Consumption Trends of Edible Mushrooms in Developing Countries: The Case of Mexico

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ABSTRACT. Mushrooms are an important commodity worldwide. However, a thorough understanding of consumption trends is not yet available. In developing countries, the importance of edible mushrooms within consumer preferences and perceptions has not been studied. We carried out a study (2000-2003) to understand the patterns of mushroom consumption in central Mexico, where most wild/cultivated mushrooms

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are produced and/or marketed. About one-half (49.4%) of urban consumers bought mushrooms, independently of their social level [fresh or canned: white button mushroom (*Agaricus*), oyster mushroom (*Pleurotus*), shiitake (*Lentinula*)]. Preferences and perceptions from Mexican consumers depended on the social level. Mushroom prices were considered very or moderately expensive. Mushrooms were markedly more expensive than foods widely consumed. The variation of mushroom prices was a major factor influencing consumption. Basic data to carry out further marketing research are discussed, as well as an integral strategy considering social levels and regions to increase mushroom consumption.

KEYWORDS. *Agaricus*, *Lentinula*, *Pleurotus*, production-consumption chain, social preferences, social perceptions, Mexico

INTRODUCTION

Globalization is affecting food production and consumption chains worldwide. Consumers from many regions are increasingly getting a wider variety of food products of higher quality and lower price. In this context, many food products are in fact competing with each other to appeal to consumers. Mushrooms are an important commodity worldwide, whose production has been increasing steadily. However, a thorough understanding of consumption trends is not yet available. In developing countries, the importance of edible mushrooms within consumer preferences and perceptions has not been studied. During the past decades, major efforts in the cultivation of edible mushrooms have been focused on technological developments and yield (Flegg et al., 1985; Elliott, 1995; Royse, 1996; Martínez-Carrera, 1998; Van Griensven, 2000). This approach has led to a significant increase in the world production of edible mushrooms, which has been estimated at about 4.9 million metric tonnes (Chang, 1999). However, in a global economy, the future of mushroom cultivation will also depend on a thorough understanding of consumption trends worldwide. This is particularly the case in developing countries where mushroom production is in its infancy.

Growers' associations from Australia, Japan, Canada, U.S.A., and several European countries have developed statistics on mushroom production, surveys on consumer demands, and have promoted market research and successful marketing strategies (Berendse, 1984; Potter, 1993; Phelps and Greenan, 1996; Bing and Li, 2004; Seymour and Brownlee, 2004; Stanton and Tucci, 2004). In Mexico, the cultivation of edible mushrooms has been developing during for more than 70 years (since 1933) on a large and small (rural) scale (Martínez-Carrera et al., 1991a, 1991b, 1998, 2002; Martínez-Carrera, 2000). At present, the commercial mushroom production has been estimated to be 38,708 tonnes per year, including the champignon (*Agaricus*: 94.3%), oyster mushrooms (*Pleurotus*: 5.6%), and shiitake (*Lentinula*: 0.04%). Its economic value reached around 100 million dollars in 2002, and there are already about 20,000 workers devoted directly or indirectly to this activity (Martínez-Carrera, 2002). Despite the social, economic, and ecological importance of commercial mushroom production in Mexico, several aspects are virtually unattended: (1) organization of growers (large, small); (2) improvement of the channels of distribution; (3) integral marketing strategies; and (4) analysis of the consumer needs. This situation has made it difficult to carry out an overall strategic planning for the development of the mushroom industry in a national and global context, as current production data, domestic consumption, imports, and exports are difficult to follow (Martínez-Carrera et al., 1992, 2000; Martínez-Carrera, 2002). Furthermore, the urban population in Mexico increased from 35.1% in 1940 (6.8 million people) to 74.6% in 2000 (72.7 million people) [INEGI, 2000]. Most wild and cultivated mushrooms are gathered, produced and/or marketed in the central region, where urbanization has developed consistently and there is a tradition of mushroom consumption. We carried out research work at different levels of the production-consumption chain within this region, particularly focused on urban consumers. This allowed us to understand the patterns of mushroom consumption, and provided fundamental information to carry out further marketing research and to develop suitable strategies for making mushroom attributes available to all possible consumers.

METHODOLOGY

Region of Study

The States of Mexico, Puebla, and Tlaxcala, located in the central region of Mexico, were selected for this study during 2000-2003. Studies

were carried out in large, medium and small cities involving Mexico (8.6 million people), Puebla (1.3 million people), and Tlaxcala (0.073 million people), respectively, where there is a wide diversity of mushroom sources and products available to the consumer. There is also a broad consumer diversity as a result of rural migration from differing regions of the country (INEGI, 2000, 2001; Mayett et al., 2004).

The Production-Consumption Chain

Interviews were made to people for assessing the proportion of mushroom consumers (540), as well as to those people involved at different levels of this chain: growers [large (3), small (9)], retailers (11), restaurants (23), "tacos" outdoor stands or stalls (39), and mushroom consumers [public markets (241), "tianguis" (popular market days) (58), gastronomic fairs (102)]. Supermarkets did not allow interviews, and accordingly only prices, as well as mushroom promotion/advertising at the point of sale, were studied in these places.

Structured Interviews at the Point of Sale

There are many factors involved in the social consumption of any product. These factors can be social (e.g., preferences, perceptions), economic (e.g., incomes, prices), and ecological (e.g., local availability). In this study, the main variables were prices, incomes, consumption preferences (what, how, when, and where mushrooms are consumed), consumption perceptions (mushroom quality, flavour, appearance, nutritional and medicinal value), and promotion/advertising at the point of sale. Interview protocols for the groups of people involved in this study were developed, having a series of variables studied within short-answer items, as well as items with adjectival and adverb responses. Appropriate measurement scales were assigned to each variable. We used balanced, nonforced scales of nominal, ordinal, and ratio type, following a noncomparative itemized scaling technique. The interview protocol was applied individually by formal interviews, followed by an observation protocol. Cities were studied considering a sample size determined by the following formula: $n = \sigma^2 pq/e^2$ [$\sigma^2 = 1.96^2$; p = probability that the event occurs (0.50); q = probability that the event does not occur (0.50); e = maximum acceptability of error (0.04 or 0.05)] (Zikmund, 1998). As mushrooms are not homogeneously available to the consumer, we selected representative public markets (8), "tianguis" (3), and

gastronomic fairs (4), where mushrooms are sold within the cities studied, as a sampling frame. A set of interviews was applied to 540 consumers in order to know the proportion of people who eat mushrooms. Another set was applied to 401 mushroom consumers in order to know about variables studied. In both cases, we used the systematic sampling technique selecting differing days of the week and schedules as starting points, as well as a sample interval of 30 minutes between interviews during 4 hours in a day. All data from interviews were checked, edited, coded, and processed using cross-tabulations.

