The Spawn Run

JOURNAL OF THE SOUTH AFRICAN MUSHROOM FARMERS' ASSOCIATION

I am sure that I am not alone in saying that 2012 has been a difficult and tiresome year and it is easy to wish away the last few weeks in hope that January will bring with it better prospects. Unfortunately this is nothing more than defrauding oneself of valuable time. This should be a time to go "back to basics" in all spheres of life, from the technicalities in the workplace to the delicate relationships in the home and hopefully this kind of reflection will help prepare the road into the New Year.

2013 does without doubt hold many challenges for the mushroom industry but also some very exciting opportunities. The development of an ecologically friendly alternative to peat is well on its way and covered in this issue of the Spawn Run. We touch on new methods of watering and also finish up our report on ISMS Beijing with a look at the farm visits that took place.

On behalf of The Spawn Run, I would like to wish all our readers, supporters and contributors a safe, peaceful and happy Christmas and New Year

"Whether we want them or not, the New Year will bring new challenges; whether we seize them or not, the New Year will bring new opportunities." - Michael Josephson.

Nathan Jones
nathan@highveldmushrooms.co.za

CONTENTS

Farm Visits: 18th ISMS Conference, Beijing, China
Ross Richardson, Highveld Mushrooms *page 2*

Microbiological quality and safety of *Agaricus bisporus*
Werner Rossouw et al *page 5*

The Mushroom Calendar *page 11*

SAMFA / MABU Casing Trials
Linda Meyer, Mabu Casing *page 12*

New watering system & concept for *Agaricus bisporus* cultivation
Ofer Danay et al *page 13*

SAMFA's PR Initiatives - a festive ending to 2012
Riana Greenblo, Riana Greenblo Communications *page 14*

FARM VISITS AT THE ISMS CONGRESS HELD IN BEIJING IN AUGUST 2012

By Ross Richardson, Highveld Mushrooms

Eight or ten (I am not too sure) golden buses snaked through the Beijing traffic being determinately led by an extensive police escort. Traffic parted and this "Golden Snake" slithered efficiently through red traffic lights and through bumper to bumper traffic. Kilometres of flags lined the highway welcoming the delegates to the 18th ISMS Congress in Beijing, China. Billboards reserved for money spinning brands to entice the mass of consumers were changed to welcome messages for our visit. We certainly felt what it was like to be a national sporting team or a VIP politician.

Fig 1: Cases of substrate in bottles ready for inoculation

We were on our way to visit 3 facilities as part of the ISMS's programme. This impressive movement of delegates was being coordinated in such a way to make sure that we arrived and left on time and had a most enjoyable and interesting day.

The first farm that we visited was the **Beijing Fugin Edible Mushroom Science and Technology Co. Ltd**. This company produces *Flammulina velutipes* or as we refer to them, Enoki

Fig 2: Spawn run of the mycelium up to 25 days

mushrooms. This farm was built in 2007 producing 20 tons of Enoki per day. It was impressive, with a constant stream of plastic bottles filled with inoculated substrate going into clean hi-tech growing rooms whilst others were being emptied.

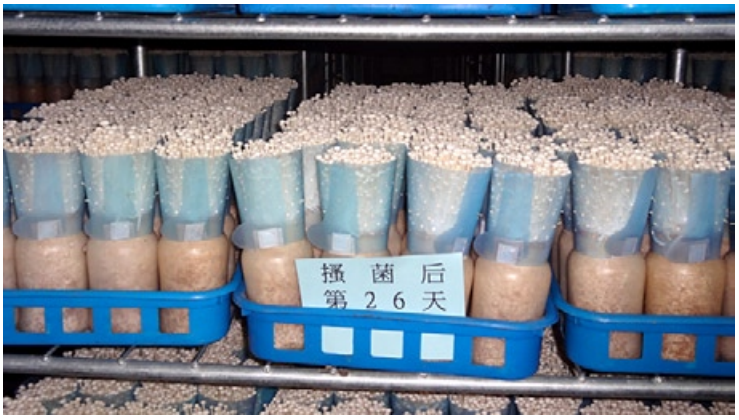
Substrate is filled into plastic autoclavable bottles (fig.1). After sterilisation and cool down of the substrate it is inoculated in clean conditions. After a 25 day spawn run (fig. 2) the lids are removed and the bottles are moved to growing rooms for fruiting (fig. 3 & 4). The mushrooms are all even and perfect. They are then transported to the Pack-house by a unique overhead conveyer. The mushrooms are then cut, plastic wrapped and placed into containers for delivery to customers. The operation was neat and clean, and demonstrated that this farm was "in business".

Fig 3: Mushrooms after 18 days into the growing cycle

The second stop was at the very interesting **Tongzhou Edible Mushroom Demonstration Park** and the **Beijing Lvyuanyongle Agriculture Science and Technology Development Co**. The latter is a large commercial concern that covers approximately 140,000m^2. It has 3 main production facilities. The first is the commercial production facility of *Pleurotus eryngii* (King Oyster) with a daily production of 50 tons! (Fig 5) The second area is where 22 000 artificial logs per day are produced for contract farmers and the third area is the spawn production area.

At the demonstration park on the other side of the road we visited the 66 spring and autumn cultivation sheds of approximately 400m^2. These are used to demonstrate and research new varieties and techniques. Eight different mushroom types were cultivated at the time of the visit, being *Lentinula edodes*, *Pleurotus ostreatus*, *Coprinus comatus*, *Agrocybe cylindracea*, *Clitocybe maxima*, *Xerula radicata*, *Auricularia polytricha* and *Gandoderma lucidum* (Fig. 6, 7 & 8). The sheds were of simple design, being double layered in shade cloth with insect proof net, a buffer entrance zone and a variety of insect traps and sticky tapes.

Fig 4: A collar is added for protection. These are on day 26 just before harvesting



After seeing the demonstration park, we were escorted to a **Mushroom Museum**. It was built to highlight the different types of mushrooms produced in China and the development of the Chinese Mushroom Industry. It had displays showing the areas where mushrooms are grown and other interesting details such the locations of previous ISMS Congresses (Fig 9).

VIP's get very hungry after all the interesting things we had seen, so off to a Chinese buffet lunch which was delicious and full of mushrooms and delicious vegetables.

The final visit for the day was to the **Beijing Hendaxing Edible Mushroom Co Ltd**. Also established in 2007, this facility produces 6.5 tons of *Pleurotus eryngii* var. *ferulae* (King Oysters) per day. It is made up of the new factory and old factory with the new factory being 66 000 m^2 and the old about 20 000 m^2.

A day is only so long and sadly we had to return to our hotels. Our trip was incredibly interesting and showed the Chinese mushroom industry to be large and very well run. All the facilities were modern, clean and mechanised, and certainly up to the standards needed to supply the growing number of Chinese consumers.

