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Non-volatile components of several novel species of edible fungi in China

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Abstract

Four species of newly commercial edible mushrooms in China, including red oyster mushroom (*Pleurotus djamor*), ferula mushroom (*Pleurotus ferulae*), white-ling mushroom (*Pleurotus nebrodensis*) and purple spore oyster (*Pleurotus sapidus*) were studied. Their carbohydrate, polysaccharide, crude fibre, crude protein, crude fat and ash contents were in the ranges of 46.2–59.9%, 9.02–18.8%, 11.2–17.2%, 15.6–30.3%, 1.65–7.35% and 3.84–5.83%, respectively. Their mineral element contents varied significantly, with the (highest) potassium contents ranging from 12.3 to 16.3 mg/g of dry weight and the (lowest) zinc contents ranging from 0.02 to 0.18 mg/g of dry weight detected among six mineral elements. Their total soluble sugar contents ranged from 9.37 (red oyster mushroom) to 31.9 mg/g (purple spore oyster) with the same levels in ferula mushroom (20.2 mg/g) as white-ling mushroom (23.7 mg/g). Their total amino acid contents and essential amino acid contents ranged from 84.4 to 192 mg/g and from 24.8 to 71.5 mg/g, respectively. Glutamic acid, aspartic acid, leucine and arginine were four major amino acids in these four species of mushrooms. Their palatable amino acid contents were high in ferula mushroom (53.6 mg/g), moderate in white-ling mushroom and purple spore oyster (about 33.8 mg/g), and low in red oyster mushroom (15.8 mg/g). Results showed that these four species of newly commercial mushrooms in China were distinctly different in non-volatile components.

Keywords: Mushroom; *Pleurotus djamor*; *Pleurotus ferulae*; *Pleurotus nebrodensis*; *Pleurotus sapidus*; Soluble sugars; Amino acids; Mineral elements

1. Introduction

Pleurotus djamor (Fr.) Boedjin.Sense Lato, *Pleurotus ferulae* Lanzi., *Pleurotus nebrodensis* (Inzengae) Quél. and *Pleurotus sapidus* (Schulz) Sacc. are four species of newly commercial edible mushrooms in China. They are becoming increasingly popular. Their annual production exceeded thousands of tons in recent years, for example, over 60,000 tons of *P. ferulae*, 52,200 tons of *P. nebrodensis* and 20,000 tons of *P. sapidus* were produced in 2003 in China (Chang, 2005). *P. djamor* is also called red oyster mushroom. It was introduced in South China from India in the 1990s. *P. ferulae* is also called ferula mushroom because its wild strain always grows very close to or on the stem of the plant ferula. It was successfully domesticated in the 1990s in the northwest of China. *P. nebrodensis* is also called white-ling mushroom. It was domesticated in China in the 1990s too. Some workers regard it as a variant of *P. ferulae* (Pu & Qi, 2001). *P. sapidus* is also called delicious oyster or purple spore oyster since its spore is purple. It was introduced in China from Japan in the 1990s.

The non-volatile components of paddy straw mushroom (*Volvariella volvacea*), common button mushroom

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(*Agaricus bisporus*), shiitake mushroom (*Lentinula edodes*), winter mushroom (*Flammulina velutipes*), abalone mushroom (*Pleurotus cystidiosus*), and tree oyster mushroom (*Pleurotus ostreatus*) have been reported (Mau, Chyau, Li, & Tseng, 1997; Tseng & Mau, 1999; Yang, Lin, & Mau, 2001). The non-volatile taste components of basket stinkhorn mushroom (*Dictyophora indusiata*), maitake mushroom (*Grifola frondosa*), lion's mane mushroom (*Hericium erinaceus*), white matsutake mushroom (*Tricholoma giganteum*), Southern poplar mushroom (*Agrocybe cylindracea*), ear mushroom (*Auricularia auricula*), and king oyster mushrooms (*Pleurotus eryngii*) have also been reported (Mau, Lin, Ma, & Song, 2001; Mau & Tseng, 1998; Mau, Lin, Chen, Wu, & Peng, 1998; Mau, Wu, Wu, & Lin, 1998). The non-volatile components of several medicinal mushrooms, Ling Chih (*Ganoderma lucidum*), Sung Shan Ling Chih (*Ganoderma tsugae*) and Yun Chih (*Coriolus versicolor*) have been reported too (Mau, Lin, & Chen, 2001). However, the non-volatile components and nutritional values of four species of currently commercial and very popular edible mushrooms in China, including *P. djamor, P. ferulae, P. nebrodensis* and *P. sapidus* are not clearly understood. Therefore, the objective of this work was to examine the non-volatile taste components in these four novel commercial species of popular edible mushrooms, including their proximate compositions, mineral elements, soluble sugars, amino acids and taste amino acids. The differences between species were also compared.

