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Effect of Whey Protein- Rice Bran Oil Incorporated *Zataria multiflora* Extract Edible Coating on Chemical, Physical and Microbial Quality of Chicken Egg

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Abstract

In this study, the effects of coating with whey protein concentrate (7.5% w/v) alone and/or in combination with rice bran oil and *Zataria multiflora* extract on the quality attributes and egg shelf life were observed and analyzed during 4 weeks. Weight loss, Haugh index, yolk index, pH, air cell depth, shell strength and the impact of this coating on the microbial load of the eggs surface were studied at the end of each week. After 4 weeks of storage, the weight loss in all of the treated eggs with whey protein concentrate and 0.2 gr of rice bran oil was significantly lower than that of the control group($P<0/05$). Regards to Haugh index and yolk index, egg shelf life increased about 4 weeks compared with the control samples. Haugh Index changes revealed that the coated samples remained at grade A after 3 weeks of storage, while the control samples were relegated from grade AA to B after one week. pH values of the control group were higher than those of the coated groups. The shell strength of the coated group was more than that of the control group (uncoated) and in coated samples, whey protein concentrate and 0.2 gr of rice bran oil coated samples had high shell strength. The depth of the air cell of the coated groups was determined to be less than that of the control group during the storage period. The minimum inhibitory concentration was 1 µL of *Zataria multiflora* extract. In sensory evaluation, the coated eggs had more overall acceptance than the uncoated group. In conclusion, coating as a practical and cost effective method can maintain the quality parameters of eggs and lead to durability of supply conditions in addition to the product marketability

Keywords: Edible coating, chicken egg, whey protein concentrate, rice bran oil, *Zataria multiflora* extract, Shelf life.

Introduction

Nowadays, edible films have revolutionized food packing industry. There have been quite number of studies on the importance of such packing.

The aim of food packaging is to preserve the quality and safety of the food. The concern about packaging waste has led the world to establish a directive to reducing the impact of packaging waste on the environment. Edible films and coatings offer an efficient alternative for packaging which provides barriers to moisture, gas or solute, improve mechanical integrity of foods, transports food ingredients and is completely biodegradable, reducing thus environment pollution (Yoshida et al., 2004). The film-forming properties of several proteins have been utilized in developing edible, protective films and coatings (Gennadios et al., 1994). Edible films and coatings derived from whey protein have been investigated for their application as new packaging (Javanmard and Golestan, 2007, Javanmard 2007, 2008).

Many applications for protein-based edible films have been proposed but little attention has been paid to the feasibility of using these films in real food systems. Edible film wraps may be able to partially replace some conventional synthetic packaging materials used to preserve and protect foods (O'Riordan *et al.* 2005).

There is a growing consumer preference for natural agents which have been isolated from microbiological, plant, and animal sources.

Active substances of biological origin have a powerful wide-spectrum activity with low toxicity, and are expected to be used for food

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preservation as a means of antimicrobial packaging. *Zataria multiflora* Boiss belonging to Laminaceae family is a local plant in Iran.

Traditionally it is used as flavor especially for yoghurt.The main oil essence compound of it is carvacrol and thymol (Aligiannis *et al*., 2001).

Eggs are a good source of high quality protein and provide a unique and well-balanced source of nutrients for persons of all ages. Maintaining fresh egg quality from producer to consumer is one of the major problems facing those engaged in marketing eggs. While a considerable amount of research has been conducted with films made from milk proteins on fruits and vegetables and other dairy foods, there are limited studies addressing the application of these films on eggs. Mpieri and Obanu (1984) investigated the efficiency of peanut oil, cottonseed oil and coconut oil in maintaining egg quality under tropical conditions. Hettiarachy *et al*. (2002) studied effects of edible coatings containing serum proteins, carboxymethyl cellulose, gluten and soy protein isolates on the egg with the mechanical and antibacterial properties. Alleonil and Aloisio (2004) used a milk serum protein concentrate coating on the internal quality of eggs.

