 28 | Phallales looking like a puffball because they are incased in an outer skin known an | spores | Peridium | peridioles | spore masa | Peridium |
| 29 | Saffron milk cap is otherwise called | morchella species | boletus mellea | Russula speciea | lactarius deliciosus | lactarius deliciosus |
| 30 | Consumption of Psilocybecubensis appear in | 30 minutes | 30-60 minute | . 20 minutes | within few minutes | 30-60 minute |
| 31 | Amanita muscuria and A.pantherina mushrooms contain | protein | muscarine and ibotenic acid | norcaperatic acid | psilocybin | muscarine and ibotenic acid |
| 32 | How to differentiate edible mushroom and poisonous mushroom | shape | small | Colour | size | colour |
| 33 | Amanita and phalloidin toxin producing mushroom | Amanitaphalloides | A.muscuria | angel mushroom | Gyromitraesculenta | Amanitaphalloides |
| 34 | Which types of mushroom is has no cap, gills or stems | Hymenogastrales | Nidulariales | Lycoperdales | phallales | Nidulariales |

| | | | | | | |
|---|---|---|---|---|---|---|
| 35 | Paddy straw is made into bundles having ---------- diameter | 2 to 4 diameter | 3 diameter | 0.80 to 1.00 diameter | 0.5 to 1 diameter | 0.80 to 1.00 diameter |
| 36 | Moisture contain in mushroom | 85% | 90% | 69% | 45% | 90% |
| 37 | Mushroom lack of | protein | aminoacids | Chorophyll | toxin | chorophyll |
| 38 | Consumption of Psilocybecubensis appear in | 30 minutes | 30-60 minutes | 20 minutes | within few minute | 30-60 minutes |
| 39 | SCP contain ----% protein | 55% | 45% | 75% | 100% | 45% |
| 40 | Which of the following is a good compost ? | wet compost | with offensive smell | with Ph 4 | with pH 7 and no offensive smell of ammonia | with pH 7 and no offensive smell of ammonia |
| 41 | Mushroom cultivation was started first in | France | China | England | Italy | France |
| 42 | Spawn is : | mycelium of fungus | fruiting body of fungus | type of compost | thin layer of soil forming | mycelium of fungus |
| 43 | For oyster mushroom cultivation beds are prepared in | Plastic bags | trays | Pots | buckets | Plastic bags |
| 44 | The mushroom spawn preparation needs addition of calcium carbonate abecause it | maintain Ph | absorbs excess water | helps in grains separate | all of the above | all of the above |
| 45 | The method of mushroom harvesting is | handpicking | machine lifting | lifting with trowels | using scissors | handpicking |

**UnitIII**

Equipmentandsterilizationtechniques.Isolationandcultureofspores,culturemediapreparation.Productionofmotherspawn, multiplicationofspawn–Inoculationtechnique–Cultivationtechnology–Substrates,compostingtechnology,bed,polythenebag preparation,spawning–casing–cropping–Mushroomproduction–harvest–packing,storageandmarketing.

TissueCulture

Tissueculturetechniqueis usedtobringtheediblemushroomtopureculturesothatthemushroomfungus can furtherbeusedtopreparespawn,whichis anessentialmaterialformushroomcultivation.Thisnucleus cultureis grownonPotatoDextroseAgarmediumintesttubes.Asmalltissuefromawell-grownmushroomisaseptically transferredtoagarmediuminatesttubeinacultureroom.

Thetesttubes areincubatedunderroomtemperaturefor10daysforfullwhitegrowthoffungalculture. Thisis furtherusedforpreparationofmotherspawn.

**Procedure**

1. Selectwellgrown,diseasefreebuttonmushroomearlyinthemorningandkeepitonacleanpaperfor2-3 hr,togetcertainamountofmoisturepresentinthemushroomtogetevaporated.
2. Cleantheculturereom/laminarflowchamber withantisepticsolution.
3. KeepthesterilizedPDAslants,razorblades,forceps etc. insidethechamberandputonheUVlight.
4. After20minutes putofftheUVlightandstartworkingafter5minutes.
5. Sterilizealltheinstruments tobeusedbyexposingtoBunsenburner.
6. Takeinthemushroomandsplitopenthemushroomlongitudinallyintotwohalves.
7. Usingabladecutasmallpieceoftissuefromthecentreofthespiltmushroomatthejunctionofpileusand stipe.
8. Removethecottonplugoftheagarslantandthetissueisasepticallyplacedinsidetheslantbyusinga sterilizedforceps andclosesitimmediately.
9. Aftertransferringtissuesfromthemushroom,thetubearearrangedinawirebasketandkeptinaclean roomatroomtemperatureforthegrowthofthefungus
10. Observethetubeatperiodicalintervalsandremovethecontaminatedones.Thetubeswillbereadyfor furtherusewithinanothertendays.Thebasespawnis usedforpreparationofmotherspawns.

**Precautions tobeobserved:**

- Washthehandswithantisepticlotionbeforestartworkinginsidethechamber.Ifpossible,itisbettertouse handgloves whileoperation.
- Itisbetterthatthemaximumoftwopersonsmayworkinsidetheroomatatime.Avoidunnecessary talkingwhileworkinginsidethe room.
- Whileseparatingthetissuefromthecentreofthemushroomitshouldnottouchthebottomorsidesofthe mushroom.

**Expt:3Spawnmakingusingsorghum**

**MotherSpawn:**

Motherspawnisnothingbutthemushroomfungusgrown onagrainbasedmedium.Amongtheseveralsubstrate materialstestedby TNAU,Coimbatore,sorghumgrainsarethebestsubstrateforexcellentgrowth ofthefungus. Well-filled,disease-freesorghumgrainsareusedassubstrateforgrowingthespawnmaterials.Thevarioussteps involvinginpreparationofmotherspawnarelistedbelowhereunder.

**Procedure**

1. Washthesorghumgrainsinwaterthoroughlytoremovechaffyanddamagedgrains.
2. Cookthegrainsinanautoclave/vesselfor30minutes justtosoftenthem.
3. TakeoutthecookedgrainsandspreadevenlyoveraHessianclothonaplatformtoremovetheexcess water.
4. MixCalciumcarbonate (CaCO3)thoroughlywiththecooked,driedgrains@20g/kg.
5. Fillthegrainsinpolypropylenebagsupto¾thheight(approximately300-330g/bag),insertaPVCring,boldtheedges ofthebagdownandplugthemouthtightlywithnon-absorbentcottonwool.
6. Coverthecottonplugwithapieceofwastepaper andtietightlyaroundtheneckwithajutethread.
7. Arrangethebagsinsideanautoclaveandsterilizeunder20lbs.pressurefor2hours.
8. Takeoutthebags aftercoolingandkeeptheminsidetheculturerоomandputontheUVlight.

9. After20minutesputofftheUVlightandstartworkingintheculturereom.Cutthefungalcultureintotwo equalhalvesusingainoculationneedleandtransferonehalfportiontoabag.Similarly,transferanother halfportionoftheculturetoananotherbag.
10. Incubatetheinoculatedbagsinacleanroomunderroomtemperaturefor10daysforfurtherusetoprepare bedspawn. Whatismushroom spawn?Isitaseedoraroot?Doyouplantitorsowit,orhowdoyouprepareit?aresomeofthequestionsaskedmenowand again.Tothegeneralpublicthereseemstobesomegreatmystery surrounding thisspawn question;infact,itappearstobethechiefenigmaconnectedwithmushroom-growing.Now,thetruthis,thereisnomysteryatallaboutthematter.Whatpracticalmushroomgrowers call spawn,botaniststermmycelium.

Thespawnis thetruemushroomplantandpermeatestheground,manure,orothermaterialinwhichitmaybe growing;andwhatweknowas mushroomsis thefruitofthemushroomplant. Thespawnis representedbya delicatewhitemold-likenetworkofwhitishthreads whichtraversethesoilormanure.Underfavorable circumstancesitgrows andspreads rapidly, andinduetimeproduces fruit, ormushrooms as wecallthem.The mushroomsbearmyriads ofspores whichareanalogoustoseeds,andthesespores becomediffusedinthe atmosphereandfalluponthe ground.Itis reasonabletosupposethattheyaretheoriginofthespawnwhich producesthenaturalmushroomsinthefields, alsothespawnwefindinmanureheaps.Butweneverhavebeen abletoproducespawnartificiallyfromspores, orinotherwords,mushroomshaveneverbeengrownbyman,so faras Icanfindanyauthentic record, from"seed."How, then,dowegetthespawn?Bypropagationbydivision. Wetakethemushroomplantor[Pg79]spawn,as wecallit,andbreakitupintopieces, andplantthesepieces separatelyinapreparedbedofmanureorothermaterial,underconditionsfavorablefortheirgrowth, andwefind thatthesepieces ofspawndevelopintovigorous plants thatbearfruit(mushrooms)inabouttwomonthsfrom plantingtime.Whenthespawnhas borneitsfullcropoffruititdies.

Well,then,ifwecannotproducespawnfromspores,andthespawninthebeds thathavebornemushrooms has diedout, howarewetogetthespawnforourfuturecrops?is aquestionthatmaysuggestitselftothe inexperienced.Bysecuringitwhenitisinitsmostvigorous condition,whichis beforeitbegins toshowsigns of formingmushrooms,anddryingit,andkeepingitdrytillrequiredforuse.Butinordertosecurethespawnwe needtotakeandkeepwithitthemanuretowhichitadheres orinwhichitis spreading.Inthis wayitcanbekept ingoodconditionforseveralyears andwithoutits vitalitybeingperceptiblyimpaired.Keepingitdrymerely suspendsits growth;as soonasitis againsubmittedtofavorableconditions ofmoistureandheatits pristine activityreturns.

Mushroomspawncanbeobtainedatanyseedstore.Ourseedsmenalways keepitinstock,boththebrick (English),andtheflake (French)spawn.Itis retailedinquantities ofonepoundormore,andas thearticleis perfectlydryitcanbeeasilysentbymailin smallquantities.

TheseedsmenimportitfromEuropeeveryyear alongwiththeirseeds.AprominentBostonseedsmanwritesme: "WegetoursupplythroughtheLondonwholesaleseedsmen,forthesakeofconvenienceandcheaperocean

freight,etc.Comingwithashipmentofothergoods andonsamebillofladingbrings thefreightcharges down. Thelowpriceatwhichmushroomspawnis soldinquantitycanonlybemaintainedwith[Pg80]lowfreightrates, as thereis adutyhereof20%onthearticle."


Fig.21.BrickSpawn.

Bydirectinquiryoftheleadingimportersindifferentcities Ifindthatweimportabout4500lbsofFrenchorflake spawn,and4000bushels,or64,000lbsofEnglishorbrickspawn,andthatfullyahalfofthis wholeimportationis handledbytheseedsmenofNewYorkcity.InNewYorkonefirmalone,whomakeaspecialtyofsupplying marketgardeners,hasinoneyearimported1500bushels ofbrickspawn.ButthevicinityofNewYorkis thegreat mushroom-growingcenterofthecountry, alsothebestmarketformushroomsinthecountry.Onegardenerat Jamaica,L.I.,bought1000lbsofbrickspawnatonetime, andaneighborofhisbought400lbs;this shows whata largequantityofspawnmarketgardeners require.Andthedemandthisyearis unprecedented; someofourleading importers hadsoldouttheirsupplybeforethefirstofNovember.Anditisnotprivategrowers somuchasmarket growers[Pg81]whoarethecauseofthis;themarketmenfindthereismoneyingrowingmushrooms andtheyare goingintoit.

Spawncomesintheformofdry,hard,solidmanurebricks,andalsointheformofflakes ofhalfrottedstrawymanure.Thesebricks andflakes arecompletelypermeatedwiththemushroommycelium.

Thebrickspawnis commonlyknownas Englishspawn,andwhatisimportedintothis countryismadeinEngland, mostlyaboutLondon. Thebricksmadebythedifferentmanufacturers varyalittlein sizeandweight;insome casestenbricks gotothebushel,inothersfourteen,andinothers sixteen.Thislastis thecommonestsizedbrick, andweighs exactlyapound,andmeasures abouteightandone-half incheslong,fiveandone-fourthinches wide,

andoneandone-fourthinches thick;itis whatthe Londonspawnmakers calla9x6x2inchbrick,butitshrinksin drying.Inretailingbrickspawninthis countryitissoldbyweightandnotbymeasure.

Mill-trackmushroomspawnis advertisedbysomeofourseedsmen,butwhattheysellunderthisnameis onlythe ordinaryEnglishbrickspawn.Oneofourprominentseedfirms whoadvertiseitwriteme:"Genuinemill-track spawnusedtobethebestinEngland,butithasbeensuperseded, althoughEuropeangardeners stillcallforEnglish spawnunderthenameof'mill-track.'" The realmill-trackspawnis thenaturalspawnthathas spreadthroughthe thoroughlyamalgamatedhorsedroppingsinmill-tracks orthecleaningsfrommill-tracks.Itis usuallysoldinlarge, irregular,somewhatsoftlumps,andismuchesteemedbyspawnmakersforimpregnatingtheirbricks,but nowadays,thathorses havegivenplacetosteamasamotivepowerinmills,wehavenofurthersupplyofmill-trackspawnforuseinspawningourmushroombeds.Wedonotfeelthisloss,however,asthespawnnow manufacturedbyourbest[Pg82]makerswillproduceas goodacropofmushrooms as theoldmill-tracknatural spawnusedtodo.

Theflakespawnis whatis generallyknownas Frenchspawn, andisimportedintothis countryfromFrance.But themanufactureof"French" spawnforsale,however,isnotstrictlyconfinedtoFrance.Itis putupintwoways, namely,nicelypackedinthinwoodenboxes,eachcontainingtwoorthreepoundsofspawn, andalsolooseinbulk whenitis soldbyweightormeasure.

Virginspawnis whatwecallnaturalspawnorwildspawn;thatis,thespawnthatoccurs naturallyinthefields,in manurepiles,orelsewhere,andwithoutanyartificialaid.Itis supposedtobeproduceddirectlyfromthe mushroomspores,andisnotanewgrowthofsurvivingpartsofoldspawnthatmayhavelivedoverintheground. Itisfarmorevigorousthan"made" spawn, andspawnmakers always endeavortogetittouseinspawningthe artificial spawn.Itis seldomusedforspawningmushroombedsbecausenoteasytoobtain.Nowandagainwe comeuponalotofitinamanurepile;itlooks likeanettedmass ofwhitestrings traversingthemanure.As soonas discoveredsecureallyoucanfind,bringitindoorstoaloft,shed,orroom,andspreaditouttodry;afterdryingit thoroughlykeepit[Pg83]dryandpreserveanduseitas youwouldFrenchspawn,foritis thebestkindofflake spawn.Inusingvirginspawnforspawningbeds Ihaveobtainedlargerandheaviermushrooms thanfrom"made" spawn,andthebedslastedlongeringoodbearing,buttheweightofthewholecrophas notbeenmorethanfrom artificial spawn.

**HowtoKeepSpawn.**—Spawnshouldbekeptinadry, airyplace,somewhatdark,ifconvenient,andina temperaturebetween35°and65°.Whereverthings will"must," as inacellar,cupboardagainstawall,orina close,dampbuilding,is averypoorplaceforkeepingspawn.Ifthespawnis perfectlydryandkeptinadry, airy place, andnotinlargebulk,andcovered,itwillbearahightemperaturewithapparentimpunity,butwhenever dampness,evenoftheatmosphere,is coupledwithheat, themyceliumbegins togrow,andthis,inthestoreroom, is ruinous tothespawn.Judgingfromournaturalmushroomcrops, thespawnforwhichmustbealiveinthe groundinwinter, oneconcludes thatfrostshouldnotbeinjurious totheartificial spawn,stillmyexperienceis that hardfrostdestroys thevitalityofbothbrickandflakespawn.Andthisis one reasonwhyIgetourfullsupplyof spawninthefallandkeepitmyselfratherthansubmitittothemercyoftheseedstore.

