Federal Polytechnic Ilaro Journal of Pure & Applied Sciences {FEPI- JOPAS}

Volume 3 Issue 1,
June, 2021 Edition.

Published by:

The School of Pure and Applied Sciences (SPAS)
The Federal Polytechnic Ilaro, Ogun State, Nigeria.
https://fepi-jopas.federalpolyilaro.edu.ng
E-mail:fepi.jopas@federalpolyilaro.edu.ng

ISSN: 2714-2531

FOREWORD

I warmly welcome all and sundry to the volume 3 issue 1 of Federal Polytechnic – Journal of Pure and Applied Sciences (FEPI-JOPAS) which is a peer reviewed multi-disciplinary accredited Journal of international repute. FEPI-JOPAS publishes full length research work, short communications, critical reviews and other review articles. In this issue, readers will find a diverse group of manuscripts of top-rated relevance in pure and applied science, engineering and built environment. Many of the features that you will see in the Journal are result of highly valuable articles from the authors as well as the collective excellent work of our managing editor, publishing editors, our valuable reviewers and editorial board members.

In this particular issue, you will find that Joseph and Adebanji provided innovative technology on light traffic control system. Ogunkoya and Sholotan engaged standard method for microbiological assessment of shawarma from Igbesa metropolis for possible microbial contamination. Ilelaboye and Kumoye unveiled the effect of inclusion of different nitrogen source on growth performance of mushroom. Ogunyinka et al utilized Fletcher Reeves conjugate gradient method as a robust prediction model for candidates' admission to higher institutions. Omotola and Fatunmbi examined the impact of thermal radiation with convective heating on magnetohydrodynamic (MHD), incompressible and viscous motion of non-Newtonian Casson fluid. Aako and Are meticulously investigated factors affecting mode of delivery using binary dummy dependent models. Abiaziem and Ojelade successfully synthesized biologically active silver nanoparticles using *Terminalia catappa* bark as the eco-friendly source.

In addition, Olowosebioba et al. assessed the rectifying effects of various diodes in power supply units using multisim circuit design software programme. Olujimi et al. successfully accomplished the use of fingerprint based biometric attendance system for eliminating examination malpractices with enhanced notification. Alaba reported the nutritional status assessment of school age children (6-12 years) in private primary school in Ilaro. Muhammed-lawal et. al. assessed the execution and effect of corporate social responsibilities and return to marketing. Awolola and Sanni's research was about achieving quality of engineering education and training in Nigeria using Federal Polytechnic, Ilaro as the case study. Oladejo and Ebisin expatiated on virtual laboratory as an alternative laboratory for science teaching and learning.

Finally, Aneke and Folalu investigated the prospect and problems of the hotels in Ilaro, Ogun State.

I would like to thank and extend my gratitude to my co-editors, editorial board members, reviewers, members of FEPI-JOPAS, especially the Managing Editor, as well as the contributing authors for creating this volume 3 issue 1. The authors are solely responsible for the information, date and authenticity of data provided in their articles submitted for publication in the Federal Polytechnic Ilaro – Journal of Pure and Applied Sciences (FEPI-JOPAS). I am looking forward to receiving your manuscripts for the subsequent publications.

You can visit our website (https://www.fepi-jopas.federalpolyilaro.edu.ng) for more information, or contact us via e-mail us at fepi.jopas@federalpolyilaro.edu.ng.

Thank you and best regards.

E-Signed
Prof. Olayinka O. AJANI

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Experiment

Effect of Inclusion of Different Nitrogen Sources in Various Substrates on Growth Performance of Mushroom (*Pleurotus Plumonarius*)

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Abstract

Indian mushroom (*Pleurotus plumonarius*) is a widely consumed mushroom due to its nutritional, medicinal and potential commercial value. In Nigeria, the fungus is grown presently on sawdust and rice husk. This study evaluated the effectiveness of addition of various nitrogen sources to different substrates on mushroom growth performance. The experiment consisted of forty-eight samples in which three substrates (Melina tree sawdust, waste paper and corncob) were supplemented with five different percent (0 -12.5 %) of nitrogen sources (urea, wheat bran and moringa leaves) at interval of 2.5 %. Growth parameters such as spawn run, pin head formation time, pileus diameter, stripe length, total yield and biological efficiency were determined using standard methods. Results indicate that waste paper substrates especially 5 % moringa leaves supplementation, exhibited the best growth performance compared to the other substrates, in terms of spawn run, pin head appearance, pileus diameter, stripe length, yield and biological efficiency. Melina sawdust substrates were the least performing substrates. Inclusion of nitrogen sources improve the *Pleurotus plumonarius* growth parameters in all the substrates, until a threshold after which the effect of such addition may result in poor growth and contamination.

