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Effect of Dehydration on Several Physico-Chemical Properties and the Antioxidant Activity of Leeks (*Allium porrum* L.)

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Abstract

This study investigated the changes in some physico-chemical properties and variations in antioxidant compounds of leeks (cv. 'Inegol-92') caused by the drying process. The dry matter and ash contents of the fresh leek samples were 8.06 and 0.58 g 100 g^{-1}, respectively. The pH of the fresh leek samples was 6.02, and the titritable acidity in terms of citric acid was 0.14%. As expected, application of hot-air drying significantly increased the dry matter and ash values due to removal of water from the leek slices. The rehydration ratio of dried leeks at 45°C was 5.41, and the coefficient of rehydration was 0.47. The contents of chlorophyll *a* and *b* were higher in the dried leeks than in the fresh leeks. The dehydrated leeks showed a high total color difference (ΔE=12.53) mainly due to the effect of temperature on heat-sensitive compounds. As expected, both fresh and dried leek samples exhibited antioxidant activity with fresh leeks showing a higher capacity of antioxidant activity. Drying the leeks resulted in some ascorbic acid loss. Fresh leeks had much higher phenolic values (26.33 mg rutin eq 100 g DM^{-1}) than the dehydrated samples. The antioxidant capacity of leeks was decreased by more than 50% during the drying process. Although being the most applied method of thermal dehydration, hot air drying causes the degradation of sensitive components, which results in significant losses in sensorial and physico-chemical properties of the dried products.

Keywords: antioxidant activity, carotenoids, drying, leek, phenolic compounds

Introduction

Fruits and vegetables have an important role in human nutrition because they contain constituents that have health benefits and anti-disease factors, such as antioxidants and polyphenols. These components are known to scavenge harmful free radicals that are associated with incidence of cancer and heart diseases (Cao *et al.,* 1996; Velioglu *et al.,* 1998).

Leeks (*Allium porrum* L.) are the most commercially produced vegetables in the world. Along with onions and garlic, leeks belong to the *Allium* genus (family *Alliaceae*). Indonesia is the largest producer of leeks in the world, followed by Turkey, France and Belgium. In 2009, leek production in Turkey was 320,000 metric tons, and leeks are the second most exported dried product after tomatoes with 116,000 metric tons (Anonymous, 2008). Fresh leeks are a good source of nitrates, flavonoids, polysaccharides and glucosinolates in addition to numerous organosulfur components contributing to their rich flavor (Ferary and Auger, 1996; Mondy *et al.,* 2002; Lanzotti, 2006). Epidemiological and laboratory studies have suggested that *Allium* vegetables have tumor-inhibitory properties. The consumption of leeks reduces risk of prostate, colorectal, stomach and breast cancer (Bianchini and Vainio, 2001; Hsing *et al.,* 2002). The anti-carcinogenic action may be related to the high content of organosulfur compounds and other biophenols with high antioxidant activity (Steinmetz and Potter, 1996; Fattorusso *et al.*, 2001; Galeone *et al.,* 2006). These bioactive compounds also have antifungal activity (Vergawen *et al.,* 1998; Yin and Tsao, 1999) and inhibitory activity on human platelet aggregation, which can prevent atherosclerosis (Fattorusso *et al.,* 2001). Similar to other agricultural products, leeks are perishable and must either be consumed rapidly or preserved by various methods, such as drying, freezing or cold storage (Magra *et al.,* 2006; Tsouvaltzis *et al.,* 2006). The process of drying is one the oldest methods for food preservation, and drying is a complex process involving heat and mass transfer phenomena, which occurs frequently in most of the food processing industries (Cohen and Yang, 1995; Vega-Gálvez *et al.,* 2009).