Social Levels

Consumers interviewed were grouped into low, medium, and high social level, according to their education, household facilities and services [bedrooms, lavatory/shower-bath rooms, kitchen, television (TV) set, telephone, car], salary (some cases), qualitative potential to assimilate the media messages, and purchasing power. Distinguishing characteristics of this standard classification are shown in Table 1. Some additional criteria from the Bank of Mexico (*http://banxico.org*), and the Mexican Association of Research Agencies on Markets and Public Opinion (*http://amai.org.mx*) were also considered.

Databases

National and international official databases on social aspects and mushroom prices recorded were analyzed. In Mexico, fundamental databases were: (1) INEGI (National Institute of Statistics, Geography and Informatics; Secretary of Finance and Public Credit; *http://inegi.gob.mx*) through the national survey of household incomes and expenses carried out every two years; (2) The Bank of Mexico (*http://banxico.org*) through the consumer price index (INPC-Mexico) recorded biweekly; and (3) CONASAMI (National Commission of Minimum Wages; Secretary of Labour and Social Prevision; *http://conasami.gov.mx*) through the minimum wages recorded yearly. Other secondary databases from the Secretary of Economy, which occasionally do include mushrooms, were also analyzed: (1) SNIIM (National System of Information and Market Integration; *http://secofi-sniim.gob.mx*) which provides monthly wholesale prices for *Agaricus* at several cities across the country; and (2) PROFECO (Federal Procuracy of the Consumer; *http://profeco.gob.mx*) which keeps track of the retail price index (monthly) for basic products. At present, mushrooms are not yet consid-

TABLE 1. Basic Standard Classification of Social Levels Used to Group Consumers Interviewed in This Study

Category	Social level		
	Low	Medium	High
Education	No formal education, Primary school	Secondary school, High school	Bachelor degree, Postgraduate level
Family size	≥ 7	4-6	1-3
Household facilities:			
Bedrooms	0-1	2-3	≥ 3
Lavatory/shower-bath rooms	0-1	1-2	≥ 2
Kitchen (refrigerator)	0-1	1	≥ 2
Household services:			
Television set	0-1	1-2	≥ 2
Telephone	0-1	1-2	≥ 2
Car	0	1-2	≥ 2

ered as a generic product within these databases, so only fresh *Agaricus* is included. A generic product is the basic unit to calculate the INPC-Mexico, according to the methodology from the Bank of Mexico, which consists of a group of specific products having similar characteristics. According to this study, we considered all mushrooms commercially available in Mexico as the generic product called "mushrooms," whose price is the average consumer price of all mushroom species and product lines. International databases were those available electronically (e.g., Department for Environment, Food and Rural Affairs: *http://defra.gov.uk*; Market AG: *http://marketag.com/markets/*; National Agricultural Statistics Service: *http://usda.mannlib.cornell.edu*). In order to compare the evolution of the purchasing power from different years (1940-2002), minimum wages (MW) were subjected to deflation through the following formula: Real MW (year) = (MW/consumer price index)100 (Wonnacott and Wonnacott, 1984). Mushroom and food prices were also subjected to deflation using the same formula.

Statistical Analysis

In any society from developing countries, the relationship between price-consumption, income-consumption, and perceptions/preferences-consumption are fundamental to understand the main patterns followed by consumers. Data were statistically analyzed considering the type of

scale and the number of variables involved in order to understand the main patterns followed by Mexican consumers. Variables measured on an ordinal scale, amongst social groups and groups of the chain, were analyzed according to the non-parametric test of Kruskal-Wallis through the SPSS software (version 11.0). Those variables measured on a ratio scale and a nominal scale, amongst social groups and places of purchase, were analyzed through the Analysis of Variance (ANOVA) and Chi-square (χ^2) tests, respectively (Berenson and Levine, 1991).

RESULTS

Profile of People Interviewed

Men (40.4%) and women (59.6%) from all social levels were interviewed, having a wide age range (16-80 years old), education, occupations, and family size. Data from household facilities indicated that most people interviewed have good potential: (1) To assimilate the media messages on edible mushrooms (96.1%); (2) To be informed about mushroom storage at home (93.2%); and (3) To provide basic information for surveys on trends of mushroom consumers. Only a small proportion of people did not have either a TV set (3.9%) or a refrigerator (6.8%) at home. Consumers interviewed were representative of each social level in the region (low: 29.9%; medium: 41.4%; high: 28.7%).

Proportion of Mushroom Consumers Within the Population

Interviews showed that about one-half (49.4%) of urban consumers did buy mushrooms, independently of their social level (Table 2). The other half (50.6%) did not buy them for a number of reasons, such as feelings of not liking (75.5%), unawareness (18.3%), or various perceptions (6.2%; harmfulness, uncleanness, unavailability, ignorance of cooking methods).

Patterns of Mushroom Production and Consumption

Growers

Large growers were men of high social level, while small growers were men (22.2%) and predominately women (77.8%; $p < 0.05$,

TABLE 2. Proportion of Mushroom Consumers in the Region Studied, According to Interviews (n = 540) Carried Out at Public Markets and Places, as well as "Tianguis" (Popular Market Days)

Social level	Frequency	City (Percentage from the total)	Mushroom consumption (%)	
			Consumer	Non consumer
Low[a]	105		46.7	53.3
Medium[a]	261		49.8	50.2
High[a]	174		50.6	49.4
Total	540		49.4	50.6
		Mexico[b]	48.4	51.6
		Puebla[b]	47.1	52.9
		Tlaxcala[b]	56.5	43.5

[a]Data were not statistically different between social levels, according to the Chi-square test ($p < 0.05$; Pearson $\chi^2 = 0.427$).
[b]Data were not statistically different between cities, according to the Chi-square test ($p < 0.05$; Pearson $\chi^2 = 2.281$).

Pearson $\chi^2 = 22.2$) of low (55.6%), medium (33.3%) and high (11.1%) social levels. Mexican mushroom growers were very heterogeneous in terms of species cultivated, preferences, perceptions of the mushroom quality and price, and local market management (Table 3). In general, mushroom yields decrease during local autumn and wintertime, when mushroom prices are also higher. Large mushroom growers were producing mushrooms (*Agaricus*, *Pleurotus*, *Lentinula*) commercially for more than 11 years in most cases (diverse product lines: fresh, fresh and packed, canned), including the processing of wild mushrooms [e.g., "cuitlacoche," *Ustilago maydis* (DeCandolle)Corda]. When market prices are very low, growers recovered their competitive value by intentionally discarding mushrooms. Perceptions of these growers included: mushroom quality is variable (excellent to bad); mushroom nutritional and medicinal value is regular to high or very high, or just unclear; and the mushroom price is from not expensive to very or moderately expensive. Large growers perceived the fresh product packed as a main trend, and did not foresee new product lines in the near future, such as canned, cooked, or frozen. Small mushroom growers were mainly producing oyster mushrooms (*Pleurotus*) on a small scale (3.5-154 kg/week) for less than 11 years. The regional market trends usually affect the performance of these growers throughout the year.