Keywords: Growth Performance, Mushroom, Nitrogen Sources, Substrates

INTRODUCTION

The growing of fungi is a recent development, unlike the cultivating of higher plants, which started in prehistorical times (Sofi, Ahmad and Khan, 2014). Mushrooms are edible fungi belonging to the genus *Pleurotus* under the class Basidiomycetes, which are fleshy, the spore-bearing reproductive structures were grown on organic substrates (Etich, Nyamangyoku, Rono, Niyokuri, and Izamuhaye, 2013). *P. pulmonarius* popularly identified as Indian Oyster, like other spp in the genus, efficiently suitable in conversion of industrial / agrowastes to protein-rich, vitamins and minerals (Onuoha, Uchechi, and Onuoha, 2009), because they can directly breakdown lingocellulosic materials. Mushroom proteins are considered to be intermediate between that of animals and vegetables (Syed, Kadam, Mane, Patil, and Baig, 2009) as it contains all the nine essential amino acids required for the human body.
While, mushrooms such as *Pleurotus* spp are commercially produced and sold in markets in Asia, America and Europe, they are still being hunted for in forests and farmland for sale in Africa (Onuoha et al., 2009), hence the need for their commercial production. *P. pulmonarius* is selected for this study because it is one of the species commonly eaten in Nigeria (Liasu, Adeeyo, Olaosun, and Oyedokun 2015). Various substrates such as rice straw, coffee pulps, sawdust and even paper have already been identified as suitable for Mushroom's cultivation without a requirement for costly processing methods and enrichment materials (Chang and Miles, 2004). The traditional substrate for cultivation of *P. pulmonarius* is sawdust (Onuoha et al., 2009). The environmental impact disposal of sawdust and other industrial /agrowastes such as waste paper and corncob are reasons why the suitability of waste paper and corncob for the production of *P. pulmonarius* ought to be looked into.

Various factors like substrate source, substrate quality, compost and supplement affect the growth and performance of Oyster mushrooms (Royse, Rhodes, Ohga, and Sanchez, 2004; Jafarpour, Jalali, Dehdashtizadeh, and Eghbalsaied, 2010). High protein content and nitrogen source have been reported to be effective in shortening the growth period and increasing both yield and biological efficiency. (Peksun and Yakupoghu, 2009; Adebayo, Omolara, and Toyin, 2009; Fanadzo, Zireva, Dube, and Mashingaidze 2010;

Jafarpour et al., 2010). The study was conducted to evaluate the performance of oyster mushrooms on agricultural residues such as melina tree sawdust, waste paper and corncob using different ration of nitrogen source (supplements) such as Urea, Wheat bran and Moringa leaf.

MATERIALS AND METHODS

The entirely mystified spawn grain of *Pleurotus plumonarius* used for this research work was collected from the biotechnology department of the Federal Institute of Industrial Research Oshodi (FIIRO), Lagos, Nigeria. Melina tree sawdust was obtained from Sawmill, Ilaro Ogun State, Waste paper and corncob was obtained from a dumpsite in Orita, Ilaro, Ogun State. The nitrogen sources (urea, wheat bran and moringa leaves) were obtained from Oja Odan and Ilaro, Ogun State.

