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CANNING TECHNOLOGY AS AN ALTERNATIVE FOR MANAGEMENT AND CONSERVATION OF WILD EDIBLE MUSHROOMS IN MEXICO

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ABSTRACT

There is a long cultural tradition in Mexico for seasonal consumption and commercialization of fresh edible mushrooms from the wild. Rural indigenous peasants, as well as national and foreign private enterprises, carry out these activities on a large or small scale. However, the potential impact of mushroom processing for management and conservation of this natural resource has not yet been assessed. Nine wild edible mushrooms, highly appreciated in popular markets of central Mexico, were characterized, prepared, cooked, and canned in glass containers. Three acidified (pickled) Mexican recipes, "hongos silvestres en escabeche" (HSE), "hongos silvestres en adobo" (HSA), and "hongos silvestres en salsa" (HSS), were used to evaluate financial feasibility. The canned product was safe, stable, tasty, nutritive, and economic. Advantages of canning wild edible mushrooms were defined: 1) Fruit-body

quality is standardized, 2) Consumer's reluctance to eat wild mushrooms is diminished, 3) Mushrooms are available throughout the year, 4) Good recipes may highlight certain culinary properties of mushrooms, 5) Commercial prices are lower, 6) The value added to wild mushrooms is increased, 7) Marketing strategies can be developed, and 8) Management and conservation policies can be established to regulate commercial picking and to avoid over-exploitation. However, several disadvantages should also be considered. A general strategy involving financial and technical assistance, organization, training of peasant communities, marketing, and conservation is outlined.

Key words: Wild edible mushrooms, processing, canning, rural communities, conservation, Mexico.

INTRODUCTION

The commercial exploitation of wild edible mushrooms is carried out in many regions of the world. Total world production of wild chanterelles (*Cantharellus* spp.) may reach about 200,000 tonnes per year, whose economic value has been estimated to be in excess of $ 1.6 billion dollars (Watling, 1997). In Mexico, seasonal consumption and commercialization of wild edible mushrooms as human food, tonic, or medicine, are well documented (Pérez-Silva, 1979; Guzmán, 1977, 1984; Estrada-Torres & Aroche, 1987; Villarreal & Pérez-Moreno, 1989a; Moreno-Fuentes *et al*., 1996; Hernández & Montoya, 1997; Palm & Chapela, 1997). Most research work has been focused on conventional taxonomy, reporting native names, and highlighting the traditional use and knowledge by peasant communities. Although deforestation and density of people in Mexican forest areas are rapidly increasing, there are weak regulations and few studies for assessing the impact of direct exploitation on natural production of edible mushrooms. Direct exploitation is carried out for household consumption, and for commercialization on a large or small scale. Private enterprises have been reported to hire peasants during the rainy season for gathering wild mushrooms, which are distributed profitably at high prices in national or international markets (Villarreal & Pérez-Moreno, 1989b; Valenzuela & Zamora-Martínez, 1997; Zamora-Martínez, 1998). This is mainly carried out in the States of Durango, Hidalgo, Mexico, Michoacan, Oaxaca, Puebla, and Veracruz. However, fruit-body quality is a serious commercial limitation, as wild mushrooms are normally bruised, unclean, partly broken, and irregular in size; stalks and caps may often be associated with larval damage from insects; and they undergo rapid deterioration after picking. A good deal of wild mushrooms collected is unfortunately lost before marketing, as commercial quality standards are not reached. Processing technologies to overcome this problem are not easily available.

In this study, several species of wild mushrooms were processed in glass containers using Mexican recipes in order to define advantages and disadvantages of canning technology for management and conservation of this natural resource. A general strategy involving financial and technical assistance, organization, and training of rural peasant communities is outlined.

