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Stabilization of sunflower oil by garlic extract during accelerated storage

Shahid Iqbal [a,*], M.I. Bhanger [b]

[a] Department of Chemistry, University of Sargodha, Sargodha 40100, Pakistan
[b] National Center of Excellence in Analytical Chemistry, University of Sindh, Jamshoro 76080, Pakistan

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Abstract

Efficacy of garlic extract in stabilizing sunflower oil during accelerated storage has been studied. Extracts of garlic were prepared in different solvents; extract yield was in the range of 6.24–23.2% and antioxidant activity range in the linoleic acid system was 14.1–93.2%. Being highest in yield and antioxidant potential, methanolic extract was thermally evaluated by heating the extract at 185 °C for different intervals, i.e. 0–80 min and evaluating antioxidant activity of the heated extract in the linoleic acid system (71.6% inhibition). Methanolic extract of garlic at three different concentrations, i.e. 250 (SFO-250), 500 (SFO-500) and 1000 ppm (SFO-1000) were added to preheated RBD sunflower oil. BHA (SFO-BHA) and BHT (SFO-BHT) at 200 ppm served as standards besides the control. Weight gain (WG), antioxidant activity index (AAI), free fatty acid (FFA) content, peroxide value (PV), conjugated dienes (CD), conjugated trienes (CT) and thiobarbituric acid-reactive substances (TBARS) were taken as parameters for evaluation of effectiveness of garlic in stabilization of sunflower oil. Results from different parameters were in agreement with each other, suggesting the highest efficiency of SFO-1000, followed by SFO-BHT, SFO-BHA, SFO-500, SFO-250 and Ctrl. Results reveal garlic to be a potent antioxidant for stabilization of sunflower oil.

Keywords: Garlic; Sunflower oil; Antioxidant activity; Thermal stability

1. Introduction

Vegetable oils and fats are recognized as important components of our diet. They provide essential fatty acids, which are precursors of important hormones, such as prostaglandins, and control many physiological factors such as blood pressure, cholesterol level, and the reproductive system (Walisiewicz-Niekbalska, Kosmacinska, & Chmielarz, 1997). Lipid peroxidation is responsible for the quality deterioration of vegetable oils, fats and other food systems (Che Man & Tan, 1999). It results in the losses of nutritional value of food as well as changes in colour, texture, sensory and other physiological properties (Kazuhisa, 2001). Due to these changes, consumers do not accept oxidized products and industries suffer from economic losses. The oil industry has to pay special attention in this context, as oils, fats and fatty foods suffer stability problems (Wu & Nawar, 1986). The oils with higher contents of unsaturated fatty acids, especially polyunsaturated FA, are more susceptible to oxidation. In order to overcome the stability problems of oils and fats, synthetic antioxidants, such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), *ter*-butyl hydroquinone (TBHQ) have been used as food additives. But recent reports reveal that these compounds may be implicated in many health risks, including cancer and carcinogenesis (Hou, 2003; Prior, 2004). Therefore, the most powerful synthetic antioxidant (TBHQ) is not allowed for food application in Japan, Canada and Europe. Similarly, BHA has also been removed from the generally recognized as safe (GRAS) list of compounds (Farag, Badei, & El Baroty, 1989).

Due to these safety concerns, there is an increasing trend among food scientists to replace these synthetic antioxidants with natural ones, which, in general, are supposed

* Corresponding author. Tel.: +92 321 6011304/333 6776819; fax: +92 22 2771560.
E-mail address: ranashahid313@yahoo.com (S. Iqbal).

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to be safer. The effectiveness of different natural sources in stabilizing vegetable oils has been previously studied (Anwar, Bhanger, & Yasmeen, 2003; Ito et al., 1986). Jung, Lee, Hun, Kyung, and Chung (2001) evaluated the effect of natural lecithin on the stability of borage oil. Shahidi and Wanasundara (1992) investigated the stabilization of canola oil with canola meal. Fruits, vegetables, nuts, seeds and barks are being investigated for their antioxidant potential (Pratt & Hudson, 1990).

Garlic is indigenous to Asia and is cultivated worldwide for the fleshy segments of its bulbs, which are used as a condiment, especially in Asian cuisine (Dorant, Vanden, & Goldbolm, 1993). Antioxidant potential of garlic in vivo and in vitro has been proved (Jackson et al., 2002). In addition to its antioxidant activity, it has antimicrobial, antibacterial, antiviral, antifungal, antiprotozoal properties and beneficial effects on the cardiovascular and immune systems (Harris, Cottrell, Plummer, & Lloyd, 2001). Garlic is rich in selenium and organosulphur compounds, which have pronounced antioxidant activity (Yin, Hwang, & Chan, 2002; Li, 2000).