2. Materials and methods

2.1. Mushrooms

Fresh fruiting bodies of *P. djamor, P. ferulae, P. nebrodensis, P. sapidus* were purchased in a local supermarket in Guangzhou city, China. The fruiting bodies of each species were randomly selected and weighed on an electronic balance as three replicates, about 500 g for each sample. Then they were subjected to air-drying in an oven at 80 °C to constant weight before component analysis.

2.2. Proximate analysis

The proximate compositions of the four species of edible mushrooms, including dry matter, carbohydrate, crude fibre, crude protein, crude fat, ash, were determined according to the methods of AOAC (1990). The nitrogen factor used for crude protein calculation was 4.38 (Crisan & Sands, 1978). Polysaccharides were determined as follows: the dry fruiting body of each sample was ground to powder. Ten grammes of the powdered samples were extracted with 100 ml of boiling water for 30 min; 400 ml of absolute alcohol were added to precipitate the water-soluble polysaccharide. The precipitated polysaccharide was collected by centrifugation at 5000 rpm for 10 min in a bench centrifuge and subsequently dried at 60 °C to remove residual ethanol. The polysaccharide content was determined by the phenol–sulfuric acid assay according to (Dubois, Gilles, Hamilton, Rebers, & Smith, 1956).

2.3. Mineral element analysis

About 1.5 g of air-dried mushroom was calcined to white powder in a LTA-154 plasma calcination furnace. For phosphorus determination, each sample of the powder was dissolved in 25 ml of vanadium–ammonium molybdate buffer containing 1.0 N HCl and 8 g/l of vanadium–ammonium molybdate and 0.5 g/l of fructose and was boiled for 20 min in a boiling water bath. Then the boiled sample solution absorbance was determined at 660 nm using a 755-B UV–Visual spectrophotometer. KH_2PO_4 was prepared as the standard. For other mineral element determinations, each sample of the ashing powder was dissolved in 50 ml of 1% HNO_3 solution. Then the solution was analysed for its calcium (Ca), magnesium (Mg), potassium (K), iron (Fe) and zinc (Zn) contents by using an atomic absorption spectrometer (Varian Spectr AA-220 FS). The Varian Spectr AA-220 FS system was equipped with a Mark VII double-beam flame atomizer, a programmed gas controller, a deuterium background correction system and a IEEE card (Varian, USA). These analyses were done in the Instrumental Analysis & Research Centre of South China Agricultural University.

2.4. Soluble sugar analysis

About 1.5 g of air-dried mushroom powder was extracted with 60 ml of 80% aqueous ethanol at 60 °C for 45 min. The resulting suspension was centrifuged at 15,000 *g* for 10 min. The supernatant was concentrated at 60 °C under reduced pressure and defatted three times with 10 ml of ethyl ether, successively. After concentration with a rotary evaporator at 40 °C, the solid residues were dissolved in deionized water to a final volume of 10 ml. Then soluble sugar contents were determined with a high-performance liquid chromatograph (HPLC, Agilent 1100). The HPLC system consisted of Hewlett–Packard Agilent 1100 Series components, including a quaternary pump, degasser, auto-sampler, and variable-wavelength UV detector. Chromatographic separations were achieved using an Agilent Eclipse XDB-C8 column (150 × 2.1 mm, i.d. 5 μm) and a Phenomenex Security Guard C18 guard column. The mobile phase was acetonitrile and deionized water at 17:3 (v/v) and the flow rate was 1.5 ml/min. The column temperature was at 25 °C. These analyses were also performed in the Instrumental Analysis &

Research Centre of South China Agricultural University.