**NewVersus OldSpawn.**—Howlongspawnmaybekeptwithoutits vitalitybecomingimpairedis anunsettled question,butthereis nodoubt, ifproperlykept,itwillremaingoodforseveralyears.ButIcannotimpress too stronglyuponthe readertheimportanceofusingfreshspawn.Donotuseanyoldspawnatanyprice;donotaccept

itgratis andruinyourprospectofsuccess byusingit.Ittakesthreemonthsfromthetimewhenthemanureis gatheredforthebeds untilthemushrooms areharvested.Canyou, therefore,afford[Pg84]tospendthis time,and undergothecareandtroubleandexpense,andcourtafailurebyusingoldspawn?Wehaverisks enoughwithnew spawn,letaloneoldspawn.Idonotuseanymoreoldspawn,butIhaveuseditoftenandlongenoughtobe convincedofits generalworthlessness,unless preservedwiththegreatestcare.

**HowtoDistinguishGoodfromPoorSpawn.**—Thisis averydifficultmatter,notwithstandingwhatpeoplemay saytothecontrary.Ifwecouldpositivelytellgoodfrombadspawn,wewouldneverusebadspawn,and, therefore, withordinarycare,havevery fewfailuresinmushroom-growing;forgoodspawnis therootofsuccess inthisbusiness.Spawndiffers verymuchinits appearance; sometimes thebricks showverylittleappearanceof thepresenceofspawn,andstillareperfectlygood;andagain,wemaygetbricks thatareprettywellinterlacedand cloudedwithbluishwhitemoldorfinethreads,andthis,too,is good. Whenthebricks arefreelypervadedwith pronouncedwhitethreads thisis nosignthatthespawnisbad.Bricks driedas hardas aboardmaybeperfectly good; so, too,maybethosethatarecomparatively soft.Mushroomspawnshouldhaveadecided smellof mushrooms,andwhatevercobweb-likemoldmaybeapparentshouldbeofafreshbluishwhitecolor,andthefine threads clear white.Prominentyellowishthreads orveins areasignthatthemyceliumhadstartedtogrowand beenkilled. Distinctwhitemoldpatches onthesurfaceofthebricksindicatethepresenceofsomeotherfungous parasiteonthemushroommycelium;theabsenceofanymushroomsmellinthespawnindicatesits worthlessness andthatthemyceliumis dead.Onefamiliar withmushroomspawncantellwithconsiderablecertainty"very living" spawnand"verydead" spawn,butIamfarfromconvincedthatanyonecandecideunhesitatinglyinthe caseofmiddlingorweakspawn.

[Pg85]Mr. S. Henshaw,inHenderson's HandbookofPlants, tells us:"Thequalityofthespawnmaybeveryeasily detectedbythemushroom-likesmell,...andIshouldhavenohesitationinpickingoutgoodspawninthedark." Sanguine,surely,butIhavetrieditandfoundthetestwanting.M.Lachaumesays thatgoodspawnshows "an abundanceofbluish-whitefilaments wellfittedtogether,andgivingoffastronglymarkedodorofmushrooms.All thoseportions which showtracesofwhiteoryellowmoldorhaveafloury appearance,shouldbe rejectedand destroyed." Mr.Wrightsays: "Abrickmaybeamass ofmoldiness, andyetbequiteworthless;andifthemoldhas aspottedappearance,as iffinewhitesandhadbeendredgedonandthroughthemass,itis certainthereis no mushroom-growingpowerthere.... Ifthickthreadspass throughthemass andtherearesigns ofminiaturetubercles onthem,thenthespawnmaybe regardedastoofargone....Clusters ofwhitespecks onthespawndenotesterility."

Mr.A.D.Cowan, ofNewYork,whohas the reputationofbeinganexcellentjudgeofmushroomspawn,writes me:"Tocorrectlyjudgethequalityofbrickspawnbyits appearance requires experienceinhandlingit,anda trainedeyewhichenables onequicklytodetectgoodfrombad,fairtomiddling.As twolots seldomcomeexactly ornearlyalikeinappearance,itis hardlypossibletogiveprecise rules tofollow,exceptingthenever-failing requisitewhichthespawnmustpossess tobegood,namely,themoldyappearanceonthesurface,themorethe better,withoutshowingthreads.Toomanyofthesetoagivenspaceareasureindicationofexhaustedvitality, arisinggenerallyfromthebricksbeingheapedtogetherwheninprocess ofmanufacture,beforetheyare sufficientlydried.Healthybricks areusuallyofadustybrowncolor,andoflightweight. [Pg86]Blackcolored spawnis tobeavoided,as a rule,andwhentheblackappearanceisveryprevalentinacargoofbricksitis astrong indicationthatthespawnhasnotrunits course;andasitisnotexpectedtodosoafterithas reachedthehandsof the retaileritis economytocastitaside.Somepersons breakabrickintoseveralpieces toseehowitlooksinside. Totheexperiencedeyethisis notnecessary,oreventolayhands uponit,astheoutwardmoldyappearanceis the

bestofallevidenceofitshealthyvitality, andthis never existsifthebricks havelosttheirgerminatingpower, excepting,ofcourse,whereitheyhavebeenkeptdamp,andthespawnhas spentits power, whichis detectedbythe whitethreads appearingingreatquantity."

**American-made Spawn.**—Sofaras Ihavebeenabletofindoutbydiligentinquiry,mushroomspawnis notmade forsaleinthis country.ButIaminformedthatafewgrowers dosaveandusetheirownflakespawn.Someofour principalgrowers,VanSiclen,Gardner,andHenshaw,forinstance,intimepastattemptedtomaketheirown spawn,butwithonlypartial success,andnowtheyconfinethemselves totheimportedarticle.Butthis stateof affairs cannotlongcontinue.Thedemandhereforfreshmushroomsis sogreat,theindustryofmushroom-growingsoimportant,thepriceofimportedspawnsohigh, andthequantityofforeignspawnimportedannually intothis countryis solarge,that,beforelong,wehopesomeonewillfindittohis advantagetomakeaspecialtyof growingmushroomspawninthis countrytosupplytheAmericanmarket. Thereis nopracticaloperationin connectionwiththecultivationofmushrooms solittleknownorunderstoodbythegeneralgroweras thegrowing (or"making," asitiscommonlycalled) andpreservingofmushroomspawn.Generalcultivators inEnglandand France (outsideofthe Paris caves)donotmaketheirown[Pg87]spawn;itis adistinctbranchofthebusiness, and carriedonbyspecialists whogrowmushroomsforsaleinwinter,andspawninsummer.

Thetimeandattentionrequiredtoproduceasmallquantityoffirst-class spawnareworthmorethanthecostofthe spawnattheseedstore.Inordertomakespawnprofitablywemustmakeitinlargequantity,andweneednot attempttomakeitunless wehavegoodmaterials andconditionsforits properpreparation,andwillgiveitevery attentionpossibleforits bestdevelopment.

BecausespawnmaybemadeinAmericais noreasonwhateverwhytheAmericanpeoplewillbuyit.Wemust produce, atleast,as goodanarticleas thebestinEuropebeforewecanfindcountenanceinourhomemarket. Itis nottheshapeofthemanurebrick,its size,finefinish,hardness,softness,orfreshness,thatcounts inthis case;itis thefullness andvitalityofthemass ofmyceliumormushroomplantthatis containedwithinit.

terthemushroombedismadeupitshould, withinafewdays,warmtoatemperatureof110°to120°.Carefully observethis,andneverspawnabedwhentheheatis rising,orwhenitis warmerthan100°,butalways whenitis onthedeclineandunder90°.Inthis thereis perfectsafety.Haveagroundthermometerandkeepitplungedinthe bed;bypullingitoutandlookingatitonecanknowexactlythetemperatureofthebed.Haveafew straight, smoothstakes,likeshortwalkingcanes, andsticktheendoftheseintothebed,twelvetotwentyfeetapart;by pullingthemoutandfeelingthemwiththehandonecantellprettycloselywhatthetemperatureofthebedis.

Allpracticalmushroomgrowers knowthatifthetemperatureofatwelveinchthickbedatseveninchesfromthe surfaceis 100°,thatwithinaninchofthesurfaceofthebedwillonlybeabout95°indoors,and85°to90°outof doors. Also, thatwhen theheatofthemanureis onthedeclineitfalls quite rapidly,five,oftentendegrees,aday, tillitreaches about75°,andbetweenthatand65°itmayrestforweeks.

Someyears agoIgaveconsiderableattentiontothismatterofspawningbeds atdifferenttemperatures.Spawn plantedas soonas thebedwasmade (fivedays afterspawningtheheatininteriorofbedranupto123°)yieldedno mushrooms,themyceliumbeingkilled.Thesamewas thecaseinallbeds wherethespawnhadbeenplanted beforetheheatinthebedshadattaineditsmaximum[Pg97](120°orover).Wheretheheatinthemiddleofthe bedneverreached115°,thespawnputinwhenthebedwasmade,andmoldedoverthesameday,yieldedasmall

cropofmushrooms.Abedinwhichtheheatwas decliningwas spawnedat110°;thisboreaverygoodcrop, andat 100°andunderto65°goodcrops ineverycaseweresecured,withseveraldays'delayinbearinginthecaseofthe lowesttemperatures.Butnotwithstandingthesefacts, myadvicetoallbeginnersinmushroomgrowingis,wait untiltheheatofthebedis onthedeclineandfallentoatleast90°,beforeinsertingthespawn.

Writingtomeaboutspawninghis beds,Mr.Withington, ofNewJersey,says:"Ibelieveabedspawnedat60°to 70°,andkeptat55°afterthemushrooms appear, willgivebetterresults thanonespawnedatahighertemperature, say90°**PreparingtheSpawn.**—Ifbrickspawnisusedcutupthebricks (standard size)intotenortwelvepieces withasharphatchet,andavoid,asmuchas possible,makingmanycrumbs,asis thecasegenerallywhena hammerormalletis usedinbreakingthebricks.Extralargepieces ofspawnareapttoproducelargeclumps of mushrooms,butthisis notalways anadvantage,as whenmanymushrooms growtogetherinaclumptheyareapt tobesomewhatundersized,andingatheringwecannotpluckthemalloutcleanenoughsoasnottoleaveapartof the"root"inthegroundtopoisonthe[Pg98]balanceoftheclump,incases whereseveralormanyofthemspring fromonecommonbase.

**Insertingthe Spawn.**—Whenbrickspawnis usedplantthelumps aboutaninchdeepunderthesurfaceofthe manure,andaboutteninches aparteachway.Ifthespawnlooks verygood, andthelumps arelargedonotplant themquitesocloseas whenthespawnshowslessmyceliuminit,andthelumps aresmall.Neveruseadibberin plantingspawn;simplymakeaholeinthemanurewiththefingers,insertthelumpandcoveritoveratonce,and assoonasthebedhasbeenplantedfirmitwellallover.Althoughthelumps areburiedonlyaninchdeepunderthe manure,wehavetomakeaholethreeorfourinches deeptopushthelumpintotogetitburied.

Frenchorflakespawnisinsertedinmuchthesamewayandaboutthesamedistance,only,insteadofcuttingit upintolumps,wemerelybreakitintoflakypiecesaboutthreeincheslongbyaninchthick,andinplantingitin thebeds,inplaceofpushingitintothehole,layintheflakeonits flatsideandatoncecoverit.

Manygrowers plantspawnagooddealdeeperthanIdo,butIhaveneverfoundanyadvantageindeepplanting.In moderatelywarmbeds,orbeds thatarelikelytoretaintheirheatforaconsiderabletime,Iamsatisfiedthat shallowplantingis betterthandeepplanting.Whenwewanttomoldoverourbeds soonafterspawningthem, shallowplantingis tobe recommended.Butifthebeds areonly75°to78°,beforebeingspawned;thenIthink deepplantingis betterthanshallowplanting,becausethegenialtemperaturegives themyceliumabetterstartin lifethanwouldthecoolermanurenearerthesurface.

Ifthereis anylikelihoodofthesurfacemanuregettingwetfromthecondensedmoistureoftheatmosphere,I wouldagaincoveroverthebeds withsomehayor [Pg99]straw,andletitremainonuntilmoldingtime.Andifthe bedis alittlesluggish,—thatis,cool,—this coveringwillhelpinkeepingitwarm.Outsidebeds shouldbemolded overinthreeorfourdays afterspawning;insidebedsineighttotendays.

**SteepedSpawn.**—Asbrickspawnis sohardanddryIhavetriedtheeffectofsteepingitintepidwaterbefore planting; somepieces weremerelydippedinthewater,andothers allowedtosoakinthepails one-half,one,five, andtenhours.Theeffectwas prejudicialineveryinstanceandruinous inthecaseofthelong-soakedpieces.

**Flake Spawn.**—"Thisis producedbybreakingupthebrickspawnintopieces abouttwoinches squareandmixing theminaheapofmanurethatisfermentinggently.Afterlyinginthis heapaboutthreeweeksitwillbefoundone

massofspawn, andjustinthe rightconditionforrunningvigorouslyallthroughthebedinaveryshorttime.... Whenflakespawnis usedtheappearanceofthecropisfromtwotothreeweeks earlierthanwhenbrickspawnis used."—Mr.Henshaw,infirsteditionof"Henderson's HandbookofPlants." Ihavetriedthismethodandgivenit carefulattention,butthe results wereinferiortothoseobtainedwhereplain,commonbrickspawnhadbeenusedat once.

InallmypracticeIhavefoundthatanydisturbanceofthespawnwheninactivegrowthwhichwouldcausea breaking,exposing,orarrestingofthethreads ofthemyceliumhas alwayshadaweakeninginfluenceuponit.I havetransplantedpieces ofworkingspawnfromonebedtoanother,astheFrenchgrowers do, butam satisfiedthat Igetbetter crops andlargermushroomsfrombeds spawnedwithdryspawnthanfrombeds plantedwithworking spawnfromanyotherbeds.

LOAM FOR THEBEDS.

Ingrowingmushrooms weneedloamforcasingthebeds aftertheyarespawned,topdressingthebearingbeds whentheyfirstshow signs ofexhaustion,fillingupthecavitiesinthesurfaceofthebeds causedbythe removalof themushroomstumps,andformixingwithmanuretoformthebeds.Theselectionofsoildepends agooddealon whatkindofsoilwehaveathand,or canreadilyobtain.

Thebestkindofloamforeverypurposeinconnectionwithmushroom-growingis rich,fresh,mellowsoil,suchas florists eagerly seekforpottingandothergreenhousepurposes.Inearly fallIgettogetherapileoffreshsodloam, thatis,thetopspitfromapasturefield,butdonotaddanymanuretoit.Ofcourse,whilethis contains agooddeal ofgrassysodthereismuchfinesoilamongit,andthisis whatIuseformushrooms.BeforeusingitIbreakupthe sods withaspadeorfork,throwasidetheverytoughestpartsofthem,andusethefinerearthyportion,butalways inits roughstate,andneversifted.Thegreen,soddypartsthatarenottooroughareallowedtoremaininthesoil, fortheydonoharmwhatever, eitherinarrestingthemyceliumorcheckingthemushrooms,andthereisnodanger thatthegrass wouldgrowupand smotherthemushrooms.

Commonloamfromanopen,well-drainedfallowfieldis good,and,ifthesoilisnaturallyrich,excellentforany purpose. Butdonottakeitfromthewetpartsofthefields.Rejectall stones,roughclods, tussocks, andthelike. Suchloammaybeusedatonce.

[Pg101]Ordinarygardensoilis usedmorefrequentlythananyothersort,andaltogether withhighlysatisfactory results.ThegreatestobjectionIhavetoitis theamountofinsectsitis apttocontainonaccountofits often repeatedheavymanurings.

Roadsidedirt,whetherloamyorgritty,mayalsobeusedwithgoodresults.Iffreefromweeds,sticks,stones and roughdrift,itmaybeusedatonce,butitismuchbettertostackitinapiletorotforafewmonthsbeforeusing.

Sandysoil,suchas occursinthewater-sheddriftsalongthe roads andwhereithasbeenwashedintothefields,is muchinferiortostifferandmorefibrous earth.

Ihaveusedthe richdarkcoloredsoilfromslopes anddryhollowsinwoods, and,oddthoughitmayappear,as mushrooms donotnaturallygrowinwoods, withsuccess.Butitis notas goodas loamfromtheopen field.

Peatsoilorswampmuckthathas beencompostedfortwoorthreeyearshasfailedtogivemegoodreturns.The mushrooms willcomeupthroughitallright,buttheydonottakekindlytoit.

Heavy, clayeyloamis,inoneway, excellent,inanother,notsogood. Solongas wecankeepitequablymoist withoutmakingitmuddyitis allright,butifweletitgetalittletoodryitcracks,andinthis waybreaks the threads ofthespawnandruins themushrooms thatwerefedthroughthem.

