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Extraction yield and nutraceuticals of mushroom *Pholiota* species

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비늘버섯류의 추출수율 및 영양 약리학적 특성

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ABSTRACT : This study was performed to obtain basal data for development of new functional food by using mushroom *Pholiota* spp.. Among several kinds of extracts, water extracts of *Pholiota adiposa* ASI 24027 showed the highest solid yield of 58.7%. Crude protein of *Pholiota adiposa* ASI 24015 and β-glucan contents of *Pholiota adiposa* ASI 24005 were 25.0% and 0.66%, respectively. K and Mg were also contained plentifully in the fruiting body of *Pholiota adiposa* ASI 24004 (3,649 mg and 138 mg/100g dried fruiting body, respectively). Amino acid and total fatty acid contents were similar between almost all of *Pholiota* spp..

KEYWORDS : Extraction yield, nutraceuticals, *Pholiota* species

Mushroom has become more and more attractive as gourmet and functional foods, as well as a source for the development of new drugs or nutraceuticals (Park et al, 2005; Jeong et al, 2003; Lee et al, 2003). It provides potentially beneficial effects for several common diseases afflicting human being, including cancer.

Mushroom *Pholiota* spp. commonly called "yellow-cap fungus", is classified as the Strophariaceae family (Sung et al, 2000) and also is found exclusively in Korea, Japan, China, Europe and North America. There are some kinds of *Pholiota* sp. in *Pholiota* genus such as *Pholiota adiposa*. They were very similar with morphological characteristics, so it was very difficult to identify and classify (Lee et al, 2005). Furthmore, they are toxic or non-toxic. Therefore, it is necessary to develop useful methods for classification of toxic or non-toxic mushroom *Pholiota* spp.. Few studies were done on the identification protocol and the pharmaceutical effect of *Pholiota* spp., except on its antibiotic or antitumor activities.

This paper describes on yields of water and methanol extracts from mushroom *Pholiota* spp. and further analyses nutritional and functional characteristics of mushroom, *Pholiota* spp..

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Materials and Methods

1. Mushrooms and chemicals

Mushrooms *Pholiota* spp. used in this study were obtained from Korean National Institute of Agricultural Science and Technology, RDA in Suwon. All chemicals used in this study were special pure grade.

2. Preparation of extracts from *Pholiota* spp.

Powders of 15 kinds of *Pholiota* spp. were added in each water and methanol(1:20, v/v) and then shaked for 12hrs. at 30℃. Each extracts were filtered by Whatman 0.45㎛ membrane filter(No. 7404-004) and lyophilized.

The lyophilized extracts was weighed and then calculated the yield as % per dry weight of *Pholiota* spp. fruiting body.

3. Nutritional component and amino acid content analysis of mushroom

Protein content of mushroom *Pholiota* spp. were determined by the Kjeldahl method of AOAC method

(AOAC. 1990) and its mineral components was analyzed by atomic absorption spectrophotometry and ICP after calcification. Vitamin B_1, B_2 and niacin contents were determined by the Thiochrome method, AOAC method and Koning reaction method, respectively and β-glucan contents was also determined by AOAC method. Amino acid composition was quantitatively analyzed by HPLC with fluorescece detector after derivatization process using Water Acc Q · Fluor™ reagent.

Results and Discussion

1. Solid yield of water and methanol extracts

17 kinds of *Pholiota* spp. were extracted by water and methanol, and then solid yields of the extracts were determined(Table 1). Water extract of *P. adiposa* ASI 24027 showed the highest solid yield of 58.7% and methanol extract of *P. adiposa* ASI 24013 showed also high solid yield of 25.3%. Furthermore, yields of water extracts were generally higher than those of methanol extracts. It suggests they probably contain more water-soluble compounds than water-insoluble compounds in the fruiting body of *Pholiota* spp.

Meanwhile, it was not increased by pretreatment such as heating and soaking(data not shown).

2. Nutritional component and amino acid content of mushroom, *Pholiota* spp.

Nutritional component and amino acid content of mushroom, *Pholiota* spp. were shown in Table 2 and 3.

Crude protein content of *Pholiota* spp. fruiting bodies were various in ranging of 0.2% - 25.0% and especially, fruiting body of *P. malicola* ASI 24015 contained 25% of crude protein.

Among minerals, K was contained plentifully in the *Pholiota* spp. and Ca was also contained the most abundantly in *P. adiposa* ASI 24013. In the fruiting body of *P. adiposa* ASI 24004, K and Mg were also contained a large amounts of 3649 and 138 mg per 100g of dried fruiting body, respectively.

