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Basil-seed gum containing *Origanum vulgare* subsp. *viride* essential oil as edible coating for fresh cut apricots

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ABSTRACT

Basil seed gum (BSG) edible films containing with *Origanum vulgare* subsp. *viride* essential oil (OEO) (1–6%) were formulated in order to coating of fresh cut apricots. Chemical attributes, microbial load and sensory characteristics of coated fresh apricot-cut during cold storage at 4 °C for 8 d were investigated. The addition of OEO significantly decreased water vapor permeability (WVP) of films while increased their moisture content ($p < 0.05$).The applied coatings reduced total plate count, yeasts and molds populations. Among all tested treatments, the BSG +6% OEO was determined as the most effective in reducing the microbial populations of apricot cuts. In comparison with the control, total soluble phenolic and antioxidant activity of OEO added samples was enhanced significantly at the end of cold storage. The new introduced incorporated OEO BSG film and coating could provide great improvement in terms of odor and overall acceptability and it could be applied in order to maintain quality of fresh apricot cuts.
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1. Introduction

Apricot (*Prunus armeniaca* L.), a member of *Prunus* species of the *Rosaceae* family, could be found as a fruit in Asia especially in South East region (Sartaj et al., 2011; Hacıseferoğulları et al., 2007). This fruit could take part in human nutrition and health because of high mineral content in addition of sugars, fibers, vitamins and other phytochemicals such as phenolic substances, carotene and lycopene pigments (Ghasemnezhad and Shiri, 2010; Leccese et al., 2007). some spoilage characteristic such as senescence, apricot can be appeared after a short time after harvest (Egea et al., 2007). Consumers usually take appearance and freshness into consideration as primary criteria at the time of purchase of fresh-cut fruit such as apricot (Benítez et al., 2015). It was demonstrated that process such as peeling and slicing promote a faster metabolic activity, physiological deterioration and microbial spoilage in the products which resulting in a short shelf life (Azarakhsh et al., 2014; Sanchís et al., 2016). Hence, application of new types of coating in order to inhibit deterioration and microbial spoilage can be considered one of most accepted strategies.

Recently, several technologies were introduced with the aim of decontamination and preservation of fruit in fresh-cut form. Hence, edible film technology could be considered as an alternative approach in order to improve of the quality beside extending the commercial shelf-life of coated products by modifying internal atmosphere, reducing microbial proliferation and delaying weight loss, oxidation and respiration rate (Benítez et al., 2015; Moreira et al., 2015; Hashemi et al., 2015; Perdones et al., 2012).Moreover, providing the mentioned characteristics for product could not be achievable without application of preservatives.

Synthetic preservatives have different application in food industry. However, consumers all around the world tend to consume products free of synthetic preservatives (Teixeira et al., 2013). Therefore, special regard has been driven to applying the essential oils (EOs) as a potential source of functional bio-compounds. EOs, as important natural extracted products from different type of plants, have been employed in food industry as

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flavoring and antibacterial agent (Miller et al., 2015). Incorporation of EOs into the formulation of edible coatings/films is conceivable, efficient, and also mandatory strategy to solve the problems related to their applications while maintain their effectiveness and improve the functionality of coatings (Sánchez-González et al., 2010a, 2010b). Nevertheless, the application of EOs as the processing aid in food products still faces some problems such as the changing organoleptic attributes of foodstuff in addition of high cost. Among essential oils, extracted EOs from oregano (*Origanum vulgare*), as an herb belonging to the *Lamiaceae* (Teixeira et al., 2013), can be applied as treatment for respiratory disorders, dyspepsia, painful menstruation, rheumatoid arthritis, scrofulosis and urinary tract disorders (Fleming, 1998).

Basil seed gum (BSG) is a typical gum which can be extracted from *Ocimum basilicum* L, a member of genus *Ocimum*. The extracted BSG as a hetero-polysaccharide composed of two major fractions: commonly known as glucomannan (43%) along with highly branched arabinogalactan, as the hydrophobic fraction, and xylan (24.29%), the responsible part for its hydrophilic properties. The hydrophilic part can absorb water during soaking and swell into mucilage due to the presence of a polysaccharide substance (Hosseini-Parvar et al., 2010). Although BSG has several advantages such as high availability, low production cost, convenience of extraction and hydrophilic properties, its potential applications in the food industry particularly for food packaging is not well demonstrated (Hosseini-Parvar et al., 2010; Karimi and Kenari, 2016).

As far as we know, the effects of employing the OEO in BSG based coating for preservation of fresh-cut fruits hasn't been reported. Consequently, the conducted study was aimed to determine the approaches of BSG-based coating as fresh apricot-cut packaging. Moreover, microbiological and sensory properties of employed fresh-cut apricot among refrigerated storage were studied.

