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Original Article

Evaluating the effect of active edible coating of quince seed mucilage and green tea extract on the quality of fried shrimps: physicochemical and sensory properties

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ABSTRACT

Background and Objectives: In recent years, to reduce the adverse effects of fried products, various techniques have been suggested for reduction of oil uptake in fried product. The use of edible coating is one of the most important technologies proposed. In the study, the effect of bioactive coating composed of quince seed mucilage (QSM) and incorporating green tea extract (GTE) on the physicochemical quality of shrimp after deep-fat frying were investigated.

Materials and Methods: In this study, active edible coating using quince seed mucilage and adding different concentration of GTE (0-20%) was prepared. The effects of five coating solutions (QG 0-4) on physicochemical properties of shrimp after deep-fat frying were evaluated.

Results: The results showed that incorporating GTE (5-20%), increased the moisture content and had a reverse effect on the final oil content in coated fried shrimps. In addition, the peroxide value of the coated shrimp significantly decreased ($p<0.5$) with the increasing GTE concentration. Adding 10% GTE compared to control sample did not have any significant effect on the L* value but increasing concentrations of GTE from 10 to 20% significantly affected ($p< 0.05$) L* value of the fried shrimps and L* value of them decreased from 60.35 ±3.4 to 48.5 ± 1.74. Also adding GTE significantly increased ($p<0.05$) a* value and b * values of the fried shrimps.

Conclusions: This study indicated the benefits of adding of GTE into QSM coating and proposed it as a novel active coating.

Keywords: Shrimp, Edible coating; Quince seed mucilage, Green tea extract; Physicochemical properties

Introduction

Cooking process such as deep- fat frying is used to accomplish desirable sensory attributes such as flavor, texture and appearance for foods like shrimp. For this purpose, oils are used as the heat transfer medium which in direct contact with the food usually at a temperature above 150 °C. After frying, oil content of fried product increased up to 40% due to the evaporation of water from the raw material and partially replaced with oil(1, 2). In recent years, to reduce the adverse effects of fried products, various techniques have been suggested for the reduction of oil absorption in fried product, for example, vacuum frying and air frying. The use of edible coating is one of the most important technologies proposed. Carbohydrates due to having good barrier property against oxygen, carbon dioxide and lipid which could decrease oil absorption during deep fat-frying are more desirable–(3-6). However, through the recent years, there is a major emphasis on investigating different renewable resources for the production of active edible coating. Quince is the sole member of the genus Cydonia in the family Rosacea and is native to rocky slopes and woodland margin in South-West Asia, Turkey and Iran. The

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constituents of quince seed mucilage are cellulosic fraction with a more readily hydrolyzed polysaccharide such as arabinose and xylose. These polysaccharides having unique colloidal properties, low production cost and easy extraction are suitable for edible coating or film(7).

Green tea (*Camellis sinensis*) is one of the most important sources of polyphenolic compounds such as catechin, theaflavins and thearubigins, which have strong antioxidant properties. The beneficial effects of the phenolic compounds are believed to result from their ability to scavenge oxygen and to delay the onset of lipid oxidation(8). Therefore, the objective of this study was to evaluate the active edible coating effects of quince seed mucilage and green tea extract (as an antioxidant compound) on the oil absorption, moisture reduction and physicochemical properties of deep -fat fried shrimp.

Materials and Methods

The quince seeds and green tea were purchased from the grocery store in Ahvaz, Iran. Fresh, homogenous in size and non-treated Pacific white shrimp (L. *vannamei*) was obtained from the local shrimp market in Ahvaz, Iran (at one time). Immediately after purchase, the shrimps were de-shelled, washed in cold water and kept in the refrigerator. All chemicals used were of analytical grade and were obtained from Merck.

Preparation of coating solutions: The method of Jouki *et al* (2014) was used to extract quince mucilage seed. After quince seeds sieving (about 10g), it was with its triple weight of ethanol (96% w/v) for 5 minutes under constant stirring. Seeds were dried in an oven at 45 °C after removing ethanol. For the extraction of quince seed mucilage from whole seeds, distilled water (water to seed ratio of 30:1) was used and then filtered with cheese cloth (9).

