Comparative efficacy of various compost on the growth and seasonal production of *Agaricus bisporus* (Lange) Imbach,by long term process

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By

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CERTIFICATE - I

This is to certify that the thesis entitled ***"Comparative efficacy of various compost on the growth and seasonal production of Agaricus bisporus (Lange) Imbach,by long term process"*** *submitted in partial fulfilment of the requirement for the degree of* ***MASTER OF SCIENCE*** *in* ***PLANT PATHOLOGY*** *of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by* ***Mr.Gyanendra Pratap Tiwari*** *under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instruction.*

No part of the thesis has been submitted for any other degree or diploma (certificate award etc.) or has been published / published part has been fully acknowledged by him.

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CERTIFICATE – II

This is to certify that the thesis entitled ***"Comparative efficacy of various compost on the growth and seasonal production of Agaricus bisporus (Lange) Imbach,by long term process"*** *submitted by* ***Mr. Gyanendra Pratap Tiwari*** *to the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfilment of the requirement for the degree of* ***MASTER OF SCIENCE IN AGRICULTURE*** *in the Department of* ***PLANT PATHOLOGY*** *has been after evaluation, approved by the External Examiner and by the student's Advisory Committee after an oral examination on the same.*

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LIST OF ABBREVIATION

Abbreviation	Stand for
@	At the rate of
%	Percent
±	Plus or minus
eg	As for example
^{0}C	Degree centigrade
µ	Micron
µm	Micrometer
kg	Kilogram
WP	Wettable powder
DAS	Days after sowing
Sp.	Species
ha	hectare
lb	Pound
PDA	Potato dextrose agar
i.e.	That is
viz.,	Namely
et al.	Co- workers
fig	Figure
CD	Critical difference
cm	Centimeter
ha	Hectare
No.	number
PDI	Percent disease intensity
ml	Milliliter
mm	Millimeter
g	Gram
mg	Milligram
NS	Non significant
SEm ±	Standard error of mean
psi	Pound square inch
Nm	New molecule
Morn.	Morning
Even.	Evening
Max.	Maximum
Min.	Minimum

INTRODUCTION

Mushrooms are large macroscopic fruiting bodies of edible fungi belongs to either division Basidiomycotina or Ascomycotina and may be epigeal or hypogeal. The vegetative part of the mushroom mainly consists of thread like long thin mycelia and form the fruiting bodies under suitable condition. Mushroom comprises a large heterogeneous groups and having various shape, size, colour and all quite different in characters, appearance and edibility. More than 45,000 spp. of fungi have been identified, of which 2000 are edible (Kohlii, 1990) and near about 300 species have been reported from India (Chandha, 1994).

Mushroom have significant important due to their nutritive and medicinal value. Mushrooms are the good source of quality protein with 70-80 % digestibility and having all essential amino acid *i.e.* lysine and methonine which are lacking in cereals and pulses. Mushroom protein are superior than vegetable and fruit protein and equivalent to animal protein. (Chang and Miles, 1989) Mushrooms are like vegetables, they contain 90% moisture and have low calorie value, 35 cal. / 100 g of fresh weight (Crisan and Sand, 1978) they contain very low amount of fat and rich in 72 % linoleic acid as unsaturated fatty acid, which is essential for human body. They contain high amount of fibre. Besides that, they are also good sources of vitamin C, B complex, B-12, Thiamine, Riboflavin, Niacin and folic acid and also contain high amount of Potassium, Copper, Phosphorus and low in Sodium and Iron.

Near about 80 species of mushrooms have been cultivated experimentally on various substrates of which few are commercially cultivated in different part of the world. The annual production of commercially cultivated mushrooms are about 10 million tonnes /annum and India contributes 70,000 tonnes /annum (Singh and Mishra, 2006).

In M.P.contributes approximately 2800 metric tonnes/annum, (Anonymous, 2006) In India, most of the three cultivated mushrooms namely

A. bisporus (white button mushroom), *Pleurotus* spp. (Oyster mushroom) and *Volvoriella* spp. (paddy straw mushroom) and *Calocybe indica* (white milky mushroom).

Among the cultivated mushrooms *A. bisporus* is popularly known as white button mushroom. These mushrooms are extensively grown through out the world and occupy 50 % of the world total production. In India, it is grown seasonally by farmers as well as by industrialist in control condition and contributed 90 % of the total production (Verma, 1999)

The cultivation of white button mushroom *(A. bisporus)* was started four centuries back. Its cultivation was originated in Paris (France) during 1650 than spread to other European countries. Initially, it was cultivated out door where crops were unprotected. Indoor cultivation was started around 1810 in France and Holland. French botanist Tome fort describes its cultivation for the first time in 1917.

The cultivation of white button mushroom *(A. bisporus)* in India was started at Solan (H.P) in 1961. Later on, it was cultivated experimentally at Shrinagar. The first commercially production unit of button mushroom was established at Chail (H.P) during 1966 by maharaja of Patiala. Therefore, many units come up in H.P, J&K, Uttranchal, Karnataka, Tamil Nadu, Maharastra and M.P. In M.P. Oyster and button mushroom are successfully grown in various regions.

White button mushroom *(Agaricus bisporus,)* also known as Khumbi and European mushroom is the most popular mushroom in the world and contributes around 40% of world production of mushroom. It is cultivated of a fermentation process brought about by a number of thermophilic organisms which decompose plant residues and other organic and inorganic matters. Today, white button mushroom is cultivated on the compost prepared by the traditional methods known as “Long method of composting” (Nair *et al*. 1991) or Short method of composting (Sinden and Hauser 1953) or compost prepared by an accelerated method also known as “Rapid composting method” (indoor compost).Preparation of compost by these methods is an old concept and has been abounded in most parts of the world except in few countries in Asia. Compost prepared by such method besides taking more time (around one month) given low yield as it is prone to be attacked by many pest and diseases (Vijay and Gupta, 1995). However preparation of productive compost in lesser duration has also been reported by several workers (Dhar and Kapoor, 1989a; Vijay and Gupta 1992-93). Yields obtained using such compost ranges between 8-12 kg. mushroom per 100 kg. of compost. However, higher yield to the tune of 18-22 kg. have also been demonstrated by some growers using high yielding strains compost by this method is prepared on clean cemented platform. If this facility is not available than a simple brick platform can be used for this purpose.

An Experiment was conducted in Kanpur, Uttar Pradesh, India to determine the effective and optimum casing thickness (3,4,5 and 6cm) for maximum growth and production of *Agaricus bisporus*, the highest yield (18 kg) was obtained with 4 cm casing whereas 6 cm casing give lowest yield (11.66 kg.) The yield obtained from 3,4 and 5 cm casing were statistically at par with each other Pandey *et al.,* (2007) .

Keeping the above facts in mind, the current studies were undertaken to assess the effect of various parameters related to mushroom (*A.bisporus*).The specific objective of the studies were as follow:

- To study the cultural characteristics of white button mushroom (*Agaricus bisporus).*
- To screen the best performing compost for *Agaricus bisporus*.
- To find out the optimum casing thickness and type to obtain maximum yield of *Agaricus bisporus*.

REVIEW OF LITERATURE

This chapter deals with the brief review of research work done earlier related to production technology of *Agaricusbisporus* and various related parameters affecting its morphological and yield.The literature pertaining studies is reviewed as under:

Composting

Govi*et al*., (1996). Compost from selected organic waste (vegetable waste from fruit and vegetable market and pruning residues) was used alone and in mixture (25% of volume) with a substrate from straw-bedded horse manure, normally used in mushroom farms, for the cultivation of *Agaricusbisporus* (common white mushroom). The compost was found to be suitable for the cultivation of *A. bisporus*. The production of beds with the compost from selected organic waste alone was 18.34 kg/m, the beds where this compost formed 25% of the volume was 23.21 kg/m and the beds with the compost from straw-bedded horse manure alone was 24.93 kg/m No differences were observed in the quality of the mushrooms from the three different substrates.

Dogan*et al.,* (2000). The effect of some nutrients added to synthetic compost prepared from wheat straw, on mycelium growth, yield and early production of *A. bitorquis* were investigated. The compost was prepared by fermentation and chemical disinfection methods. Corn flour, wheat flour, hen grain, soyabean meal and sunflower seed hulls were used as additional nutrients. The experiments were performed at 20-22 ^{0}C and 80-90% RH in the cropping rooms. The shortest mycelium growth period (average 14 days) was obtained in sacks containing sunflower seed hulls at 350 g or 450 g/10 kg. The highest yields were obtained in the sacks containing hen grain at 450 g/10 kg (average 2381.7 g) and sunflower seed hulls at 450 g/10 kg (average 2308.3 g).

Colak*et al.,* (2007).This study was performed to determine the effects of composts and casing materials on dry matter, protein, and carbohydrate contents of the fruit bodies of *Agaricusbisporus*. Results showed that dry matter of *A. bisporus* cultivated on peats was remarkably higher than cultivated on other casing materials No significant differences were found among casing soil groups in terms of protein content cultivated on wheat straw. But, there were significant differences between casing soil groups in terms of protein content cultivated on waste tea leaves. Carbohydrate content of *A. bisporus* on peats was higher than those of other casing materials.

Peker *et al., (*2007).This study was designed to determine the pin head formation time and yield values of *Agaricusbisporus* on some casing materials. Composts were prepared basically from wheat straw and waste tea leaves by using wheat chaff as activator substance. Temperatures of the compost formulas were measured during composting at various depths in order to determine the compostability level. Results showed that in both compost types, maximum temperature values were recorded in the second turning stage. Composting was completed in 21 days for both composts. While the fastest pin head formation (12.50 days) was obtained on wheat straw based compost using peat of Bolu (PB) and peat of Agacbasi (PA) (50+50; in volume); waste tea leaves based compost using peat of Caykara (PC) and forest soil (FS) mixture (50+50; in volume) as casing material gave the fastest pin head formation (13.25 days). In terms of yield, a mixture of peat of Bolu and peat of Agacbasi (PA) (50+50; in volume) gave the highest yield for wheat straw based compost, a mixture of peat of Agacbasi and perlite (P) (80+20; in volume) had the highest yield for waste tea leaves based compost.

Simsek*et al.,* (2008) The study was conducted to investigate yields of mushroom (*Agaricusbisporus*) on wheat straw and waste tea leaves based composts. Mixtures (50:50, v/v) of some locally available peats including peat of Bolu (PB), peat of Agacbasi (PA), peat of Caykara (PC) and their mixture (80:20; v/v) with which piece of mosaic and sand were used. Also, some activator materials such as wheat bran, wheat chaff, chicken manure, pigeon manure, and poplar leaves were used for *A. bisporus*cultivation.

The results on wheat straw based composts provided the highest mushroom yield (23.01%) that was obtained on wheat straw and pigeon manure based compost using a mixture of PA with PC (50+50; v/v) as casing material. For waste tea leaves based composts, the highest mushroom yield (24.90%) were recorded on wheat straw and pigeon manure based compost using a mixture of PC with sand (80+20; v/v) as casing material.

Ram and Holkar(2009). Initiations of pinheads began after 33-35 days of spawning in different casing mixtures. Use of coconut coir pith+vermicompost+sand gave 1st and 2nd flush in the shortest time. Number of sporophores produced in different casing materials bariedbetween 18-44. Maximum fruit body weight was recorded in coconut coir pith+vermicompost+FYM+sawdust+sand casing mixture, whereas maximum length of stalk was recorded in coconut coir pith+FYM+saw dust casing mixture. Significantly the highest yield was recorded in coconut coir pith+vermicompost+sand.

Royse (2010).Double-cropping offers growers an opportunity to increase production efficiency while reducing costs. We evaluated degree of fragmentation, supplementation, and addition of phase II compost (PIIC) to 2nd break compost (2BkC) on mushroom yield and biological efficiency (BE%). One crop was extended as a triple crop in which we evaluated effect of compost type, and addition of phase II compost and supplement. All crops involved removing the casing layer after 2nd break and then using 2BkC for the various treatments. Simple fragmentation of the compost increased mushroom yield by 30% compared to non-fragmented compost. Addition of a commercial supplement to fragmented compost increased mushroom yield by 53-56% over non-supplemented, fragmented 2BkC. Fragmented, supplemented 2BkC resulted in a 99% and 108% yield increase over the non-fragmented control depending on degree of fragmentation (3x, 1x, respectively). A 3rd crop of mushrooms was produced from 2BkC, but yields were about one-half that of the 1st and 2nd crops. Double-cropping (and even triple-cropping) offers growers an opportunity to increase bio-efficiency, reduce production costs, and increase profitability. The cost of producing *Agaricusbisporus* continues to rise due to increasing expenses including materials, energy, and labor. Optimizing production practices, through double- or triple-cropping, could help growers become more efficient and competitive, and ensure the availability of mushrooms for consumers.

Vijay (2010a,b). Studied the effect of various method of compost preparationand post composting supplement on growth and yield of white button mushroom.

Gea*et al*.,(2012). Preliminary studies suggested that the use of compost tea made from spent mushroom substrate (SMS) may be regarded as a potential method for biologically controlling dry bubble disease in button mushroom. The aim of this study was to assess the effect of SMS compost tea on the host, the button mushroom, to ascertain whether the addition of these water extracts has a toxic effect on *Agaricusbisporus* mycelium growth and on mushroom yield. In vitro experiments showed that the addition of SMS compost tea to the culture medium inoculated with a mushroom spawn grain did not have an inhibitory effect on *A. bisporus*mycelial growth. The effect of compost teas on the quantitative production parameters of *A. bisporus* (yield, unitary weight, biological efficiency and earliness) was tested in a cropping trial, applying the compost teas to the casing in three different drench applications. Quantitative production parameters were not significantly affected by the compost tea treatments although there was a slight delay of 0.8-1.4 days in the harvest time of the first flush. These results suggest that compost teas have no fungitoxic effect on *A. bisporus* so that they can be considered a suitable biocontrol substance for the control of dry bubble disease.