2. Materials and methods

2.1. Plant materials and chemicals

The air-dried *Origanum vulgare* subsp. *viride* was obtained from agriculture research fields belongs to Ferdowsi University of Mashhad, Mashhad, Iran. Basil seeds were purchased from a local grocery, Shiraz, Fars province, Iran and confirmed by Dr. Javanmardi from the Horticulture Department of the Faculty of Agriculture of Shiraz University. All used chemicals were obtained from Sigma-Aldrich (St. Louis, MO, USA) and Merck (Darmstadt, Germany).

2.2. Extraction process of essential oil

Extraction of OEOs from dried plant was accomplished using the Ultrasonic-Ohmic apparatus (Hashemi et al., 2016). The ohmic-extractor unit consist cylindrical Teflon chamber with internal diameter of 0.07 m and total length of 0.25 m equipped with two titanium electrodes. The instrument was entirely automated and controllable with voltage (0–300 V), current (0–16 A) and temperature, which were monitored and recorded during the experiment. The extraction unit was equipped with a Clevenger-type device made of glass. For this purpose, 20 g of the plant samples with moisture content of 9% was added into 500 mL salted water (NaCl) solution (0.3% w/v). Brine supplies enough electrical conductivity between two electrodes for the heating step. Before heating process, plant samples were sonicated using a Hielscher ultrasonic device (UP100H, 100 W, 30 kHz) with a titanium sonotrode (tip diameter 10 mm) for 5 min. The ohmic system was then switched on and extraction was performed at constant voltage of 120 V between the two electrodes for increasing the solution temperature to boiling temperature. OEO was extracted during 30 min. The OEO was collected and water was removed from extracted OEO using anhydrous sodium sulfate. Finally, extracted OEO stored in sealed vials at 4 °C for further experiments.

2.3. Gas chromatography/mass spectrometry (GC–MS) analysis

The EO composition was determined by an Agilent 6890N gas chromatography (Agilent Technologies, Palo Alto, CA, USA) equipped with an HP-5MS 5% phenylmethylsiloxane capillary column (30 m × 0.25 mm, film thickness 0.25 μm). Initially oven temperature was adjusted at 50 °C for 5 min, afterwards increased with the rate of 3 °C/min to 240 °C followed by additional increase in temperature up to 300 °C at 15 °C/min. The final temperature holds for 3 min in order to clean up whole column. Injector temperature was set at 290 °C. The carrier gas was helium which used as at a flow rate of 0.8 mL/min. One microliter of sample diluted with n-hexane (1/10, v/v) was manually injected using the split mode (split ratio: 1/10). The used GC was equipped with an Agilent 5973N (Agilent Technologies, Wilmington, DE, USA) mass selective detector which operating at ionization voltage of 70 eV. Retention time was determined using retention times of normal alkanes (C_5-C_{24}) (purity: 99%; Sigma- Aldrich, Swiss) that had been injected after the oil in equal conditions. Further determinations of OEO constitutes were conducted by comparing the resulted mass fragmentation patterns with the Wiley/NBS mass spectral library or with the previously published data.

2.4. Extraction of basil seed gum

The BSG gum was extracted applying the described procedure by Khazaei et al. (2014). Basil seeds (50 g) were sieved and then added to its triple weight of ethanol in order to washing under constant stirring for 10 min. Ethanol was removed from seeds by filtration followed by drying in oven at 60 °C. Distilled water was used in order to steeping of the seeds (the ratio of 12:1 v/w was used for water/seed) at 37 °C for 7 h. After, stirring of seed–water slurry with a rod paddle blender at 1200 rpm for 15 min, gum layer of the seed surface was conducted. BSG was separated from the swollen seeds using filtration (cheese cloth). Then, insoluble residues of basil seed were discarded and the dry matter of filtrate was determined.

2.5. Preparation of edible coating solution

In order to preparation the film forming solution, aqueous hydrocolloid solution containing 5% BSG (Khazaei et al., 2014) with appropriate amount of glycerol (30% w/w) were stirred and warmed up to 35 ± 1 °C under constant stirring at 600 rpm for 15 min. To assist dispersion of OEO in film forming solution and also to obtain a stabilized emulsion, Tween-20 was used at 15% (v/v), depending on the OEO content and mixture was stirred for 15 min. OEOs were incorporated into film solution to reach final proposed concentrations (0, 1, 2, 3, 4, 5 and 6% (v/v)). Afterwards, obtained solution was degassed at ambient condition using a vacuum pump. The prepared films as result of casting 20 mL of film-forming solution into Petri dishes (9 cm internal diameter) were dried at 35 °C for 48 h. The obtained dried film was peeled off and stored for further evaluations.

2.6. Determination of physical characters of films

2.6.1. Film conditioning

Prior to determining film properties, all films were stored in a storage room at adjusted temperature (25 °C) and humidity (53%) for 48 h.

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