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Investigation on Antioxidant Effect of Ginger (*Zingiber officinale*) Essence Oil on Oily Cake

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Abstract

In recent years, essential oils have been qualified as natural antioxidants and proposed as potential substitutes of synthetic antioxidants in food preservation. The safety of the synthetic antioxidants has been doubted. The aim of this study was to evaluate efficiency of *Zingiber Officinale* essential oil as antioxidant agent and use in cake preservation as a natural plant preservative due to the harmful effects of synthetic antioxidants. Cakes were treated with *Zingiber Officinale* essential oil in three levels (0.3%, 0.4%, 0.5%), cakes were treated with synthetic antioxidant (tert butyl hydroquinine= TBHQ) in two levels (0.01%, 0.02%) agents. In all samples peroxide value, acidity test were determined at time intervals 1, 10, 20, 30, 40, 50 and 60 days. Statistical results showed that, the sample containing *Zingiber Officinale* at 0.5%, had good antioxidant activity in comparison with the control samples (without any synthetic and natural antioxidant agents) ($p<0.01$). But its activity was less than that of synthetic ones TBHQ as antioxidant agent. Results showed that this essential oil could be used as natural antioxidant in foodstuffs especially those lipid containing.

Keywords: Oily cake, Zingiber Officinale, Antioxidant activity, Essential oil

Introduction

Cake manufacturers face a major problem of lipid oxidation and mould growth which limits shelf-life of their product. The use of antioxidant and preservatives can reduce this problem [1]. The antioxidants most frequently used are synthetic phenols such as butylated hydroxy toluene (BHT), butylated hydroxyl anisole (BHA) and propyl gallate [2]. However the safety of these synthetic antioxidants and preservatives has been questioned due to toxicity, liver damage and carcinogenicity. Therefore development and use of safer antioxidants from natural sources are of interest because of possible negative effects of synthetic food additives on human health [3]. Some studies have disclosed the potential sources of natural antioxidants for the bakery products [3]. The keeping quality of baked foods such as crackers, cookies and biscuits is of great economic importance since these products are widely used and are often stored for extended periods before consumption. The spices most commonly used in bakery products are cinnamon, mint, mace cloves, poppy and sesame [4].

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Plants are a potential source of natural antioxidants. Natural antioxidants or phytochemical antioxidants are secondary metabolites of plants [5]. Carotenoids, flavonoids, cinnamic acids, benzoic acids, folic acid, ascorbic acid, tocopherols, tocotrienols, *etc*. are among the antioxidants produced by plants for their own sustenance. Beta-carotene, ascorbic acid and alpha tocopherols are widely used antioxidants [6]. *Zingiber officinale* contains a number of antioxidants such as beta-carotene, ascorbic acid, terpenoids, alkaloids, and polyphenols such as flavonoids, flavones glycosides, rutin, *etc.* [7].

Easily cultivable, *Zingiber officinale* with its wide range of antioxidants can be a major source of natural or phytochemical antioxidants [8]. Although various extracts are obtained from ginger, it is the CO_2 extracts that are richest in polyphenol compounds and have a composition that closely resembles that of the rhizomes [9, 10]. The method of preparation has been used in commercial ginger preparation, since ginger has been widely speculated to be beneficial for human health because it exerts antioxidant activity [7]. Previous studies on the antioxidant properties of various ginger species had been confined only to the rhizomes [11, 12], which have been reported to have tyrosinase inhibiting properties [13]. Recently, skin-lightening cosmeceutical products have been developed from the rhizomes of gingers [14]. Ginger oil has been shown to prevent skin cancer in mice and a study at the University of Michigan demonstrated that gingerols can kill ovarian cancer cells. (6)-Gingerol (1-[4'-hydroxy-3'-methoxyphenyl]-5-hydroxy-3-decanone) is the major pungent principle of ginger. The chemopreventive potentials of (6)-gingerol present a promising future alternative to expensive and toxic therapeutic agents. Ginger contains up to 3% of a fragrant essential oil whose main constituents are sesquiterpenoids, with (-)-zingiberene as the main component. Smaller amounts of other sesquiterpenoids (β-sesquiphellandrene, bisabolene and farnesene) and a small monoterpenoid fraction (β-phelladrene, cineol, and citral) have also been identified. The pungent taste of ginger is due to nonvolatile phenylpropanoid-derived compounds, particularly gingerols and shogaols, which are formed from gingerols when ginger is dried or cooked. Zingerone is also produced from gingerols during this process; this compound is less pungent and has a spicy-sweet aroma. Ginger is also a minor chemical irritant, and because of this was used as a horse suppository by pre-World War I mounted regiments for feaguing [15].