Biladeau and Keener (2009) determined effects of four coatings on eggs may extend shelf-life under refrigerated storage. Four food-grade coatings, paraffin wax, mineral oil, soy protein isolate, and whey protein isolate (WPI) were selected. Suppakul *et al*. (2010) were examined the effect of coating with methylcellulose and hydroxypropyl methylcellulose on the strength and permeability of water vapor in eggs. Wardy et al. (2010) evaluated the ecacy of soybean oil compared to chitosan, whey protein concentrate (WPC) and mineral oil as coating materials for extending the she lf life of chicken eggs.

The objective of this study was to coat eggs with whey protein-rice bran oil and Zataria multiflora extract and observe the changes of chemical, physical and microbiological properties of the whole coated egg.

Materials and methods

Whey protein Concentrate (WPC 85% protein) supplied by Arla Foods (Videbaek Denmark), rice bran oil obtained from Etka Company (Manjil-Iran), and Glycerol (Gly) (Merk) was added as a plasticizer to all film-forming solutions. Chicken egg was supplied from Tehran Super star mall. *Zataria multiflora* was purchased from local market in Shiraz-Iran.

Film formation

Heat-denatured WPC films were prepared using the Shaw N.B. *et.al*. Method (2002). Aqueous solution of 7.5% (w/w) WPC was prepared and was stirred continuously on a magnetic stirrer at room temperature for 2h. To prepare heat-denatured coating, WPC solutions were heated at 90°C for 30 min in a water bath. Heated solutions were cooled to room temperature and adjusted to pH 7.0 with drop-wise addition of 1N NaOH. Gly was added to film-forming solutions to give glycerol: protein (Gly: Pr) ratios (w/w) of 1/2 and this ratio was kept constant throughout the study. The rice bran oil was added in the amounts of 0.2, 0.4, and 0.6 g in 100 ml coating solution to the heat denatured WPC solution containing glycerol. Zataria multiflora extract (1 and 2 µL in 100 ml coating solution) was added to the solutions. Whole eggs dipped in coating solutions and were allowed to dry at room temperature over 1h and then all samples stored for 28 days at room environment temperature and humidity (table 1).

Determination of weight loss

Before and after preservation, the samples were weighed in cold storage with a digital scale BA 310S model (Sartorius, Germany) with the precision of 0.01 gram Quauz GT 2100 and their weight loss because of dehydration was determined and reported in percentages.

Determination of air cell depth

The air cell depth of eggs was measured by a digital clipper using a bright light source

behind the egg to show egg air cell through the shell (candling). A very simple candling device was made in our Lab using (Kekeocha method, 1985), that is, placing a lamp in a dark chamber (paper box) and positioning an egg on top of the chamber in a hole and looking at the interior quality.

pH Measurements

The albumen and yolk were separated and pH was measured using a model 220 Denver Instrument pH meter (Denver Instrument, Denver, CO).

Shell strength measurement

Shell strength was analyzed on an egg shell force Gauge –Model-2 texture analyzer (Japan). The eggs were placed in a 1.3- cm diameter polyvinyl chloride cap with the blunt and round tips of the eggs being horizontal and 90 º from the 70-cm diameter cylinder probe when contact was made with the sides of the egg.

Haugh unit

Haugh unit was calculated by the following formula:

Haugh unit=100 log (H - 1.7 $G^{0.37}$+ 7.6)

Where H is the height of the thick albumen in millimeters and G is the mass of the whole egg in grams. The parameter H was estimated by averaging three measurements carried out in different points of thick albumen at the distance of 10 mm from the yolk using a digital caliper.

Yolk index

Yolk index was calculated as yolk height /yolk width. Yolk width was measured by a digital caliper.

