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Original Research

Influence of different source of dipping solution and duration of application on prolongation of the storage life of paddy straw mushroom *Volvariella volvacea*

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ABSTRACT:

Three experiments were conducted in the cold storage unit at Department of Horticulture and Landscape Design and the laboratories of the project of Fungi-Medicinal and Aromatic Plants Research Unit, College of Agriculture, University of Baghdad from 1.3.2014 to 15.5.2014. The spawn of strain V106 of the paddy straw mushroom *Volvariella volvacea* from china V106 was produced using fragmentation tissue culture. When the fruiting bodies of paddy straw mushroom were harvested by twisting carefully by hand at the egg stage. The fruiting bodies were treated with different types of dipping solution treatments either by Cumin seeds Extract (CE) at the concentration of 0, 100, 200, 400, 800 $mg.L^{-1}$ or Citric Acid solution (CA) at the concentration of 0, 20, 40, 60 $g.L^{-1}$ or dipping in Hydrogen peroxide Solution (HS) at the concentration of 0%, 0.2%, 0.4%, 0.6%. All fruiting bodies in these treatments were dipped in 5 sec or 10 sec and the excess water was removed using paper towel and they were kept in plastic container with the capacity of 50 g. All containers were covered by plastic films and stored at 10±1°C for one week. The results showed that the influence of types of dipping solutions have significantly decreased the physiological disorder, the percentage of post protein storage loss, on the percentage of opening of fruiting bodies, the percentage of post storage weight loss of fruiting bodies and the percentage phenolic compound of fruiting bodies after storage. The best type of dipping solution treatments was cumin seeds extract at 800 $mg.L^{-1}$ compared with the control treatment (dipping in water only), and best duration of dipping fruiting bodies which significantly decreased the physiological disorder, the percentage of protein loss, the percentage of opening of fruiting body and the percentage of weight loss of fruiting bodies was 10 sec but the 5 sec significantly the best duration of dipping which decreased the phenolic compounds.

Keywords:

Cumin seeds extract, Citric acid, Hydrogen peroxide, Shelf life, Paddy straw mushroom.

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INTRODUCTION

Paddy straw mushroom *Volvariella volvacea* is the fifth edible mushroom well known in the world with good quality characters and nutrient value rich substance for the human being. The 100 g of fresh mushroom contains 3.9 g protein, 90-4 g water, 0.25 g fibers, 0.10 g phosphours, 0.32 g potassium, 1.70 g iron, 5.60 g calcium, 0.14 g thiamine, 0.61 g Riboflavin, 2.40 g niacin, 18 g ascorbic acid (Verma, 2002).

There are six stages of development, Pinhead stage, tiny button stage, button stage, eggs stage, elongation stage and mature stage (Justo and Castro, 2010). The harvesting of paddy straw mushroom was done at egg stage when it papers as a colony or as a single mushroom (Al-Wandawy, 2014). It is stated that this mushroom gives a big cap with feeble stem susceptible to break during harvesting (Ahlawat and Tewari, 2007).

The plant extract and fresh better orange juice and some chemical compounds such hydrogen peroxide and citric acid can be used to control the postharvest disease and conserve the quality of the vegetable and fruits and that is due its function as anti-oxidant or anti-bacterial or anti-fungal agents and also preventing browning of these fruits or vegetables. These compounds also acts as a preserver of the food values, its flavour, texture and structure of the fruiting bodies.

These chemical compound was added to the food material as preserver due to its role in controlling the growth of microbial organism during the storage such as bacteria and fungi (Wiley, 1994).

Dipping the fruiting bodies of the white agricultural mushroom in citric acid preserved the mushroom tissues and white color of the fruiting bodies for five days storage period at 13°C for Czapski (2000) and he attributed that to the role of citric acid in inhibiting the activity of the enzyme polyphenol oxidase which is responsible for browning of the living tissue (Vauqhan and Duck, 1984). While Soler-Rivas *et al*. (1999) found that storing the white agricultural mushroom fruiting bodies with the preserving compounds will shorten the shelf life of the mushroom, he stated that this mushroom contains high percentage of water, perishable and with high rate of respiration and these character will lead to the infection with the bacteria specially during storage and marketing and this will activated tyrosinase. This enzyme induce the browning of fruiting bodies.