Suman(2012a).Compost is the substrate on which mushroom grows, the materials is the result of decomposition process governed by a number of microorganism which produces important chemicals reaction there by making it selective for *Agaricusbisporus* and not for other microorganism, the process of compost making is known as composting is best approached through the concept of ecosystem management, starting with the initial ingradientscomposting requires the management of various chemicals factors that select for a succession of microbial population and substrates changes process, in India seasonal and small growers prepare compost from cereal straw in a single prolonged phase with outpasteuization .

Suman(2012b). Among fourtytwo single spore isolates developed from parent stain S-130 of *Agaricusbisporus*, 7 isolates with strandy growth were further screened for yield and other quality trails on short method of compost under seasonal growing conduction.

Characterization

Maghsoudlou(2008).Button mushrooms are picked and marketed at different stages of development. The stage at which mushrooms are harvested influence the quality and the total yield. Also due to variation in metabolic activity, it is natural for the sporophores to exhibit different post harvestbehaviors. This investigation was therefore carried out to study the effect of harvesting stage on the quality parameters and the storage behavior of mushrooms so as to determine the optimum stage for their harvest. In this study mushrooms were picked at six different stages of development namely cap diameter of 20 mm as stage 1; 21-25 mm as stage 2; 26-30 mm as stage 3; 31-35 mm as stage 4; 36-40 mm as stage 5 and 41-45 as stage 6. The stipes were trimmed to a length of 5 mm, washed, drained and stored at 5 degree celcious and 80-85 percent relative humidity. The results indicated that mushrooms picked at stage 4 showed maximum dry matter content, maximum firmness and minimum respiratory rate at harvest time while during storage they recorded minimum respiratory rate, minimum loss in weight and firmness and possessed maximum storage life.

Prakasam*et al.,* (2008).Cultural and morphological variations of seven strains of *Agaricusbisporus* (CM-1, CM-5, CM-10, Delta, S- 130, S-140 and X-13) and one strain of *A. bitorquis* (NCB-13) were studied on the basis of growth on MEA medium, synthetic compost and casing soil as well as the different characters of their fruiting body. S- 130 showed maximum growth on MEA medium, compost and casing soil, whereas NCB-13 produced higher fruit body weight and stipe width. Lesser stipe length and maximum pileus diameter were observed in strain Delta. Maximum pileus thickness was observed in CM-5. These information generated in the present study will be useful in breeding programmes to develop high yielding strains of button mushroom.

Arumuganathan*et al*.,(2009).Button mushroom (*Agaricusbisporus*) fruitbodies were subjected to six different drying methods, namely sun-drying, fluidized-bed drying, freeze-drying, dehumidifying air-cabinet drying, cabinet-drying and osmo-air drying to study their effects on different textural profile characteristics namely, firmness, firmness strength, cutting force, cutting strength, fracture force and fracture energy. The button mushrooms dried by the freeze-drying method showed least firmness with mean firmness force 2.06 N and strength 6.18 N-mm. Highest firmness was observed in mushroom fruitbodies dried by osmo-air drying method. High cutting strength, in terms of cutting force of 93.40 N and strength of 105.89 N-mm, was observed for those dried by the osmo-air drying. Minimum force of 1.89 N and energy of 2.91 N-mm was sufficient to fracture the freeze-dried button mushrooms where as the highest values of fracture force and energy were observed for the osmo-air dried mushrooms. In terms of retention/improvement of the texture in the button mushrooms, osmo-air drying gave firm mushroom, while freeze-drying method was the best in providing soft texture.

Ramezan, and Siahsar (2011). Casing material or soil (casing) is used in mushroom (*Agaricusbisporus*) culture to cover a nutritional composted substrate colonised with mycelium, and has an essential function in stimulating and promoting the development of sporophores (fruit bodies).

In order to use the agricultural by products (different wastes) to reduce peat consumption of casing soil in button mushroom production, an experiment was conducted in 2010 with treatments of casing soil and three replicates in a completely randomized design. Results indicated that treatment of spent mushroom compost+north peat (40%, 60%) produced highest yield (2093 kg) after Holland peat. In addition, in this treatment, harvested mushroom had the highest protein content compared to other treatments. The lowest yield was obtained in loam soil+sand (70%, 30%) due to an final decrease of casing soil porosity and Water Holding Capacity. Therefore, spent mushroom compost is an alternative to reduce peat consumption in button mushroom production.

Dandge(2012).*Agaricusbisporus* (button mushroom) is an edible Basidiomycetes mushroom native in Europe & North America. It is cultivated in more than 70 countries. It is one of the most commonly widely consumed mushrooms in the world having medicinal value. India produces 20,000 tons of button mushrooms. The reasons for such a low production can be attributed to lack of awareness among masses, shortage of quality spawn, and use of traditional methods of cultivation inadequacy of post harvest disposal facilities. A number of harmful fungi are also encountered in compost & casing soil during the cultivation which causes damage to mushrooms directly or indirectly which can adversely affect the final yield. In present investigation studies on some fungi in Button mushroom cultivated at Akola and some preventive measure were taken into consideration during processing.

Media

Gapinski*et al*., (1988). Mycelium growth of 4 strains on 6 synthetic and natural media was investigated. Growth was best on Hansen's medium. Hauser A 3.3 and Hauser A 6 were the fastest growing strains.

Siwulski (1990).Six media were tested in studies with the strains Somycel 91, Hauser A 8.8 and Hauser A 6. The tissue culture was maintained at 24-25 degrees C and 80-85% RH.

The mycelial growth was best on potato and next best on Hansen medium; however, on the former some morphological malformations were observed and the Hansen medium was considered best.

Ziombra*et al*.,(1991).Three strains of each fungus species were grown on 4 different media viz. Hansen, wheat, reproductive or ryegrass (the last 2 were made up locally). Details are given of each medium. Mycelium growth depended on the species, strain and medium*. P. ostreatus* mycelium showed the most intensive growth and that of *A. bisporus* least intensive irrespective of cultivar or medium. Within the species, the fastest mycelium growth was observed in *A. bisporus* strain Somycel 91, *P. ostreatus* strains Px and NB-80*, L. edodes* strains C5 and C9, and *S. rugoso-annulata* strain Jantar. The reproductive medium was best for *P. ostreatus* and *L. edodes* strains. Strains of *S. rugoso-annulata* differed in their preference for the medium.

Straatsma*et al., (*1993) Mycelial growth of the cultivated mushroom in compost is stimulated by the thermophilic fungus *S. thermophilum*. The specific growth rate (micro) of *A. bisporus* cultured with and without (control) *S. thermophilum* was determined indirectly by analysing mycelial extension on compost agar and directly by biomass measurements in liquid compost-extract medium. The radial extension rate (Kr) of *A. bisporus* mycelium was higher in the presence of *S. thermophilum* than in the control (7.8 and 4.1 mm/day, respectively). The width of the peripheral growth zone (w) of *A. bisporus* was 15 and 3.5 mm when grown with and without *S. thermophilum*, respectively. Since micro =Kr/w, indirect evaluation of micro gives values of 1.2/day for controls and 0.5/day with *S. thermophilum*. Measurement of *A. bisporus*biomass in liquid medium in the absence of *S.thermophilum* gave a value for micro of 0.9/day. The data suggest that *S.thermophilum* affects the radial extension rate only and does not influence the specific growth rate of *A. bisporus*mycelium.

Manukovsky*et al*., (1998) Biohumus was obtained by vermicomposting of spent substrate after growth of *Pleurotusostreatus* on wheat straw. The influence of biohumus on the mycelial growth and fructification of edible fungi was studied. With *P.ostreatus*, the growing media tested comprised 0, 25...100% wheat straw and 100, 75...0% biohumus.

The highest yield of fruiting bodies per 100 g dry substrate was 9.73 g, on a substrate comprising 25% biohumus and 75% wheat straw. Studies on the uptake of elements (N, P, K, S, Ca and Mg) suggest that the effectiveness may be due to the higher phosphorus content in the substrate. Higher biohumus contents increased the mycelial growth rate but decreased the yield of fruiting bodies. *Agaricusbisporus* was grown on media comprising 90, 92...100% wheat grains and 0-10% biohumus. Mycelial growth rate (<1 mm/day with no biohumus) reached 2.2-2.4 mm/day, on substrates containing 94-96% wheat grains and 6-4% biohumus, respectively.

Dong ChangJin (2001) The influence of adding different waste materials used for the cultivation of *Pleurotusostreatus* (WMCPO) to medium on the hyphal growth (HG), fruit body formation time and yield of *Agaricusbisporus*was investigated. *A. bisporus* strain Xinong No.1, was inoculated on 4 media: (A) with 86% rice straw (RS) or wheat straw (WS) and 0% WMCPO, (B) with 81% RS (or WS) and 5% WMCPO, (C) with 76% RS (or WS) and 10% WMCPO, and (D) with 66% RS (or WS) and 20% WMCPO. The fastest rate of degradation (3 days) or HG (0.1777 cm/day) for *A. bisporus* was recorded on C. The ranking of the 4 media with regard to time to form 1st-flush mushroom primordia was C<B<A<D, and the fruiting bodies were formed 4 days earlier on C than on A. The average yield was highest on C (8.3 kg/m2 culture material), next highest on B (11.5 kg/m2), third highest on A (9.8 kg/m2), and lowest on D (8.3 kg/m2). It is concluded that adding 10% WMCPO to the medium favoured HG and yield increase of *A. bisporus*.

Wozniak *et al.* ,(2001)The paper present multiplication and mycelium growth of *Agaricusbisporus* (Lange) Sing cultivars Hauser 2092 and Polmycel 013x1 as influenced by production method. Mycelium was produced using Hansen medium and multiplied either on Petri dishes with agar solidified medium or in liquid medium using shaker 358 S or in New Brunswick Scientific Co. bioreactor. It was found out that mycelium grew faster in liquid than solid medium. The highest efficiency of mycelium production in the shortest time was obtained in the bioreactor. Mycelium of Hauser 2092 cv. developed twice as fast as Polmycel 013x1 mycelium.

Ma GuoLiang (2004) The aim of this paper was to investigate the hyphal growth, yield and biological efficiency of *Agaricusbisporus* strain Pinggu 819 in 5 different culture media, using pea stems (PS) as the culture substrate. Media included the control A (93% cotton seed hulls; CSH), and medium B (63% CSH + 30% PS), C (43% CSH + 50% PS), D (23% CSH + 70% PS) and E (3% CSH + 90% PS). These culture media were also supplemented with 2% plaster, 1% urea and 4% maize powder. Their pH value varied from 7.5 to 8.0. Significant differences in mushroom yield and biological efficiency were recorded among different culture media. The best hyphal growth situation and the highest mushroom yield were recorded in medium B, followed by medium C, and the worst and lowest in medium E. The biological efficiencies in the media A, B, C, D and E were 300, 310, 290, 175 and 100%, respectively.

Singh and Shwet (2011).Sixty-three fertile single spore isolates (SSIs) representing five strains were screened for radial growth on Malt Extract Agar (MEA) medium, downward linear growth on compost and yield. The morphological traits like size of gill, pileus and stipe were also recorded in the above isolates. There was no significant correlation of yield with radial growth on MEA (r=-0.124) suggesting that the growth on MEA in petriplates cannot be an indicator of yield performance of the genotype. In another study on seventeen isolates conducted earlier, no significant association of yield was recorded with radial growth on malt, Coon's and yeast potato dextrose agar. The downward linear growth on compost, however, showed highly significant relationship with yield (r=0.771; y=0.33x -10.01; R2=0.59) suggesting that mycelial growth on compost can be used to predict the yield potential and at least can be used to reject the isolates. On the other hand, radial growth on MEA showed significantly negative interrelationship with gill (r=-0.381) and stipe size (r=-0.310).

Production

Kumar and Chandra (*1988*)Spawn was prepared on substrates composed of rice bran or each of 5 grains (*Paspalumscrobiculatum, Pennisetumtyphoides [P. americanum],* Amaranthus, *Sorghum vulgare [S. bicolor]* or wheat) or combinations of each of these grains with rice bran in the proportions 1:1, 1:2 or 1:4 w/w (total of 21 substrates). Mycelial growth was fastest on the sorghum substrate. The spawn prepared on the various substrates was subsequently used in cropping experiments, 50 g spawn being mixed with 6 kg compost. Fruiting body yields were highest (16.44 kg/m) with spawn prepared on the Amaranthus substrate. Of the grain + rice bran spawn substrates, P. scrobiculatum + rice bran (1:1) gave the highest mushroom yields (14.51 kg/m).

Suman*et al.* , (1988) This method consists of filling glass bottles with wheat or other grain mixed with gypsum and CaCO3 and an equal quantity of water before autoclaving, omitting the usual stage of boiling the grains and leaving them overnight before use. The new method saves labour and time, thus reducing the cost of spawn production.

Suman*et al*., (1988)Four spawn substrates, comprising wheat grain mixed with maize cobs, rice husks, wheat bran or wheat straw (1:1 w/w) with added $CaCO_3$ and $CaSO_4$, were tested. Mycelial growth was faster on the substrates containing wheat straw or rice husks compared with a wheat grain control. Spawn produced on the wheat grain + rice husk substrate gave fruiting body yields comparable to those of spawn produced on wheat grain alone (10.64 and 10.39 kg/m respectively) in subsequent cropping studies.