Although the leaves of ginger species have been used for food flavouring and in traditional medicine, insufficient research has been done on their antioxidant and tyrosinase antioxidant and tyrosinase inhibiting properties. Antioxidants affect the process of lipid oxidation at different stages due to the differences in their mode of action. Because of the complexity of the oxidation process itself, the diversity of the substrates and the active species involved, the application of different test methods is necessary to evaluation antioxidants. The aim of this study was to evaluate antioxidant of *zingiber officinale* essential due to the good antioxidant effect on cake shelf life.

Materials and Methods

Materials

Ginger essential oil (*Zingiber Officinale*) was used as source of natural antioxidant. It was purchased from the Institute of Medicinal Plants and Natural Products Research in Mashhad, Iran (May 2014) and then the essential oil was extracted by steam distillation, using a Clevenger-type apparatus [16]. The obtained essential oil was dried over anhydrous sodium sulphate and kept at 4°C until it was used. Oil with no antioxidant was purchased from Behshahr factory, flour with no additive was purchased from Taban Factory, eggs and baking powder were purchased from market. Chemicals (of analytical grade) required:, acetic acid glacial, chloroform, tert butyl hydro quinine (TBHQ), sodium hydroxide, ethanol, sodium thiosulfate, saturated potassium iodide, potassium sorbate, were obtained from authentic companies

Materials Preparation of cake

Cakes were prepared by the following method. Sugar (2200 g) and egg (1500 g) were mixed for 3-4 minutes, after that flour (3000 g) and baking powder (150 g) were added and creamed. The essential oil was blended with fat (3000 g) and mixed with the above cream. After 5 min of mixing water was added to the dough then it was mixed to obtain homogenous dough and placed on aluminum plates, then baked at 180^{o}C for 20 min after baking, plates were allowed to cool, were covered with air-tight sterile foil and stored in ambient temperature. Treatments included a control (no antioxidant and preservative), examples of synthetic antioxidant TBHQ at two levels (0.01 and 0.02) essential Ginger oil 3 (0.3, 0.4, 0.5) respectively.

Peroxide value (PV)

Oxidation was periodically assessed by the measurement of peroxide value (PV) at 1st, 7th, 15th, 30th, 45th, 60th and 60th days of storage according to the AOCS method [17].

Acidity values

Oxidation was periodically assessed by the measurement of acidity values at 1st, 7th, 15th, 30th, 45th, 60th and 60th days of storage according to the AOCS method [17].

Statistical analysis

The experimental data were analyzed statistically for variance by using SPSS 18 program. Data recorded as means ± standard deviation of three replicate measurements. Analyses of variance were performed by ANOVA test and significance of differences between the means was determined by Duncan's multiple range tests.

Results

Chemical analyses

Three different concentrations of ginger essential oil were used in present study as source of natural antioxidant agent. The effects of antioxidants on the stability of the added fat were determined by monitoring PV, Acidity under actual storage conditions (ambient temperature). Cakes containing synthetic antioxidant (TBHQ) chemicals possess stronger activity than the natural ones but in comparison to samples with no synthetic antioxidant agent, ginger essential oil had significant activity ($p<0.01$) and the effect of ginger essential oil increased with increasing concentration. Antioxidant activity of plants is mainly due to the presence of phenolic compounds [2]. From Table 1 the results showed a significant difference in parameters from Peroxide value (level %1).

Source	Sum of square	DF	Mean square	F value
Test	154.567	5	30.913	21.589**
Error	171.828	120	1.432	
Total	723.765	126		
Significant (level %5)*, Significant (level %1)**				

Table 1: PV (meq o_2 /kg oil) Analysis of Variance.

From Table 2, indicated that the peroxide value in blank sample was higher than the other samples. The sample containing essential oils (0.3, 0.4, 0.5) there was no difference in terms of peroxide. Additives antioxidants also attribute these differences are not significant and had the least amount of peroxide than the other treatments.

Tests	Means
Blank	3.92[a]
Essential 0.3%	2.05[b]
Essential 0.4%	1.86[b]
Essential 0.5%	1.54[b]
Control 0.01%	0.57[c]
Control 0.02%	0.69[c]

Table 2: Comparison of mean PV values in samples was determined by Duncan's multiple (leves %5).