Drying brings substantial reduction in weight and volume, which minimizes packaging, storage and transportation costs (Okos *et al.,* 1992; Sobukola *et al.,* 2007). Moreover, products with a low moisture content can be stored at ambient temperatures for longer periods of time due to a considerable decrease in the water activity of the material, reduced microbiological activity and minimized physical and chemical changes (Araujo *et al.,* 2004; Vega-Gálvez *et al.,* 2007). However, food products are sensitive to drying temperature, which can induce degradation (e.g. oxidation, loss of color, shrinkage or loss of texture) and nutritional/functional properties (Attanasio *et al.,* 2004;

Luangmalawat *et al.,* 2008). Therefore, the key factor in successful drying of vegetables depends on the application of heat to lower the moisture content as quickly as possible at a temperature that does not seriously alter the flavor, texture and color of the product. Furthermore, circulation of dry air to absorb and carry off the released moisture is also important for a successful drying.

Several types of dryers and drying methods are commercially used to remove moisture from a wide variety of vegetables. There are three basic types of drying processes as follows: *i*) sun and solar drying; *ii*) batch and continuous atmospheric drying; and *iii*) subatmospheric dehydration. The selection of a particular dryer/drying method depends on the type of raw material, properties of the raw material, desired characteristics of the dried product, restrictions on the operating conditions and cost (Raghavan and Orsat, 2007). Natural sun drying is a slow process when compared to other drying methods, and quality losses are observed mainly in color degradation, microbial growth and poor rehydration (Latapi and Barrett, 2006).

Dried vegetables are more concentrated than any other preserved form of foodstuffs and are tasty, nutritious, lightweight and easy to prepare, store and use (Senadeera *et al.,* 2000). However, the drying process may lead to changes in physico-chemical and functional components. Therefore, the main objectives of this study were to determine the effect of hot air drying on the antioxidant activity and total phenolic content of leeks.

Materials and methods

Leek samples

Fresh and dried leek (*Allium porrum* L.*,* cv. 'Inegol-92') samples were obtained from a commercial company processing dried vegetables in Bursa. The fresh leek samples were washed in tap water, and all inedible parts were removed manually or using a steel knife. Bruised or wounded leeks were discarded.

For the dehydration process, leeks were cut into slices (1 cm x 1 cm; ±0.1 cm) with a cutting machine and placed on stainless steel trays in a forced-air drier in a commercial dehydration plant. The leeks were dried at a temperature of 63°C±2°C for 3 h with an air velocity of 2.5 m/s. The dried leeks were immediately packed in airtight, resealable polyethylene bags and stored at 25°C±1°C. Each experiment was carried out in triplicate.

Chemicals and reagents

All chemicals and reagents used were of analytical quality grade. All samples and standard preparations were performed under subdued light. Contact with air was avoided as much as possible, and most experiments were carried out under a nitrogen atmosphere. Ascorbic acid and lycopene were purchased from Sigma-Aldrich (St. Louis, MO, USA). Gallic acid was purchased from CQA Quimica (Campinas, SP, Brazil). All other reagents, including Folin-Ciocalteu reagent, potassium hydroxide, ethanol absolute, methanol, tetrahydrofuran, hexane, acetone, petroleum ether (40 to 65°C), di-tert-butyl-methylphenol (BHT), sodium chloride and magnesium carbonate, were purchased from Merck (Darmstadt, Germany).

Physico-chemical analysis

For each physico-chemical analysis, at least 300 g of fresh leeks was chopped in a domestic chopper (model K 1191, Arcelik Inc., Turkiye), obtaining a homogenized leek extract that was used in all analyses and stored at -20°C until analysis. Three independent samples were prepared, and each sample was analyzed in triplicate.

Rehydration experiments were carried out in distilled water at 45°C. Dried leek samples (10 g) were added to 100 ml of water and mixed thoroughly. The samples were allowed to rehydrate for 5 h, and the rehydration temperature was kept constant using a water bath with adjustable temperature control. At the end of the rehydration period, the water was drained, and the weight and moisture content were determined. The rehydration ratio was expressed as a ratio of water absorbed by the dried sample (W_r) to the weight of the dried sample (W_d) (rehydration ratio, R_r) (Eq. 1). The coefficient of rehydration (CR) representing water absorption during rehydration was determined as suggested by Rangana (1986) (Eq. 2). The following equations were used to calculate the rehydration ratio and coefficient of rehydration:

$$R_r = W_r/W_d \qquad \text{(Eq. 1)}$$

$$CR = \frac{D_{wt} \times (100 - A)}{(W_d - B) \times 100} \qquad \text{(Eq. 2)}$$

where D_{wt} is the drained weight of rehydrated sample; A is the moisture of sample before drying (% wet basis); W_d is the weight of dried sample; and B is the moisture present in the dried sample taken for rehydration (% wet basis).

