Saudi Journal of Biological Sciences (2016) 23, 607–613

King Saud University

Saudi Journal of Biological Sciences

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ORIGINAL ARTICLE

Evaluation of edible mushroom *Oudemansiella canarii* cultivation on different lignocellulosic substrates

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Received 9 February 2015; revised 9 July 2015; accepted 22 July 2015
Available online 29 July 2015

KEYWORDS

Biological efficiency;
Chemical content;
Lignocellulosic substrates;
Oudemansiella canarii;
Yield

Abstract In this study, the mycelial growth rate, mycelial colonization time, yield, and biological efficiency of the edible mushroom *Oudemansiella canarii* were determined, and the effects of different substrate combinations on productivity, chemical contents and amino acids were evaluated. Lignocellulosic wastes, such as cottonseed hull, sawdust, corncob, and their combinations supplemented with 18% wheat bran and 2% lime, were used for the cultivation of *O. canarii*. The biological efficiency (BE) and essential amino acid content of treatment T1, which consisted of 80% cottonseed hull, were the highest among all the tested treatments. Mixtures that included sawdust, such as treatments T2 (80% sawdust), T4 (40% sawdust + 40% cottonseed hull), and T6 (40% sawdust + 40% corncob), exhibited lower yield and BE. Corncob was good for *O. canarii* production in terms of yield and BE, whereas the mycelial growth rate and colonization time were lower compared to those on other substrates. Comparing the BE, essential amino acids, and other traits of the six treatments, treatment T1 (80% cottonseed hull) was the best formula for *O. canarii* cultivation and should be extended in the future.

1. Introduction

Mushrooms of the genus *Oudemansiella*, belonging to Basidiomycota, Agaricales, Physalacriaceae (Kirk et al., 2008), are consumed worldwide (Magingo et al., 2004). The number of *Oudemansiella* species reported in Ainsworth and Bisby's Dictionary of fungi (10th Edition) (Kirk et al., 2008) and Index Fungorum (synonymous species included, 2015) are 15 and 138, respectively. Many *Oudemansiella* species contain

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.sjbs.2015.07.001

bioactive compounds, such as oudenone (Tsantrizos et al., 1999), lectin (Matsumoto et al., 2001; Liu et al., 2013), mucidin (Subik et al., 1974), oudemansin (Anke et al., 1979, 1982), and polysaccharides (Zou, 2005). Some of these compounds display antihypertensive (Hamao et al., 1974; Tsantrizos and Zhou, 1995), immunologically stimulating, anti-cancer (Hamao et al., 1974; Tsantrizos and Zhou, 1995), antimicrobial and antibiotic (Anke et al., 1990; Luiz et al., 2003, 2005) properties, and have an inhibitory effect on sarcoma 180 and Ehrlich carcinoma in mice (Ying et al., 1987). However, to the best of our knowledge, only few *Oudemansiella* species has been reported to be artificially cultivated, including the following: *O. radicata* (Ji et al., 1982; Shim et al., 2006; Gao, 2000), *O. canarii* (Ruegger et al., 2001), *O. mucida* (Lee et al., 2007), *O. brunneomarginata* (Qi et al., 2011), *O. submucida* (Li et al., 2012), and *O. tanzanica* (Magingo et al., 2004). Of these, only *O. radicata* is commercially cultivated in China. The yield was reported to be approximately 6592 tons by the China Edible Fungi Association (CEFA) in 2012.

One *Oudemansiella* sp. strain (HKAS No.76681) sampled in 2011 from Dadugang, Jinghong County, Xishuangbanna City, Yunnan province, China, was identified as *O. canarii* by Prof. Zhuliang Yang of the Kunming Institute of Botany, Chinese Academy of Sciences (Beijing, China). The cultivation of this mushroom was first reported by Ruegger et al. (2001) using sugarcane bagasse and eucalyptus sawdust substrates. Their biological efficiency (BE) was 55.66% and 19.51%, respectively, which was far lower than the cultivation of *O. tanzanica* on different substrates (101.9–145.4%) reported by Magingo et al. (2004). To date, there is no report on the cultivation of *O. canarii* in China. Furthermore, large volumes of cottonseed hull, sawdust, and corncob are produced as agricultural byproducts every year in China and could be used as substrates for mushroom cultivation and to avoid serious environment pollution problem by improper disposal.

