Egypt. J. Agric. Res. , 71 (3), 1993.

CHEMICAL COMPOSITION AND PROCESSING POTENTIAL OF OYSTER MUSHROOM, *PLEUROTUS OSTREATUS*

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(Manuscript received 1 July 1991)

Abstract

The fruiting bodies of three strains of *P. ostreatus*, grown on rice straw, were subjected to chemical analysis. Trials to increase their shelf life was investigated by freezing, drying or canning. Fruiting bodies contained (on dry basis) 8.8-9.9% digestible protein, 64.3-66.3 % total soluble carbohydrates, 12.0% fiber, 5.0 % ash and 5.0% fat. Chemical composition of mushrooms was slightly changed according to the processing method and/or additives for processing. Off-flavour was demonestrated in the unblanched and frozen mushroom. Both sun-drying without steam blanching and canning in either cream or butter sauces show reasonable potentialities for the industrial development of *P. ostreatus* mushroom products .

INTRODUCTION

Pleurotus cultivation and trade is spreading rapidly in various parts of the world due to its ability to grow on a wide range of unfermented plant waste materials with low labour and energy costs, thus low initial investment is needed for the production (Nair 1982).

Although growth requirments and cultivation methods for *Pleurotus* spp. have been extensively studied (Rajarathnam and Bano, 1987), the available references for the industrial processing of this mushroom appeared to be very limited and some of the results are conflicting (Gormley and O' Riodain 1976 and Cho *et al.,* 1982). The shelf life of fresh oyster mushrooms appeared to be only 24 h when stored at ambient temperatures and could be extended to 3-7 days when stored at chilling temperatures (Gormley and O' Riodian, 1976 and Rajarathnam *et al.,* 1983).

Metabolic activities of fresh mushrooms quickly decline leading to deterioration in the form of discolouration and off-flavours. Heavy loss in moisture followed by increased toughness accompanied by changes in both protein composition and content during storage at 18°C have been reported (Hammond and Nichols 1975; Hammond 1978 ; Rajarathnam *et al.,* 1983).

Diphenoloxidases and polyphenol oxidases in mushrooms have a definite role in browning of fruits (Murr and Morris, 1975) due to oxidation of colourless phenol compounds into red to reddish brown quinons which then combine with amino acid derivatives to form highly coloured complexes. (Cho *et al* 1982; Rajarthnam *et al.,* 1983).

Thus processing for inactivation of both respiratory and browning enzymes is an essential step in extending the shelf life of the stored mushrooms (Mc Coard and kilaso 1983).

The present investigation aimed at assessing the potential of freezing, canning and drying on expanding the shelf life of *P. ostreatus* mushroom. The chemical compostion of fresh mushroom was also evaluated.

MATERIALS AND METHODS

Mushrooms of different *P. ostreatus* strains i.e. NRRL 2366, Somycel B 3004 and HARI 7, grown on rice straw in the facilities of Tanta Mushroom farm, were used.

Processing of materials:

Freezing unblanched and steam-blanched mushroom samples were frozen in

stainless steel containers covered with aluminum foil at either 0°C or at -30°C. Blanching treatments were in an enclosed stainless steel containers for 3 minutes (Oddson and Jelen, 1981).

Drying : Unblanched and steam-blanched mushroom samples, protected from the direct sunheat, were sun-dried for 16-18 h at a recorded temperature ranged from 20-82°C. A batch of the unblanced mushroom samples were also dried in an oven at either 45°C for 6 h or at 65°C for 3 h (Oddson and Jelen ,1981).

Canning: Stipes and caps of the mushroom samples were separately steam blanched for 3 minutes in a solution containing 1% sodium hydroxide and 0.05-0.1% citric acid. Samples were placed in pyrex containers, then the containers were filled with one of the following solutions a: 2% Na Cl, b: butter sauce (1 part flour, 3 parts butter and 4 parts water) and cream sauce (1 part flour, 2 parts butter and 15 parts whole milk). The filled contatiners ware autoclaved for 12 minutes at 121°C (Oddson and Jelen 1981).