Means that have common letters are not statistically significantly different from each other

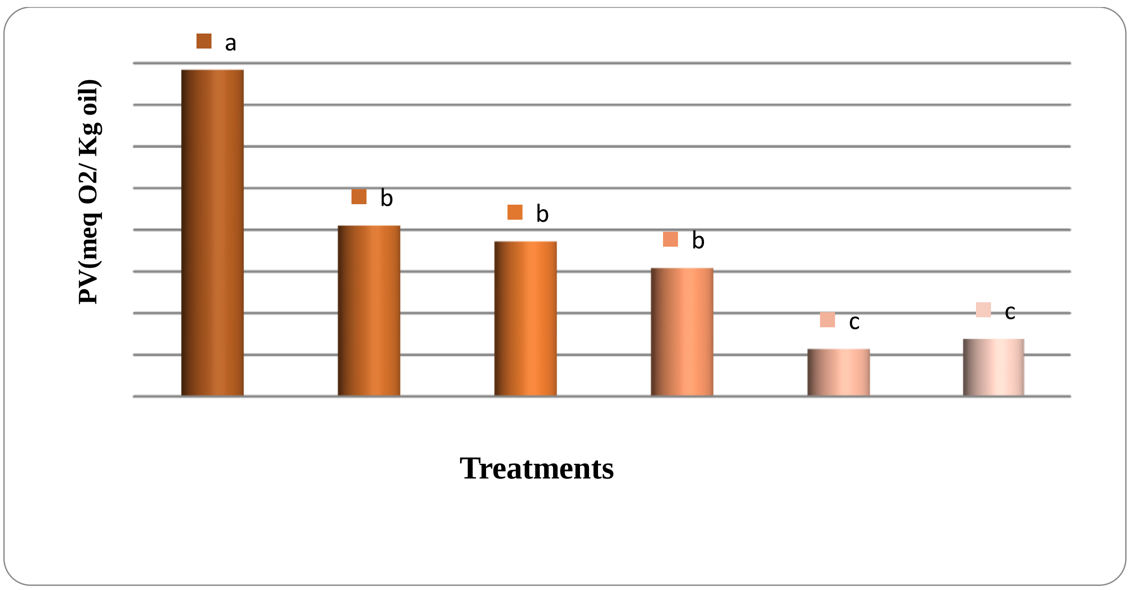

Figure 1: Comparison of mean PV values in samples during the storage period.

Generally, during the period of seven experiments, indicating that the increase in the amount of peroxide. In comparison with Figure 2 sample, the cakes containing ginger essential oil had lower PV but their peroxide values were higher. It was interesting to note that cakes prepared by ginger essential oil at high concentration (0.5%) had the lowest PV during the storage, in fact increased of concentration caused decreased PV. The peroxide values after 60 days were different significantly among the all samples.

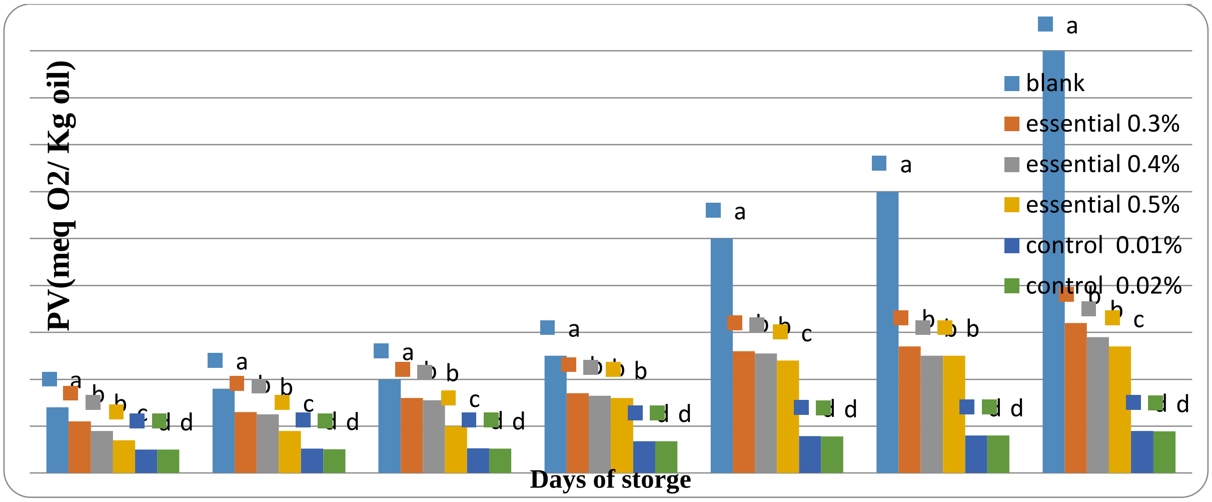

Figure 2: PV (meq O2/kg oil) changes of produced cakes samples during 60 days of storage.