Marshall *et al*. (2000) found that citric acid is a chelated compound, that seize the ion of the needful mineral elements which inhibit the action of the bacteria responsible for the function of the enzymes which causes the browning of the fruiting bodies during storage and marketing. Muslat (2002) found that dipping the fruiting bodies of the mushroom *Pleurotus ostreatus* on citric acid at a concentration of 200 or 250 $mg.L^{-1}$ increases the shelf life at a rate 50% and he related that to the function of citric acid on inhibiting the activity of the enzyme poly phenol oxidase which is responsible for the browning of fruiting bodies during the storage.

Brennan and Gormley (1998) found that dipping the fruiting bodies of the white agricultural mushroom in hydrogen peroxide prevent the infection of these bodies with bacteria such as *Pseudomonas* sp during storage and marketing. Sodhi and Kapoor (2007) suggested that fruiting bodies of paddy straw mushroom must be consumed fresh because it's perishable specially at maturing while at the egg stage it can be stored in benched bags with the capacity of 200 g at 15-22°C to 4 days.

The plant extracts play a good role in the food technology either on perishable food or processed due to its role on antimicrobial activities. They are used in preserving foods, in pharmacological industry and as medicinal and natural remedy (Lis-Balchin and Dens 1997; Ageena *et al*., 2009). The provision of low price spices and plant herbs even in countries which are not grown could be used widely an antimicrobial agents specially in food storage (Oiye and Muroki, 2002). The plant ex-

tracts was used by many researches because it is a source of natural products and it has a protective and defending when it is used as curative agents in many diseases and also used as preservative agents in the food technology (Tepe *et al*., 2004).

The cumin seed *Cuminum cyminum* extract was widely used in the preservation of food due to its role in preventing the growth of the microbe which deteriorate food stuff during storage and that it is attributed to the aplenty of this extract to control the microorganism causes the diseases (Saksena and Saksena, 1948; Ageena *et al*., 2009). Ageena *et al*. (2009) reported that using ethanol alcohol extract as preservative solution during storing revaluate inhibiting activity that agents the bacteria at 80 mg/ml and he attributed that to the alcoholic compounds and aldehyde's such us cumin alcohol and cumin aldehyde in this extract which was reported by many research against the micro-organisms De *et al*. (2003). Many research workers have reported that cumin seeds contain many compounds which inhibit the growth of the bacteria which causes the spoilage of these food stuff during storage and those compound are limonene, eugenol and pinenes (Mozaffarian 1996; Zargari, 2001; Omidbaigi, 2008; Derakhshan *et al*., 2008, 2010). The water extract of cumin seeds worked as antioxidant agent, it contains a good percentage of A, E, C vitamins (Riaz, 2012).

The objective of this research work is to make a comparative study between the synthetic extracts and natural extract from plant source such as cumin seeds at different concentration to find the right concentration to be used.

MATERIALS AND METHODS

These experiments were conducted in the cold storage unit at Department of Horticulture and Landscape Design and the laboratories of medicinal and aromatic plant units, mushroom project in the college of Agriculture during 1.3.2014-15.5.2014. The pure spawn of the paddy straw mushroom *Volvariella volvacea* strain (V106) was obtained from china and simulated by fragmentation of the tissue on potato dextrose agar to propagate and produce the mother culture (Oei, 2005). The fungal inoculums were headed on wheat grain media to produce spawn (Oei, 2005). The grinded wheat straw was used as media to grow the paddy straw mushroom. The wheat straw was dipped in 0.5% formaldehyde solution (35%) with pavasten (antifungal) at 25 ppm (Oei, 2003; Muslt, 2002; with some modification), for 20 h. The wheat straw was dried in clean place to remove the excels humidity to get 60-70 relative humidity. Calcium carbonate (lime) at 3% was added to the straw and also wheat bran at 10% was added and mixed well then bagged in clear polyethylene bags (30×51 cm) which contain 2 kg of the straw (60-70% RH).