TABLE 3. Main Perceptions and Management of Edible Mushrooms by Growers in Central Mexico

Aspect studied	Category	Growers (%)	
		Large [n = 3]	Small [n = 9]
Type of product	Fresh	100	100
	Canned	33.3	-
	Wild	33.3	-
Cultivated mushrooms	*Agaricus*–champignon	100	-
	Agaricus–cremini	100	-
	Agaricus–portobellini, portobello	100	-
	Pleurotus	66.7	100
	Lentinula	33.3	-
Amount per week	< 10 kg	-	55.6
	10-29 kg	-	22.2
	100-1000 kg	-	11.1
	> 1000 kg	100	-
	Variable	-	11.1
New product lines	Fresh	-	22.2
	Packed	100	22.2
	Cooked	-	33.4
	Dried	-	22.2
Quality[a] (flavour, appearance)	Excellent	20	44.4
	Good	40	55.6
	Regular	20	-
	Bad	20	-
Price	Very or moderately expensive	33.3	11.1
	Not expensive	66.7	88.9
Nutritional and medicinal value	Unknown, unclear	16.7	11.1
	Very high, high	75.0	61.1
	Regular	8.3	27.8

[a]Data were significantly different between all groups of the chain (growers, retailers, restaurants, "tacos" outdoor stands, consumers), according to the Kruskal-Wallis test. Fresh *Agaricus*–champignon: $p < 0.05$; $\chi^2 = 28.7$. Fresh *Pleurotus*: $p < 0.05$; $\chi^2 = 16.8$.

Perceptions of small growers included: mushroom quality is good or excellent; mushroom nutritional and medicinal value is regular to high or very high, or just unknown; and the mushroom price is moderately or not expensive. Small growers perceived the product diversification as an important trend, and foresaw new product lines, such as cooked or dried.

Retailers

Mushroom retailers interviewed were predominately women (81.9%; $p < 0.05$, Pearson $\chi^2 = 22.2$) and men (18.1%) of medium (63.7%), low (27.3%) and high (9.0%) social levels. Retailers who were working for more than 11 years normally sold fresh *Agaricus*-champignon and *Pleurotus* throughout the year, either packed (occasionally) or in bulk. Most mushrooms are bought at the main city market (81.8%, "Central de Abastos"), while a small proportion is bought to suppliers (18.2%). Retailers offered to consumers several mushroom grades and prices, as it may have taken more than one day to sell all mushrooms. They normally sold other products, mainly vegetables. Approximately one-half of retailers managed 10-59 kg per week (45.5%), while the remainder (54.5%) between 100-875 kg per week. Perceptions of these retailers included: mushroom quality is good to excellent (47.3%), or depends on the supplier (52.7%); mushroom nutritional and medicinal value is regular to high or very high, or just unknown; and the mushroom price is very or moderately expensive (73.7%), as expensive as other food products (15.8%), or not expensive (10.5%). Mushroom retailers perceived the fresh product as a main trend (54.5%), while others foresaw new product lines, such as canned, cooked, or frozen (45.5%) [Table 4].

Restaurants

Chefs interviewed were men (74.0%) and women (26.0%) of medium (78.2%), high (17.4%) and low (4.4%) social levels. Restaurants, which had been working for more than 11 years, normally processed recipes for main dishes containing fresh mushrooms (80%), mainly *Agaricus* (champignon: 55.5%; portobello: 5.6%) and *Pleurotus* (38.9%), although they also used canned (11.1%) and wild (8.9%) mushrooms. Wild mushrooms are cooked when available during the rainy season, or during spring and summer. Soups, pizzas and salads were other important ways in which mushrooms are prepared. Accordingly, mainly these recipes and the local tradition led restaurants to include mushrooms in their menu (Tables 4-5). Most restaurants consumed less than 100 kg of fresh mushrooms per week, between 10-29 kg/week of canned mushrooms, and variable amounts of wild mushrooms during the rainy season. Edible mushrooms were bought to suppliers, public markets, the main city market ("Central de Abastos"), and supermarkets (canned products). Perceptions of these restaurants included: mushroom quality is good to

TABLE 4. Main Perceptions and Management of Edible Mushrooms by Retailers, Restaurants, and "Tacos" Outdoor Stands (TOS) in Central Mexico

Aspect studied	Category	Retailers (%) [n = 11]	Restaurants (%) [n = 23]	TOS (%) [n = 39]
Type of product	Fresh	100	80.0	100
	Canned	-	11.1	-
	Wild	-	8.9	-
Cultivated mushrooms	*Agaricus*-champignon	100	55.5	90.5
	Agaricus-portobello	-	5.6	-
	Pleurotus	90.9	38.9	9.5
Amount per week	< 10 kg	-	9.5	81.0
	10-29 kg	18.2	42.9	16.7
	30-59 kg	27.3	9.5	2.3
	60-99 kg	-	14.3	-
	100-1000 kg	54.5	14.3	-
	Variable	-	9.5	-
New product lines	Fresh	54.5	78.3	79.5
	Cooked	18.2	-	2.5
	Frozen	18.2	4.3	10.3
	Others[b]	9.1	17.4	7.7
Quality[a] (flavour, appearance)	Excellent	36.8	66.7	38.1
	Good	10.5	11.1	45.2
	Regular	-	2.8	4.8
	Depending on the supplier	52.7	19.4	-
	DB	-	-	11.9
Price	Very or moderately expensive	73.7	61.1	71.4
	Not expensive	10.5	13.9	19.0
	As expensive as others	15.8	25.0	9.6
Nutritional and medicinal value	Unknown	44.8	12.4[c]	38.1
	Very high, high	18.4	66.3[c]	34.5
	RL	36.8	21.3[c]	27.4

DB = Depending on where mushrooms are bought. RL = Regular; low, very low.
[a]Data were significantly different between all groups of the chain (growers, retailers, restaurants, "tacos" outdoor stands, consumers), according to the Kruskal-Wallis test. Fresh *Agaricus*-champignon: $p < 0.05$; $\chi^2 = 28.7$. Fresh *Pleurotus*: $p < 0.05$; $\chi^2 = 16.8$.
[b]Canned, sliced, cleansed/disinfected.
[c]Cultivated, canned and wild mushrooms were combined in this item.

