The Effect of Mangosteen (*Garcinia mangostana*), Cinnamon (*Cinnamomum verum*) and Chilli (*Capsicum annum*) Extracts in Minimizing Autoxidation of Sesame (*Sesamum indicum*) Oil

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Abstract: During the past two decades, the use of natural plant extracts as antioxidants in edible oils is becoming popular to prevent the use of synthetic antioxidants. This study was carried out to study the effect of three natural plant extracts; mangosteen (*Garcinia mangostana*) peel, cinnamon (*Cinnamomum verum*) and chilli (*Capsicum annum*) extracts on autoxidation of sesame (*Sesamum indicum*) oil. Dried powder (20 g) of each plant was mixed with 30 ml of acetone, stirred for 30 min at room temperature and filtered and the solvent was removed by rotatory evaporator to get plant extracts. Sesame oil was heated to 60 °C and plant extract was added at 5 mg per 100 mg of sample while stirring. Just after adding plant extracts, oil samples (5 mL) was taken into glass vials, flushed with nitrogen and closed with caps to assess the oxidative stability by accelerated oven storage test (at 65±5 °C for up to 28 days). Samples were drawn on 1, 3, 5, 7, 14, 21 and 28 days and analyzed for chemical parameters such as peroxide value (PV), thiobarbituric acid reactive substance (TBARS) assay and specific absorptivity of conjugated dienes (CDs) and conjugated trienes (CTs). All samples treated with plant extracts showed increased stability against autoxidation than control. The samples treated with mangosteen peel showed significantly ($p<0.05$) lower rate of percent increment of PV, CDs, TBARS and CT (2.76, 0.84, 0.12 and 1.14%, respectively) than the samples treated with other extracts. The samples treated with cinnamon showed significantly ($p<0.05$) higher percent increment of PV and CTs (3.18 and 1.97%, respectively) than the samples treated with chilli extract (2.99 and 1.42%, respectively) while CDs and TBARS values of samples treated with cinnamon extract were significantly ($p<0.05$) lower than the samples treated with chilli extracts. Therefore it is concluded that all three plant extracts can act to reduce the autoxidation of sesame oil, however, the mangosteen peel extract is the most effective to reduce the autoxidation of sesame oil. Thus, mangosteen peel, a waste product, could be effectively used at low cost to increase the stability of sesame oil against autoxidation.

Keywords: oxidative stability, sesame oil, natural plant extracts, autoxidation

Introduction

Use of natural plant derived sources as antioxidants in fats and oils is an emerging trend. Oxidation of oil destroys essential fatty acids and produces low molecular weight off flavor compounds and other toxic compounds which make the oil less acceptable or unacceptable for consumption. The unsaturated fatty acids

present in the oil can undergo autoxidation easily because the hydrogen atom adjacent to the double bond can be removed easily to produce free radicals which then undergo chain reaction (Choe and Min, 2006). Thus, incorporation of some antioxidants could retard the autoxidation reaction. The growing interest in the replacement of synthetic food antioxidants by natural ones has led the focus on inexpensive natural sources (Suttirak and Manurakchinakorn, 2014).

Sesame is an ancient and most important oil crop cultivated in the world. Sesame plays an important role in human nutrition and medicinal and pharmaceutical uses. About 65% of annual sesame crop planted is processed into oil. Sesame seed contains high content of oil (50%). Sesame oil contains oleic (35-50%), linoleic (35-50%), palmitic (7-12%) and stearic (3.5-6%) acids. Sesame oil has superior oxidative stability compared with most other vegetable oils during processing and storage. This stability could be attributed to endogenous antioxidants namely lignans (sesamin and sesamol) and tocopherols (mainly γ -tocopherol) (Kamal-Eldin and Appelqvist, 1995). Since sesame oil contains unsaturated fatty acids which can undergo autoxidation, incorporation of antioxidants could reduce the autoxidation. Studies on effect of natural plant extracts on autoxidation of sesame oils are limited.

Therefore in this study, effect of three natural plant extracts mangosteen peel, cinnamon and chilli, which are known antioxidant sources were studied on minimizing autoxidation of sesame oil. Mangosteen peel contains high levels of xanthenes as α -mangostin and γ -mangostin which are known to possess strong antioxidant activity. Cinnamon contains high amount of polyphenols and proanthocyanidins and the extract is able to reduce lipid peroxidation in β carotene – linoleic acid system and it has a protective capacity against irradiation induced lipid peroxidation in liposomes (Mancini-Filho and Van-Koij, 1998). Chilli is a rich source of vitamin C and contains compounds like capsaicin, capsanthin and capsorubin. It has been found that the capsanthin suppressed hydroperoxide formation and the radical scavenging effect of capsanthin was found to last longer (Pandey *et al.*, 2012).

Materials and Methods

Materials

Sesame oil was obtained from local market in Sri Lanka. All the chemicals used in this study were of analytical grade with highest purity available (>99.5%) and obtained from Sigma Chemicals Company (MO, USA).

Preparation of plant extracts

Mangosteen peel extract

Mangostin peels were removed and chopped into small pieces and dried for about two days in a dryer to remove moisture. Dried mangosteen peel pieces were ground and sieved through a sieve (500 gauge). A sample of (20 g) mangosteen peel powder was mixed with 30 mL of acetone and stirred for 30 minutes using mechanical stirrer. Then the solution was filtered using no.1 Whatman filter paper and the filtrate was collected into round bottom flask. The solvent was removed using Rotorvapor (Rotavapor R-3000, Switzerland) to obtain the extract.