Iron(Fe) contents was the highest in *P. adiposa* ASI 24024 (19.6mg/100g of dried fruiting body). Phosphorus(P) contents was the highest in *P. malicola* ASI 24015 (859.1 mg/100g of dried fruiting body).

Vitamin B_1, B_2 and niacin contents were similar between almost all of samples, but B_2 and niacin were not determined in *Pholiota* sp. ASI 24008 and *P. adiposa* ASI 24010.

β-Glucan, known anticancer substance in mushrooms (Yang et al., 1996) were contained more plentifully in *P. squrrosa* ASI 24005(0.66±0.05%) and *P. adiposa* ASI 24001(0.63±0.05%). This content is two times higher than *Pleurotus ostreatus* (0.25±0.09%), suggesting that *P. squrrosa* ASI 24005 should be show high anticancer activity.

Amino acid and total fatty acid contents were also similar in almost all of mushrooms tested.

Table 1. Solid yields of some extracts from *Pholiota* spp.

(%)

Species	Origins	Strain No.	Water extracts	MeOH extracts
Pholiota adiposa	PAD-018	ASI24004	50.2	18.7
	PAD-019	ASI24010	38.6	13.6
	PAD-020	ASI24012	50.6	17.3
	PAD-021	ASI24013	56.6	25.3
	PAD-022	ASI24018	40.0	16.7
	PAD-023	ASI24022	46.7	6.7
	PAD-024	ASI24024	52.0	15.3
	PAD-031	ASI24001	36.3	12.2
	PAD-035	ASI24027	58.7	10.7
Pholiota squrrosa	PSQ-002	ASI24002	42.6	11.6
	PSQ-003	ASI24005	41.3	13.3
	PSQ-004	ASI24007	55.0	17.2
Pholiota malicola	PMA-001	ASI24015	47.3	16.0
Pholiota sp.	PSP-019	ASI24008	49.3	10.7
Pholiota terrestris	PTE-002	ASI24017	52.6	14.6

Table 2. Nutritional and functional components of mushroom, *Pholiota* spp.

StrainsNo	Crude protein (%)	Mminerals (mg/100g)							Vitamins (mg/100g)			β-glucan (%w/w)
		Ca	K	Na	Zn	Mg	Fe	P	B1	B2	niacin	
*ASI 24004	21.4	6	3649	149	5.5	138	3.2	743.3	1.37	2.24	2.06	0.59±0.08
ASI 24010	18.9	5	3545	144	4.8	95	5.4	725.8	1.17	-	-	0.55±0.02
ASI 24012	23.1	2	2581	199	6.1	98	7.9	561.3	1.33	2.18	1.49	0.53±0.07
ASI 24013	17.2	8	2686	204	4.8	118	5.9	610.8	1.17	1.60	1.49	-
ASI 24018	23.0	13	3197	321	5.4	127	5.1	817.6	1.24	2.64	1.65	0.37±0.04
ASI 24022	22.0	1	3307	476	6.3	122	6.4	699	-	-	-	0.38±0.04
ASI 24024	1.2	2	3194	191	4.7	126	19.6	682.6	-	-	-	0.32±0.07
ASI 24001	0.2	4	2956	145	6.4	87	5.9	607.2	1.01	1.47	-	0.63±0.05
ASI 24027	2.09	1	3555	116	6.3	125	3	665.8	1.32	1.81	1.69	0.35±0.08
ASI 24002	20.5	4	2991	103	4.6	109	5.2	691.5	1.64	1.52	2.97	0.43±0.04
ASI 24005	19.7	4	3174	279	4.4	112	7.9	732.5	1.78	1.68	2.60	0.66±0.05
ASI 24007	16.4	3	3167	239	3.7	111	7.1	691.3	1.74	1.81	2.69	0.35±0.07
ASI 24015	25.0	4	3592	288	3.1	122	6.8	859.1	1.33	3.82	1.90	-
ASI 24008	18.7	6	3308	332	5.4	104	8.7	698.1	1.25	-	-	0.44±0.07
ASI 24017	20.4	2	2669	253	5.4	109	4.4	666.7	1.52	2.53	2.10	0.38±0.03
Pleurotus ostreatus (Control)		1	2497	642	1	118	6.3	927				0.25±0.09

* ASI strains were same as Table 1.

Table 3. Amino acid contents of mushroom, *Pholiota* spp.