Green tea was extracted according to the method described by Sabaghi *et al*, (2015). Briefly, a blender was used to ground the dried green tea leaves (Moulinex 320, Spain), and screened through a mesh (0.23 mm sieve size). To prepare GTE solution, ground green tea powder was blended in distilled water (1:5 w/w) in an Erlenmeyer flask and stirred in a water bath at at 80 °C (Heraeus, Germany) for 15 min under constant string, this was done to attain maximum phenolic compound extraction. The whatman No.1 (11 mm) filter paper was used to filter the GTE solution (10). Different concentration of GTE (0-20%) was blended to obtain five coating solutions (QG 0-4). For control, a non-coated treatment was used.

Shrimp coating solutions: The peeled shrimps were submerged in the coating solution for 30 seconds. Coated shrimps were then placed on a dry tray overnight. After drying, the coated shrimps were fried for the needed time (300S) at 160 °C(2).

Frying conditions: In this study for each new treatment, sunflower oil was used, because of its high smoking point. Samples were located in a wire basket and then immersed (shrimp to oil ratio of 1:15,), for the needed time (300s) at 165 °C. Samples were instantly removed from oil after each frying batch. After the frying time, tissue paper was used to elimination surplus oil on the surface. Before further tests, the samples were allowed to cool at room temperature.

Physicochemical properties of fried samples

Moisture content: Conventional oven (105 °C, 24 h) was used to measure the moisture content of the whole fried samples (11).

Oil uptake: The soxhlet extraction method was used for the measurement of oil uptake(12). Equation (1) was used to calculate the oil uptake (%):

$$\text{Oil uptake (\%)} = \frac{O_f - O_i}{O_i} \times 100$$

Where O_f is the oil content of fried shrimps and O_r is the initial oil content of shrimp displayed as dry matter.

Lipid oxidation: The method of Lea (1952) was used to determine Peroxide value **(**PV). Briefly, a blend of methanol, water and chloroform was used to extract lipid from shrimps. A total of 1 g of extracted lipid was mixed in 25 ml of chloroform- acetic acid (2:3) mixed solution and added saturated solution of KI (1ml). By adding distilled water (30 ml), the blend was titrated against sodium thiosulphate (0.01 M)(13). PV was calculated as follows (Equation 2):

$$PV = (S-B) \times N \times 1000/w$$

Where S indicates to the volume of $Na_2S_2O_3$ standard solution used by the sample (ml); B indicates to the volume of $Na_2S_2O_3$ standard solution used in blank test (ml); N indicates to the molar concentration of $Na_2S_2O_3$ standard solution (mol/L) and W is the mass of lipid extracted (g).

Thiobabituric acid reactive substances (TBARS): TBARS was investigated as explained by Nirmal and

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Benjakul (2009). Briefly, white shrimp samples (2 g) were blened with 50 ml of TBARS solution with 0.2 g of TBA, 7.5 g of TCA and 0.50 ml of hydrochloric acid. The solution was placed in hot water bath for 10 minute and after chilling, it was centrifuged at 4000 g for 20 minute. A digital spectrophotometer was used to measure of absorbance at 532 nm (14).

Texture analyses: A texture analyzer (TA. XT2i, stable Micro System, Goldalming, UK) with cylindrical 6 mm probe and 5 mm/min post speed was used to investigate of shrimps fried texture (15).

Color analysis: Shrimps color was evaluated with a tri stimulus colorimeter (Konica Minolta, CR400, Japan) using the CIE Lab scale (L*, a* and b*)(16). The mean of three evaluations taken at room temperature from different points of each sample expressed as results.

Sensory evaluation: Sensory evaluation was performed according to the method of Morin *et al*. (2002) with a 9-point Hedonic scale, (9 being the highest quality score and 1 the lowest) was used to appraise of sensory evaluation. (17). The sensory attributes of fried shrimps were investigated by a sensory panel of ten trained assessors, age ranging from 22 to 31 years, chosen according to ISO 8586 and trained using discriminative tests with practice evaluation methods of specifying quality characteristics in fried shrimp(2). Panelists were asked to score overall acceptability of the products based on color, order and texture.