The fungal inoculums at 5% to each bag at a layer in the top of the bag and the either at the out side of the bag (Oei, 2003 with some modification). The poly ethylene bags were closed and stored on the shelf's in raising room at 30±2°C. To promote the growth with of mushroom mycelium and after the complement of growth, the bags were open and a layer of sterilized peat moss to cover the bags and lighting of 100-150 lux was provided daily and ventilation for 4 h per day to reduce the CO_2 concentration during the production stage and also to provide humidity suitable for the growth of the mushroom. When the growth of the mushroom reach the egg stage, it was harvested and the following experiments were carried out.

The influence of different concentration of cumin aquatic extract in the shelf life of paddy straw mushroom

When the fruiting bodies of baddy straw mushroom gets matured, it was harvested by carefully twisting its head by hand at the egg stage. The fruiting bodies were dipped in aquatic extract of cumin at the concentration of 0, 100, 200, 400 and 800 $mg.L^{-1}$ and represented cumin extract. These concentrations were pre-

pared by dissolving the following weight 0.1, 0.2, 0.4, 0.8 g of cumin seeds. According to Harborne (1984) and Ladd *et al*. (1987) methods, each concentration was dissolved in one liter of distilled water. A magnetic heater starrer was used to exhilarate the dissolving of cumin seed powder in the water. After the dissolving of cumin seed in the water. The solution was sterilized by water bath for 15 min. then cooled and the fruiting bodies were dipped in it for 5 sec or 10 sec and the excess of water was removed using paper towel and kept in a plastic container with a capacity of 50 g. The container was covered by plastic films and stored at 10±1 ċ for one week

The influence of synthetic citric acid on the shelf life of paddy straw mushroom

The experiment was designed to investigate the influence of fruiting bodies of oyster mushroom which were produced.

The citric acid solution was prepared at the concentration of 0, 20, 40, 60 $g.L^{-1}$ according to Brenna and Gormley (1998) method and represented by citric acid. the fruiting bodies was dapped for 5 and 10 sec; then the excess of water was removed using paper towel and kept in plastic container with 50 g capacities and covered by plastic films and stored at 10 ċ for a week.

The influences of hydrogen peroxide on shelf life of paddy straw mushroom

Hydrogen peroxide was used to control the storage micro organism (Juven and Pierson, 1996). The fruiting bodies was dipped in hydrogen peroxide at 0%, 0.2%, 0.4 % and 0.6% for 5 and 10 sec and represented by HS. The fruiting bodies was removed from the hydrogen peroxide and dried using paper towel and kept in plastic container 50 g capacity then covered with plastic films and stored at 10±1 ċ for one week.

The studied characters

- The percentage of post storage physiological disorder such cracker. Secondary growth, changes in colour, watery break down or spotting were analysed using the following equations:

$$\text{Physiological disorder (\%)} = \frac{\text{Weight of infected fruiting bodies}}{\text{Total weight of fruiting bodies}} \times 100$$

$$\text{Protein loss (\%)} = \text{Pre storage protein (\%)} - \text{Post storage protein (\%)}$$

- Percentage of open fruiting bodies after storage period using following equation:

$$\text{Open fruiting bodies (\%)} = \frac{\text{Number of open fruiting bodies}}{\text{Total number of stored fruiting bodies}} \times 100$$

- The percentage of post storage weight loss using the following equation (Abdulhadi *et al*., 2013):

$$\text{Weight loss (\%)} = \frac{\text{Pre storage weight of fruiting bodies} - \text{Post storage weight of fruiting bodies}}{\text{Pre storage weight of fruiting bodies}} \times 100$$

- The percentage of phenolic compounded in fruiting bodies using the following equation (Abdulhadi, 2012):

$$\text{Total phenol loss (\%)} = \frac{\text{Pre storage phenol content} - \text{Post storage phenol content}}{\text{Pre storage phenol content}} \times 100$$

Experimental Design

The statistical analysis of these experiments done using Completely Randomized Design (CRD) with 3 replicates for each factor. The first factor (A) was the concentration for dipping solutions. The symbol for cumin extract, cumin extract, citric acid and hydrogen peroxide and the second factor the duration of dipping, five and ten sec (Al-Rawi and Khalfalah, 1980). The comparison between the statically mean was done using LSD using SAS (SAS, 2012).