Figure 5: A room with King Oyster Mushrooms

Fig 6: *Ganoderma lucidum* commonly known as Ling Zhi is renowned for its health stimulating properties and is grown from January to April. The substrate is cut logs underneath the soil requiring a temperature of 25- 28°C for fruiting

Fig 9: A section of the map showing all ISMS Congresses

Fig 7: *Xerula radicata* is inoculated in April and the bags opened and cased at the end of July. The substrate is cottonseed and *Pluerotus eryngii* spent substrate supplemented with wheat bran and lime

Fig 8: *Lentinula edodes* (Shiitake) is grown on compressed logs made of saw dust supplemented with wheat bran and gypsum. Spawn run requires a temperature of 24 – 27°C and 15 – 25°Cfor fruiting. You can clearly see the steel lattice to hold up the logs

MICROBIOLOGICAL QUALITY AND SAFETY OF WHOLE WHITE BUTTON MUSHROOMS *(AGARICUS BISPORUS)*

Werner Rossouw, Erika du Plessis and Lise Korsten
Institute of Food, Nutrition and Well-being,
Department of Microbiology and Plant Pathology,
Faculty of Natural and Agricultural Sciences,
University of Pretoria

Introduction

Food Safety and quality assurance of fresh fruit and vegetables are critical factors for the modern consumer (European Parliament, 2012). More people are aware of and attentive to the quality, value for money and safety of the food they are purchasing. The general public are also becoming more aware of microorganisms, such as *Escherichia coli* and *Salmonella* spp. in the food chain. Fresh mushrooms are traditionally used as an additive in cuisine as a vegetable; they are appreciated not only for their nutritional value (Manzi *et al.*, 2001; Diez and Alvarez, 2001) but also for their organoleptic characteristics and functional properties (Wasser and Weis, 1999; Zhang *et al.*, 2001). The quality of mushrooms is defined by a combination of parameters which include microbial counts, texture and whiteness (Gormley, 1975). The potential exists for fresh mushrooms to carry food borne bacteria derived from various sources. Cultivated mushrooms such as *Agaricus bisporus* (Lange and Imbach) can be contaminated during all growth, harvesting and storage stages. Although various other crops have been implicated in disease outbreaks, there has been no conclusive report of a food safety related disease outbreak on *A. bisporus* (Strapp *et al.*, 2003; Penn State College of Agricultural Science).

Fresh produce harbours transient as well as residential microbes (Simon *et al.*, 2005). These microbial populations play an important role in maintaining product quality by preventing the establishment of pathogenic organisms. Since little is known of the microbiology of fresh mushrooms, the total microbial load and profile were determined. The aim of this study was to address the lack of scientific knowledge regarding the microbiological quality and safety of freshly harvested white button mushrooms as well as to determine if harvesting and packaging affect the microbial dynamics present on these mushrooms.

Methods

Mushrooms were collected before and after harvest for all the breaks in a growing/harvesting cycle. Eight samples consisting of 250g of mushrooms were aseptically picked. Eight punnets of 250g of mushrooms were also collected directly from the cold-room after packaging and labelling. Pre- and post-harvest sampling was repeated for each break. The samples were transported in cooler boxes back to the University, where they were processed within 24 hours.

From each punnet a 10g sample was placed in 90ml Tryptone Soy Broth (Merck-bioline, Johannesburg) and macerated in a Seabird 33000 stomacher for 5 min at 230 revolutions per minute (rpm). A standard dilution series was made for each sample. The macerated samples were plated on Standard I (Merck) and Malt Extract Agar (Merck) for the enumeration of bacteria and fungi as well as yeasts respectively. Detection of *E. coli*, coliforms and *Staphylococcus* spp., were performed by plating out the samples onto Eosin-methylenblau-Lactose-Saccharose-Agar (Merck), *E.coli*/ Coliform and *Staph* Petrifilm (3M) respectively and selective steps were included for the detection of *Salmonella* spp., Xylose lysine deoxycholate agar (Merck) and Brilliance Salmonella (Oxoid) were used. Total plate counts were done for the STD I, MEA and Petrifilms. Selective media were only recorded as positive or negative. Single dominant colonies were isolated, purified and preserved (Maintenance of Microorganisms) for further identification. Bacterial isolates were identified using the Burker-DaltonikBiotyper [see Identification of natural internal microflora using Matrix Assisted Laser Desorption Ionisation-Time of Flight (MALDI-TOF)]. DNA extractions were performed for all the isolates and sequenced, to confirm identity.

DNA extraction and Polymerase Chain Reaction (PCR)

In order to confirm identity, PCR was performed using DNA extracted from the isolated bacteria, fungi and yeast. Bacteria and yeast single colonies were inoculated into Tryptone Soy Broth (Merck) and cultured aerobically for 48 hours at 25˚C with no agitation. Isolated fungal cultures were grown on MEA agar. DNA was extracted using the Quick-GDNA miniprep kit (ZymoResearch) for the bacteria and the Nucleospin® Plant II DNA Extraction kit (Macherey-Nagel) for the yeasts and fungi respectively. Primers used are listed in Table 1. For control purposes, a PCR reaction mixture containing sterile double distilled water and all other reagents except template DNA was included. Thermocycling was performed using an EppendorfThermocycler (Merck) and the PCR conditions were as follows: 95˚C for 2 min, followed by 35 cycles of 94˚C for 30 s, 58˚C for 45 s, and 72˚C for 1.5 min, with a final extension at 72˚C for 7 min. PCR products were visualised following gel electrophoresis on 1% gels for the 16S amplified product and 2% agarose gels for the ITS amplified product. DNA of *E. coli* 0157: H7 and *Penicillium* spp., were included as positive controls.

Primer	Specificity	Sequence 5'-3'
16s 27 Forward	Conserved ribosomal DNA sequence	GAGTTTGATCCTGGCTCAG
16s 1492 Reverse	Conserved ribosomal DNA sequence	TACGGYTACCTTGTTACGACTT
ITS 1 Forward	Conserved ribosomal DNA sequence	TCCGTAGGTGAACCTGCGG
ITS 4 Reverse	Conserved ribosomal DNA sequence	TCCTCCGCTTATTGATATGC

Table 1: Primers used for the amplification of 16S-rRNA and ITS-rRNAsequences

Identification of environmental bacterial isolates using Matrix Assisted Laser Desorption Ionisation-Time of Flight (MALDI-TOF).

Purified bacterial cultures isolated from the selective media were transferred in duplicate directly to the MALDI-TOF (Bruker, Bremen, Germany), and overlaid with the α-cyano-4-hydroxycinnamic acid matrix (Bruker). The target plate was subsequently analysed using BrukerMicroFlex LT MALDI-TOF in conjunction with BrukerBiotyper Automation Software and library. The MALDI-TOF was calibrated prior to use with the bacterial standard supplied by Bruker. Duplicate score values (SV) were recorded; SV were used to determine the accuracy of identification. A SV of between 1.999 and 1.700 was used to identify the genus name of the organism, and a value of above 2.0 was used to determine the genus and probable species of an organism.