**LoamContainingOldManure.**—Loaminwhichthereis agooddealofold,undecomposedmanure,suchas the richsoilofourvegetablegardens,is unqualifiedlycondemnedbysomewriters becauseofthequantityofspurious andnoxiousfungiitis supposedtoproducewhenusedinmushroombeds.ButIcannotjoininthis denunciation becausemyexperiencedoes notjustifyit.This earthis theonlykindusedbymanymarketgardeners,as theyhave noother,andcertainlywithout[Pg102]apparentinjurious effect.WhenIwas connectedwiththeLondonmarket gardens,sometwentyyears ago, Steele,Bagley,Broadbent,andtheotherlargemushroomgrowers intheFulhamFields casedalloftheirbedswiththecommongardensoil—perhaps themostmanure-filledsoilonthefaceofthe earth—andspuriousfunginevertroubledthem.Indeed,Icannotunderstandwhyitshouldproducebanefulcrops oftoadstools whenusedinmushroombeds,andnotoadstools whenusedforotherhorticulturalpurposes,as onour carnationbenchesingreenhouses,inourlettuceor cucumberbeds,orinthecaseofpottedplants.True,spurious fungimayappearintheearthonourgreenhousebenches orframebeds ormushroombeds atanytimeandinmore orless quantity,butIamconvincedthatthe richearthofthevegetablegardenhas nomoretodowithproducing toadstools thanhas anyothergoodsoil,andoldmanurehasfarless todowithitthanhasfreshmanure.

Allpracticalgardeners knowhowapthotbeds,inspringwhentheirheatis onthedecline,aretoproduceanumber oftoadstools;and, also, thatwhenthebedis "spent,"thatis,whentheheatis altogethergone, thetendencytobear toadstools has gonetoo. This peculiarityismoreapparentinspringthaninfall.Allmushroomgrowers knowthat spuriousfungi, whentheyappearatall,aremostnumerous threetotwoweeks beforeitis timeforthemushrooms tocomeinsight. Thesamegrowthappears inthemanurepilesoutintheyard;afewweeks afterthestrongheatof themanurehas gonelotsoftoadstoolsmaybeobservedonandaboutheaps,butonthepiles ofwell-rottedcold manureweseldomfindtoadstools atall.

Thefresh, cleanstablemanureusedinmushroom-growingisnotapttobechargedwiththesporesofpernicious toadstools;theirpresenceis alwaysmostmarkedinthecaseofmixedmanures.

[Pg103]Andthereis acurrentideathatmushrooms willnotthriveinbedsinwhicholdmanureabounds, eitherin theloamorfermentingmaterial;thatitkills themycelium.This,too, Imustrefute.Ihaveseenheavycropsof spontaneousmushrooms comeupinvioletandcarnationbedsinwinter,andwherethesoilconsistedofatleast one-fourthofrottedmanurewellmixedwiththeearth. Incucumber andlettucebeds thesamethinghas taken place.Andinsimilarbeds thathavebeenplantedartificiallywithspawn,goodcropsofmushroomshavealsobeen raised, andthemycelium,insteadofevadingthelumps ofoldmanureinthesoiloftenforms awhitewebright throughthem.

EARTHINGOVER THEBEDS.

Thisis animportantoperationinmushroom-growing,andtheoneforwhichloamisindispensable.Itconsistsin coveringthemanurebeds, aftertheyhavebeenspawned,withacoating,orcasingasitismorecommonlycalled,

ofloam.Thespawnspreadsinthemanureandrises upintothecasing,wheremostoftheyoungmushrooms develop,andallfindafirmfoothold.Theloamalsocontributes totheirsustenance.Anditprotectsthemanure, hencethespawn,fromsuddenfluctuations oftemperature,andpreservesitfromunduewettingordrying.

Thebestsoiltouseforthis purposeis rich,fibrous,mellowloam,suchasis described,page100.

Ifthemanureisfreshandingoodconditionandthebeds areinasnugcellarorclosedmushroomhouse,Iwould notcasethemuntilthesecondweekafterspawning,[Pg104]sayabouttheeighthortenthday;butwerethesesame bedsinanopen,airyshedorotherbuildingIwouldcasethemoversomedays earlier,saythefourthorfifthday.A fearis oftenexpressedthatwhenbeds arecasedwithinthreeorfourdays afterbeingspawnedthecloseexclusion ofthemanurefromtheairis apttoraisetheheatofthemanureinthebed,andtherebydestroythespawn;butI haveneverknownofanytruthinthis theory,andwithwell-preparedmanureIamsatisfiednobriskreheatingtakes place,atleastthethermometerdoes notindicateit. Thegreatdangerofearlycasingisinkillingthespawnby buryingittoodeepindampmaterialandbeforeithas beguntorunthroughthemanure.

Ihaveconductedseveralexperimentsinordertosatisfymyselfregardingwhenis thepropertimetocasethebeds, andhavefoundnodifferenceinresultsbetweenbeds thatwerecasedoveras soonas theywerespawnedand others thatwerenotcasedoveruntilthefourth,seventh,tenth, orfourteenthdayafterspawning.Thegoodorbad resultsinthetimeofcasingdependontheconditionofthemanureinthebeds,thedepthatwhichthespawnhas beeninserted, theopenness orcloseness oftheplaceinwhichthebeds aresituated,andotherculturalconditions. Buttodelaycasingaslateas thefifteenthorsixteenthdayafterspawningisinjurious tothecrop,becausein applyingthecoveringofsoilwearesuretobreakmanyofthemyceliumthreads thathavebythis timesofreely permeatedthesurfaceofthemanure.Afterthefourthweeklittlewhiteknots maybeobservedhereandthereon thespawnthreads; theseareformingmushrooms,andtodelaycasingthebeduntilthis timewouldsmotherthese littlepinheads,andgreatlymarourprospectsofagoodcrop.

PeterHenderson,inhisinvaluablework, "GardeningforProfit," has givenrisetoadeepseatedprejudice[Pg 105]againstmoldingovermushroombeds as soonas theyarespawnedbytellingus thatinhisfirstattemptat mushroom-growinghehadlaboredfortwoyearswithoutbeingabletoproduceasinglemushroom,andall becausehemoldedoverhisbeds withatwo-inchcasingofloamjustas soonas hehadspawnedthem.Thenhe changedhis tactics,anddidnotmoldoverthebedsuntilthetenthortwelfthdayafterspawning,andwas rewarded withgoodcropsofmushrooms.Now,notwithstandingMr.Henderson's experience,itis afactthatmanyexcellent growers spawnandmoldtheirbeds thesameday,andwithsuccess.ButMr.H.has donemuchgoodindisplaying arockagainstwhichmanymightbewrecked,somuchdepends uponotherculturalconditions.Theoldpracticeof insertingthespawnthreeormoreinches deepintothemanurebedandthenmoldingitatoncewithtwoinches deepofloamwas enoughtodestroythemostpotentspawn;nowadays webarelycoverthespawnwiththemanure, andthisis howmoldingoveratonceis sosuccessful.

Allthepreparationnecessaryis tohavetheloaminmediumdry,mellowcondition,wellbrokenupwiththespade ordiggingfork,andfreedfromsticks,stones,bigroots, clods,chunks ofoldmanure,andthelike.

Siftingthesoilforcasingthebedsislaborlost.Siftedsoilhas noadvantageoverunsiftedearth,exceptwhenitis tobeusedfortopdressingthebearingbeds orfillingupthe holesintheirsurface.

Theconditionofthesoilshouldbemellowbutinclinedtomoist.Ifwetitcanonlybeusedclumsilyandspread withdifficulty;ifdryitcanbespreadeasilybutnotmadefirm,andonridgebeds cannotbeputonevenly.But whenmoderatelymoistitcanbespreadeasilyandevenlyonflatorroundedsurfaces,andmadefirmand smooth.

Howdeepthemold shallbeputuponthebedis also[Pg106]anunsettledquestion.Somegrowers recommend three-fourths ofaninch,othersone, oneandone-half,two,ortwoandone-half inches,andsomeofourbest growersoffiftyorseventy-fiveyears agowereemphaticinassertingthreeinches as theproperdepth, butamong recentwriters Idonotfindanywhogobeyondtwoandone-half inches.Myownexperienceisinfavorofaheavy covering,sayoneandone-halftotwoinches.Inthecaseofathincoveringthemushrooms comeupallrightbut theirtexture is notas solidasitisinthecaseofaheavycovering,nordothebeds continueaslonginbearing; besides,"foggingoff"ismuchmoreprevalentunderthinlycoveredthanunderheavilycoveredbeds;also,when thecoatingofloamisheavyagreatmanymoreofthe"pinheads" developintofullsizedmushrooms thaninthe caseofthinlymoldedbeds.

Opinions differas tofirmingthesoil.Iaminfavorofpackingthesoilquitefirm,andhaveneverseengood mushrooms thatcouldnotcomethroughawellfirmedcasingofloam, andIneverknewofaninstancewherefirm casingstoppedor checkedthespreadingofthemyceliumorthedevelopmentofthemushrooms.Inthecaseofflat beds,—forinstance,thosemadeonshelves andfloors,—aslightlycompactedcoating(andthisis allMr.J.G. Gardneruses)maybeallright,butinthecaseofalongside-of-walls,ridge,andotherroundedbeds Imuchprefer andalways usesolidlycompactedcasings.

Mr.Henshawhasforseveralyears usedgreensods abouttwoinches thick,putalloverthebed,grass sidedown, andbeatenfirmly.Theadvantageofusingsodsinsteadofsoil,hethinks,is thattheyoungclusters ofmushrooms neverdampor"foggoff" as theyareapttodowhensoilis used.

Ihavegiventhis greensodsmethodrepeatedandcarefultrials,andam satisfiedthatithas noadvantages,inany way,overcommonfibrousloam;indeed,itis[Pg107]notas good. Nomatterhowfirmlyasod,havingits green sidedown,maybebeatenontoabedofmanure, thereis barelyanyunionbetweenthetwo;thesodmerelyrests uponthedung,butsocloselythatthemyceliumenters itfreely.Aslightmovementordisplacementofthesod afterthespawnentersitwillbreakthethreads ofmyceliumbetweenthemanureandthesod, andthis willdestroy theimmaturemushroomsforminginthesod. Thisgavemeagooddealoftrouble.Steppingonthesodwould disturbit.Aclumpofstrongmushroomsformedunderitsometimes displacesitinforcingtheirwaytothesurface.

Sods areonlyfitforuseonflatbeds wheretheycanliesolid;onroundedorridgebeds theyaretooliabletobe disturbed.Andthetroubleandexpenseofprocuringsods aretoogreattowarranttheiruse,eveniftheyhadany advantages.

TOPDRESSINGWITHLOAM.

Inbeds thatare infullbearingoralittlepasttheirbestweoftenfindmultitudes ofverysmallorwhatwecall "pinhead"mushrooms,thatseemtobesittingrightonthetopoftheloam,orclumps thathavebeenraisedalittle abovethesurfacebygrowinginbunches,orwhatweterm"rocks";nowatopdressingoffinelysiftedfreshloam, aboutone-fourthtoone-half inchthick,spreadalloverthebed, willhelpthesemushroomsmateriallywithout doinganyofthemharm.Butwhilethis topdressingassists allmushrooms thatarevisibleaboveground,nomatter

how smalltheymaybewhenthedressingis applied,I amnotconvincedthatit[Pg108]induces greaterfertilityin thespawn,or,inotherwords,induces thespawntospreadfurtherandproducemoremushrooms thanitwould werenotopdressingapplied.Iknowthatthisis contrarytotheopinions andwritings ofmany,atthesametimeitis accordingtomyownobservation.

Gooverthebedverycarefullyandpickouteverysoftor"fogged-off"mushroom,nomatterhowsmallitmaybe, androotouteverybitofoldmushroomstemortough spongymaterialformedbyit,andinthis waygetthebed thoroughlycleaned.Thenfillupalltheholes causedbypullingthemushrooms orrootingouttheoldstumps,and whenthewholesurfaceislevelapplythetopdressingevenlyalloverthefaceofthebed,avoiding,as muchas possible,buryingthewelladvancedmushrooms.Whileitwouldbeverywelltopackthedressing smoothlyover thebed,itisimpracticable;wemaypressitgentlywiththebackofthehandonthebarespots betweenthe mushrooms,butweshouldnotevendothis overthemushrooms,nomatterhowtinytheymaybe, elsemanyofthe "pinheads" willbeinjuredandcause"foggingoff."

Butwecan firmthedressingtothebedbywateringit,whichmaybedoneoverthewholesurfaceofthebed,and withoutsparingthemushrooms,largeorsmall.Useclearwaterandapplyitgentlythroughawater-potrose. I always dothis,andhaveneverknownittoinjuretheyoungmushrooms.

Inthecaseofmushroombedsinwhichblackspothas appearedinthecrop, Ihavefoundthatatopdressingoffine, freshearthappliedevenlyalloverthebedacts, toacertainextent,as apreventiveoffurtherattack,butofcoursehas noeffectuponanyofthealreadyaffectedmushrooms,largeorsmall.

THEPROPER TEMPERATURE.

Thebesttemperatureatwhichtokeepthemushroomhouseorcellaris 55°to57°.Butmuchdepends uponthe methodofgrowingtheesculent;theconstructionofthehouseorcellar,andothercircumstances.Mushrooms can besuccessfullygrowninbuildingsinwhichthetemperaturemaybeaslowas 20°oras highas 65°.Bycovering thebeds wellwithhayorotherprotectingmaterialtheycanbekeptwarm,eveninsharpfrostyweather,asthe Londonmarketgardeners dowiththeiroutdoorbedsinwinter;butwhenthetemperatureinthestructureinwhich themushrooms aregrownaverages ashighas 70°wecannothopeforsuccess;indeed,65°is toohigh.

Ahightemperatureinaclosehouseorcellarisinjurious;ithurriesinthecropandforces upthemushrooms weak andthin-fleshedandwithungainly,longstems;itsoonexhausts thebed.Thetimewhenits evileffects areleast visibleis earlyinthefallandlateinspringwhentheoutsidetemperatureishigh,andwhenthebedsarein somewhatairyratherthanclosequarters. IntheDosoriscellars thereis asteadydifferenceofabout5°inthe temperaturebetweentheendnexttheboiler,whichis keptat60°precisely, andthatofthefartherend,which registers 55°steadily.Thereisverylittledifferenceintheweightofcropproducedonthebeds ateither endof thesecellars,butwhatlittlethereisisinfavorofthecoolerend.At60°thecropbegins tocomeininsixtoseven weeks afterspawning,lasts forthree[Pg110]tofourweeks inheavybearingandaweekormorelongerinlight bearing,andthenitgraduallydwindles.

Inatemperatureof55°itmaybesevenweeks afterspawningbeforethemushrooms appear.Inatemperatureof 50°theymaytakeafewdayslongerinappearing,but,as arule,theyarefirm,heavy,short-stemmed,andperhaps alittlefurryontopandclammytothetouch,andthebedslastingoodbearingfortwomonths;indeed,oftena

wholewinterlong.ButIhavefailedtofindthatthewholecropfromabedina45°to50°temperaturewas any greaterthanthatofalikebedina55°to57°temperature;itismerelyacaseofgettinginsixweeksfromthe warmerhousewhatittakestenweeks togetfromthecoolerone.

Inatemperatureof50°itisnotnecessarytocoverthebeds toincreasetheirwarmth,norisitneedfuleveninone of45°,ifthereis afairwarmthinthebodyofthebedtokeepthespawnworking;butifthewarmthoftheinterior ofthebedfalls under57°,andtheatmospherictemperatureunder45°, thebed shouldbekeptwarmbycovering withhay,straw,matting,orothermaterial,orbetterstillbyboxingitoverandlayingthis coveringontheoutside oftheboxing.Whencoldthickenthecovering,whenwarmlessenit.

ATERINGMUSHROOM BEDS.

Ifthebeds getdrytheyshouldbewatered, formushrooms willnotgrowwellindrybeds orinadryatmosphere. Wateringis anoperationrequiringmuchcare.Inproperly-madebeds themanureshouldremainmoistenoughfrom firsttolast,andwhateverdrynessis evidentshouldbeintheloamcasingofthebeds andtheatmosphere.Inall artificiallyheatedmushroomhouses thebeds andatmosphereareapttogettoodryatonetimeoranother;in undergroundhouses orcellars thisisless apparentthaninabove-groundstructures;inshadednorth-facinghouses drynessisless troublesomethaninhousesmoreopenlyplaced.