Sumanand Sharma (*1990*)Grains of wheat cultivars KalyanSona, Sonalika (S-303), Shailaja (HS 1138-6-4), WG 357, VL-421, C-285, Sanora-64, SharbatiSanora, SafedLerma and HP-1102 were boiled in tap water for 20 min, left to soak for a further 20 min and then drained on wire netting. Nine kg (wet weight) of grains were mixed with 30 g calcium carbonate and 120 g gypsum. Half-litre bottles were filled to a depth of 10 cm with grains, plugged with non-absorbent cotton and sterilized at 22 lbp.s.i. for 2 h.

The pH and moisture content of the grains were determined after sterilization. After cooling, the bottles were inoculated with *A. bisporus* strain S-11 and incubated at 25 degrees C. The best mycelial growth was obtained on grains of KalyanSona and Sonalika (S-308) which had moisture contents of 40 and 42%, respectively, after sterilization.

Frieland Mchoughlin(2000)The production of a homogeneous liquid culture of mushroom mycelium with a high density of viable inoculum points is a prerequisite for the adaptation of the liquid culture technology to the mushroom spawn production process. Homogenization proved unsuitable as a technique to produce a morphology of this nature because of the shear sensitive nature of mushroom. To overcome this limitation, a homogeneous culture was produced by exposing culture flasks to alternating periods of shear stress (300 rpm on a shaker table for 60 min/day) and recovery (23 h/day under static conditions

Sanchezand Rovse(2001)A pasteurized, non-composted substrate (basal mixture) consisting of oak sawdust (28%), millet (29%), rye (8%), peat (8%), alfalfa meal (4%), soyabean flour (4%), wheat bran (9%), and CaCO3 (10%) was adapted from use for shiitake [Lentinulaedodes] culture to produce the common cultivated mushroom (brown; portabello*), Agaricusbisporus*. Percentage biological efficiency (ratio of fresh mushroom harvested/oven-dry substrate weight, %BE) ranged from a low of 30.1% (when wheat straw was substituted for sawdust) to 77.1% for the basal mixture. Special, high gas-exchange bags were required to optimize mycelial growth during the spawn run. This formula may allow mushroom growers to produce portabello mushrooms on a modified, pasteurized (110 degrees C for 20 min) substrate commonly used for shiitake production without the added expense of compost preparation.

Kurbanoglu*et al.*, (2004)The production of the fungus *A. bisporus* ATTC 10893 was studied in submerged fermentation with horn hydrolysate as the main substrate source. First, horns were ground and 35 g of the horn powder were chemically hydrolysed (acid hydrolysis). As a result of this process, 30 g of the 35 g horn powder (85.7%) could be hydrolysed.

The effects of different concentrations (1-7% v/v) of CHH on the growth of *A. bisporus* were investigated and 2% of the CHH (horn broth=HB) was optimal. The HB contained 20 g glucose, 20 ml CHH and 1 g KH2PO4 per litre of laboratory quality water. The optimum growth conditions for the *A. bisporus* in HB were as follows: initial pH: 6; temperature: 26 ^{0} C; fermentation time: 8 days and agitation: 150 rpm. Under these optimal conditions, initial carbohydrate content of HB was reduced from 2.02 to 0.2% and the biomass yield was 10.8 g litre-1. The biomass contained ~47.1% of protein, 5.8% of fat and 7.9% of ash (on a dry weight basis). The results with HB were also compared with previously reported data on edible mushroom mycelium grown on some substrates. It was found that HB could be used as a substrate for the production of *A. bisporus* mycelium.

Sumanand Paliyal (2004).The effects of garden soil, farmyard manure (FYM; 2 years old), coconut coir pith (CCP), FYM + CCP (4:1, v/v), spent compost (2 years old) + FYM (1:1, v/v), spent compost + CCP (4:1, v/v) and

FYM + garden soil (1:1, v/v; control) as casing materials on the performance of were studied. FYM + CCP had greater waterholding capacity (180%), porosity (70%), and N (0.168%), P (0.020%), K (1.05%), Fe (0.028%), Mn (0.100%) and Zn (0.064%) contents, and lower particle density (0.70 g/cm3), bulk density (0.28 g/cm3), and number of days to primordial formation (12 and 15 days for the short and long methods of composting, respectively) than the control. The highest average yields (23.8 and 17.6 kg for the short and long methods of composting) were also obtained with FYM+CCP.

Becharа*et al.,* (2006) Non-composted grain-based substrates were evaluated for the cultivation of mushrooms (*A. bisporus*) with the goal of eliminating the need for the lengthy and often malodorous composting process. Millet grain, millet grain mixed with soyabean, and commercial rye grain spawn were used as the substrates. Treatments included different proportions (100, 75, 50 and 25%) of millet grain, or grain spawn with perlite as an inert bulking material. For the millet and soyabean mixtures, the biological matter (millet and soyabean) was set at 75% by volume, while the ratios of millet to soyabean were varied.

To induce fructification, all the substrates were overlain with a sterilized mixture of peat and calcium carbonate (casing) containing 25% activated charcoal (v/v), which was shown to be as effective as a commercial non-sterile casing. Among the various treatments, the highest mushroom yield among all the 3 grain treatments was recorded for the 100% millet/0% perlite treatment (8.7 kg/m2), which was comparable to that of compost (7.7 kg/m2). In contrast, the millet/soyabean mixtures failed to produce any mushrooms when soyabean was added to the substrate. The highest recorded mushroom yield for commercial grain spawn was 5.3 kg/m2 for the 100% spawn/0% perlite treatment. This yield was lower when compared to the millet grain and compost substrates. However, biological efficiency (fresh weight of mushroom divided by dry weight of substrates x 100) was 117% for the 25% spawn/75% perlite treatment, while that of compost and the 75% millet/25% perlite treatment were 98% and 55%, respectively. The results suggest that mushrooms can be grown in a non-composted substrate, but further economic analysis will need to be performed to determine the economic viability of alternative substrates.

Sabeh*et al* .,(2006)A study was conducted to demonstrate the effects of three air distribution layouts on the uniformity of temperature and humidity within *Agaricusbisporus* mushroom production rooms. Carbon dioxide levels were also monitored. *A. bisporus* mushrooms were grown in commercial-design production rooms at the Mushroom Test Demonstration Facility at the Pennsylvania State University. Three different crops were studied under three different air distribution schemes that provided a mixture of fresh and re-circulated air at an exchange rate of 6 to 9 air changes per hour. Temperature and relative humidity were measured over seven mushroom growing trays every 30 min. For the central overhead duct and drop-tube duct arrangements, the bottom production trays tended to experience the coolest, driest air conditions in the room, and the air over the middle production trays was generally warmer with higher moisture levels. The central overhead duct system, combined with two sidewall-floor ducts, produced the most spatially uniform environmental conditions of all three distribution layouts studied.

Carbon dioxide levels generally remained below the 3000-ppm maximum target during the study period in all three production rooms. Improved uniformity did not correlate with an improvement in quality or increase in yield. Mushrooms grown under air temperatures less than 13 degrees C and at absolute humidities below 10 g m-3 had the poorest quality.

Bechara*et al.,* (2008)Non-composted substrates composed of commercial grain spawn and delayed-release nutrient supplements were tested for mushroom production as alternatives to the environmentally problematic composting process associated with conventional commercial mushroom (*Agaricusbisporus*) cultivation. The effect of casing type, thiophanate-methyl (fungicide) use, delayed-release supplement type (S41 and S44) and level, and perlite addition were tested on mushroom production. Use of a non-sterile casing overlain on grain spawn/supplement substrate produced mushrooms comparable to a steam- treated casing with 25% activated carbon, yielding 6.4 and 7.6 kg $m\text{-}^{2}$, respectively. Thiophanate-methyl severely reduced mushroom yield when used. Average mushroom yield from treatments with S41 supplement was greater than that of S44, and when commercial grain spawn substrate was underlain with a layer of perlite (2000 mL over 0.048 m^2) to absorb and release excess water, mushroom yield increased two-fold, producing 13 kg m^{-2}, compared to 7.6 kg m^{-2} for treatments without perlite.

Pardo*et al*., (2010). Production and quality parameters of three commercial strains of cultivated mushroom *Agaricusbisporus* (Lange, Imbach) were evaluated. A correlation matrix was made between the main parameters. Blancochamp BL-40, a smooth white hybrid, generally produced the greatest number of mushrooms and provided the highest yield, and its firm mushrooms showed high protein, dry matter, and soluble solid content. Pla. 8.9, a midrange hybrid type, produced mushrooms with a high protein, soluble solid, and ash content. The third strain assayed was Gurelan 45, which produced large, firm off-white mushroom crops. A correlation matrix was made between the main parameters. In regard to the other parameters considered, no strain stood out from the others.

The Rioja-type casing produced the greatest number of mushrooms, although these were smaller and harvested earlier than those produced in other casing mixtures. Soil without additives produced the largest mushrooms, which also had a higher dry matter content, were firmer, and contained more soluble solids. The other casing materials, binary mixtures of soil with sphagnum or black peat, produced mushrooms of intermediate values. The correlation matrix showed that the higher the number of mushrooms, the greater the overall yield, the smaller the size, and the earlier the first flush. It was also observed that a higher content in dry matter was correlated with firmer texture, greater contents in soluble solid and protein, and lower pH and ash content.

Bechara*et al.*,(2011).Grain-based substrates subjected to a two-stage solid-state fermentation (SSF) process for *Agaricusbisporus* mushroom production were tested as alternatives to the environmentally problematic compost-based substrate. Scytalidiumthermophilum, the dominant thermophilic fungal species found in compost-based substrates, was used in the primary stage of the SSF process to pre-treat grain-based substrates, which was followed by inoculation with *A. bisporus* in the secondary stage. The results indicated that incubation period, but not grain type, had a significant effect on mushroom yield and substrate bioefficiency (p<0.05). Yield decreased significantly beyond the 10-day incubation period with *S. thermophilum* compared to that of the control treatment without S. thermophilum. Use of shorter primary stages with *S. thermophilum* (0, 2, 4, and 6 days) suggested that both incubation duration and the interaction of grain type and incubation duration were significant for mushroom yield and substrate bioefficiency (p<0.05). The substrate colonization periods for *A. bisporus* using substrates pre-colonized by *S. thermophilum* were shorter (22 to 23 days) when compared to control treatments (44 to 50 days) without *S. thermophilum*pretreatment (p<0.05). In conclusion, when using grain-based substrates for mushroom production, the addition of *S. thermophilum* in the primary stage of the SSF process shortened the time for substrate colonization by *A. bisporus* in the secondary stage.Further, the two-stage SSF process described herein increased mushroom yield when using an oat grain-based substrate.

Casing thickness

Tripathi*et al*.,(1991).*Agaricusbrunnescens* [*A.bisporus*] mushrooms were produced using 6 different casing materials (FYM, spent compost + 8% calcium carbonate, FYM + rocky soil, garden soil, FYM + garden soil or rocky clay soil). The highest yield (853.00 and 968.33 g/polyethylene bag (50 x 30 cm) in 1986/87 and 1987/88, respectively), was obtained with spent compost + 8% calcium carbonate as casing material due to its porosity, high water holding capacity, pH value and the presence of beneficial nutrients.

Saini and Prashar(1992). Of 7 casing media tested, farmyard manure (FYM) + waste compost + soil, FYM + soil, and waste compost + soil resulted in the earliest appearance of pinheads. A casing medium of FYM + waste compost + soil at a ratio of 2:1:1 (by vol.) gave the greatest yield of mushrooms (6.45 kg/100 x 50 x 15 cm tray). The lowest yield (1.92 kg/tray) was obtained with a 3:1 mixture of FYM + lime.

Alberto (1995).To investigate the possibilities of cultivating different *Agaricus species* with a view to both commercial production and also their use in breeding and selection, strains of the naturally occurring, edible species *A. bisporus, A. campestris, A. fiardii, A. nivescens, A. pampeanus* and *A.pseudoargentinus*were grown on *A. bisporus* compost. All strains grew well on sterile wheat grains, allowing optimum spawn production. Colonization of compost took between 11 and 18 days after spawning. Casing depth had no effect on fruit body production. Spawn run after casing was slower and reached the surface in about 13 days. Only *A. bisporus* and *A. pseudoargentinus* produced fruit bodies. *A. pseudoargentinus* produced pin-heads after 42 days of casing and developed fruit bodies at 18 degrees C, but the yield was low.

Suman, (2004).Reported that out of more than fifty strains of *Agaricusbisporus* procured from different sources and screened at the station, ten were selected for further evolution. Strain 454, recorded the highest average yield of 23.25 and 18.50 kg per 100 kg compost on long and short method of compost, respectively and it was 33 and 29 percent higher than in control (S-11). The fruiting bodies of strains 454, 837 and HU3, were found to have most suitable characteristics.

Vijay (2006). A methodology for the production of indoor compost had been standardized using a combination of the INRA method (double phase high temperature method) and the Anglo Dutch method (single phase low temperature method) for the cultivation of button mushroom (*Scytalidiumthermophilum*). Using facilities for phase one and phase 2 operations, the compost could be produced in 12 days. Almost identical yields per unit weight of the compost was obtained by this technique compared to the short method. However, overall yields were higher in indoor compost as this method produced approximatety 30% more compost biomass. Moreover, this technique improved the consistency of the compost quality, improved material handling and reduction in raw material losses during composting with minimal air pollution.

Pandey et al., (2007) An experiment was conducted in Kanpur, Uttar Pradesh, India to determine the effective and optimum casing thickness (3,4,5 and 6 cm) for maximum growth and production of *Agaricusbisporus*. The highest yield (18.00 Kg) was obtained with 4cm casing whereas 6cm casing gave the lowest yield (11.66 Kg). The yield obtained from 3.4 and 5cm casing were statistically at per with each other.

