Journal of Food Research; Vol. 5, No. 4; 2016
ISSN 1927-0887 E-ISSN 1927-0895
Published by Canadian Center of Science and Education

Consumer Acceptability and Descriptive Characterization of Fresh and Dried King Oyster (*Pleurotus eryngii*) and Hedgehog (*Hydnum repandum*) Mushrooms

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Received: May 4, 2016 Accepted: June 6, 2016 Online Published: July 7, 2016

doi:10.5539/jfr.v5n4p55 URL: http://dx.doi.org/10.5539/jfr.v5n4p55

Abstract

King oyster *(Pleurotus eryngii)* and hedgehog (*Hydnum repandum)* mushrooms have great commercial interest due to their nutraceutical and nutritional properties, besides being new products on the market. The aim of this study was to evaluate the acceptability and characterize descriptively fresh and dried *Pleurotus eryngii* and *Hydnum repandum* mushrooms. Raw mushrooms were analyzed by descriptive tests and cooked mushrooms were analyzed by hedonic, discriminative and descriptive tests. Descriptive analysis was performed by QDA^{TM} method with a semi-trained panel. Acceptability as a guide to consumer trends was assessed as hedonic tests with 20 untrained judges to evaluate appearance, aroma, texture, flavor, and purchase decision. To evaluate the influence of the drying process in sensory characteristics, mushroom risottos were compared by discriminative analysis. Raw fresh hedgehog mushroom was mainly characterized by the presence of teeth, cap waviness and intensity of aroma. Raw dried *H. repandum* was mainly depicted by the presence of teeth and wrinkles, crunchiness and hardness. Well-defined gills and velvet touch characterized raw fresh *P. eryngii*. Dried *P. eryngii* mushroom was crunchy and had different colors of cap and stem. All cooked mushrooms presented average hardness and were slightly umami, watery, chewy and had some umami aftertaste. Cooked *Hydnum repandum* presented high intensity of aroma and bitter aftertaste. Fresh and dried *Pleurotus eryngii* were well accepted, as well as fresh *H. repandum*. Dried *H. repandum* had low acceptability scores, being thus not recommended to be consumed sautéed, but in sauces or risottos.

Keywords: Acceptability, descriptive analysis, *Hydnum repandum*, mushrooms, *Pleurotus eryngii*, sensory analysis

1. Introduction

Edible mushrooms have become very popular due to their high nutritional value, low calorie, fat and sodium values, and for being cholesterol-free (Valverde, Hernández-Pérez, & Paredes-López, 2015). They are constituted approximately of 90% of water and their dry matter is composed by 35-70% of carbohydrates, 15-35% proteins and less than 5% of lipids. Moreover, mushrooms also contain a significant amount of vitamins (B1, B2, B3, B9, B12, C, D, E and ß-carotene) and minerals (Ca, K, Mg, P, Cu, Fe, Mn, Se and Zn) (Pereira, Barros, Martins, & Ferreira, 2012).

Sensory analysis of *Hydnum repandum* mushroom is still unexplored, since the literature on this mushroom focus mainly on metal bioaccumulation (Severoglu, Sumer, Yalcin, Leblebici, & Aksoy, 2013), radioactivity (García, Alonso, & Melgar, 2015; Kalač, 2001) and antioxidants (Fernandes et al., 2013; Heleno, Barros, Sousa, Martins, & Ferreira, 2010). Antimicrobial and antitumoral effects of this mushroom were also reported regarding this mushroom (Ozen, Darcan, Aktop, & Turkekul, 2011).

Pleurotus eryngii mushrooms contain antifungal properties, antioxidant components (Mishra et al., 2013) and a high amount of dietary fibers (approximately 35%, of which 88% are insoluble) (Manzi, Marconi, Aguzzi, &

Pizzoferrato, 2004). This species is also considered a unique and delicious mushroom (Li et al., 2014, 2015) due to its non-volatile taste components (Beluhan & Ranogajec, 2011). Its nutritional composition and taste compounds have also been investigated (Li et al., 2014; Mishra et al., 2013). Sensory analysis of *Pleurotus eryngii* mushrooms has been used as a complement of quality and shelf life studies (Li et al., 2013), and with products developed with *P. eryngii* (Jeong & Shim, 2004; Sung, Kim, & Kang, 2008).