Contents of moisture, ash, pH and titritable acidity (expressed as % citric acid) were measured according to the Association of Office Analytical Chemists (AOAC, 2000). Dried leeks were analyzed after rehydrating at 25°C for 3 h.

The CIELAB coordinates, including L^* (color lightness), a^* (position on the green/red axis; blue/green and red/purple hue component), and b^* (position on the blue/yellow axis; yellow/blue hue component), were measured on randomly selected locations of fresh (along the white to green cut) and dried leeks (where the white and green cuts are mixed) using a Minolta Chromameter CR-300 (Minolta Camera Co. Ltd., Osaka, Japan). The chromameter consisted of a measuring area of 8 mm in diameter, and diffuse illumination/0° viewing was used. The measurements were taken with a pulsed xenon lamp. Color changes in

the leek samples due to drying were evaluated through the total color difference (ΔE; Eq. 3) parameter as follows:

$$\text{TCD } (\Delta E) = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2} \qquad \text{(Eq. 3)}$$

where ΔL is the difference of lightness ($L\text{-}L_0$); Δa is the difference of redness ($a\text{-}a_0$); and Δb is the difference of yellowness ($b\text{-}b_0$).

Quantitative analysis of chlorophyll a and b in leeks

Fresh and dried leek samples (3 g) were homogenized with quartz sand, and 20 to 25 ml of 85% acetone was added followed by additional homogenization. The homogenate was then filtered into a 100 ml volumetric flask. The residue was washed with acetone approximately three times until the extract was clear, and 85% acetone was added to a final volume of 100 ml. The samples were kept in the dark until spectrometric analyses. The absorbance of the extract was measured at 663, 645, 652 and 750 nm (reference=acetone). The E_{750} value was subtracted from the E_{663} (chlorophyll *a*), E_{645} (chlorophyll *b*) and E_{652} (total chlorophyll) values. The corrected values were used for the determination of chlorophyll *a*, chlorophyll *b* and total chlorophyll concentrations in the leeks (Wellburn, 1994; Butz *et al.,* 2002).

Quantitative analysis of antioxidant compounds

L-Ascorbic acid

Ascorbic acid content was determined using the 2,6-dichlorophenol-indophenol (0.0012%) method at 520 nm described by the Association of Official Analytical Chemists (AOAC, 1996). *L*-ascorbic acid was used to prepare a standard solution (1 mg ml^{-1}). The ascorbic acid concentration was calculated by comparison with the standard and expressed as mg 100 g $mass^{-1}$.

Total phenols

Determination of total phenolic content was based on the method described by Spanos and Wrolstad (1990) with some modifications. Briefly, 150 µl of extract, 2400 µl of nanopure water, and 150 µl of 0.25 N Folin-Ciocalteu reagent were combined in a plastic vial and mixed well using a vortex. The mixture was allowed to react for 5 min followed by the addition of 300 µl of a saturated Na_2CO_3 (1 N) solution. Distilled water was added to a final volume of 10 ml, and the samples were mixed thoroughly. The solution was incubated at room temperature (23°C) in the dark for 2 h. The absorbance readings of the reaction mixtures were measured at 725 nm using a spectrophotometer (Hewlett Packard 8452A, Diode Array, USA) against a blank. The results were expressed in Gallic acid equivalents (GAE; mg 100 g fresh $mass^{-1}$) using a Gallic acid (GA) standard curve (0-0.1 mg ml^{-1}). The results were expressed as milligram GAE per gram of fresh weight. Additional dilutions were carried out if the measured absorbance value was greater than the linear range of the standard curve.

