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The effect of edible coating based on Arabic gum, sodium caseinate and essential oil of cinnamon and lemon grass on guava

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ABSTRACT

The effect of five coating formulations viz.: (A) 5% Arabic gum (AG) + 1% sodium caseinate (SC) + 1% cinnamon oil (CE); (B) 5% AG + 1% SC + 2% CE; (C) 5% AG + 1% SC + 1% lemongrass oil (LG); (D) 5% AG + 1% SC + 2% LG; and (E) 5% AG + 1% SC + 2% CE + 2% LG on guava during 35 days storage at 4–7 °C was investigated. Thereafter samples were allowed to ripen for five days at 25 ± 2 °C. The quality of guava was analyzed at an interval of 7, 21, 35 and 40 days. The coating applications resulted in lower activity of PPO & POD, higher DPPH radical scavenging activity, higher retention of ascorbic acid, phenol & flavonoid content, exhibited slower rise of reducing and total sugar in guava pulp. Samples in treatment B and D were the best formulations for extending shelf-life of guava up to 40 days versus seven days of uncoated samples.

1. Introduction

Guava (*Psidium guajava* L.) fruit is an excellent source of dietary fiber, pectin (0.5–1.8%), vitamin A, phosphorus, vitamin C (78 up to 1014.4 mg per 100 g of fresh weight), calcium, iron, thiamine, niacin, riboflavin and carotene, etc. The consumption of guava fruit is known to reduce serum cholesterol levels, triglycerides, and hypertension while increasing the level of good cholesterol (high-density lipoprotein) (Mangaraj, Goswami, Giri, & Joshy, 2014). The climacteric nature of guava limits its postharvest shelf-life to 3–4 days at 25 ± 2 °C, and storage under refrigerated conditions aggravates chilling injury symptoms (Murmu & Mishra, 2017a).

Edible coatings are made from mainly polysaccharide, protein, with functional additives like essential oil (EO), antimicrobial agents, and antioxidants, etc., which enhance appearance, integrity, microbial safety, mechanical strength and slow down the diffusivity of antimicrobial agents from the food surface. Edible coatings reduce the transpiration and weight loss of fruits (Murmu & Mishra, 2016). The addition of EOs and lipid sources enhance this characteristic, as may be expected from its hydrophobic character. International regulations consider edible coating as part of the food (Fucinos et al., 2017). Hence, they are of great interest to researchers.

Arabic gum (AG) has excellent film forming capability (Ali, Maqbool, Ramachandran, & Alderson, 2010; Maqbool, Ali, Ramachandran, Smith, & Alderson, 2010). It is composed of complex branched, heteropolysaccharide with a backbone of 1,3-linked β-galactopyranose units and side-chains of 1,6-linked galactopyranose or arabinose units terminating in rhamnose or glucuronic acid or 4-*O*-methylglucuronic acid residues (Murmu & Mishra, 2017b). All the components of AG consisted multiple polar (–OH and C═O) groups. The sodium caseinate (SC) based films also have a large number of polar (–OH and –NH) groups in its structure. This enabled extensive intermolecular hydrogen bonds between the electronegative oxygen/nitrogen and electropositive hydrogen in the AG-SC matrix. The SC-based films also formed hydrophobic bonds due to their random coil nature.

Various edible coating formulations have been studied on guava. For e.g. the edible coating formulations based on potato starch and pectin (Quezada Gallo et al., 2004); wax coating (Pal, Ahmad, Roy, & Singh, 2004); cassava starch (2%) with cinnamon essential oil (0.01%) (Botelho, Rocha, Braga, Silva, & de Abreu, 2016); cassava starch (2%) formulation with chitosan (2%) and Lippa gracilis Schauer genotypes (Aquino, Blank, & de Aquino Santana, 2015); cashew gum and carboxymethyl cellulose based coatings (Forato, de Britto, de Rizzo, Gastaldi, & Assis, 2015) extended the shelf-life of guava to about two weeks at ambient temperature. At 12 °C, the hydroxypropyl cellulose or carnauba wax coating resulted in 7 days shelf-life of guava (McGuire & Hallman, 1995). The application of 2% chitosan coating resulted 12 days shelf-life of guava at 11 °C (Hong, Xie, Zhang, Sun, & Gong, 2012). At 10 °C, 30 days shelf-life was reported for guava coated with xanthan gum and carnauba wax (Zambrano-Zaragoza et al., 2013). Our earlier work had shown that 5% AG and 1% SC-based coating formulation exhibited best film forming properties with optimum oxygen transfer rate, carbon dioxide transfer rate and water vapor transfer rate