MATERIALS AND METHODS

Fruit bodies of wild edible mushrooms, highly appreciated as a food in central Mexico, were studied (**Fig. 1**). Nine species were bought in popular markets from Puebla, Puebla: *Amanita caesarea* (Scop. ex Fr.) Grev., *Amanita rubescens* (Pers. ex Fr.)S.F. Gray, *Boletus edulis* Bull. ex Fr., *Laccaria laccata* (Scop. ex Fr.)Berk. & Br., *Lactarius indigo* Schw. ex Fr., *Lyophyllum decastes* (Fr. ex Fr.)Sing., *Ramaria flava* (Fr.)Quél., *Russula brevipes* Peck, and *R. brevipes* attacked by *Hypomyces lactifluorum* (Schw. ex Fr.)Tulasne. Mushrooms were cleaned, characterized following standard methods, and cooked. Three acidified (pickled) Mexican recipes, known as "hongos silvestres en escabeche" (HSE), "hongos silvestres en adobo" (HSA), and "hongos silvestres en salsa" (HSS), were prepared and canned in glass containers as previously described (Martínez-Carrera *et al.*, 1996; López, 1987; Leistner & Gorris, 1994). A preliminary sensory evaluation of each recipe was performed according to Watts *et al.* (1992). Financial analysis in U.S.A. dollars

Fig. 1. Commercialization of wild edible mushrooms on a large or small scale in a popular market from Puebla, Puebla, Mexico.

(USD) was carried out to calculate the cost-benefit ratio and the value added to fresh mushrooms (Gittinger, 1978). Food microbiological analyses were carried out according to official government regulations NOM-092-SSA-94, NOM-113-SSA-94, and NOM-111-SSA1-94 (Official Journal, 1996).

RESULTS AND DISCUSSION

Wild edible mushrooms bought in popular markets showed initial disadvantages for processing (**Table 1**), in comparison with cultivated mushrooms. Improper handling and transportation from the forest to urban markets caused fruit-body spoilage. Several mushroom species

Table 1. Popular names of wild edible mushrooms studied, and their general characteristics after buying in the market-place.

Species	Popular name	Injured areas removed	Unpleasant appearance		Washing	
			Larval damage[1]	Residual soil[1]	L	S
Amanita caesarea	"Tecomate"	N	N	N	x	
Amanita rubescens	"Mantequilla"	N	N	N	x	
Boletus edulis	"Pancita"	Y	Y	N		x
Laccaria laccata	"Socoyotl"	N	N	N	x	
Lactarius indigo	"Azul"	N	N	N	x	
Lyophyllum decastes	"Tenzo"	N	N	Y		x
Ramaria flava	"Escobeta"	Y	Y	N	x	
Russula brevipes	"Trompa"	Y	Y	Y		x
R. brevipes attacked by *Hypomyces lactifluorum*	"Enchilado"	N	N	N		x

[1] In stalks and/or caps.
L= Light washing with tap water. S= Strong washing with tap water. Y= Yes. N= No.

were more susceptible to injury than others, according to their size, stage of development, shape, and texture. Damaged areas were removed in fruit bodies from *Boletus edulis*, *Ramaria flava*, and *Russula brevipes*. Wild mushrooms are also normally associated to larval damage from insects and to residual soil, which may render an unpleasant appearance. This was particularly observed in *Boletus edulis*, *Lyophyllum decastes*, *Ramaria flava*, and *Russula brevipes*. It is therefore recommended to cool (4-5^{o}C) wild mushrooms after picking, in order to avoid further deterioration before processing. Mushroom appearance for canning can be improved by washing fruit bodies carefully with tap water. A light washing was enough to remove undesired residues from *Amanita caesarea*, *A. rubescens*, *Laccaria laccata*, *Lactarius indigo*, and *Ramaria flava*; whereas *Boletus edulis*, *Lyophyllum decastes*, *Russula brevipes*, and *R. brevipes* attacked by *Hypomyces lactifluorum*, required a stronger washing. Those mushrooms having good appearance were preselected for canning on the basis of their general characteristics.

Fresh wild mushrooms had a low-acid pH ranging from 5.7-6.8. After blanching, pH was slightly higher for most species varying from 6.2-7.1 (**Table 2**). In fresh fruit bodies, the lowest pH was recorded in *A. rubescens*, while the highest pH in *Laccaria laccata*. By contrast, the lowest pH in blanched fruit bodies was found in *Ramaria flava*, and the highest pH in *L. laccata*.