TABLE 5. Main Preferences About Cultivated (Fresh, Canned) and Wild Mushrooms Associated to Restaurants (RES) and "Tacos" Outdoor Stands (TOS) in Central Mexico

Aspect studied	Category	RES (%) [n = 23]			TOS (%) [n = 39]
		Fresh	Canned	Wild	
Main season for mushroom dishes	All year	60.0	100	-	88.4
	Spring-summer	20.0	-	40.0	-
	Other	8.6	-	-	7.0
	Rainy season	8.6	-	60.0	4.6
	Autumn-winter	2.8	-	-	-
Where mushrooms are bought	Public markets	14.3	-	25.0	92.8
	Supermarkets	-	80.0	-	-
	"Tianguis"	-	-	-	2.4
	Main city market	28.6	-	25.0	2.4
	Supplier	57.1	20.0	50.0	-
	Other	-	-	-	2.4
Method of preparation/ cooking	Main dishes	63.8[a]	66.6[a]	40.0[a]	28.6
	Soups	34.0	16.7	60.0	-
	Mexican cheese "tacos"	-	-	-	66.6
	Salads-pizzas	2.2	16.7	-	4.8

[a]People expressed: (1) Associated to all kinds of meat; (2) Combined with Mexican traditional sauces ("salsas," "mole," "pipián," "chipotle"); (3) Associated to all kinds of local vegetables (chillies, herbs, maize, nopals, tomatoes, potatoes, onions, garlic); (4) Combined with traditional dishes ("tortas," "tacos," "tamales," "empanadas," "pozole," and others); and (5) Mushrooms stuffed with cheese or savoury mixture.

excellent (77.8%), regular (2.8%), or depends on the supplier (19.4%); mushroom nutritional and medicinal value is regular to high or very high; and the mushroom price is very or moderately expensive (61.1%), as expensive as other food products (25.0%), or not expensive (13.9%). Important restaurants are getting good services from growers and suppliers, so they expressed no serious problems for getting mushrooms of good quality but at a high price. In terms of new product lines, restaurants expressed preference for the fresh product (78.3%), although they also mentioned other two alternatives: (1) Canned, sliced, and/or cleansed/ disinfected (17.4%); and (2) Frozen mushrooms (4.3%).

"Tacos" Outdoor Stands

Men (25.7%) and predominately women (74.3%; $p < 0.05$, Pearson $\chi^2 = 22.2$) were interviewed from low (69.2%), medium (28.2%) and high (2.6%) social levels. "Tacos" outdoor stands normally processed fresh *Agaricus* (champignon: 90.5%) and *Pleurotus* (9.5%) mushrooms throughout the year. Stands managed up to 59 kg per week, which are bought mainly at public markets (92.8%); "tianguis" (2.4%); the main city market (2.4%, "Central de Abastos"); or where good mushroom quality is available (2.4%). Main recipes were Mexican cheese "tacos," typical main dishes, and salads-pizzas. Perceptions of these outdoor stands included: mushroom quality is good to excellent (83.3%), regular (4.8%), or depends on the place of purchase (11.9%); mushroom nutritional and medicinal value is regular to high or very high, or just unknown; and the mushroom price is very or moderately expensive (71.4%), not expensive (19.0%), or as expensive as other food products (9.6%). Mushrooms are basically processed by these stands following the demand of the customer (61.9%), although traditional recipes (33.3%) and influence from the media (4.8%) were also important factors. Most outdoor stands perceived the fresh product as a main trend (79.5%), although a smaller proportion (20.5%) foresaw new product lines, such as canned, sliced, cleansed/disinfected, cooked, or frozen (Tables 4-5).

Consumers

Interviews were carried out at public markets, "tianguis," and gastronomic fairs. There were significant differences between places of purchase studied and consumer social level, class, age, education, and occupation (Table 6). Public markets were characterized by consumers from low and medium social levels, whereas "tianguis" and gastronomic fairs by consumers from the high and medium social levels. Women (80.5%), mostly housewives, were predominant in all places studied independently of their social level ($p < 0.05$; Pearson $\chi^2 = 68.3$). A lower proportion were men (19.5%).

Most Mexican consumers ate fresh (75.5%), canned (21.3%), and wild (3.2%) mushrooms since childhood. Canned mushrooms were more preferred by the high social level, in comparison with the medium and low levels. Consumers expressed that fresh and canned mushrooms were known by tradition (64.4%; i.e., a custom acquired within the family), oral communication (25.3%; i.e., a custom acquired outside the

TABLE 6. Profile of Consumers Interviewed According to the Place of Purchase in Central Mexico

Consumer	Category	Frequency			
		Public markets (n = 241)	"Tianguis" (n = 58)	Gastronomic fairs (n = 102)	Total (n = 401)
Social level[a]	Low	100	12	8	120
	Medium	119	27	20	166
	High	22	19	74	115
Class[b]	Women	215	57	51	323
	Men	26	1	51	78
Age[c]	< 30	36	9	32	77
	31-50	129	33	56	218
	> 51	76	16	14	106
Education[d]	No formal education	15	1	1	17
	Primary school	84	10	7	101
	Secondary school	53	6	7	66
	High school	51	18	9	78
	Bachelor degree	34	21	64	119
	Postgraduate level	4	2	14	20
Occupation[e]	Housewife	172	39	18	229
	Student	3	1	11	15
	Trader	17	0	8	25
	Professional	11	4	37	52
	Worker	35	13	26	74
	Freelance	3	1	2	6

Data were significantly different between places, according to the Chi-square test:
[a]$p < 0.05$; Pearson $\chi^2 = 145.7$. [b]$p < 0.05$; Pearson $\chi^2 = 83.9$. [c]$p < 0.05$; Pearson $\chi^2 = 30.3$. [d]$p < 0.05$; Pearson $\chi^2 = 130.7$. [e]$p < 0.05$; Pearson $\chi^2 = 122.9$.

family, e.g., friends, traders), and the media (10.3%). The media were more important avenues for information about mushrooms in the high social level, in comparison with the medium and low levels. However, tradition was a more important factor promoting consumption of wild mushrooms (90.7%) than the media (5.6%) and oral communication (3.7%). Cultivated mushrooms and their main product lines available to consumers in Mexico were: fresh (*Agaricus*-champignon, *Agaricus*-portobello, *Agaricus*-portobellini, *Agaricus*-cremini, *Pleurotus*, *Lentinula*), canned *Agaricus* [whole, sliced, pieces, Mexican sauces ("salsa verde," "salsa pasilla"), "escabeche"], and canned *Pleurotus* (whole). There were predominant preferences for fresh mushrooms,

followed by canned and wild mushrooms. *Agaricus* (77.7%) mushrooms were the most widely consumed, while *Pleurotus* (22.1%) and *Lentinula* (0.2%) represented a lower proportion. Consumers from the high social level bought more mushroom species and product lines than the medium and low levels. Fresh mushrooms are bought mainly in public markets (67.2%), supermarkets (14.7%), "tianguis" (8.6%), greengroceries (2.7%), and miscellaneous places (6.8%) during all or most of the year. Canned mushrooms showed a different pattern, as they are bought in supermarkets (87.7%), convenience shops (6.6%), public markets (5.3%), and "tianguis" (0.4%) [Tables 7-8].