Therefore, the present study was initiated to determine suitable substrates to improve the BE for cultivation of *O. canarii* and evaluate the chemical biomass composition of the fruiting bodies grown on different substrates.

2. Materials and methods

2.1. Microorganism and spawn preparation

The *O. canarii* strain used in this study was isolated from the wild (Fig 1.) and preserved in the Beijing Engineering Research Center for Edible Mushroom, Beijing Academy of Agriculture and Forestry Sciences (Beijing, China), where it is designated as JZB2115055. The mycelium was transferred onto potato dextrose agar (PDA; 200 g/l diced potatoes, 20 g/l glucose, 15 g/l agar) medium at 25 °C. Spawn preparation was carried out according to the method described by Pant et al. (2006).

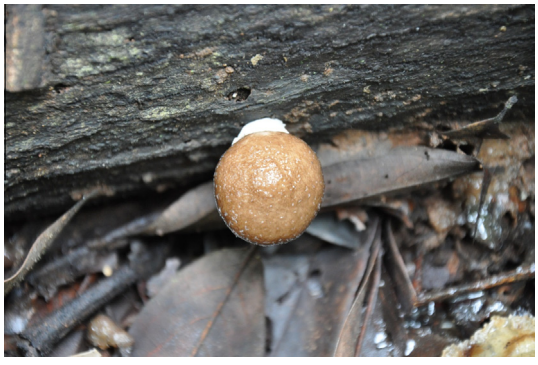

Figure 1 The fruiting bodies of *Oudemansiella canarii* in nature.

2.2. Substrate preparation, inoculation, and incubation

The cottonseed hull, sawdust, corncob, and wheat bran used in this study for the cultivation of *O. canarii* were agricultural byproducts obtained from Beijing Yingliang agricultural development Co., Ltd. (Beijing, China). These materials were analyzed for their carbon (C) and nitrogen (N) contents following the method described by Dundar et al. (2009). Finally, the carbon/nitrogen (C/N) ratios of each raw material were calculated and are shown in Table 1.

All the materials used in this study were sun dried, and there was no contamination with mold. Six treatments (T1, T2, T3, T4, T5, and T6) with different combinations of substrates were designed (Table 2), and the C:N ratio of each treatment was 45.66, 88.53, 45.88, 60.91, 45.76, and 63.23, respectively. Cottonseed hull, sawdust, corncob, and their combination were used as base substrates for mushroom cultivation. Wheat bran and lime were supplementary substances applied to provide nitrogen sources and adjust the pH of the substrate, respectively.

The water content of the final mixture was adjusted to 65% (w/w), and the prepared substrate was placed into polypropylene bags (17 cm × 33 cm × 0.04 cm) at a packing density of 1000 g substrate per bag. The bags were autoclaved at 121 °C for 120 min. The sterile substrates were inoculated by spreading the spawn on the surface of substrate at 2% (w/w) of substrate fresh weight. Sixty sterilized polypropylene bags were used and divided into three replicates for each treatment.

The inoculated bags were kept in the spawn running room at 25 °C and 70% relative humidity (RH) in the dark. The mycelial growth rate was determined following the method of Gregori et al. (2008) with a modification of the racing tube size (25 mm in diameter and 220 mm in length), and the mycelial colonization time (the number of days from inoculation to complete colonization of the substrate by the mycelium) was also recorded.

2.3. Cropping, harvest and determination of BE

After a complete spawn run, the bags were moved to a greenhouse at 20–25 °C and 80–90% RH with the upper parts

Table 1 Carbon (C) and nitrogen (N) analysis of lignocellulosic agricultural byproducts used for *Oudemansiella canarii* cultivation.