RESULTS AND DISCSSION

The influence of the types and duration of dipping solution and the interaction between them on the percentage of disorder of fruiting bodies of paddy straw mushroom

There is a significant influence of types of dipping solution on the physiological disorder of the fruiting bodies of paddy straw mushroom after the storage duration (Table 1). The best treatment was the cumin extract dipping solution at 800 $mg.L^{-1}$ in which the percentage of physiological disorder was 1.70% after stor-

age the control treatment gave the highest percentage 6.95% (Table 1). The citric acid and hydrogen peroxide dipping solution decreased this percentage but less than the treatment cumin extract at 800 $mg.L^{-1}$. The duration of dipping significantly decreased the percentage of physiological disorder. Dipping for 10 sec gave the lowest percentage 4.07% while dipping for 5 sec gave a percentage 4.25% (Table 1).

The interaction between type of dipping solution and the duration of dipping significantly influenced the percentage of physiological disorder. The interaction between the cumin extract dipping solution at 800 $mg.L^{-1}$ and the duration of 10 sec. gave the lowest percentage 1.50% while the treatment with distilled water for 10 sec. gave the highest percentage 7.67% (Table 1).

The superiority of cumin extract type of dipping solution at 800 $mg.L^{-1}$ over the other types of solution was due to the fact that cumin extract was inhibit the growth of the micro organism (Saksena and Saksena, 1948; Ageena *et al*., 2009). Ageena *et al*. (2009) stated that ethanol extract of cumin gave a good inhibiting effect that agents the bacteria at 80 mg/ml and that was because, this extract contains alcoholic compounds and aldehydes such as cumin alcohol and cumin aldehyde which worked as inhibitor for the micro-organism (De *et al*., 2003). Cumin seeds contain many compounds which inhibit the growth of the bacteria which spoiled the food during storage and these compound were limonene, eugenol and β-pinenes (Mozaffarian, 1996; Zargari, 2001; Omidbaig, 2008; Derakhshan *et al*., 2008; 2010). The 10 sec duration of dipping was more effective in inhibiting the growth of the micro organism was due to the fact that the fruiting bodies received more cumin extract when dipped for 10 sec and that's why treatment with 800 $mg.L^{-1}$ was more effective in preventing the spoilage of fruiting bodies (Table 1).

Influence of type and duration of dipping solution and the interaction between them on the percentage of protein loss from paddy straw mushroom fruiting bodies

The experimental results in Table 2 show a significant influence of the type of dipping solution on the percentage of post storage protein loss from paddy straw mushroom in all the treatments. Dipping the fruiting bodies in cumin extracted 800 $mg.L^{-1}$ decreased the percentage of protein loss to 1.50% as compared with the

Table 1. Influence of the type and duration of dipping and the interaction between them on the percentage of physiological disorder in fruiting bodies of paddy straw mushroom after storage

S. No	Duration of dipping / Types of dipping solution	The percentage of physiological disorder		
		Dipping for 5 sec.	Dipping for 10 sec.	Mean of types of dipping solution
1	Dipping in distilled water (control)	6.23	7.67	6.95
2	Dipping in CE 100 $mg.L^{-1}$	4.50	3.50	4.00
3	Dipping in CE 200 $mg.L^{-1}$	4.10	2.97	3.53
4	Dipping in CE 400 $mg.L^{-1}$	3.03	2.03	2.53
5	Dipping in CE 800 $mg.L^{-1}$	1.90	1.50	1.20
6	Dipping in CA 20 g $.L^{-1}$	2.60	1.57	2.08
7	Dipping in CA 40 $g.L^{-1}$	3.50	2.80	3.08
8	Dipping in CA 60 g $.L^{-1}$	5.00	4.13	4.57
9	Dipping in HS 0.2%	4.90	5.90	5.42
10	Dipping in HS 0.4%	5.00	5.93	5.47
11	Dipping in HS 0.6%	5.83	6.70	6.27
12	Means of types of dipping solution	4.25	4.07	
	L.S.D(0.05)	Duration of dipping	Type of dipping solution	Interaction
		0.01	0.26	0.37