Statistical analysis: All the experiments were replicated three times, and the average values are reported. Data analysis carried out using SPSS statistics software (SPSS 19 for windows, SPSS Inc., Chicago,IL, USA). One-way analysis of variance was used to determine of difference between the mean values of test samples. The Tukey's multiple comparison tests were used, considering significance at 95% confidence level (P< 0.05).

Results

Moisture and oil content: To evaluate the oil absorption during deep-fat frying, the moisture content is main factor. Because of the removal of moisture from the samples, cavities or capillary pores were created inside which the oil penetrates through during deep-fat frying. The opposite relationship among moisture loss and oil uptake can be observed. In the study, a negative relationship was observed between moisture content and oil uptake (R^2= 0.918). Table 1 shows the moisture and oil content of fried shrimps. As can be seen, the used of coating increased the moisture content of fried shrimps.

Lipid oxidation: The peroxide value (PV) and thiobarbituric acid (TBA) were used to investigate the influence of active coating on lipid oxidation of shrimp during the frying process. To evaluate the oxidative state of lipid-containing food, the PV indicated the amount of primary products of lipid oxidation. In deep frying operations, peroxides are unstable and can break down to secondary oxidation products such as carbonyl and aldehyde compounds. Therefore, for measurement of secondary oxidation products, the TBA test was used which indicated the amount of malondialdehyde formed during oxidation of oils. Table 2 shows the influence of coating treatment on alterations of PV and TBA of shrimp. As can be seen, the uncoated white shrimp has the highest amount of both primary (peroxide) and secondary (malondialdehyde) oxidation products of 6.25±0.21 (mmol peroxide/kg) and 0.32±0.02 mg MDA/kg respectively.

Table 1. Effect of deep-fat drying on fat and moisture content of shrimp

	Fat content (%)	Moisture content (%)	Oil uptake (%)
Uncoated raw shrimp	4.25±1.41^{a}	79.56±1.84^{a}	
Uncoated fried shrimp	25.45±2.4^{b}	30.33±1.84^{b}	498.8235±8.24
QG0	24.8±1.8^{b}	35.11±1.21^{c}	483.5294±6.59
QG1	18.13±1.58^{c}	45.6±2.04^{d}	444.2353±7.21
QG2	19.41±2.16^{c}	40.43±1.1^{d}	356.7059±6.7
QG3	21.68±1.67^{c}	39.84±1.87^{d}	198.3529±9.34
QG4	19.9±2.04^{c}	41.68±1.81^{d}	203.5294±8.27

Values with the same letters in the each raw indicate not significantly difference (P<0.05)
QG0: Control solution (without GTE); QG1: coating solution including 5% v/v GTE; QG2: coating solution including 10 % v/v GTE; QG3: coating solution including 15% v/v GTE; QG4: coating solution including 20% v/v GTE.

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Table 2. Effect of deep-fat frying on PV and TBA of shrimp samples

Treatment	uncoated	QG0	QG1	QG2	QG3	QG4
PV (mmol peroxide/kg)	6.25±0.21[a]	6.5±0.52[ab]	5.25±0.23[b]	3.05±0.12[c]	2.1±0.1[d]	1.1±0.14[e]
mg MDA/kg	0.32±0.02[a]	0.23±0.01[b]	0.22±0.08[bc]	0.19±0.04[cd]	0.17±0.01[d]	0.12±0.1[e]

Values with the same letters in the each raw show not significantly difference (P<0.05)

Texture analysis: In this study, hardness was used to described of the textural properties of the fried shrimps. Fig 1 shows the effect of different coating on the hardness of the fried shrimps. The results showed the coated shrimp compared to uncoated shrimp has a lower hardness. This phenomenon may be ascribed to the increased moisture content.