Pardo*et al.,* (2008).The agronomic performance of different proportions of mixtures of coconut fibre (CF) pith and spent mushroom substrate (SMS) was studied for their use as casing material in mushroom cultivation. After chemical and biological characterisation of the casing substrates qualitative and quantitative production parameters were evaluated in a cycle of *Agaricus* production.

An increase in the proportion of SMS reduced the number of carpophores and overall yield; while the first flush was delayed, mushroom size tended to increase and the mushrooms had a higher dry matter content and a better texture, although their colour was worse. Combinations of CF pith and SMS of 4:1 and 3:2 (v/v) gave biological efficiencies of 92.9 and 82.6 kg 100 kg-1 compost, respectively. These values compare well with that obtained from the commercial casings used as a control. The high electrical conductivity of the mixture containing the highest proportion of SMS would limit its use. However, the results indicate the viability of reusing SMS as an ingredient of casing material for mushroom cultivation. This alternative could be considered to partially replace the organic substrates normally used for mushroom cultivation, with the double advantage of decreasing cost and reducing the environmental impact of waste disposal.

MATERIAL AND METHODS

The present investigation entitled "Comparative efficacy of various compost on the growth and seasonal production of *Agaricusbisporus (*Lange) Imbach, by long term process(LTP)was conducted during 2012-13. The materials and methods wereused during the present investigation are given here.

GENERAL

(A) Experimental site

The experiments were conducted at mushroom spawn production unit and mushroom laboratory Department of plant pathology college of Agriculture, J.N.K.V.V, Jabalpur.

(B) Cleaning and sterilization of glassware and apparatus

During the present experiment, Borosil mark glassware's were used. The glasswares prior to use were washed with chromic acid and vim powder followed by rinsing with tap water. The glasswares were dried in oven at 60°C for 15 minutes and sterilized at 180 °C for 2 hours. The inoculation needle, knife, scissors, blades, and cork borer were sterilized by dipping them in 95% alcohol followed by heating over flame.

(C) Source of material

The pure culture of one species of *Agaricusbisporus*were obtained from mushroom spawn laboratory, college of agriculture, J.N.K.V.V, Jabalpur. The cultures were further multiplied. On malt extract agar medium and potato dextrose agar medium, Richards medium, wheat extract medium,Asthana and Hawker´s medium, maintained at 4 °C for entire work. The other materials i e. wheat straw, empty glucose bottles, polypropylene bags, wheat grains, chemicals like Formaldehyde solution, Calcium carbonate, Calcium sulphate and other materials were procured from Department of plant pathology, J.N.K.V.V., Jabalpur.

(D) Meteorological data

The meteorological data on daily temperature (maximum, minimum, and average) and relative humidity (morning and evening) of mushroom hut were recorded and used during present study. (Appen.1)

(E) Statistical analysis

Completely Randomized Design was employed for the experiments. All the experimental data were analyzed statistically with the help of Department of statistics. The critical difference were worked out at five percent probability level

(F) Preparation of media

During the period of present experiment the following media were used are as follows;

(i) Potato dextrose agar (PDA) medium

Potato (pealed and sliced)	-	200g
Dextrose Agar	-	20g
Distilled water	-	1000ml

(ii) Richard's medium

Potassium nitrate	-	10g
Potassium dehydrogenate phosphate	-	5g
Magnesium sulphate	-	5g
Ferric chloride	-	0.02g
Sucrose	-	50g
Agar-agar	-	20g
Distilled water	-	1000ml

(iii) Wheat extract medium

Wheat grains	-	200 g
Dextrose	-	20 g
Agar-agar	-	20 g
Distilled water	-	1000 ml

(iv) Malt extract agar medium

Malt extract	-	20 g
Agar-Agar	-	20 g
Distilled water	-	1000 ml

(V) Asthana and Hawkers medium

Sucrose	-	5 g
Potassium Dehydrogenate phosphate	-	1.75 g
Magnesium sulphate	-	0.75 g
Potassium nitrate	-	3.5 g
Agar- Agar	-	20 g
Distilled water	-	1000ml
Distilled water	-	200 ml

The prepared media were sterilized in autoclave at 15 lbs. p.s.i for 60 minutes and then kept in the refrigerator for further use.

(G) Isolation and purification

Sporophore of *Agaricusbisporus* were collected from mushroom production unit. The culture was obtained by tissue culture method under aseptic conditions. First of all, hands were washed and sterilized by ethyl alcohol. The outer surface of sporophore was sterilized by rubbing the alcohol rinsed cotton. Forceps was sterilized by dipping in alcohol and flamed until red hot and cooled for 30 seconds and mushrooms stipe was split open lengthwise from the cap downwards with bare hands. A small piece of the internal tissue of the spillitedsporophore was cut and removed with the help of flamed forceps. The cut piece was placed in to the dextrose agar medium slants. The inoculated tubes were incubated at 25 ± 1 °C for 7 days. Seven days old culture was purified by cutting single hypal tip and maintained on potato dextrose agar medium for further studies.

(H) Preparation of mother spawn

Clean and healthy wheat grain was used for the preparation of mother spawn. The wheat grain was washed and soaked in fresh water for two hours then boiled with two liters of water per kg seed for 15-20 minutes till they become soft but remain firm. Water was drained off and boiled wheat was spread over blotting paper to remove the water for 20 minutes. The grains were impregnated with 2% Calcium carbonate and 1 % Calcium sulphate on the dry weight basis. Two hundred gram of coated wheat was filled in each bottle of glucose saline. The bottles were closed/plugged by non absorbent cotton. These bottles were sterilized at 15 psi for 20 minutes. The sterilized bottles were left for 12 hours and shaked for reabsorbing the condensed water droplets. Sterilized bottles containing wheat were inoculated with seven days old half plate culture of *Agaricusbisporus.*covered the grains completely within 15 days of incubation. The spawn prepared by this way was called as mother spawn and used throughout the period of study.

(I)Preparation of mother spawn on brans

During the study of mother spawn preparation different types of available brans viz: Black gram, wheat, Pea, Pigeon pea. Chickpea was used for supplementing nutrition required and for quick spawn run.

(J) Preparation of planting spawn

Spawn required for different studies was multiplied from mother spawn using both glucose bottles and polythene bags. In each glucose bottles/ bags, 250 g of wheat grains were taken and inoculated with a spoon of grains frommother spawn. The glucose bottles / bags were then incubated in the same as the mother spawn.

(K)Compost preparation:

The substrate for cultivation is specially prepared compost. The mushroom house should have the facilities for temperature control and pasteurization. Buildings are constructed of wood or hollow cement bricks or double walls. The shed is partitioned into small compartments and provided with trays. Environmental conditions like temperature, relative humidity and ventilation are controlled inside the shed by installing suitable equipment.

Compost is the substrate in which the mushroom mycelium grows and on which it produces fruiting bodies. It is the product of a fermentation process brought out by a number of mesophilic and thermophilic microorganisms that decompose plant residues and other organic and inorganic matters. The quality of compost influences the yield of mushroom. Compost prepared out of horse manure and wheat straw is ideal one. Since these materials are not easily available, many substitutes are suggested and are in use. There are two methods of composting, Long method and short method. The distinction is based on the time taken for composting and the long method needs three to four weeks, while the short method requires only 12-15 days, since the composting procees is hastened by pasteurization. In the long method of composting, pasteurization is avoided, which will make the compost poor in quality and often gives variable yields.

(L) Preparation of compost for *Agaricusbisporus*:-

For the preparation of the compost by long term compost method the following composition was use for compost preparation different formulae used for making compost .

(a) IARI Delhi formula

Wheat straw	-	350kg
Horse manure	-	1000kg
Urea	-	3kg
Gypsum	-	40kg

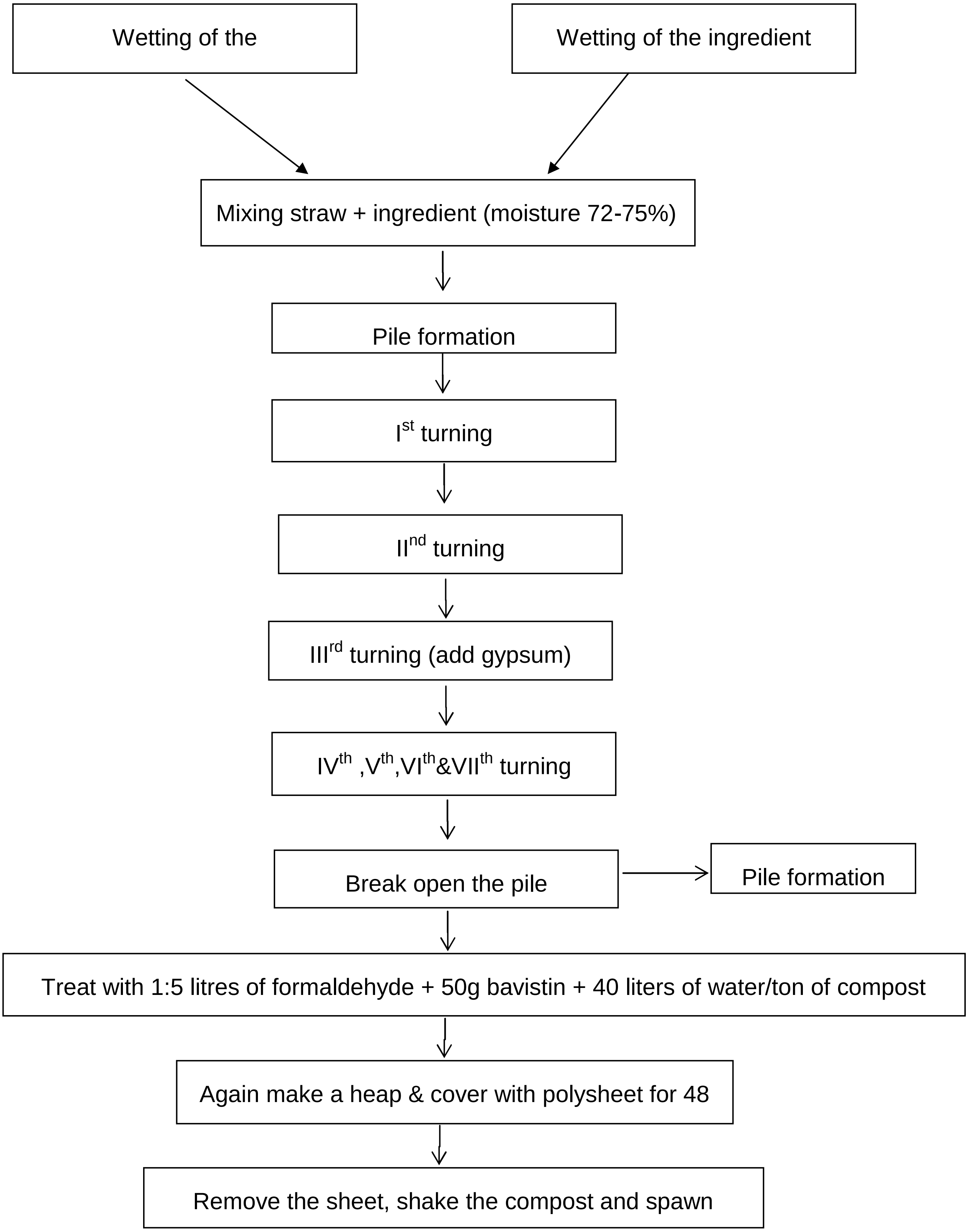
(b). NCMRT Solan Formula:-

Wheat straw	-	300 kg
Wheat bran	-	15 kg
Chicken manure	-	5.5 kg
Urea	-	20 kg
Lindane dust	-	250 kg

(c). IIHR Bangalore Formula:-

Paddy straw	-	1000 kg
Rice bran	-	166 kg
Neem cake	-	40 kg
Urea	-	16 kg
Gypsum	-	30 kg

Flow Chart Long Method Compost



A heap of straw was made on concrete floor and whole straw was sprinkled with tap water, so that straw absorb the sufficient water but not leach from bottom and kept for two days.

This stage was called as 2 days. Thereafter, heap was broken and all the ingredients were mixed except gypsum, again heap (10’ 1 x 5’x 3’ h) was made and following turning schedules was given;

At each turning a little amount of water was sprinkled to avoid the dryness of compost, at 5^{th} turning Gypsum was added to maintain the pH of the compost. After 19^{th} days following parameters were taken to test.

Moisture content	-	68 %
pH	-	6.9%
Colour	-	Light brown
Ammonia	-	No smell of ammonia, pleasant smell

The prepared compost was filled in metal trays (120" x 36") and spawning was done @ 1% of compost by layer method for *Agaricusbisporus.*

The top of each metal tray was covered with moist newspaper, which was previously sterilized with 1 % Formaldehyde and 0.1 % Bavistin. The spawned trays were kept in mushroom growing hut, for spawn run where 20-25 °C temperature and 80 % relative humidity was maintained. A little amount of water was sprinkled on the surface of newspaper when required to avoid the dryness of compost. Each tray contains 100 kg of compost and 3 replications were maintained in each species. After completion of spawn run the newspapers were removed from the bags and cased with casing soil (Garden soil + FYM + sand, 2: 1:1). The case soil was pasteurized prior to use at 20 Ibs.p.s.i. for one hour.

A 3 cm,4cm,5cm thick layer of casing soil was placed on the surface of spawned compost. After maintaining casing temperature and relative humidity of the mushroom hut at 22-25 °C and 75-90 % respectively, for a week, it was 16-20 °C with 80-85 % relative humidity. Normal ventilation was provided to induce the fruiting and watering was done twice or thrice in a day depending upon weather conditions during cropping. The individual fruiting body was harvested with the help of sharp knife before spraying the water. The observations were recorded for number of days taken for spawn run, case run, number of fruting bodies and total yield on compost prepared by various formulas.