The amount of mushrooms bought weekly varied: fresh (up to 3.9 kg: 96.0%; $\geq$ 4 kg: 4.0%), canned (< 1.9 kg: 88.9%; 2.0-3.9 kg: 11.1%), and wild (up to 1.9 kg: 93.4%; variable amounts: 6.6%) to be eaten in main dishes or in salads and pizzas. Although fresh mushrooms predominated (59.7%) consumer preference, new product lines were also emerging, such as cooked (21.4%), frozen (10.7%), dried (4.2%), and various (4.0%: canned, snacks, blanched, sliced, and/or cleansed/disinfected) mushrooms. Consumers from the high social level were particularly demanding new product lines. The frequency of mushroom consumption varied from 1-4 times per week (49.4%), 1-2 times per month (41.6%), daily (5.3%), to occasionally (3.7%). Perceptions in Mexican consumers included that mushroom flavour, appearance and quality are good to excellent, despite the fact that international standards are not yet thoroughly reached in either cultivated or wild mushrooms. Mushroom nutritional and medicinal value was high or very high (46.3%), just unknown (40.8%), or regular to very low (12.9%). The mushroom price was considered very or moderately expensive by all social levels (75.5%), followed by not expensive (15.3%), depending on where mushrooms are bought (4.9%), and as expensive as other food products (4.3%) [Tables 7-8]. This perception was associated with historical documental records and databases, because the inflation-free minimum wage had decreased significantly during the period 1940-2002 (63.9%) affecting directly the purchasing power of Mexican consumers. Although the consumer price of most popular foods also decreased during the same period (20.3-54.0%), the highest proportion (86.2%) was recorded for *Agaricus*-champignon amongst items studied (Table 9). Despite this decrease, the current average consumer prices of *Agaricus*, *Pleurotus*, and *Lentinula* mushrooms still were more expensive than several foods widely consumed, such as meat, chicken, beans, tomatoes, eggs, avocados, rice, milk, sugar and nopal (Figure 1). Furthermore, the annual variation of wholesale and consumer mushroom

TABLE 7. Main Preferences and Perceptions on Edible Mushrooms by Consumers from All Social Levels in Central Mexico

Aspect studied	Category	Consumers per social level (%)			
		Low [n = 120]	Medium [n = 166]	High [n = 115]	A
Type of product[a]	Fresh	87.2	76.2	63.1	75.5
	Canned	9.6	20.2	34.1	21.3
	Wild	3.2	3.6	2.8	3.2
Cultivated mushrooms[b]	*Agaricus* champignon	84.6	81.7	67.1	77.7
	Pleurotus	15.4	18.3	32.2	22.1
	Lentinula	-	-	0.7	0.2
Amount per week[f]	< 0.5 kg	46.3	43.8	45.3	45.1
	0.5-1.9 kg	39.7	42.7	41.6	41.3
	2.0-3.9 kg	10.3	10.4	8.0	9.6
	≥ 4 kg	3.7	3.1	5.1	4.0
New product lines[c]	Fresh	77.4	63.9	37.8	59.7
	Cooked	11.4	14.2	38.7	21.4
	Frozen	4.8	13.0	14.3	10.7
	Dried	2.4	4.1	5.9	4.2
	Others[h]	4.0	4.8	3.3	4.0
Quality[e] (flavour, appearance)	Excellent	40.8	44.9	41.0	42.2
	Good	44.2	45.6	50.2	46.7
	Regular	9.3	4.5	7.4	7.0
	DB	5.3	4.1	1.2	3.5
	Bad, very bad	0.2	0.4	0.2	0.3
	Unknown	0.2	0.5	-	0.3
Price[d]	V	75.0	75.0	76.6	75.5
	Not expensive	8.1	16.7	21.2	15.3
	DB	8.8	3.6	2.2	4.9
	As expensive as others	8.1	4.7	-	4.3
Nutritional and medicinal value[g]	Unknown	51.1	42.9	28.3	40.8
	Very high, high	30.6	44.6	63.8	46.3
	RL	18.3	12.5	7.9	12.9

A = Average from each category. DB = Depending on where mushrooms are bought. V = Very or moderately expensive. RL = Regular; low, very low.
Data were significantly different between social levels, according to the Kruskal-Wallis test:
[a]$p < 0.05$; $\chi^2 = 71.47$. [b]$p < 0.05$; $\chi^2 = 11.07$. [c]$p < 0.05$; $\chi^2 = 39.28$. [d]$p < 0.05$; $\chi^2 = 30.64$.
[e]Data were significantly different between all groups of the chain (growers, retailers, restaurants, "tacos" outdoor stands, consumers), according to the Kruskal-Wallis test. Fresh *Agaricus*-champignon: $p < 0.05$; $\chi^2 = 28.7$. Fresh *Pleurotus*: $p < 0.05$; $\chi^2 = 16.8$.
[f]Data were not statistically different between social levels, according to the ANOVA test ($p < 0.05$; $\bar{X} = 2.12$; Standard deviation = 3.52; $F = 0.543$).
[g]Cultivated, canned and wild mushrooms were combined in this item.
[h]Canned, sliced, cleansed/disinfected, snacks, blanched.