Table 2. Influence of type and duration of dipping and the interaction between them on the percentage of post storage protein loss of fruiting bodies of paddy straw mushroom

S. No	Duration of dipping / Types of dipping solution A	The percentage of protein loss after storage		
		Dipping for 5 sec.	Dipping for 10 sec.	Mean of types of dipping solution
1	Dipping in distilled water (control)	8.70	9.80	9.23
2	Dipping in CE 100 mg.L^{-1}	6.53	5.00	5.77
3	Dipping in CE 200 mg.L^{-1}	5.20	3.00	4.50
4	Dipping in CE 400 mg.L^{-1}	3.10	2.43	2.77
5	Dipping in CE 800 mg.L^{-1}	1.80	1.20	1.50
6	Dipping in CA 20 g .L^{-1}	6.50	5.10	5.82
7	Dipping in CA 40 g.L^{-1}	4.80	3.70	4.27
8	Dipping in CA 60 g .L^{-1}	7.60	8.60	8.10
9	Dipping in HS 0.2%	6.70	7.63	7.15
10	Dipping in HS 0.4%	7.80	9.00	8.42
11	Dipping in HS 0.6%	6.80	7.50	7.15
12	Means of types of dipping solution	5.96	5.80	
	LSD(0.05)	Duration of dipping	Type of dipping solution	Interaction
		0.088	0.206	0.291

control treatment in which the percentage was 9.23% (Table 2).

The duration of dipping significantly influenced the percentage of protein loss from paddy straw mushroom after storage. Dipping for 10 sec gave a percentage of 5.80% while dipping for 5 sec gave 5.96%. The interaction between type of dipping solution and the duration of dipping significantly influenced the percentage of protein loss after storage. Dipping in cumin extract solution at 800 mg.L^{-1} for 10 sec reduced the protein loss to 1.20% as compared with 9.80% when the fruiting bodies dipped in water for 10 sec (Table 2).

The reduction of the percentage of protein loss after storage specially when the fruiting bodies was dipped in cumin extract at 800 mg.L^{-1} for 10 sec. because cumin seed contained limonene, eugenol and β-pinenes (Mozaffarian, 1996; Zargari, 2001; Omidbaig, 2008; Derakhashan *et al*., 2008; 2010), and these compounds inhibited the growth of bacteria which causes the spoilage during storage (Table 1). Reducing the spoilage of fruiting bodies reduced the rate of respiration and that reduced the protein loss of paddy straw mushroom after storage (Golan *et al*., 1984; Al-Badrany, 2014).

The influence of types and duration of dipping and the interaction between them on the percentage opening of paddy straw mushroom fruiting bodies after storage

There is a significant influence of the type of dipping solution on the percentage of opening of fruiting bodies of paddy straw mushroom after storage. Dipping fruiting bodies on cumin extract at the rate of 800 mg.L^{-1} reduced this percentage to 4% while the control treatment gave a highest percentage of 15.0% (Table 3).

Fruiting bodies dipped for 10 sec in the cumin extract significantly reduced the percentage of opening to 10.83% while dipping for 5 sec increased this percentage (11.47%) slightly (Table 3).

The interaction between the types of dipping solution and the duration of dipping significantly influence the percentage of opening of fruiting bodies. The treatment cumin extract at 800 mg.L^{-1} for 10 sec. significantly reduced this percentage to 4% while the treatment with water for 10 sec increased this percentage to 15.6% (Table 3).