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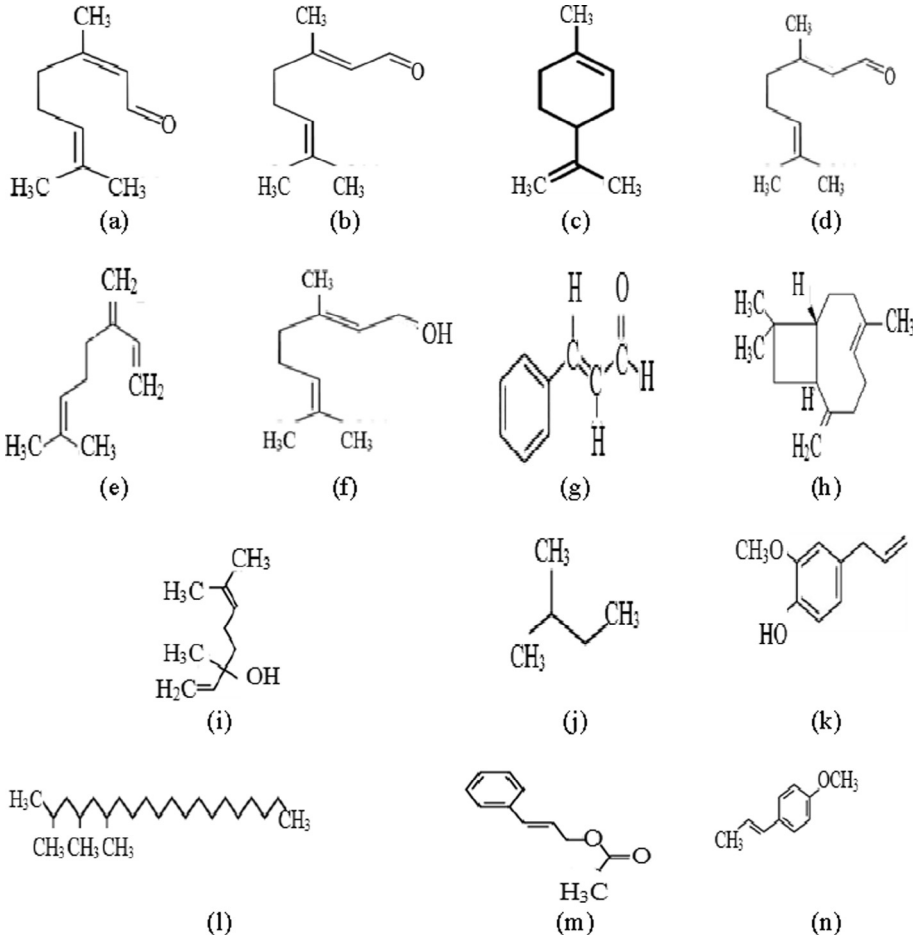

Fig. 1. The chemical structures of different active components in lemon grass oil: (a) neral; (b) geranial; (c) limonene; (d) citronellal; (e) *a*-myrcene; (f) geraniol; and cinnamon oil: (g) cinnamaldehyde; (h) b-caryophyllene; (i) linalool; (j) isopentane; (k) euganol; (l) eicosane; (m) cinnamyl acetate; and (n) anethole.

for guava (Murmu & Mishra, 2017b).