2.5. Amino acid analysis

About 1.5 grammes of air-dried mushroom powder was hydrolyzed in 10 ml of 6 N HCl under vacuum in an ampulla tube at 110 °C for 22 h. The resulting suspension was filtered through a Whatman 3 filter paper; 2 ml of filtrate were withdrawn and evaporated with a vacuum evaporator. The solid residue was dissolved in 2 ml of deionized water and evaporated twice again, successively. The last residue was dissolved in 10 ml of 0.01 N HCl and filtered with a 0.45 μm filter membrane. Then the filtrate was ready for quantification of amino acids. An additional sample of *P. djamor* was hydrolyzed with 10 ml of 2.5 N NaOH under N_2 in an ampulla tube at 110 °C for 22 h for tryptophan quantification. The amino acid components and their contents in the filtrates were determined by using the HITACHI-automated amino acid analyzer L-8800. The L-8800 HITACHI-automated amino acid analyzer system was equipped with a #2622 ion-exchange column (4.6 × 60 mm) and a UV-detector. The temperature of the separation column was at 57 °C. The buffer flow rate was 0.40 ml/min and the pressure of the buffer pump was 12 Pa. The ninhydrin flow rate was 0.30 ml/min and the pressure of ninhydrin pump was 1.1 kPa. These analyses were also performed in the Instrumental Analysis & Research Centre of South China Agricultural University.

2.6. Statistical analysis

Three samples of the fruiting bodies of each mushroom species were analyzed for the determination of their components. The experimental data were subjected to analysis of variance for the completely randomized design with a single factor, as described by Dean and Voss (1999). The least significant differences among means were determined by Duncan's multiple comparison test at the level of 0.05. After multiple comparisons, the means in the following Tables were followed with different small letters "a–d" based on their values and statistical differences. In the case of means followed with the same letter(s), these means were not significantly different from each other. However, means with different letters were significantly different at the level of 0.05.

3. Results and discussion

3.1. Proximate compositions

Water contents of red oyster mushroom (*P. djamor*), ferula mushroom (*P. ferulae*), white-ling mushroom (*P. nebrodensi*), purple spore oyster mushroom (*P. sapidus*) ranged from 82.21% to 91.11% (Table 1). This is consistent with the result reported by Crisan and Sands (1978) that most fresh mushrooms contained about 90% moisture. However, red oyster mushroom seemed to be less moist. Its water content was significantly less than that of other mushrooms. Ferula and white-ling mushrooms contained less carbohydrate (47.8% and 46.2%, respectively) than did red oyster mushroom and purple spore oyster mushroom (59.9% and 57.1%, respectively). However, these carbohydrate contents were all in the range 44.0–74.3% (Crisan & Sands, 1978) and 46.6–81.8% (Bano & Rajarathnam, 1988).

Polysaccharides in edible mushrooms are highly regarded as biologically or medically active compounds and are used as functional food ingredients or nutraceuticals. Polysaccharide contents varied among these four species of *Pleurotus* mushrooms and ranged from 9.02% to 18.8% dry weight and were in the order: red oyster mushroom, purple spore oyster mushroom, ferula mushroorm, white-ling mushroom. They were significantly different from each other.

The fibre content in red oyster mushroom (17.2%) was much higher than those in the other three

Table 1
Proximate compositions of *Pleurotus djamor, Pleurotus ferulae, Pleurotus nebrodensis*, and *Pleurotus sapidus*