Preparation and inoculation of substrates

Preparation and inoculation of substrates were done according to Jawad, Muhammad, Waqas, Chaudhry and Jamil (2013) with modification. Melina tree sawdust, treated waste paper (0.5cm width paper soaked in 10 L solution of 0.15 % hypochlorite in a bucket for about an hour) and crushed corncob (about 0.5 cm in size) were soaked seperately in water for 24 hours. After soaking, the substrates were made into a heap on a cement platform to drain the water to 72 % moisture content by using the squeeze method. Lime and sugar (1% each of the substrate's total weight) were added to every substrate to neutralize the substrate's acidity and temporarily provide glucose to the mycelia while the cellulose and lignin are being converted into useful forms of carbohydrates. The substrates mixture was thoroughly mixed together until none of the additives were visible and divided into six portions of five replicate each.The percentage concentration of the nitrogen sources i.e., urea, (U) wheat bran (WB) and air-dried moringa leaves (M) were added at intervals of 2.5 % separately to each replicate from 0 to 12.5 %. The substrates were left to decompose for 14 days with regular turning once in a week, maintaining the moisture content at 72 % by sprinkling water on the substrates. Each substrate mixture (300g) packed in a well labeled poly propylene bags, plugged with cotton wool and-covered with aluminum foil to prevent insects and rodent infestation. The bags were pasteurized at 16psi for one and a half hour using an oil drum. After sterilization the bags were left to cool before inoculating with 5g of fully colonized grain spawn and were incubated until mycelium fully colonized at room temperature with relative humidity between 70-80 % by watering everyday

Data collection

The yield of *P. pulmonarius* on the different substrate combination was determined by recording the weight, diameter of pileus and size of the fruit bodies after primordial initiation. The measurements from the various replicates were added and their mean value calculated. The height was measured in centimeters using a steel ruler of dimension 50 cm by 2.5 cm (Dongguan Hust Tony Instrument Co. Ltd, Guandong, China) from the base of the stipe to the pileus. Pileus diameter measured in centimeters with ruler from one edge of the pileus across the stripe to the other edge **Fresh weight of fruit bodies** was done using an electrical weighting balance (APX 200, Denver Instrument, Arvada, Colorado). *Biological Efficiency was* determined as the percentage ratio of the fresh weight of harvested mushroom over the substrate's dry weight. Other data collected include time of mycelia growth after inoculation and days of primordial initiation.

Data Analysis

One-way Analysis of variance (ANOVA) employed to analyze data collected, and significant differences among the treatment means were separated by Duncan Multiple Range Test using the Statistical Package for the social sciences for windows (SPSS2007)

RESULTS AND DISCUSSION

Spawn run

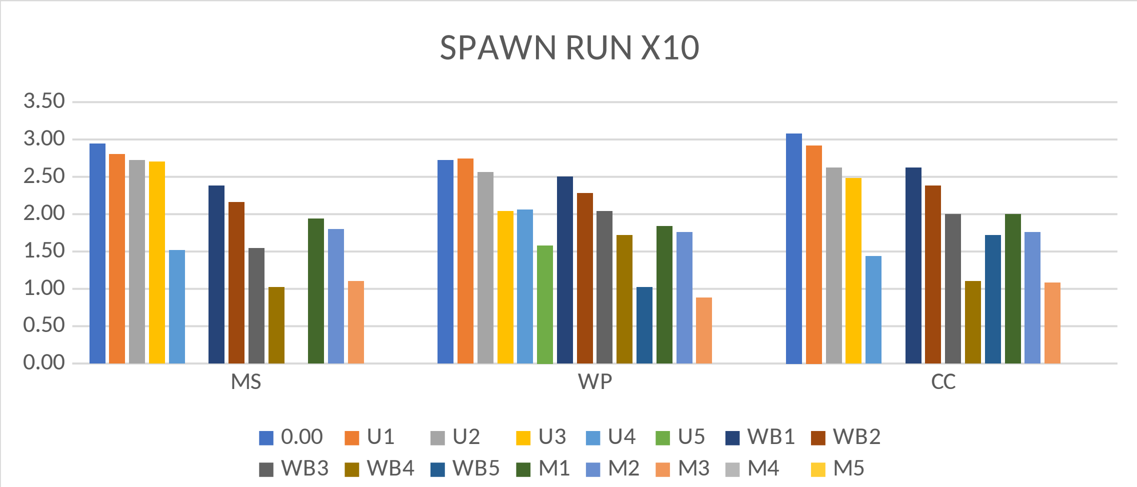

Figure.1: spawn run time of mushroom cultivated on substrates supplemented with nitrogen sources
*Melina tree sawdust (MS), Waste paper (WP), Corncob (CC)