(M)Spawning:

The prepared compost was filled in metal trays (120" x 36") and spawning was done @ 2.0,3.0, and 4.0 kg/100 kg compost.

Tray system of cultivation: The compost when ready is taken in trays leaving about 5 cm from the top. There are different methods of spawning and indicated below.

1. **Single layer spawning:** The grain spawn is scattered uniformly all over the compost surface in a tray, which is then covered with athin layer of compost.200 gm spawn/m^2beds.
2. **Double layer spawning:** The trays are half filled and spawn is scattered. Then the tray is filled completely compost and spawn is applied as above and covered with a thin layer of spawn.

(N) Effect of casing sterilizing agents;

After spawn run a 3 cm thick casing soil was placed on the surface of compost which was treated prior to use by 4 methods. The details of casing soil sterilization as follows;

- The required quantity of casing soil was placed on polypropylene sheet thereafter, 2 % formalin was sprinkled till saturation and covered with another polypropylene sheet for 48 hours.
- Similarly, 0.1 % bavistin was spread on casing soil (T2).
- Similarly 2% formalin + 0.1% bavistin(T3)
- Streaming under 15 lbs pressure for 15 minuts(T1)
- Control only water spray(T4)

After casing favorable environmental conditions were provided for fruitification the observations were recorded for number of case run, days taken for initiation of pinhead formation and total yield in compost weight. The spawned trays were shifted in mushroom growing house for spawn run where appropriate temperature (22-25 °C) and relative humidity (75-85 %) were maintained. Compost prepared by LMC harbors a large no. of organism at spawning. may of which are strong competitors of *Agaricusbisporus.* Best way to eliminate these organisms is to use compost prepared by short method (pasteurized product). However, procurement/ production of such compost is beyond the research of many growers. To control yellow moulds and other disease NCMRT come out with a novel chemical pasteurization technique of long method compost. The development technique is as follows and tested at Jabalpur condition.

(O) Casing thickness

The experiments were conducted during the winter season with three replications under perforated metal trays. Each tray contains 100 kg compost and spawning was done @ 1 % wet compost. The spawned bags were shifted in mushroom growing house and maintained suitable environmental conditions for spawn run. After spawn run the trays were cased with pasteurized casing soil (Garden soil + FYM + sand, 2:1:1). A layer 3 cm, casing soil was placed on spawn run compost. The trays were kept in mushroom growing house for fruitification and appropriate environmental conditions were maintained in growing house. The observations were recorded for spawn run, casing run days, pin head initiation, number of fruiting bodies and total yield.

(P) Watering of the compost bed

The Button mushroom compost were tray are kept in mushroom house. These beds were watered once a day. Watering was stopped a day before harvesting and again continued. Diffused light, good ventilation was provided during the entire cropping period.

(Q) Harvesting of sporophore

Harvesting is done at button stage and caps measuring 2.5-4cm. across and closed are ideal for the purpose. The first crop appears about three weeks after casings Mushroom need to be harvested by light twisting without disturbing the casing soil. Once the harvesting is complete the gaps in the beds should be filled with fresh sterilized casing material and then watered.

(R) Weighing of sporophore

The weighing of freshly harvested sporophore was a single Electronic balance for weighing sporophore used for the determination of moisture, ash, protein, fat and carbohydrate content.

(S) Yield of the mushroom

The weighing of freshly harvested sporophore was done by Electronic balance. Yield was calculated by adding the fresh weight of all the three flushes of mushroom fruting bodies produced per kg dry substrate.

(T) Biological efficiency

Biological efficiency (BE) expressed in percentage and was calculated by following formula given below, Patidar (2008).

$$\text{Biological efficiency} = \frac{\text{Fresh weight of mushroom}}{\text{Dry weight of substrate/Compost}} \times 100$$

RESULT

An investigation entitled **’’Comparative efficacy of various compost on the growth and seasonal production of *Agaricusbisporus* (Lange) Imbach,by long term process’’**was conducted during 2012-2013. The results of the finding are presented below.

1. Effect of different media on mycelia development of *Agaricusbisporus*.

It is evident from the data (Table1) that the growth of *Agaricusbisporus* highly significant on different media.Potato dextrose agar medium gave maximum 85.77mm colony diameter after 18 days followed by 64.95mm after 12 days and 24.74mm days after 6 days. Least mycelia growth 16.32mm found in Asthana Hawker´s medium after 6days,where as 39.83mm mycelia growth was found after 12 days and 74.40mm growth after 18 days was found on Richard´s medium.

Data also revealed that out of five media tested for growth of *Agaricusbisporus* was found to be Potato dextrose agar best. WhereasRichard´s medium was found to be least suited for growth of *Agaricusbisporus*.

Table 1 Effect of different media on mycelial development of white button mushroom (*Agaricusbisporus*)

S.No.	Media	Mycelial growth(mm.)		
		(6 days)	(12 days)	(18days)
1.	Potato Dextrose Agar	24.74	64.95	85.77
2.	Wheat Extract Agar	24.17	64.00	85.67
3.	Malt Extract	23.40	59.70	85.66
4.	Richard´s Medium	19.77	39.83	76.40
5.	Asthana Hawkers	16.33	52.13	82.32
	SEm±	0.63	1.00	1.01
	CD at 5% level	1.98	3.16	3.18

*Average number of three replication.

2. Effect of different brans on mother spawn preparation of *Agaricusbisporus*.

Data presented in Table 2.revealed that, the various brans influence the spawn run period of *Agaricusbisporus*.Among brans, wheat bran took less period of time 13.53.average number of day for spawn run whereas, chickpea brans took 15.40 number of days ,black gram took spawnrun in days 13.60,Pigeon pea 15.07 etc.

Different bran used for mother spawn preparation influence the spawn run period of *Agaricusbisporus*.

Table 2 Effect of different brans on mother spawn preparation of *Agaricusbisporus*

S.No.	Brans	Spawn run (days)
1.	Black gram	13.60
2.	Wheat	13.53
3.	Pea	14.63
4.	Pigeon pea	15.07
5.	Chickpea	15.40
	SEm±	0.44
	CD at 5% level	1.40

***** Average number of three replication.

3. Effect of various compost on the growth and biological characteristics of *Agaricusbisporus*.

The result presented in Table -3 revealed that maximum spawn run in days were found 16.53 in compost formulated by IARI,whereas least period of time noted in formula NCMRT(14.26 days).

Least number of days of casing run was found in NCMRT formula .where as maximum days required in IARI formula (22.36days).Maximum number of days for pinhead initiation was recorded in compost prepared by IARI formula (28.26) and minimum was noticed in formula 26.23 .Number of fruiting bodies harvested was found minimum in IIHR formula 52.64 and 47.34 in IARI formula.Maximumsporophore yield (kg/100kg compost) found in composting by NCMRT formula (12.98) followed by IIHR formula (11.90)and minimum in IARI formula (9.02).Biologicalefficiency (%) was recorded maximum in compost prepared NCMRT formula i.e 12.9% followed by 11.9 in IIHR formula and minimum in IARI formula 9.02%.

Table 3: Effect of various compost on the growth and biological characteristics of white button mushroom (*Agaricus bisporus*)

S. No.	Compost prepared by various formula	Marphological Character					
		Avg. number of days			No. of fruiting bodies	Sporophore yield (Kg/100 kg compost)	Biological efficiency %
		Spawn run	Casing run	Pinhead initiation			
1.	IARI	16.53	22.36	28.26	47.34	9.02	9.02
2.	IIHR	14.76	22.16	28.23	52.64	11.9	11.9
3.	NCMRT	14.26	20.29	26.23	58.52	12.98	12.9
	SEm±	0.24	0.33	0.38	0.28	0.29	0.29
	CD at 5% level	0.72	1.01	1.14	0.85	0.89	0.890

*Average number of three replication.

4. Effect of spawning rate on the production of white button mushroom (*Agaricusbisporus*) by long term compostingmethod +NCMRT.

Data presented in Table-4 showed, that morphological characters like spawn run (in days) found maximum at rate per 3.0kg/100kg compost 18.90.where as 14.84 days in spawning 4.0kg/100kg compost and minimum 13.53 days at spawning rate 5.0kg/100kg compost.Maximum number of days i.e 24.06 required for casing run was observed at spawning rate of 3.0kg/100kg compost followed by 24.05 at 4.0kg/100kg compost minimum 19.30 days at 5.0 rate of spawning.As for as, pinhead initiation was noticed maximum pinhead 32.10 days was recorded at 5.0kg spawning rate.Whereasminimum was noticed at spawning rate 5.0kg/100kg compost.Maximum yield 720.0g/5kg was recorded at spawning rate of 5.0kg followed by 632.12g/5kg in 4.0kg /100kg compost and minimum 538.44g/5kg compost was recorded at 3.0kg/100kg compost.Biological efficiency percentage maximum 14.39% was observed in 5.0 kg/100kg compost spawning rate followed by 12.69% in 4.0kg/100kg and minimum 10.76% in 3.0kg/100kg compost.

Table 4 Effect of spawining rate on the production of white button mushroom (*Agaricusbisporus*) by Long Term Composting method + NCMRT

S. No.	Spawning rate(kg)	Marphological Character					
		Avg.number of days			No. of fruiting bodies	Yield (g/5kg)	Biological efficiency %
		Spawn run	Casing run	Pinhead initiation			
1.	3.0	18.90	24.06	32.10	25.58	538.44	10.76
2.	4.0	14.84	24.05	29.33	27.81	635.12	12.69
3.	5.0	13.53	19.30	27.13	32.80	720.01	14.39
	SEm±	0.15	0.65	0.22	0.16	2.14	0.04
	CD at 5%level	0.49	2.00	0.70	0.50	6.60	0.13

*Average number of three replication.

5. Influence of casing thickness on yield of white button mushroom (***Agaricusbisporus***).

Effect of casing thickness on casing run was found minimum on 3cm thickness where as maximum days 37.55 days took more time for casing run on 5cm of thickness .Least Pinhead initiation 31.45 days was found at casing thickness of 5cm. whereas maximum 40.74 days average number of days for pinhead initiation in 3cm was found.

Maximum number of fruiting bodies that is 74.30 days was found at 5cm of casing thickness whereas least number i.e49.00 was found at 3cm casing thickness.As for as the yield parameter and concerned maximum yield i.e 917.6g/5kg compost at 5cm was found superior.Whereas lowest yield was found 430.33g/5kg compost at 3cm of casing thickness.Maximum Biological efficiency %18.01 was found at casing thickness of 5cm. whereas least biological efficiency percent of i.e 9.08 was found at 3cm at casing thickness.The yield obtained from 3,4and 5cm casing were statically at par with each other.

Data also reveled at influence of various casing thickness significantly affect the morphological character that is casing run.Pinhead initiation, Number of fruiting bodies and yield of white button mushroom.

Table 5 Influence of casing thickness on yield of white button mushroom (*Agaricusbisporus*)

S. No.	Casing thickness (cm.)	Marphological Character				
		Avg. number of days		No. of fruiting bodies	Yield (g/5kg)	Biological efficiency %
		Casing run	Pinhead initiation			
1.	3	37.55	40.74	49.20	430.44	9.02
2.	4	32.44	36.15	67.27	771.18	16.12
3.	5	29.99	31.55	74.30	917.66	18.01
	SE_m ±	0.38	0.45	0.64	10.61	0.22
	CD at 5% level	1.17	1.38	1.98	32.70	0.68

* Average number of three replication.

6. Effect of various treatment of casing material by Long Method Composting.

Data presented in Table number-6 reveled that condition of spawn run was found in the treatment (T_3) as compared to other treatment.Days required for fruiting was found maximum(34.40days)T_1 followed by T_2 (33.50days),T_4(32.50days),control(32.50days)and maximum (31.50days)was recorded in treatment used for treatment used for treating casing material with compression of T_3.Average fruiting body weight(g) was found maximum 10.95g in treatment T_3 followed by T_1(9.85g),T_2(9.55g),T_4(8.65g)and control(8.65g).Maximum sporophore yield 18.20kg /100kg compost was found in treatment T_3,followed by T_1(16.10kg),T_2(15.05kg),T_4(14.10kg) and least in control (10.60).Percent increase in yield over control found maximum 72.50% in T3 followed by T2(43.00%),T4(32.50%), and in minimum T1(30.60).

Table 6 Effect of various treatment of casing material by Long Method Composting

S.No.	Treatment (50kg compost)	Condition of spawn run	Days required for fruiting	Avg. fruit body weight (g)	Yield kg/100 kg compost	% Increased in yield over control
1.	T_1	+++	34.50	9.85	16.10	30.60
2.	T_2	++	33.50	9.55	15.05	43.00
3.	T_3	++++	31.50	10.95	18.20	72.50
4.	T_4	++	32.50	8.65	14.10	32.50
5.	Control (water spray)	++	32.50	8.75	10.60	-
	SEm±		0.60	0.06	0.11	1.06
	CD at 5% level		1.81	0.18	0.33	3.18

* Average number of three replication**.**

DISCUSSION

The present investigation entitled" Comparative efficacy of various compost on growth and seasonal production of *Agaricus bisporus* (Lange) Imbach by long term process was undertaken with the objective to find out the suitable medium method, spawning rate, casing thickness and casing treatment to obtain good yield,mycelia growth and biomass.

