



Effect of storage atmosphere and temperature on the oxidative stability of almond kernels during long term storage



Marzieh Raisi, Mohammad Ghorbani^{*}, Alireza Sadeghi Mahoonak, Mahdi Kashaninejad, Hamed Hosseini

Department of Food Science and Technology, Gorgan University of Agricultural Sciences & Natural Resources, Gorgan, Iran

ARTICLE INFO

Article history:

Received 15 December 2014

Received in revised form

28 February 2015

Accepted 13 March 2015

Available online 24 March 2015

Keywords:

Almond

Oxidative stability

Modified atmosphere packaging

Peroxide value

Conjugated triene

ABSTRACT

In this study, the oxidative stability of almonds (Var. Mamaei) stored for a period of 10 months was examined. The influence of temperature (ambient and refrigeration), type of atmosphere (vacuum, CO₂ and normal air) and the product physical shape (whole kernels and ground) on the oxidation stability were studied under conditions of darkness. Peroxide value (PV) and conjugated trienes (K₂₆₈) were used as indicators for oxidation progress. Odor and flavor were also used for sensory evaluation. According to the results, effects of differing temperature, type of atmosphere or physical shape on PV and K₂₆₈ were significantly different ($P < 0.05$). At the end of storage with PV of 3.41 meqO₂/kg and K₂₆₈ of 3.42 μmol/g the ground almond sample exposed to air at ambient temperature was the least stable, and the whole kernels under vacuum kept in a refrigerator at 4 °C with PV of 0.69 meqO₂/kg and K₂₆₈ of 0.63 μmol/g were the most stable form against oxidation. As a result, with regard to PV, unpacked whole kernels and ground almonds stored at ambient temperature remained fresh for 8–9 and 7 months of storage, respectively, while the same samples in refrigeration had shelf lives above 10 months. The use of modified atmosphere packaging under vacuum and CO₂ provided a shelf life of at least 10 months for all samples irrespective of storage temperature and physical shape of the nuts. Thus modified atmosphere packaging was a most effective method for protecting the almonds from oxidation.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

The almond, *Prunus dulcis* belongs to the subfamily *Prunoideae* of the family Rosaceae (Ahmad, 2010). Almonds and other tree nuts contain dietary fiber, vitamin E, phytosterols, antioxidants, minerals, numerous bioactive substances and several key micro-nutrients that have health benefits and nutrient profile (Dreher et al., 1996; Kris-Etherton et al., 2001; Amarowicz et al., 2005; Blomhoff et al., 2006; Chen et al., 2006). Lipid contents with a range of 44–61% have been reported for almonds in studies of commercially or locally important cultivars grown in different zones (Yada et al., 2011). Healthy fats in nuts contribute to the beneficial effects of frequent nut intake observed in epidemiological studies as they can prevent coronary heart disease, diabetes, and sudden death (Ros and Mataix, 2006). Almonds are consumed as peeled or unpeeled, raw or roasted, whole or ground kernels, and are also used

as components of many foodstuffs including bakery products and confectionery as well as in flavoring agents for beverages and ice-creams (Mexis and Kontominas, 2010). The quality of stored almonds depends mainly on the kernel moisture and fat content, storage temperature, relative humidity (r.h.), oxygen level, type of packaging, the form of stored nut (in-shell or shelled, peeled, roasted, etc.), content of tocopherols and peroxide value. Also the soils and the climates where almonds are grown as well as the almond variety can play an important role in the shelf-life (Garcia-Pascual et al., 2003; Kazantzis et al., 2003). Lipid oxidation is the main cause of off-flavor development in almonds due to their high content of unsaturated fatty acids. Oxygen concentration is one of the most important extrinsic factors affecting nuts lipid oxidation.

Shelf lives of almonds stored in different conditions have been reported by a few researchers (Guadagni et al., 1978; Senesi et al., 1991; Severini et al., 2000; Garcia-Pascual et al., 2003; Mexis et al., 2009; Mexis and Kontominas, 2010). However the effect of packaging almonds under CO₂ and under vacuum at different storage temperatures on oxidative stability of the whole kernels and ground form has not yet been reported.

^{*} Corresponding author.

E-mail address: m.ghorbani@gau.ac.ir (M. Ghorbani).

2. Material and methods

2.1. Almonds

The almonds used in this study were of the *Mamaei* variety, collected from local farms of Shahre-kord, Iran in September 2012. The nuts were cracked by hand cracker and after shelling, half of the kernels were kept intact while the other half was ground using a domestic grinder.