Material	C (%)	N (%)	C/N
Cottonseed hull	38.06	0.57	66.77
Sawdust	41.34	0.12	358.61
Corncob	29.21	0.37	78.49
Wheat bran	36.92	1.98	18.65

Table 2 Six culture medium treatments used for *Oudemansiella canarii* cultivation (% by dry weight).

Material	Treatment group					
	T1	T2	T3	T4	T5	T6
Cottonseed hull	80	0	0	40	40	0
Sawdust	0	80	0	40	0	40
Corncob	0	0	80	0	40	40
Wheat bran	18	18	18	18	18	18
Lime	2	2	2	2	2	2

unfolded for cropping. The greenhouse was sprayed intermittently to maintain the desired moisture during the cropping time.

Fruiting bodies were harvested when the mushroom cap surfaces were open. All fruiting bodies were collected in 3 d including the pinheads that formed but never matured. The substrates were incubated for another 7 d after harvesting. The harvested fruiting bodies in each bag were weighed. At the end of the harvesting period, the accumulated data were used to calculate the BE and mushroom weight (Yang et al., 2013).

$$\mathrm{BE}(\%) = \text{Weight of fresh mushroom fruiting bodies} / \text{weight of dry substrates} \times 100$$

2.4. Chemical biomass composition and statistical analysis

The fruiting bodies of *O. canarii* were collected after the first flush and dried in an oven at 60 °C to constant weight. The dried fruiting bodies were kept at 4 °C. Mushroom samples were analyzed for chemical composition (moisture, dietary fiber and ash) using AOAC procedures (AOAC, 1995). Protein concentration was determined according to the method of Leco Manuel (thermal conductivity) by the Kjeldahl method. The nitrogen factor used for protein calculation was 4.38 (N × 4.38) (Chang and Miles, 1989). Energy, fat and carbohydrate levels were determined by the method of Watt and Merrill (1975). Amino acids concentrations were determined based on the methods of Kim et al. (2009). These analyses were performed at the PONY Testing International Group (Beijing, China).

Data obtained from six consecutive harvests and chemical biomass composition analyses were subjected to a one-way analysis of variance. Differences among the means of six treatments were assessed using Duncan's multiple range tests at the 95% confidence level. All statistical analyses were performed using SPSS 20.0 for Windows.

3. Results

3.1. Mycelial growth and mycelial colonization of different treatments

The mycelial growth rate and mycelial colonization time of *O. canarii* cultivated on different treatment substrates are shown in Table 3. Of the substrate treatments, treatment T2 displayed a significantly faster mycelial growth rate (5.51 ± 0.30 mm/d) compared to the others, followed by treatment T4 (4.93 ± 0.16 mm/d). Treatments supplemented with corncob (T3, T5, and T6) showed slower growth rates than the others. Addition of sawdust (T4 and T6) showed faster mycelial growth rate than their counterparts (T1 and T3) with only one substrate except for wheat bran. In general, the mycelial colonization time of the different treatments was in consistent with the mycelial growth rate.

3.2. Production of O. canarii

Fig. 2 shows the fruiting bodies of *O. canarii* grown on cottonseed hull substrates containing wheat bran. The fresh weight of different flushes (g), total yield (g), and BE (%) of *O. canarii* cultivated on different treatments are presented in Table 4. Cultivation continued for 85–90 days, and 6 flushes were harvested. Most of the treatments yielded 85–91% of the total fresh mushroom weight in the first 4 flushes except for treatments T5 and T6, which were only 78% and 80%, respectively. Furthermore, approximately 81% of the total fresh mushroom weight was centralized in flush 2, flush 3, and flush 4 for treatment T2, which had 80% sawdust and 18% wheat bran in the medium. The greatest yield and the highest BE were found for treatment T1, which had 80% cottonseed hull and 18% wheat bran in the medium, and the values were 7955.1 ± 217.5 g and 113.64 ± 3.11%, respectively. The second highest values were obtained from treatment T5, which was 40% cottonseed hull, 40% corncob, and 18% wheat bran in the medium, and the values were 7707.9 ± 231.6 g and 110.11 ± 3.31%, respectively. There was no significant difference between treatment T1 and T5 in total fresh weight and BE. The lowest yield occurred in treatment T6, which consisted of 40% sawdust, 40% corncob, and 18% wheat bran as the culture medium.