Component[a]	Content(%)[b]			
	P. djamor	*P. ferulae*	*P. nebrodensis*	*P. sapidus*
Water	82.21 ± 1.35c	91.11 ± 0.88a	87.74 ± 0.72b	90.53 ± 1.74a
Dry matter	17.79 ± 1.35a	8.89 ± 0.88c	12.26 ± 0.72b	9.47 ± 1.74c
Carbohydrate	59.9 ± 1.03a	47.8 ± 0.96c	46.2 ± 1.25c	57.1 ± 1.12b
Polysaccharide	9.02 ± 1.27d	15.9 ± 0.25b	18.8 ± 0.76a	11.2 ± 0.13c
Crude fibre	17.2 ± 0.72a	11.2 ± 0.19bc	15.7 ± 1.18b	12.3 ± 0.22bc
Crude protein	15.6 ± 1.52c	30.3 ± 1.45a	27.7 ± 1.71a	20.4 ± 1.09b
Crude fat	1.65 ± 0.32c	5.71 ± 0.61b	7.35 ± 0.93a	4.85 ± 0.24b
Ash	5.83 ± 1.06a	4.96 ± 0.36b	3.84 ± 0.48c	5.32 ± 0.88ab

[a] Water and dry matter contents are presented based on fresh weight, others are presented based on dry weight.
[b] Each value is expressed as mean ± standard error of three replicate analyses. Values with different small letters in the same row are significantly different at the level of 0.05.

mushrooms, and even higher than those in white and yellow winter mushrooms (*F. velutipes*) at 16.0% and 17.0%, respectively (Yang et al., 2001). The fibre contents in ferula mushroom, purple spore oyster mushroom and white-ling mushroom ranged from 11.2% to 15.0% and were quite high in comparison with those in king oyster mushrooms (*P. eryngii*) (5.97–9.15%) (Mau et al., 1998) and many other edible mushrooms (3.70–11.1%) (Bano & Rajarathnam, 1988; Chang & Miles, 1989; Crisan & Sands, 1978; Mau, Lin, & Ma et al., 2001; Yang et al., 2001).

Edible fungi are highly valued as a good source of protein and their protein contents usually range from 19% to 35% of dry weight (Crisan & Sands, 1978), from 15.4% to 26.7% (Yang et al., 2001) or from 14.6% to 22.3% (Mau, Lin, & Ma et al., 2001). Here, protein contents in these four species of *Pleurotus* mushrooms ranged from 15.6% to 30.3% and were in the order: red oyster mushroom, purple spore oyster mushroom, white-ling mushroom, ferula mushroom. This meant that red oyster mushroom contained mush less protein than common mushrooms.

Crude fat contents here ranged from 1.65% to 7.35% and were in the range of 1.1–9.23% (Crisan & Sands, 1978; Mau, Lin, & Ma et al., 2001; Yang et al., 2001). Ash contents ranged from 3.84% to 5.83% in these four species of mushrooms. This meant that they contained less ash in comparison with other common mushrooms (5.27–9.62%) (Yang et al., 2001). In general, from the results shown in Table 1, these four *Pleurotus* mushrooms were considerately different in their proximate compositions.

3.2. Mineral element contents

Potassium contents ranged from 12.3 to 16.3 mg/g of dry weight in these four species of *Pleurotus* mushrooms and were the highest among detected six mineral elements and indeed were much higher than those of other mineral elements (Table 2). Phosphorus ranked second highest followed by magnesium. Iron and zinc contents ranged from 0.05 to 0.59 mg/g and from 0.02 to 0.18 mg/g, respectively. Among these four *Pleurotus* mushrooms, red oyster mushroom contained slightly more mineral element contents than the other three mushrooms.

Zhang, Huang, Lai, and Lin (1995) reported that the fruiting body of *P. djamor* contained calcium (Ca) 1270 μg/g, phosphorus (P) 7780 μg/g, potassium (K) 13,000 μg/g, sodium (Na) 380 μg/g, iron (Fe) 478 μg/g, magnesium (Mg) 1100 μg/g, zinc (Zn) 200 μg/g, copper (Cu) 46 μg/g, molybdenum (Mo) 0.2 μg/g, and manganese (Mn) 32 μg/g. These data were consistent with the data presented in this work.