Statistical Analysis

The experiments were designed as a randomised block design. The data obtained was analysed with SAS software, as a one-way ANOVA. Treatment means were separated using Fisher's protected least significant difference (LSD) at the 1% significance level.

Results

No significant difference were found (P > 0.05) between the microbial counts before and after harvest for all the breaks tested (Figure 1). The total microbial load during pre-harvest significantly increased from first to third break, while for post-harvest, the total population increased with every break (Figure 1).

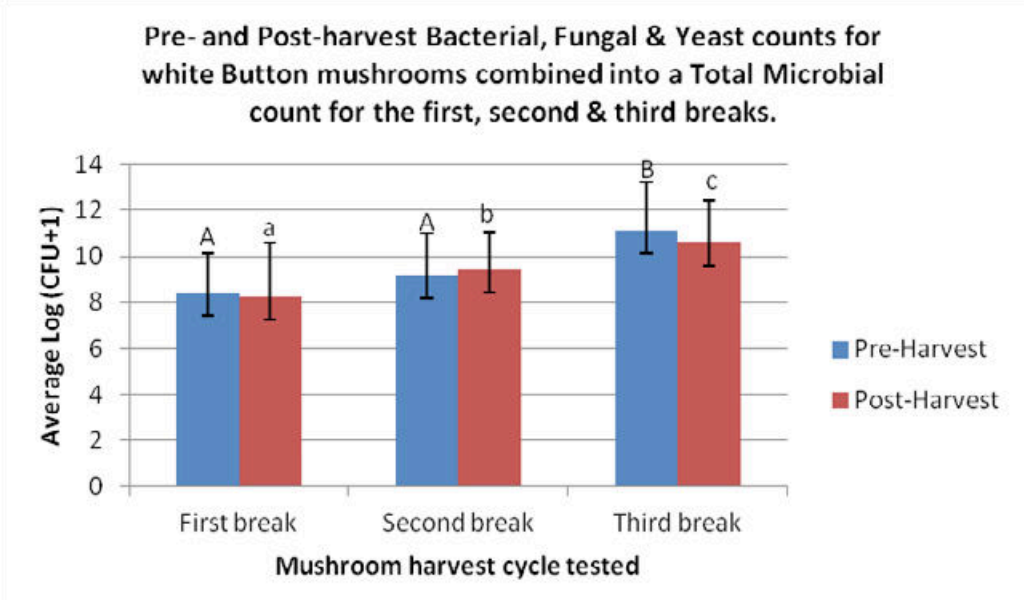


Figure 1: Total microbial load (bacteria, fungi and yeast combined) at the three different breaks. Bars with the same upper or lowercase letter did not differ significantly at the 1% significance level.

Various presumptive positive colonies were observed on the selective media for *E. coli*, *Staphylococcus* spp., and *Salmonella* spp., however only *Salmonella* spp. could be confirmed positively. High numbers of coliforms were also observed with higher counts before harvest and throughout all the breaks, but were not significantly different between pre- and post-harvest (Figure 2).

Bacteria dominated the total microbial load and of these, *Pseudomonas* spp. was found

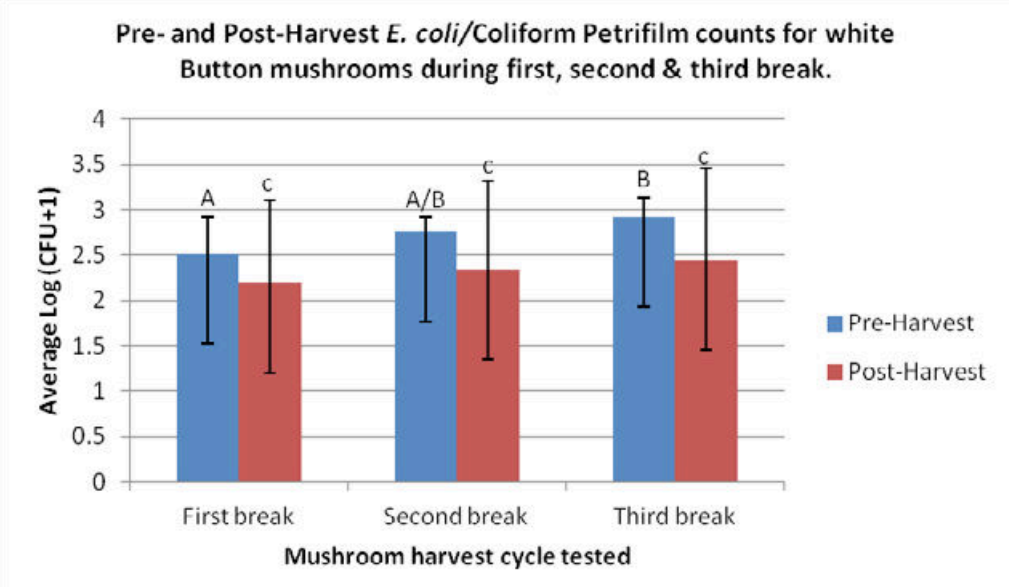


Figure 2 Average *E. coli*/Coliform counts before and after harvest for each growth/harvesting cycle. Bars with the same upper or lowercase letter did not differ significantly at the 1% significance level.