As depicted in Figure 1, increase in concentration of all the nitrogen sources (urea, wheat bran and moringa) supplementation in the substrates resulted in decrease in spawn run time. Each substrate exhibited different mycelium colonisation period. The unsupplemented substrates took longest to colonise (MS 29.4 days, WP 27.2 days and CC 30.8 days) while 7.5 % moringa inclusion in all the substrates gave the fastest spawn run (MS 11.0 days, WP 8.8 days and CC 10.8 days). The results corroborate the findings of researchers that addition of nitrogen sources in the substrates lowers colonize days because it reduces the carbon/nitrogen ratio which favours mycelium run (Royse et al., 2004; Oseni Wahome, Masarirambi and Earnshaw, 2012; Khare, Mutuku, Achwania, and Otaye, 2010; Mane, Patil, Syed and Baig, 2007). Sarker et al (2014) found that mycelium running rate of oyster mushroom is greatly influenced by the supplementation of substrates with various sources of organic nitrogen in different level because the absorption of these molecules is more energetically efficient than synthetic molecules, which allow the fungi to obtain more energy for mycelial growth and mushroom formation Mateus et al. (2012). Comparatively, waste paper substrate supported colonization better than the remaining two substrates.

Pin head appearance

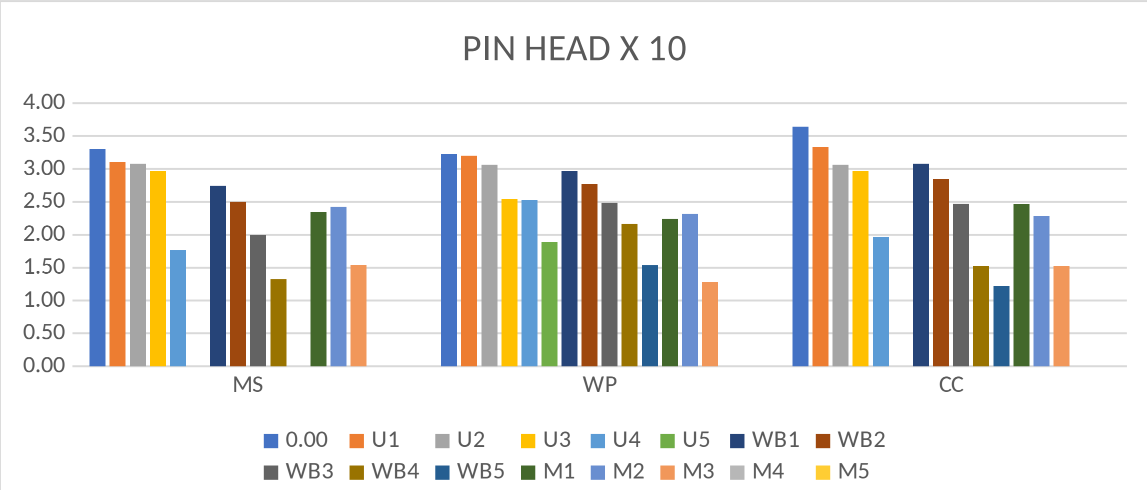

Figure 2: Pin head appearance time (days) of mushroom cultivated on substrates supplemented with nitrogen sources

According to figure 2, primordial initiation (pin head appearance). In all the substrates significantly ($P<0.05$) decreased as the concentration of nitrogen sources increased. This further confirms the previous work by researchers that application of nitrogen rich source during mycelium growth gives early primordial emergence (Fan, Soccol, Pandey, Vandenberghe de Souza, and Soccol, 2006; Kimenju et al., 2009). The formation of pin head of mushroom follows the same trend as spawn run in all the substrate with waste paper having the primordial initiation (urea 32days – 18.8 days, Wheat bran 29.6 days – 15.3 days, Moringa leaves 22.4 days – 12.8 days), followed by mellenia sawdust (urea 31.0 days – 17.6 days, Wheat bran 27.4days – 13.2 days, Moringa leaves 23.4 days – 15.4 days), corn cob (urea 33.3 days – 19.7 days, Wheat bran 30.8days – 12.2 days, Moringa leaves 24.64 days – 15.2days). The average time interval between complete colonisation of the substrate and primordial initiation is 2.4-4.6 days in MS, and 4.0 -5.3 days in WP and CC. The results obtained for WP and CC are within values of Patra and Pani (1995), who found that Oyster mushroom took 4-8days for the initiation of fruiting bodies, while that of MS agrees with the observation of Jawad et al. (2013) that P. *ostreatus* took a minimum time interval of 3.73 days

