Extend shelf life of two Iraqi strains of oyster mushroom

Pleurotus ostreatus and *Pleurotus eryngii*

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Abstract

The study aimed to preserve edible mushrooms by canning and drying methods , and studying the efficiency of solutions used in both methods to increase the storage life of *Pleurotus ostreatus* and *Pleurotus eryngii* which newly cultivated in Iraqi environment , by using different solutions, contained from 2% salt (brine solution) with different concentrations of 0.3 and 0.5% citric acid, 0.1 and 0.2% ascorbic acid, and Himalayan salt at 1 and 2%, compared with fruiting bodies kept in boiling water only (control treatment),for drying preservation methods was done by spraying the fruit bodies with solutions of citric acid 1% and ascorbic acid 0.5%, spraying with a solution of 1% citric acid , control treatment (without treatment) .after 30 days, microbial and chemical tests were done, in addition sensory evaluation of samples from both methods for all treatments. The resultsof microbial test for canning samples showed that they were free from contamination.after rehydration the drying sample of control and 1% citric acid by air drying had recorded highest ratings scorefor taste and color.While control in oven-dried mushrooms showed the highest percentage of dry matter amounted to 36.32% and 28.38%,and the highest percentage of protein had recorded(21.6, 20.34%) and (18. 01, 17.98%)in air and electric oven dryingfor *Pleurotus ostreatus* and *Pleurotus eryngii* respectively,While Himalayan salt solution (HM1) 1% achieved the highest percentage of protein(15.64%) in canning. Highest ash percentages was found in mixture treatment (CAA)dried by air and electric oven which recorded 8.91 and 8.70% for *Pleurotus ostreatus* and 8.27, 8.34% for *Pleurotus eryngii*, while (HM2) solution recorded 13.29%.

key words : Iraqi *Pleurotus* strains, preservation, canning, drying, preservation**.**

Introduction

Pleurotus is one of the most important nutritional mushroom,take the second ranking in terms of quantity of world production after *Agaricus bisporus* [38, 28]. *Pleurotus ostreatus* is most important species of oyster mushroom, the second largest production of edible mushroom at 19% of total global production [28,29].while *Pleurotus eryngii* characterized by nutritional and medical characteristics including carbohydrate of 52. 2% ,fat 3. 0% ,protein 28. 8%,ash 3. 5% based on dry weight [2]. As well high levels of antioxidant and antimicrobial compounds [12, 13,14]. Mushrooms are generally perishable foods because of high moisture content up to 80-85%, so fruit bodies can only preserved at normal temperatures for 24 hours [42,3]. *Pleurotus ostreatus* were minimized in hardness about 162.8 to 1.49 N / m^2 after 15 days of storage at 4 C^o because of constantly

moisture losing and shrinkage and high rate respiration of mushroom tissue [8; 10, 34]. Effectiveness of Polyphenol Oxidase (PPO) also plays an important role in the enzymatic reactions. Drying, which is one of the oldest and simplest thermal processes for mushrooms preservation. So [4] was tested drying method on oyster mushroom samples after soaking them with citric acid, sodium bisulfate meta, and amine-acetic dayethylene acid that effectively contributed to a decrease water activity of dried sample to 0.366 and 0.40. Canning preservation is also another important commercial technology used to provide a relatively long shelf life [5]. Canning causes changes in the chemical and physical properties of mushrooms and nutrients can be oozed from tissue during blanching and sterilization, which in turn affects the biological active substances [41].Therefore, the current study aimed to preserve the fruiting bodies of cultured mushrooms by drying and canning methods, and to test the efficiency of several solutions substitute for other chemical preservative compounds and their effect on some of the sensory and chemical properties of mushrooms.

Materials and methods

1.Mushroom processing and preservation

A-1 Preparation solutions for canning

Preservation fruiting body by canning were used six aqueous solutions included Himalayan salt 1% (HM1), Himalayan salt 2% (HM2), salt 2% + 0.3% citric acid (SAC1), salt 2% + 0.5% citric acid (SAC2), salt 2% + 0.1 ascorbic acid (SAA1), salt 2% + 0.2% ascorbic acid (SAA2), Control treatment (

Cont.) Filled with boiling water only.