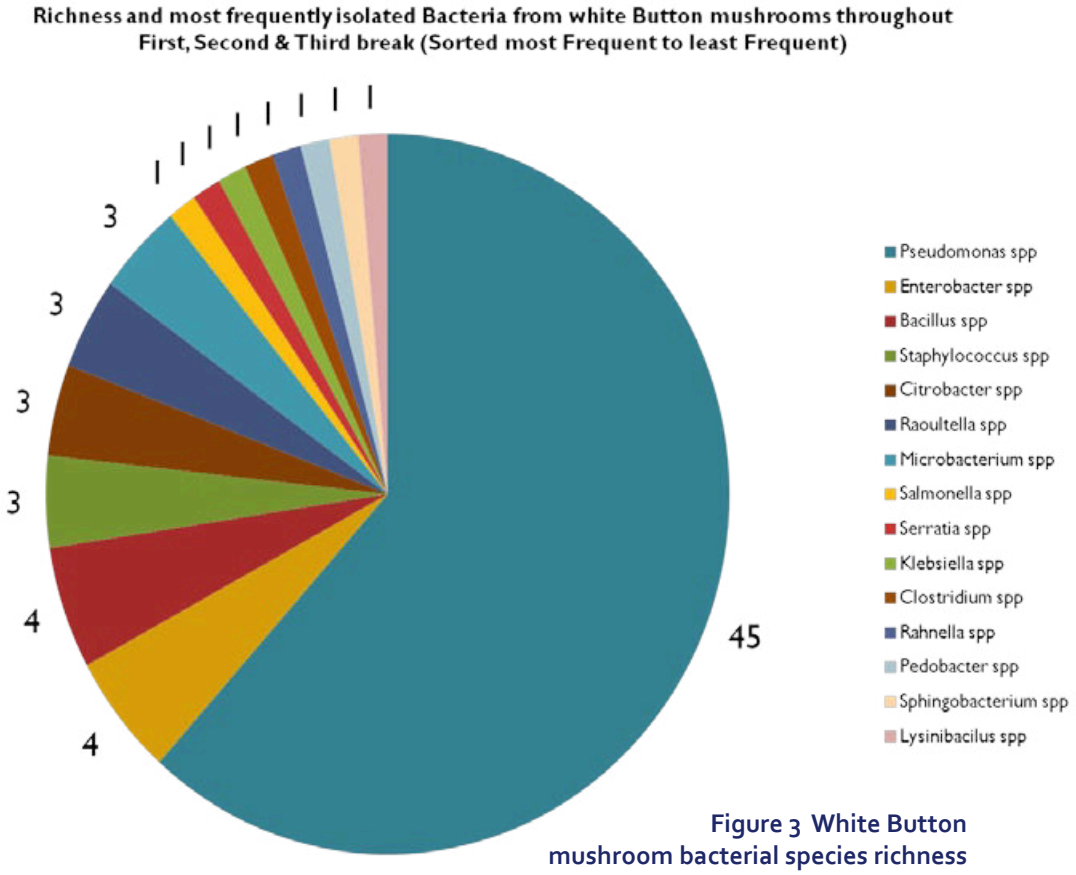


Figure 3 White Button mushroom bacterial species richness

to be dominant. Further identification confirmed the presence of *Salmonella enterica* (Figure 3).

Fungal species identified include *Penicillium brevicompactum* (Dierckx) and *Thrichoderma longibrachiatum* (Rifai), these were found to be the most dominant (Figure 4).

Discussion

Various microorganisms are found naturally on fresh produce and as a result make out part of the epiphytic flora. Depending on the season and climate the presence and population consistency may vary. *Pseudomonas* spp. was found to be the most dominant of the bacteria that were isolated from white button mushrooms. This finding correlates with Venturini *et al*. (2011), who described *Pseudomonas* spp as the most dominant bacterial group isolated from mushrooms. Pseudomonads are further well known microorganisms present in the casing layer in mushroom production systems and play an important role in stimulating fruiting body formation (Hayes *et al*., 1969). *Pseudomonas* has also been reported as pathogenic on mushrooms causing post-harvest browning and decay (Wells *et al*., 1996). The dominance of *Pseudomonas* spp. was also associated with low bacterial population diversity on mushrooms. Other microorganisms isolated from fresh mushrooms are *Staphylococcus* spp. and *Salmonella* spp., which include well known foodborne pathogens. The *Staphylococcus* spp. isolated and identified in this study is not considered foodborne pathogens. Koo (2008) described these organism as part of the normal microflora of humans that are only associated with food as a consequence of human handling. The *Salmonella* spp. isolated was identified as *Salmonella enterica* which is known to be a causal agent of salmonellosis (Murray *et al*., 2007).

Penicillium brevicompactum was found to be the most dominant fungal isolate. This particular fungus can act as a weak pathogen and have previously been reported as a postharvest pathogen of mushrooms (Pitt and Hocking, 1997).

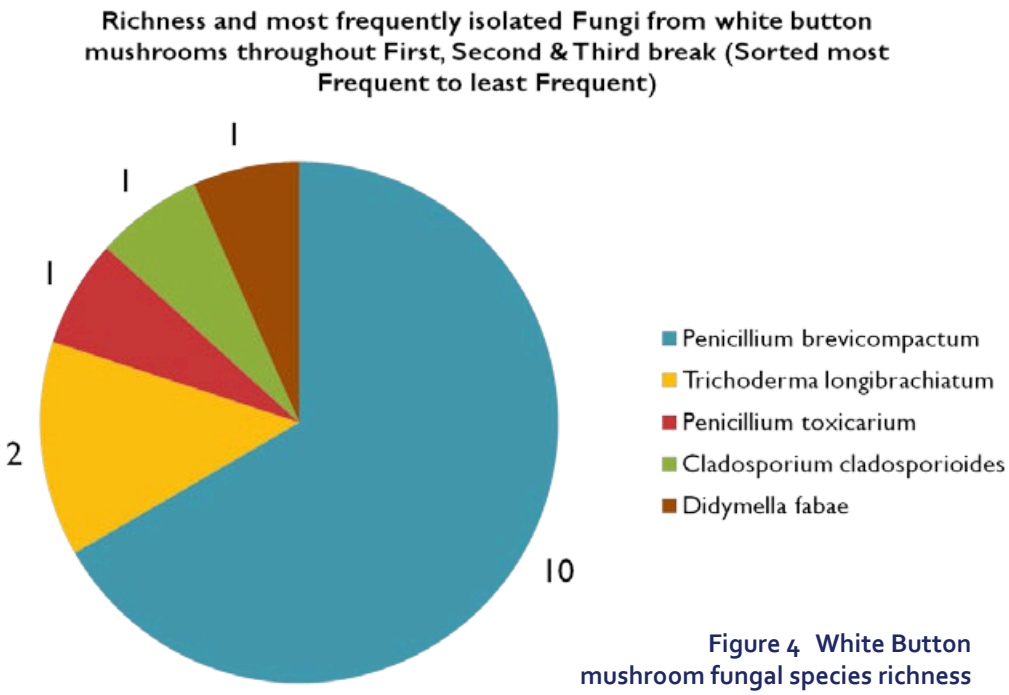


Figure 4 White Button mushroom fungal species richness

Trichoderma longibrachiatum is usually isolated from soil and other environments such as mushrooms. It is further reported to be an abundant indoor fungus, especially in environments such as water-damaged buildings and mushroom farms infected with a green mould infection (University of California).

On average a microbial load of 9.491 log cfu/g were found on fresh mushrooms. This finding is consistent with previous studies by Venturini *et al*. (2011) assessing fresh, cultivated and wild mushrooms. They found the total microbial load to range from 4.4 to 9.4 log cfu/g. Doores *et al*. (1987) reported the microbial load of *A. bisporus* to be in the range of 6.3 to 7.2 log cfu/g. In our study we also found the *E. Coli*/Coliform counts using the Petrifilm method as 2.5 log cfu/g. Using *E. coli* and Coliform counts as indicator systems in food premises have not been linked with total microbial loads of fresh mushrooms. The establishment of a more realistic hygiene monitoring system should therefore be developed based on sound scientific evidence of natural microbial loads on fresh mushrooms.