Pileus diameter

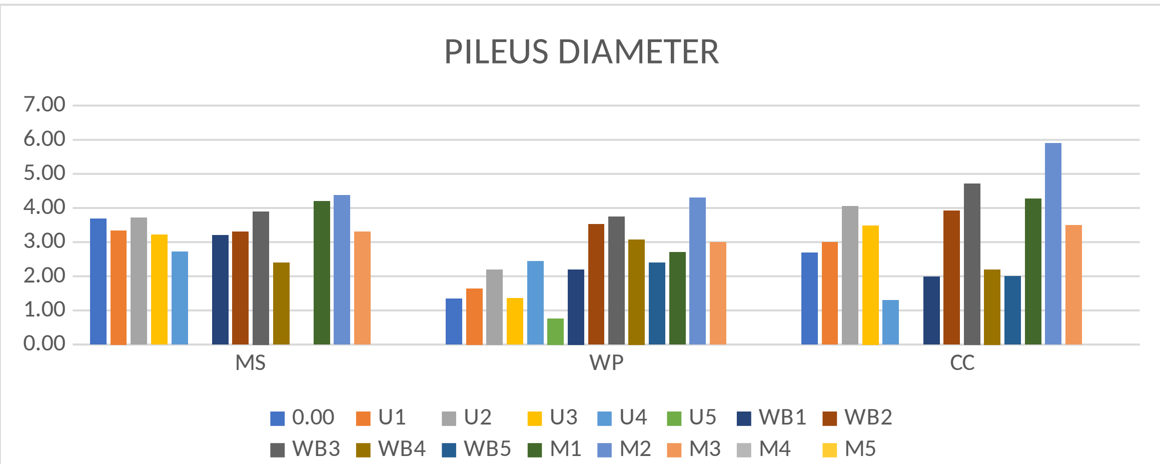

Figure 3: Pileus diameter (cm) of mushroom cultivated on substrates supplemented with nitrogen sources

The highest pilus diameter is shown in all the substrates supplemented with 5.0 % moringa leaves (MS 4.38 cm, WP 4.30 cm and CC 5.90 cm) and significantly (P<0.05) different from the rest of the nitrogen source treatments (figure 3). In all the treatments CC gave the widest pilus diameter (Moringa leaves 5.90 - urea 1.30 cm,), followed by MS (Moringa leaves 4.38 – wheat bran 1.30 cm,), while WP gave the least pilus diameter (Moringa leaves 4.30 - urea 0.76 cm,). The pilus diameter is the favoured part of the mushroom, hence mushrooms with high pilus diameter are essential, (Demirer, Rock-Okuyucu, and Ozer, 2005). According to the provisions of the European Community Commission Regulation for cultivated mushrooms size that the minimum pilus diameter must be at least 1.5 cm for closed, veiled and open mushrooms (EC, 2002). Also, the provisions of the EC Regulation categorized mushrooms as small (1.5-4.5 cm); medium 3.0-6.5 cm); and large when the size is greater than 7.0 cm. The average cap diameter of all nitrogen sources in this study, was considerably higher than this limit and are within small to medium size mushrooms.

Stripe length

As shown in figure 4, the inclusion of nitrogen sources (urea, wheat bran, and moringa leaves) in the substrates impacted significant difference on the stripe length of mushroom grown on each substrate. The shortest stripe lengths are found in CC (4.87 – 3.76 cm), followed by MS (6.34 – 2.94 cm), while the longest stripe length are found in WP (6. 64 – 1.52 cm). The highest percent inclusion (12.5 %) of nitrogen sources in all the substrate produced mushrooms