There was a direct influence of preselection and blanching on final weight and price of wild edible mushrooms before canning (**Table 3**). Weight losses ranged from 24.5-59.7%. The highest loss from preselection was recorded in *Russula brevipes*, mainly due to larval damage, while the lowest loss was found in *Lactarius indigo*. The highest loss due to blanching was recorded from *Amanita caesarea*, whereas the lowest loss was also found in *L. indigo*. Taking into account these variables, local commercial prices of wild mushrooms may vary from 24-60% before canning, without considering labour cost, in relation to the initial price in a popular market.

After preselection and blanching, wild edible mushrooms were mixed and cooked with different ingredients. Three Mexican recipes studied contained: 1) "Hongos silvestres en escabeche" (HSE). Wild mushrooms, "jalapeño" peppers (*Capsicum*), vinegar, carrots (*Daucus*), onions (*Allium*

Table 2. Comparative average pH from wild edible mushrooms, either fresh or after blanching.

Species	Fresh mushrooms		Mushrooms blanched	
	Sample (g) + H_2O (ml)[3]	pH[1]	Sample (g)	pH[2]
Amanita caesarea	29 + 5	6.4	27	6.6
Amanita rubescens	28	5.7	25	6.4
Boletus edulis	29 + 10	6.2	27	6.3
Laccaria laccata	29 + 15	6.8	27	7.1
Lactarius indigo	27	6.2	26	6.5
Lyophyllum decastes	40	6.6	32	6.6
Ramaria flava	28	6.1	31	6.2
Russula brevipes	28 + 20	6.3	27	6.3
R. brevipes attacked by *Hypomyces lactifluorum*	28 + 10	6.5	29	6.8

[1] Average from three replicates.
[2] Average from two replicates.
[3] Distilled water was added.

cepa), vegetable oil, garlic (*A. sativum*), salt, oregano (*Origanum*), olive oil, laurel (*Laurus*), thyme (*Thymus*), black pepper (*Piper*), and water (**Fig. 2**); 2) "Hongos silvestres en adobo" (HSA). Wild mushrooms, tomatoes (*Lycopersicon*), potatoes (*Solanum*), "chileancho" red peppers (*Capsicum*), vinegar, salt, onions, vegetable oil, garlic, black pepper, "chipotle" peppers (*Capsicum*), cinnamon (*Cinnamomum*), clove (*Eugenia*), and water; and 3) "Hongos silvestres en salsa" (HSS). Tomatoes, wild mushrooms, "jalapeño" peppers, onions, vegetable oil, vinegar, garlic, salt, cumin (*Cuminum*), and water. Each recipe was canned in glass containers, which were subjected to a thermal process.

Table 3. Weight losses during the processing of wild edible mushrooms for canning.

M	IW	IP	Weight losses (kg)			FW		FP	
	(kg)	(USD/kg)	Ps	B	T	kg	%IW	$	%IP
Ac	5.930	3.0	0.622	1.246	1.868	4.062	68.4	3.96	32.0
Ar	1.923	1.0	0.294	0.176	0.470	1.453	75.5	1.24	24.0
Be	2.050	3.0	0.775	0.187	0.962	1.088	53.0	4.41	47.0
Ll	0.550	1.0	0.157	0.059	0.216	0.334	60.7	1.39	39.0
Li	0.360	1.0	0.088	0.019	0.107	0.253	70.2	1.30	30.0
Ld	4.060	1.0	1.210	0.931	2.141	1.919	47.2	1.53	53.0
Rf	1.280	1.0	0.470	0.293	0.763	0.517	40.3	1.60	60.0
Rb	7.190	1.4	4.204	0.050	4.254	2.936	40.8	2.23	59.0
Rb/Hl	0.840	1.4	0.102	0.169	0.271	0.569	67.7	1.85	32.0

M= Mushroom species. IW= Initial weight. IP= Initial price in a popular market. FW= Final weight before canning. FP= Final price (USD). Ps= Preselection of mushrooms suitable for canning. B= Blanching. T= Total weight loss. %IW= Percentage of mushrooms as a proportion of the initial weight. %IP= Percentage of increase in relation to the initial price. *Ac*= *Amanita caesarea*; *Ar*= *Amanita rubescens*; *Be*= *Boletus edulis*; *Ll*= *Laccaria laccata*; *Li*= *Lactarius indigo*; *Ld*= *Lyophyllum decastes*; *Rf*= *Ramaria flava*; *Rb*= *Russula brevipes*; *Rb/Hl*= *R. brevipes* attacked by *Hypomyces lactifluorum*.