Gong, Yu, and Qu (2003) reported that the fruiting body of *P. ferulae* contained calcium (Ca) 69 μg/g, iron (Fe) 33 μg/g, zinc (Zn) 78 μg/g and selenium (Se) 0.04 μg/g. However, Shi and Shao (2003) reported that there were Ca 96.8 μg/g, Fe 887 μg/g and Zn 190 μg/g in the fruiting body *P. ferulae*. These data were very different from the data in our work. This difference probably arose from different mushroom samples cultivated with different substrates.

Chen (1999) reported that there were K 16,398 μg/g, Na 190 μg/g, Ca 98 μg/g, Mg 597 μg/g, Mn 2.2 μg/g, Zn 17.5 μg/g, Cu 3.2 μg/g, P 5,190 μg/g and Se 0.068 μg/g in the fruiting body of *P. nebrodensis*. These data were equivalent to the data in our work.

Zhang, Zheng, Li, and Xu (1995) reported that there were Al 95.7 μg/g, B 13.5 μg/g, Ba 5.59 μg/g, Cd 0.42 μg/g, Co 0.10 μg/g, Cr 1.50 μg/g, Cu 90.9 μg/g, Fe 227 μg/g, La 0.90 μg/g, Mg 2170 μg/g, Mn 0.85 μg/g, Ni 0.44 μg/g, P 10,161 μg/g, Pb 2.59 μg/g, Sr 0.05 μg/g, Ti 5.72 μg/g and Zn 80.3 μg/g in the fruiting body of *P. sapidus*. These data were very different from the data in our work. No other information on toxic metals, such as arsenic, lead, mercury and cadmium, in these four mushrooms has been reported. Further investigation on these toxic metals and other macro and micronutrients is needed.

3.3. Soluble sugar contents

Glucose contents in the four *Pleurotus* mushrooms were found at two distinct levels, a high level in white-ling mushroom and purple spore oyster mushroom,

Table 2
Mineral element contents of *P. djamor, P. ferulae, P. nebrodensis*, and *P. sapidus*

Mineral element	Content (mg/g dry weight)[a]			
	P. djamor	*P. ferulae*	*P. nebrodensis*	*P. sapidus*
Ca	1.42 ± 0.08a	0.23 ± 0.05c	0.17 ± 0.07c	0.84 ± 0.11b
Mg	1.21 ± 0.15a	0.85 ± 0.17b	0.79 ± 0.10b	1.19 ± 0.13a
P	7.57 ± 0.33a	4.99 ± 0.68b	5.10 ± 0.91b	5.13 ± 0.95b
K	12.3 ± 1.66c	16.2 ± 0.75a	16.3 ± 0.42a	14.3 ± 0.57b
Fe	0.59 ± 0.12a	0.07 ± 0.01c	0.05 ± 0.01c	0.19 ± 0.05b
Zn	0.18 ± 0.07a	0.08 ± 0.02b	0.02 ± 0.01c	0.07 ± 0.02b

[a] Each value is expressed as mean ± standard error of three replicate analyses. Values with different small letters in same row are significantly different at the level of 0.05.

but low levels in ferula mushroom and red oyster mushroom (Table 3). But glucose contents here were much lower than those ranging from 10.6 to 42.3 mg/g reported by Yang et al. (2001). Mannitol and trehalose were two major components in common button mushroom *A. bisporus* (Hammond & Nichols, 1976), paddy straw mushroom (Mau et al., 1997), shiitake and winter mushrooms (Yang et al., 2001), basket stinkhorn (*D. indusiata*), maitake (*G. frondosa*), lion's mane (*H. erinaceus*), white matsutake (*T. giganteum*), and other oyster mushrooms *P. cystidiosus, P. ostreatus, Pleurotus flabellatus* (Bano & Rajarathnam, 1988; Yang et al., 2001). This was the same results. However, their contents and total soluble sugar contents in these four *Pleurotus* mushrooms were significantly below in other mushrooms.