Microbial analysis

Microbial analysis of aerobic mesophilic bacteria was carried out on the day of arrival and a month after the storage for each sample using the procedure by AOAC. For mesophilic aerobic plate counts, the whole egg samples were washed with sterile peptone water (diluted 1:10) and the subsequent dilutions were prepared by mixing a 1-ml sample with 9 ml of sterile peptone water. For bacterial counts, 0.1 ml of selected dilutions was spread on plates containing solid nutrient agar (Merck) and incubated for 24–48 h at 35 °C. Microbial counts were expressed as the number of viable bacterial colonies per egg (log CFU/egg). Minimum inhibition concentration was determined using the research results by Ramazan and Javanmard (2011).

Sensory analysis

To investigate the sensory characteristics of the eggs, 5-Point Hedonic Scale was used. 10 trained panelists (IROST staffs and postgraduate students) evaluated the egg surface transparency and shell gloss, shell smell and odor, broken eggs smell and odor and finally the overall acceptability. In this test, scores were of 1 to 5 for excellent and the least characteristic, respectively.

Statistical analysis

Data from microbial properties, weight loss, pH , Haugh unit, egg air cell height, egg shell strength and sensory properties were subjected to an analysis of different coating formulations and coated eggs compared with uncoated and storage time (0.0, 1,2, 3, 4 weeks) by simple and interaction effects using ANOVA. The comparison of means was according to Post Hoc multiple test .

Results and discussions

Table 2 shows weight loss changes of control and coated eggs during storage. The greatest water loss occurred in control uncoated eggs (6.122±0.380 %) after 4 weeks of storage. Coated eggs led to minimum weight loss. Increasing the rice bran oil content had a significant effect on the weight loss of the eggs. The results agree with the findings of Wardy *et al*. (2010) which shows that coating of eggs can be effective in minimizing the weight loss during 5 weeks storage but coating formulation with WPC and rice bran oil in this research revealed less weight loss (table 2).

Whey protein films may exhibit poor misture barrier properties because of their

hydrophilicity. But WPC and rice bran oil coatings obviously rendered excellent sealing properties , and their hydrophobicity confers good moisture barrier properties for eggs destined for extended storage at room temperature.

The shell strength of a chicken egg is an important economic consideration. (Wang *et al.* 1996). The results from this study found significant ($P<0.05$) change in shell strength during storage. The strongest shell strength belonged to coating containing whey protein concentrate and 2 grams of rice bran oil. The other coated eggs and the uncoated eggs had less strength and there was no significant difference between them. Increasing concentrations of rice bran oil in coating formulations decreased egg shell strength. Wang *et al.* (1996) showed that protein based edible coating exhibit the least moisture loss, the strongest shell strength and coated eggs maintained a higher Haugh unit.

Air cell depth increased depending on the storage time and the size of eggs, and even it reached 16 mm. The depth of the air cell is a rough indication of the age of the egg and there is often a relation between this depth and the internal quality. Results showed that the depth of the air cell for the coated eggs were significantly ($P <0/05$) lower than that of the control group (Table 3). The mean air cell depth in the control uncoated eggs were found to be 13.167±1.041 mm after 4 weeks of storage. Coating containing whey protein concentrate and 2 grams of rice bran oil showed the least depth of the air cell.

Haugh unit between 20 and 100 for albumin is estimated to be inappropriate (unsuitable) and excellent quality respectively for human consumption. More haugh unit represents a better quality of albumin. The results of the changes in the haugh units are shown in table 4. There was downward trend of Haugh unit over the 4-week storage period in control and treated samples. This result agree with the findings of Wardy *et al*. (2010) that found the Haugh unit significantly decreased by increasing storage periods at both 25^{oC} and 4^{oC}.