Financial analyses for every recipe, involving an estimated commercial cost-benefit ratio of 2.0 and considering the final price of wild mushrooms before canning, are shown in **Tables 4-6**. Total ingredients, containers, energy, and labour cost during canning, were also considered. The lowest prices were recorded in *Amanita rubescens* and *Lactarius indigo,* whereas the highest prices in *Boletus edulis* for all cases. In the recipe HSE, the production cost per glass container varied from USD $ 0.62 to $ 1.00, whose market value was estimated in $ 1.24 and $ 2.00, respectively. These data indicated that the commercial production of 45 jars can generate profits between $ 27.90-45.00 (Table 4). Similar is the case for

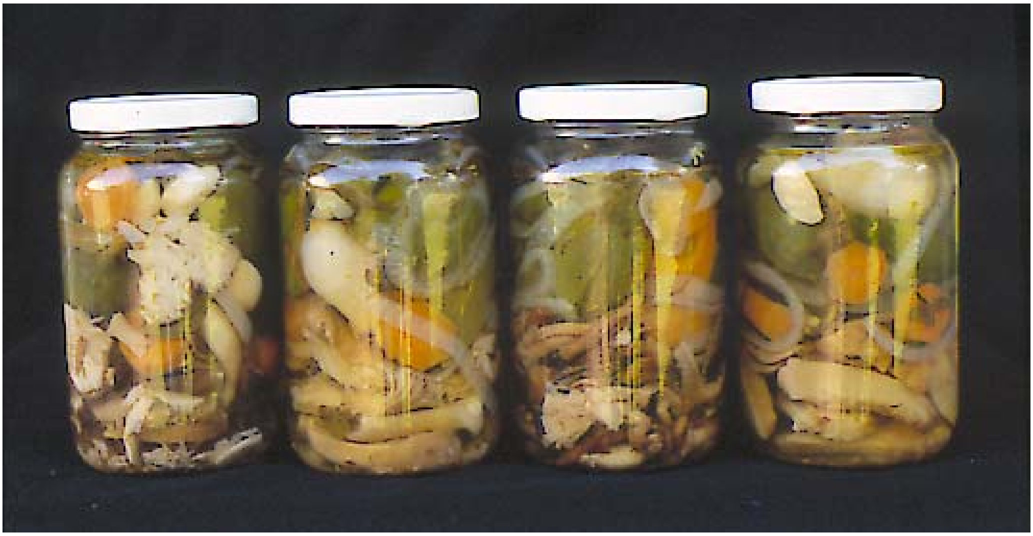

Fig. 2. Wild edible mushrooms canned in glass containers using the acidified Mexican recipe "hongos silvestres en escabeche" (HSE). Mushroom species in each jar (from left to right): *Russula brevipes*, *Lyophyllum decastes*, *Amanita caesarea*, and *Boletus edulis*.

the recipe HSA, in which the production cost ranged from \$ 0.72 to \$ 1.18. The market value per glass container for these species was estimated in \$ 1.44 and \$ 2.36, respectively. The commercial production of 38 jars can generate profits varying from \$ 27.36-44.84 (Table 5). Financial analysis for the recipe HSS showed a production cost ranging from \$ 0.61 to \$ 1.05, with a market value of \$ 1.22 and \$ 2.10, respectively. Commercial production of 43 glass containers can generate profits between \$ 26.23-45.15 (Table 6). A larger amount of jars produced would increase profits proportionally by economy of scale. In all Mexican recipes studied, there was no significant variation between canning wild

Table 4. Cost-benefit analysis (USD) from canning wild edible mushrooms using the Mexican recipe "hongos silvestres en escabeche" (HSE), in comparison with that from a cultivated oyster mushroom.