Endeavorbyallfairmeans tolessenthenecessityforwateringthebeds,butwhenwateris neededneverhesitateto giveitfreely.Mulchingthebeds andmaintainingamoistatmospherearethebestpreventives.Afterthebeds are spawnedandmoldeditis agoodplantocoverthemwithalightcoatingofstrawylitterorhaytopreventdrying, butthismulching shouldbe removedwhenitis neartimefortheyoungmushrooms toappear.Alightsprinklingof wateroverthismulchingevery fewdays,butneverenoughtoreachthesoil,assistsinpreservingenoughmoisture inthebedunderthemulchandalsointheatmosphereofthehouse.

Clean,softwateratatemperatureof80°or90°;alittlewarmerora littlecolder willnothurt,butdonotusewater higherthan110°,asitmightinjurethelittlepinheads,norlowerthantheaveragetemperatureofthe[Pg 112]house,as itwouldchillthebed,andthis shouldalwaysbeavoided.

Useasmallormedium-sizedwateringpotwithalongspoutandafine rosesprinkler.Applythewaterinagentle showeroverthebed,mushrooms andall,butneveruseenoughtoallowittosettleinpools orrunoffinlittle streams.Cleanwatersprinkledoverthemushrooms does notappeartohurtthem,buttheyshouldneverbetouched withmanurewater,as itstains them.Justas soonas thesurfaceofthebed shows signs ofdryness giveitwater, the quantitydependingupontheconditionofthebed.Neverletabedgetverydrybeforewateringit. Tothoroughly moistenaverydrybedrequires aheavywatering;somuch,indeed,thatthesuddenchangemightinjuriouslyaffect theyoungmushrooms andspawn. Giveenoughwateratatimetomoderatelymoistenthesoil,notto soakit,but neversufficienttopass throughthesoilintothemanure.Cleanwateronlyshouldbeuseduntilthebeds comeinto bearing,butafterthattimemanurewatermaybeemployedwithadvantage;however,thisisnotatallimperative; indeed,excellentcrops canbeandarecontinuallybeingproducedwithouttheaidofmanurewateratall.

Inthecaseofbedsinfullbearing,manurewaterisbeneficialtothecrop.Applyitfromasmallwateringpotwitha longnarrowspoutbutnorose, andpourtheliquidongentlyoverthesurfaceofthebed,runningitfreelybetween theclumps butnevertouchinganyofthemushrooms.Forthis reasonaroseshouldnotbeused.

Ihavealways usedmanurewaterformushroomsmoreorless,butduringthepasttwoseasons—'87-'88and'88-'89—Ihaveexperimentedwithitcontinuouslyandverycarefully,usingitinsomeformorotheronpartofevery bed,andam satisfiedthatmanurewatermade[Pg113]fromfreshhorsedroppingsis thebest,andthedarkcolored liquid,thedrainingsfrommanurepiles,is thepoorest;infact, thislatterisnotas goodas plainwater, foritseems tohaveadeadeningratherthanquickeningeffectuponthebeds.Cowmanureand sheepmanuremakeagood liquidmanure,butstillIpreferthehorsemanure,andalthoughhavinggivenhenandpigeonmanureandguanofair tests Iamnotsatisfiedthattheyhavebenefitedthecrop, andthereis always ariskintheiruse.Liquidmanure madefromthecontentsofthebarnyardtankhasnotdonemuchgood,butfreshurinefromthehorseandcow stables dilutedtwelvetofifteentimesitsbulkhas givenfavorable results.

Mushrooms notonlybear withimpunitybutappeartoenjoyastrongerliquidmanuremorethandoanyother cultivatedplants,andIamsatisfiedthattheweakliquids usuallyrecommendedforpotandgardenplants wouldbe barelymoreefficacious thanplainwaterformushrooms.

Themanurewaterthathas givenmemostsatisfactionis preparedas follows:Dumptwobushels offreshhorse droppingsintoaforty-fivegallonbarrelandfillupwithwater; stiritupwellandletitsettleovernight.Drainoff theliquidthenextdayandaddapoundofsaltpetertoit. Foruse, toapailfulofthisliquidaddapailfulofwarm water. Waterofabout80°to90°isbestformushroombeds.Saltpeteris anexcellentfertilizerformushrooms.I useitintwoways,namely:First,powderedandmixedinthesoilforcasingthebeds,atthe rateoftwoounces of saltpetertothebushelofearth.Second,dissolvedinwateratthe rateoftwoounces ofsaltpetertoeightgallons of water, andsprinkledoverthebeds.

CommonsaltIuseas aninsecticideandalsoas afertilizer,andamsatisfiedthatitproves beneficialinbothways. Sometimes Isprinkleitbroadcastonthesurface[Pg114]ofthebeds, always onthebareplaces,nevertouchingthe mushrooms,andleaveitthereforadayortwo, thenwithafine,gentlesprinklingofwaterwashitintothesoil. Thisis tohelpdestroytheanguillulæ.As afertilizeronlydissolvefourounces ofsaltintengallons ofwater,and withthis sprinklethebeds.

Atoodryatmospherecanbe remediedbysprinklingthefloors,walls,orlittercoverings onthebeds withwater, notheavilyorcopiously,butgentlyandonlyenoughtowetthesurfaces;bettermoisteninthis wayfrequentlythan drenchtheplaceatanyonetime.ButIverymuchdislikesprinklingthebedsinordertomoistentheatmosphere. Anexperiencedmancantellinamomentwhetherornottheatmosphereofthemushroomhouseis toodry.Theair inthemushroomhouseshouldalwaysfeelmoist,atthesametimenotrawor chilly, andthefloorandwall surfaces shouldpresentaslowtendencytodryup,andtheearthonthebeds shouldretainits dark,moistappearance.The leasttendencytodryness shouldatoncebe relievedbydampingthewallandfloorsurfaces.

Inhousesheatedbysmokeflues,orstillmorebyordinarystoves andsheetironpipes,itmaybenecessaryto dampenthefloors andwalls onceorseveraltimes adaytomaintainasufficientlymoistatmosphere,butwherehot waterpipes areusedandthehouses aretightenoughtorequirebutlittleartificialheat,suchfrequentsprinkling willnotbenecessary.Inthecaseofbedsinunheatedstructurestheordinaryatmosphereis generallymoistenough.

**Manure SteamforMoisteningtheAtmosphere.**—ThelateJamesBarnes,ofEngland,agrandoldgardener, writingintheLondon *Garden*,Vol.III,page486,describeshismethodofgrowingmushrooms sixtyyears ago, andsays:"Inwinteranicemoistheatwas maintainedbyplacinghotstablemanureinside,andoften[Pg

115]turningitover." Mr. JohnG.Gardner, ofJobstown,N.J., is oneofMr.Barnes's oldpupils andamost successfulmushroomgrower,andhenowpractices this samemethodofmoisteningtheatmospherebyhotmanure steam.

Indampingthefloorsofthemushroomhouse,as wellas thebeds,Iuseamedium-sizedwateringpotandfine rose; butinsprinklingthewalls andotherparts notreadilyaccessiblebythewateringpotIuseacommongarden syringe.GATHERINGAND MARKETINGMUSHROOMS.

Thisis animportantpointinthecultivationofthis esculent,andshouldbeattendedtowithpainstakingdiscretion.

Whenmushrooms arefittopickdepends uponseveralconditions;forinstance,whetherformarketorforhome use,andifforthelatter, whethertheyarewantedforsoupsorstews.Forfreshandattractiveappearanceandbest appreciationinthemarket, pickthemwhentheyareplumpandfreshandjustbeforethefrillconnectingthecap withthestembreaks apart. TheFrenchmushrooms shouldalwaysbegatheredbeforethefrillbursts;theEnglish mushrooms alsolookbestwhengatheredatthis time,buttheyareadmissibleifgatheredwhenthefrillbegins to burstandbeforethecaphas openedoutflat. Ifthemushrooms displayatendencytoproducelongstems pickthem somewhatearlier,soonenoughtogetthemwithshortshanks,forlongstems aredislikedinmarket;so, too,are darkordiscoloredoroldmushrooms ofanysort. Sometimes we [Pg116]maynothaveenoughmushrooms ready atonegatheringtomakeitworthwhilesendingthemtomarket,andaretemptedtoletthemstayungathereduntil to-morrow,whentheyhavegrownlarger andmanymoreshallhavegrownbigenoughtogather.This shouldnever bedone.Itwillgiveanunfavored,unequallot,somebig,somelittle,someold,someyoung.Farbetterpickevery onethemomentitis readytogather,andkeepallsafeinacoolplaceandcovereduntil somemoreare readyfor use,andinthis wayhaveauniformappearinglotofyoungproduce.

Mushroomsforsoups shouldalwaysbegatheredbeforetheyburstheirgills;indeed,theyaremostlygathered wheninabuttonstate;thatis,whentheyareaboutthesizeofmarbles.Inthis condition,whencooked,theyretain theirwhiteappearanceanddonotdiscolorthesoup.Immaturemushrooms aredeficientinflavor.

Forhomeuse,forbaking,stewing,broiling,orfor cookinginanywayinwhichthetenderness ofthe fleshandthe delicious aromaofthemushrooms aredesirableintheirfinestcondition,letthemushrooms attaintheirfullsize andbursttheirfrills,as seeninFig.24,andgatherthembeforethecaps openoutflat, orthegillsloseanyoftheir brightpinkcolor.Ifyouletthemgetoldenoughforthegills toturnbrownbeforegathering,themushrooms will becomeleatheryintexture,andloseinflavoranddarkensadlyincooking.


Fig.24.APerfectMushroom.

Inpicking, always pullthemushrooms outbythe [Pg117]root, andnever,ifpracticabletoavoidit,cutthemover withaknife.Ingathering,takeholdofthemushrooms andgivethemasharpbutgentletwist,pressingthemdown atthesametime,andtheygenerallypartfromthebedwithoutanytrouble;thenplacetheminthebaskets, root-end down,soastokeepthemperfectlycleanandfreefromgrit. Sometimes whenseveralmushrooms arejoined togetherinone root-stockanditisimpossibletoremoveonewithoutdisturbingthewhole,cutitoverratherthan pullitout. Inthecaseofclumps ofyoungmushrooms,whereonecannotbepulledoutwithoutdisplacingsomeof theothers also,cutitoutratherthanpullit.Thereis aknackinpullingmushrooms,easilyattainedbypractice.And evenwhentheycomeupinthickbunches anditwouldappearimpossibletopulloutthefull-grownones without disturbingtheothers,apracticedhandwillgivethematwitchandapull—theyoftenpartfromthebedbythe gentlesttouch—andgetthemoutwithoutunfasteninganyofthemultitudeofsmallbuttonsthatmaybegrowing aroundthem.

Theadvantages ofpullingovercuttingareseveral:Itbenefitsthebed.Ifwecutoveramushroomandleaveits stumpintheground,inafewdays decaysets inandafluffyorspongysubstancegrows aroundtheoldbutt, which destroysmanyofthelittlemushrooms aroundit, as wellas everythreadofmyceliumthatcomesincontactwithit. Oneshouldbeparticulartoscoopoutthesestumpswithaknifebeforethis conditiontakes place,andgooverthe beds everyfewdays tofilluptheholes,madeinscoopingouttheoldstumps, withfreshloam.

Pulledmushrooms always keepfreshlongerthandothosethathavebeencut. Intheinterestofthemarketgrower theyhaveanotheradvantage.Mushrooms areboughtandsoldbyweight, andas thestems arealways[Pg 118]retainedtothecaps allareweighedtogether;ifpartofthestems hadbeencutofftheweightwouldhavebeen

reduced,and,inlikeproportion, theprice;butifthestems are retainedentirenotonlyarethemushrooms benefited,buttheweight,andwithittheprice,is alsoincreased.

**GatheringFieldorWildMushrooms.**—Goinsearchoftheminthemorningbeforethesunshinegets warmand theybecometooopenorold.Ifyouwishtogatherandpreservethemintheirmostperfectconditionpullthemup bythe"roots," carefullyremoveanysoilfromthem, andthenlaythemorderlyinthebasket, therootenddown; andbyspreadingastoutsheetofpaperoverthelayer,anothermaybearrangedaboveitinthesameway,andsoon untilthebasketisfull.Butifyouarenotsoparticularandwishthemforimmediateuse, orforketchupordrying, thecommonwayofcuttingthemoffandcarryingthemhomeinbulkwillanswerwellenough.

**MarketingMushrooms.**—Mostmarketgrowerswholiveimmediatelyaround NewYorkCityselldirect,and delivertheirmushrooms tohotels,restaurants,andfancyfruiterers.Butsomeofthem,alsomostofthosewholive ataconsiderabledistancefromthecity,selltheirmushrooms throughcommissionmerchantsinNewYork;they, inturn,sellinquantities tosuitcustomers.

Mushrooms aresoldbythepound,andcomeintomarketinboxesmadeofstrongundressedpaper.Somegrowers havelightwoodenboxesmadethatholdfromonetofourpounds ofmushrooms each,andthesemakeconvenient andstrongpackagesforshippingbyexpress.Theymaybesentsingly,or,as is thecasewiththepaperboxes, severalpackedtogetherincrates orboxes.Insendingdirectlytohotels, cheapbaskets,holdingoneorseveral pounds—Mr.Gardner's baskets holdtwelvepounds—areoftenused,butinsendingtocommission[Pg 119]merchants,whohavetodealthemoutinquantities tosuitcustomers,mushrooms shouldalways bepackedin one, two,threeorfourpoundboxes orbaskets,preferablyonepound.Mushrooms arenotlikepotatoes orapples, thatcanbehandled,remeasured,andrepackedwithoutdamagingthem.Eachrehandlingwillcertainlydiscolorand perhapsbreakagoodmanyofthem,renderingthemunsalable,ifnotworthless.

Theutmostcareingatheringandpackingofmushroomsforshippingis ofprimaryimportance.Gatherthemthe momenttheyareinbestcondition,nomatterwhetherornottheyaretobepackedand shippedthesameday;never letthemblowopenbeforegatheringthem;andnevercutoffshortstems.Longstems havetobeshortened,butnot untileverythingis readytopackthem.Withaverysofthairbrushdustoffanyearththatmaysticktothecapofthe mushroom,andwithaharderbrushorthebackofaknife rubtheearthoffofthe rootendofthestem.Thensort themushrooms,—thebigones bythemselves,themiddle-sizedbythemselves,thesmallorbutton-sizedones by themselves,andpackeachkindbyitself.Packveryfirmlywithoutbruising,andsoas toshowtheprettycaps to thebestadvantage.Neverpackmushroomsmorethantwodeepwithoutusingplentyofsoftpaperbetweenthe layers,andneverputaheavybulkofthemintooneboxorbasket.Theydiscolorsoeasilythat,allthings considered,aboutapoundis enoughinabox,ifwewishthemtocarrysafelyandretaintheirbright, freshskin withouttarnishing.

Mr.Barter,ofLondon,writesme:"Thepunnets weuseformarketingourmushroomsinarethesamethatareused forstrawberriesorpeaches.Theseholdjustonepound,butitis becomingmorecustomarynowtohavelittleboxes madeholdingfromthreetofivepounds,as thesearebetterforpackinginlargercasesforlongjourneys."

## MUSHROOM CULTIVATION-17MBU601

### Possible questions

1. Differentiate edible mushroom from poisonous mushroom.
2. Write about Volvariella volvacea.
3. How to prepare bed for mushroom cultivation?
4. Write the hematological value of mushroom.
5. Write the processing of mushroom.
6. Explain the harvesting technique, storage & packaging of mushrooms
7. Write in detail about the production of mother spawn & its multiplication.
8. Explain the nutritional values- vitamins & minerals, calorific values of mushroom.