The albumen height decrease during storage is attributed to the proteolysis of ovomucin and cleavage of disulphide bonds and interactions with lysozyme (Stevens, 1996). The lowest haugh unit was in the control group (44.827±14.726) after 4 weeks of storage. Coated eggs with WPC+0.2 Rice bran oil+ 1µL Z. multiflora extract showed the highest haugh unit (63/948±5.257). Haugh unit >72, 60 to 72 and 31 to 60 demonstrated AA, A and B, respectively. Eggs coated with WPC-Rice bran oil incorporated with Zataria multiflora had significantly higher Haugh units than those of uncoated samples. Compared with coated eggs, uncoated eggs gained B grade at the end of the first week, while all coated eggs maintained A grade quality up to the end of the 2 weeks of storage. The incorporation of rice bran oil in coating formulation significantly increased Haugh units in the eggs (Table 4).

The primary yolk index of eggs was 0.37± 0.02 on the first day of study. The yolk index decreased from 0.310±0.010 to 0.240±0.010 for the control uncoated eggs after 4 weeks of storage. All coated eggs after 4 weeks of storage showed significantly ($P<0.05$) higher yolk index than the control uncoated eggs. Among coated eggs, only those coated with 0.2 rice bran oil showed significantly higher yolk index (Table 5). The yolk index decrease due to weakening of the membranes and liquefaction of the yolk was caused mainly by water diffusion from the albumen (Obanu and Mpieri, 1984).

Nutrient Broth was used to determine the minimum inhibition concentration of the extract. 1 µL of Zataria multiflora extract was selected to be the effective dose. Initial total mesophilic counts on the whole egg surface were 2.32±0.18 log10 CFU. After 4 weeks of storage the mean bacterial loads on the surface of uncoated eggs (control) was 2.76±0.23 log10 CFU. The coated samples W, W+0.2 R, W+0.4 R, W+0.6 R, W+0.2 R+Z1, W+0.2 R+Z2, W+0.4 R+Z1, W+0.4 R+Z2, W+0.6 R+Z1 and W+0.6 R+Z2 showed 1.47, 1, 0.49, 0.5, 0.51, 0.0, 0.21, 0.0,0.0 and 0.0 log10 CFU total mesophilic counts, respectively.

Eggs albumen pH is an important value of

egg quality and freshness. In this research (Table 6), changes in pH of coated and uncoated eggs were significant (interactions between coating treatment s *storage time, $P < 0.05$).

Table 7 shows the sensory evaluations of the control uncoated and coated eggs in different WPC, rice bran oil and Zataria multiflora extract. After 21 days of storage, concentrations of rice bran oil in coating formulations gave no significant difference in the surface shell smoothness of the eggs (Table 7). Adding 0.4 and 0.6 rice bran oil showed significant effect on in shell gloss (opacity). The broken egg smell and overall acceptability of the coated eggs with 0.6 rice bran oil and 2µL Zataria multiflora extract had significantly ($P < 0.05$) lower points than those of the control and other treatments. There was no significant difference in the shell smell of the coated eggs and the uncoated ones (control).

Table 1. Sample preparation and treatment

Sample	Treatment
Control	Uncoated eggs
W	Coated with WPC
W+0.2 R	WPC+0.2 Rice bran oil
W+0.4 R	WPC+0.4 Rice bran oil
W+0.6 R	WPC+0.6 Rice bran oil
W+0.2 R+Z1	WPC+0.2 Rice bran oil+ *Z. multiflora* extract 1µL
W+0.2 R+Z2	WPC+0.2 Rice bran oil+ *Z. multiflora* extract 2µL
W+0.4 R+Z1	WPC+0.4 Rice bran oil+ *Z. multiflora* extract 1µL
W+0.4 R+Z2	WPC+0.4 Rice bran oil+ *Z. multiflora* extract 2µL
W+0.6 R+Z1	WPC+0.6 Rice bran oil+ *Z. multiflora* extract 1µL
W+0.6 R+Z2	WPC+0.6 Rice bran oil+ *Z. multiflora* extract 2µL

Table 2. Weight loss (%)* changes in eggs coated and uncoated within 4 weeks of storage at ambient conditions