M	Number of jars	Production cost per jar	Market value	Gross incomes	Profits	Cost-benefit ratio
Ac	45	0.96	1.92	86.40	43.20	2.0
Ar	45	0.62	1.24	55.80	27.90	2.0
Be	45	1.00	2.00	90.00	45.00	2.0
Ll	45	0.64	1.28	57.60	28.80	2.0
Li	45	0.62	1.24	55.80	27.90	2.0
Ld	45	0.66	1.32	59.40	29.70	2.0
Rf	45	0.67	1.34	60.30	30.15	2.0
Rb	45	0.74	1.48	66.60	33.30	2.0
Rb/Hl	45	0.70	1.40	63.00	31.50	2.0
Po	45	0.67	1.34	60.30	30.15	2.0

M= Mushroom species. *Ac*= *Amanita caesarea*; *Ar*= *Amanita rubescens*; *Be*= *Boletus edulis*; *Ll*= *Laccaria laccata*; *Li*= *Lactarius indigo*; *Ld*= *Lyophyllum decastes*; *Rf*= *Ramaria flava*; *Rb*= *Russula brevipes*; *Rb/Hl*= *R. brevipes* attacked by *Hypomyces lactifluorum*. *Po*= *Pleurotus ostreatus*, the cultivated oyster mushroom.

mushrooms and cultivated edible mushrooms. Production costs, market values, and profits obtained from *Ramaria flava* were shown to be equal to those for canning the cultivated oyster mushroom (*Pleurotus ostreatus*).

Acidity standards were assessed after heat processing and food stabilization, *i.e*. 45-91 days after canning (**Table 7**). Final pH had a slight variation within each recipe, as follows: 1) HSE, 3.6-3.9; 2) HSA, 4.2-4.4; and 3) HSS, 4.1-4.3.

Excluding production costs, canning technology increased the value of wild edible mushrooms in popular markets through processing. This value added to wild mushrooms studied is shown in **Table 8**. Data varied within each recipe from 184.4-406.7% (HSE), from 183.7-398.8% (HSA), and from 170.6-352.5% (HSS). This is equivalent to the value added obtained from canning the cultivated oyster mushroom (HSE: 340.6%, HSA: 330.6%, HSS: 295.6%).

Nutrition facts from every recipe studied were compared with human daily requirements (**Table 9**). All recipes were low in calories, fat, and

Table 5. Cost-benefit analysis (USD) from canning wild edible mushrooms using the Mexican recipe "hongos silvestres en adobo" (HSA), in comparison with that from a cultivated oyster mushroom.

M	Number of jars	Production cost per jar	Market value	Gross incomes	Profits	Cost-benefit ratio
Ac	38	1.11	2.22	84.36	42.18	2.0
Ar	38	0.72	1.44	54.72	27.36	2.0
Be	38	1.18	2.36	89.68	44.84	2.0
Ll	38	0.74	1.49	56.24	28.12	2.0
Li	38	0.72	1.44	54.72	27.36	2.0
Ld	38	0.76	1.52	57.76	28.88	2.0
Rf	38	0.77	1.54	58.52	29.26	2.0
Rb	38	0.86	1.72	65.36	32.68	2.0
Rb/Hl	38	0.80	1.60	60.80	30.40	2.0
Po	38	0.77	1.54	58.52	29.26	2.0

M= Mushroom species. *Ac*= *Amanita caesarea*; *Ar*= *Amanita rubescens*; *Be*= *Boletus edulis*; *Ll*= *Laccaria laccata*; *Li*= *Lactarius indigo*; *Ld*= *Lyophyllum decastes*; *Rf*= *Ramaria flava*; *Rb*= *Russula brevipes*; *Rb/Hl*= *R. brevipes* attacked by *Hypomyces lactifluorum*. *Po*= *Pleurotus ostreatus*, the cultivated oyster mushroom.

Table 6. Cost-benefit analysis (USD) from canning wild edible mushrooms using the Mexican recipe "hongos silvestres en salsa" (HSS), in comparison with that from a cultivated oyster mushroom.