3.4. Amino acid contents

Total amino acid contents in these four *Pleurotus* mushrooms were very high and ranged from 84.4 to 192 mg/g dry weight (Table 4). Ferula mushroom contained the highest amount of total amino acids whereas red oyster mushroom contained the lowest amount of amino acids. White-ling mushroom and purple spore oyster mushroom contained equivalent amounts of amino acids with no significant difference. Contents of essential amino acids varied among these four mushrooms and were in the same order as the total amino acid contents for these mushrooms. The four *Pleurotus* mushrooms were considerably different in the profiles of their amino acid contents. Red oyster mushroom contained relatively more arginine, aspartic acid and glutamic acid,

Table 3
Soluble sugar contents of *P. djamor, P. ferulae, P. nebrodensis*, and *P. sapidus*

Sugar	Content (mg/g dry weight)[a]			
	P. djamor	*P. ferulae*	*P. nebrodensis*	*P. sapidus*
Glucose	1.47 ± 0.29b	3.39 ± 1.16b	6.85 ± 1.04a	7.25 ± 0.69a
Mannitol	3.65 ± 0.81b	10.1 ± 0.22a	9.33 ± 0.49a	9.91 ± 1.35a
Trehalose	4.25 ± 0.32c	6.68 ± 0.51b	7.51 ± 0.97b	14.8 ± 0.66a
Total	9.37 ± 1.13c	20.2 ± 1.65b	23.7 ± 1.92b	31.9 ± 2.24a

[a] Each value is expressed as mean ± standard error of three replicate analyses. Values with different small letters in same row are significantly different at the level of 0.05.

Table 4
Amino acid contents of *P. djamor, P. ferulae, P. nebrodensis*, and *P. sapidus*

Amino acid	Content (mg/g dry weight)[a]			
	P. djamor	*P. ferulae*	*P. nebrodensis*	*P. sapidus*
Alanine	5.50 ± 0.92c	12.9 ± 1.33a	5.66 ± 0.36c	7.85 ± 0.41b
Arginine	7.36 ± 0.71c	12.6 ± 1.04a	10.1 ± 0.11b	8.13 ± 0.25c
Aspartic acid	8.64 ± 0.16c	21.11 ± 1.42a	11.8 ± 0.82b	12.4 ± 0.79b
Cysteine	5.86 ± 0.11a	2.51 ± 0.07b	0.53 ± 0.03c	0.73 ± 0.19c
Glutamic acid	7.11 ± 1.07c	32.5 ± 2.28a	22.2 ± 1.59b	21.2 ± 0.93b
Glycine	5.53 ± 0.78b	9.53 ± 0.24a	5.62 ± 0.17b	5.59 ± 0.67b
Histidine	1.84 ± 0.21c	4.47 ± 0.52a	3.19 ± 0.13b	3.29 ± 0.07b
Isoleucine	4.33 ± 0.33c	11.38 ± 1.24a	5.76 ± 0.22b	5.56 ± 0.28b
Leucine	4.14 ± 0.69c	22.31 ± 1.90a	8.96 ± 0.75b	9.58 ± 1.21b
Lysine	3.65 ± 0.66c	12.96 ± 1.44a	6.75 ± 0.78b	7.81 ± 0.35b
Methionine	1.23 ± 0.04d	3.62 ± 0.13b	2.61 ± 0.05c	6.24 ± 0.09a
Phenylanaline	2.69 ± 0.15d	8.68 ± 0.29a	4.54 ± 0.03c	5.57 ± 0.44b
Proline	4.66 ± 1.05b	5.66 ± 0.77b	7.06 ± 0.21a	2.46 ± 0.38c
Serine	6.01 ± 0.43b	8.61 ± 1.16a	4.56 ± 0.53c	6.63 ± 0.22b
Threonine	3.73 ± 0.64c	8.06 ± 0.55a	4.65 ± 0.70c	6.23 ± 0.18b
Tryptophan	3.16 ± 1.56a	Not available	Not available	Not available
Tyrosine	3.35 ± 0.67ab	3.29 ± 0.53ab	2.47 ± 0.04b	3.62 ± 0.21a
Valine	5.57 ± 0.71c	11.8 ± 1.31a	6.82 ± 0.17b	6.49 ± 0.85bc
Total	84.4 ± 1.66c	192 ± 3.11a	113 ± 3.59b	119 ± 1.72b
Essential AA	24.8(29.4%)	71.5(37.2%)	36.5(32.2%)	44.3(37.1%)

[a] Each value is expressed as mean ± standard error of three replicate analyses. Values with different small letters in same row are significantly different at the level of 0.05.