Refined, bleached, and deodorized (RBD) sunflower oil was used to evaluate antioxidant efficacy of garlic extracts because it is used in nutrition and is highly appreciated as a source of the essential linoleic acid. Furthermore, due to its higher content of polyunsaturated fatty acids, the stabilization effect is more pronounced in sunflower oil (Shahidi, Janitha, & Wanasundara, 1992).

2. Materials and methods

2.1. Materials

Refined, bleached, deodorized (RBD) sunflower oil was obtained from Wazir Ali Oil Industries Ltd., Hyderabad. Garlic was purchased from local market. All the chemicals and reagents used were of analytical reagent grade and were purchased from Fluka, or E. Merck. BHA and BHT were purchased from Sigma Chemical Co (St. Louis, MO, USA).

2.2. Extraction

Garlic was peeled and dried in an oven at 55 °C for 3 h. The dried garlic was ground to pass through a 1 mm sieve. About 5.0 g of garlic was extracted into 150 ml of methanol, ethanol, diethyl ether, acetone, hexane and ethyl acetate; extracts were subjected to shaking at room temperature overnight at a speed of 1000 vib/min. The extracts were filtered and residue was again extracted with 100 ml of each solvent. This procedure was repeated thrice to ensure the complete extraction of phenolic compounds. Then, the filtrate was subjected to rotary evaporation at 40 °C under reduced pressure for the removal of solvent. The extracts were weighed to calculate the yield and were stored under nitrogen prior to further analyses.

2.3. Evaluation of antioxidant activity

Antioxidant activity was determined in the linoleic acid system. Linoleic acid emulsion (0.02 M) was prepared with linoleic acid (0.2804 g) and Tween 20 (0.2804 g) in potassium phosphate buffer (50 ml, 0.05 M, pH 7.4). A reaction solution containing extracts (0.2 ml, 5.0 mg/ml), linoleic acid emulsion (2.5 ml), and potassium phosphate buffer (2.3 ml, 0.2 M, pH 7.0) was mixed with a homogenizer. The reaction mixture was incubated at 37 °C in the dark, and the degree of oxidation was measured by the thiocyanate method (Misuda, Yasumoto, & Iwami, 1966), by sequentially adding ethanol (4.7 ml, 75%), ammonium thiocyanate (0.1 ml, 30%), sample solution (0.1 ml), and ferrous chloride (0.1 ml, 0.02 M). After the mixture had been stirred for 3 min, the peroxide value was determined by reading the absorbance at 500 nm, and the percent inhibition of linoleic acid peroxidation was calculated as (%) inhibition = 100 − [(absorbance increase of sample/absorbance increase of control) × 100]. All analyses were conducted in triplicate and results were averaged.

2.4. Evaluation of thermal stability of garlic extract

Methanolic extract, being rich in antioxidant activity, was used for further studies. Thermal stability of methanolic extracts was evaluated by heating at 185 °C in an oven for a period of 0, 10, 20, 30, 40, 50, 60, 70, and 80 min in separate crucibles. After each interval, a crucible was removed from the oven, cooled to room temperature and stored at 4 °C before antioxidant activity evaluation in linoleic acid system following the above-cited method.

2.5. Sample preparation

Methanolic extracts of garlic were added to preheated RBD sunflower oil (at 50 °C for 3 h) at concentrations of 250, 500, and 1000 ppm. Synthetic antioxidants (BHA and BHT) were employed at their legal limit of 200 ppm (Duh & Yen, 1997) to compare the efficacy of natural antioxidants. All the samples (120 ml) were placed in dark brown coloured reagent bottles with narrow necks, without stoppers and stored in an oven at a fixed temperature of 65 °C. Control samples were also placed under the same storage conditions. Analyses were carried out after regular intervals of 4 days (96 h). At least three samples of each category were analyzed.

2.6. Weight gain analysis

For weight gain analyses, 2.0 g of each sample (in triplicate) were placed in glass Petri dishes, which were kept in a vacuum oven overnight at 35 °C to remove any traces of moisture. The samples were reweighed and stored in the oven at 65 °C, along with other samples. The rate of oxidation, in terms of weight increase, was recorded at 24 h