	Storage time (week)			
	1	2	3	4
Control	0.724 ± 0.210^{ax}	1.538 ± 0.177^{bz}	3.935 ± 0.684^{cn}	6.122 ± 0.380^{dk}
W	0.487 ± 0.156^{ay}	1.096 ± 0.122^{bw}	2.426 ± 0.104^{ep}	3.697 ± 0.513^{cn}
W+0.2 R	0.420 ± 0.199^{ay}	1.036 ± 0.124^{bw}	2.171 ± 0.828^{ep}	3.249 ± 1.266^{cm}
W+0.4 R	0.677 ± 0.260^{ax}	1.329 ± 0.188^{bw}	2.407 ± 0.343^{ep}	3.220 ± 0.442^{cm}
W+0.6 R	0.729 ± 0.055^{ax}	1.490 ± 0.191^{bw}	2.696 ± 0.347^{eq}	3.338 ± 0.248^{cm}
W+0.2 R+Z1	0.468 ± 0.183^{ay}	1.010 ± 0.095^{bw}	2.173 ± 0.339^{ep}	3.358 ± 0.382^{cm}
W+0.2 R+Z2	0.700 ± 0.131^{ay}	1.148 ± 0.087^{bw}	2.155 ± 0.168^{ep}	3.402 ± 0.722^{cm}
W+0.4 R+Z1	0.469 ± 0.148^{ay}	1.042 ± 0.071^{bw}	2.146 ± 0.711^{ep}	3.412 ± 0.288^{cm}
W+0.4 R+Z2	0.514 ± 0.097^{ay}	1.047 ± 0.057^{bw}	2.183 ± 0.174^{ep}	3.250 ± 0.255^{cm}
W+0.6 R+Z1	0.481 ± 0.207^{ay}	1.254 ± 0.267^{bw}	2.290 ± 0.425^{ep}	3.492 ± 0.552^{cm}
W+0.6 R+Z2	0.518 ± 0.084^{ay}	1.145 ± 0.162^{bw}	2.365 ± 0.405^{ep}	3.321 ± 0.567^{cm}

*Means ± SD of 3 measurements

Table 3. Air cell depth (mm) changes in coated and uncoated eggs within 4 weeks of storage at ambient conditions

Treatments	Storage time (week)				
	0	1	2	3	4
Control	2.750 ± 0.354^{bs}	5.533 ± 0.503^{ev}	7.000 ± 1.000^{gx}	8.500 ± 0.500^{hy}	13.167 ± 1.041^{jo}
W	2.500 ± 0.000^{bs}	$3.167\pm.289^{ct}$	4.000 ± 0.000^{du}	6.000 ± 0.000^{fw}	$9.000\pm.000^{iz}$
W+0.2 R	2.500 ± 0.000^{ar}	2.833 ± 0.289^{bs}	3.500 ± 0.500^{ct}	4.333 ± 0.764^{du}	5.000 ± 1.000^{ev}
W+0.4 R	2.500 ± 0.000^{bs}	3.667 ± 0.764^{ct}	5.167 ± 0.764^{ev}	5.667 ± 0.764^{ev}	7.167 ± 0.764^{gx}
W+0.6 R	2.750 ± 0.354^{bs}	4.000 ± 1.000^{du}	6.167 ± 0.289^{fw}	6.167 ± 1.258^{fw}	7.500 ± 0.500^{gx}
W+0.2 R+Z1	3.250 ± 1.061^{ct}	4.000 ± 0.500^{du}	5.000 ± 0.500^{ev}	6.500 ± 0.500^{fw}	7.833 ± 1.607^{gx}
W+0.2 R+Z2	3.250 ± 0.354^{ct}	3.667 ± 0.764^{ct}	5.750 ± 0.354^{ev}	5.333 ± 0.764^{ev}	8.500 ± 0.866^{hy}
W+0.4 R+Z1	2.750 ± 0.354^{bs}	4.500 ± 0.500^{du}	6.000 ± 1.000^{fw}	6.833 ± 1.041^{fw}	9.333 ± 1.528^{iz}
W+0.4 R+Z2	2.833 ± 0.764^{bs}	3.750 ± 1.061^{ct}	4.833 ± 1.041^{du}	6.500 ± 0.500^{fw}	8.833 ± 0.764^{hy}
W+0.6 R+Z1	2.500 ± 0.707^{bs}	3.833 ± 0.764^{ct}	5.167 ± 0.289^{ev}	7.000 ± 0.500^{gx}	9.167 ± 1.041^{iz}
W+0.6 R+Z2	3.167 ± 0.764^{bs}	4.000 ± 0.500^{du}	5.667 ± 1.155^{ev}	6.667 ± 0.764^{fw}	8.667 ± 0.289^{hy}