TABLE 8. Main Preferences About Fresh Cultivated Mushrooms Associated to Consumers in Central Mexico

Aspect studied	Category	Consumers per social level (%)			
		Low [n = 120]	Medium [n = 166]	High [n = 115]	A
Main season for mushroom dishes	All year	53.6	56.1	50.3	53.3
	Spring-summer	17.1	18.8	31.8	22.6
	Other	23.5[a]	18.5[a]	11.0[a]	17.6[a]
	Rainy season	5.8	5.6	2.8	4.8
	Autumn-winter	-	1.0	4.1	1.7
Where mushrooms are bought	Public markets	79.1	70.5	52.0	67.2
	Supermarkets	6.2	10.4	27.6	14.7
	"Tianguis"	4.6	11.5	9.8	8.6
	Greengroceries	2.3	1.6	4.1	2.7
	Other	7.8	6.0	6.5	6.8
P-C	Main dishes	95.0[b]	85.0[b]	66.3[b]	82.2[b]
	Salads-pizzas	5.0	15.0	33.7	17.8

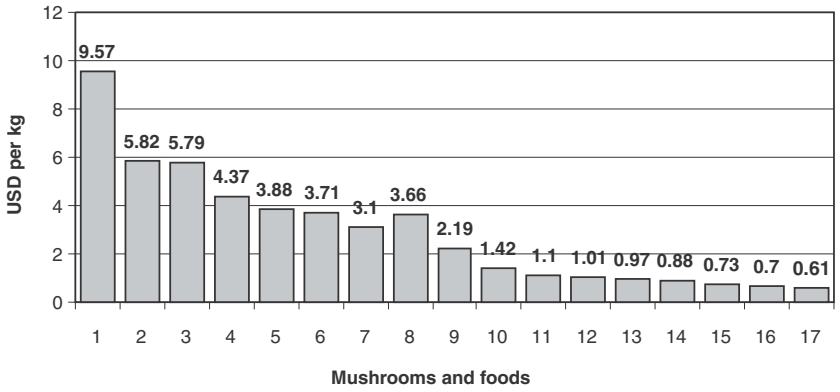
A = Average from each category. P-C = Method of preparation and cooking.
[a]People expressed: by individual taste, or depending on the mushroom price, quality, and availability.
[b]People expressed the same dishes as for Table 5, except for Mexican cheese "tacos" and soups which were added to traditional dishes by consumers. Likewise, they did not mention savoury mixture.

TABLE 9. Decrease of Average Consumer Prices from *Agaricus*-champignon Mushrooms in Mexico, as well as Those from Some Other Foods Widely Consumed (1940-2002)

Year	CPI (2002 = 100)	MW (USD)	Mushroom (*Agaricus*) (USD/kg)	Other foods (USD/kg)				
				Meat	Tomato	M	Sugar	Rice
1940	0.0025067	11.40	24.78	4.50	1.57	1.20	1.45	1.53
1950	0.0098895	6.24	21.23	5.15	1.21	0.85	1.02	1.47
1960	0.019179	7.45	18.27	7.20	0.83	0.96	0.83	1.45
1970	0.023952	12.07	17.87	8.26	1.18	1.02	0.75	1.63
1980	0.11218	12.98	16.13	9.94	1.46	0.69	0.67	1.51
1990	16.791	6.14	3.25	4.87	1.37	0.65	0.63	1.41
2000	89.690	4.05	5.08	3.32	1.16	0.81	0.77	0.83
2001	94.967	4.10	3.66	3.25	1.03	0.80	0.76	0.72
2002	100.204	4.11	3.40	3.19	1.25	0.76	0.70	0.70
D (%)		−63.9	−86.2	−29.1	−20.3	−36.1	−51.8	−54.0

CPI = Consumer price index according to the methodology from the Bank of Mexico. MW = Inflation-free minimum wage. M = Milk (USD/L). D = Decrease. Exchange rate: USD $ 1.00 = $ 9.66 Mexican pesos. Mushroom (*Agaricus*) and food prices taken from diverse references, databases, and estimations, were subjected to deflation (Martínez-Carrera et al., 1991b, 1992, 2000; Martínez-Carrera, 2000, 2002; INEGI, 2000).

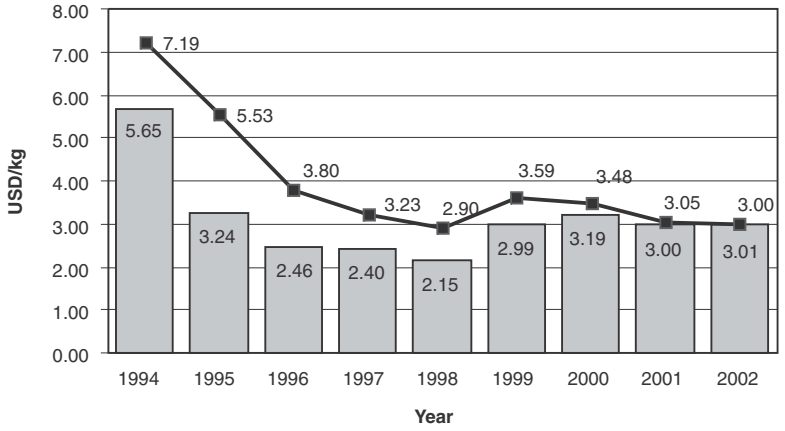
FIGURE 1. Comparison of current consumer prices (2002, average) of edible mushrooms in central Mexico, compared with those from several other foods widely consumed. Average data per kilogram recorded in this study (except where otherwise indicated): (1) Fresh shiitake (*Lentinula edodes*). (2) Fresh *Agaricus*-cremini. (3) Fresh *Agaricus*-portobello. (4) Fresh oyster mushrooms (*Pleurotus*). (5) Canned *Agaricus* (average: whole, sliced, pieces, "escabeche"). (6) Fresh *Agaricus*-champignon (price from databases). (7) Fresh *Agaricus*-champignon. (8) Meat (popular milled beef). (9) Chicken (legs). (10) Bean (packed). (11) Tomato. (12) Egg (12 per box). (13) Avocado. (14) Rice (packed). (15) Milk (Liter). (16) Brown sugar (price from databases). (17) Nopal. Exchange rate: USD $ 1.00 = $ 9.66 Mexican pesos.



prices between cities, places of purchase, and regions was high affecting consumption.

At a national level, although current wholesale prices of fresh *Agaricus* mushrooms per year were unstable ranging from $2.15-5.65, its real value actually decreased as the inflation-free price diminished significantly (58.2%) during the period 1994-2002 (Figure 2). Differences of fresh *Agaricus*-champignon wholesale prices (USD) were significant between regions during 1996-2002: Southeast region (States: Quintana Roo, Tabasco, Yucatán), $3.35-5.43 (4.39); Central east region (States: México, Puebla, Querétaro, Veracruz), $2.33-2.97 (2.65); Western region (States: Guerrero, Jalisco, Michoacán), $2.34-3.16 (2.75); and Northern region (States: Durango, Nuevo León, San Luis Potosí), $2.40-5.08 (3.74). This made a global variation of *Agaricus*-champignon wholesale prices of $2.33-5.43 during 1996-2002. The annual variation of mushroom prices was very high. In 2002, average consumer