Table 5
Contents of amino acids with taste characteristics of *P. djamor, P. ferulae, P. nebrodensis*, and *P. sapidus*

Taste characteristics[a]	Content (mg/g dry weight)[b]			
	P. djamor	*P. ferulae*	*P. nebrodensis*	*P. sapidus*
Palatable	15.8 ± 1.10c	53.6 ± 2.35a	34.0 ± 2.31b	33.7 ± 1.65b
Sweet	20.8 ± 1.15c	39.1 ± 1.28a	20.5 ± 1.04c	26.3 ± 0.96b
Bitter	30.3 ± 1.35c	74.8 ± 3.20a	42.0 ± 1.56b	44.9 ± 1.71b
Tasteless	7.00 ± 1.08c	16.3 ± 1.69a	9.22 ± 0.83bc	11.4 ± 0.61b

[a] Palatable, Asp Glu; Sweet, Ala Gly Ser Thr; Bitter, Arg His Ile Leu Met Phe Trp Val; Tasteless, Lys Tyr.
[b] Each value is expressed as mean ± standard error of three replicate analyses. Values with different small letters in same row are significantly different at the level of 0.05.

but all were in equivalent amounts. Aspartic acid, glutamic acid and leucine were three major amino acids in ferula mushroom and purple spore oyster mushroom; they accounted for 40.0% and 36.2% of their total amino acid contents, respectively. Arginine, aspartic acid and glutamic acid were three major amino acids in white-ling mushroom and they accounted for 38.9% of total amino acid contents.

According to the classification described by Mau, Lin, and Ma et al. (2001) and Yang et al. (2001), amino acids in edible mushrooms were divided into several groups on the basis of their taste characteristics. Group one was monosodium glutamate-like (MSG-like) or palatable taste amino acids, including aspartic and glutamic acid (Table 5). Group two was sweet taste amino acids, including alanine, glycine, serine and threonine. Group three was bitter taste amino acids, including arginine, histidine, isoleucine, leucine, methionine, phenylanaline, tryptophan and valine. Palatable amino acid contents in these four *Pleurotus* mushrooms ranged from 15.8 to 53.6 mg/g dry weight. In comparison with the previous results reported by other researchers, the contents of palatable amino acids in these four *Pleurotus* mushrooms were in the high range. Mau et al. (1997) reported that palatable amino acids in paddy straw mushrooms ranged from 11.2 to 26.2 mg/g dry weight. The contents of palatable amino acids were in the range 10.9–11.9 mg/g in *A. cylindracea* (Mau & Tseng, 1998), 1.01–1.77 mg/g in *P. eryngii* (Mau et al., 1998), 0.05–0.34 mg/g in *Auricularia* spp. and *Tremella fuciformis* (Mau et al., 1998), and 22.7–47.1 mg/g in common button mushroom (Tseng & Mau, 1999). Palatable amino acid contents were found to be 0.84–7.06 mg/g in several commercial mushrooms, including *F. velutipes, L. edodes, P. cystidiosns and P. ostreatus* (Yang et al., 2001), 0.68–1.09 mg/g in several speciality mushrooms, including *D. indusiata, G. frondosa, H. erinaceus* and *T. giganteum* (Mau, Lin, & Ma et al., 2001), and 0.17–0.50 mg/g in medicinal mushrooms, including *G. lucidum, G. tsugae* and *C. versicolor* (Mau et al., 2001).

Sweet amino acid contents in these four *Pleurotus* mushrooms ranged from 20.5 to 39.1 mg/g dry weight. They were also in the very high range based on the previous results of 2.25–13.6 mg/g in several commercial mushrooms (Yang et al., 2001) and 0.36–8.71 mg/g in several speciality mushrooms (Mau, Lin, & Ma et al., 2001). Due to their low soluble sugar contents, the sweet taste of these four *Pleurotus* mushrooms mainly depends on the sweet amino acid contents.

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