Means with same superscript are not significantly different ($P > 0.05$).

Table 4. Haugh units (±SD) and grades changes in eggs coated and uncoated within 4 weeks of storage at ambient conditions

Treatments	Storage time (week)				
	0	1	2	3	4
Control	74.6 ± 6.834	67.421±6.940 ^{ax*} A**	59.206±7.225 ^{bz} B	53.088±15.129 ^{a} B	44.827±14.726^{bz} B
W		68.210±7.180 ^{cy} A	64.355±4.370 ^{ax} A	54.635±9.908 ^{bz} B	50.820±5.227 ^{bz} B
W+0.2 R		76.988±7.979 ^{cy} AA	76.502±8.901 ^{cy} AA	70.309±4.721 ^{ax} A	51.645±6.690 ^{bz} B
W+0.4 R		80.217±2.992^{cy} AA	65.990±3.854 ^{ax} A	60.640±2.606^{axz} A	53.939±12.137^{bz} B
W+0.6 R		73.593±2.984 ^{cy} AA	66.223±7.773 ^{ax} A	65.539±7.070 ^{ax} A	51.767±5.930 ^{bz} B
W+0.2 R+Z1		74.940±13.169 ^{ax} AA	60.377±12.854^{ax} A	66.812±12.196 ^{ax} A	63.948±5.257 ^{ax} A
W+0.2 R+Z2		75.652±3.099 ^{cy} AA	72.467±10.741^{cy} AA	65.792±8.156 ^{ax} A	52.170±0.700 ^{bz} B
W+0.4 R+Z1		77.844±9.794 ^{cy} AA	65.236±2.037 ^{ax} A	63.531±4.269 ^{ax} A	50.622±17.283^{bz} B
W+0.4 R+Z2		73.546±9.173 ^{cy} AA	65.057±5.622 ^{ax} A	62.914±10.766^{ax} A	52.210±4.450 ^{bz} B
W+0.6 R+Z1		72.374±5.164 ^{cy} AA	64.970±2.900 ^{ax} A	60.972±2.187^{axz} A	53.888±10.462^{bz} B
W+0.6 R+Z2		73.077±4.849 ^{cy} AA	60.861±8.85^{ax} A	60.034±21.791^{axz} A	48.591±14.717^{bz} B

* Means with same superscript are not significantly different ($P > 0.05$).

**A and B indicate degree of the eggs depend of Hu

Table 5. Yolk index (±SD) changes in coated and uncoated eggs within 4 weeks of storage at ambient conditions