A-2 Samples (mushrooms) collection and Preparation

In this study , two local fully matured mushrooms were used including (PoL) *P.ostreatus*, (PeL) *P.eryngii* were collected (Figure1) ,the mushrooms were firstly identified before transfer to the laboratory . canning process was done as in [34,32].(Figure 2)

Figure 1. fruiting body of isolates oyster mushroom grown on CC substrate , A *(Pleurotus ostreatus*) , B (*Pleurotus eryngii*)

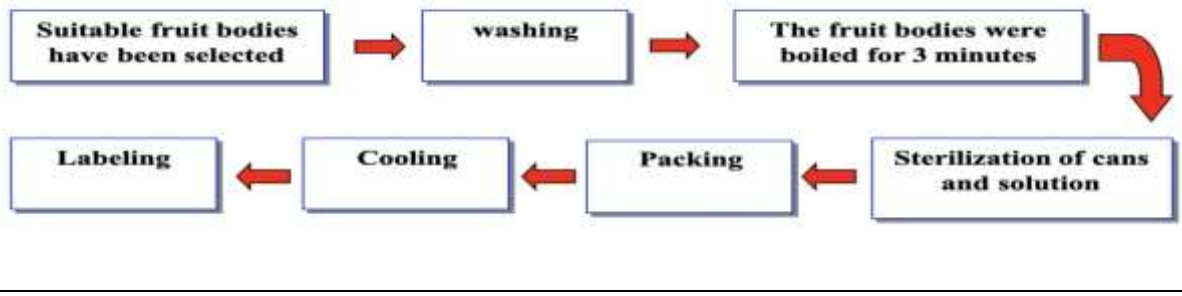

Figure 2: Flow chart for mushroom canning preparation

B. Sample preparation and drying

Oyster mushrooms fruit bodies were divided into six equal parts ;first part serve as the control (without any treatment) while other two parts subjected to the following treatment the first sprayed with Citric acid 1% (CA) , Citric acid 1% + 0.5% Ascorbic acid (CAA) . after subjecting samples each treated were divided into two equal parts andsubjected to different drying methods was used drying and drying in a electric oven. Until reaching constant weight .

2. Microbial test

The pathogenicity assay for canning samples was carried out in (Bioassay laboratory of the National Center For Organic Farming \ Ministry of agriculture). After preparing the samples and serial dilutions up to $10^{-4}$of each mushrooms homogenate were made , 0.1 ml was spread into sterile Petri dishes containing both MacConkey Agar and S.S Agar with three replicates for each sample, The plates were incubated in incubator at 37 °C for 48-24 hours, as in [22,42] .

3.Taste and color evaluation

Sensory evaluation was done after 30 days by Six people (3 men and 3 women) aged between 35-50 years were evaluated mushrooms canning and drying samples after rehydration in tab water for 3 hours .including ,color and taste .the samples were prepared for evaluation using the traditional cooking method with some additions which in same quantities for all samples equally, each one gave his assessment of the taste and color as in [6,35] and the scores used for assessment were as follows:

- From 10: 9 (Excellently desirable)
- Less than 9:8 (very good)
- Less than 8:7 (good)
- Less than 7:6 (desirable to an acceptable degree)
- Less than 6 (undesirable)

4.chemical analyzes

For the determination of ash and protein, and as mentioned in [1] the samples were dried by placing them in a thermal oven at 40 °C. The protein content was estimated by determination of total nitrogen using the Micro Kjeldhal method (conversion factor for mushrooms is 4.38) [37,24] the following equation was used :

Protein [%] = N % x 4.38

The percentage of ash was determined using the following equation:

$$\text{Ash [\%]} = \frac{\text{Final weigh} - \textit{Empty crucible}}{\text{Initial weigh}} * 100$$

The dry matter ratio for dried samples :

Dry matter ratio = 100 – moisture content

Results and discussion

Microbial analysis and sensory evaluation of canned oyster mushroom affect by different preservation solutions

microbial analysis of the canned oyster mushrooms showed an absences of microorganism on the MacConkey agar and S.S agar (Fig. 3) either after canning or during storage . *Salmonella* and *E.coli* bacteria as well as a group of coliform bacteria, including and thermotolerant coliform is commonly used as indicators of sanitary quality of water and food so microbial indicators are used to assess the food safety and may eventually lead to spoilage [15]. Its presence indicates means a defect in the efficiency of heat treatment, especially that it can be eliminated at a temperature of 80 ° C [9]. Sensory evaluation (flavor and color) of canned oyster mushrooms samples in different solutions. For PoL samples ranged between acceptable for salt treatment 2% + ascorbic acid 0.1% (SAA1) and good for the salt treatment 2% + citric acid 0.3% (SAC1), while the salt treatment 2% + citric acid 0.5 %(SAC2) recorded a very good evaluation and the rest of the treatments recorded an unacceptable taste by the evaluation committee .While the evaluations of canned PeL(*Pleurotus eringii*) mushrooms samples were similar to the taste evaluation ofPoL(*Pleurotus ostreatus*) samples , but with lower rates, to score very good as the highest evaluation of SAC2 and acceptable for the two treatments SAC1 and SAA1 (Table 1). ,As for color PoL(*Pleurotus ostreatus*) and PeL(*Pleurotus eringii*) canned mushrooms in SAC2.