Dehydration is a process that increases shelf life of food, stabilizes microbiological activity, reduces package size and avoids the need of refrigeration, making commercialization much easier and therefore being one of the most used methods for preservation of fruits and vegetables (Li et al., 2015). Thus, it is important to investigate if mushroom drying process lowers their acceptability and in which ways it changes their sensory characteristics.

Characterizing a product through consumer's perception is central for marketing, product development and consumer acceptance (Lee & O'Mahony, 2005). This study aimed at evaluating the acceptability and describing the sensory characteristics of fresh and dried *Pleurotus eryngii* and *Hydnum repandum* mushrooms.

In the present study, the definitions of mushroom forms used were:

Fresh – fresh mushroom, not processed or preserved;

Dried –mushroom preserved by hot air drying;

Raw – uncooked mushroom, may be in dried or fresh form;

Cooked – mushroom prepared by cooking, may be fresh (before cooked), or dried (in this case, rehydrated prior to cooking).

2. Materials and Methods

In the present study, raw mushrooms were characterized by descriptive analysis and cooked mushrooms were evaluated by three sensory tests: hedonic, to perceive acceptability as a guide for consumer trends; discriminative, to evaluate if the drying process significantly changed sensory characteristics when the mushrooms were included in a recipe; and descriptive, for descriptive characterization. All tests were performed for both mushroom species *(P. eryngii* and *H repandum*) in fresh and dried forms. Sensory analyses of cooked mushrooms were performed with 10 g of samples at 30 ^{o}C served in three-digit coded white plastic cups and with white plastic spoons. Water and low-salt toasts were available for mouth cleansing.

2.1 Samples

Hydnum repandum mushrooms were collected in the Inner Center region of Portugal, in natural habitats of pines (*Pinus pinaster* and *Pinus pinea*), oaks (*Quercus* sp.) and hazelnut trees (*Corylus avellana*), from November/2014 to January/2015. *Pleurotus eryngii* mushrooms were produced by Voz da Natureza, Lda., and BLC3 Association (Oliveira do Hospital, Portugal). All collected and produced mushrooms were cleaned using paper towels and brushes before use. Mushrooms were sliced (approximately 0.8 mm) and hot air dried in convective oven (ON-01E, Lab Companion JeioTech, South Korea) at 40 ^{o}C for 24 hours and then stored in sealed plastic bags. Fresh mushrooms were kept under refrigeration at 3 ^{o}C and tests were performed up to three days after mushroom picking.

2.2 Panel Selection and Training

In order to form internal panels for acceptability and characterization studies, an online questionnaire was performed on 26 employees from BLC3 Association, which were divided in two different panels according to their answers: a non-trained panel for the hedonic tests, and a semi-trained panel for descriptive and discriminative analyses. Questions included socio-demographic data and requisites for participating in the panels. Requisites for the non-trained panel were: not being sick or having a chronic disease that could affect sensory perception, not being pregnant, interest in performing the tests, availability and liking the analyzed product. For the semi-trained panel, the requisites also included interest in being trained, not being colorblind and having a good capacity of oral communication (Stone & Sidel, 2009).

A discriminative triangular test was performed according to ISO 4120:2004 (ISO, 2004) for the final selection of the semi-trained panel to evaluate the aptitude of the judges to discriminate concentrations of the basic tastes. To accomplish this evaluation, two different concentrations of each of the following solutions were used: sucrose (12 and 24 g/L), citric acid (0.6 and 1.2 g/L), monosodium glutamate (1 and 2 g/L), caffeine (0.27 and 0.54 g/L) and sodium chloride (2 and 4 g/L) for sweet, sour, umami, bitter and salt tastes, respectively.

The panel was semi-trained over seven sessions of two hours each, in a total of 14 hours. The training included explanations about sensory tests, the most common mistakes in sensory tests, and taste and odor physiology.

Out of the 26 interviewed individuals, 20 fulfilled the requisites to participate in hedonic tests. Therefore, ten women and ten men, aged between 21-45 years old, composed the untrained panel. Twelve individuals fulfilled the requisites to be trained, but only eight passed the selection test and composed the semi-trained panel. Semi-trained judges were aged between 18-35 years old.