Treatments	Storage time (week)				
	0	1	2	3	4
Control	0.37± 0.02	0.310±0.010^{ax}	0.280±0.010^{cy}	0.267±0.006^{dz}	0.240±0.010^{dz}
W		0.347±0.006^{bw}	0.320±0.010^{ax}	0.303±0.006^{ax}	0.283±0.006^{cy}
W+0.2 R		0.360±0.010^{bw}	0.350±0.010^{bw}	0.313±0.006^{ax}	0.307±0.006^{ax}
W+0.4 R		0.350±0.010^{bw}	0.330±0.000^{bx}	0.317±0.006^{ax}	0.287±0.006^{cy}
W+0.6 R		0.340±0.010^{bw}	0.320±0.010^{ax}	0.297±0.006^{cy}	0.280±0.010^{cy}
W+0.2 R+Z1		0.357±0.006^{bw}	0.343±0.006^{bw}	0.317±0.006^{ax}	0.303±0.006^{ax}
W+0.2 R+Z2		0.347±0.006^{bw}	0.330±0.010^{bx}	0.303±0.006^{ax}	0.297±0.006^{cy}
W+0.4 R+Z1		0.340±0.010^{bw}	0.320±0.010^{ax}	0.307±0.006^{ax}	0.280±0.000^{cy}
W+0.4 R+Z2		0.338±0.013^{bw}	0.320±0.010^{ax}	0.303±0.006^{ax}	0.293±0.006^{cy}
W+0.6 R+Z1		0.320±0.010^{ax}	0.297±0.015^{cy}	0.290±0.010^{cy}	0.277±0.006^{cy}
W+0.6 R+Z2		0.323±0.006^{ax}	0.303±0.006^{ax}	0.293±0.006^{cy}	0.267±0.006^{dz}

Means with same superscript are not significantly different ($P > 0.05$).

Table 6. Albumen pH (±SD) changes in coated and uncoated eggs within 4 weeks of storage at ambient conditions

Treatments	Storage time (week)			
	1	2	3	4
Control	9.031±0.217^{va}	9.117±0.147^{wd}	9.243±0.112^{wd}	9.557±0.120^{z}
W	7.977±0.232^{va}	8.983±0.310^{yc}	8.280±0.602^{xc}	9.197±0.164^{w}
W+0.2 R	7.840±0.227^{va}	8.500±0.066^{xyc}	8.933±0.100^{yc}	9.143±0.130^{w}
W+0.4 R	8.270±0.132^{xb}	9.010±0.272^{wd}	9.060±0.066^{wd}	9.157±0.064^{w}
W+0.6 R	8.897±0.175^{yc}	8.877±0.404^{yc}	9.207±0.078^{wd}	9.237±0.085^{w}
W+0.2 R+Z1	8.213±0.040^{xb}	9.177±0.196^{wd}	9.033±0.131^{wd}	9.333±0.187^{w}
W+0.2 R+Z2	8.307±0.119^{xb}	8.987±0.364^{yc}	9.163±0.070^{wd}	9.267±0.156^{wd}
W+0.4 R+Z1	8.520±0.391^{yc}	8.683±0.115^{yc}	9.153±0.242^{wd}	9.187±0.059^{wd}
W+0.4 R+Z2	8.527±0.460^{yc}	8.703±0.169^{yc}	9.083±0.263^{wd}	9.323±0.206^{wd}
W+0.6 R+Z1	8.973±0.194^{yc}	8.797±0.306^{yc}	9.073±0.150^{wd}	9.390±0.135^{wd}
W+0.6 R+Z2	8.583±0.452^{yc}	8.957±0.224^{yc}	9.200±0.202^{wd}	9.403±0.127^{wd}

Means with same superscript are not significantly different ($P > 0.05$).

Table 7. Sensory properties of coated and uncoated eggs within 4 weeks of storage at ambient conditions

Traits \ Treatments	Control	W	W+0.2 R	W+0.4 R	W+0.6 R	W+0.2 R+Z1	W+0.2 R+Z2	W+0.4 R+Z1	W+0.4 R+Z2	W+0.6 R+Z1	W+0.6 R+Z2
Shell smoothness	3.2^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3.2^{a}	3.2^{a}	3^{a}	3.2^{a}	3.2^{a}	3^{a}
Shell gloss	3.2^{a}	3^{a}	3.2^{a}	2.6^{b}	2.6^{b}	3^{a}	3.2^{a}	3.6^{a}	3^{a}	2.8^{b}	2.8^{b}
Shell smell	3.2^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3.2^{a}	3.2^{a}	3^{a}	3^{a}	3.2^{a}	3^{a}
Broken egg smell	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	2.8^{b}
Overall acceptability	3.4^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3.2^{a}	3.2^{a}	3.2^{a}	3.2^{a}	3.6^{a}	2.8^{b}