In the present investigation, potato dextrose agar media supported significantly higher radial growth of *A.bisporus* followed by wheat extract. It was noted that malt extract, Richards & Hawker medium showed less mycelia growth.Testing of various media for the growth of this mushroom was also reported by Gapinski *et al.* (1988), Suman & Sharma (1990), Ziombra *et al* (1991), Dong Chang Jin (2001), Guoliang (2004), Singh & Kamal (2011).

Use of different bran for mother spawn preparation was tried just to see the effect of sources which can influenced the growth period of spawn run.It was found that black gram and wheat bran most effective but at par. Both support the spawn in between 13-14 days whereas other bran like pea, pigonpea, chickpea took slightly more number of days. Similar results were obtained by Suman*et al,(*1998) and Kumar & Chandra,(1988).

Compost prepared by various formulas (Long Term Composting)like IARI,IIHR, and NCMRT influenced the morphological characters as well as sporophore yield of *A.bisporus*. It found that formula NCMRT was best suited for our area because availability of substrate for formulation of compost.Several findings on compost preparation & formulation suggested that Wheat straw (Dogan *et al*. 2000; Vijay, 2006;) vegetable wastes (Govi *et al,*1996), peat (Colak*et. al* 2007), Wheat straw+Tea waste (Suman, 2004; Suman & Paliyal, 2004; Simsek et al. 2008).

Among the spawning rate 3.0,4.0,5.0 kg per 100 kg compost, significantly affect the morphological characters like spawn & casing run, Pin head initiation number of fruiting bodies, yield and biological efficiency.Spawning rate @ 4.0-5.0 per 100 kg compost found most effective for growth and production of this mushroom. Similar results were also obtained bySuman (2004) and Pandey et al. (2007).

Treating of casing material by various chemicals and fungicides, it was found that combination of Formaldehyde + Bavistin took less period of time for fruiting as well as gave maximum yield. Casing thickness significantly affect the morphological characters and yield of *A.bisporus*but 5.0 cm casing thickness found the best among three thickness tested. Similar results were observed by Tripathietal.(1991);Saini & Prashar (1992); Alberto (1995); Ram & Holkar (2009).

SUMMARY, CONCLUSION AND SUGGESTION FOR FURTHER WORK

The present investigation on **“Comparative efficacy of various compost on the growth and seasonal production of *Agaricusbisporus* (Lange) Imbach by long term process” were** carried out in the Department of Plant Pathology, JNKVV, Jabalpur, The silent findings summarized as:

- Among different media,potato dextrosse agar medium was found to be the best mycelial growth of *Agaricusbisporus* followed by Wheat extract agar.
- Among different type of bran tested wheat bran found to be the best preparation of the mother spawn.
- Compost prepared by the formula NCMRT,morphological characters like spawn run, casing run, pinhead initiation, took less period of time as compare to other formulas like IARI,IIHR. It also give more number of fruiting bodies ,sporophore yield and biological efficiency.
- Some work should be carried out on low cost preservation of white button mushroom (*A.bisporus*) to enhance quality and shelf life.
- Rate of spawning @ 3.0, 4.0,5.0, kg per 100 kg compost influence the morphological characters and sporophore yield. Rate 5.0 kg per 100 kg compost gave highest yield with good performance in LTC method
- Attampt should made to evaluate spawning rate (2.0,3.0,4.0kg)per 100kg compost.It was found that 4.0 kg/100kg compost best for quick spawn, casing run and highest yield.
- Casing thickness of 5cm was found to be most suitable for highest yield production and took less time for casing run and pinhead initiation.
- Out of various treatment used for sterilizing casing material by long term composting a combination of Formalin+Bavistin(60ml+2g)/50kg found the best.

Based on findings of present investigation it is suggested that :

1. Attempt should be made to study the performance of new strains of white button mushroom *A.bisporus*for suitability of existing condition in M.P. under LTC method
2. Research work should be under taken on evaluation of short term composting method to avoid pressure of competitor moulds/ bacteria

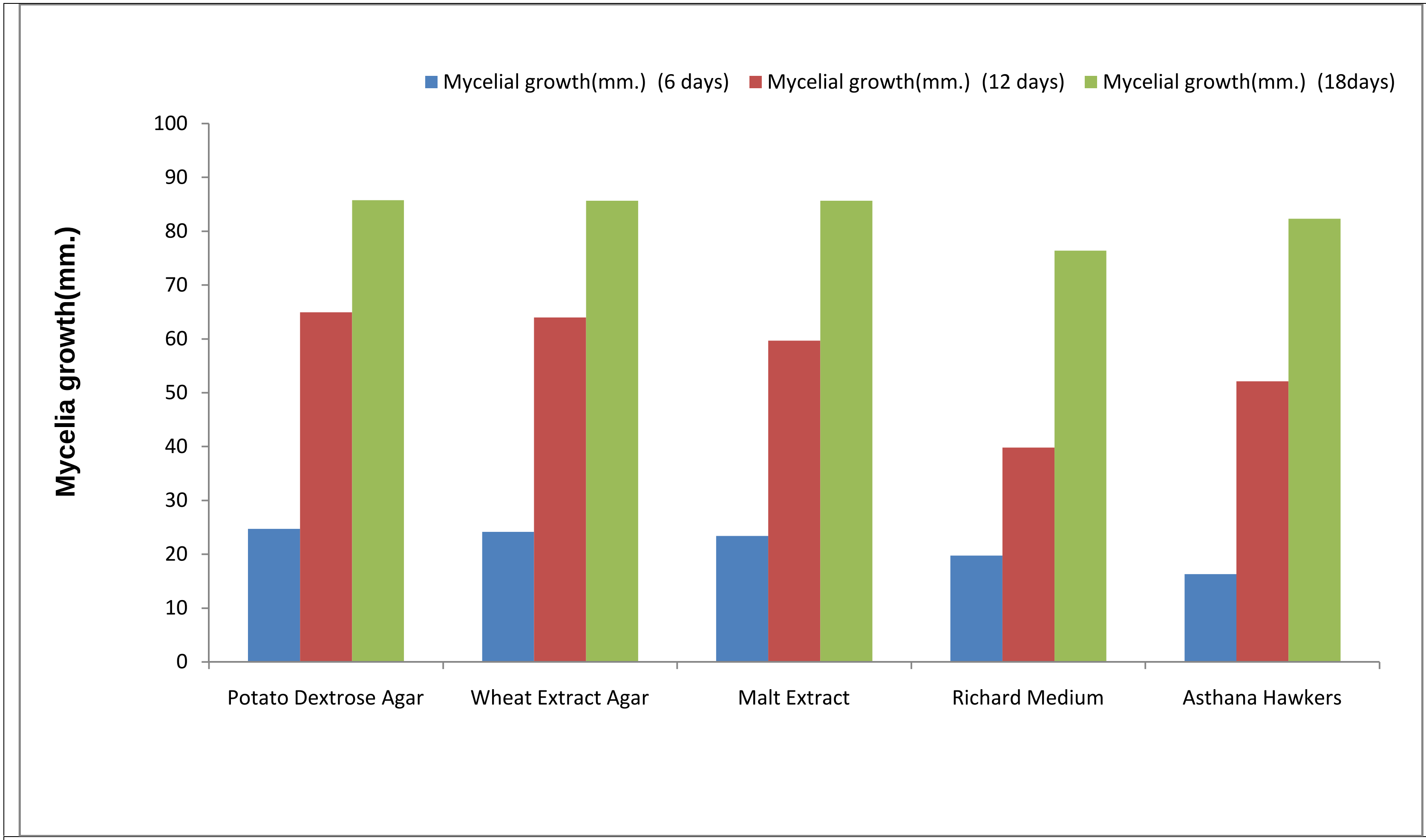


Fig. : Effect of different media on mycelial development of white button mushroom(*Agaricus bisporus*)

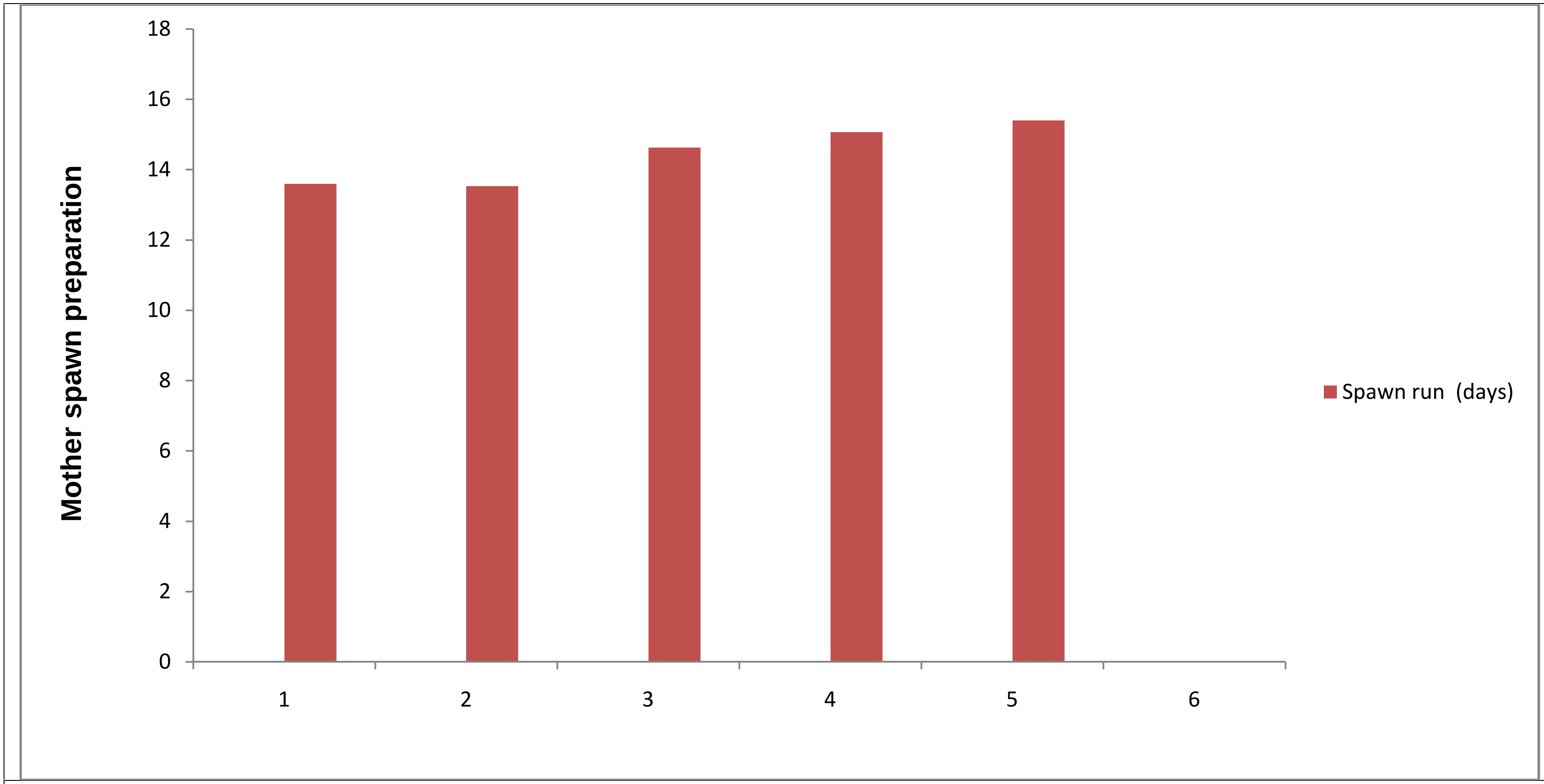
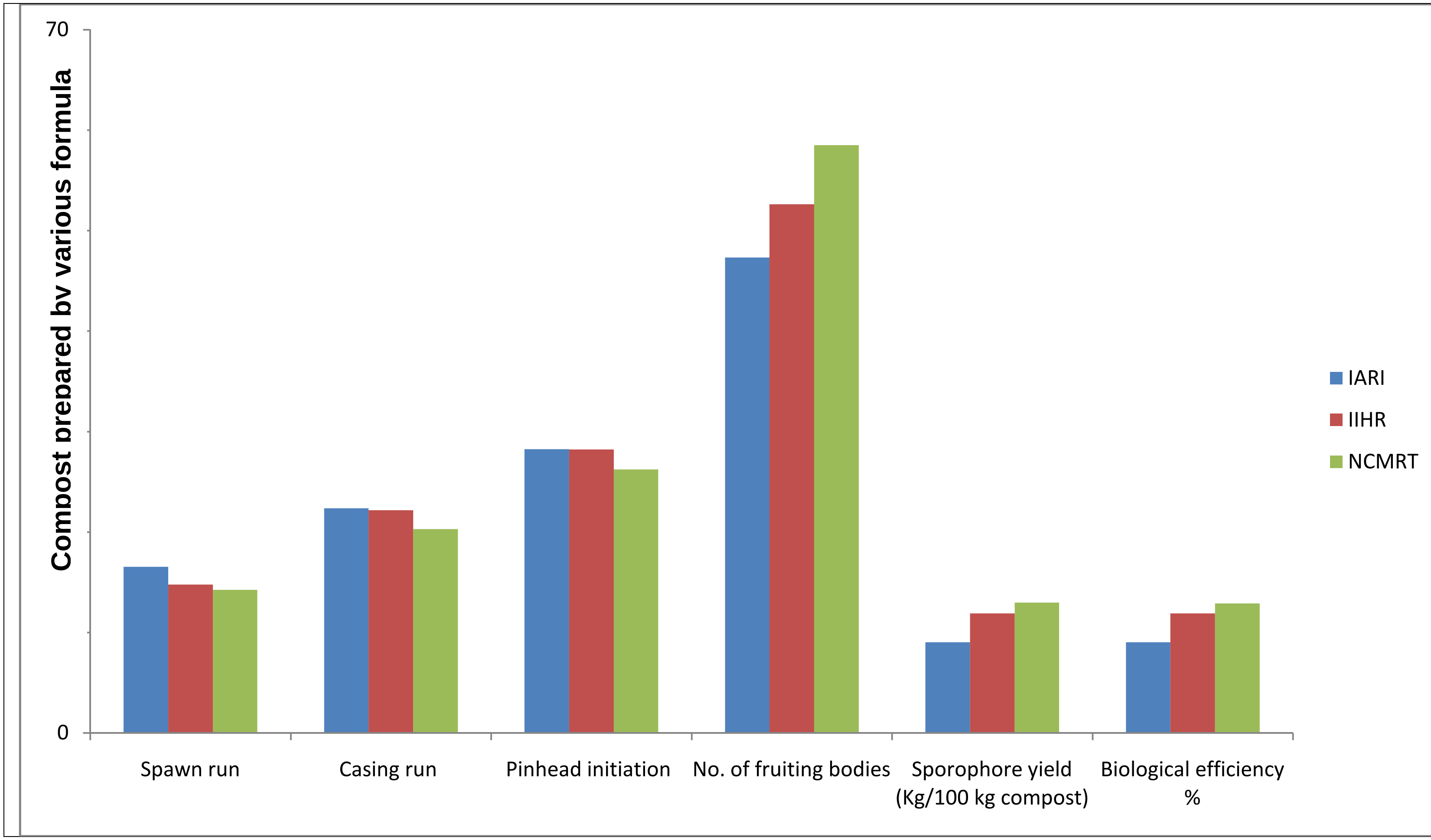