3.3. Chemical biomass compositions of O. canarii

To evaluate the chemical biomass compositions of *O. canarii* cultivated on six different combinations of substrates, the chemical and amino acid composition of the fruiting bodies were analyzed.

Table 5 lists the chemical compositions of *O. canarii* fruiting bodies grown on different treatments. The moisture and ash contents of *O. canarii* varied from 6.63 to 6.78 and 7.99 to 8.91, respectively. There were different protein contents in the 6 treatments. Treatment T5 had the highest protein content

Table 3 Comparison of mycelial growth rate and mycelial colonization time of *Oudemansiella canarii* cultivated on different treatment groups.

Treatment group	Growth rate[a] (mm/d) mean ± SD	Mycelial colonization time (days)
T2	5.51 ± 0.30a	25
T4	4.93 ± 0.16b	31
T1	4.88 ± 0.06b	28
T6	4.45 ± 0.20c	35
T3	4.32 ± 0.27c	38
T5	3.94 ± 0.16d	34

[a] Values are mean of 3 replicates. Means in the column followed by the same superscripts are not significantly different at $P < 0.05$ according to Duncan's multiple range tests.

Figure 2 The artificial fruiting bodies of *Oudemansiella canarii* on 80% cottonseed hull medium mixed with 18% wheat bran.

with 18.88 ± 0.02 g protein in 100 g dry fruiting bodies, followed by treatment T4 with 18.55 ± 0.05 g protein. The lowest protein content was observed for treatment T2 at 16.35 ± 0.05 g. The fat contents were also different among the 6 treatments and the highest fat content was found for treatment T2, followed by treatment T4. The lowest fat content was observed for treatment T1. The highest dietary fiber content was treatment T2, followed by T6, and the lowest was treatment T1. The carbohydrate contents from treatment T1 to T6 were 33.39 ± 0.08, 30.73 ± 0.05, 30.37 ± 0.02, 30.23 ± 0.09, 30.08 ± 0.04, and 32.02 ± 0.08 g per 100 g dry matter, respectively.

The amino acid composition and content (g in 100 g dried fruiting bodies) are shown in Table 6. *O. canarii* cultivated on the 6 treatments consisted of 18 amino acids, but the content of each amino acid differed among the treatments. The contents of essential amino acids in all treatments varied from 4.19 (treatment T3) to 4.76 g (treatment T1), which amounted to 36.05–40.37% of the total amino acids in the mushroom fruiting bodies.

4. Discussion

In this study, *O. canarii* was successfully cultivated on six treatments with cottonseed hull, sawdust, corncob and various combinations of the above agricultural byproducts. However, the mycelial growth rates of the six treatments do not correspond with the yield and BE. Treatment T2 (80% sawdust + 18% wheat bran) showed the highest growth rate and shortest colonization time, whereas the yield and BE of treatment T2 were lower than the others. This might be caused by the following reasons. Firstly, *O. canarii* grows in nature on dead wood (Fig. 1) as a saprophyte and primary decomposer, so the sawdust in the substrate may induce the secretion of lignocellulosic enzymes to degrade materials for nutrition and therefore promote mycelial growth. Secondly, sawdust can increase the air permeability of the substrates and carbohydrates derived from organic supplements in the substrates, such as wheat bran, will be easily metabolized. Finally, *O. canarii* may not be suitable for cultivation on sawdust because all the treatments (treatment T2, T4, and T6) containing sawdust had lower yields and BEs compared with treatments without sawdust. Ruegger et al. (2001) also reported that the BE of *O. canarii* cultivated on eucalyptus sawdust was 19.51%,

Table 4 Comparison of yield and biological efficiency of *Oudemansiella canarii* on different treatment groups[a] (mean ± SD, $n = 3$).