(mg/100g)

Amino acid / Strains	Pro	Tyr	Val	Met	Lys	Ile	Leu	Phe
*ASI 24004	155.3±5.2	168.9±7.9	24.7±3.4	21.1±3.3	17.5±2.1	99.7±3.4	92.4±2.8	346.3±12.2
ASI 24010	439.6±13.4	27.0±2.4	119.4±1.1	24.5±2.5	14.9±1.1	54.1±2.4	41.0±0.3	265.6±2.8
ASI 24012								
ASI 24013	300.4±8.1	19.0±1.4	59.5±8.9	5.6±0.4	44.8±7.5	59.4±14.6	54.6±6.1	229.5±17.1
ASI 24018	137.9±12.1	234.6±4.7	13.5±0.3	11.4±0.2	47.9±8.4	50.3±1.1	41.9±4.9	246.9±11.2
ASI 24022	59.9±9.8	128.6±0.1	9.3±1.4	7.5±1.7	22.4±2.2	42.4±6.6	54.3±10.9	210.8±14.8
ASI 24024	102.9±4.2	195.5±3.9	5.4±0.9	2.9±1.9	27.6±3.5	40.0±1.9	51.8±1.7	196.7±8.2
ASI 24001	124.0±8.2	173.2±15.6	7.7±1.9	2.5±1.6	9.7±1.8	29.9±2.9	61.3±6.7	193.3±15.2
ASI 24027	108.7±9.4	202.0±5.2	12.6±0.1	13.2±0.3	37.1±5.4	55.8±1.3	40.0±7.2	220.4±0.9
ASI 24002	131.8±2.5	195.2±0.1	14.2±0.6	9.8±0.1	11.5±1.6	43.1±3.7	52.8±5.9	219.4±2.8
ASI 24005	197.0±8.3	252.2±6.9	19.7±1.1	16.8±0.4	13.2±0.7	74.7±6.2	133.9±10.9	439.2±0.4
ASI 24007	207.4±14.4	305.1±10.8	21.0±1.7	16.5±1.0	56.6±8.8	49.1±1.1	42.5±0.5	247.8±2.4
ASI 24015	146.1±10.5	184.5±6.9	13.1±0.1	7.5±0.4	35.3±1.4	49.4±0.3	48.4±5.2	217.0±14.1
ASI 24008	186.4±1.8	245.5±14.9	17.0±0.8	15.8±0.4	12.5±3.0	54.0±0.6	48.5±9.5	259.4±4.9
ASI 24017	97.7±1.1	211.3±8.9	8.6±0.1	5.6±0.3	29.5±1.3	42.9±0.8	48.7±0.4	225.1±11.7
Pleurotus ostreatus (Control)	71.0±4.3	176.9±12.0	7.3±0.4	3.8±0.1	32.6±2.2	30.0±0.8	57.3±4.5	215.6±5.8

Table 3. Continue

Strains \ Amino acid	Asp	Ser	Glu	Gly	His	Arg	Thr	Ala
*ASI 24004	311.9±2.3	245.9±15.2	541.1±2.8	102.1±8.2	230.6±4.2	3.2±0.4	204.2±13.9	63.8±10.1
ASI 24010	157.0±5.2	233.9±7.4	292.2±11.2	148.8±6.7	340.2±15.3	520.0±2.4	225.3±2.9	28.7±0.7
ASI 24012								
ASI 24013	214.7±6.1	145.0±1.6	270.7±3.7	25.7±0.2	200.2±1.5	275.0±2.8	100.1±2.3	19.6±0.8
ASI 24018	171.8±7.1	192.5±4.6	311.1±3.2	97.9±5.1	203.7±6.6	420.3±5.4	189.2±10.3	7.8±0.5
ASI 24022	246.4±15.2	143.3±9.6	403.2±8.1	61.3±10.7	180.0±10.4	342.7±8.5	126.1±9.0	6.2±1.4
ASI 24024	219.8±7.0	145.2±8.6	367.0±4.2	44.6±10.9	115.7±8.2	351.9±14.2	153.9±15.3	6.2±0.8
ASI 24001	239.1±14.0	172.7±16.5	356.7±9.0	68.0±6.3	185.2±4.4	203.8±7.7	158.3±9.1	13.6±2.8
ASI 24027	171.0±0.8	205.0±19.2	326.9±0.6	94.3±12.3	194.5±10.7	448.4±12.4	185.3±8.8	8.4±1.2
ASI 24002	214.2±18.0	188.1±9.3	348.7±11.2	110.4±3.5	154.4±10.8	273.1±6.3	282.4±11.3	6.8±0.2
ASI 24005	396.8±1.2	330.4±5.8	657.7±5.6	89.1±1.6	316.8±9.8	2.7±0.2	283.5±8.8	14.1±0.8
ASI 24007	157.3±0.4	212.5±0.5	274.9±8.8	133.5±5.7	238.5±4.2	456.9±7.6	183.0±5.7	9.7±0.2
ASI 24015	171.1±17.4	187.8±7.6	235.1±9.6	90.3±11.7	171.2±2.7	5.0±0.7	147.1±3.6	4.3±2.9
ASI 24008	175.4±18.7	206.6±7.0	306.6±4.0	234.0±5.8	223.8±6.6	6.6±0.4	186.9±16.2	8.3±0.4
ASI 24017	209.2±2.9	171.5±0.5	357.7±13.3	83.6±3.4	194.5±0.4	421.2±3.4	180.4±1.5	6.9±0.1
Pleurotus ostreatus (Control)	241.1±12.0	180.1±1.3	335.9±8.5	55.3±7.5	207.5±4.1	4.3±0.4	224.3±2.5	0.5±0.2

* ASI strains were same as Table 1.