2.3 Descriptive Characterization of Raw Mushrooms

Descriptive tests were carried out with 8 semi-trained judges, using QDA™ method (Stone, Sidel, Oliver, Woolsey, & Singleton, 2004) for mushroom characterization. Descriptor generation was carried out individually by species (*P. eryngii* and *H. repandum*) and treatment (dried and fresh), due to mushroom morphology. Descriptors of raw mushrooms were generated for appearance, aroma (3-5 cm from the nose) and non-oral texture. Descriptor selection criterion was to be cited by more than half of the panel. The descriptors used for raw mushrooms are defined in Table 1.

Table 1. Descriptors and definition used in sensory analysis for raw mushrooms

Treatment	Mushroom	Descriptor	Definition
Fresh	*Hydnum repandum*	Presence of teeth	Presence of teeth under the cap
		Fragility of teeth	Ease of teeth to detach from the cap
		Moldy	Aroma of mold
		Hardness	Resistance to deform with touch
		Cap waviness	Waviness of the cap
		Intensity of aroma	Intensity of aroma in general
		Difference of hardness	Hardness difference between cap and stem
Dried	*Hydnum repandum*	Presence of teeth	Presence of teeth under the cap
		Fragility of teeth	Ease of teeth to detach from the cap
		Moldy	Aroma of mold
		Hardness	Resistance to deform with touch
		Crunchiness	Crunchy texture
		Wrinkles	Wrinkled surface
Fresh	*Pleurotus eryngii*	Difference of color	Color difference between cap and stem
		Gill definition	Ease to visualize the definitions of the gills
		Cap definition	Ease to visualize the definitions of the cap
		Velvet touch	Velvet touch
		Stem hardness	Resistance of stem to deform with touch
		Intensity of aroma	Intensity of aroma in general
Dried	*Pleurotus eryngii*	Difference of color	Color difference between cap and stem
		Crunchiness	Crunchy texture

For descriptive tests, the selected descriptors were presented in a sheet of paper with 10 cm unstructured line scales. The judges placed a mark in the scale indicating the perceived intensity. Later, that mark was converted to a number representing the distance of the mark from the zero end of the scale (values between 0.0-10.0). Therefore, descriptors that presented higher values were more characteristic. The descriptors attributed to both fresh and dried treatments were also compared to verify if dehydration culminated into sensory changes.

2.4 Acceptability and Descriptive Characterization of Cooked Mushrooms

2.4.1 Acceptability

Internal hedonic tests were carried out for cooked *Hydnum repandum* and *Pleurotus eryngii* mushrooms with 20 untrained judges in order to evaluate acceptability as a guide to consumer trends (Kemp et al., 2009). Fresh samples were sliced and sautéed with olive oil and salt (1:10:100 salt:oil:mushroom, m/m/m). Dried samples

were rehydrated for 30 min in hot water (80 ^{o}C) and also sautéed with olive oil and salt (1:10:100 salt:oil:mushroom, m/m/m). Appearance, aroma, texture, flavor and global acceptance were analyzed using a Likert scale (1-9): "Dislike extremely", "Dislike very much", "Dislike moderately", "Dislike slightly", "Neither like nor dislike", "Like slightly", "Like moderately", "Like very much" and "Like extremely". Purchase decision was also evaluated with a Likert scale (1-5): "Very unlikely", "Unlikely", "Neither likely nor unlikely", "Likely" and "Very likely".

2.4.2 Discriminative Tests

Eight semi-trained individuals assessed mushroom risottos to evaluate if the drying process significantly changed sensory characteristics when the mushroom was included in a dish. Tests were performed on *H. repandum* and *P. eryngii* species. For fresh mushrooms, the risotto was prepared by mixing rice and mushrooms simultaneously and cooking them until ready. Dried mushrooms were rehydrated for 30 min in hot water (80 ^{o}C) before being added to rice to be cooked. Triangle tests were performed according to ISO 4120:2004 (ISO, 2004).

2.4.3 Descriptive Characterization

Descriptor generation for cooked mushrooms was carried out for mushrooms in general, as fresh and dried cooked *P. eryngii* and *H. repandum* were presented altogether. Descriptors of cooked mushrooms were generated for appearance and aroma (3-5 cm from the nose) before being tasted and for texture and flavor during and after tasting samples. Descriptive selection criterion and tests were carried out likewise raw mushrooms. The selected descriptors for cooked mushrooms are defined in Table 2.