Fig. Effect of different brans on mother spawn preparation of *Agaricus bisporus*



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Compost prepared by various formula
Spawn run
Casing run
Pinhead initiation
No. of fruiting bodies
Sporophore yield (Kg/100 kg compost)
Biological efficiency %
IARI
IIHR
NCMRT

Fig.3 : Effect of various compost on the growth and biological characteristics of white button mushroom (*Agaricus bisporus*)

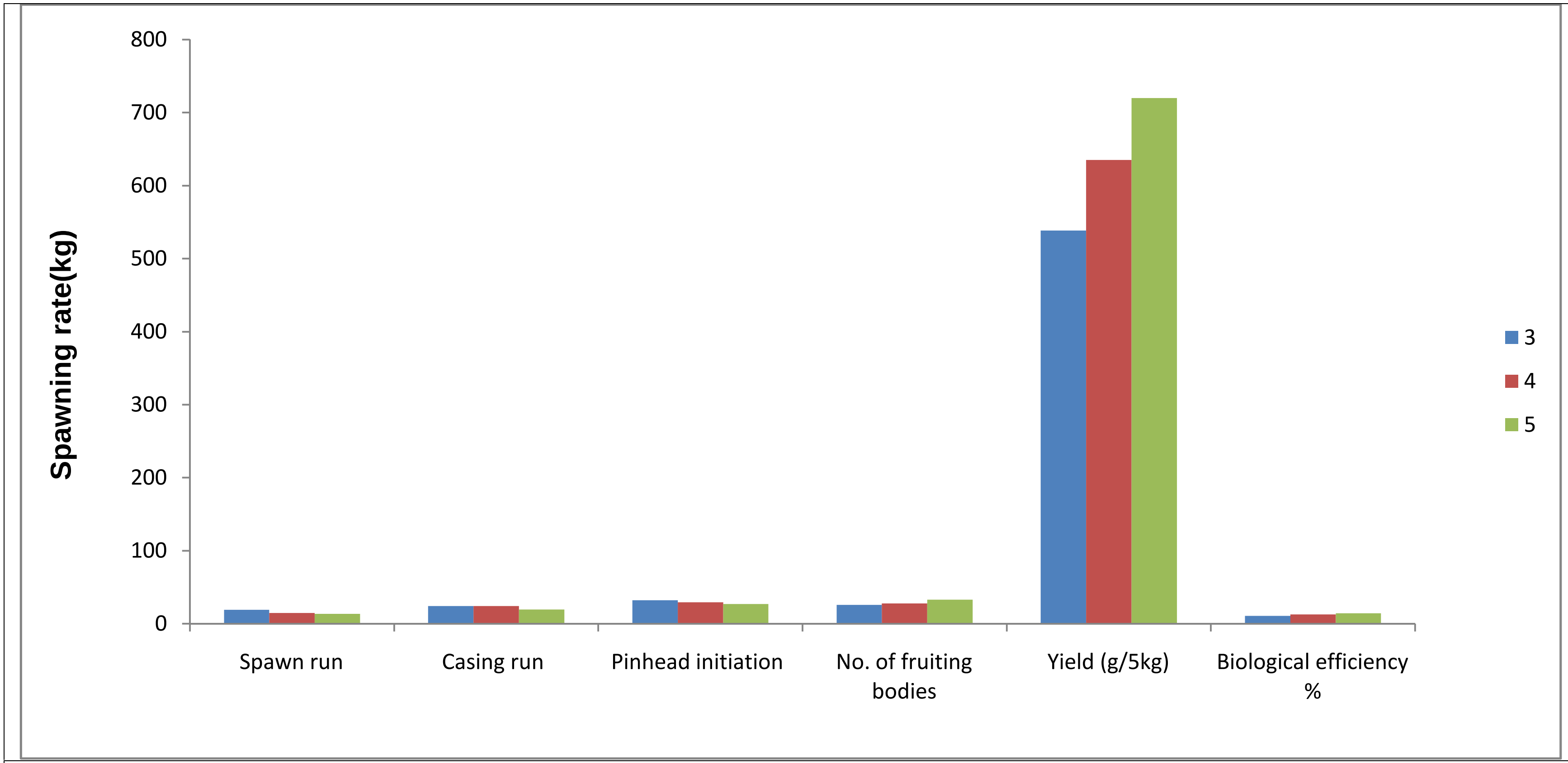

Table 4 Effect of spawining rate on the production of white button mushroom (*Agaricus bisporus*) by Long Term Composting method + NCMRT

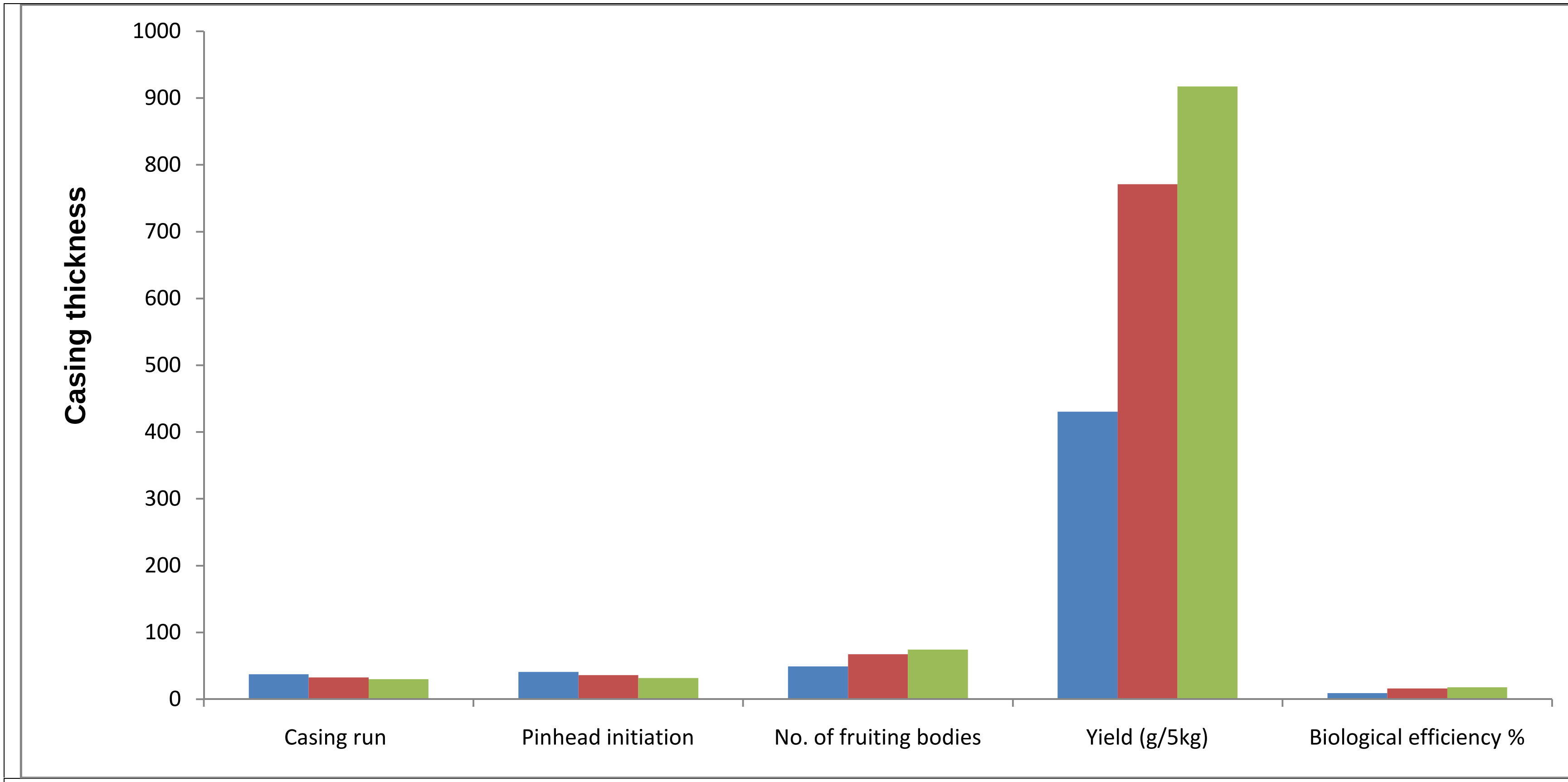

Table 5 Influence of casing thickness on yield of white button mushroom (*Agaricus bisporus*)

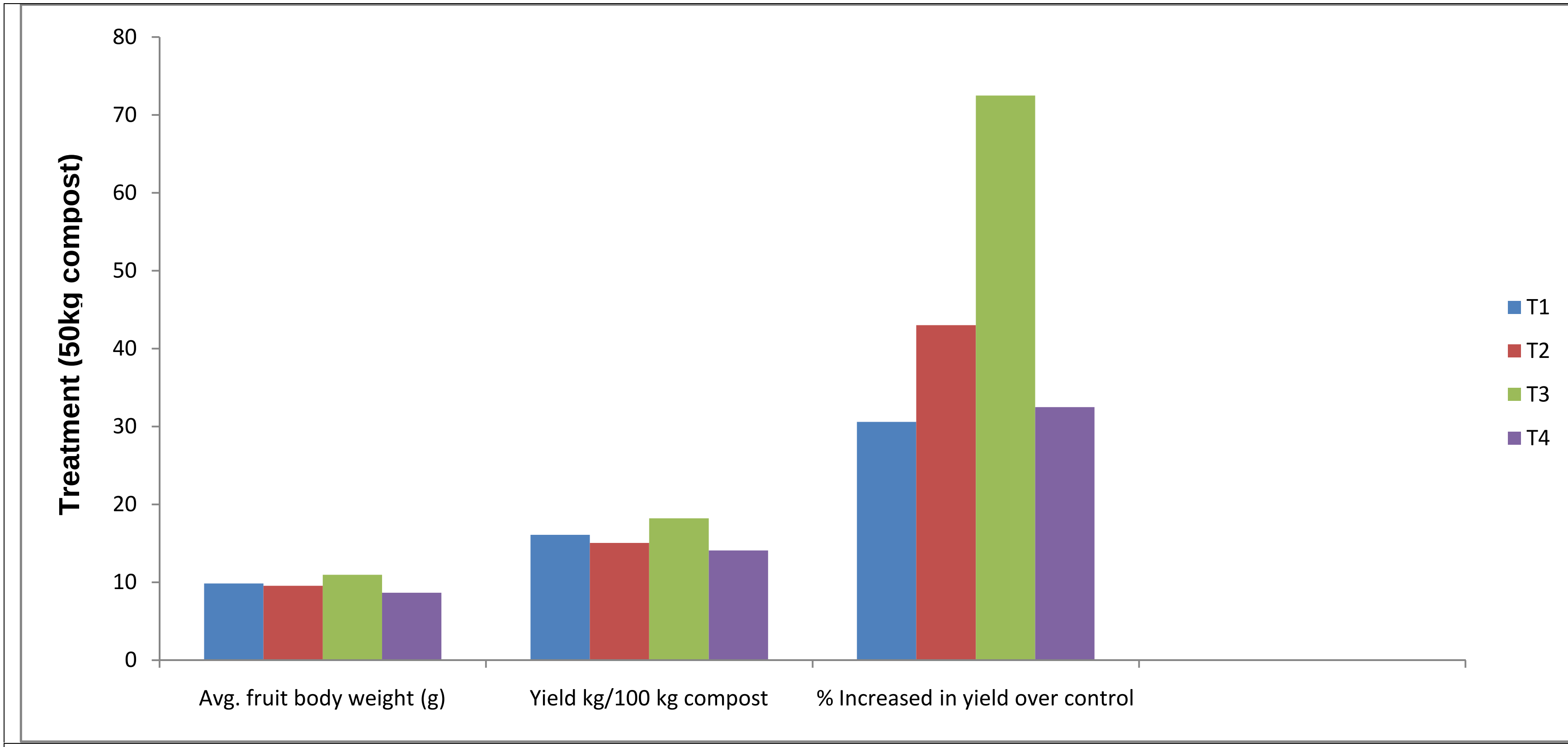

Fig. 6 : Effect of various treatment of casing material by Long Method Composting