The importance of citric acid due to its mechanism of action it works to reduce the acidity of solution pH ≤ 4.5, which in turn works to reduce the acidity of the cytoplasm in the microbial cell, leading to denature protein and inhibit membrane transport leading to death of cell [16]. In addition its role in promoting the reduction of PPO enzyme activity after the blanching process, because the enzyme activity is at its peak at pH 7-6 andbecomes inactive when the pH is reduced to 3 [30]. Ascorbic acid treatment which caused noticeable color changes because oxidation of ascorbic acid in heat treatment before canning, then it cannot reduce O-quinones and brown color persists causing melanin generation [30].

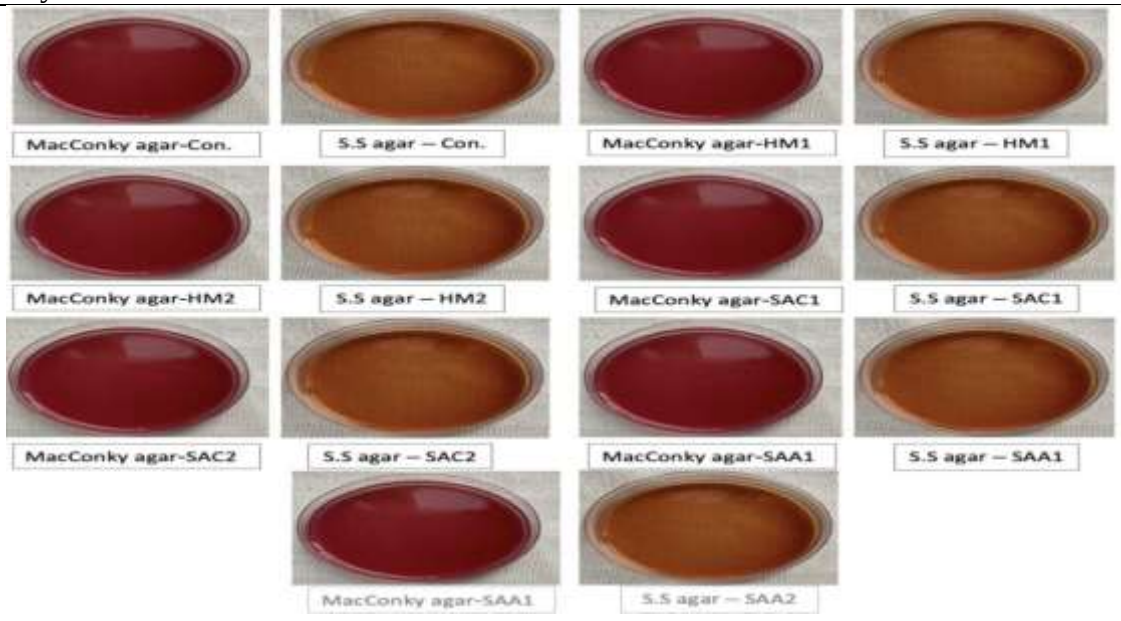

Figure (3) Microbial test of canned samples after 48 hours of incubation at 37 °C

Table 1: sensory acceptability score of canning oyster mushroomafter 30 days affected by different preservation solutions.

Treat	PeL		PoL	
	Taste	Color	Taste	Color
Cont.	3.66	1.66	5	3.30
HM1	4.33	3.66	6.00	4.83
HM2	3.33	5.33	5.66	5.50
SAC1	7.00	6.66	7.66	7.16
SAC2	8.33	8.00	8.66	8.66
SAA1	6.16	6.33	6.00	6.66
SAA2	5.00	5.83	5.16	5.33

Values represented as mean of Six people evaluation

Treatments : Control(cont.),Himalayan salt 1% (HM1), Himalayan salt 2% (HM2), salt 2% + 0.3% citric acid (SAC1), salt 2% + 0.5% citric acid (SAC2), salt 2% + 0.1 ascorbic acid (SAA1), salt 2% + 0.2% ascorbic acid (SAA2).