Table 2. Descriptors and definition used in sensory analysis for cooked mushrooms

Descriptor	Definition
Intensity of aroma	Intensity of aroma in general
Hardness	Resistance to deform with touch
Umami	Umami basic taste – Reference: monosodium glutamate
Wateriness	Water released from mushroom while chewing
Chewiness	Hard texture at first and then elastic – Reference: bubble gum
Toughness	Resistance to mastication
Bitter aftertaste	Bitter basic taste – Reference: caffeine
Umami aftertaste	Umami basic taste – Reference: monosodium glutamate

2.5 Statistical Analysis

Values of hedonic tests are presented as medians, first and third percentiles (P25 and P75, respectively), as Likert scales were ordinal. Descriptive results are presented as means and standard deviations, since line scales result in ratio variables. However, the number of judges for descriptive tests was small and therefore data was considered non-parametric. Thus, data from hedonic and descriptive tests was analyzed by Friedman test and sum of ranks for multiple comparisons with a significance level of 5% using R-package *agricolae* (Mendiburu, 2014) and R software 3.2.1 (R Core Team, 2015). Binomial test with 1/3 chance of success was performed for discriminative tests.

3. Results and Discussion

3.1 Descriptive Characterization of Raw Mushrooms

In the present study, raw mushrooms were described according to species (*H. repandum* and *P. eryngii*) and treatment (dried and fresh), with the aim of characterizing these mushrooms in raw and cooked forms. Means and standard deviation of similar and different descriptors for fresh and dried raw mushrooms are shown in Table 3 and Table 4 for *H. repandum* and *P. eryngii*, respectively. Judges considered that four descriptors of fresh *H. repandum* mushroom were similar to the dried form: presence of teeth, fragility of teeth, moldy aroma and hardness. The other descriptors were representative of the treatments: cap waviness, intensity of aroma and difference of hardness between cap and stem for fresh *H. repandum* mushroom; and crunchiness and wrinkles for dried *H. repandum* mushroom.

According to judges, fresh hedgehog mushroom was characterized mainly by the presence of teeth, cap waviness and intensity of aroma, as may be seen by the higher values in Table 3. Fragility of teeth, moldy aroma, difference of hardness between cap and stem, and hardness were less characteristic. Dried *H. repandum* was mostly characterized by the presence of wrinkles and teeth, crunchiness and hardness. These aspects are recurrent in dried mushrooms and, for this reason, dehydration and rehydration of mushrooms have been studied (Dinani, Hamdami, Shahedi, & Havet, 2015; Reyes et al., 2014). Aroma loss in dried mushroom was depicted by a lower value of the moldy aroma in comparison to the fresh mushroom, besides the inexistence of the descriptor intensity of aroma in the dried mushroom. Presence and fragility of teeth had lower scores in dried *H. repandum* mushroom in comparison to the fresh form. Hardness scores were higher in dried *H. repandum*, as Kotwaliwale et al. (2007) observed in oyster mushrooms.

Table 3. Descriptive results of raw *Hydnum repandum* (mean ± standard deviation, n=8 judges)

	Fresh *Hydnum repandum*		Dried *Hydnum repandum*	
Similar descriptors	Presence of teeth	$9.3 \pm 0.5^{a,A}$	Presence of teeth	$8.1 \pm 1.4^{ab,B}$
	Fragility of teeth	$6.5 \pm 2.9^{c,A}$	Fragility of teeth	$5.2 \pm 3.0^{bc,B}$
	Moldy	$5.4 \pm 3.4^{c,A}$	Moldy	$3.8 \pm 3.5^{c,B}$
	Hardness	$4.9 \pm 2.2^{c,B}$	Hardness	$7.9 \pm 1.8^{abc,A}$
Different descriptors	Cap waviness	8.2 ± 1.6^{b}	Crunchiness	8.0 ± 2.1^{a}
	Intensity of aroma	7.7 ± 2.3^{b}	Wrinkles	8.1 ± 1.6^{ab}
	Difference of hardness	5.0 ± 2.6^{c}		

Values within the same column with different lower case letters are significantly different ($p<0.05$). For similar descriptors, values within the same row with different upper case letters are significantly different ($p<0.05$).

Judges considered that only difference of color between cap and stem was a descriptor of both fresh and dried *P. eryngii*. The other descriptors were representative of the treatments: gill definition, cap definition, velvet touch, stem hardness and intensity of aroma for fresh *P. eryngii* mushroom; and crunchiness for dried *P. eryngii* mushroom.