M	Number of jars	Production cost per jar	Market value	Gross incomes	Profits	Cost-benefit ratio
Ac	43	0.99	1.98	85.14	42.57	2.0
Ar	43	0.61	1.22	52.46	26.23	2.0
Be	43	1.05	2.10	90.30	45.15	2.0
Ll	43	0.63	1.26	54.18	27.09	2.0
Li	43	0.61	1.22	52.46	26.23	2.0
Ld	43	0.65	1.30	55.90	27.95	2.0
Rf	43	0.66	1.32	56.76	28.38	2.0
Rb	43	0.74	1.48	63.64	31.82	2.0
Rb/Hl	43	0.69	1.38	59.34	29.67	2.0
Po	43	0.66	1.32	56.76	28.38	2.0

M= Mushroom species. *Ac*= *Amanita caesarea*; *Ar*= *Amanita rubescens*; *Be*= *Boletus edulis*; *Ll*= *Laccaria laccata*; *Li*= *Lactarius indigo*; *Ld*= *Lyophyllum decastes*; *Rf*= *Ramaria flava*; *Rb*= *Russula brevipes*; *Rb/Hl*= *R. brevipes* attacked by *Hypomyces lactifluorum*. *Po*= *Pleurotus ostreatus*, the cultivated oyster mushroom.

carbohydrates, had no cholesterol, and contained dietary fiber, proteins, vitamin A and C, and iron. Several nutritional characteristics in 100 g of HSE are calories (50), fat (5 g), carbohydrates (2 g), dietary fiber (0.5g), proteins (1 g), vitamin A (15%), vitamin C (30%), and iron (6%). Similar is the case for HSA which contained calories (60), fat (5 g), carbohydrates (3 g), dietary fiber (0.6 g), proteins (2 g), vitamin A (10%), vitamin C (20%), and iron (6%); and for HSS which had calories (50), fat (6 g), carbohydrates (2 g), dietary fiber (0.6 g), proteins (1 g), vitamin A (8%), vitamin C (30%), and iron (6%).

Selected sensory evaluations involving untrained panellists indicated that there was certain preference for most canned wild mushrooms in comparison with canned cultivated mushrooms, on the basis of taste and texture. *Lyophyllum decastes* and *Amanita caesarea* showed higher preference in the recipe HSS. Microbiological analysis (the number of colony forming units from mesophilic bacteria, yeasts, and fungi) of glass containers, after 63-91 days, showed that canned recipes were in a condition of commercial sterility, despite wild mushrooms were initially associated to larvae and residual soil. The product was, therefore, microbiologically stable and safe in terms of public health, and equivalent to that obtained from cultivated oyster mushrooms under the same conditions.

Table 7. Comparative pH from wild edible mushrooms canned in glass containers using Mexican recipes.

Species	Average pH from the recipe[1]		
	"Hongos silvestres en escabeche" (HSE)	"Hongos silvestres en adobo" (HSA)	"Hongos silvestres en salsa" (HSS)
Amanita caesarea	3.8	4.4	4.3
Amanita rubescens	3.8	4.3	4.2
Boletus edulis	3.8	4.2	4.3
Laccaria laccata	3.7	4.2	4.1
Lactarius indigo	3.6	4.2	nd
Lyophyllum decastes	3.9	4.3	4.3
Ramaria flava	3.7	4.4	4.2
Russula brevipes	3.8	4.3	4.2
R. brevipes attacked by *Hypomyces lactifluorum*	3.9	4.2	4.3

[1] Average from three replicates, data taken 45-91 days after canning.
nd= Not determined.

Table 8. Value added to wild edible mushrooms using canning technology by which Mexican recipes were prepared in glass containers. This analysis considered a commercial cost-benefit ratio of 2.0 for each mushroom species. Data are compared with the value added to a cultivated oyster mushroom by the same technology.

Species	Value added per recipe (%)		
	"Hongos silvestres en escabeche" (HSE)	"Hongos silvestres en adobo" (HSA)	"Hongos silvestres en salsa" (HSS)
Amanita caesarea	197.1	192.5	179.1
Amanita rubescens	406.7	398.8	352.5
Boletus edulis	184.4	183.7	170.6
Laccaria laccata	374.5	365.6	324.8
Lactarius indigo	388.0	380.5	336.2
Lyophyllum decastes	351.0	341.3	304.4
Ramaria flava	340.6	330.6	295.6
Russula brevipes	269.8	264.8	237.8
R. brevipes attacked by *Hypomyces lactifluorum*	307.6	297.1	267.2
Pleurotus ostreatus	340.6	330.6	295.6