Figure 4:Color changes of the local *P.ostreatus* preserved by canning in several solutions

Dry matter ratioand sensory evaluation of dried oyster mushrooms

Table 2 shows air dried techniques produced average of dry matter which recorded (22.73 and 24.68%) for PoL and PeL respectively with no significant differences . as well as PeL recorded the highest percentage of dry matter recorded (27.50%)with no significant differences with untreated samples (Cont.) which recorded 26.50%. while PeL was found to belowestin drying electric oven with a mixture of CAA (citric acid 1% and ascorbic acid 0.5%) samples (20.00%) which show significant differences with highest dry matter of PoL (36.32%) in untreated samples (Cont.). Dry matter in mushrooms is low, ranging from 80-140 g/kg, especially for newly grown mushrooms due to the high moisture content of 70-95%, and carbohydrates constitute 50-65% of this rate [20]. The variation of dry matter in different treatments may be due to the difference in moisture rates, which is affected by environmental factors such as high temperature in the production rooms before harvest, low humidity and increased ventilation rates.

Table2: show dry matter of dried oyster mushroom, by air and by electric oven

Dry matter (%)				
Treat.	Electric oven drying		Air drying	
	PeL	PoL	PeL	PoL
Cont.	28.38	36.32	26.50	22.80
CA	21.77	29.03	20.06	20.20
CAA	20.00	25.38	27.50	25.20
Average	23.38	30.24	24.68	22.73
LSD (0.05) *mushroom	2.205		4.09	
LSD (0.05) mushroom * treatment	3.82		7.08	

Treatments: Control (Cont.),citric acid 1% (CA), citric acid 1% + ascorbic acid 0.5%(CAA).

Table3: show sensory evaluations of pre-treated and dried mushrooms sample of PoL and PeL spraying with citric acid CA (1%) and with a mixture of CAA (citric acid 1% and ascorbic acid 0.5%) .The air-dried untrated treatment (Cont.) was found to be highest evaluations in color and taste recording (desirable excellent for color and very good for taste) . At oven drying CA samples recording (very good desirable) for PoL and PeL , followed by evaluations of the control sample (Cont.) recorded (good)for taste and (very good) evaluation for the color property. On the other hand the mixture treatment (CAA), had the lowest evaluation (undesirable) for color and (good) for taste .Air-drying quality of control treatment which was distinguished by its white color be because of natural air temperature, especially during the drying period in winter. while color deterioration becomes faster when drying by using hot air due to the transfer of thermal energy inside material . Therefore, lower temperatures reduce the thermal stress on the surface with less cellular destruction and disclocation occur [33].at high temperature of drying the browning of dried product is more pronounced because of high temperature may be a catalyst for some enzymatic reactions, such as Poly phenol oxidase (PPO) enzyme reactions, in addition to non-enzymatic reactions such as Millard reactions and Caramel reactions [11].The maximum effectiveness of PPO enzyme is at 30 °C , between 30 - 70 °C. A gradual decrease in its activity occurs with increasing temperature and becomes very low at 70 °C. This is a very important factor for the difference between two types of drying [23]. And may treatment of 1% citric acid helped reduce the color changes by PPO enzyme by lowering the pH to 3.0 [23].

Table 3: sensory acceptability score of dried oyster mushroomat 45Cº affected by pre-treatment and drying methods

Treat.	Electric oven drying				Air drying			
	PeL		PoL		PeL		PoL	
	color	Taste	color	Taste	color	Taste	color	Taste
Cont.	8.66	7.80	8.00	7.33	8.00	8.16	8.66	9.00
CA	8.33	8.50	7.83	8.16	7.50	7.33	7.33	7.16
CAA	5.83	7.16	5.33	7.00	6.00	7.00	5.33	6.66

Values represented as mean of Six people evaluation
Treatments:Control (Con.),citric acid 1% (CA), citric acid 1% + ascorbic acid 0.5%(CAA).

Chemical analysis

Table 4: showed a decrease in protein content of pre-treatment *P.ostreatus*(PoL) and *P.eryngii*(PeL) samples by spraying citric acid 1% and citric acid 1% + ascorbic acid 0.5% dried in air and oven . protein was found to be highest in the untreated air dried samples (21.6 , 18.01%) for PoL and PeL respectively. while the least protein contentin air and oven dried for Pel samples pretreated with CAA recorded (16.46 , 13.77%) .at the same time untreated canning had the highest protein content (19.14%) .canning samples with Himalayan salt 1% (HM1) had had recorded(15.64%) . PoL canning in salt 2%+ ascorbic acid 0.1% found to be least in protein content (13.40%) and (11.09%) for PeL.(Table 5)

Protein content of dried mushrooms ranged from 19% to 39% same as value obtained in this study [36].due to mushroom have no pectin in cell wall component ,but consist fromglucan, chitin and protein so acid mainly effected on cells' protein [25] .when protein subjected to an acidic pH some of side chain (Carboxyl group) lose their ionic charge leading to denaturation [42]. In addition heat treatments (Blanching) weakness cell wall firmness so this facilitates the movement of water and some solid out of mushrooms' tissues including water soluble single cell protein [32] .