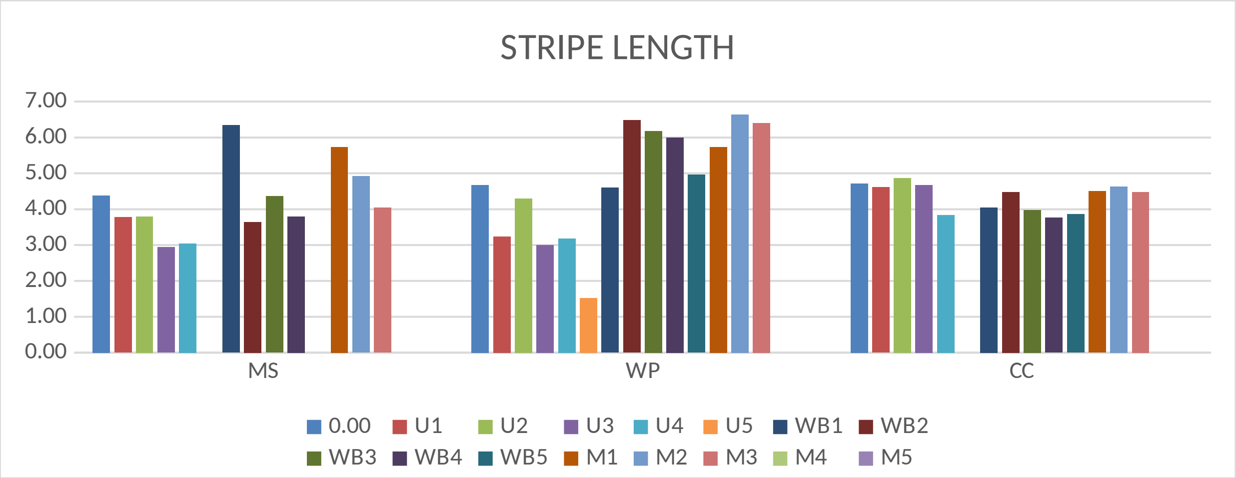

Figure 4: Stripe length (cm) of mushroom cultivated on substrates supplemented with nitrogen sources

with shortest stripe length. The shorter days of colonization of mycelia the longer the stipe length (Vetayasuporn, 2007), and the length of stripe determines the quality of mushroom *Pleurotus spp.* high stripe length denotes poor quality of mushroom (Ovat, Ijomah, Bukie, and Ugobo, 2017).

Total yield

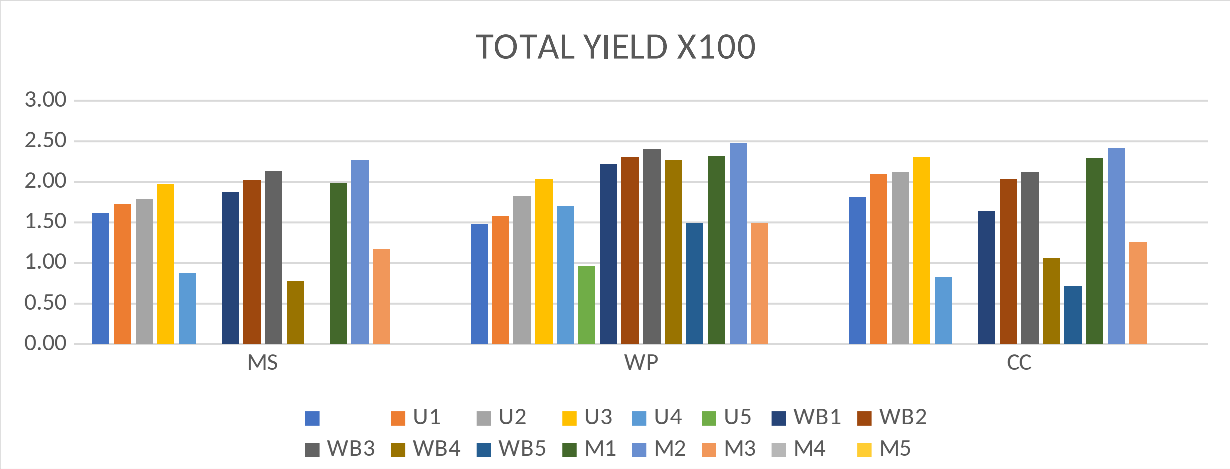

Figure 5: Total yield (g) of mushroom cultivated on substrates supplemented with nitrogen sources