# KARPAGAM ACADEMY OF HIGHER EDUCATION

**CLASS:III B.Sc MB COURSE NAME: MUSHROOM CULTIVATION**

**COURSE CODE: 17MBU601A UNIT 3 BATCH-2017-2020**

| S.N | unit-3 | Option A | Option B | Option C | Option D | Answer |
|---|---|---|---|---|---|---|
| 1 | Mushroom fungus can be isolated from _____ | Soil | pasture | dead matter | all of the above | all of the above |
| 2 | The first step of spawn production was performed on _____ | Natural media | Artificial media | other sources | none of the above | Artificial media |
| 3 | Which species is used for the grain spawn? | *Agaricus spp* | *Volvariella spp* | *Pleurotus spp* | Both a and b | Both a and b |
| 4 | What are the different kinds of grains used | Wheat | Millet | sorghum | all of the above | all of the above |
| 5 | Which is used to encourage for the good growth for spawn? | Calcium carbonate | calcium chloride | calcium sulphate | calcium sulphide | calcium carbonate |
| 6 | Avoid _____ plugging of spawn bottles | loose | tighten | over tighten | none of the above | loose |
| 7 | _____ should be advised once in the month. | fumigation | sterilization | aeration | disinfection | fumigation |
| 8 | We should maintain the mushrooms in _____ condition. | good hygeine | poor hygeine | improper handling | none of the above | good hygeine |
| 9 | In culture inoculation which is mixed in boiled grains? | chalk powder | gypsum | lime stone | both a and b | Both a and b |
| 10 | _____ Cultures can be stored on compost for two years. | Agaricus | bacteria | actinommycetes | molds | agaricus |
| 11 | Recently a new method of growing mushroom in | India | Taiwan | China | U.K | Taiwan |

| | | | | | | |
|---|---|---|---|---|---|---|
| | plastic bags has been developed in _____. | | | | | |
| 12 | For spawning the bag _____ is commonly used. | Molasses | saw dust | wood powder | husk | saw dust |
| 13 | In _____ the cultivation of straw mushroom is conducted outdoors | Thailand | Modern cotton waste | Malaysia | Hongkong | Hongkong |
| 14 | In _____ method straw is soaked first of all and is mixed with cattle manure before making the stack. | Thailand | Modern cotton waste | Malaysia | Hongkong | Malaysia |
| 15 | In _____ method dry rice straw and cotton waste are used to prepare substrate. | Thailand | Modern cotton waste | Malaysia | Hongkong | Modern cotton waste |
| 16 | _____ Mushroom grows in nature on the dead wood of a number of hard wood trees. | button | shittake | paddy straw | oyster | shittake |
| 17 | _____ Mushroom grows in nature on the dead wood of a number of hard wood trees. | button | shittake | lentinus edodes | oyster | lentinus edodes |
| 18 | The mycelium of _____ grows both on composted and fresh straw. | calocybe indica | button | shittake | lentinus edodes | calocybe indica |
| 19 | Pasteurization of substrate gives _____ results. | good | bad | moderate | worst | good |
| 20 | Wheat grains free from diseases and insect pests should be boiled for | 10 – 15 mins | 15-20min | 20-25 min | 20-30min | 15 – 20 mins |

| | | | | | | |
|---|---|---|---|---|---|---|
| 21 | The spawned trays are kept in cropping rooms for _____ days for mycelia growth and spread | 8 – 10 | 12 – 15 | 2 – 6 | 6 – 9 | 8 – 10 |
| 22 | *Flammulina velutipes* forms _____ fruit bodies. | Small | big | medium | large | small |
| 23 | *Flammulina velutipes* mushroom usually appears in winter season in _____ | Japan | India | Malaysia | Hongkong | Japan |
| 24 | *Flammulina velutipes* mushroom is also called as _____ mushroom | winter | summer | rainy | autumn | winter |
| 25 | The whole cultivation process from spawning to cropping usually takes about _____ months. | 9 | 6 | 4 | 3 | 3 |
| 26 | Mushroom is cultivated on logs or on the mixture of saw dust supplement with _____ bran | Wheat | barley | rice | corn | wheat |
| 27 | Temperature between ____ to ____ deg C is suitable for cultivation of mushroom | 4 – 9 | 8 – 15 | 2 – 6 | 6 – 9 | 8 – 15 |
| 28 | Temperature below ____ deg C also affects the formation of fruiting bodies. | 2 | 4 | 6 | 8 | 8 |
| 29 | _____ is the most versatile method of preserving large quantities of mushroom. | Blanching | freezing | pickling | both a and b | both a and b |
| 30 | _____ Mushrooms are taken directly from a cold water basin or sink where they have been cleaned | washed | dried | freezed | none of the above | washed |

| | | | | | | |
|---|---|---|---|---|---|---|
| 31 | _____ stops enzymatic actions | Blanching | freezing | pickling | both a and b | Blanching |
| 32 | The age old method of _____ mushrooms is still one of the best methods of preserving mushrooms. | drying | Blanching | freezing | pickling | drying |
| 33 | Drying mushrooms preserves for very _____ period of time. | limited | long | short | none of the above | long |
| 34 | the first steps in spawn production are performed on _____. | artificial | natural | superficial | none of the above | artificial |
| 35 | _____ Cultures are then made for this starter culture | agar | broth | samples | specimens | agar |
| 36 | The _____ culture should be produced from tissue culture. | agar | broth | mother | specimens | mother |
| 37 | _____ Spawn is used to inoculate | agar | broth | mother | specimens | mother |
| 38 | Good spawn shows _____ mycelial growth | Vigorous | less | high | medium | Vigorous |
| 39 | For spawning the bag _____ is commonly used. | Molasses | Saw dust | Wood powder | Husk | Saw dust |
| 40 | In _____ method dry rice straw and cotton waste are used to prepare substrate. | Thailand | Modern cotton waste | Malaysia | Hongkong | Thailand |
| 41 | Secondary mycelium of mushroom produces umbrella like structure called as | pileus | gills | primary mycelium | tertiary mycelium | pileus |
| 42 | Agaricus bisporus was first cultivated in | M.P | H.P | U.P | PUNJAB | H.P |

| | | | | | | |
|---|---|---|---|---|---|---|
| 43 | In I ndia only three genera of mushroom are considered as edible varieties | Agaricus, as Lentinus, Plammutina | **Agaricus, Pleurotus, Volvariella** | Pleurotus, Lycoperdon, Geastrum | none of the above | **Agaricus, Pleurotus, Volvariella** |
| 44 | Mushroom are used in the preparation of | pizza | soup | pickles | all of the above | all of the above |
| 45 | Mushrooms belong to class | phytomycetes | basidiomycetes | chloromycetes | none of the above | basidiomycetes |

**UnitIV**

NutritionalprofileofMushrooms:protein,aminoacids,calorificvalues,carbohydrates,fats,vitamins&minerals.MedicinalProperties ofMushrooms:Antibacterial,antifungal,antiviral,anti-tumoureffectandhematologicalvalue.Cardiovascularandrenaleffect,in therapeuticdiets,adolescence,foragedpersonsanddiabetesmellitus.Mushroomnutriceuticals.

**Medicinalproperties**

Mainarticle: Medicinalmushrooms

*Ganodermalingzhi*

Some mushrooms areused or studied as possibletreatments fordiseases,particularlytheirextracts, including polysaccharides, glycoproteinsandproteoglycans.[39]In somecountries, extracts of polysaccharide-K, schizophyllan, polysaccharidepeptide,or lentinanare government-registeredadjuvant cancer therapies,[40][41]even though clinicalevidenceof efficacyin humans has not been confirmed.[42]

HistoricallyintraditionalChinesemedicine, mushrooms arebelieved to havemedicinal value,[43]although thereis no evidenceforsuch uses.

**Otheruses**

Atinderfungus, *Fomesfomentarius*

Mushrooms can beusedfor dyeingwooland other natural fibers. The chromophoresofmushroom dyesare organic compounds andproducestrong and vivid colors, and allcolors ofthespectrum can beachieved with mushroom dyes.Beforetheinvention of synthetic dyes, mushrooms werethesourceof manytextile dyes.[44]

Some fungi, types of polyporeslooselycalled mushrooms, havebeen usedas firestarters (knownas tinder fungi).

Mushrooms and other fungi playarolein thedevelopment of new biological remediation techniques (e.g., using mycorrhizaeto spur plant growth)and filtration technologies(e.g. usingfungi to lower bacterial levels in contaminated water).[45]

## Nutrition

Mushrooms (brown, Italian) or Crimini(raw)

**Nutritionalvalueper100g (3.5 oz)**

**Energy**94kJ(22 kcal)

**Carbohydrates**4.3 g **Fat**0.1 g

**Protein**2.5 g

| **VitaminsQuantity%DV**† | |
|---|---|
| Thiamine (B1) | 9% 0.1 mg |
| Riboflavin (B2) | 42% 0.5 mg |
| Niacin (B3) | 25% 3.8 mg |
| Pantothenicacid (B5) | 30% 1.5 mg |
| Vitamin B6 | 8% 0.11 mg |
| Folate (B9) | 6% 25 µg |
| Vitamin C | 0% 0 mg |
| Vitamin D | 1% 3 IU |

| **Minerals** | **Quantity%DV**† |
|---|---|
| Calcium | 2% 18 mg |
| Iron | 3% 0.4 mg |
| Magnesium | 3% 9 mg |
| Manganese | 7% 0.142 mg |
| Phosphorus | 17% 120 mg |

| | |
|---|---|
| Potassium | 10% 448 mg |
| Sodium | 0% 6 mg |
| Zinc | 12% 1.1 mg |

| Other constituents | Quantity |
|---|---|
| Selenium | 26 |
| ugCopper | 0.5 mg |
| Vitamin D(UVexposed) | 1276 IU |

FullLinkto USDA NutrientDatabase entry;(exposedto UVlight)

•Units

•µg= micrograms•mg=milligrams

•IU= Internationalunits

†Percentages areroughlyapproximatedusing US recommendationsfor adults.

Source:USDANutrientDatabase

Raw brown mushroomsare92%water, 4%carbohydrates, 2% proteinandless than 1% fat.Ina100 gram (3.5 ounce) amount, raw mushrooms provide 22ource(20%or moreof the DailyValue, DV) of Bvitamins, such as riboflavin,niacinand DV) and), and a moderate source(10-19%DV) ofphosphorus,zincand or no

**VitaminD**

Thevitamin D content ofamushroom depends onpostharvesthandling, inparticularthe unintendedexposureto sunlight. The US Department ofAgricultureprovided evidencethat UV-exposed mushrooms contain substantial amounts of vitamin D.[17]When exposed toultraviolet (UV)light, evenafter harvesting,[18]ergosterolinmushrooms is convertedto vitamin $D_2$,[19]aprocess now used intentionallyto supplyfresh vitamin D mushrooms forthe functionalfoodgrocerymarket.[20]Ina comprehensive safetyassessment of producingvitamin D in fresh mushrooms, researchers showed that artificial UVlight technologies were equallyeffectivefor vitamin D production as in mushrooms exposed to natural sunlight,and that UVlighthas alongrecord of safe usefor production ofvitamin D in food.[20]

Mushrooms as asourceof food

Man has been huntingfor thewild mushrooms since antiquity(Cooke, 1977). Thousands ofyears ago, fructifications of higher fungi havebeen used as asourceoffood(Mattila etal., 2001)dueto their chemical

composition which is attractivefrom thenutritionpointof view. Duringthe earlydays of civilization, mushrooms were consumed mainlyfor their palatabilityand unique flavors (Rai, 1994,1997). Present use ofmushroomsis totallydifferent from traditional because, lotof research has been doneonthe chemical composition of mushrooms which revealed that mushrooms can beused as adiet to combat diseases.The earlyhistoryregardingthe useof mushrooms in different countries has beenreviewed bynumber ofworkers(Buller, 1915; RolfeandRolfe, 1925; Singer, 1961; Atkinson,1961; Banoet al., 1964;Jandaik and Kapoor,1975; Banoand Rajarathnam, 1982; Abou et al., 1987; Houghton, 1995).Theoriental useofmushroomsis older than the European(Lambert, 1938). Rolfe and Rolfe(1925)mentioned that themushrooms likeAgaricuscampestris, Morchellaesculenta, Helvellacrispa, Hydnumcoralloides, Hypoxylonvernicosum and Polyporusmylittaewereused muchearlierinIndia. Lintzel (1941, 1943)recommended that 100 to 200 gof mushrooms (dryweight) is required to maintain an optimal nutritional balancein a man weighing70kg.Banoet al. (1963)determined the nutritive valueof Pleurotusflabellatus as 0.974% ash, 1.084%crude fibre, 0.105%fat, 90.95%moisture, 0.14%non-protein nitrogen and 2.75%protein.Bano(1976) suggested that food value ofmushrooms lies between meat and vegetables. Crisanand Sands (1978)observed that mushrooms in general contain 90%waterand 10%drymatter. Moreso, the protein content variesbetween 27and 48%. Carbohydrates areless than60% and lipids arebetween 2 to 8%. OrgundanaandFagade(1981) indicatedthat an averagemushroom is about 16.5% drymatter out of which 7.4%is crudefibre, 14.6%is crudeproteinand 4.48%is fat and oil.Gruenand Wong(1982)indicated that ediblemushrooms werehighlynutritional andcomparedfavourablywith meat, eggand milk food sources. Ofseveral thousand mushroom species known worldwide, onlyaround 2000 are considered edible, of which about 20 are cultivated commerciallywith only4 to 5 underindustrial production (Chang, 1990). Thereis also a significant differencein thenutrient contents of pileus verses stalks (Latifahet al., 1996;Zakia et al., 1993).

Carbohydrates

The carbohydratecontentof mushrooms represents thebulk of fruitingbodies accountingfor50 to 65%on dry weight basis. Freesugars amounts to about 11%. Florezaket al.(2004) reported thatCoprinusatramentarius(Bull.: Fr.)Fr.contain 24%of carbohydrateon dryweightbasis. Themannitol, also called as mushroom sugar constitutes about 80% ofthe totalfreesugars, henceitis dominant (Tseng and Mau,1999; Wannet et al., 2000). Mc-Connell and Esselen(1947) reported that a fresh mushroom contains 0.9% mannitol, 0.28% reducingsugar,0.59% glycogenand 0.91%hemicellose. Carbohydrates of Agaricusbisporuswerereported byCrisanand Sands (1978). Raffinose, sucrose,glucose, fructoseand xylose aredominant in it. (Singh and Singh, 2002). Watersoluble polysaccharides of mushrooms areantitumor (Yoshioka et. al., 1975

Proteins

Protein is an important constituent of drymatter of mushrooms (Aletor,1995; Alofe et al., 1995; Fasidiand Kadiri, 1990; FlorczakandLasota, 1995; Zrodlowski, 1995; ChangandBuswell, 1996).Lintzel (1941)reported the digestibilityof mushroom protein to be as highas 72 to 83%. Theproximate analysisof mushroom mycelia has been reported byanumberof workers(Humfeld, 1948;Humfeld andSugihara,1949; Blocket al., 1953) and that ofMorchellaspecies by Litchfield et al. (1963). Protein content ofmushrooms depends on the composition of thesubstratum, sizeof pileus, harvest time and species ofmushrooms (Banoand Rajarathnam, 1982). Protein content ofthe mushrooms has also been reported to varyfrom flush to flush (Crisanand Sands, 1978). Haddadand Hayes (1978)indicated that protein in A. bisporusmycelium ranged from 32 to42%on the dryweight basis. Abouet al. (1987)found 46.5%protein on dryweight basis in A. bisporus. Samajipati(1978) found30.16, 28.16, 34.7 and 29.16%protein in dried mycelium of A. campestris, Agaricusarvensis,M. esculenta and Morchelladeliciosarespectively.

Purkayasthaand Chandra (1976) found 14 to 27%crudeprotein on dryweight basis in A. bisporus,Lentinus

subnudus, Calocybeindica and Volvariellavolvacea. On drymatterbasis, the protein content ofmushrooms varies between 19/100 and 39/100 g(Weaveret al., 1977; Breene, 1990).In termsof the amountof crudeprotein, mushrooms rank below animal meats butwellabovemostotherfoods includingmilk (Chang, 1980).On adry weight basis, mushrooms normallycontain 19 to 35%proteins as comparedto 7.3% in rice, 12.7%in wheat, 38.1%in soybean and 9.4%in corn (Crisanand Sands, 1978;Li and Chang, 1982;Banoand Rajarathnam, 1988). Vermaet al. (1987) reported that mushrooms areveryuseful for vegetarian becausetheycontain some essential amino acids which are foundin animal proteins. The digestibilityof Pleurotus mushrooms proteins is as that ofplants (90%) whereas that of meat is 99% (BanoandRajarathnam, 1988). Raiand Saxena(1989a) observed decreasein theprotein content of mushroom on storage. Theprotein conversion efficiencyofedible mushrooms per unit of land and per unit timeis far moresuperior compared to animal sources of protein (Banoand Rajarathnam, 1988).Mushrooms in general havehigher proteincontentthan most othervegetables (Bano andRajarathnam, 1988)and most of thewild plants (Kallman, 1991). Sharma et al. (1988)reported14.71 to 17.37% and 15.20 to 18.87%protein in the fruitingbodies ofLactariousdeliciosusandLactarioussanguiffus respectively. Mushroomscontain allthe essentialamino acids required byan adult(Hayes and Haddad, 1976). Gupta andSing (1991) reported 41.4% essentialamino acids in Podaxispistillaris. Friedman (1996)reported that the total nitrogencontentof drymushrooms is contributedbyprotein amino acids and also revealed that crude protein is 79% comparedwith 100% for an ideal protein.