Treatment group	Fresh weight of mushrooms by flushes (g)						Total fresh weight (g)	BE (%)
	1st	2nd	3rd	4th	5th	6th		
T1	1958.2 ± 259.1a	2099.7 ± 520.4a	1541.0 ± 298.8a	1165.3 ± 129.8b	663.4 ± 125.8b	527.5 ± 19.0b	7955.1 ± 217.5a	113.64 ± 3.11a
T2	261.2 ± 67.9c	1715.7 ± 245.8ab	1747.5 ± 341.1a	1401.2 ± 273.6ab	549.2 ± 174.4bc	309.6 ± 193.3c	5984.4 ± 92.3a	85.49 ± 1.32c
T3	2079.3 ± 469.7a	1891.9 ± 173.5ab	1312.6 ± 161.1ab	1411.2 ± 139.7ab	439.6 ± 32.2bc	261.0 ± 33.1c	7395.5 ± 68.3b	105.65 ± 0.98b
T4	1211.7 ± 166.2b	2112.4 ± 172.8a	1175.2 ± 195.4ab	704.8 ± 113.7c	376.2 ± 212.0c	241.1 ± 36.5c	5821.5 ± 175.1c	83.26 ± 2.50c
T5	1816.6 ± 325.4a	1341.7 ± 319.2b	1333.7 ± 427.7ab	1518.3 ± 72.7a	932.8 ± 138.8a	764.8 ± 177.8a	7707.9 ± 231.6ab	110.11 ± 3.31ab
T6	1020.4 ± 53.8b	1497.6 ± 243.6b	864.5 ± 304.7b	872.0 ± 89.3c	617.6 ± 112.4bc	433.1 ± 78.1bc	5305.2 ± 424.3d	75.79 ± 6.06d

[a] Means in each column followed by the same superscripts are not significantly different at $P < 0.05$ according to Duncan's multiple range tests.

Table 5 Comparison of chemical compositions of *Oudemansiella canarii* on different treatment groups[a] (100 g of dry matter, mean ± SD, $n = 3$).

Parameter	T1	T2	T3	T4	T5	T6
Protein (g)	16.65 ± 0.05e	16.35 ± 0.05f	18.45 ± 0.05c	18.55 ± 0.05b	18.88 ± 0.02a	17.07 ± 0.07d
Moisture (g)	6.69 ± 0.01c	6.63 ± 0.00d	6.68 ± 0.02c	6.73 ± 0.03b	6.78 ± 0.02a	6.67 ± 0.00c
Ash (g)	8.13 ± 0.03c	7.99 ± 0.02d	8.41 ± 0.03b	8.91 ± 0.02a	8.05 ± 0.07d	8.04 ± 0.04d
Fat (g)	1.64 ± 0.01f	3.04 ± 0.01a	1.96 ± 0.01d	2.36 ± 0.01b	2.32 ± 0.01c	1.96 ± 0.01d
Dietary fiber (g)	33.52 ± 0.05e	35.27 ± 0.03a	34.13 ± 0.05c	33.24 ± 0.06f	33.91 ± 0.03d	34.25 ± 0.03b
Carbohydrate (g)	33.39 ± 0.08a	30.73 ± 0.05c	30.37 ± 0.02d	30.23 ± 0.09e	30.08 ± 0.04f	32.02 ± 0.08b

[a] Means in each column followed by the same superscripts are not significantly different at $P < 0.05$ according to Duncan's multiple range tests.

Table 6 Comparison of amino acid content and composition of *Oudemansiella canarii* on different treatment groups[a] (g in 100 g of dry matter, mean ± SD, $n = 3$).