All descriptors, except intensity of aroma, presented high values for fresh *Pleurotus eryngii* and thus were characteristic (Table 4). Gill definition and velvet touch obtained the highest scores, between 8.1-9.0. Difference of color between cap and stem, cap definition and stem hardness were scored between 7.2-8.1. Although intensity of aroma was low scored, it may also be used as an attribute, as the presence of other aroma would be considered off-odors. For dried *P. eryngii* mushroom, crunchiness and difference of color between cap and stem were scored between 6.2-7.9. Comparing dried and fresh *P. eryngii* mushrooms, sensory analysis indicated that the drying process did not alter the difference of color between cap and stem.

Table 4. Descriptive results of raw *Pleurotus eryngii* (mean ± standard deviation, n=8 judges)

	Fresh *Pleurotus eryngii*		Dried *Pleurotus eryngii*	
Similar descriptors	Difference of color	$8.1 \pm 1.0^{b,A}$	Difference of color	$6.2 \pm 2.7^{a,A}$
Different descriptors	Gill definition	9.0 ± 0.7^{a}	Crunchiness	7.9 ± 2.3^{a}
	Cap definition	8.1 ± 1.6^{b}		
	Velvet touch	8.1 ± 1.4^{ab}		
	Stem hardness	7.2 ± 1.5^{b}		
	Intensity of aroma	3.5 ± 2.8^{c}		

Values within the same column with different letters are significantly different ($p<0.05$). For similar descriptors, values within the same row with different upper case letters are significantly different ($p<0.05$).

3.2 Acceptability and Descriptive Characterization of Cooked Mushrooms

Values of the hedonic tests for *Hydnum repandum* and *Pleurotus eryngii* mushrooms are shown in Table 5 as medians and percentiles. Although the internal panel was smaller than usual consumer panels, it produced results as guides to consumer trends, which may indicate the viability of commercialization of the products assessed. Nonetheless, further consumer hedonic tests should be assessed in order to obtain a more significant evaluation.

Neither dehydration nor mushroom species influenced on appearance or aroma acceptability (Table 5), parameters in which both mushrooms had good scores with median values of "Like slightly" and "Like moderately". Aroma may be lost after dehydration (Rivera, Blanco, Salvador, & Venturini, 2010) or due to cooking process (MacLeod & Panchasara, 1983). The judges may have not perceived differences between dried and fresh mushrooms due to aroma loss during cooking and therefore their acceptability was not altered. Other hypothesis is that judges perceived those differences, yet it did not change their acceptability.

Table 5. Acceptability of cooked *H. repandum* and *P. eryngii* (n=20 judges). Values in Median (P25;P75)

Acceptability attribute	*Hydnum repandum*		*Pleurotus eryngii*	
	Fresh	Dried	Fresh	Dried
Appearance (1.0-9.0)	7.0 (6.0; 7.0)[ab]	6.0 (5.0; 7.0)[b]	7.0 (7.0; 8.0)[a]	7.0 (6.75; 8.0)[a]
Aroma (1.0-9.0)	6.5 (6.0; 7.0)[a]	6.0 (4.75; 7.0)[a]	7.0 (6.0; 7.0)[a]	6.0 (5.0; 7.25)[a]
Texture (1.0-9.0)	7.0 (6.0; 8.0)[a]	6.0 (3.0; 6.0)[c]	7.0 (6.0; 8.0)[ab]	6.5 (4.0; 8.0)[b]
Flavor (1.0-9.0)	6.0 (5.5; 7.0)[b]	4.0 (2.0; 5.25)[c]	7.0 (6.0; 8.0)[a]	7.0 (6.0; 7.25)[ab]
Global acceptance (1.0-9.0)	6.5 (5.0; 7.0)[b]	4.5 (3.0; 6.0)[c]	7.0 (6.0; 8.0)[a]	7.0 (6.0; 7.25)[ab]
Purchase decision (1.0-5.0)	4.0 (2.75; 4.0)[a]	2.0 (2.0; 3.0)[b]	4.0 (3.0-5.0)[a]	4.0 (2.75-5.0)[a]

Values within the same row with different letters are significantly different ($p<0.05$).