Sensory evaluation :

A panel of six persons was chosen to evaluate the organoleptic qualities of mushroom samples. These qualities included flavour, colour, taste and texture. A hedonic scale rating from zero to six was used for quality parameters. Mushroom samples were cooked in butter for 3 minutes before serving, while dried products were first rehydrated for 5 minutes. Canned mushrooms in cream and butter sauce were warmed approximately to 60°C before serving. The organoleptic qualities were evaluated immediately after harvest for fresh mushrooms and after 3 months storage for the processed products (Oddson and Jelen, 1981).

Chemical analysis :

Moisture, total nitrogen, fat, fiber and ash were analysed using the standard methods as described by Lau (1982). Total soluble carbohydrates were calculated by difference. The digestible protein (NX4.38) and energy values (k.cal. per 100 g dry wt. = 2.62 x (% Nx6. 25) + 8.37 x 5 fat + 4.2x % carbohydrate) were calculated as mentioned by Crisan and Sands (1978). Zinc, manganese, iron, sodium, copper and potassium were determined as mentioned by Chapman and Pratt (1961). Phosphorus was measured according to Jackson (1958). Calcium and magnesium were estimat-

ed as described by Lau (1982).

RESULTS AND DISCUSSION

Chemical composition of the fruiting bodies of *P.ostreatus* strains:

The proximate composotion of the fruiting bodies of the studied strains of *P. ostreatus* is shown in Table 1. Protein contents, were found to be in the range of 8.78 to 9.72% with higher proteins detected in caps than in stipes . Fat of the whole fruiting bodies was almost equal in the three strains and ranged from 4.20 to 4. 55%. Cap also showed higher fat contents than stipes. Ash contents found in this study, ranged from 4.35 to 4.50% for caps and from 5.0 to 5.65% for stips. Fiber of the fruiting bodies were around 12.0% and stipes contained higher fiber than caps. Total carbohydrates of the fruiting bodies ranged between 64.3 and 66.3%. Nearly, similar calorific values for the three studied strains ranged from 341 to 356 K cal per 100 g of dry mushrooms. Similar results were recorded by many investigators (Crisan and Sands 1978; Bano and Rajarathnam 1982).

Potassium and phosphorus were found to be the main constituents of ash for *P. ostreatus* with quite fair amounts of sodium and magnesium and very low contents of calcium and iron (Table 2). The obtained figures are within the range recorded by Crisan and Sands (1978). Copper, manganese and zinc concentrations were within the acceptable range reported by FAO/WHO (Bano and Rajarathnam, 1982).

Effect of processing on th chemical composition of *P.ostreaus*:

The chemical and organoleptic qualitites of the processed products of the three studied strains were similarly affected and showed the same trend. Therefore, the discussion of the obtained results was limited to *P. ostreatus* NRRL 2366. Table 3 shows the changes in the chemical composition of this strain as affected by the differernt processing methods.

Both frozen and canned samples showed slightly lower moisture than the fresh sample. The sun-dried mushrooms contained higher moisture than the hot air dried products with highest moisture in blanched samples.

Table 1. Chemical composition of the produced mushrooms of *P. ostreatus* strains.

P. ostreatus Strains	Fruiting part	Chenical composition						* Energy value joule (*K. cal*/100g)
		Moisture %	*Fiber %	* protien %	* Total %	* Fat, %	* Ash, %	
NRRL 2366	Cap	86.20	7.75	12.04	64.97	5.60	4.50	364
	Stipe	83.30	16.78	7.79	63.60	3.50	5.00	327
	whole Fruit	84.75	12.27	9.92	64.28	4.55	4.75	341
Somycel B 3004	Cap	92.00	7.85	12.48	64.39	5.50	4.45	361
	Stipe	86.00	16.29	5.64	67.44	3.20	5.01	344
	whole Fruit	89.00	12.07	9.70	65.91	4.35	4.73	355
HARI 7	Cap	90.00	6.80	12.26	66.05	5.30	4.35	371
	Stipe	85.30	16.20	5.26	67.55	3.10	6.65	329
	whole Fruit	87.50	11.99	8.76	66.31	4.20	5.00	356

* Dry weigh basis

Table 2. Mineral content of *P. ostreatus* strains.