Amino acids	T1	T2	T3	T4	T5	T6
Asparagine	0.97 ± 0.03a	0.90 ± 0.04b	0.92 ± 0.05ab	0.88 ± 0.01b	0.93 ± 0.04ab	0.90 ± 0.04b
Threonine*	0.56 ± 0.01a	0.50 ± 0.01c	0.50 ± 0.01c	0.50 ± 0.00c	0.53 ± 0.02b	0.53 ± 0.01b
Serine	0.55 ± 0.01a	0.51 ± 0.04b	0.51 ± 0.02ab	0.50 ± 0.00b	0.54 ± 0.02ab	0.53 ± 0.02ab
Glutamic acid	1.42 ± 0.05bc	1.49 ± 0.22b	1.23 ± 0.15c	1.81 ± 0.02a	1.24 ± 0.08c	1.31 ± 0.12bc
Proline	1.16 ± 0.05bc	1.21 ± 0.18b	1.00 ± 0.14c	1.44 ± 0.02a	0.98 ± 0.06c	1.01 ± 0.10bc
Glycine	0.44 ± 0.01a	0.42 ± 0.03ab	0.41 ± 0.02b	0.42 ± 0.01ab	0.41 ± 0.01ab	0.42 ± 0.01ab
Alanine	0.73 ± 0.01a	0.69 ± 0.03bc	0.67 ± 0.03c	0.71 ± 0.00ab	0.67 ± 0.02c	0.69 ± 0.02bc
Cysteine	0.12 ± 0.01b	0.06 ± 0.01c	0.21 ± 0.00a	0.22 ± 0.01a	0.21 ± 0.00a	0.22 ± 0.01a
Valine*	1.42 ± 0.02a	1.27 ± 0.03b	1.21 ± 0.06c	1.30 ± 0.01b	1.30 ± 0.03b	1.32 ± 0.02b
Methionine*	0.69 ± 0.02a	0.64 ± 0.04b	0.60 ± 0.05bc	0.64 ± 0.01ab	0.59 ± 0.03bc	0.56 ± 0.02c
Isoleucine*	0.51 ± 0.01a	0.45 ± 0.03b	0.45 ± 0.01b	0.41 ± 0.01c	0.47 ± 0.00b	0.47 ± 0.00b
Leucine	0.74 ± 0.01a	0.67 ± 0.02c	0.69 ± 0.02bc	0.63 ± 0.00d	0.71 ± 0.02b	0.69 ± 0.01bc
Tyrosine*	0.17 ± 0.01ab	0.19 ± 0.03a	0.17 ± 0.01ab	0.13 ± 0.01c	0.17 ± 0.01ab	0.15 ± 0.00bc
Phenylalanine*	0.53 ± 0.01a	0.45 ± 0.01c	0.45 ± 0.01c	0.45 ± 0.01c	0.48 ± 0.01b	0.48 ± 0.00b
Lysine*	0.66 ± 0.01a	0.60 ± 0.02b	0.61 ± 0.02b	0.57 ± 0.00c	0.64 ± 0.02a	0.61 ± 0.01b
Histidine*	0.22 ± 0.01a	0.20 ± 0.01b	0.20 ± 0.01b	0.20 ± 0.01b	0.20 ± 0.00b	0.20 ± 0.01b
Tryptophan	0.19 ± 0.00b	0.14 ± 0.00c	0.22 ± 0.01a	0.20 ± 0.01b	0.21 ± 0.00a	0.12 ± 0.01d
Arginine	0.71 ± 0.01a	0.63 ± 0.02d	0.63 ± 0.02 cd	0.64 ± 0.01bcd	0.66 ± 0.02b	0.66 ± 0.01bc

[a] Means in each column followed by the same superscripts are not significantly different at $P < 0.05$ according to Duncan's multiple range tests.
* Essential amino acids.

which was 1/3 the value of *O. canarii* grown on sugarcane bagasse. Treatment T3 (80% corncob + 18% wheat bran) displayed a lower growth rate and longest colonization time. Although it had better air permeability than all other substrates, corncob had a low water-holding capability and large volume for the same dry weight, which might explain these results. The yield and BE of treatment T3 were quite good compared with others, which might be explained by the easy decomposition of the carbon and nitrogen sources in corncob. In China, most of the industrial mushroom cultivation companies, which demand only one flush for the whole production, supplement parts of corncobs in the substrates to reduce life cycle and achieve a higher yield (Zhang et al., 2014). Treatment T1 (80% cottonseed hull + 18% wheat bran) showed the fastest growth rate, shortest colonization time, and highest yield and BE. As we all know, cottonseed hulls are byproducts of cotton production. Previous studies revealed that cottonseed hulls possess advantages as a substrate material due to their high water-holding capability, nitrogen content and contribution to high mushroom yield (Quinio et al., 1990; Li et al., 2001; Zhou et al., 2011).

