Food Chemistry 154 (2014) 63–70

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Effects of olive oil and olive oil–pomegranate juice sauces on chemical, oxidative and sensorial quality of marinated anchovy

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ARTICLE INFO

Article history:
Received 10 October 2013
Received in revised form 18 December 2013
Accepted 29 December 2013
Available online 8 January 2014

Keywords:
Fish marinades
Emulsions
Sauces
Anchovy
Pomegranate juice
Lipid oxidation
Antioxidants

ABSTRACT

This study describes the potential use of olive oil and olive oil–pomegranate juice sauces as antioxidant, preservative and flavoring agent in fish marinades. The olive oil and sauces, produced from emulsifying of olive oil and pomegranate juice with gums, were blended with marinated anchovy (*Engraulis encrasicholus*) fillets. The aim of the present study was to produce a new polyphenol-rich marinade sauces by emulsifying pomegranate juice with olive oil in different proportions (25%, 35% and 50% v:v). In order to evaluate the effects of olive oil and olive oil–pomegranate juice sauces on quality of anchovy marinades, the chemical (TVB-N and TMA), oxidative (peroxides value, K_{230}, thiobarbituric acid and K_{270}) and sensory analyses were carried out during storage at 4 °C. The present study showed that saucing of anchovy marinades with olive oil–pomegranate sauce can retard the undesirable quality changes, prolong the lipid oxidation and improve the sensory properties.

1. Introduction

Fish marinades are popular ready-to-eat seafood products in Turkey. Due to its high nutritional value and no necessity of additional preparation by the consumer the consumption of marinades is constantly growing (Szymczak & Kolakowski, 2012). The term "marinades" or "marinated fish" is used to define fish products which consist of fresh, frozen or salted fish or portions of fish processed by treatment with an edible organic acid, usually acetic acid, and salt and put into brines, sauces, or oil (Meyer, 1965). Commercial fish marinades are produced from mainly herring, anchovy (*Engraulis encrasicolus*) and anchovies because of their high oil content. Anchovy oil contains a high proportion of polyunsaturated fatty acids (PUFA) including eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) known as omega-3 fatty acids which are important fatty acids for the growing up of the retina, brain and nervous system of infants during early life (Wang et al., 2011). Nevertheless PUFAs are susceptible to oxidation which is responsible for rancidity taste and loss in nutritive value. Various synthetic antioxidants, such as butylated hydroxytoluene (BHT) butylated hydroxyanisole (BHA), tert-butylhydroxyquinone (TBHQ) and propyl gallate (PG) have been used in various food products in order to prevent lipid oxidation but there is a growing demand for naturally derived antioxidants obtained from wide variety of different plant sources (Kindleysides, Quek, & Miller, 2012).

Generally fish marinades are packed with various vegetable oil or sauces considering to consumers preferences. Although there are many studies about marination of fish, studies on marinated fish packed with sauce are limited. The effects of tomato sauce addition to marinated sardine were studied by Kilinc and Cakli (2005). Gökoğlu, Topuz, and Yerlikaya (2009) investigated the effects of pomegranate sauce and sunflower oil on quality of marinated anchovy. The effect of Europe's most popularcover brine (vinegar, oil and sur cream on the quality of herring meat was investigated by Szymczak, Szymczak, Koronkiewicz, Felisiak, and Bednarek (2013).

Pomegranate (*Punica granatum* L.) is one of the important fruits grown in Turkey, Iran, USA, Middle East, Mediterranean and Arabic countries. The edible part of the fruit contains considerable amount of acids, sugars, vitamins, polysaccharides, polyphenols and important minerals (Maskan, 2006). Consumption of pomegranate fruit and product such as juice and dressing have enormously increased in recent decade owing to healthful potential of various compounds in pomegranate (Türkyılmaz, Tağı, Dereli, & Özkan, 2013). Pomegranate juice are rich in polyphenols, including ellagitannins, gallotannins, ellagic acids, gallagic acids, catechins, anthocyanins, ferulic acids, and quercetins. These polyphenols exhibit various biological activities, such as eliminating free radicals, inhibiting oxidation and microbial growth, and

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0308-8146/$ - see front matter © 2014 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.foodchem.2013.12.103

decreasing the risk of cardio and cerebrovascular diseases and some cancers (Çaliskan & Bayazit, 2012).

Olive oil is an important component of the diet of the countries surrounding the Mediterranean Sea. There is also increasing evidence that some of its constituents, mainly phenolic antioxidants, inhibit or modulate oxygen-related reactions and have a substantial favorable effect against oxidative injury. Recently olive oil is gaining interest among consumers of northern Europe, USA, Canada, Australia and other countries, mainly due to the belief that there is a positive role of the Mediterranean diet in the prevention of certain diseases (Boskou & Visioli, 2003; Paraskevopoulou, Boskou, & Kiosseoglou, 2005).

Sauces are very popular oil-in water emulsion products, which may vary in fat content and viscosity (Dickinson, 1992). Various emulsifiers and stabilisers (e.g., proteins, polysaccharides) are used for obtaining a stable emulsion with a long shelf life in oil-in water emulsion. Emulsifiers act by one or two mechanisms, including reduction of interfacial tension between oil and water phase, or covering oil droplets with a charged layer to create a physical barrier preventing flocculation (Paraskevopoulou et al., 2005). The effect of concentrated pomegranate juice on quality of marinated anchovy has been investigated in previous work (Gökoğlu et al., 2009). Although pomegranate juice had a good antioxidative effect on quality of marinated anchovy but its effect was limited because of coalescence and stability problems. Thus, the objective of the present study was to develop a "fish marinade sauces" containing olive oil and pomegranate juice that would exhibit reasonable stability over prolonged storage. The effects of sauces on chemical quality, lipid oxidation, sensory properties and shelf life of marinated anchovy were evaluated in this work. The aim of the addition of sauces containing olive oil and pomegranate juice into the marinated anchovy was to protect initial quality, prevent the undesired chemical and oxidative alterations during storage at 4 °C and fulfill the consumer demand.