Table 4. Total fatty acid contents of mushroom, *Pholiota* spp.

Strains	% of total fatty acid content					
	C15:0	C16:0	C16:1	C18:0	C18:1	C18:2
*ASI 24004	0.4±0.0	9.8±0.0	0.1±0.2	2.9±0.2	15.6±0.1	71.2±0.4
ASI 24010	0.5±0.0	9.0±0.1	0.3±0.0	1.6±0.1	15.2±0.3	73.4±0.1
ASI 24012	0.7±0.0	10.8±0.2	0.1±0.1	1.8±0.1	7.8±0.1	78.8±0.3
ASI 24013	1.0±0.0	16.9±0.1	0.0±0.0	3.0±0.1	12.3±0.0	66.9±0.2
ASI 24018						
ASI 24022	0.3±0.0	10.2±0.1	0.0±0.0	2.9±0.1	8.6±0.1	78.0±0.3
ASI 24024	0.4±0.0	10.0±0.0	0.4±0.0	2.2±0.1	13.4±0.0	73.7±0.0
ASI 24001						
ASI 24027	0.2±0.2	9.0±0.7	0.1±0.2	1.2±1.7	16.1±0.2	73.5±3.0
ASI 24002	0.5±0.0	8.7±0.0	0.4±0.0	1.6±0.0	18.6±0.2	70.2±0.2
ASI 24005	0.5±0.0	8.9±0.1	0.4±0.0	1.6±0.1	19.2±0.1	69.4±0.4
ASI 24007	0.4±0.0	9.3±0.3	0.3±0.0	1.8±0.1	14.9±0.6	73.0±0.6
ASI 24015	1.2±0.0	15.0±0.1	0.0±0.0	3.0±0.0	13.0±0.3	67.9±0.2
ASI 24008	0.5±0.0	8.8±0.0	0.4±0.0	1.5±0.0	19.5±0.1	69.3±0.2
ASI 24017	0.2±0.3	10.2±0.1	0.1±0.2	2.0±0.0	10.0±0.0	77.5±0.4
Pleurotus ostreatus (control)	1.1	11.8	0.4	1	5.7	79.9

* ASI strains were same as Table 1.

※ Fatty Acid

- C15:0 ; Pentadecanoic Acid Methyl Ester, C16:0 ; Palmitic Acid Methyl Ester
- C16:1 ; Palmitoleic Acid Methyl Ester, C18:0 ; Stearic Acid Methyl Ester
- C18:1 ; Oleic Acid Methyl Ester, C18:2 ; Linoleic Acid Methyl Ester

적 요

비늘버섯류(*Pholiota* spp.)의 추출수율 및 영양 약리학적 특성

본 연구에서는 비늘버섯을 이용하여 비교적 가격이 저렴하고 부작용이 없는 우수한 건강 기능성 제품을 개발하기 위한 기초 자료를 얻고자 17종의 비늘버섯 자실체 분말을 각종 유기용매로 추출한 후 이들의 수율을 조사하였고 여러 가지 영양학적, 생리기능적 성분 함량을 조사하였다. 17종의 비늘버섯 자실체들의 물과 메탄올 추출물을 제조하여 이들의 추출 수율을 측정한 결과 *Pholiota adiposa* ASI 24027의 물 추출물이 58.7%로 가장 높았다. 비늘버섯 자실체의 조단백질 함량은 대체로 0.2%−25.0% 이었고 이중 P*holiota adiposa* ASI 24015가 가장 많은 단백질을 함유하고 있었다. 무기물 중에는 K를 많이 함유하고 있었고 철과 인은 *Pholiota* sp. ASI 24024의 자실체에서 각각 100g 건조 자실체량 19.6 mg, 859.1 mg 을 함유하고 있었다. 항암성분으로 알려진 β−glucan은 *Pholiota adiposa* ASI 24005에서 약 0.66%로 비교적 많이 함유하고 있었으나 비타민과 아미노산 및 지방산 등은 비늘버섯 시료간에 큰 차이가 없었다.

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