2.2. Packaging and storage

The shelled and ground almonds were prepared to be stored under three different storage conditions: 30 g of the test samples 1) exposed to open air in polypropylene (PP) single use trays without lids, 2) under 95% vacuum, 3) under 95% CO₂ and 5% air. The latter two were carried out using a packaging set with gas injector (Henkman, Model Boxer 42) in low-density polyethylene/polyamide/low-density polyethylene (LDPE/PA/LDPE) laminated sheeting. Flexible pouches, with 75 µm thickness, having an oxygen permeability of 52.2 cm³ m⁻² day⁻¹ atm⁻¹ at 75% r.h., 25 °C, a water vapor permeability of 2.4 g m⁻² day⁻¹ at 100% r.h., 25 °C, and a CO₂ permeability of 189 cm³ m⁻² day⁻¹ atm at 25% r.h., 25 °C (according to the supplier's data) were employed for the experiments. Samples were stored in the dark at two temperature conditions, ambient (c.23 °C) and refrigeration (4 °C, 78% r.h.) for 10 months. All samples were analyzed regularly (every month) to study the oxidation progress. In the ambient storage trials the temperature and r.h. were monitored every day using a digital temperature and moisture meter (Gemini Data Loggers, West Sussex, UK). Duplicate measurements were carried out for chemical analysis. Moisture content, total oil contents, protein, ash, fiber and carbohydrate of fresh almond were determined using standard AOAC (2005) methods.

2.3. Oil extraction

Extraction of oil from the nut samples was carried out using hexane, as described by López-Duarte and Vidal-Quintanar, 2009. The powdered almond (30 g) was stirred for 6 h at room temperature (25 °C) with hexane (200 ml) in the dark. The resulting oil in hexane mixture was filtered through a Whatman No.4 filter paper via a Buchner funnel. The solvent was removed by rotary evaporation (Model RV O5 BASIC, IKA, USA) at 35 °C and the residue was kept in a screw cap bottle until used for chemical analysis.

2.4. Assessment of oxidation

Lipid oxidation was evaluated by measuring a) peroxide value (PV) for primary oxidation products and b) spectrophotometric index (K₂₆₈) in order to evaluate the formation of triple conjugate double bonds (Tienes) for secondary oxidation products. Since hydroperoxides are the primary products of lipid oxidation, their content is often used as an indicator for the initial stages of oxidation during storage. Peroxide value (PV) was determined by the iodometric assay according to IUPAC standard method 2.501 (IUPAC, 1992). The contents of 2,2,4-trimethylpentane as a measure of trienes was measured at 268 nm (K₂₆₈) with a spectrophotometer (PG Instruments, T80 + UV/VIS model, UK) using a quartz cuvette. Conjugated trienes were calculated according to IUPAC Official Method 2.205 based on measured absorbance of a solution containing 0.01–0.03 g of oil in 25 ml of isooctane.

2.5. Sensory evaluation

The sensory panel was selected from a group of 30 untrained people (university students and staff) with ages between 20 and 40 years. For sample evaluation the panelists were served a control reference sample (stored at –18 °C). Samples were randomly coded with 6-digit numbers and were allowed to equilibrate to tasting room temperature (21 ± 1 °C). The panelists rinsed their mouths with water, between each tasting. All samples were supplied in a white plastic cup, containing 30 g of whole kernels or ground almond. Sensory attributes evaluated were odor and flavor since these attributes are directly dependent on lipid oxidation. Scoring was carried out on paper ballots using a 9 point hedonic scale where: 9 = extremely like and 1 = extremely dislike for evaluation of the samples' odor and flavor. Analyses were performed at least twice and a score of 5 was considered as the lower limit of acceptability for odor and flavor. Sensory evaluations were performed bimonthly during a period of 10 months.

2.6. Statistical analysis

Data were subjected to analysis of variance (ANOVA) using JMP 10 software for Windows. Differences were estimated by the analysis of variance followed by Tukey's "honest significant difference" test. Differences were considered significant at *P* < 0.05.

3. Results and discussion

3.1. Chemical composition

Chemical compositions of the nut which were measured on a wet basis are summarized as follows. Moisture, total oil, protein, ash, fiber and carbohydrate contents of the fresh almond measured 3.29 ± 0.5, 48.32 ± 2.45, 18.36 ± 1.54, 3.38 ± 0.51, 5.36 ± 0.98 and 21.37 ± 3.01 g/100 g respectively.

3.2. Storage temperature and relative humidity

Table 1 shows the variations in temperature and r.h. in the storage room during the 10-month period of storage. The average temperature and r.h. for the entire 10-month period were 23 °C and 33.5% respectively. Moisture contents of the whole kernels and ground almonds stored in different conditions did not show significant differences during the 10-month period of storage (average moisture content was determined as 3.25%). The low moisture content of the nut and insignificant fluctuations in the room r.h. during the storage period caused little change in moisture contents of the samples. Also, almonds contain high amounts of fats as well as proteins. Peptides can react with lipids and affect the stability of the nut's membrane which in turn prevents water from being lost

Table 1
Mean psychrometric data of the storage room.

Storage period in months	Mean storage temperature ±0.1 (°C)	Mean relative humidity ± 1 (%)
1	20.6	40%
2	20.2	39%
3	19.3	40%
4	20	40%
5	20.4	38%
6	24	36%
7	24.4	37%
8	26	31%
9	26.2	30%
10	26.1	34%

Download English Version:

<https://daneshyari.com/en/article/4517044>

Download Persian Version:

<https://daneshyari.com/article/4517044>

[Daneshyari.com](https://daneshyari.com)