Conclusion

The total microbial load of fresh white button mushrooms studied reflected high microbial counts, which was dominated by *Pseudomonas* spp. The presence of *Salmonella enterica* should be further investigated. Total microbial loads indicate a healthy natural microflora.

Acknowledgement:

This project was funded by South African Mushroom Farmers Association (SAMFA).

References

Brennan, M., Port, G. L. and Gormley, R. 2000. Post-harvest treatment with citric acid or hydrogen peroxide to extend the shelf life of fresh sliced mushrooms.Lebensm.Wiss. Technol., 33 pp. 285-289.

Díez, V.A. and Alvarez, A., 2001. Compositional and nutritional studies on two wild edible mushrooms from northwest Spain. Food Chemistry 75 (4), 417e422.

Doores, S., Kramer, M. and Beelman, R.B., 1987. Evaluation and bacterial populations associated with fresh

mushrooms (Agaricus bisporus). In:Wuest, P.J., Royce, D.L., Beelman, R.B. (Eds.), Cultivating Edible Fungi: Developments in Crop Science. Elsevier Science Publishers, Amsterdam, pp. 283e294.

European Parliament, The EU fruit and vegetablessector: overview and post 2013 Cap Perspective, http://www.europarl.europa.eu (accessed 16/11/2012).

Gormley, T.R., 1975. Chill storage of mushrooms. Journal of the Science of Food and Agriculture 26 (4), 401e411.

Hayes, W. A., Randle, P. and Last, F. T. 1969. The nature of microbial stimulus affecting sporophore formation in Agaricus bisporus (Lange) Sing. Annals of Applied Biology 64 (1): 177-187.

Koo, I. 2007. Food Poisoning: Staphylococcus aureus in Food Left Out, Certain Foods Could Be Breeding Grounds for Food Poisoning Updated October 28, 2008. http://infectiousdiseases.about.com/od/diseasesbyname/a/food_staph.htm (accessed 4/12/2012), reviewed by the Medical Review Board

Manzi, P., Aguzzi, A., Pizzoferrato, L., 2001. Nutritional value of mushrooms widely consumed in Italy. Food Chemistry 73 (3), 321e325.

Maintenance of Microorganisms. A manual of Laboratory methods. Edited by B. E. Kirsop and J. J. S. Snell. 207pp. Academic press inc. London, New York.

Murray, P. R., Baron, E. J., Jorgensen, J. H., Landry, M. L., & Pfaller, M. A. (Eds.). 2007. Manual of Clinical Microbiology (9th ed.). Washington: ASM Press.

Penn State University, College of Agricultural Science, http://extension.psu.edu/food-safety/producers/psu-resources/food-safety-for-mushroom-growers-and-packers (accessed 6/12/2012)

Pitt, J. I. and Hocking, D. 1997. Fungi and Food Spoilage. Third edition, Springer

Simon, A., Gonzalez-Fandos, E., Tobar, V. 2005. The sensory quality and microbiological quality of fresh sliced mushroom (Agaricus bisporus L.) packaged in modified atmospheres. International Journal of Food Technology, 40 pp. 943-952.

Strapp, C.M., Shearer, A.E., Joerger, R.D., 2003. Survey of retail alfalfa sprouts and mushrooms for the presence of Escherichia coli O157:H7, Salmonella, and Listeria with BAX, and evaluation of this polymerase chain reaction-based system with experimentally contaminated samples. Journal of Food Protection 66 (2), 182e187.

University of California, http://genome.jgi.doe.gov/Trilo1/Trilo1.home.html (accessed 5/12/2012).

Venturini, M. E., Reyes, J. E., Rivera, C. S. and Oria, R., Blanco, D. 2011. Microbiological quality and safety of fresh cultivated and wild mushrooms commercialized in Spain. Food Microbiology 28, 1492-1498.

Wasser, S.P. and Weis, A.L., 1999. Medicinal properties of substances occurring in higher basidiomycetes mushrooms: current perspective (review). International Journal of Medicinal Mushrooms 1 (1), 31e62.

Wells, J. M., Sapers, G. M., Fett, W. F., Butterfield, J. E., Jones, J.B., Bouzar, H. and Miller, F.C. 1996. Post-harvest discolouration of the cultivated mushroom Agaricus bisporus caused by Pseudomonas tolaasii, P.reactants, and P. gingeri. Phytopathology 86:1098-1104.

Zhang, M., Cheung, P.C.K. and Zangh, L., 2001. Evaluation of mushroom dietary fibre (nonstarch polysaccharides) from sclerotia of Pleurotus tuber-regium (Fries) Singer as a potential antitumor agent. Journal of Agriculture and Food Chemistry 49 (10), 5059e5062.

IMPORTANT DATES ON THE MUSHROOM CALENDAR

2013

7th International Conference on Mycorrhiza (ICOM7)
6 - 11 January 2013,
New Delhi, India
www.teriin.org/events/icom

Dutch Mushroom Days
29 - 31 May 2013,
Brabanthallen, 's-Hertogenbosch,
The Netherlands
www.mushroomdays.com

7th International Medicinal Mushroom Conference
26 - 29 August 2013,
Beijing, China
www.immc7.com

22nd North American Mushroom Conference
22 - 24 June 2013,
Vancouver, BC
Canada
www.namc.canadianmushroom.com

2014

10th International Mycology Congress, Bankok, Thailand
Dates and venue to be announced

FIRST SAMFA AND MABU CASING TRIALS PROVE PROMISING

By Linda Meyer – Mabu Casing

SAMFA-funded research at the University of Pretoria (UP) resulted in the development of a local, cost-effective, environmentally friendly alternative to peat as a casing soil. Pith is a waste product in the Triple Green™ paper-making process at SAPPI's Stanger facility in Kwazulu-Natal. The exceptional water-holding capacity of pith cells in sugarcane bagasse makes it ineffectual for the paper-making process, and is therefore removed in a wet de-pithing step. Ironically that is also the reason why pith holds so much potential as casing soil. The procedure to transform the raw pith to a suitable casing substrate takes place over 10-12 weeks using the UP patented process.

In addition to a good water-holding capacity, processed pith casing is free from pests and disease, has suitable pH and EC levels and does not break down after repeated watering.

Growers at Highveld Mushrooms, Country Mushrooms and Denny's Deodar Farm have conducted the first trials to determine the potential of MABU casing. Growers have reported that small changes may be necessary in watering and growing regimes when using pith casing. The case-run for instance is slower than on peat, but with a growth surge before 1st break and a very strong 2nd break, resulting in yields equal to that on peat.

In addition, the mushrooms are of good quality and the average mushroom weight and density compares favourably with that of mushrooms grown on peat. Initial results also confirmed the absence of any pests or diseases.

The next step is to case entire rooms or larger growing areas with MABU casing in order to optimise watering and growing regimes. These trials will start early in 2013.