2. Materials and methods

2.1. Materials

Fresh anchovies (*E. encrasicholus*) were provided from the fish market of Antalya in January 2013. Anchovies were transferred to laboratory in polystrene boxes with in an hour after purchase. The fishes were deheaded and eviscerated manually to obtain fillets. Before the marinating, the fish fillets were washed with tap water. Sodium alginate and xanthan gum, purchased from Sigma Chemical Co. (USA) were used as emulsifier. Extra virgin olive oil (Kristal Sızma İzmir-Turkey) and ripened pomegranate fruits (*Punica granatum* L.) were purchased from a local market in Antalya-Turkey. The pomegranate peel, pulp and arils were separated manually. Then the pomegranate juice was extracted from fresh arils with using mechanical press. The brix of pomegranate juice, measured with hand refractometer (WYT-4, Quanzhou, China) was 16.1 °Bx.

2.2. Preparation of olive oil–pomegranate juice sauce

Three olive oil–pomegranate juice emulsions containing 25%, 35% and 50% (v/v) pomegranate juice were prepared according to method of Paraskevopoulou, Boskou, and Paraskevopoulou (2007). A pomegranate juice polysaccharide solution was first prepared by slowly dispersing emulsifiers (0.5% w/v sodium alginate and 0.5% w/v xanthan gum) with stirring for at least 4 h, to ensure complete dissolution. The emulsions were prepared by adding dropwise of virgin olive oil to the pomegranate juice-polysaccharide solution, while mixing with a propeller-type mechanical stirrer. 50%, 35%, 25% and 0% v/v pomegranate juice polysaccharide solution containing sauces were denoted as S_{50}, S_{35}, S_{25} and S_0, respectively. All emulsified sauces were stirred with a vortex for 2 min. The droplet size of the resulting crude emulsion was then reduced further using an Ultra-Turrax T25 homogeniser (IKA Instruments, Germany). After the emulsions had been properly formed, olive oil and olive oil–pomegranate juice emulsions were stored in screw-capped glass containers at cold temperature (4 ± 1 °C) prior to use as marinating sauce.

2.3. Marination process

Marination process was carried out according to the method of Gökoğlu et al. (2009) with a slight modification. All anchovy fillets were immersed into a marinating solution consisting of 2% (v:v) acetic acid and 10% (w:v) NaCl salt, with a final pH of 2.35. The fish to solution ratio was 1:1.5 (w:v), and the marination mixture was stirred at 3 h intervals. The marinating process, performed at ambient temperature (20 ± 1 °C) was completed within 30 h. After marination process, the fish fillets were removed from the marinating solution and left to drain on sterile stainless steel wire mesh for 5 min. Before adding olive oil–pomegranate sauce to the marinated anchovy, preliminary trials were performed in order to determine the suitable concentration in terms of taste. Thus the selected ratio of olive oil–pomegranate sauce to marinated anchovy filet was 1:4 (v:w). Marinated anchovy fillets were divided into five groups. First group was packaged without sauce in polyethylene bags (HDPE bags), and denoted as MC. Other groups were packaged with sauces containing different concentrations pomegranate juice. The samples treated with S_{50}, S S_{35}, S_{25} and S_0 sauces were denoted as M50, M35, M25 and M0. Before the analysis sauces and oil was removed from anchovy fillets with using laboratory paper towel. All samples were stored at cold temperature (4 ± 1 °C) for 100 days and analysed to determine the quality changes at 20 days intervals. Once the sauces were added to marinated anchovy fillets, the initial analyses were performed in same day (day 0).

2.4. Analyses

2.4.1. Total phenolic content

The total aqueous and lipid soluble phenolic content were determined separately using the Folin–Ciocalteu reagent with gallic acid as a standard in the range 0–1.0 mg/ml (Thomas, Bernards, Drake, & Guglielmo, 2010). The aqueous (phenolics soluble in aqueous solution) and lipid soluble (phenolics soluble in organic solvent such as aceton) phenolic contents were determined by adding 500 μl of the samples extracted with 50 mM sodium phosphate buffer (pH 7.5) and acetone, respectively, to 1 ml of ultra pure water and 2.5 ml Folin–Ciocalteu reagent (diluted 10-fold) in test tubes. The test tubes with the mixture were incubated in the dark at room temperature for 1 h. After incubation, 200 μl of each sample mixture were placed in spectrometer (Thermo Scientific Evolution 160 UV–VIS, Germany) wells and the absorbance measured at 755 nm. The results were expressed as mg gallic acid equivalents/ml sample (GAE/ml sample). Values for total phenols were determined by summation of the aqueous and lipid soluble phenol values.

2.4.2. Antioxidant activity

The hydrophilic and lipophilic antioxidant activities of olive oil (S_0), pomegranate juice (PJ) and olive oil–pomegranate sauces (S_{25}, S_{35} and S_{50}) were measured according to the method of Thomas et al. (2010) with slight modification. This method is based on the capacity of a sample to scavenge the ABTS radical caption compared to standard antioxidant (Trolox) in a dose–response curve (0–20 μM).