Rai and Arumuganathan (2008) found that the

Table 3. Influence of type and duration of dipping and the interaction between them on post storage percentage of fruiting bodies opening of paddy straw mushroom

S. No	Duration of dipping B / Types of dipping solution A	The percentage of post storage opening of fruiting bodies		
		Dipping for 5 sec	Dipping for 10 sec	Mean of types of dipping solution
1	Dipping in distilled water (control)	15.0	15.6	15.3
2	Dipping in CE 100 mg.L^{-1}	12.0	11.0	11.5
3	Dipping in CE 200 mg.L^{-1}	10.0	9.0	9.5
4	Dipping in CE 400 mg.L^{-1}	8.0	6.0	7.0
5	Dipping in CE 800 mg.L^{-1}	5.8	4.0	4.9
6	Dipping in CA 20 g .L^{-1}	12.3	11.0	11.6
7	Dipping in CA 40 g.L^{-1}	10.0	9.0	9.5
8	Dipping in CA 60 g .L^{-1}	11.2	10.0	10.6
9	Dipping in HS 0.2%	12.6	13.6	13.1
10	Dipping in HS 0.4%	14.2	14.8	14.5
11	Dipping in HS 0.6%	14.1	15.7	14.6
12	Means of types of dipping solution	11.47	10.83	
	L.S.D(0.05)	Duration of dipping	Type of dipping solution	Interaction
		0.830	0.201	0.284

mushroom continue its growth and respiration after harvest and that will results in a loss in the weight and cap opening cum spoilage of fruiting bodies. The reduction in the percentage of cap opening of fruiting bodies after the treatment with cumin extract at the rate of 800 mg.L^{-1} may be attributed to the role of cumin seed in controlling the growth of bacteria which causes the spoilage of the mushroom during storage Mozaffarian, 1996; Zargani, 2000; Omidbaig, 2008; Derakhshan *et al.*, 2008, 2010), and also cumin extract may be influenced by some physiological activity inside the fruiting bodies such as the respiration during the storage period (Al-Badrany *et al*., 2014).

Table 4. Influence of type and duration of dipping and their interaction on the percentage of post storage weight loss of paddy straw mushroom

S. No	Duration of dipping B / Types of dipping solution A	The percentage of post storage weight loss of paddy straw		
		Dipping for 5 sec	Dipping for 10 sec	Mean of types of dipping solution
1	Dipping in distilled water (control)	12.0	13.0	12.5
2	Dipping in CE 100 mg.L^{-1}	9.7	6.6	8.1
3	Dipping in CE 200 mg.L^{-1}	8.8	5.2	7.0
4	Dipping in CE 400 mg.L^{-1}	6.2	3.0	4.6
5	Dipping in CE 800 mg.L^{-1}	4.0	2.2	3.1
6	Dipping in CA 20 g .L^{-1}	10.5	9.6	16.1
7	Dipping in CA 40 g.L^{-1}	8.3	7.6	7.95
8	Dipping in CA 60 g .L^{-1}	7.5	5.9	6.55
9	Dipping in HS 0.2%	11.9	12.0	11.9
10	Dipping in HS 0.4%	9.8	10.8	16.3
11	Dipping in HS 0.6%	8.2	9.9	9.07
12	Means of types of dipping solution	8.8	7.8	
	L.S.D(0.05)	Duration of dipping	Type of dipping solution	Interaction
		0.064	0.149	0.211

The influence of types and duration of dipping and their interaction on the percentage of post storage weight loss of paddy straw mushroom

The dipping solution used in this study significantly influenced the percentage of post storage weight loss of the fruiting bodies. The treatment with cumin extract at 800 $mg.L^{-1}$ significantly reduced the weight loss of paddy straw mushroom and the percentage was 3.1% as compared with other treatments while the percentage was 12.5% in the control treatment (Table 4).