Conclusion

Edible WPC-rice bran oil containing Zataria multiflora essential oils were tested for their application as an antimicrobial edible coating on eggs. The results indicate that adding rice bran oil to WPC films makes them more perceptible in a food system while maintaining moisture and oxygen barrier, certain tensile properties as well as the improvement of the shelf life of the eggs. Adding the essential oils of Zataria multiflora as active substances of biological origin have also a powerful wide-spectrum activity against microbial load on egg surface. This edible coating can fulfill a packaging function in real food applications.

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تأثیر پوشش خوراکی پروتئین آب پنیر حاوی عصاره آویشن شیرازی و روغن سبوس برنج بر کیفیت شیمیایی، فیزیکی و میکروبی تخم‌مرغ

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چکیده

هدف از این تحقیق، استفاده از پوشش خوراکی فعال بر پایه پروتئین آب پنیر حاوی روغن سبوس برنج و ترکیب ضدمیکروبی عصاره آویشن شیرازی، به منظور بهبود خواص فیزیکی و شیمیایی، میکروبی و استحکام ساختاری تخم‌مرغ در برابر شکستگی و بطور کلی افزایش کیفیت و ماندگاری تخم‌مرغ می‌باشد. در این پژوهش، تأثیر پوشش‌دهی با کنسانتره پروتئین آب پنیر به تنهایی و در ترکیب با روغن سبوس برنج و ترکیب ضدمیکروبی عصاره آویشن شیرازی بر روی ویژگی‌های کیفی و ماندگاری تخم‌مرغ بررسی شد .نتایج نشان داد که میزان درصد کاهش وزن در همه گروه‌های پوشش داده شده به طور معنی‌داری ($P< ۰/۰۵$) کمتر از گروه شاهد (فاقد پوشش) است. ماندگاری تخم‌مرغ نیز با توجه به میزان اندیس Haugh و اندیس زرده حدود ۴ هفته نسبت به نمونه‌های شاهد افزایش یافت . استحکام پوسته گروه‌های پوشش‌دار بیشتر از گروه کنترل بود . .حداقل غلظت ممانعت کنندگی عصاره آویشن شیرازی در محیط کشت ۱میکرولیتر بود. غلظت ۱ میکرولیتر عصاره آویشن شیرازی باعث کاهش بار میکروبی کل سطح پوسته تخم‌مرغ تا ۸۷ ٪ گردیده و غلظت ۲ میکرولیتر، بار میکروبی کل را به صفر کاهش داد. در ارزیابی‌های حسی، از نظر گروه ارزیاب، تخم‌مرغ‌های پوشش دیده نسبت به گروه پوشش ندیده (شاهد) پذیرش نهایی بیشتری داشته و در میان تیمارها نیز تخم مرغ های پوشش دیده حاوی درصد پائین روغن سبوس برنج، پذیرش نهایی بیشتری از نظر مصرف‌کنندگان داشته است. بطور کلی استفاده از روش پوشش دهی به عنوان یک روش کاربردی و مقرون به صرفه، می‌تواند باعث حفظ پارامترهای کیفی در تخم‌مرغ شده و علاوه بر حفظ بازارپسندی محصول، منجر به افزایش ماندگاری در شرایط عرضه آن گردد.

واژه‌های کلیدی: پوشش خوراکی، تخم‌مرغ، کنسانتره پروتئین آب پنیر، عصاره آویشن شیرازی، ماندگاری

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