Even with wrinkling and darkening that may be caused by dehydration (Kotwaliwale, Bakane, & Verma, 2007; Reyes, Mahn, Cubillos, & Huenulaf, 2013), median values for appearance did not significantly differ between dried and fresh mushrooms (Table 5), probably due to the darkening of all mushrooms and water loss during cooking process. Li et al. (2013) obtained color acceptability values of 2.6 out of 5.0 and aroma acceptability 3.1 out of 5.0 on fresh *P. eryngii*, slightly lower values than those obtained in the present study. Dehydration process significantly reduced acceptability of *H. repandum* mushroom on texture, flavor and global, in contrast to *P. eryngii*, that did not show significant differences between fresh and dried samples. Fresh king oyster had "Like moderately" evaluation for flavor and global acceptance, as fresh hedgehog had "Like slightly". On the other hand, dried mushrooms presented greater difference of scores for global acceptance, since king oyster was scored as "Like moderately" and hedgehog as "Dislike slightly".

Hot air drying may cause cellular damage and structural shrinkage, resulting in loss of rehydration capacity (García-Segovia, Andrés-Bello, & Martínez-Monzó, 2011), and Krokida and Marinos-Kouris (2003) observed that there were pores from *Agaricus bisporus* and vegetables that were not filled during rehydration after hot air drying. Although increasing of hardness and chewiness has been observed in *Pleurotus* sp. during drying process (Kotwaliwale et al., 2007), in this study, dried *P. eryngii* had no significant difference from fresh in texture acceptability (Table 5). These results support the descriptive analysis performed, which provided no differences between dried and fresh samples regarding chewiness and hardness (Table 6).

Flavor acceptability of dried *H. repandum* was significantly lower than fresh mushroom (Table 5), which may have been caused by a combination of toughness, intensity of aroma and bitter aftertaste, as seen in the results of descriptive analysis of cooked mushrooms (Table 6). Dried *H. repandum* also had a significant lower median value for global acceptance, and purchase decision was "Unlikely" (Table 5). This shows that consumer trends for dried *H. repandum* are not favorable when the mushroom is sautéed. However, mushrooms may be consumed as an ingredient of a recipe (sauces, with meat, etc.). In this way, the parameters that presented lower acceptability when the mushrooms were assessed only sautéed may be not perceived in a sauce or risotto, as occurred in the discriminative analysis, presenting a possibility of market for dried mushrooms. Another possible application of this mushroom is through the development of new products where texture and flavor intensity can

be studied and controlled, using sensory characteristics perceived by consumers to drive a formulation (Raz et al., 2008).

Table 6. Descriptive characterization of cooked *P. eryngii* and *H. repandum* mushrooms (mean ± standard deviation)

Descriptor	Fresh *H. repandum*	Dried *H. repandum*	Fresh *P. eryngii*	Dried *P. eryngii*
Intensity of aroma	4.2 ± 2.3^a	4.7 ± 2.4^a	2.0 ± 1.5^b	2.0 ± 1.6^b
Hardness	5.1 ± 2.3^a	5.7 ± 2.8^a	5.7 ± 3.0^a	6.6 ± 2.3^a
Umami	6.0 ± 2.9^a	5.3 ± 3.7^a	6.0 ± 2.3^a	3.7 ± 2.4^a
Wateriness	4.7 ± 3.6^a	3.4 ± 3.0^a	4.8 ± 3.0^a	4.2 ± 2.9^a
Chewiness	4.8 ± 2.9^a	4.1 ± 2.5^a	3.7 ± 2.3^a	4.6 ± 3.0^a
Toughness	3.2 ± 2.8^b	5.9 ± 2.4^a	3.9 ± 2.6^b	6.4 ± 2.6^a
Bitter aftertaste	6.8 ± 2.9^a	6.3 ± 2.9^a	1.9 ± 1.7^b	2.1 ± 2.4^b
Umami aftertaste	4.2 ± 2.4^a	3.7 ± 2.6^a	3.2 ± 2.6^a	3.0 ± 2.1^a

Values within the same row with different letters are significantly different ($p<0.05$).

In the present study, the judges did not discriminate dried from fresh cooked mushrooms in a risotto ($p=0.273$) in discriminative analysis, neither *H. repandum* nor *P. eryngii*. Reyes, Mahn and Vasquéz (2014) noted that dried and fresh button mushrooms (*Agaricus bisporus*) were not significantly different regarding color, shrinkage, texture and thermal efficiency. Also, discriminative tests were carried out to compare fresh and frozen truffle aroma (*Tuber melanosporum*), and in all cases they were discriminated, showing that freezing influenced organoleptic properties in truffles (Culleré, Ferreira, Venturini, Marco, & Blanco, 2013) and pointing that dehydration may be a better alternative to mushroom conservation.