Table 4:The proximate composition of protein in air and oven dried oyster mushroom .

Protein (%)				
Treat.	Electric oven drying		Air drying	
	PeL	PoL	PeL	PoL
Cont.	17.98	20.34	18.01	21.6
CA	14.87	17.56	17.21	18.44
CAA	13.77	19.66	16.46	17.78
Average	17.36		18.25	
LSD (0.05) *mushroom	0.390			
LSD (0.05) mushroom * treatment	1.405			

Table 5: The proximate composition of protein in canning oyster mushroom with different solutions

Protein (%)			
Treatments	Canning mushrooms		Treat. average
	PeL	PoL	
Cont.	20.98	17.30	19.14
HM1	15.95	15.32	15.64
HM2	13.14	14.84	13.99
SAC1	14.89	14.41	14.65
SAC2	14.01	14.26	14.14
SAA1	11.09	13.40	12.24
SAA2	12.07	16.31	14.19
Average	14.85		
LSD (0.05) *treatment	1.979		
LSD (0.05) mushroom * treatment	2.732		

Treatments : Control(cont.),Himalayan salt 1% (HM1), Himalayan salt 2% (HM2), salt 2% + 0.3% citric acid (SAC1), salt 2% + 0.5% citric acid (SAC2), salt 2% + 0.1 ascorbic acid (SAA1), salt 2% + 0.2% ascorbic acid (SAA2).

Table 6 showed the value of ash for both air and oven dried sample.CAA treatment was found to be the highest ash content in air and oven dried for PoL(8.91 , 8.70%) and for PeL (8,27 , 8.34%) respectively .the untreated air dried samples had the lowest ash content (8.50 ,7.65%) for PoL and PeL respectively. at the same time recorded (7.30,7.70%) in oven dried samples. While ash content in canning samples was found to be high in HM2 solution (13.29%) with no significant difference with salt 2%+ascorbic acid 0.1% (SAA2) recorded 13.11% and salt 2%+citric acid 0.5% (SAC2) recorded 12.56% .untreated sample of PoL and PeL had the lowest value (11.00,12.00%) respectively.(Table 7)

Ash can give general indication of mineral constituents of mushrooms the total ash content is very less about 5-12% [21]. However our result similar to [19] who evaluated the effect of pre-treatments and drying methods on chemical composition, ash content was increased and measured between 4-7.5% treated with salt and citric acid solution. inorganic matters increased in salted brine and along the storage period and that effects on the other component [7] . As for the high percentage of ash in control samples, it may be attributed to the different nutritional grown on different substrate that affects the percentage of protein, ash, carbohydrates and fibers of fruiting bodies[18].

Table 6:The proximate composition of ash in air and oven dried oyster mushroom

Ash (%)				
Treat.	Electric oven drying		Air drying	
	PeL	PoL	PeL	PoL
Cont.	7.70	7.30	7.65	8.50
CA	8.00	7.35	7.90	8.89
CAA	8.34	8.70	8.27	8.91
Average	7.89		8.35	
LSD (0.05) *mushroom	0.601			
LSD (0.05) mushroom * treatment	1.024			

Treatments: Control (Cont.),citric acid 1% (CA), citric acid 1% + ascorbic acid 0.5%(CAA).

Table 7: The proximate composition of ash in canning oyster mushroom with different solutions

Ash(%)			
Treatments	Canning mushrooms		Treat. average
	PeL	PoL	
Cont.	12.00	11.00	11.50
HM1	13.02	12.40	12.71
HM2	13.53	13.04	13.29
SAC1	12.5	11.40	11.95
SAC2	12.9	12.22	12.56
SAA1	13.00	11.20	12.10
SAA2	14.20	12.02	13.11
Average	12.46		
LSD (0.05) *treatment	1.024		
LSD (0.05) mushroom * treatment	1.410		

Treatments : Control(cont.),Himalayan salt 1% (HM1), Himalayan salt 2% (HM2), salt 2% + 0.3% citric acid (SAC1), salt 2% + 0.5% citric acid (SAC2), salt 2% + 0.1 ascorbic acid (SAA1), salt 2% + 0.2% ascorbic acid (SAA2).

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