Figure 5 depicted that there was an increase in the yield of mushroom as percent inclusion of nitrogen sources in all the substrates rise to a level before the yield start to drop. The result is in line with the report of previous work done that addition of nitrogen sources to certain percentage of substrates improved mushroom yield (Kadiri and Fasidi 1993; Ukoima, Ogbonnaya, Anikpo, and Ikpe 2009). Also, the supplement ratio above these levels resulted in low yield of mushroom because the excess nitrogen can slow down the growth of mushroom. (Fasehah and Shah 2017; Oseni et al., 2012). Except moringa leaves supplementation which gave the highest yield at 5 % inclusion in all the substrates (MS 227.0 g, WP 248.0 g, CC 241.0 g), other nitrogen sources (urea and wheat bran) gave their best yield at 7.5 % inclusion in all the substrates. Baysal, Peker, Yalinkilic, and Temiz (2003) reported that the trend of economic yield corresponds with different supplements at a different level

Biological efficiency

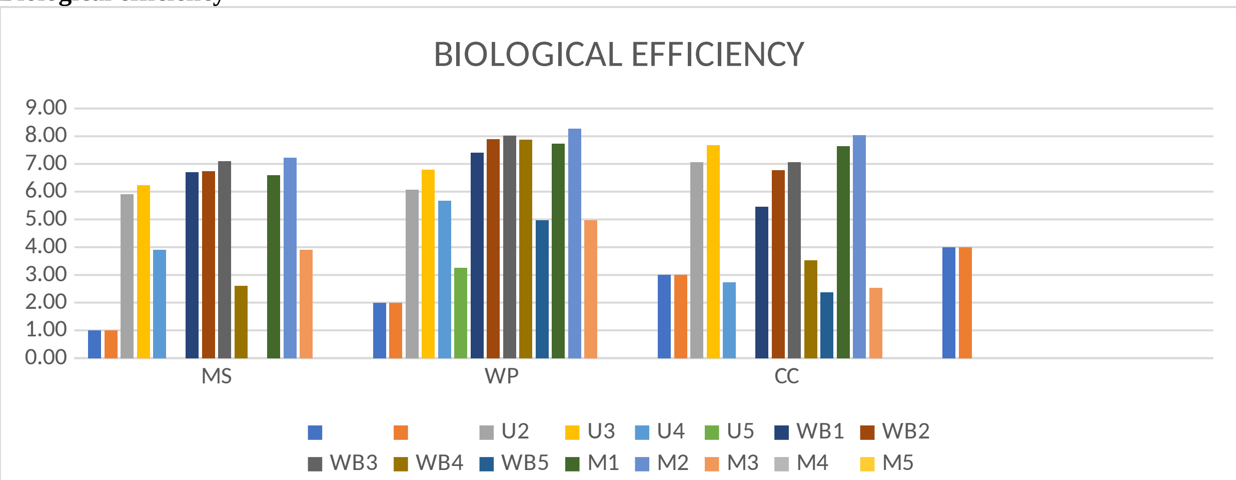

Figure 6: Biological efficiency (%) of mushroom cultivated on substrates supplemented with nitrogen sources

As shown in figure 6, the supplemented waste paper gave an average highest biological efficiency ranging from 12.5 % urea (32.6 %) to 5 % moringa leaves (82.7 %). The effect various percent addition of nitrogen sources (urea, wheat bran and moringa leaves) to all the substrates (MS, WP and CC) on biological efficiency follows the same trend as their yield. The decreased biological efficiency observed at a point as the nitrogen sources increased confirms the previous published work report that better growth is directly associated with concentration of nutrient until a threshold after which the effect of such addition may result in poor growth and contamination, because excess nitrogen might result in overheating of the substrate and affect mushroom growth and efficiency of substrate (Kang and Iersel, 2004; Royse, Bhaler, and Bhaler, 1990).

CONCLUSION

In overall consideration, waste paper substrates especially 5 % moringa leaves supplementation, exhibited the best performance compared to the other substrates, in terms of growth parameters such as spawn run, pin head appearance, pileus diameter, stripe length, yield and biological efficiency. Melina sawdust substrates were the least performing substrates in terms of growth parameters, mushroom yield and biological efficiency. Excess nitrogen sources doses in the substrates caused high temperature, which was harmful to mushroom growth parameters and attracted the growth of competing bacteria.

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