Fats

In mushrooms, thefat content is verylowas compared to carbohydratesand proteins. Thefats present in mushroom fruitingbodies aredominated byunsaturated fattyacids. Singer (1961)determined the fat content of some mushrooms as 2.04%in Suillusgranulatus,3.66%in Suillusluteusand 2.32%in A. campestris. Hugaes (1962) observed that mushrooms arerich inlinolenic acid which is anessential fattyacid. Total fatcontent in A. bisporuswas reported to be 1.66 to 2.2/100 gon dryweight basis (Maggioni et al., 1968). Ogundana and Fagade(1981) indicatedthat mushrooms have4.481%fats on dryweight basis.Kanwaret al. (1990) has reportedafat content of11.52%in theAmanitaceasareafruitingbodies on dryweight basis.In 100 gfresh matter of A. bisporus(Lange) Singand Pleurotusostreatus (Jacq: Fr.)Kumm, thecontent offattycompounds were foundto be 0.3 and 0.4g respectively(Manzi et al., 2001), but on dryweight basis, it is 2 and 1.8 g respectively(Shahet al.,1997). Aletor(1995), Manzi et al. (2001), Sanmeet al. (2003) and Manzi et al. (2004) worked on the fibrecontent of differentmushrooms. Mushrooms areconsideredgood sourceoffats and minerals (Jiskani, 2001). Yilmazet al. (2006) andPedneaultet al. (2006)reported that fat fraction in mushrooms is mainlycomposed of unsaturatedfattyacids.

Vitamins

Mushrooms areoneof the best sources of vitamins especiallyVitamin B (Breene, 1990; Mattila etal., 1994; Zrodlowski, 1995; ChangandBuswell, 1996; Mattila et al., 2000). Vitamin content of ediblemushrooms has been reported byEsselenand Fellers (1946),Block et al.(1953) andLitchfield (1964). Manning(1985) gavea comprehensive data ofvitamin content of mushrooms ad somevegetables.Accordingto Mattila et al. (1994), wild mushrooms contains much higher amounts of vitamin D2 than dark cultivated A. bisporus. Mushrooms also contain vitamin Cinsmall amounts

Mineral constituents

Thefruitingbodies of mushrooms arecharacterized byahigh level of wellassimilated mineral elements. Major mineral constituents in mushrooms areK, P, Na, Ca, Mg and elements likeCu,Zn, Fe, Mo, Cd formminoconstituents (Banoand Rajarathanum, 1982;Banoet al., 1981; Chang, 1982). K, P, Na and Mgconstitute about 56 to 70% ofthe total ash content ofthe mushrooms (Li andChang, 1982) while potassium aloneforms45%of the total ash. Abou-Heilahet al. (1987)found that content ofpotassiumand sodium in A. bisporouswas 300 and 28.2

ppm. respectively. A. bisporusash analysisshowed high amountof K, P, Cu and Fe(Anderson andFellers, 1942). Kaul (1978)reported thatM. esculenta contains Ca(0.5776 mg), P (3.313mg),Fe(1.213 mg) andK (3.831 mg). Varo etal. (1980)reported that A. bisporuscontainsCa(0.04g), Mg (0.16), P (0.75g), Fe(7.8 g), Cu (9.4 mg), Mn(0.833 mg)andZn (8.6mg) per kilogramfresh weight. Mushroomshavebeenfoundto accumulate heavymetals like cadmium, lead, arsenic, copper,nickel, silver, chromiumand mercury(Schmittand Sticher, 1991; MejstrickandLepsova, 1993; Wondratschekand Roder, 1993; Kalac and Svoboda, 2000; Svoboda et al., 2001;Issilogglu et al., 2001; Malinowska, 2004).Themineral proportions varyaccordingto thespecies, ageand the diameter ofthefruitingbody.Italso dependsupon the typeof thesubstratum(Demirbas, 2001).Themineral content ofwild edible mushrooms has been foundhigher than cultivated ones (Aletor,1995; Mattillaet al., 2001; Rudawska andLeski, 2005).

Medicinal importance

Medical mycologyis asold as traditional uses ofmushrooms. Theyhavebeen used in medicinesincethe Neolithic and Paleolithiceras (Samorini, 2001).First centuryGreek physician Dioscorides, includedthe lurch polypore,(Fomitopsisofficinalis (Villars: Fr.) Bond and Singer, Polyporaceae; syn.Laricifomesofficinalis (Villars: Fr.) in his DeMateriamedicaknown then as Agaricumand latteras the Quinine conk.It was used for the treatment of "consumption", adiseasenow knownas tuberculosis. Althoughmushrooms as medicinehave been used in China since100 A.D. (Gunde, 1999),but it was onlyin 1960 that scientistsinvestigatedthe basic activeprinciples of mushrooms which arehealthpromoting. Mushrooms havebeen used in health carefor treatingsimpleand ageold common diseases likeskin diseases to present daycomplexand pandemicdisease likeAIDS. Theyarereputed to possess anti-allergic, anticholesterol,anti-tumor and anti-cancer properties (Jiskani, 2001). Aqueous extracts from Pleurotussajorcaju provesgood in renal failure(Tam et al.,1986). The first successful researchdiscovered theantitumor effects ofthe hot water extracts from several mushrooms (Ikekawa etal., 1969). Themain components proved to be polysaccharides especiallyβ–D-glucans. Chihara et al. (1969)isolated from theshiitakefruitingbodies, an antitumor polysaccharide, whichwas named lentinan. Bahl (1983) reported thatmushrooms cureepilepsy,wounds, skin diseases,heart ailments, rheumatoid arthritis, cholerabesides intermittent fevers, diaphoretic, diarrhea, dysentery, cold, anesthesia, liverdisease,gallbladder diseasesand usedas vermicides. Most of themushroom drugsarenow available in tablet form in China (Yanget al., 1993).In underdeveloped countries whereprotein malnutrition has taken epidemic proportions,Food and Agricultural Organization (F. A. O.) has recommended mushroom foods to solvethe problem ofmalnutrition (Sohi, 1988). Mannentake(Ganodermalucidum)are known to lower blood pressureand serum cholesterol concentration ofhypertensive rats (Kabiret al., 1988).Lentinustigrinusand G. lucidium areproved anticholesterolmic(Renet al., 1989).Lentinusedodus has been used toenhancevigour, sexuality,energyand asan anti agingagent (Gareth, 1990).Lentinansulphateobtained fromLentinus species inhibits HIV (Gareth, 1990). Jonget al. (1991)reported that mushroomscauseregression ofthediseasestate. Mushroommedicines are withoutside effects (Sagakamiet al., 1991). Puffballs havebeen used inurinaryinfections (Buswelland Chang, 1993). Maitake extract has been shown to killHIV and enhancetheactivityof T-helper cells (Nanba, 1993; King, 1993). Ganodermanutriceuticals haveexhibited promisingantiviral effects like, anti-hepatitis B(Kino et al., 1989), anti-HIV(Kim et al., 1993;Liu and Chang,1995). Dreyfussand Chapela(1994)reported hundreds of secondarymetabolitesof fungal origin possessingbiological activity. Mushrooms act as biological response modifiers bypromotingthepositive factorsand eliminatingthe negativefactors from the human bodyand thus regardedas the fourth principal form of theconventional cancer treatment (Yanget al., 1993).G. lucidium(Fr.)Karst is believed to act as ananti-inflammatoryagent (Stavinoha et al., 1991); acts asanti-diabatic(Teow, 1997).Itis also used by Indian tribals fortreatingjoint pain (Harshet al., 1993). Hobbs (1995) reportedvarious medicinal uses ofmushrooms likereishi, cordyceps, enoki, maitake, lion's mane and splitgill for

cancer treatment;shiitake, blazei, reishi, enoki,
cordyceps, maitake, mesimaand oysterwere found
effectiveagainstcholesterol reduction. Reishi, cordyceps, shiitake and maitakeis used forreducing stress.Lion's manehas been used for memoryimprovement; reishiforinducingsleep, cordyceps for physicalenduranceand sexual performance, reishi, cordyceps,chaga and lion's maneforasthma and allergy treatment. Shiitake, cordyceps, chaga, shiitake and turkeytailas liver protectants; reshi, maitake, turkeytail and shitakefortreatingdiabetes.It is also believed to be agood health elevator (Mizuno, 1996). Auricularia species wereused sincetimes fortreatinghemorrhoids and various stomach ailments (Chang and Buswell, 1996). Pleurotus tuber-regiummushroom havebeen used forcuringheadache, high blood pressure,smallpox, asthma, colds and stomach ailments (Oso, 1997; Fasidiand Olorumaiye, 1994).It has been reportedthat P. ostreatuslowers theserum cholesterol concentration in rats (Bobeket al., 1996).PSK, an anticancerdrugfrom the mushroom, Coriolusversicoloraccountedfor25.5%of the country's total sales in Japan in 1987 as anticancer drug(ChangandBuswell, 1996). Puffballs (Clavatia,Lycoperdon)havebeen used forhealingwounds (Delena, 1999). Pharmaceutical substances with potentand unique health enhancingproperties havebeen isolated from mushrooms (Wasser and Weis, 1999). Fresh mushrooms areknown to contain both soluble and insoluble fibres; thesoluble fibreis mainlybeta-glucans polysaccharidesand chitosans which arecomponents of the cellwalls (Sadler, 2003). Soluble fibrepresent in mushrooms prevents and managescardiovascular diseases (Chandalia et al., 2000). Wasser(2005)reported that mushroom health supplements are marketed in the form ofpowders, capsules or tabletsmadeof driedfruiting bodies, extracts of mycelium with substrate, biomass or extract from liquid fermentation. P.sajor-caju has been found to be inductivefor growth of probioticbacteria(Oyetayoetal., 2005). Cordycepssinensisalso treated ashalf caterpillar and half mushroom has been known and used formanycenturies in traditional Chinesemedicine. Cordyceps has been used to inducerestful sleep, acts asanticancer, antiaging, andantiasthamaagents besides proved effectiveformemoryimprovement and as sexual rejuvenator(Sharma, 2008).

Antioxidantactivity

Antioxidants arechemical compounds that protectcells from thedamagecaused byunstablemolecules known as freeradicals. Freeradicals arepowerful oxidants and those chemical entities that contain unpairedelectrons. Theyare capable ofrandomlydamagingallcomponentsof thebody, viz. lipids, proteins, DNA, sugars and are involved in mutations and cancers (Przybytniaketal., 1999). Thenascent oxygen is trapped byenzymes like superoxide dismutase, catalase andglutathioneperoxidase.Over production of freeradicals creates oxidative stress. The antioxidants arean important defenseof thebodyagainstfreeradicals and mushrooms which are rich sources ofthese antioxidants (Mau et al.,2004; Puttaraju et al., 2006;Ferreira etal., 2007; Oyetayoet al., 2007). Waxycap mushroom extracts (Hygrocybecoccinea)areinhibitoryto sarcoma (Ohtsuka et al., 1997).Immunoceticalsisolated from morethan 30 mushroom species haveshownanticancer action in animals (Wasserand Weis, 1999). Schizophyllanfrom Schizophyllum commune is effective againsthead and neckcancer (Kimura et al. 1994;Borchers etal., 1999). Antioxidant propertyof compounds is correlatedwith their phenolic compounds (Veliogluet al., 1998). Kimand kim(1999)reportedthat mushroom extracts possess DNAprotectingproperties. G. lucidumextracts can trap number offree radicals 2602 J. Med. Plant. Res.(Jones andJanardhanan,2000). Mau et al. (2001)foundantioxidant properties of several ear mushrooms. Manyspecies ofmushrooms havebeen found to be highlypotent immune enhancers, potentiating animal and human immunityagainst cancer (Wasserand Weis, 1999; Borchersetal., 1999;Kidd, 2000; Fenget al., 2001). Tyrosinasefrom A. bisporus is antioxidant (Shi et al., 2002).Lakshmiet al. (2005)determined antioxidantactivityof P.sajorcaju. Russell and Paterson (2006)observed that triterpenoidesarethemainchemical compounds in G. lucidium. Camptothecinis responsible for antioxidant properties in G. lucidum (Zhou et al.,

## MUSHROOM CULTIVATIONS-17MBU601A

## POSSIBLE QUESTIONS

1. Differentiate edible mushroom from poisonous mushroom.
2. Write about Volvariella volvacea.
3. How to isolate & culture the spores for mushroom cultivation?
4. Write about the anti-tumour effect of mushroom.
5. Write the steps involved in post harvest technologies of mushroom cultivation.
6. Write about the Anti tumour effect & Hematological value of mushroom.
7. Explain the outline of nutritional profile of mushroom.
8. Explain the spore germination & life cycle of Agaricus bisporus.

| SN | unit-4 | Option A | Option B | Option C | Option D | Answer |
|---|---|---|---|---|---|---|
| 1 | Mushrooms considered as _____ source of food. | alternative | moderate | generalised | all of the above | alternative |
| 2 | Mushrooms are rich in _____ | fats | carbohydrates | proteins | minerals | proteins |
| 3 | _____ is a building material for all body tissues | fats | carbohydrates | proteins | minerals | proteins |
| 4 | Proteins are made up of _____ | fats | carbohydrates | aminoacids | minerals | aminoacids |
| 5 | Mushroom proteins contain _____ essential amino acids. | 5 | 2 | 9 | 12 | 9 |
| 6 | The moisture content of the fresh mushroom is _____ | 60% | 90% | 40% | 30% | 90% |
| 7 | The moisture content of the dried mushroom is _____ | 5% | 15% | 3% | 6% | 15% |
| 8 | Mushrooms contains very low level of _____ | Carbohydrates | aminoacids | minerals | fats | fats |
| 9 | The _____ content of mushrooms are quite low. | Carbohydrates | aminoacids | minerals | fats | Carbohydrates |
| 10 | The carbohydrate content in mushroom are _____ | high | quitelow | very low | moder | quitelow |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | ate | |
| 11 | Mushrooms contain _____ level of fats. | high | quitelow | very low | moder ate | very low |
| 12 | Fresh mushrooms contain _____ level of moisture | high | quitelow | very low | moder ate | high |
| 13 | There are _____ in calories, carbohydrates and calcium. | high | low | moderate | none of the above | low |
| 14 | Which vitamins are present in mushrooms | thiamine | riboflavin | niacin | all of the above | all of the above |
| 15 | Mushrooms are highly _____. | Toxic | Nutritious | non toxic | fatty | Nutritious |
| 16 | They are _____ in calories, are great sources of fiber and protein (good for plant-based diets | High | low | moderate | none of the above | low |
| 17 | They are packed with many _____ as more colourful fruits and vegetables | Antioxida nts | Toxic | non toxic | fatty | Antioxidants |
| 18 | Eating mushrooms may also help to prevent _____ | Respirator y infections | Toxic | non toxic | fatty | Respiratory infections |
| 19 | _____ may help you live a longer, healthier life. | Antioxida | Anti pulmonary | Both a and b | None of the | Both a and b |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | nts | infection | | above | |
| 20 | Mushrooms are a _____. | gut friendly food | highly toxic | poisonous | respiratory infection | gut friendly food |
| 21 | They also contain ____ types of dietary fibers, beta-glucans and chitin. | 6 | 8 | 2 | 9 | 2 |
| 22 | Mushrooms contain a class of proteins called _____ which are able to bind to abnormal cells and cancer cells and label the cells for destruction by our immune system. | Lectins | pectins | albumin | none of the above | lectins |
| 23 | Some wild mushrooms are _____ to humans. | Not edible | Toxic | **Not edible and are toxic** | none of the above | **Not edible and are toxic** |
| 24 | The products of mushrooms are | mushroom cofee | mushroom elixir | mushroom powder | all of the above | all of the above |
| 25 | The _____ content in mushrooms all contribute to cardiovascular health | fibre | potassium | vitaminC | all of the above | all of the above |
| 26 | Potassium and sodium work together in the body to help regulate | blood pressure | high pressure | low pressure | none of the above | blood pressure |
| 27 | One cup of chopped or sliced raw white mushrooms contains | 15 calories | 10grams of | 2.2 grams of | all of the | all of the |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | fat | protein | above | above |
| 28 | Mushrooms are rich in ____ vitamins | A | B | C | D | B |
| 29 | The B vitamins help the body to form _____ | RBC | WBC | Both a and b | none of the above | RBC |
| 30 | Reishi mushroom contains chemicals that seem to have a variety of _____ effects, including activity against tumors (cancer) and beneficial effects on the immune system | **Potentially beneficial** | Toxic | non toxic | none of the above | **Potentially beneficial** |
| 31 | Vitamin D (both Vitamin_____) which plays a critical role in bone health, immune system, energy and mood. | D1 and D2 | D3 and D4 | D2 and D3 | D4 and D5 | D2 and D3 |
| 32 | Mushrooms have _____ fiber which helps support digestion and may help increase beneficial gut bacteria in your digestive system. | **Dietary** | **Diet** | Both a and b | none of the above | **Dietary** |
| 33 | Mushrooms provide a variety of essential ecosystem functions, including: | Absorbing pollution | Cleaning polluted soil | Producing natural insecticides | all of the above | all of the above |
| 34 | Mushrooms provide a variety of essential ecosystem functions, including: | Breaking down nerve agents | Providing a sustainable fuel source | Producing rich soil for farms and forests | all of the above | all of the above |
| 35 | Producing rich soil for farms and forests | high | low | moderate | very | very low |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | low | |
| 36 | Some wild mushrooms are _____ to humans | Not edible | Toxic | **Not edible and are toxic** | none of the above | **Not edible and are toxic** |
| 37 | The moisture content of the fresh mushroom is _____ | 60% | 90% | 30% | 40% | 90% |
| 38 | Mushrooms contains very low level of _____ | Carbohydrates | fats | proteins | none of the above | fats |
| 39 | In which of the following stages of development mushrooms should be picked | 15 to 20$^0$C | 30 to 35$^0$C | not certain | **22 to 25$^0$C** | **22 to 25$^0$C** |
| 40 | FYM is | farmyard manure | fungal yeast medium | fy medium | none of the above | farm yard manure |
| 41 | Media for mushroom | PDA | NA | KBA | SSA | PDA |
| 42 | the characterisation of poison mushroom is | pink spore | bright coloured | hot burning taste | all of the above | all of the above |
| 43 | Which mushroom is less poisonous out of the following | Amantia phalloides | Amantia muscara | Russia emitica | all of the above | Russia emitica |
| 44 | Mushroom contains ---------- amount of protein | 100% | 10% | negligible | 20-40% | 20-40% |