The percentage of weight loss of fruiting bodies was the lowest 7.8% when the fruiting bodies was dipping for 10 sec while it was 8.8% when the duration of dipping was 5 sec (Table 4). There is a significant influence of the interaction between the treatment with the dipping solution and the duration of the treatment on the percentage of post storage weight loss fruiting bodies. The cumin extract treatment at a concentration of 800 $mg.L^{-1}$ for 10 sec decrease this percentage to 2.2% while dipping in water for 10 sec increased this percentage to 13% (Table 4). Many researchers have reported that cumin seeds contain antibacterial compound such as limonene, eugenol and β-pinenes (Mozaffarian, 1996; Zargari, 2001; Omidbaig, 2008; Derakhashan *et al*., 2008; 2010). From Table 1, it is revealed that dipping fruiting bodies in water increased the percentage of physiological disorder and the rate of respiration and lastly increased the percentage of weight loss of fruiting bodies after storage (Rai and Arumuganathan, 2008).

The influence of type and duration of dipping and the interaction between them on the percentage of phenolic compounds in fruiting bodies of paddy straw mushroom

Treating paddy straw mushroom with the dipping solutions significantly decreased the percentage of phenol compounds. Cumin seed extract at the rate of 800 $mg.L^{-1}$ significantly decreased this percentage to reach 1.63% while this percentage was 8.95% in control treatment (Table 5).

The duration of dipping significantly influenced the highest percentage of phenolic compound 6.512% and found when the duration of dipping was 10 sec. While the lowest percentage of phenolic compound 6.204% in fruiting bodies was when the dipping done at

Table 5. Influence of type and duration of dipping and interaction between them on post storage percentage of phenolic compounds in the fruiting bodies of paddy straw mushroom

S. No	Duration of dipping B / Types of dipping solution A	The percentage of post storage phenolic compounds of fruiting bodies		
		Dipping for 5 sec	Dipping for 10 sec	Mean of types of dipping solution
1	Dipping in distilled water (control)	8.43	9.47	8.95
2	Dipping in CE 100 $mg.L^{-1}$	6.96	5.17	6.07
3	Dipping in CE 200 $mg.L^{-1}$	5.13	4.30	4.73
4	Dipping in CE 400 $mg.L^{-1}$	3.10	2.40	2.75
5	Dipping in CE 800 $mg.L^{-1}$	2.00	1.27	1.63
6	Dipping in CA 20 g $.L^{-1}$	6.00	7.40	6.70
7	Dipping in CA 40 $g.L^{-1}$	7.53	8.13	7.83
8	Dipping in CA 60 g $.L^{-1}$	8.13	9.30	8.72
9	Dipping in HS 0.2%	6.90	4.47	7.18
10	Dipping in HS 0.4%	7.00	7.40	7.50
11	Dipping in HS 0.6%	7.30	8.70	8.20
12	Means of types of dipping solution	6.246	6.512	
	L.S.D(0.05)	Duration of dipping	Type of dipping solution	Interaction
		0.078	0.182	0.258

5 sec (Table 5).

The interaction between dipping treatment and the duration of dipping significantly influenced the percentage of phenolic compound in fruiting bodies the dipping in cumin extract at 800 mg.L^{-1} for 10 sec, which significantly decreased this percentage to reach 1.27% while dipping in water for 10 sec. and significantly increased this percentage to 9.47% (Table 5).The phenolic compounds were the most complicated compounds in the fruits (Al-Ani,1985). They are one of the glycoside groups and the sugar bounded with a group of non-carbohydrate glycoside which form a part with the medicinally active compound which reacts with the acids or by some enzymes resulting the formation one or more type of sugar. One of them may be reducing sugar and one or more of non sugar materials (Al-Shamma,1989).

The cumin seed extract is one of the best antioxidant compounds due to its contents of vitamins A,E,C (Riaz, 2012). So that dipping fruiting bodies in cumin extract cumin extract at 800 mg.L^{-1} causes a reduction of the percentage of phenolic compound after storage in fruiting bodies of paddy straw mushroom.

CONCLUSION

In this research we found that the best types of dipping solutions treatments was cumin seeds extract at 800 mg. L^{-1} and best duration of dipping was 10 sec which significantly decreased the physiological disorder, the percentage of protein loss, the percentage of opening of fruiting body and the percentage of weight loss of fruiting bodies.

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