Available online at www.sciencedirect.com
SCIENCE DIRECT®
Food Control 16 (2005) 169–175
FOOD CONTROL
www.elsevier.com/locate/foodcont

Enhancement of the storage quality of frozen bonito fillets by glazing with tea extracts

Chih-Cheng Lin [a,*], Chung-Saint Lin [b]

[a] Department of Food Science, Yuanpei University of Science and Technology, No. 306, Yuanpei Street, Hsin-Chu, Taiwan
[b] Department of Food and Beverage Management, Yuanpei University of Science and Technology, No. 306, Yuanpei Street, Hsin-Chu, Taiwan

Received 23 March 2003; received in revised form 3 January 2004; accepted 13 January 2004

Abstract

The effect of glazes of various tea extracts upon the storage stability and the quality of bonito fillet and its associated storage deterioration are examined. Fresh bonito fillets were glazed using either water or tea extracts, which had been allowed to ferment to various extents. Ice glazing enhanced the storage quality of the bonito fillet as compared to an untreated sample. Some of the tea-glazing treatments did provide some degree of protection, although some did not. The antioxidant activity of a particular species of tea as impacted upon bonito flesh related substantially to the extent of natural fermentation of the tea species used for glazing. Green tea and Pouchong tea afforded better protection than black tea for both lipid oxidation and protein oxidation within bonito flesh, therefore they maintained a better quality of preserved bonito fillet. The combination of a glazing treatment and the application of green or Pouchong tea extract at a 5% concentration was able to greatly increase the storage quality of the frozen bonito fillets.

Keywords: Tea; Glazing; Bonito; Frozen storage; Oxidation

1. Introduction

Oxidation is an important cause of quality deterioration for frozen seafood (Khayat & Schwall, 1983). Fish meat is more susceptible to oxidative degradation than is chicken or pork during frozen storage due to the abundance of polyunsaturated fatty acids present in the flesh (Khayat & Schwall, 1983). Lipid oxidation promotes physicochemical changes, rancidity and the deteriorating flavor of the fish meat (He & Shahidi, 1997; Karel, Schaich, & Roy, 1975; Refsgaard, Brockhoff, & Jensen, 2000). Various methods for retarding or preventing the oxidation or the level of rancidity of frozen fish meat include storage at low temperature, appropriate packaging, glazing with various chemicals, and the incorporation of antioxidants (Brannan & Erickson, 1996; Erickson & Hung, 1997; Hwang & Regenstein, 1988). Glazing treatment has been used extensively to maintain the quality of the fish by preventing the deterioration of the fish meat during frozen storage. Glazing consists of a thin coating of ice, which covers the exposed surfaces of the seafood (Doré, 1991, pp. 34–35). Antioxidants are common additives to glazing solutions, apart from ice glazes (Erickson & Hung, 1997).

Antioxidants such as ascorbic acid, α-tocopherol and Trolox C have been previously reported to have been successfully used to maintain the quality of refrigerated mackerel fillet (Lin, 2000). Smith (1987) revealed that the incorporation of the antioxidants BHA (butylated hydroxy anisol), propyl gallate, and/or citric acid into turkey meat prior to freezing, considerably inhibited lipid oxidation, but did not effectively protect against the functional deterioration of the flesh-contained protein during short-term storage. Natural antioxidants can be used as alternatives to synthetic antioxidants because they are typically less harmful than synthetic antioxidants, and because they appear to demonstrate an equivalent effect to many synthetic antioxidants as regards their effect upon the inhibition of tissue oxidation (Cao, Sofic, & Prior, 1996). Tea catechins may be used to reduce oxidation for mackerel patties during refrigerated (4 °C) and illuminated storage (Tang, Kerry,

* Corresponding author. Tel.: +886-3-5381183x8220; fax: +886-3-5308515.
E-mail address: lcc@mail.yust.edu.tw (C.-C. Lin).

0956-7135/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.foodcont.2004.01.007

Sheehan, Buckley, & Morrissey, 2001). Green tea and fermented or black teas have long been acclaimed for their antioxidative effects upon various foodstuffs, the effect deriving from the presence of tea catechins (Chen & Ho, 1995; Ho, Chen, Wanasundara, & Shahidi, 1997; Roedig-Penman & Gordon, 1997; Wiseman, Balentine, & Frei, 1997).