Ross Richardson, Chairman of SAMFA says, "The product looks very promising. Hopefully we will end up with us achieving our dream that we set out to find over 10 years ago in funding research to find a locally available alternative to peat."

John Heritage, the Production Director of Highveld Mushrooms agrees with other growers saying, "Mabu casing is showing definite signs that it may be a viable casing ingredient in a mix form with peat. We are therefore proceeding with further trials".

THE DEVELOPMENT OF A NEW CONCEPT AND SYSTEM FOR WATERING DURING *AGARICUS BISPORUS* CULTIVATION

by Ofer Danay[1], Ran Kadosh[1], Dov Raz[2], Gabi Yasinov[1], Nirit Ezov[1], Moshe Miron[1], Yitzhak Hadar[3] and Dan Levanon[1]

1 Migal, Galilee Technology Center, Kiryat Shmona, Israel
2 Netafim Irrigation, Tel Aviv, Israel
3 The Faculty of Agriculture Nutrition and Environmental Sciences, The Hebrew University of Jerusalem, Rehovot, Israel
Presented at the ISMS congress in Beijing in August 2012 and reprinted with kind permission of ISMS and the authors

Preface

The two main substrates used in *Agaricus bisporus* cultivation are compost and casing soil (Levanon and Danai 2004). The compost serves as the main source of nutrition for the fungus. The casing layer, composed mainly of peat moss and limestone that covers the compost and has two main functions: water supply to the growing mycelium and fruit bodies and induction of fruit body development. The casing features include physical structure that ensures high water holding capacity and enough air; optimal pH of 7.3 -7.8; low content of soluble ions (low electrical conductivity) and the presence of bacteria that are needed for induction of fruit body development. The fungal mycelium and the developing fruit bodies consume water from the compost and the casing layer. By means of evaporation the pin heads are developing into fruiting bodies which have a water content of 90-95%. Water utilisation is enhanced before and during mushroom picking. Water availability in both casing and compost is crucial for the production of mushrooms, both in terms of quantity and quality. Water addition to the casing layer is done by spraying on the casing layer. The main limitations of this technique are: (a) during the development of fruit body pins (flushing or aeration), watering is stopped

in order to avoid damage to the pins. At this stage the moisture content in the casing and compost decreases to below optimum levels; (b) wetting the developing fruit bodies enhances the occurrence of diseases, mainly bacterial blotch caused by *Pseudomonas tolaasii*. When mushrooms remain wet after watering for a few hours, the bacteria cause browning of the mushrooms rendering them unsalable. In order to minimize these negative effects, drip irrigation was studied and developed in an effort to replace water spraying.

Figures 1 & 2: The pipe work of the drip irrigation incorporated into the casing layer

Materials and Methods

The trials were carried out on a commercial mushroom farm "The Champignon Farm" in Zarit, in northern Israel. It is a shelf farm with the treated areas consisting of two rows of 6 shelves high (total of 382m^2. Synthetic phase III compost was used and cased with black peat and limestone, obtained from Harte Peat, Ireland. The compost was spawned with white *Agaricus bisporus* strain, Lambert 901, at a rate of 8 l/ton compost. Supplement (18 kg/ton compost) was added to the compost at the time of casing. Inoculated compost was mixed into the casing (Cacing). The casing layer was applied at a thickness of 5cm. In part of the experiments, with the drip irrigation, this thickness was reduced by 40%.

Experimental Design

In each experiment two rooms were used for each treatment: the control (watering by spraying) and watering by drip irrigation. The 6 plots treated were each 63.5 m² of shelf area. Every plot was picked separately to record yield and quality.

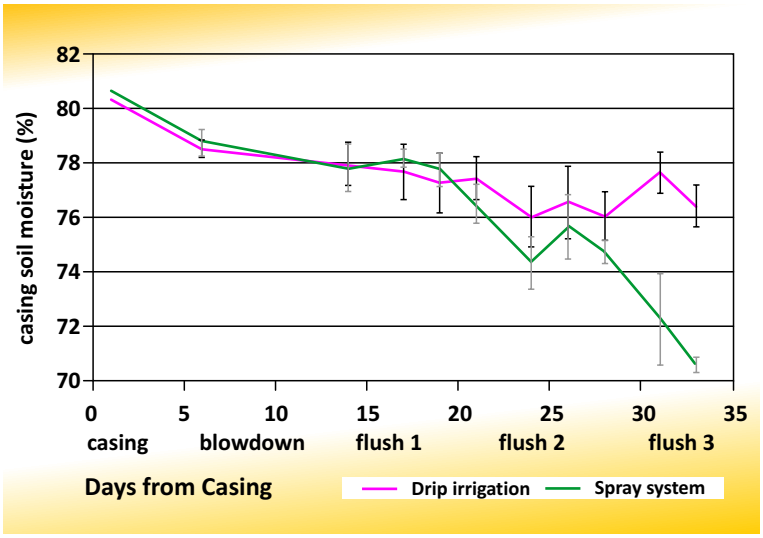


Fig. 3: The impact of watering method, on casing moisture during mushroom cultivation on phase II compost

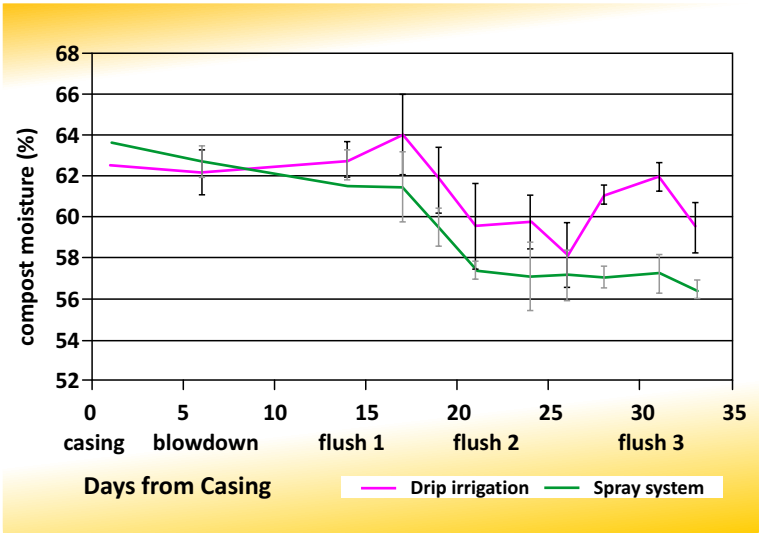


Fig. 4: The impact of watering method on compost moisture during mushroom cultivation on phase II compost