Flow Chart Long Method Compost

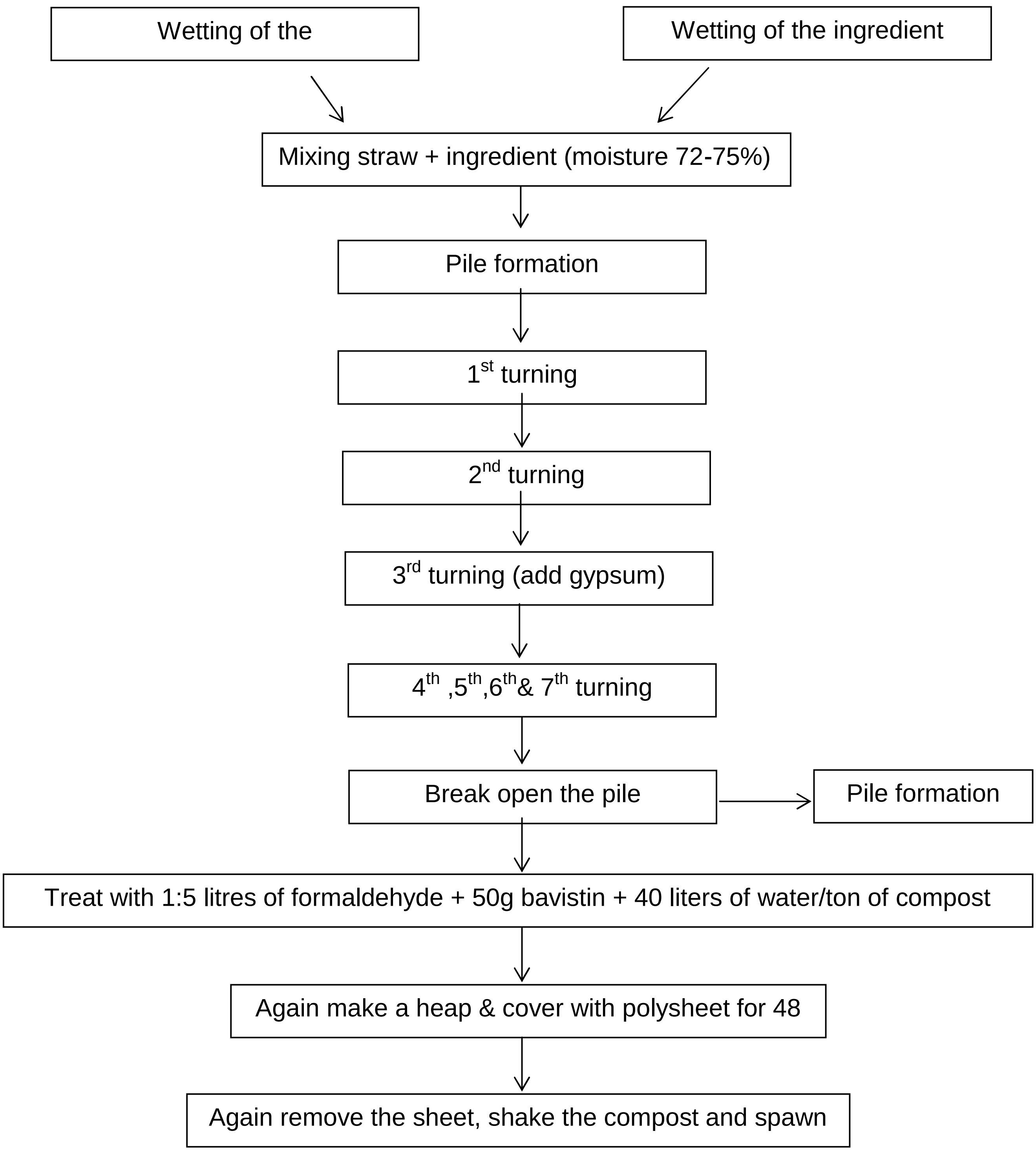

Table 1 Effect of different media on mycelial development of white button mushroom(*Agaricus bisporus*)

S.No.	Media	Mycelial growth(mm.)		
		(6 days)	(12 days)	(18days)
1.	Potato Dextrose Agar	24.74	64.95	85.77
2.	Wheat Extract Agar	24.17	64.00	85.67
3.	Malt Extract	23.40	59.70	85.66
4.	Richard Medium	19.77	39.83	76.40
5.	Asthana Hawkers	16.33	52.13	82.32
	SE_m ±	0.63	1.00	1.01
	CD at 5% level	1.98	3.16	3.18

- **Average number of three replication.**

Table 2 Effect of different brans on mother spawn preparation of *Agaricus bisporus*

S.No.	Brans	Spawn run (days)
1.	Black gram	13.60
2.	Wheat	13.53
3.	Pea	14.63
4.	Pigeon pea	15.07
5.	Chickpea	15.40
	SE_m ±	0.44
	CD at 5% level	1.40

- **Average number of three replication.**

3 Effect of various compost on the growth and biological characteristics of white button mushroom (*Agaricus bisporus*)

S.No.	Compost prepared by various formula	Marphological Character					
		Avg. number of days			No. of fruiting bodies	Sporophore yield (Kg/100 kg compost)	Biological efficiency %
		Spawn run	Casing run	Pinhead initiation			
1.	**IARI**	16.53	22.36	28.26	47.34	9.02	9.02
2.	**IIHR**	14.76	22.16	28.23	52.64	11.9	11.9
3.	**NCMRT**	14.26	20.29	26.23	58.52	12.98	12.9
	SE_m ±	0.24	0.33	0.38	0.28	0.29	0.29
	CD at 5% level	0.72	1.01	1.14	0.85	0.89	0.890

- **Average number of three replication.**

Table 4 Effect of spawining rate on the production of white button mushroom (*Agaricus bisporus*) by Long Term Composting method + NCMRT

S.No.	Spawning rate(kg)	Marphological Character					
		Avg.number of days			No. of fruiting bodies	Yield (g/5kg)	Biological efficiency %
		Spawn run	Casing run	Pinhead initiation			
1.	**3.0**	18.90	24.06	32.10	25.58	538.44	10.76
2.	**4.0**	14.84	24.05	29.33	27.81	635.12	12.69
3.	**5.0**	13.53	19.30	27.13	32.80	720.01	14.39
	SE_m ±	0.15	0.65	0.22	0.16	2.14	0.04
	CD at 5% level	0.49	2.00	0.70	0.50	6.60	0.13

- **Average number of three replication.**

Table 5 Influence of casing thickness on yield of white button mushroom (*Agaricus bisporus*)

S.No.	Casing thickness (cm.)	Marphological Character				
		Avg. number of days		No. of fruiting bodies	Yield (g/5kg)	Biological efficiency %
		Casing run	Pinhead initiation			
1.	**3**	37.55	40.74	49.20	430.44	9.02
2.	**4**	32.44	36.15	67.27	771.18	16.12
3.	**5**	29.99	31.55	74.30	917.66	18.01
	SE_m ±	0.38	0.45	0.64	10.61	0.22
	CD at 5% level	1.17	1.38	1.98	32.70	0.68

- **Average number of three replication.**

Table 6 Effect of various treatment of casing material by Long Method Composting

S.No.	Treatment (50kg compost)	Condition of spawn run	Days required for fruiting	Avg. fruit body weight (g)	Yield kg/100 kg compost	% Increased in yield over control
1.	T_1	+++	34.50	9.85	16.10	30.60
2.	T_2	++	33.50	9.55	15.05	43.00
3.	T_3	++++	31.50	10.95	18.20	72.50
4.	T_4	++	32.50	8.65	14.10	32.50
5.	Control (water spray)	++	32.50	8.75	10.60	-
	SE_m ±		0.60	0.06	0.11	1.06
	CD at 5% level		1.81	0.18	0.33	3.18

- **Average number of three replication.**

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APPENDICE-1

METEROLOGICAL DATA NOVEMBER 2012 - MARCH 2013 (WEEKLY)

S. NO.	STANDARD WEEK	TEMPERATURE (°C)		RELATIVE HUMIDITY (%)	
		MAX	MIN	Morn.	Even.
1	41	30.4	16.5	85	37
2	42	30.5	16.6	81	34
3	43	29.6	13.2	84	37
4	44	25.9	13.6	93	53
5	45	26.2	12.6	90	32
6	46	26.6	8.0	87	30
7	47	25.9	8.6	90	31
8	48	26.4	9.5	85	35
9	49	26.7	8.6	87	28
10	50	27.0	12.0	94	43
11	51	23.3	5.1	90	31
12	52	21.8	3.0	92	32
13	01	21.3	5.2	89	44
14	02	21.0	3.2	89	34
15	03	24.7	8.1	86	38
16	04	19.7	3.0	88	38
17	05	22.6	5.4	93	37
18	06	23.9	9.3	90	49
19	07	23.2	11.0	88	45
20	08	23.0	9.0	85	47
21	09	26.0	7.2	86	50
23	10	25.0	8.5	85	50
24	11	24.0	7.3	82	48
25	12	26.5	8.0	81	46
26	13	27.3	7.7	78	43

APPENDIX-2

Table 1: Effect of different media on mycelial development of (*Agaricusbisporus*)

Anova Table- after 6 days					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	4	152.133	38.033	32.105	1.105
Error	10	11.846	1.186	-	-
Total	14	-	-	-	-

Anova Table- after 12 days					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	4	1284.680	321.177	107.756	3.526
Error	10	29.804	2.984	-	-
Total	14	-	-	-	-

Anova Table- after 18 days					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	4	197.348	49.334	16.175	0.002
Error	10	30.491	3.043	-	-
Total	14	-	-	-	-

Table 2: Effect of different brans on motherspawnpreparation

Anova Table-					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	4	8.570	2.145	3.589	0.041
Error	10	5.970	0.593	-	-
Total	14	-	-	-	-

Table 3: Effect of various compost on the growth biological characteristics of (*Agaricusbisporus*)

Anova Table- Spawn run (days)					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	8.508	4.254	32.724	0.005
Error	6	0.780	0.130	-	-
Total	8	-	-	-	-

Anova Table- Casing run (days)					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	7.840	3.920	15.197	0.004
Error	6	1.546	0.252	-	-
Total	8	-	-	-	-

Anova Table- Primodial initiation (days)					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	8.135	4.067	12.453	0.003
Error	6	1.960	0.326	-	-
Total	8	-	-	-	-

Anova Table- No. of fruiting bodies					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	170.668	85.334	209.260	2.820
Error	6	2.446	0.407	-	-
Total	8	-	-	-	-

Anova Table- Sporophore yield (kg/100 kg composed)					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	27.440	13.720	42.439	0.002
Error	6	1.940	0.323	-	-
Total	8	-	-	-	-

Anova Table- Biological efficiency					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	28.886	14.443	72.621	6.248
Error	6	1.193	0.198	-	-
Total	8	-	-	-	-

Table 4: Effect of spawining rate on the production of (*Agaricusbisporus*) by LTC method

Anova Table- Spawn run					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	41.420	20.710	18.711	0.006
Error	6	6.632	1.105	-	-
Total	8	-	-	-	-

Anova Table- Casing run					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	53.436	26.713	25.698	0.001
Error	6	6.234	1.039	-	-
Total	8	-	-	-	-

Anova Table- Pinhead initiation					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	25.684	12.847	9.730	0.010
Error	6	7.913	1.313	-	-
Total	8	-	-	-	-

Anova Table- No. of fruiting bodies					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	77.204	38.607	11.640	0.005
Error	6	19.884	3.315	-	-
Total	8	-	-	-	-

Anova Table- Yield 5kg					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	44886.782	22443.391	222.885	2.345
Error	6	604.160	100.693	-	-
Total	8	-	-	-	-

Anova Table- Biological efficiency					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	17.961	8.985	224.487	2.293
Error	6	0.241	0.040	-	-
Total	8	-	-	-	-

Table 5 : Influence of casing thickness on yield of (*Agaricusbisporus*)

Anova Table- Casing run (days)					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	79.751	39.875	48.073	0.002
Error	6	4.970	0.825	-	-
Total	8	-	-	-	-

Anova Table- Pinhead initiation (days)					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	119.046	59.528	37.172	0.004
Error	6	9.606	1.601	-	-
Total	8	-	-	-	-

Anova Table- No. of fruiting bodies					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	1011.965	505.982	230.358	2.128
Error	6	13.172	2.195	-	-
Total	8	-	-	-	-

Anova Table- Yield gm / 5 kg					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	352086.222	176043.111	121876.000	1.493
Error	6	8.666	1.444	-	-
Total	8	-	-	-	-

Anova Table- Biological efficiency					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	126.150	63.075	199.528	3.254
Error	6	1.898	0.311	-	-
Total	8	-	-	-	-

Table 6 Effect of various treatment of casing material by LMC

Anova Table- Days required for fruiting bodies					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	4	10.400	2.600	5.200	0.048
Error	5	2.500	0.500	-	-
Total	9	-	-	-	-

Anova Table- Average fruiting bodies (gm)					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	4	2.200	0.550	110.000	4.641
Error	5	0.020	0.000	-	-
Total	9	-	-	-	-

Anova Table- Yield kg/100kg composed					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	4	62.884	15.721	924.767	2.348
Error	5	0.089	0.019	-	-
Total	9	-	-	-	-

Anova Table- % increase in Yield over control					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F cal**	**F prob**
Treatments	2	1720.333	860.166	860.166	7.261
Error	3	3.000	1.000	-	-
Total	5	-	-	-	-

VITA

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