P. ostreatus Strains	Chenical composition								
	Calcium	Phosphrous	Iron	Sodium	potassium	Zinc	Magnesium	Copper	Manganese
NRRL 2366	60	700	1.3	40	2000	10.0	120	2.7	1.0
Somycel B 3004	61	720	1.4	33	2000	13.0	135	2.4	1.6
HARI 7	61	450	1.7	38	1500	12.5	130	2.8	1.4

Freezing showed slight decreases in digestible protein contents with minor differences recorded in the blanched and unblanched frozen samples. Besides, no differences were fpimd in fat contents between the fresh and frozen products. In addition, total carbohydrates showed slight decreases. The apparent increases in both ash and fiber percentage, might be due to the decrease in moisture and other nutrients. Slight changes of protein, fat and carbohydrates percent were noticed in the product after all methods for drying.

Chemical changes due to canning with brine solution was expressed in slight decrease in protein, fat and ash, with slight increase in fiber and carbohydrates. Such results might be due to partial leaching of protein, fat and ash in the brine. The opposite results were obtained when canning in either butter or cream sauces. This could be due to tje additional protein and fat present in the sauces. Slight changes were noticed for the calorific value except in case of additional cream or butter sauces.

Sensory evaluation:

The highest overall sensory scores were recorded for the canned caps in either butter or cream sauces, which surpassed the fresh mushrooms (Table 4). The steam blanched frozen samples had higher scores than the unblanched ones. Among the drying treatments, sun-drying without blanching demonstrated the greatest scores. Addition of either cream or butter sauces appreciably improved the acceptability of canned mushroom caps. Addition of brine solution could however be recommended for canning the stipes. Forzen products at $30^{o}C$ had suprior scores than the frozen ones at $0^{o}C$ for flavour, taste and texture. Off-flavour development in the unblanched mushrooms during frozen storage might be due to lipid rancidity and breakdown of phospholipids (Oddson and Jelen, 1981).

Blanched and dried mushromms were however very dark in colour and had a semi-translucent appearance. Among the dried samples, unblanched sun-dried mushrooms had the highest scores for all the attributes as well as the overall scores, followed by the hot dried ones and then the blanched sun-dried mushrooms. The low rating of the dried samples is attributed to the dark colour and bad appearance of these products (Oddson and Jelen, 1981).

Canned products showed considerable differences between the stipes and caps in all sensory attributes and overall scores. Canned stipes in brine solution rated

Table 3. Effect of processing on the chemical composition of *P. ostreatus* NRRL 2366

Treatment	Moisture %	*Fiber %	*protein %	*Fat %	*Total Carbohydrated %	* Ash, %	*Energy value K. cal./ 100g
Fresh	84.75	12.27	9.92	4.55	64.28	4.75	349
Frozen at OC	83.20	13.00	8.93	4.54	63.71	6.00	337
Frozen at O^{O}C with blanching	83.40	13.00	8.83	4.54	63.46	6.40	336
Frozen at 30^{O}C	83.80	13.60	9.11	4.54	62.06	6.80	331
Frozen at 30^{O}C with blanching	83.60	14.10	8.97	4.54	61.61	6.95	328
Sun-drying	10.75	12.50	9.81	4.45	64.05	5.00	341
Sun-drying with blanching	11.80	12.90	9.67	4.44	63.06	5.20	338
Air-drying at 45^{O}C	7.36	13.50	9.11	3.99	63.11	6.40	329
Air-drying at 65^{O}C	7.00	14.00	8.41	3.90	62.60	7.50	327
Canning in brine solution	83.80	13.00	8.49	4.20	66.80	4.00	341
Canning in butter sauce	83.00	11.25	10.69	6.56	62.20	4.70	361
Canning in cream sauce	83.08	10.00	10.79	7.00	64.70	3.00	370

* Dry weigh basis

Table 4. Mean score from the sensory evaluation of the processed *P. ostreatus* NRRL 2366