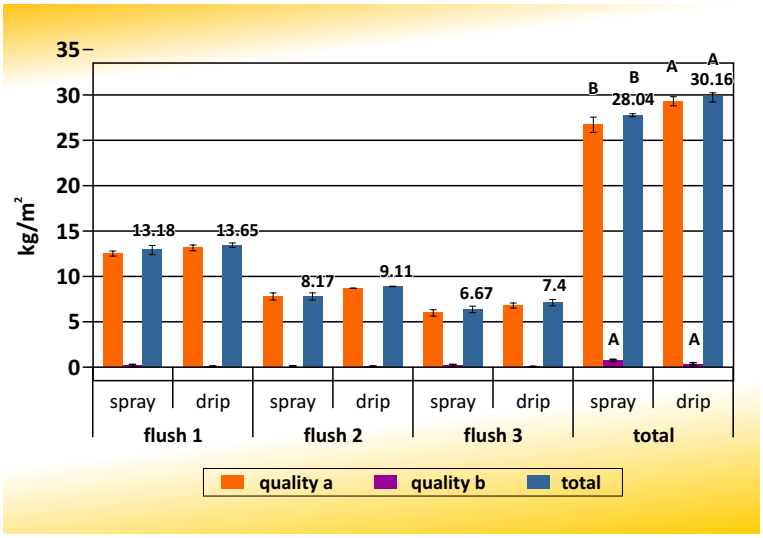


Fig. 5: The impact of the two watering methods on mushroom yield

Irrigation Methods

The control rooms were watered by Dofra automatic watering systems. For the drip irrigated rooms, a special drip irrigation system was developed in co-operation with Netafim Irrigation Systems (Israel). The drip pipelines were incorporated into the casing, during cacing, below the casing surface (Fig 1 & 2). Figures 1 & 2: The pipe work of the drip irrigation incorporated into the casing layer. Growing room water was added in amounts between 30-50 l/m². During aeration when watering is normally halted, drip irrigation was continued.

Laboratory Analysis

Random samples of both compost and casing were taken every two days. Four samples of 0.5 kg each were collected from each treatment. Electrical conductivity (EC) was measured. Moisture and ash content was determined, as well as the water content of the mushrooms (3 samples of 250 g each were collected during each day of mushroom picking and dried at 105°C).

Mushroom Yields

Mushrooms harvested from each plot were picked and weighed separately. The mushrooms were graded as grade A (white closed buttons) or grade B (open cup, broken or distorted). Mushrooms infected with bacterial blotch (grade B) were monitored separately and calculated as the percentage of the total yield.

Results

The impact of the method of watering on casing and compost moisture was monitored during the entire growing cycle (fig. 3 and 4).

It is demonstrated that the use of drip irrigation during mushroom cultivation retarded the decrease in casing (fig. 3) and compost (fig. 4) water content. These results were especially significant during the 2nd and 3rd flushes. Similar results were demonstrated during mushroom cultivation on phase III compost.

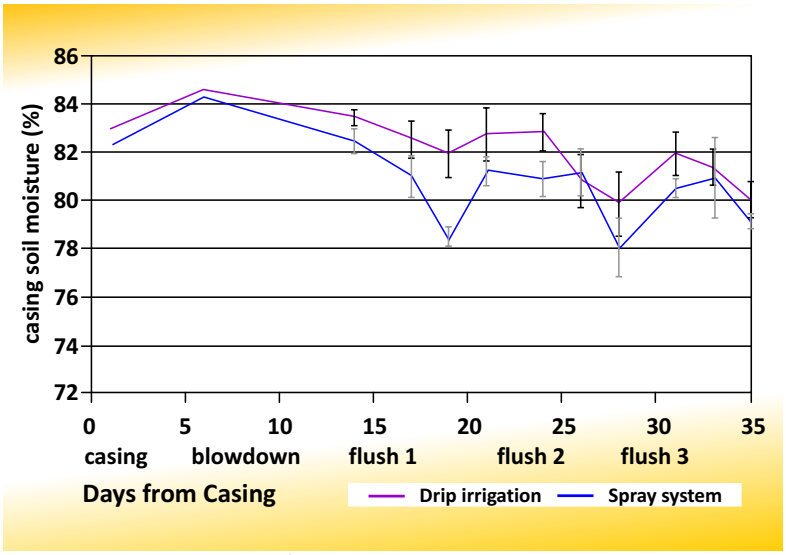


Fig. 6: The impact of watering method on casing moisture. Casing layer thickness was reduced by 40%, with the drip irrigation treatment.

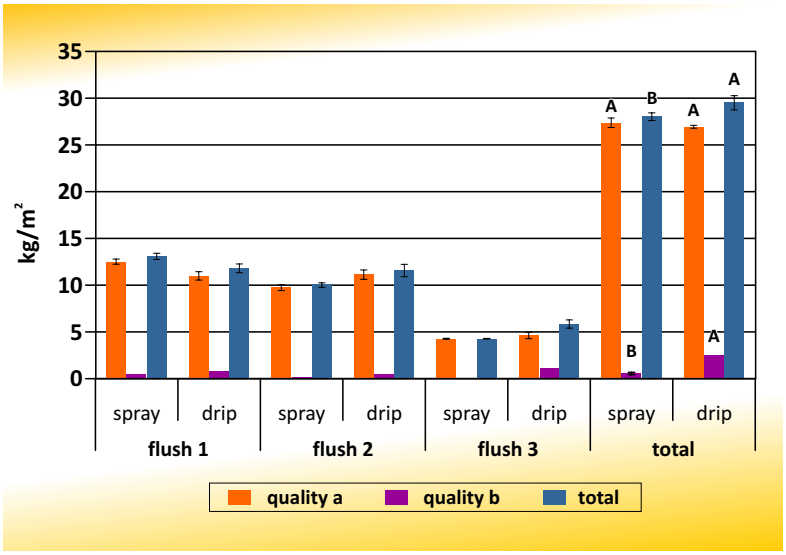


Fig. 7: The impact of watering method on mushroom yields. Casing layer thickness was reduced by 40%, in the drip irrigation treatment

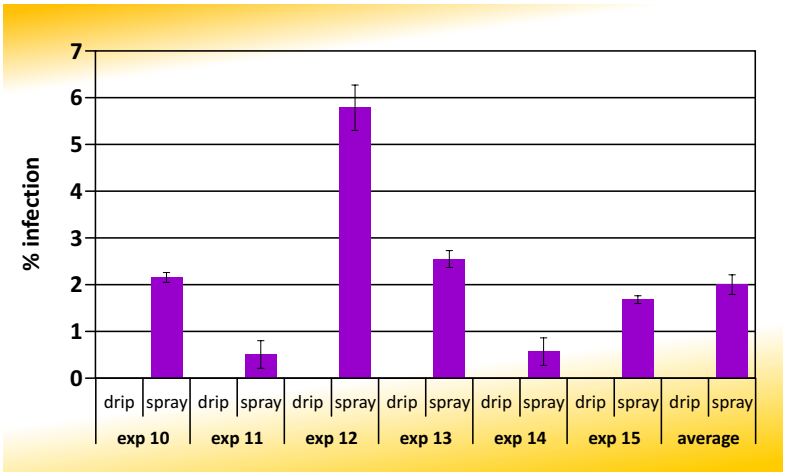


Fig. 8 : Bacterial blotch incidence, in mushrooms cultivated with the two watering methods

The impact of the two watering methods on mushroom yields is illustrated in fig 5.