FIGURE 2. Evolution of current wholesale prices (bars) of fresh *Agaricus*-champignon per year in Mexico, in comparison with inflation-free wholesale prices (lines; exchange rate: USD $ 1.00 = $ 9.66 Mexican pesos). Current prices per year: 1994 (5.35-5.95), 1995 (2.99-3.49), 1996 (2.34-2.59), 1997 (2.22-2.58), 1998 (2.01-2.30), 1999 (2.78-3.20), 2000 (2.89-3.51), 2001 (2.81-3.20), 2002 (2.81-3.20). Data from the SNIIM.



prices (USD) ranged in central Mexico according to every mushroom: fresh *Agaricus*-champignon $1.80-5.01 (total average from databases and this survey), *Agaricus*-portobello/portobellini $5.37-6.20, *Agaricus*-cremini $4.86-6.78, *Pleurotus* $2.07-6.68, *Lentinula* $8.79-10.34, and canned *Agaricus* $3.26-4.51. Differences in mushroom prices to consumers were seen even between close cities: fresh *Agaricus*-champignon (Mexico city: $1.66-5.17; Puebla: $1.04-4.81), canned *Agaricus*-champignon (Mexico city: $3.26-4.51; Puebla: $3.72-3.92), *Pleurotus* (Mexico city: $2.07-6.68; Puebla: $2.48-6.20). Mushroom prices also varied at the place of purchase: public markets (fresh *Agaricus*-champignon: $1.04-4.14; fresh *Pleurotus*: $2.07-5.18); "tianguis" (fresh *Agaricus*-champignon: $2.48-3.31; fresh *Pleurotus*: $3.11-4.35); and supermarkets (fresh *Agaricus*-champignon: $2.26-5.17; fresh *Pleurotus*: $3.30-6.68). *Agaricus*-portobello/portobellini, *Agaricus*-cremini, and *Lentinula* are normally sold in supermarkets.

A comparison of the difference between wholesale and consumer prices (USD) showed a decreasing trend (79.2%), as *Agaricus*-champignon prices varied during the 2000 period (wholesale: $3.19; consumer:

$5.08)–2002 (wholesale: $3.01; consumer: $3.40). In terms of purchasing power, Mexican consumers had also further comparative disadvantages at the international level, as the average wholesale price (USD) of *Agaricus*-champignon in Mexico for the period 1999-2002 ($3.04) was higher than that in other developed countries according to databases, such as the U.S.A. ($2.40), Canada ($3.02, for 2001-2002), Australia ($2.58, for 2002), Poland ($0.85, for 2001-2002), and Great Britain ($1.66).

Social Consumption of Edible Mushrooms As a Commodity

Data analysis from this study and from databases allowed to understand the economic importance of mushrooms within the society. The impact of mushroom consumption on the household economy was estimated inferring the quarterly and total spending on the product, as well as the number of households consuming the product, in comparison with other foods widely consumed in Mexico (Table 10).

DISCUSSION AND CONCLUSIONS

Several isolated empirical attempts have been made by growers to promote mushroom consumption in Mexico since 1933. However, their success has been limited due to the lack of thorough consumer research, as well as the theoretical and practical basis of marketing. Overall data analysis from this study indicated that mushroom consumption has developed basically by inertia selling or grower-oriented strategies. As commercial mushroom production and urban population in central Mexico increased significantly during the last 20 years, the production-consumption chain has become more complex and competitive in a context where market opportunities are rapidly changing as a result of globalization. This is seriously affecting the development of the Mexican mushroom industry, as it is now facing: (1) Strong external competition (increasing mushroom imports); (2) Local competitive circumstances (increasing number of growers); (3) Competition from other food products showing increasing consumer demand trends; and (4) A decreasing food and beverage spending by the Mexican society from 45.6% to 29.9% of the current monetary spending during the period 1963 to 2000, respectively. The establishment of suitable marketing strategies are critical to allow further development of the mushroom industry. They will also increase consumption leading to a better positioning of mushrooms in the domestic market, as well as increasing mushroom exports at international level.

TABLE 10. Estimated Impact of Mushroom Consumption (Spending on Edible Mushrooms) on the Household Economy per Social Level in Mexico, Based on Data Derived from This Study and Inferred at a National Level, in Comparison with Other Foods Widely Consumed

Social level	Incomes per day[a] (USD)	Quarterly spending on the product per household (USD/three months)	Number of households for food and beverage spending	Number of households consuming the product	Food and beverage spending (USD × 1000/ three months)	Total spending on the product (USD)	Factor of impact (Fi)[b]
Low	4.11-20.59	Mushrooms: 5.13[c]	11,723,083	5,791,203.0	3,830,850.2	29,708,871.4	0.007755
Medium	20.60-32.99	Mushrooms: 5.13[c]	4,923,783	2,432,348.8	2,576,604.8	12,477,949.4	0.004842
High	> 33.0	Mushrooms: 5.13[c]	6,458,223	3,190,362.1	5,033,636.6	16,366,557.6	0.003251
All	4.11- > 33.0	Mushrooms: 5.13[c]	23,105,089	11,413,913.9	11,441,091.6	58,553,378.4	0.005117
Factor of impact of other foods widely consumed according to the Bank of Mexico and INEGI							
All levels		Milk (pasteurized)	23,105,089	13,536,454	11,441,091.6	711,473,809.5	1.86485
		Tortilla	23,105,089	17,787,805	11,441,091.6	671,823,395.4	1.22652
		Chicken (pieces)	23,105,089	11,135,450	11,441,091.6	478,844,617.0	1.05177
		Beef (milled)	23,105,089	5,585,945	11,441,091.6	249,185,196.7	0.57050
		Egg	23,105,089	14,949,786	11,441,091.6	279,948,136.6	0.53375
		Tomato	23,105,089	16,885,894	11,441,091.6	281,640,683.2	0.49532
		Bean	23,105,089	11,268,651	11,441,091.6	221,897,619.0	0.31594
		Potato	23,105,089	10,924,632	11,441,091.6	120,872,360.2	0.23429
		White bread	23,105,089	6,407,715	11,441,091.6	94,653,726.7	0.21603
		Sugar	23,105,089	9,029,773	11,441,091.6	128,159,730.8	0.20734
		Rice	23,105,089	8,763,347	11,441,091.6	87,315,113.9	0.15001
		Avocado	23,105,089	4,239,323	11,441,091.6	55,907,142.9	0.13057
		Chilli (“serrano”)	23,105,089	7,211,677	11,441,091.6	55,208,488.6	0.06715
		Nopal	23,105,089	5,652,483	11,441,091.6	71,933,022.8	0.03738

[a]Equivalent to the number of minimum wages earned by a household.
[b]Fi = Total spending on mushrooms/total food and beverages spending. The social group index considered by the Bank of Mexico to calculate the consumer price index is not included here for mushrooms.
[c]Mushrooms are considered as a generic product according to the methodology from the Bank of Mexico.