Treatment		Attributes *				
		Flavour	Colour	Taste	Texture	Overall
Fresh		5.5	5.5	5.0	5.2	5.25
Frozen at $0^{o}C$		4.5	4.5	4.0	2.5	3.87
Frozen at $0^{o}C$ with blanching		5.0	4.0	5.0	2.5	4.12
Frozen at $30^{o}C$		5.0	4.5	5.0	3.0	4.37
Frozen at $30^{o}C$ with blanching		5.0	4.0	5.5	3.0	4.50
Sun-drying		4.5	4.5	4.0	4.5	4.37
Sun-drying with blanching		4.0	2.5	4.0	2.0	3.12
Air-drying at $45^{o}C$		4.0	3.0	3.5	3.5	3.50
Air-drying at $65^{o}C$		4.0	3.0	3.0	3.0	3.25
Canning in brine solution	(cap)	3.0	2.5	2.0	2.0	2.37
	(stipe)	4.5	4.5	5.0	2.5	4.00
Canning in butter sauce	(cap)	6.0	5.5	6.0	5.0	5.62
	(stipe)	2.5	3.0	4.5	2.0	3.60
Canning in cream sauce	(cap)	6.0	5.5	6.0	5.5	5.75
	(stipe)	3.0	3.5	1.0	2.5	2.50

* Scroe code: 1 very poor; 6 excellent

better than caps canned in the same solution. On the other hand, caps canned in either cream or butter sauces showed higher scores. Butter and cream sauces seemed to improve qualities as well as the overall scores and could be considered and excellent means for canning the oyster mushrooms.

In conclusion, canning in either cream or butter sauces and sun-drying without blanching could be considered possible processing methods for extending the shelf life of oyster mushrooms (*P. ostreatus*) without considerable changes in either chemical or organoleptic qualities. More investigation might be of value in the field of processing the oyster mushroom. Blanching in solutions and permitted food additives are examples of this work.

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التركيب الكيميائى واحتمالات التصنيع لفطريات عيش الغراب بليوروتس اوستريتس

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تم فى هذا البحث دراسة التركيب الكيمائى لثلاثة سلالات من فطر عيش الغراب من النوع البليورتس أوستيرتس وأيضا دراسة إمكانية إطالة العمر التسويقى للثمار الفطرية لهذا النوع من عيش الغراب عن طريق الحفظ بالتجميد أو التعليب أو التجفيف.

وقد أحتوت الثمار الطازجة على كمية رطوبة تراوحت بين ٨ر٨٤ ، ٠ر٨٩ ٪ . واحتوي الوزن الجاف للثمار على ٨ر٨ الى ٩ر٩٪ بروتين و ٣ر٦٤ الى ٣ر٦٦٪ مواد كربوهيدراتية ذائبة ، ١٢ ٪ ألياف و ٥٪ رماد و ٥ ٪ مواد دهنية.

ولقد تسببت طرق الحفظ المختلفة لفطريات عيش الغراب الى حدوث نقص بسيط فى محتواها من المواد البروتينية ماعدا تلك المعلبة فى صلصة الكريمة أو صلصة الزبدة وايضا تسبب تعليب الأجسام الثمرية فى صلصة الكريمة أو صلصة الزبدة الى زيادة فى المواد الدهنية. وكان من نتيجة حفظ الثمار بالتجميد أو التجفيف أن زاد ظاهرياً محتواها من الألياف والرماد زيادة محسوسه. هذا ولم يلاحظ وجود إختلاف فى المحتوى من المواد الكربوهيدراتية أو السعرات الحرارية عند مقارنة الفطريات الطازجة بتلك المصنعة . وقد أظهرت الإختبارات الحسية وجود نكهة غير مرغوبة عند تجميد فطريات عيش الغراب بدون السلق بالبخار.

وبالتالى فإنه يمكن القول أن فطريات عيش الغراب بالتجفيف الشمسى وبدون السلق بالبخار أو بالتعليب فى صلصة الكريمة أو صلصة الزبدة قد أعطت نتائج مشجعة لحفظ ثمار فطريات البليورتس أو ستيرتس.