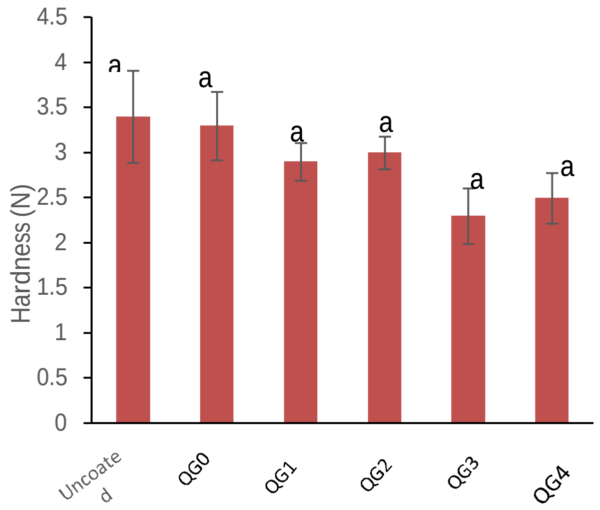

Fig1. Mechanical parameters (hardness) of fried shrimps

Image analysis: Table 3 showed the color values of fried shrimps. The samples coated QG0 contrasted to other samples after deep-frying process had the lowest value of L*. The significant reduce (P<0.05) in L* value for shrimp fried coated QG0 might be attributed to change in light absorption and light scattering resulted in the coating materials. The effect of GTE concentration on color value of fried shrimps are shown in table 3. Addition of 10% GTE did not have any significant effect on the L* value compared to control sample but increasing concentrations of GTE from 10 to 20% significantly affected (p< 0.05) L* value of the fried shrimps and L* value of them decreased from 60.35 ± 3.4 to 48.5 ± 1.74. Also, adding GTE (as the GTE concentration raised from 0 to 20%) into quince seed mucilage solution coating significantly affected (p<0.05) a* value and b * values of the fried shrimps. a* values of the fried shrimps increased from 0.12±1.47 to 1.3±0.21 (indicator of the tendency towards redness). The b* values raised from 12.53 ±3.14 to 25.07±1.84 (indicator to the tendency toward yellowness).

Sensory analysis: To investigate the influence of sensory characteristics on consumer acceptance as effective expression about the feasibility of coating with coating solutions, sensory evaluation of the fried shrimp was performed. Fig 2 showed the results of the sensory investigation (overall acceptability) of fried shrimps. There was significant difference (p<0.05) in overall acceptability between coated and uncoated fried shrimps.

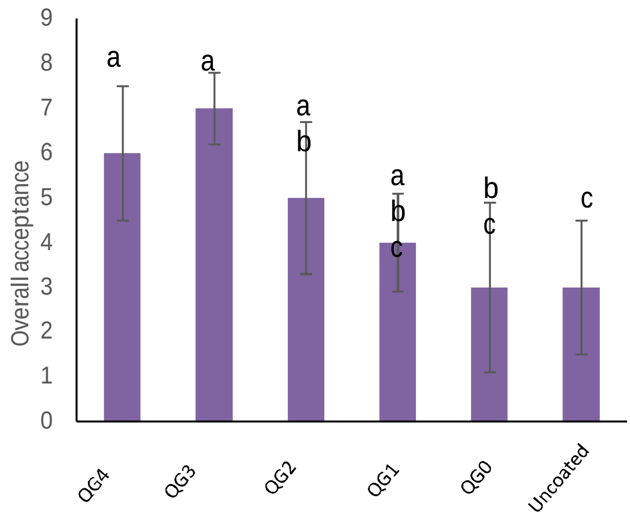

Fig2. Overall acceptability of fried shrimps

Table3. color parameters of fried shrimps

Coating solution	L*	a*	b*	ΔE
Uncoated	60.35±3.4[a]	0.12± 0.94[a]	12.55±5.12[a]	28.71±2.41[a]
QG0	44.37±1.7[d]	0.35±0.12[b]	18.04±1.4[b]	23.64±1.84[b]
QG1	54.95±3.42[bc]	0.43±0.1b[c]	19.43±2.45[bd]	20.95±2.04[bc]
QG2	55.58±1.1[ab]	1.1±0.31b[c]	17.7±3.24[b]	22.03±1.54[bc]
QG3	46.69±2.08[cd]	1.04±0.14[bc]	25.07±1.02[c]	14.05±1.61[cd]
QG4	48.5± 1.74[d]	1.3±0.26[c]	23.27±2.87[cd]	18.17±1.15[d]

Values with the different letter in the each column show significantly different at the 5% level.