| | | | | | | |
|---|---|---|---|---|---|---|
| 45 | Wild mushrooms grow during | rainy season | october season | summer | anyti me | rainy season |

**UnitV**

Problemsincultivation–diseases,pestsandnematodes,weedmouldsandtheirmanagementstrategies.Mushroomeconomics: economicsofspawnandmushroom,cultivation,postharvesttechnologies.Processingandpreservationofmushrooms.Mushroom researchcentresinIndia.

INSECT AND OTHERENEMIES.

Themushroom grower has his full shareof insects to contend with, and in order to overcome themoneshould acquainthimself with them, and knowwhat theyare, what theydo,whencetheycame,and how to destroythem. Oneshould studythe diseases and mishaps of his crop and endeavor to knowtheir cause.If weknow the causeof failinghealth in plants, even in mushrooms, we can probablystop or devisearemedyforthe diseaseor means to prevent its recurrence,and if wecan notbenefit thepresent subject weareforewarned againstfutureattacks. But thereis a deal of mysterious troublein this direction in mushroom-growing. We arelikelyto know something about thedepredations committed byinsects or parasitic molds aboveground, butIam surethereis agood deal of mischiefgoingon undergroundof which weknow verylittle, if anything.Theills to which the mycelium is subject arenotat all fullyunderstood.

**"Maggots."**—This is thecommon name amongpractical mushroomgrowers forthe larvæ ofaspecies of fly (Diptera)which from April on through the warm summer months rendersmushroom-growingunprofitable.It is unavoidable, and so far has proved invincible.It attacks themushrooms in deep cellars, above-ground houses, greenhouses, or frames, and is often quite common in earlyappearingcropsin theopen fields. Wesometimes read that itdoes not occur in unheated cellars,but this is amistake, forin our unheated tunnel [Pg123]cellars, wherethe temperaturein Aprildoes not exceed 55°, maggots always appear aboutthe end ofthis month. But it is truethat in the caseof cool houses and wherethebeds arecovered over with hayor straw maggots do not appear as earlyin the season as theydo inwarm houses and open beds. Whilerigid cleanliness, and carein keepingthehouseor cellar closed, no doubt havemuch to do in lesseningthe trouble,Ihavenever beenable to overcomeit, and know of noonewho has. Wesimplystop growingmushrooms in summer.

Themaggots or larvæare about three-sixteenths to four-sixteenths of an inch long, white with blackhead, and appear inallparts ofthemushroom, but mostlyinthe cap andatthe baseof thestem, and perforatehither and thitherleavingbehind them a disgustingnetworkof burrows. Thetinybuttons, about as soon as theyappearat the surfaceof theground, areinfested, but this does not check theirgrowth, and when theybecome mushrooms large enoughforgathering, unless itbeforadark lookingpunctureor tracingnow and then visible on theoutsideof the caps and stems, there arebut few signs to indicateto theinexperienced eyethe presenceof maggots.And this is whymaggotymushrooms areso oftenfound exposed forsale in summer.But in largeor full-grownmushrooms, and especiallythewhite-skinned varieties, their presenceis visible enough.Although veryrepugnant, however, and utterlyunfit forfood,maggotymushrooms arenot poisonous.

But all themushrooms ofsummer crops arenot maggoty, onlyalargeproportion of them;the evilbegins in April, and increases as the summer advances, untilAugust, when itdecreases, and in October completelystops—at least this ismyexperience.

A solution of salt, saltpeter, or ammonia sprinkledover thesurfaceof thebeds does not, in this case,do anygood as an insecticide, pyrethrum powder diffused [Pg 124]through the atmosphere, and tobacco smoke,havebeen ineffectual. Burning alamp set in abasin of water with alittle kerosenefloatingon the surfaceis amostdoubtful

operation. Multitudes offlies aredestroyed bythis lamp trap, but theyarethepoorlittle innocent "manureflies," and the atmosphereof thehouseis vitiated and rendered unhealthyforthecrop.Ihavetried theselamp traps season after season,andnever knew oftheirdoinganygood; that is, the maggots seemed just as numerous in the lamp-trappedcellaras in theother cellar in whichno lamp trap had been used.

Regardingthis "maggots"question, Mr. J. F. Barter, ofLondon, writes me: "Duringthe summer months the outdoor mushrooms getmaggotybeforetheyarebigenough togather, butof coursetheycan begrown in cool cellars alltheyear round....Iknow ofno surecureforthem (the maggots);of courseaslight sprinklingof saltwith manureor mold does prevent, to a certain extent, but it must be used verycarefully."Now myexperienceis, asI have alreadysaid, that itis impossibleto growmushrooms herein summer,even in cool cellars, without having them moreor less maggoty. As regards thesaltand loam preventive,Ihavetried itlightlyand heavily,but without anyapparentgood effect.

**Black Spot.**—Allmushroom growers arefamiliarwith thisdisease, but unless it appears in pronounced form very little noticeis taken of it, even bymarket men, forweseespotted mushrooms continuallyexposed for sale.It appearsas dark brown spots, streaks, or freckles, on the top ofthe mushroom caps, andincreases indistinctness and breadth with age. Fig. 25.It is caused byeel worms (*Anguillulæ*). Theseminute creatures enterthe mushrooms when the latterarein their tiniest pin form and beforetheyemergefrom theground.If abutton arises clean it remains clean, if [Pg125]diseased itcontinues to bediseased,and itis a fact that if onemushroom in a clump has black spot weusuallyfind that everymushroom in the clump has it. But mushrooms growing from thesame bit of spawn and that come upan inch ortwo awayfrom thespotted ones maybeperfectlyclean. Black spot has never occurred with mein newbeds, and seldomin thosein vigorous bearing, but it generallyappears in beds that have been in bearing condition forsomeweeks or aredeclining.It does not confine itself to anyparticular spot orpart of the bed, and sometimes it is much moreplentiful than at others.Between October and Marchwehaveverylittle black spot, but as thespringopens this diseaseincreases. Duringthewinterseason, with careful attention, perhaps not so much as oneper cent will show black spot, but as thewarm weathersets in the per centageincreases untilin May,when as manyas twentyper cent maybeaffected byit.

Fig. 25. Mushroom affected with Black Spot.

Black spot is a disease, however, thatcan becontrolled. Keep everythingin and about themushroomhouses rigidlyclean, and as soonas abed hasceased to bear acrop worth pickingclear it out, lime-wash theplaceit occupied, and makeup anotherbed. Carefullyobservethat no old loam ormanureis allowed to accumulate anywhere, orgreen scumforms upon the boards, paths, or walls; boilingwaterimpregnatedwith alum poured over the boards, walls, and other scum-covered surfaces, willkill the eel worms, but it should notbe allowed to touch the mushroom beds that arein bearingor coming into bearing. Much can bedoneto protect thebearingbeds from the ravages of this pest:In gatheringthe mushrooms remove everyvestigeof old stump and fogged-off
mushrooms, keep the holes filled [Pg126]up withfresh loam, andwhen thebed has been in bearing condition fora fortnight sprinkleitoverwith a solution of salt, and next daytopdress withahalf-inchcoatingof finelysiftedfresh loam; firm itto thebed with theback of thehand,foritcan not be pressedon with a spadeon account of the growingmushrooms.

Is black spot unwholesome?Ido not think so.Ihavenever knownanyill effects from eatingit. Thespotted parts aremerelyflavorless andtasteless. But it is averydisgustingdisease, and no one,Iam sure, would careto eat eel worms with their mushrooms. Until quite recentlyIused to regard theblackspot as the mark ofsomeparasitic fungus,and, actingunderthis impression, sent affected mushrooms to Dr.W. G. Farlow, Prof. of CryptogamicBotanyat Harvard University, forhis opinion. Hewrote me: "Ifind that thetrouble is duetoAnguillulæ, andIfind an abundanceof these animals in the brown spots."Headvised meto submitthem to an expert in "worms."Ithen sent samples to mykindfriend, Mr. William Saunders, ofWashington, D.C., who submitted them,forme, to Dr. Thomas Taylor, themicroscopistto theU. S. Department of Agriculture, and who replied:"Irecommend thatyou useasprinklingof scaldingwaterthoroughlyoverthe entiresurfaceof thebed, especiallythe portion next to the boxing. Thescaldingwater should be applied beforethe buttons appear, butnot penetrate morethanone-eighth of an inch below the surface. Anguillulæabound wherever decayingvegetablematter exists.... Thegreen algæ on the outsideofflower pots abounds in the anguillulæ."

**ManureFlies.**—This is the name wegive to the littleflies (aspecies of*Sciara*) that appear in largenumbers in springand summer in ourmushroom houses, or, indeed, in hotbeds or structures of anysort wheremanureis used, as wellas about themanureheaps in the [Pg127]yard. On account of theirhabits theyareregardedwith much ill- favor. Theyhop about thehouse and are continuallyrunningover themushrooms, beds, and walls, in the most suspicious manner. But,notwithstandingthis,Iam inclined to regard them as perfectlyharmless so far as injuring the mushroom crop is concerned,except thefact that theysoil themushrooms somewhat bytheirtravelingover them with their muddyfeet.

Inattemptingtoget rid of themaggot flyIhavedestroyed largenumbers of theselittle innocents, but without any apparent diminution in their numbers.Lachaumerecommends: "Thesefliesmaybedestroyed byplacing about a numberof pans filled with waterto whichafew drops of oil of turpentinehavebeen added. Thefliesareattracted bythe odor and drown themselves. Theymayalso be caught with afloating light, in which theywillburntheir wings andfallinto the water." Ihavefound that purebuhach powder dusted into the air orburned on ahot shovel in themushroom househas been more effectiveindestroyingtheseflies than either thelamp ordrowningprocess.

**Slugs.**—These areserious pestsin themushroom house, especiallyin above-groundstructures, and theyalso occur in annoyingnumbers incellars. Wherever hayor straw is used in coveringthebeds, or thereis muchwoodwork about thehouse, slugsappear to bemost numerous. Theyareveryfond ofmushrooms and attack them in all stages,from thetinybutton just emergingfrom the ground to thefullydeveloped plant.In the caseof thebuttons

or smallmushrooms theyusuallyeat outapieceon the top orside ofthecap, and as the mushroom advances in growth thesewounds spread openand displayanuglyscar ordisfigurement. Theyalso bite into thestems. But in the caseof fresh, full grown mushrooms theyseem to haveaparticular [Pg128]likingforthegills,andeat patches out of them hereand there.

**"Bullet"or"Shot"Holes.**—Myattention was first called to thesebyMr.A. H. Withington, of New Jersey. They arelittle holes cut clear through themushroom caps, as if perforated byabuckshot, and are evidentlythework of some insect. Hehad, beforethen, submitted some of theseperforated mushrooms to Prof. S.Lockwood, who sent them to Prof. C. V. Rileyforhis opinion. Prof. Rileyreplied that:"It is quite likelythat the damagewas doneby some myriapod, possiblyaJulus, or someof its allies. Onlyobservation onthe spot will determinethis point."AsI never hadanytrouble with myriapodsattackingmushrooms and had seen nothingof this "bullet hole"work in our own bedsIwas much interested in thequestion and determined to look out forit, soImarked offapart ofabed and left that uncared for.Isoonfoundout thetrouble. Theseholes arethework of slugs whichIhavefound and watched in theact of eatingout theholes. To findthe slugs at work, onehas to takehis lantern andgo out and look forthem at night. And to find out about plant parasites—betheyfungus, or insect—onehas to let them alone and watch them. Hadwekeptup ourunsparinghunt for slugs, probablyweshould notyet haveknownwhat caused these"bullet holes,"for no slugwould havebeen left alivelongenough to eat a holethrough amushroom cap.

Slugs must be caught andkilled. We can find them at night byhunting forthem bylamp-light;theirslimytrack glistens and reveals theirpresence. A few smallbits of slateor halfrotten boards with apinch ofbran on them laid hereand there about thebeds arehandytraps; theslugsgather to eat thebran, hide beneath therotten wood, and can then becaught and killed. Fresh lettuceleavesmakeacapital trap, but lettuces in [Pg129]JanuaryorFebruary areaboutas scarceas mushrooms themselves. Adressingof saltis distasteful to slugs, and not injurious to mushrooms. Strong, fresh lime watermaybefreelysprinkled over woodwork,pathways, walls, or elsewhere whereslugs might gatherand hide themselves; butthis solution should notbeused upon the mushroom beds. Rigid cleanliness, however, about themushroom house, and an ever-alert eyeforslugs, should keep themunder.

**WoodLice.**—These aresureto be moreor less abundant in everymushroom house, even in thecellars. They crawl in through doors, ventilators, orotherinterstices, and arebrought inwith themanure, andfind shelter about the woodwork, manure,or anybits of drylitter that maybe around.Theyattack the pinheadand smallbutton mushrooms bybitingoutlittle patches in their tops and sides; and althoughthesepatchesaresmallto begin with, the blemish spreads as themushroom grows, and is an objectionable feature. Trappingand killingthe insects is the chiefremedy. Put part ofahalf boiled potato (forwhich no salthad been used) into a littlepasteboard box, and cover thepotato with some verydryswamp moss, laythe boxon its side, and open at the end onthebed. The wood licewillgatherto eat thepotato, and remain afterfeastingbecausethedrymoss affords themacozyhiding place. Several of theselittle boxes can beused. Gothrough the housein themorning, lift thelittle traps quickly, and shake out anywood licethat maybein them into a tin pail (an old lardpailwilldo),which should contain a little water and kerosene.Thesetraps maybeusedfor anylength of time,merelyobservingto changethepotato now and again to haveitin appetizing condition. Hot wateror strongkerosene emulsion maybepoured about the woodwork, walls, and pathways, to destroythe wood lice, but should notbe allowed to touch the beds. Poisoned [Pg130]sweet apples, potatoes, and parsnips havebeen recommendedas baits forthesepests, butImust discourageusingpoisonsof anysort in themushroom house. Sixor eight inch squarepieces of halfrotten verydry boards laid in pairs, oneabovethe other,also make capital traps; thewood licegatherthereto hidethemselves; thesetraps should be examined frequentlyand theinsects shaken into the pailcontainingwaterandkerosene.