Cooked mushrooms did not present significant difference in what concerns mushroom species and drying process for hardness, umami taste, wateriness, chewiness, and umami aftertaste (Table 6). For all mushrooms tested, hardness indicated that there was some resistance to touch, corroborating previous published studies (Kim et al., 2009; Pogoń, Jaworska, Duda-Chodak, & Maciejaszek, 2013). Wateriness and chewiness indicated, respectively, the release of a certain amount of water during mastication and some plastic consistence (Table 6), as observed in Kotwaliwale et al. (2007) with *Pleurotus ostreatus*. The values of umami aftertaste reveal that these descriptive attributes are present, however not too evidently. Intensity of aroma and bitter aftertaste distinguished cooked mushroom species by being almost inexistent in *P. eryngii* and more prominent in *H. repandum* (Table 6), and did not vary with dehydration, hence being intrinsic to the *Hydnum* mushrooms.

Natural taste of *P. eryngii* is due to sweet and umami (aspartic and glutamic acids, and 5'- nucleotides) components, and bitter is camouflaged by sweet components (Li et al., 2014). As shown in Table 6, only toughness, out of the eight descriptors, was significantly different in relation to treatment (dried and fresh). These values were higher in dried mushrooms due to low moisture content in rehydrated samples (García-Segovia et al., 2011). Drying conditions can be optimized to avoid flavor loss and reduction of rehydration, such as temperature, cutting size and other possible factors that may influence mushroom texture.

The global evaluation of *Pleurotus eryngii* indicates its gastronomic quality, as cited in previous studies (Li et al., 2014, 2015; Mishra et al., 2013). Fresh *Pleurotus eryngii* and *Hydnum repandum*, as well as dried *P. eryngii*, showed to be marketable and had positive global acceptance, being good products to the Portuguese market, as well as other countries, as they are little explored so far. Dried *H. repandum*, however, is not recommended to be consumed sautéed, but in dishes as sauces or risottos. Furthermore, all their nutritional and nutraceutical properties (Li et al., 2014; Mishra et al., 2013) fulfill what the consumer has been searching recently: products with gastronomical value and nutraceutical benefits.

4. Conclusion

The present study aimed at evaluating the acceptability and characterizing descriptively fresh and dried *Pleurotus eryngii* and *Hydnum repandum* mushrooms. Raw fresh hedgehog mushroom was mainly characterized by the presence of teeth, cap waviness and intensity of aroma. Raw dried *H. repandum* was mainly characterized by the presence of teeth and wrinkles, crunchiness and hardness. Moldy aroma, presence and fragility of teeth

had lower scores in comparison to the fresh form. Hardness scores were higher for raw dried *H. repandum*. Well-defined gills and velvet touch were the strongest attributes of raw fresh *P. eryngii*. Dried *P. eryngii* mushroom was characterized as crunchy and possessed cap and stem with different colors.

Regarding acceptability, fresh and dried *Pleurotus eryngii* presented high scores in all acceptability attributes and strong purchase decisions. Fresh *Hydnum repandum* presented acceptability scores similar to *P. eryngii*, as well as "Likely" purchase decision. Dried *H. repandum* is not recommended to be consumed sautéed due to its low acceptability scores. Further studies using larger panels on hedonic tests should be applied in order to obtain a more significant evaluation.

All cooked mushrooms presented average hardness and were slightly umami, watery, chewy and had certain umami aftertaste. *H. repandum* presented higher intensity of aroma and bitter aftertaste than *P. eryngii*. The descriptors that were more characteristic may be used as attributes for marketing and values may be also used for standardization on production batches. The descriptive characterization and acceptability study implement the knowledge on sensory analysis of mushrooms and create new possibilities for investigation of fungi and its use on culinary.

Acknowledgments

The authors acknowledge the financial support of COMPETE/QREN/EU (Project "Value MicotecTruf" QREN/COMPETE/24845/2012 and Project "Fruit ECO-Drying Line" QREN/COMPETE/23266/2012) and Estoril Higher Institute for Tourism and Hotel Studies.

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