The antioxidant activity of green, Pouchong, and black teas manufactured from the same variety of tea has been examined in a previous study focusing upon tea's protection against lipid and protein oxidation (Lin & Liang, 2003). To the best of our knowledge, the specific storage quality of frozen fish, glazed with various fermented teas deriving from the same tea species, has seldom been examined previously. Maintaining the freshness of frozen fish products is a major concern for the preparation of high-quality foods. The aim of this study is to investigate the protective effect of tea extract as a glazing solution, upon the quality of bonito fillet during frozen storage. The relative efficacies of green tea, Pouchong tea, and black tea as regards preserving the freshness of frozen bonito flesh, were compared with that of ice glazing.

2. Materials and methods

2.1. Materials

Three samples of tea were provided by the Wen-Shan Substation, Taiwan Tea Experiment Station (Taipei, Taiwan). Green, Pouchong and black teas were manufactured from a single species of Taiwanese tea (TTES No. 12). Green tea was produced in three stages—fixing, rolling and firing. Pouchong tea, a type of oolong tea, was produced in six basic stages—sunlight withering (20–60 min, 30–38 °C, 50–70% humidity), room withering (8–10 h, 23–25 °C, 70–80% humidity), fixing, rolling, and firing. Finally, gentle fermentation was performed by swirling the tea several times during the withering process. The black tea used herein was produced in five distinct stages—room withering, fixing, rolling, fermentation, and firing. A sample of 5 g of tea was extracted for 1 min in 100 ml (5%) of distilled water at 90 °C. All chemical reagents were obtained from Sigma (The Sigma Chemical Co., St. Louis, MO., US) apart from Folin-Ciocalteu's phenol reagent, which was obtained from Merck Co. (Darmstadt, FRG).

2.2. Sample preparation

Fresh, live bonito specimens were purchased from a local fish market. Each bonito was carefully filleted in order to remove all bones, skin and visible dark meat, and was cut into a $0.5 \times 2 \times 3$ cm sized fillet. Each fresh bonito fillet was frozen for 24 h to complete the freezing process, and then glazed with solutions of various tea extracts in a refrigerated (4 °C) cabinet. The control fillet was glazed with distilled water (ice glazing). Untreated samples were treated with neither water nor tea extract. Each fillet was coated with aluminum foil and stored at −20 °C.

2.3. Determination of total phenolics present

Total phenolic content was analyzed according to the Folin-Ciocalteu method (Julken-Titto, 1985). One milliliter of Folin-Ciocalteu reagent (Merck Co., Darmstadt, FRG) diluted with 2 ml of distilled water was added to 50 μl of tea extract. The color of mixture was then developed using sodium carbonate. The absorbance of derived product was read at 735 nm, using gallic acid (Sigma Chemical Co.) as a standard for the calibration curve. The results were expressed as milligrams per gram of gallic acid equivalents.

2.4. HPLC analysis of catechins

The catechin content was determined by application of high-performance liquid chromatography using a Phenomenex® LUNA C_{18} reverse-phase column (25×0.46 cm^2 i.d., 5μ) and a UV–VIS detector (Applied Biosystem Co., Foster City, USA). The mobile phase contained a 1.1% solution of acetic acid (solvent A) and acetonitrile (solvent B), with a linear gradient starting with an A/B mix of (92:8) ranging to A/B (73:27) over a period of 40 min with a flow rate of 1 ml/min (Lin & Liang, 2003). The detector was monitored at 280 nm The standard compounds (+)-catechin (98%), (−)-epicatechin (EC) (98%), (−)-epicatechin gallate (ECG) (98%), (−)-epigallocatechin (EGC) (98%), (−)-epigallocatechin gallate (EGCG) (95%), and (−)-gallocatechin gallate (GCG) (98%) were all purchased from Sigma Chemical Co.

2.5. Measurement of quality of bonito flesh

The deterioration in the quality of the bonito flesh was subject to assay in order to identify the meat level of volatile-based nitrogen (VBN), the peroxide value (PV), the concentration of 2-thiobarbituric acid-reactive substances (TBARS) and protein carbonyls. Fluorescence and absorption spectrometry were also performed on the samples in order to investigate the relative quality of the contained protein. A 2.5 g sample of bonito meat from treated and untreated fillets were homogenized in a Polytron homogenizer with 20 ml 20 mM phosphate buffer (pH = 6.86) at 25 °C for a period of 2 min prior to the quality of the flesh being analyzed. The VBN value was determined using a microdiffusion method (Conway, 1950, pp. 157–159). The ferric thiocyanate method (Egan, Krik, & Sawyer, 1981) was used to determine the