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Discussion

Moisture and oil content: Freitas *et al* (2009) expressed that utilizing whey protein as coating, has enhancing retention of moisture resulting in reduction of the oil uptake(6). Kim *et al* (2011) evaluated the influence of guar gum as coating on the oil absorption of the potato strips during frying. They reported that the application of 0.9% guar gum solutions decreased the oil content of the fried potatoes by 41% compared to the control (18). Also, Increasing the concentration of green tea extract in the coating formulation reduced the moisture content in the samples. However, the moisture loss rate in uncoated shrimp was higher when compared to the coated shrimp. So that, GTE 20% led about 25% more moisture content in fried shrimp than in the uncoated samples.

In general, use of hydrocolloids as coating agent is popular for reducing the oil uptake because the thermal gelation or crosslinking properties of hydrocolloid coating prevented the creation of wide cavities or capillary pores, which resulted in less oil entrance to the samples. As can be seen, incorporating GTE (5-20%) significantly affected ($p<0.05$) the final oil content of the fried shrimps. An increase in GTE concentration as well as mixed solution of quince seed mucilage and GTE solution caused a reverse influence on the final oil content; this was apperceive for coated fried shrimps. Therefore, using a higher percentage of GTE in their relative coating solution, increases the oil content in final products (table 1). However, the rate of oil uptake in uncoated shrimp was higher when compared to the coated shrimp. So that, 20% GTE led to about 24% less oil content in fried shrimp than in the uncoated samples. This may be due to different structures of these coating solutions.

Lipid oxidation: The results showed the PV value of the coated shrimp significantly decreased ($p<0.5$) with raising GTE concentration as indicated in table 2. The coated shrimp without GTE extract indicated similar PV value of uncoated white shrimp and there was no significant difference between them. According to, Mistumoto *et al* (2005), incorporating tea extract to minced meat inhibited lipid oxidation in both raw and cooked beef meat to a greater extent(19). The results of this study showed that the coating fortified with 20% v/v GTE has an inhibitory effect on lipid oxidation in shrimp during deep frying. These coating decreased the lipid oxidation (PV) of the fried shrimp up to 1.1±0.14. Also, edible coating on surface of the product acted as a barrier to the oxygen and moisture, which reduced oxidation, as a result decreasing the PV values.

Texture analysis: The texture of the fried shrimp is effected by both raw material and process conditions and it is main sensory characteristic for acceptability of fried food. The hardness of the coated shrimps was not significantly ($p< 0.05$) lower than that of the uncoated shrimps.

Image analysis: Analogous results have been expressed by Siripatrawan and Harte (2010), who studied the incorporation of GTE in to chitosan films(20). The change in ΔE values of shrimps samples are shown in table 3. Higher ΔE results indicate a greater relative change in color compared to the color of raw shrimp. In this study, uncoated samples indicated the highest and the coated treatments with active coating QG3 and QG4 had the lowest changes in ΔE values.

Sensory analysis: The results showed the overall acceptability of the coated shrimp significantly raised ($p<0.5$) with rising GTE concentration as shown in Fig2. The coated shrimp without GTE extract indicated similar overall acceptability of uncoated white shrimp and there was no significant difference between them. The higher scores may be due to the coating solution properties such as preventing dehydration, oxidative rancidity and surface browning. The results of this study shows that the coating fortified with 20% v/v GTE had the highest overall acceptability.

Conclusion

In this study, the effect of coating treatment on some physicochemical characterizes of shrimp during deep-frying were evaluated. Results showed that after deep-frying, QG4 (containing 20 v/v GTE) contained less of the primary and secondary oxidation products than the uncoated samples. The application of QG on shrimp was found to reduce the hardness of the product with high moisture content. Also, use of active coating on the shrimp was decreased. The oil absorption, lipid oxidation a* values and b* values during the deep-frying process was increased.