Overall analysis of the results obtained in this study shows that a safe, stable, tasty, nutritive, and economic canned product can be produced using wild edible mushrooms, according to high standard regulations. Several species are more suitable for processing than others. Main advantages of canning technology are: 1) Fruit-body quality is standardized, 2) Consumer's reluctance to eat wild mushrooms is diminished, 3) Wild mushrooms can be available throughout the year, 4) Good recipes may highlight certain culinary properties of wild mushrooms, 5) Commercial prices are lower, 6) The value added to wild mushrooms is increased, 7) Marketing strategies can be developed, 8)

Management and conservation policies can be established to regulate commercial picking and to avoid over-exploitation, and 9) Jobs and profits can be generated within communities. However, several disadvantages are: 1) Identification of wild edible mushrooms should be

Table 9. Nutrition facts from Mexican recipes named "Hongos silvestres en escabeche" (HSE), "Hongos silvestres en adobo" (HSA), and "Hongos silvestres en salsa" (HSS). Composition of wild edible mushrooms studied was based on FDA values (Watt & Merrill, 1975).

Composition	Content [1]						HDR
	HSE[2]	FDA	HSA[2]	FDA	HSS[2]	FDA	
Total calories	50	15	60	80	50	60	
Calories from fat	25	10	20	25	30	40	
Total fat	3 g	0.9 g	3 g	1 g	4 g	1.5 g	< 65 g
Saturated fat	0.5 g	0.5 g	0 g	0 g	1 g	0.5 g	< 20 g
Cholesterol	0 mg	0 mg	0 mg	0 mg	0 mg	0 mg	< 300 mg
Sodium	490 mg	147 mg	790 mg	237 mg	400 mg	120 mg	< 2,400 mg
Total carbohydrate	6 g	1.8 g	8 g	2.4 g	5 g	2 g	300 g
Dietary fiber	0.5 g	< 0.5 g	0.6 g	< 0.5 g	0.6 g	< 0.5 g	25 g
Sugars	5 g	2 g	7 g	9 g	4 g	5 g	
Proteins	1 g	0 g	2 g	3 g	1 g	1 g	50 g[3]
Vitamin A	15%[4]	4%	15%[4]	12%	8%[4]	10%	5,000 IU
Vitamin C	30%[4]	10%	20%[4]	25%	30%[4]	40%	60 mg
Calcium	1.8%[4]	< 2%	1.6%[4]	< 2%	1.3%[4]	<2%	1 g
Iron	6%[4]	2%	6%[4]	8%	6%[4]	8%	18 mg

[1] Calories per gram: fat, 9; carbohydrates, 4; protein, 4.
[2] Content in 100 g.
[3] Daily reference value for adults, and children (4 years old or more).
[4] Percent daily values are based on a 2,000 calorie diet.
HDR= Human daily requirements (2,000 calorie diet). FDA= According to Food and Drug Administration labelling regulations, considering a serving size of 30 g for HSE, and 125 g for HSA and HSS. IU= International unit.

correct or reliable, 2) Natural taste and aroma from mushrooms is lost during processing, 3) Several wild mushroom species are preferred fresh by consumers from some countries, and 4) Financial and technical assistance is required for developing a successful strategy of management and conservation of wild edible mushrooms by rural communities.

Taking into account that commercial harvesting of wild edible mushrooms is being carried out on a large or small scale in different regions of Mexico, a general strategy to transfer canning technology should consider: 1) A forest region where rural communities have cultural tradition for mushroom consumption, 2) Selection of peasants capable of performing a reliable identification of wild edible mushrooms, 3) Organization and training of selected peasants for collecting and transporting mushrooms properly in order to reduce losses, 4) Cooling and canning facilities must be established for training selected peasants in mushroom processing, 5) Commercialization in national and international markets will be based on high quality standards of the canned product and on marketing strategies, 6) A proportion of the incomes should be used for encouraging management and conservation practices, as well as regulations to avoid over-exploitation of wild mushrooms, and 7) Long-term ecological research must be established to assess the impact of commercial harvesting on natural mushroom production, and to find possible methods for increasing natural yields. Financial and technical assistance is fundamental for this strategy, in which rural peasants, who traditionally know wild mushrooms and live in forest regions where mushrooms grow, are main beneficiaries and therefore responsible for local sustainable management and conservation of this natural resource.

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