Lycopene content

The extraction and detection of lycopene was carried out by a modified method described by Heinonen *et al.* (1989) and Konings and Roomans (1997). Fresh leeks were homogenized in a blender. Aliquots of sample homogenates (1.5 or 5 g) were weighed into a 250 ml separation funnel. Lycopene was extracted with methanol/tetrahydrofuran (THF) (1:1; v/v) using Na_2S0_4 and $MgC0_3$ as desiccants until colorless. The samples were extracted at least two or three times to remove all of the lycopene from the leeks. Supernatants were collected in 500 ml stoppered conical flasks. The concentrate was saponified at room temperature for 2 h in the dark with 12.5 ml of potassium hydroxide (50% KOH solution) in a mixture of petroleum ether (50 ml) and water (20 ml) until the petroleum ether phase was colorless. Before solvent extraction, the saponification extract was diluted with a solution of sodium chloride (10% in H_2O; w/v). After addition of NaCl, unsaponified and saponified solutions were extracted with 50 ml of petroleum ether. From the saponified samples, combined petroleum ether portions were washed with 100 ml portions of water until the reaction pH was neutral. Organic layers were evaporated to dryness. The residue was dissolved by ultrasonic agitation in methanol/THF (1:1; v/v) with BHT as the antioxidant, and the sample was then filtered through a 0.45 µm filter. For dried samples, the extraction and preparation of lycopene was carried out after rehydration of the dried samples at 45°C for 5 h. Both extracts of fresh and dried leeks were analyzed with the nonaqueous reversed-phase (NARP) HPLC system (Varian Vista 5500 liquid chromatographs, Varian) equipped with Varian UV-200 detectors and Varian 4270 integrators. In the NARP chromatography, the Zorbax ODS column (5 µm, 250 mm x 4.6 mm; i.d.; DuPont) was preceded by a guard column (5 cmx0.46 cm; i.d.) packed with Bondapak AX/Corasil (37-50 pm) (Waters). The elution mixture was a mixture of methanol and THF (95:5; v/v), and the flow rate was 0.8 ml min^{-1}. Lycopene was detected at 450 nm, and the columns were run at 30°C. Approximately 20 µl of both standards and samples were injected into the system. The separated peaks were recorded, and the peak areas were determined. The lycopene concentrations in the samples were identified by comparing their retention times with those of authentic standards.

Total antioxidant capacity (FRAP assay)

The ferric reducing antioxidant power (FRAP) assay was done according to the method adapted from Benzie and Strain (1999). The working FRAP reagent was freshly prepared as follows: 2.5 ml of a 10 mM 2,4,6-trispyridyl triazine (TPTZ) solution in 40 mM HCl 2.5 ml of 20 mM ferric chloride and 25 ml of 0.25 M acetate buffer

(pH 3.6). An aliquot (150 µl) of the sample was added to 300 µl of distilled water and allowed to react with 2.85 ml of the FRAP solution for 30 min in the dark followed by the addition of 3 ml of the FRAP reagent. Readings of the colored product (ferrous tripyridyltriazine complex) were then taken at 593 nm against a blank. The standard curve was constructed using ferrous sulfate standard solutions over the linearity range of 0.2 to 1.0 mmol l^{-1}. The antioxidant activities of the samples were determined from the standard curve of ferrous sulfate using their measured absorbance values. The results were expressed in mmol l^{-1}. Additional dilutions were carried out if the measured FRAP value was greater than the linear range of the standard curve.

Statistical analysis

Results were expressed as mean values ± standard deviations. Each analysis assay was done three times from the same sample to determine reproducibility. Analysis of variance (ANOVA) was used to test any difference in properties of fresh and dried leek samples. Duncan's new multiple range test was used to determine significant differences. Correlations among data obtained were calculated using Pearson's correlation coefficient (r).