Acidity test sample

From Table 3 the results showed a significant difference in parameters from acidity value (level %1).

source	Sum of square	DF	Mean square	F value
Test	151.426	5	30.285	22.273**
Error	163.167	120	1.360	
Total	398.916	126		
Significant (level %5)*, Significant (level %1)**				

Table 3: Analysis of variance of the experimental treatments on the acidity of the samples.

Results Comparison of the effects of treatments on the acidity of the samples (Table 4) showed that Examples where the use of essential oils and antioxidants no other significant differences in the acidity But were significantly different from blank samples containing so that the highest acidity was observed in controls. The lowest acidity of 0.02 was observed in number of samples containing antioxidants (Table 4).

Tests	Means
Blank	3.2668[a]
Essential 0.3%	0.40552[b]
Essential 0.4%	0.37229[b]
Essential 0.5%	0.32081[b]
Control 0.01%	0.28586[b]
Control 0.02%	0.25705[b]

Table 4: Comparison of mean Acidity values in samples was determined by Duncan's multiple (level %5).

Means that have common letters are not statistically significantly different from each other.

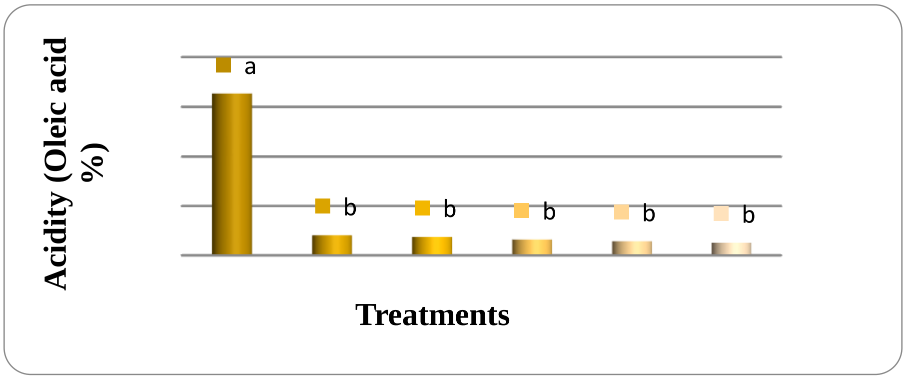

Figure 3: Comparison of mean Acidity values in samples during the storage per.