Higher mushroom yields were recorded with drip irrigation. Drip irrigation decreased the portion of Grade B mushrooms, meaning higher mushroom quality and therefore higher income for the grower.

Based on these results, drip irrigation in combination with reduced casing layer thickness (by 40%), was compared to spray irrigation on casing layer with normal thickness. It is demonstrated that with drip irrigation, casing moisture was maintained at a higher level, even on a thinner casing layer (Fig. 6).

Mushroom yields were recorded and it was demonstrated that yields were higher with drip irrigation, even when the casing layer thickness was reduced by 40% (fig. 7).

The incidence of bacterial blotch was recorded comparing the two watering methods (fig 8).

t was demostrated that up to 6% of the mushrooms were infected by bacterial blotch when watered by spraying. No blotch occurred with drip irrigation. At the time of the trials there were other rooms on the farm where bacterial blotch resulted in a 15% reduction in yield.

Discussion

Water is taken up by the mushroom mycelium and fruiting bodies, and evaporated during the entire cultivation cycle. Water had to be replaced by applying water to the casing. That is, however, halted during certain periods (aeration or flushing). To overcome this situation the concept of drip irrigation was developed. The use of under-surface drip irrigation allows continuous water supply to the casing and compost throughout the cultivation cycle. It was proven that the use of this system minimised the decrease in casing and compost water content. Furthermore, the use of drip irrigation allowed a decrease of 40% in thickness of the casing layer. The world resources of peat-moss, the main ingredient of the casing are decreasing, leading to supply limitations and increased prices. There are continuous efforts to recycle peat and develop peat alteratives for use as casing (Levanon and Danai, 2004 ; Farsi *et al.*, 2011; Noble and Dobrovin-Pennington, 2004). Therefore,

reduction of peat consumption means not only cost reduction for mushroom growers, but will also contibute to saving a limited natural resource. Another important outcome of the use of drip irrigation is the (almost) reduction of bacterial blotch disease. When mushrooms are wet, even only for few hours, the bacteria cause severe damage. There is no evidence in the literature on the ability to supply water to the casing while keeping the mushrooms dry. Drip irrigation allows this option, ensuring better mushroom quality and higher yields.

Acknowledgement

The authors thank NETAFIM Israel for their role and the financing of the research and the office of the chief scientist (OCS) for their support.

References

FARSI M, MALEKZADEH K, et al. 2011. Recycling of mushroom peat casing soil through a plastic mesh. In: SAVOIE JM, FOULONGNE-ORIOL M, et al (eds). The 7th International Conference on Mushroom Biology and Mushroom Products. Arcachon France. 433 – 436.

LEVANON D, and DANAI O. 2004 . Mushroom Production. Concise Encyclopedia of Bioresource technology [M]. Binghamton, NY USA .The Haworth Press.

NOBLE R, and DOBROVIN – PENNINGTON A. 2004. Use of the fine particle tailings in mushroom casing. In: ROMAINE P, ROYSE D, et al (eds). Mushroom Science XVI. The 16th International Conference on science and cultivation of edible fungi. Miami 335 -342.

SAMFA'S 2012 PR ACTIVITIES CONCLUDE ON A FESTIVE NOTE

by Riana Greenblo from Riana Greenblo Communications

THE SOWETO MUSHROOM FESTIVAL TURNS 7

On Saturday October 27 SAMFA celebrated the 7th annual Soweto Mushroom Festival (SMF) at Soweto's prestigious Maponya Mall and as always it was a magnificent draw card for potential new mushroom consumers.

Our brigade of CAASA (Culinary Arts Association of South Africa) chefs were in action from early morning, chopping, slicing and prepping the many mushroom dishes they were creating for the day – all to tantalise the taste buds of the Maponya Mall shoppers who were enthusiastically gathering for the Ready, Steady, Cook styled mushroom demonstrations that ran throughout the day. As happens every other year, the mushroom growing boxes on display that show visitors how mushrooms are actually grown, were a huge attraction for young and old!

The main objective of the SMF is to increase awareness of fresh cultivated mushrooms, to illustrate how easy they are to prepare, how cost effective they are and how they enhance every meal.

Our chefs were on top of their game with quick, easy and affordable mushroom dishes and the shoppers who joined our demonstrations were treated to a fun educational mushroom day. Not only did they taste many versatile mushroom dishes perfect for everyday cooking, there were also many prizes on offer from SAMFA and our prize sponsor Pick 'n Pay.

MUSHROOMS RAISE IN EXCESS OF R1 000 000 FOR REACH FOR RECOVERY - ADDING SOME REAL MUSCLE TO THE BREAST CANCER FIGHT

Mushrooms in South Africa first turned pink on supermarket shelves in October 2010 when SAMFA joined forces with Pick 'n Pay and Yucca Packaging to help raise national awareness of breast cancer during October's Breast Cancer awareness month. To date, mushrooms have raised over R1 000 000.00 for breast cancer support group Reach for Recovery.

SAMFA's motivation to support Breast Cancer month stems from the many international research studies which continue to support the positive link between mushroom consumption and the reduction of breast cancer. It is also an initiative that is supported by Mushroom councils around the globe as more and more breast cancer research studies become available.

"It is an extraordinary industry achievement," says SAMFA's chairperson, Ross Richardson, "and we are immensely proud of the efforts our members made to make this initiative the success that it is. We can proudly say that the mushroom industry is making a real difference to the well-being of breast cancer survivors."

But the beauty of SAMFA's involvement in the breast cancer fundraising initiative does not only benefit those who have been affected by cancer. It actually creates an awareness of the disease protective qualities of mushrooms. Research has shown that women who eat an average of 1 mushroom per day (around 10g) have half the risk of breast cancer.

"Our awareness campaign has become so much more than fighting the disease; mushrooms offer protection against the disease and we are looking forward to 2013 to expand on the extent of this SAMFA initiative," concludes Richardson.

Sylvan

圣诞快乐!

Joyeux Noël

Buon Natale

Nollaig Shona

FELIZ NAVIDAD

Wesołych Świąt

Prettige kerstdagen

Frohe Weihnachten

Yeni Yılınız Kutlu Olsun

Kellemes Karácsonyi Ünnepeket

Feliz Natal e próspero Ano Novo

عيد ميلاد سعيد وكل عام وأنتم بخير

Счастливого Нового Года и Рождества

З НОВИМ РОКОМ ТА РІЗДВОМ ХРИСТОВИМ!

Season's Greetings

www.sylvaninc.com