**Mites.**—Two kinds of mites areverycommon about mushrooms in springand summer; one is whitish and smaller than a"red spider" (oneof the commonest insect pestsamong garden plants), and the other isyellowish and as large as or larger than a"red spider." ButIdo not think that eitherof thesemites is worth consideringasa mushroom pest. Theyellow mite(probably*Lyroglyphusinfestans*)is extremelycommon in strawylitteron the surfaceof hotbeds,andIhaveno doubt finds its wayinto the mushroom house as manurevermin rather than a mushroom parasite. Theyaretheeffect and not thecauseof injuryto thecrop. When mushrooms are wounded or cracked, particularlyabout thestem, the crevicesoften becomeabundantlyinhabited with thesemites, but theydo no material damage.

**MiceandRats.**—Theserodents areveryfond ofmushrooms, and wheretheyhaveaccess to the beds are troublesome and destructive. Both the common housemouse and the white-bellied fencemouse aremushroom destroyers, but, so far, thenimble but timid fieldmouse(among garden, open air, andframecropsgenerally) has neveryet troubled ourmushrooms, butIcan notbelievethat this immunityis voluntaryon its part. Themicebitea little piecehere and thereout of the caps of theyoungmushrooms, and thesebite-marks, as themushrooms advancein growth, spread open and become unsightlydisfigurements.In the caseof open mushrooms, however, the mice, likeslugs, prefer [Pg131]thegills to the fleshycaps. Rats arefarmoredestructivethan mice. Trappingis the onlyremedyIuse,and would not usepoison in themushroom houses for these creatures forobvious reasons. But weshould makeourhouses secureagainsttheir inroads.

**Toads.**—These arerecommended asgood insecttraps to beused in mushroom houses, butIdo notwant them there; the cureis as badas the disease. Themushroom bed is alittle paradise for thetoad.Hegets upon itand burrows or elbows outasnuglittle holeforhimself wherever he wishes, and manyof them, too, andcares nothing about whether, in his efforts to makehimself comfortable, hehas heaved out thefinest clumps ofyoung mushrooms in the beds.

**Fogging Off.**—Thisis oneof the commonest ailments peculiar to cultivated mushrooms.Itconsistsin the softening, shriveling,andperishingof part oftheyoungmushrooms, whichalso usuallyassumeabrownish color. Thesewithered mushrooms do notoccur singlyhereand thereover thefaceof thebed, but in patches; generallyall or nearlyallof theverysmall mushrooms in a clump willturn brown and soft, and thereis no helpfor them;they never will recover their plumpness. Some writers attributefoggingoffto unfavorable atmospheric conditions,—the temperaturemaybetoo cold, or too hot, or the atmospheretoo moist, or too dry.Iam convinced thatfoggingoff is dueto thedestruction ofthe mycelium threads that supported thesemushrooms;itis a diseaseof the"root,"to use this expression; the"roots"havingbeen killed, thetops mustnecessarilyperish.If it were caused byunfavorable conditions abovegroundweshould expect all of the crop to bemoreor less injuriouslyaffected; but this does not occur; themushrooms inone clump maybewithered, and contiguous clumps perfectlyhealthy.

Anythingthat willkill thespawn ormycelium threads [Pg132]willcausefoggingoffto overtakeeverylittle mushroom that had beenattached to thesemycelium threads. Keepingthebed or part ofitcontinuouslywet or dry willcausefoggingoff, sowilldrip; watering with verycold water is also said to causeit, but thisIhavenot found to be the case.Unfasteningtheground byabruptlypullingup thelargemushrooms will destroymanyof thesmall mushrooms and pinheadsattached to thesame clump;and when largemushrooms push up throughthe soil and displacesomeof theearth, allthe smallmushrooms so displaced willprobablywaste away, as the threads of mycelium to which theywere attachedforsupporthavebeen severed. Acommon reason of fogging offis caused bycuttingoffthemushrooms in gatheringthemand leavingthestumps in the ground; in afew days' time these

stumps develop a whitefluffor fleckysubstance,which seems to poison everythread of myceliumleadingto it, allthe mushrooms, present and to come, that areattached to this arrested web of mycelium areaffected bythe poison of thedecayingold mushroom stump, and foggoff. Anyimpurematter in thebed with which the mycelium comes in contact will destroythe spawn andfogg offtheyoungmushrooms.Lachaumecomplains about thelarvæ of two beetles, namely*Aphodiusfimetarius*and *Dermestestessellatus*, which "causegreat damagebyeatingthe spawn, therebybreaking up the reproductivefilaments."Damageof this sort bytheseor anyotherinsect vermin willcausefoggingoff.ButIhavenot noticed either oftheabovebeetles ortheirlarvæabout our beds.

**Flock.**—Thisis the worstof allmushroom diseases and common wherever mushrooms are grown artificially.It is not a new disease;Ihaveknown it fortwenty-fiveyears, and itwas as common then as itis now, and practical gardeners havealwayscalled it*Flock*.Isay"worstof alldiseases"because*I know*that mushrooms [Pg 133]affectedbyit areboth unwholesome and indigestible, andIcan readilybelievethat in aggravated cases they arepoisonous.It is caused byother fungi which infest thegills and frillsof themushrooms, andrender them a hard, flockymass; sometimes the affected mushrooms preservetheir whiteskin, color, and normal form, at other times the cap becomes moreor less distorted. Theillustration, Fig. 26, is from life, and agood averageof aflock- infested mushroom.Ingatheringmushrooms thegrowers should insist that everyflock-infested mushroom be discarded,and consumers of mushrooms should familiarizethemselves with this diseaseso as to know and reject everymushroom showingatraceof it.

Flock does not affect all themushrooms in a bed at anytime, andIdo not believeitspreads in the bed, or,to use the expression, becomescontagious.If onespot ofmildew appears uponacucumber, rose, orgrapevine indoors, and is not checked, itsoon becomesgeneralallover theplant orplants, andif onespot of mold occurs in a propagatingbed and is not checkedat onceitsoon spreads over alargespaceand destroys everycuttingor seedling within its reach,but this is not the casewith flock in a mushroombed.If onemushroom isaffected with flock everymushroom produced from that pieceof spawn is affected, but notonemushroom produced from the pieces of spawn insertednext to this oneis affected byit; noteven if themycelium from theseverallumps of spawn forms an interlacingweb.If theflock is confined to themushrooms produced from acertainbitof spawn some mayask, will theotherpieces of spawn broken from thesame brick produceflock-infested mushrooms?No. Ihavegiven this pointparticular attention, [Pg134]havekept thepieces ofeach brick close together, and where flock has appearedIhavefailed to find that theotherpieces of spawnfrom that brick aremoreliableto produce flock-infested mushrooms than arethe pieces of thebricks that, asyet, havenot shown anysign of diseased produce.

Howgeneral is this disease?In abed saythreefeet wide bythirtyfeet long and oftwo months'bearingonemay getas fewas fiveor as manyas fiftyflockymushrooms; one ortwo mayoccur to-day,and wemaynot find anotherforaweek or two, when wemayget a whole clump of them, and so on.It is not the largenumberof them that makes them dangerous, fortheynever appearin quantity. Theysometimes appear amongthe earliest mushrooms in thebed, but generallynot untilafter thebed has been in bearingcondition foraweekor two.

What conditions aremostfavorable or unfavorableto thegrowth of this diseaseIdo not know; butitis certainly not caused bydebilityinthe mushroom itself, as theparasiteattacks healthy,robust mushrooms anddebilitated ones indiscriminately. This flockycondition is caused byoneor moresaprophytic and parasitic fungiof lowly origin, whosevarious parts arereduced to merethreads, simpleor branched,and divided into tubular cells at intervals, or else theyare long, continuous microscopic tubes withoutanypartitions, except at thoseoccasional

points whereabranch, destined to producespores, is given off. Generallytwo ormorespecies ofthesethread- fungi arepresent at the same timeon the mushroom host, and bythe multiplied crossing and interweavingof their threads and branches produce, through theirgreatnumbers, the whitish, felted mass of"flock"; whileas individuals the threads areso minuteasto be scarcelyor notat all visibleto thenaked eye. Similar thread-fungimayoften be foundin thewoods amongdamp [Pg135]leaves, under rotten logs, and on thoseporous fungi whichproject, shelf- like, from thetrunks oftrees. At present thereis nowayknown for destroyingthe"flock,"except totakeup and destroyeveryclump ofmushrooms attackedbyit. Fortunatelythe diseaseis not veryserious if proper precautions areobserved; for, in ourown cellars, wheremushrooms havebeengrownyear afteryearforthe past elevenyears, weget butfew flockymushrooms in anybed's bearing.Thediseaseis not morecommon to-daythan itwas in any formeryear.But wegiveour cellarsathorough cleaningeverysummer.

**Cleaning the MushroomHouses.**—After theseason'scroppingis finished the mushroom houses and cellars should bethoroughlycleaned. Clear out the old beds, and bringoutside allthe movable floor and shelf boards, scrapeupeverybitof looselitter ordirt in the place and throw it out, broomdown thewalls and whatever boarding is left. Whitewash thewalls with hotlime wash, and painteverybitof woodwork liberallywith crudeoilor kerosene. This is to destroyanguillulæand otherinsect and fungus parasites.Ifyou wish to useagain the boards brought outside, broom them over and paintthem copiouslywith kerosene.And ifyour cellar orhousehas adirt floor, aheavysprinkling of verycausticlime water allover it will do goodin riddingitof vermin.

## MUSHROOM CULTIVATION-17MBU601A

## POSSIBLE QUESTIONS

1. Write about mother spawn.
2. What is mushroom Nutraceuticals?
3. How to preserve the mushroom?
4. What are the different parts of a typical mushroom?
5. What is milky mushroom?
6. Explain the processing and preservation of mushrooms.
7. How to control pests, weed and nematodes during mushroom cultivation?
8. Write about the antibacterial & antifungal activity of mushroom.

| SI NO | unit-5 | Option A | Option B | Option C | Option D | Answer |
|---|---|---|---|---|---|---|
| 1 | Dry bubble is characterized by | Puff muddy mushroom | Green mould | Sunken sports on the cap | none of the above | |
| 2 | Verticillium chiefly is caused agent for | Dry bubble | False truffle | Mildew | Wet bubble | Dry bubble |
| 3 | Example for costing soil and growing mushroom | Fusarium | Aspergillus | Pencillium | Pezizaostracoderma | Pezizaostracoderma |
| 4 | Biotic disease causing agent is | Air pollution | waterpollution | microorganisms | lowtemperature | microorganisms |
| 5 | The infected beds usually have a peculiar disagreeable odour, find out the causative agent | Diehliomycesmicrosporrus | Fusarium | Pleurotus sp | Pezizaostracoderma | Diehliomycesmicrosporrus |
| 6 | Wet bubble disease was first described in the year of | 1435 | 1788 | 1887 | 1888 | 1888 |
| 7 | Wet bubble disease is causative agant | Mycogenpernciosa | pink mushroom | white mushroom | Hypomyces rosella | Mycogenperniciosa |
| 8 | How to treat the brown plaster disease | Use disinfect | Grown under the low temperature | Change the pH | none of the above | Color changes to cherry red on spore formation |
| 9 | Symptoms for lipstick mushroom | mycelium dark | cap turn brown | Thin caps | Color changes to cherry red on spore formation | Color changes to cherry red on spore formation |
| 10 | Bacterial blotch is discovered by | Fletcher | Tolaas | Koch | T.J.Burrill | Tolaas |
| 11 | Causative agent for bacterial blotch | *E.coli* | *Pseudomonas gingeri* | *Sallmonella* | *Pseudomonas tolaasii* | *Pseudomonas tolaasii* |
| 12 | Drippy gall disease is observed by | Fletcher | Tolaas | Koch | T.J.Burrill | Fletcher |
| 13 | *Pseudomonas gingeri* cause | Bacterial blotch | mummy disease | fungal disease | ginger blotch | ginger blotch |
| 14 | Oyster mushroom is highly affected by | *E.coli* | *Pseudomonas* | *Pleurotus* | *Sallmonella* | *Pleurotus sp* |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | *tolaasii* | *sp* | | |
| 15 | Mummy disease was first reported in | 1942 | 1947 | 1950 | 1948 | 1942 |
| 16 | Mummy disease was first reported in the year | Tucker | routeini | Panei | both a and b | both a and b |
| 17 | Mummy disease was first reported in | UK | UAE | US | none of the above | UK |
| 18 | Drippy Gall disease was first reported in | UK and Netherland | UAE | US | none of the above | UK and Netherland |
| 19 | Bacterial Rot disease was first reported in | West Bengal | Tamilnadu | Andhrapradesh | Uttarpradesh | West Bengal |
| 20 | _____ flies are also called as mushroom flies. | Sciarid | black gnot | small | none of the above | sciarid |
| 21 | _____ are rarely identified from the fly stage. | cecid | Sciarid | black gnot | small | cecid |
| 22 | Poison balting flies are present during the _____ period. | harvesting | cropping | picking | casing | cropping |
| 23 | After seven days of spawning, _____ should be sprayed on beds. | malathion | methanol | formalin | ethanol | malathion |
| 24 | After spraying the malathion,mushroom house should be closed for hours. | 1 | 2 | 3 | 4 | 2 |
| 25 | _____ spraying on beds should be avoided. | indirect | direct | alternative | none of the above | direct |
| 26 | An interval of ____ hours between spraying and picking of mushrooms must be observed. | 24 | 48 | 72 | 82 | 48 |
| 27 | _____ traps should be used to monitor the number of flies in the spawn running room. | sticky | light | dark | none of the above | sticky |
| 28 | _____ are wingless pests. | spring tails | cecid | Sciarid | black gnot | spring tails |
| 29 | Springtails are usually found at the base of the _____. | stem | root | cap | none of the above | stem |
| 30 | Three species of beetles have been reported to cause damage to mushroom. | **Oyster** | milky | paddy straw | all of the above | oyster |
| 31 | There are more than _____ species of mites which have been reported on mushroom | 24 | 54 | 44 | 84 | 54 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 32 | Nematode contamination in a _____ farm may occur at any time from composting to cropping. | Mushroom | dairy | poultry | both a and b | Mushroom |
| 33 | Fresh mushrooms are usually packed in poly packs of less than _____ gauge thickness | 100 | 200 | 300 | 400 | 100 |
| 34 | Generally, mushroom packs measuring _____ g should be made for retail sale. | 200 | 450 | 300 | both a and b | both a and b |
| 35 | _____ is the most popular method of preserving the mushrooms in long term | canning | polythene bags | bottles | none of the above | canning |
| 36 | _____ is the most popular method of preserving the mushrooms in short term. | canning | polythene bags | bottles | steeping | steeping |
| 37 | _____ is the most popular method of preserving the white button mushrooms. | canning | polythene bags | bottles | none of the above | canning |
| 38 | _____ is another method of preserving the mushrooms | canning | polythene bags | steeping | freeze drying | freeze drying |
| 39 | _____ is the most popular method of preserving the oyster and paddy straw | canning | polythene bags | steeping | drying | drying |
| 40 | Mushroom pickles can be preserved up to | 4-3 months | 1-2months | 3-4months | 6-12months | 6-12months |
| 41 | what is the period between two flushes of mushroo crop? | 3-4 days | 1-2 months | 7-10 days | not certain | 7-10 days |
| 42 | The optimum temperature required for agaricus biosporus | 10-15ºc | 20-35ºc | 25-30ºc | 40-55ºc | 25-30ºc |
| 43 | One of the best edible species mushrooms under cultivation is | Saihwal | kanpur | Jhang | kasur | Saihwal |
| 44 | Annular ring is absent in mushroom | milky white | paddy straw | button | oyster | button |
| 45 | The white button mushroom has been cultivated for its | plant consisting of fine green threads | edible fruit bodies | spores | not seeds | edible fruit bodies |