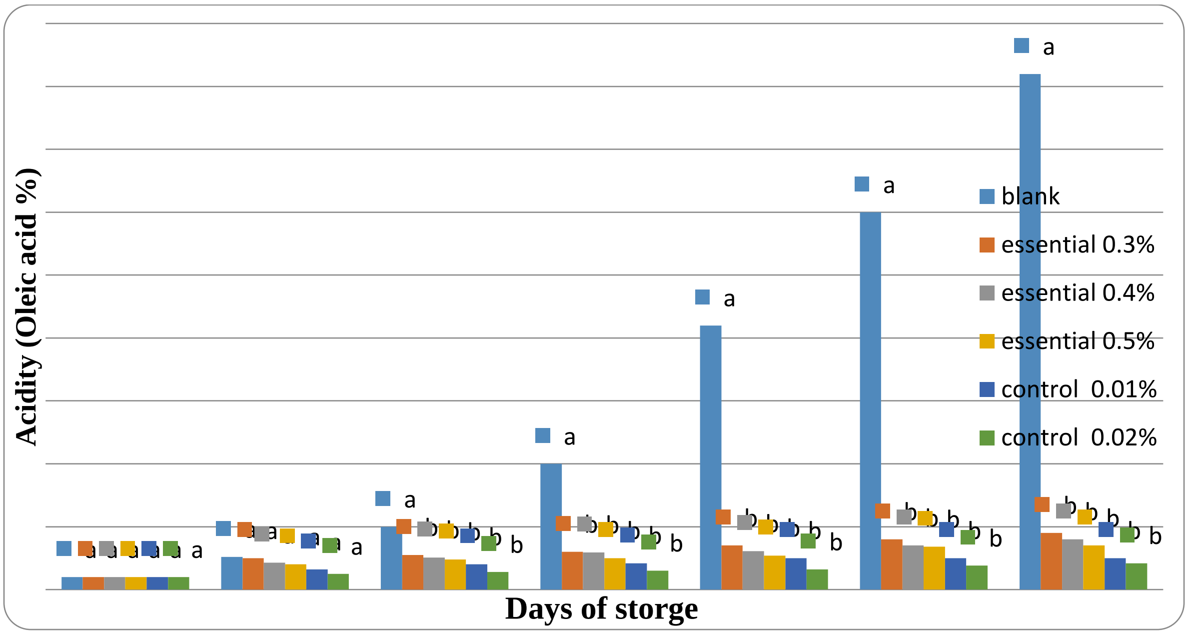

Figure 4: Acidity changes of produced cakes samples during 60 days of storage.

Discussion

In the last few years, an increased attention has been focused on the natural plant extracts and their essential oils, especially those containing phenolic compounds with antioxidant and antimicrobial properties [3,18,19,20]. The addition of natural or synthetic antioxidants to the cake affected the PV, Acidity values by degrees during 60 days storage. These primary oxidation products were broken down a free radical mechanism in which the O-O bond was cleaved on either side of the carbon atom bearing oxygen atom to give the hydroxyl free radical and many secondary products such as alcohols, aldehydes, ketones and malonaldehydes which cause off-flavors [1, 21]. Generally, the higher efficiency of natural antioxidant might be because of the stability of plant oil during baking. These results are in agreement with some previous studies [9,18], which tested the effect of essential Ginger oil of antioxidants and increasing the permeability and leakage of intracellular compared it with TBHQ in oily cake samples. So it was suggested that essential Ginger oil could enhance the antioxidant activity as well as extend the shelf life of the cakes. This result is supported by Yi et al. [22], who found that the enhanced antimicrobial activity was related to the effect of polyphenolic compounds, which could alter the integrity of the outer membrane of microorganisms and disrupt cell wall, increasing the permeability and leakage of intracellular components.

Phenolic antioxidants are proton donors which act as inhibitors for radical chain reactions on autoxidation of organic substrates. Radical scavenging activity (RSA) of coriander seed oil and oil fractions were investigated and stated Coriander seed oil and its fractions exhibited the strong RSA and can use as a natural antioxidant in lipid-containing foods [23]. In another study, by three different bioassays, indicated that extract and oil of leaves and seeds of coriander has strong antioxidant activity and thus, probably prevent oxidative deterioration of food [24]. The extract of coriander leaves was added to refined sunflower and groundnut oils heated to frying temperature and were kept for four weeks. This plant had good antioxidant activity and it is stable at high temperatures and can be used as substitutes for synthetic antioxidant. Other studies reported, antioxidant and antimicrobial effects of chamomile essential oil in cake preparation were evaluated during 75 days of storage. The results showed that, the sample containing chamomile at 0.15%, had good antioxidant and antimicrobial activity in comparison with the control samples (without any synthetic and natural antioxidant and antimicrobial agents) ($p<0.01$). But its activity was less than that of synthetic ones (TBHQ and potassium sorbate as antioxidant and antimicrobial agent) ($p<0.01$). In sensory evaluation, the sample containing chamomile at 0.05% had higher score in flavor, taste and overall acceptability than the samples at 0.15 and 0.1% ($p<0.05$) [25].

Antioxidant activity of plants is mainly due to the presence of phenolic compounds [2]. Some phenolic compounds reportedly have antioxidant effect [9, 26]. When essential oils are used in food production systems amounts required are high and as such they are often higher in quality than would normally be organoleptically acceptable [27]. Our results are in agreement with those of Al-Ismail and Aburjai, McKay and Blumberg, Holly and Patal, Pauli and Tolouee et al. [2,27,28,29], because cakes containing 0.5% essential oil had appropriate antioxidant activity while gained lower score for sensory evaluation.

Conclusion

The above results showed that, the sample containing ginger at 0.5% had better antioxidant activitiy than the samples without any synthetic and natural antioxidant and antimicrobial agents. But its activity was less than that of TBHQ as antioxidant agent (synthetic ones). The results of this study showed that ginger also increase the shelf life, taste and texture of the cake is also effective in improving the properties of the product may increase the satisfaction. Natural antioxidants can increase shelf-life of food products and due to absence of synthetic agents are safe with no side effects on human health.

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