The BE of *O. canarii* was between 75.79–113.64% (Table 4), which was 1.4–2.0-fold higher than that reported on sugarcane bagasse substrate by Ruegger et al. (2001) (55.66%). The C/N ratios of treatments T1, T3, and T5, which had high BEs, were nearly the same at 46:1 (Tables 2 and 4), while other treatments with higher C/N ratios showed lower biological efficiencies, which implies that high nitrogen content in substrates could improve the mushroom yield. This result was in accordance with the reports of other researchers (Dundar et al., 2009; Yildiz and Karakaplan, 2003; Kurt and Buyukalaca, 2010). As shown in Table 7, the highest BE of *O. canarii* obtained on cottonseed hull substrate was slightly higher than that for other *Oudemansiella* species on different substrates except for *O. submucida* on sawdust and cottonseed hulls and *O. tanzanica* on sisal waste and sawdust. Application of different substrates in the cultivation of the same species had a significant effect on mushroom yield. Therefore, additional research is still needed to optimize the cultivation formula to improve the yield of *O. canarii*.

Recently, many mushroom chemical contents analyses have been reported (Dundar et al., 2009; Lee et al.,

Table 7 Comparison of biological efficiency of *Oudemansiella canarii* and other *Oudemansiella* specie mushrooms cultivated on different substrates.

Mushroom	Substrate	Biological efficiency (%)	References
Oudemansiella tanzanica	Paddy straw	101.90	Magingo et al. (2004)
Oudemansiella tanzanica	Sisal waste	126.10	Magingo et al. (2004)
Oudemansiella tanzanica	Sawdust	145.40	Magingo et al. (2004)
Oudemansiella canarii	Sugar-cane bagasse	55.66	Ruegger et al. (2001)
Oudemansiella canarii	Eucalyptus sawdust	19.51	Ruegger et al. (2001)
Oudemansiella radicata	Oak sawdust	–	Shim et al. (2006)
Oudemansiella radicata	Sawdust	100.00	Gao (2000)
Oudemansiella mucida	Oak sawdust	–	Lee et al. (2007)
Oudemansiella brunneomarginata	Sawdust	–	Qi et al. (2011)
Oudemansiella submucida	Sawdust + cottonseed hull	140.36	Li et al. (2012)
Oudemansiella canarii	Cottonseed hull	113.64	This work
Oudemansiella canarii	Corncob	105.65	This work
Oudemansiella canarii	Sawdust	85.49	This work

2011). However, the chemical contents, which are easily affected by the strain genotype, substrate origin, and atmospheric conditions, are usually different. In the present study, the chemical compositions and contents of *O. canarii* cultivated on various substrates were determined (Table 5). The protein contents varied from 16.35 g to 18.88 g and were lower than those of the same species grown on sugarcane bagasse (19.45 g) and eucalyptus sawdust (22.81 g) substrates. The ash contents varied from 7.99 to 8.91 g, which were higher than that of the same species grown on sugarcane bagasse (7.26 g) and eucalyptus sawdust (9.15 g) substrates (Ruegger et al., 2001). The essential amino acid contents in the six treatments were different, and treatment T1, which contained 80% cottonseed hull, showed the highest content (4.76 g) (Table 6).

In conclusion, *O. canarii* demonstrated good traits in terms of mycelial growth rate, colonization time, yield, BE, chemical compositions, and amino acid contents when cultivated on treatment T1, which consisted of 80% cottonseed hull, 18% wheat bran, and 2% lime. To the best of our knowledge, this is the first report of the cultivation of this species on lignocellulosic wastes in China. Furthermore, additional experiments using cottonseed hull supplemented with different proportions (less than 40%) of corncob as the substrate should be performed to determine the most efficient one in terms of yield and BE.

Acknowledgements

This work was financially supported by National Infrastructure of Microbial Resources (NIMR-2013-7) and Beijing Innovative Grant of Modern Agricultural Technology System (Grant No. PXM2013-036204-00069).

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