At present, considering variables studied and information provided by people interviewed, the Mexican production-consumption chain can be characterized as follows:

1. Most mushroom farms are not mechanized and growing rooms do not have controlled environmental conditions. Thus growers are heterogeneous in mushroom production; they are not actively developing and/or improving channels of distribution, services, mushroom quality, and new product lines; and they are prone to follow practices for keeping competitors away and mushroom prices high.

2. Retailers, chefs/restaurants, and "tacos" outdoor stands are important elements, but mushrooms are not their main products and are only confined to small sections. They normally process and/or sell a variety of other products. The number of middlemen within long channels of distribution is usually excessive, affecting mushroom quality and prices for retailers. These retailers usually sell a variety of vegetables, where mushrooms have low importance. Chefs from restaurants are cooking and developing international or traditional recipes using a variety of mushrooms for their menu and customers, mainly from the medium and high social levels. "Tacos" outdoor stands show basic strategies following demand of the customer and product preparation at the lowest cost for customers from the low social level.

3. Mexican consumers have not been well informed about the nutritional and medicinal value of edible mushrooms. Therefore, they are not easily persuaded to buy them, as comparisons cannot be made against other food choices available. At present, though mushrooms are considered as very or moderately expensive, consumers buy them mainly by individual taste in public markets, "tianguis" and groceries where quality is low and prices high. They can get better mushroom quality and a variety of product lines at supermarkets, but prices are even higher. Fresh mushrooms predominate consumer preference, whereas the canned product is more demanded by the high and medium social levels and is basically available at supermarkets and convenience shops. New product preferences are emerging, such as cooked, frozen, dried, and various (canned, snacks, blanched, sliced, cleansed/disinfected) mushrooms.

4. Women are predominant in most levels of the production-consumption chain. This was so for small growers, retailers, "tacos" outdoor stands, and consumers.

5. The perception of mushroom quality within the production-consumption chain varied significantly between groups (growers, retailers, restaurants, "tacos" outdoor stands, consumers).

The annual variation of wholesale and consumer mushroom prices between cities, places of purchase, and regions not only affects mushroom consumption, but also the household economy. *Per capita* consumption in mushroom consumers is estimated in 902 g, meaning an average yearly spending of USD $20.52 on mushrooms (considered as a generic product) by a household (average: 4.16 members) (Martínez-Carrera, 2002). The effect of this expenditure varies significantly according to the social level. Although we did not record significant differences in mushroom consumption amongst social levels, their expenses devoted to food and beverages varied. The highest proportion from global expenditures made by households is devoted to food and beverages in the high social level (44.0%), followed by the low (33.4%) and medium (22.5%) social levels (INEGI, 2001). In Mexico, the estimated impact of average spending on mushrooms by a household, considering its total average food/beverage spending made within three months, represents a factor of 0.007755, 0.004842, and 0.003251 for the low, medium, and high social levels, respectively (Table 10). This impact can then be compared with the global expenditures made by Mexican households in food, transportation, education, leisure, hygiene, services, clothing, and medical services (USD $38,232,115.11 $\times$ 1000), where mushrooms considered as a generic product represent a proportion of 0.003%. The total spending on mushrooms (USD $58,553,378.4) is higher than that recorded for avocado, and chilli (“serrano”) [INEGI, 2001]. Therefore, any change in mushroom prices, i.e., between regions, cities, places of purchase and years, do significantly affect mushroom consumption and the household economy, mainly by the low social sector. This is also important in terms of food security, as mushrooms represent not only a natural source of unique medicinal and nutritional properties, but also an example of foods whose production is virtually organic (Martínez-Carrera, 1998; Chang, 1999). However, they have not yet been considered in official basic diets (Torres, 2000). At present, the basic Mexican diet proposed to cover minimum human needs correlated with the proportion of the minimum wage devoted to foods (Average USD per social level: $4.12, low; $6.01, medium; > $14.48, high) showed that the consumption of only 100 g of mushrooms would increase the cost of the basic diet in a day from $1.49 to $1.83 (fresh *Agaricus*-champignon), $1.92 (fresh *Pleurotus*), $2.06 (*Agaricus*-portobello), $2.07 (*Agaricus*-cremini), $2.44 (fresh shiitake, *Lentinula*), and $1.87 (canned *Agaricus*). Mushrooms may now substitute conventional foods known to cause adverse effects to human health if consumption is excessive or over long periods of time, such as pork

grease, pork meat or sugar. A periodic consumption of edible mushrooms as a functional food by all social levels should be promoted.

It is evident that, under present conditions, there are severe weaknesses to improve the position of mushrooms in the domestic market, and to increase mushroom consumption in the short term (e.g., high and fluctuating price, quality, availability to consumers, consumer awareness, and impact on the household economy). However, there are also strengths in the current situation: (1) Strong communication on mushrooms amongst consumers by tradition or oral communication; (2) Diversity of the Mexican cuisine to satisfy the consumer's individual taste (a variety of cooking methods and more than 40 recipes using mushrooms as an important ingredient); (3) Consumer perception of mushroom flavour, appearance, and quality is already good or excellent (i.e., a minimum improvement in quality would increase this perception); and (4) Most consumers eat mushrooms since childhood. We propose an integral strategy to increase mushroom consumption based on: (1) Suitable support and funding from all sectors involved within the production-consumption chain, including the academic sector; (2) To complement the individual taste from consumers and potential consumers with the awareness on the nutritional/medicinal value of edible mushrooms in order to satisfy emerging environmental and healthy eating trends; (3) The increase of promotion/advertising, particularly focused on women, at the point of sale and by the media; (4) Improving and certification of mushroom quality, packaging, channels of distribution, and services in order to avoid highly fluctuating prices to the final buyer and to promote exports; (5) Increasing mushroom production to lower prices in order to make mushrooms available at the lowest cost possible to the greatest number of consumers; (6) Introducing mushrooms as a "generic" product in all official databases to define and to evaluate consumption trends, and to monitor production, prices, exports and imports; and (7) To provide new processed products according to consumer preferences, highlighting health claims from mushrooms. This strategy, which may also be useful to other developing countries having similar socioeconomic conditions, should be ethical and divided into market segments according to social levels (low, medium, high) and regions (northern, central, southern), aiming to increase the frequency of consumption (to 1-6 times per week) and *per capita* mushroom consumption (at least up to 1.5 kg per year). In this way, the mushroom production-consumption chain as a whole will certainly be benefitted.

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