Cinnamon extract

Cinnamon powder (20 g) was mixed with 30 mL of acetone and stirred for 30 minutes on a mechanical stirrer. Resulting solution was filtered through no.1 Whatman filter paper and filtrate was collected in a round bottom flask and extraction was done using Rotavapor.

Chilli extract

Chili powder (20 g) was mixed with 30 mL of acetone and stirred for 30 minutes using a mechanical stirrer. Resulting solution was filtered through no.1 Whatman filter paper and filtrate was collected in a round bottom flask and extraction was done using Rotavapor.

Sample preparation

Sesame oil contained no added natural extracts was taken as control. For the test samples, oils were directly added with mangosteen peel, cinnamon and chili extracts each at concentration of 5 mg/100 mg of oil before being subjected to oven test.

Oven test

Samples of each oil treatment (control, with mangosteen peel, with cinnamon, with chili) were placed in separate open glass vials (5 mL) and stores in oven maintained at 60±5 °C for up to 1, 3, 5, 7, 14, 21 and 28 days. Oil samples were analyzed immediately after each storage period. The temperature of 60±5 °C was used to stimulate storage in real condition.

Chemical analysis

PV was determined according to Damaso *et al.* (2001) and TBARS was determined by AOCS method (1998). Lipid oxidation product of CDs and CTs were determined by specific absorptivity values at 232 and 270 nm using UV spectrophotometer (UV 1601, Shimadzu, Japan) (Besbes *et al.*, 2004). Specific absorptivity was calculated as follows;

$$E = \frac{A}{C \times l}$$

Where, E is the specific absorptivity, A is the absorbance measured at either 232 nm (for CDs) or 270 nm (for CTs), C is the concentration of the oil in g/100 mL and l represents the path length of the cuvette in cm (Pegg, 2005).

Statistical analysis

The data were analyzed using Minitab 16. All measurements were performed in triplicate. The ANOVA tables were constructed using GLM procedure. Duncan's new multiple range test was used to determine significant differences at 0.05 significant levels.

Results and Discussion

The figures 1, 2, 3 and 4 shows the variation of PV, TBARS, CD and CT values of oils added with different extracts up to 28 days of storage. The percent increment of PV, TBARS, CD and CT are shown in Table 1. According to figure 1, the PV of the all samples increased gradually during storage. The percentage increment of PV of control was lesser than the samples added with either cinnamon or chilli extract. There was no significant difference between the percent increment of PV between control sample and sample added with mangosteen peel extract. Among extracts tested, sample with mangosteen peel extract showed the least percent increment (2.76%) which indicate highest oxidative stability of the sample.

Table 1: Percentage increment of PV, TBARS, CD and CT of different plant extracts

Extract	PV (%)	TBARS (%)	CD (%)	CT (%)
Mangosteen peel	2.76b	0.12d	0.84c	1.14c
Cinnamon	3.18a	1.36c	1.45b	1.97a
Chili	3.33a	2.70b	1.89b	1.42b
Control	2.99b	10.32a	3.59a	1.41b

Figure 1: Variation of PV of oils added with different extracts during the storage period

TBARS is the most widely used test for measuring the extent of lipid peroxidation. The basic principle of the method is the reaction of one molecule of malonaldehyde and two molecules of TBA to form a red malonaldehyde-TBA complex, which can be quantitated spectrophotometrically at 532 nm. According to figure 2, the TBARS values increased continuously over the storage period while the oil added with mangosteen peel extract showed less value than others. The least percent increment (0.12%) of TBARS was shown by sesame oil which contained mangosteen peel extract followed by sample with cinnamon extract (1.36%) and sample with chilli extract (2.70).

Figure 3: Variation of TBARS of oils added different extracts during the storage period

The formation of peroxides is concurrent with conjugation of double bonds in polyunsaturated fatty acids, which can be measured using the specific absorptivity of CDs and CTs at 232 and 270 nm in the UV spectrum. All sesame oil samples revealed the increase of specific absorptivity values of CDs and CTs with time (Figure 3 and 4). The addition of natural plant extracts lowered these values. Among the extracts tested, sample with mangosteen peel showed the least percent increment of CD (0.84%) and CT (1.14%).

Figure 2: Variation of CD of oils added different extracts during the storage period

Figure 4: Variation of CT of oils added different extracts during the storage period

Even though all plant extracts tested in this study showed significant effect in minimizing the oxidation of sesame oil, antioxidant effect of mangosteen peel extract was higher than cinnamon and chilli extracts. Oil samples with mangosteen peel extract showed the minimum difference between final and initial PV, TBARS, CD and CT values which indicate lowest oxidation of the oil. Some other researchers also have reported the antioxidant property of mangosteen peel extract (Yoshikawa *et al.*, 1994; Okonogi *et al.*, 2007; Palakawong *et al.*, 2010) however the extraction method could have effect on extent of activity (Palakawong *et al.*, 2010). Mangosteen peel contains antioxidant namely xanthenes which is capable of reducing oxidation. There are over 200 xanthenes that can be found in nature, but mangosteen is reported to contain over 50 kinds of xanthenes (Pedraza-Chaverri *et al.*, 2008). Chilli and cinnamon extracts also showed antioxidant activity to some extent, but less than mangosteen peel extract. Chilli contains phenolic compounds such as capsaicin and cinnamon contains catechin and epicatechin which have contributed to antioxidant activity but not effective as xanthenes in mangosteen peel extract.

Conclusion

Based on the findings of this study, it can be concluded that mangosteen peel extract possess higher antioxidant effect than chilli and cinnamon extracts against oxidation of sesame oil and thus addition of mangosteen peel extract to sesame oil will reduce the rate of autoxidation. Since mangosteen peel is a waste material, it could be effectively utilized to increase the oxidative stability of plant oils.

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