Results and discussion

Physico-chemical analysis

The dry matter and ash contents of fresh leek samples were 8.06 and 0.58 g 100 g^{-1}, respectively. The pH of the fresh leek samples was 6.02, and the titritable acidity in terms of citric acid was 0.14% (Tab. 1.). As expected, application of hot air drying significantly increased the dry matter and ash values due to removal of water from the leek slices. The titritable acidity of the leeks was significantly increased by the drying process, whereas the pH values were decreased. The method of drying is one of the important factors affecting the final quality of food products. Although being the most applied method of thermal dehydration, hot air drying causes the degradation of sensitive components, which results in significant losses of sensorial and physico-chemical properties of the dried products.

The rehydration ratio of the dried leeks at 45°C was 5.41, and the coefficient of rehydration was calculated as 0.47. There are two processes during rehydration as follows: absorption of water and leaching of solutes. An observed increase in mass is a net result of the two rehydration processes. Assuming that perfect rehydration yields a product with similar proximate composition of the raw material, rapid and complete rehydration is an essential quality parameter of any dried product. Singh *et al.* (2006) and Doymaz (2008) examined the effect of water temperature on rehydration capacity, and they stated that rehydration capacity at a high rehydration temperature is improved due to the interaction between temperature and cell walls or tissues. Taiwo *et al.* (2002) reported that water uptake of dried apple slices is higher at rehydration temperatures greater than 90°C, which promote faster diffusion of water into the product through the swelling and plasticizing of cell membranes.

Color changes

Color, an important attribute in food products, can be assessed either by a sensory panel or using analytical instrumentation, and it is the quality parameter immediately perceived by the consumer. Color can also be a measurement of reaction extensions in food products since formed and/or degraded compounds may contribute to a specific coloration. The ANOVA analysis indicated significant differences ($p<0.05$) in the color characteristics between the dehydrated and fresh leeks (Tab. 2.).

The total chlorophyll content was 156.05 mg kg^{-1} in the dried leeks and 90.81 mg kg^{-1} in the fresh samples. The chlorophyll *a* and *b* contents were higher in the dried leeks when compared to the fresh leeks mainly in accordance with the increase in dry matter.

The changes in the L^*, a^* and b^* values were significant in the dehydrated leeks. The behavior of the L^* coordinate, which represents lightness, was 66.95 in the fresh leeks and 60.57 in the dried leeks. There was a clear darkening of dried leeks, which was demonstrated by a decrease in the L/L_0 value. Hot air drying resulted in a decreased L^* value (ΔL=6.38) and an increased a^* value (Δa=-10.65) for the dried samples as compared with the fresh samples. However, the b^* value (Δb=1.71) of the dried samples was

Tab. 1. Proximate composition of fresh and dried leek samples (means; n=2)

Sample	Dry matter (g 100 g^{-1})	Ash (g 100 g^{-1})	pH	Titritable acidity (%)	Rehydration ratio (R_r)	Rehydration coefficient (R_{cf})
Fresh	8.06±0.26	0.58±0.15	6.02±0.01	0.14±0.01	----	----
Dried	92.86±0.38	6.29±0.10	5.02±1.71	1.60±0.00	5.41	0.47

Tab. 2. Color characteristics of fresh and dried leek samples (means; n=2)

Sample	Chlorophyll (mg kg^{-1})			Chromaticity values			
	a	*b*	Total	L^*	a^*	b^*	ΔE
Fresh	36.23 ± 5.82	40.78 ± 4.65	90.81 ± 10.33	66.95 ± 2.81	-14.84 ± 3.94	29.24 ± 6.93	-----
Dried	79.73 ± 5.94	54.16 ± 2.19	156.05 ± 9.26	60.57 ± 3.20	4.19 ± 0.76	27.53 ± 2.71	12.53

Tab. 3. Changes in antioxidant components of fresh and dried leek samples (means; n=2)