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References

1. Bouaziz F, Koubaa M, Neifar M, Zouari-Ellouzi S, Besbes S, Chaari F, et al. Feasibility of using almond gum as coating agent to improve the quality of fried potato chips: Evaluation of sensorial properties. LWT-Food Science and Technology. 2016;65:800-7.
2. Khazaei N, Esmaiili M, Emam-Djomeh Z. Effect of active edible coatings made by basil seed gum and thymol on oil uptake and oxidation in shrimp during deep-fat frying. Carbohydrate polymers. 2016;137:249-54.
3. Yu L, Li J, Ding S, Hang F, Fan L. Effect of guar gum with glycerol coating on the properties and oil absorption of fried potato chips. Food Hydrocolloids. 2016;54:211-9.
4. Newcombe RA, Izadi S, Hilliges O, Molyneaux D, Kim D, Davison AJ, et al., editors. KinectFusion: Real-time dense surface mapping and tracking. Mixed and augmented reality (ISMAR), 2011 10th IEEE international symposium on; 2011: IEEE.
5. Karimi N, Kenari RE. Functionality of Coatings with Salep and Basil Seed Gum for Deep Fried Potato Strips. Journal of the American Oil Chemists' Society. 2016;93(2):243-50.
6. Freitas DDGC, Berbari SAG, Prati P, Fakhouri FM, Queiroz FPC, Vicente E. Reducing fat uptake in cassava product during deep-fat frying. Journal of Food Engineering. 2009;94(3):390-4.
7. Jouki M, Yazdi FT, Mortazavi SA, Koocheki A. Quince seed mucilage films incorporated with oregano essential oil: physical, thermal, barrier, antioxidant and antibacterial properties. Food Hydrocolloids. 2014;36:9-19.
8. de Lacey AL, López-Caballero M, Montero P. Agar films containing green tea extract and probiotic bacteria for extending fish shelf-life. LWT-Food Science and Technology. 2014;55(2):559-64.
9. Jouki M, Mortazavi SA, Yazdi FT, Koocheki A. Optimization of extraction, antioxidant activity and functional properties of quince seed mucilage by RSM. International journal of biological macromolecules. 2014;66:113-24.
10. Sabaghi M, Maghsoudlou Y, Khomeiri M, Ziaiifar AM. Active edible coating from chitosan incorporating green tea extract as an antioxidant and antifungal on fresh walnut kernel. Postharvest Biology and Technology. 2015;110:224-8.
11. AACC. Moisture content. In Approved methods of the American Association ofchemists. St Paul, MN: AACC. 1986.
12. AOAC. Official methods of analysis. Washington, DC: Association of OfficialAnalytical Chemists. 1990.
13. Lea C. Methods for determining peroxide in lipids. Journal of the Science of Food and Agriculture. 1952;3(12):586-94.
14. Nirmal NP, Benjakul S. Effect of ferulic acid on inhibition of polyphenoloxidase and quality changes of Pacific white shrimp (Litopenaeus vannamei) during iced storage. Food chemistry. 2009;116(1):323-31.
15. Yuan G, Lv H, Tang W, Zhang X, Sun H. Effect of chitosan coating combined with pomegranate peel extract on the quality of Pacific white shrimp during iced storage. Food Control. 2016;59:818-23.
16. Jiang M, Liu S, Wang Y. Effects of antimicrobial coating from catfish skin gelatin on quality and shelf life of fresh white shrimp (Penaeus vannamei). Journal of food science. 2011;76(3):M204-M9.
17. Morin L, Temelli F, McMullen L. Physical and Sensory Characteristics of Reduced-Fat Breakfast Sausages Formulated With Barley β-Glucan. Journal of food science. 2002;67(6):2391-6.
18. Kim DN, Lim J, Bae IY, Lee HG, Lee S. Effect of hydrocolloid coatings on the heat transfer and oil uptake during frying of potato strips. Journal of Food Engineering. 2011;102(4):317-20.
19. Mitsumoto M, O'Grady MN, Kerry JP, Buckley DJ. Addition of tea catechins and vitamin C on sensory evaluation, colour and lipid stability during chilled storage in cooked or raw beef and chicken patties. Meat Science. 2005;69(4):773-9.
20. Siripatrawan U, Harte BR. Physical properties and antioxidant activity of an active film from chitosan incorporated with green tea extract. Food Hydrocolloids. 2010;24(8):770-5.

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