Incorporation of essential oil in edible coating enhances its antimicrobial properties (Maqbool et al., 2011). Lemongrass oil (LG) is the essential oil obtained from the aerial parts of *Cymbopogon citratus* Stapf., family Poaceae. The plant has been widely recognized for its ethnobotanical and medicinal usefulness (Oyedele et al., 2002). The essential oil of lemon grass is mainly comprised of monoterpenes compound like citral (on average, 65–80%). Citral (3, 7-dimethyl-2, 6-octadienal) is a mixture of monoterpene aldehydes; isomers neral (Fig. 1a) and geranial (Fig. 1b). The other important functional components include limonene (Fig. 1c), citronellal (Fig. 1d), monoterpene olefins, such as *a*-myrcene (Fig. 1e), and alcoholic polar compound geraniol (Fig. 1f) (Schaneberg & Khan, 2002). The insecticidal, antimicrobial and therapeutic properties of LG and extracts have been reported in the literature (Oyedele et al., 2002). Antimicrobial activity of LG has been studied against several pathogenic fungi (Tyagi & Malik, 2010). The LG exhibited a broad spectrum of fungitoxicity by inhibiting completely growth of 35, 45, and 47 fungal species at 500, 1000, and 1500 ppm, respectively, and its fungitoxic potency remained unaltered for 210 days of storage, after which it started to decline, with considerable interests in the application of LG for the preservation of stored food crops (Tzortzakis & Economakis, 2007).

Cinnamomum zeylanicum (L.), commonly known as cinnamon is rich in cinnamaldehyde (Fig. 1 g) as well as b-caryophyllene (Fig. 1 h), linalool (Fig. 1i) and other terpenes which are "Generally Recognized as Safe" by the Food and Drug Administration. Several investigations have indicated that some of the substances in cinnamon oil (CE) inhibited the growth of bacteria, yeasts, and molds (Xing et al., 2011). Hili, Evans, and Veness (1997) reported that isopentane (Fig. 1j), euganol (Fig. 1 k) and eicosane (Fig. 1 l) were the three major component of the CE. Tzortzakis (2009) further mentioned that cinnamyl acetate (Fig. 1 m) and anethole (Fig. 1n) compounds in cinnamon also exhibited strongest antimicrobial activity.

From Fig. 1 it can be seen that most of the mentioned compounds in LG and CE contained polar C═O and O—H groups while; some were lipophilic (without the polar group). The lipophilic moiety of these compounds has been recognized as being responsible for its antimicrobial property (Gupta, Garg, Uniyal, and Kumari, 2008). The addition of LG and CE in AG-SC based coating formulation may act as a strong anti-microbial coating formulation with the potential to extend shelf-life of fruits.

The composite coating formulation with 10% AG combined with 0.4% CE or 0.4% LG acted as a barrier limiting the penetration of germ tube of the fungus and extended shelf-life of banana to 33 days at 12 ± 2 °C and 80% relative humidity (RH) (Maqbool et al., 2011). The cinnamic aldehyde and eugenol were entirely inhibitory to mold growth at levels above 125 ppm (Bullerman, Lieu, & Seier, 1977). Much higher concentration of chemical was required to achieve a reduction in fungal growth in the crown tissue of fruit than in vitro as it was difficult for the chemical to penetrate living tissue to reach the fungal infection (Win, Jitareerat, Kanlayanarat, & Sangchote, 2007). In vitro mycelia growth and spore germination of C. musae were suppressed when higher concentrations of the essential oil from plant extracts were used (Sangeetha, Thangavelu, & Usha Rani, 2010). The effect of LG and CE in AG-SC based coating formulation was not studied on guava.

Preliminary investigation showed that coating with only 5% AG + 1% SC resulted 33 days shelflife (28 days at 4–7 °C + 5 days at 25 °C) of guava. The aim of this work was to study the effect of different formulations of LG and CE in AG-SC based coating formulation on the shelf-life and quality attributes of guava.