Sample	Ascorbic acid (mg 100 g DM^{-1})	Total phenols (mg rutin eq 100 g DM^{-1})	Lycopene (mg kg^{-1})	Total antioxidant capacity (μmole TEAC 100 g DM^{-1})
Fresh	7.75±1.03	116.43±2.30	2.66	223.29±24.59
Dried	12.85±2.77	26.33±1.35	2.77	95.57±1.06

similar to the b^* value of the fresh samples. The overview of the color changes in the samples was observed by the total color variation value (ΔE). As expected, the dehydrated leeks showed a high ΔE (12.53) mainly due to the effect of temperature on heat-sensitive compounds, such as carbohydrates, proteins, and vitamins, which cause color degradation in fresh foods in addition to browning reactions and pigment destruction with drying processes (Maskan *et al.,* 2002; Hawlader *et al.,* 2006). Similar observations have been reported by Prothon *et al.* (2001) for apples, Di Scala and Crapiste (2008) for red peppers, Koca *et al.* (2007) for carrots, Vega-Gálvez *et al.* (2008) for red peppers.

Antioxidant compounds and total antioxidant capacity

As shown in Tab. 3., both fresh and dried leek samples exhibited antioxidant activity. As expected, fresh leeks had higher antioxidant capacity than the dehydrated samples. Ascorbic acid and phenolic compounds are the main contributors to the hydrophilic antioxidant activity of vegetables (Toor *et al.,* 2005). Decreases in both total phenolics and ascorbic acid during processing are likely to be responsible for the observed decreases in the antioxidant activity in the dried leeks.

Tab. 3 shows the amount of ascorbic acid in the dehydrated and fresh leek samples. Ascorbic acid content (12.85 mg 100 g DM^{-1}) was found higher in the dried leeks than in the fresh leeks (7.75 mg 100 g DM^{-1}).

Ascorbic acid, a water-soluble vitamin, is rapidly synthesized from carbohydrates, and variations in ascorbic acid contents occur due to the different species of plants, ripeness, place of origin, storage conditions, processing and handling (Moser and Bendich, 1991; Ottaway, 1993). As expected, the hot air drying had a statistically significant influence on the ascorbic acid contents in the leeks. The change of ascorbic acid was expressed as percentage of retention. Drying the leeks resulted in some ascorbic acid loss as compared to the fresh leeks. The ascorbic acid retention was 60% for hot-air drying. It is difficult to retain ascorbic acid during the dehydration of foods because ascorbic acid is susceptible to heat (Erdman and Klein, 1982; Takeoka *et al.,* 2001; Dewanto *et al.,* 2002). In general, increased levels of ascorbic acid degradation result from slow drying methods (Nindo *et al.,* 2003). The loss of ascorbic acid is dependent on many factors including the presence and type of heavy metals, such as copper and iron, in addition to light, pH, water activity level in the product, dissolved oxygen and drying temperature (Ottaway, 1993; Villota and Hawkes, 1992). The loss of vitamin C, which is a thermo-sensitive compound, is likely due to the elevated processing temperature (Hawlader *et al.,* 2006; Di Scala and Crapiste, 2008; Vega-Gálvez *et al.,* 2008; Sigge *et al.,* 2001) and exposure period to heat (Jayaraman and Gupta, 1995; Maharaj and Sankat, 1996).

As in Tab. 3, the fresh leeks had higher phenolic contents (116.43 mg rutin eq. 100 g DM^{-1}) when compared to the dehydrated samples (26.33 mg rutin eq 100 g DM^{-1}), which may be due to the breakdown of phenolics during dehydration (Crozier *et al.,* 1997). Meyer *et al.* (1998) stated that the antioxidant activities of phenolics in different vegetables markedly vary and that it may be due to the differences in the phenolic compound structures primarily related to their hydroxylation and methylation patterns.

The HPLC analysis in this study indicated that there was no significant difference in lycopene quantities between dehydrated leeks and fresh leeks. Dehydrated samples contained similar lycopene values as fresh leeks with values of 2.77 and 2.66 mg kg^{-1}, respectively. Previous studies have stated that longer drying times and higher temperatures result in comparable losses in color and contents of bioactive compounds. Zanoni *et al.* (1999) reported that the presence of both light and oxygen leads to a significant loss of lycopene during the processing of tomatoes. Oxygen permeability, light exposure, and presence of some metals in the processing system favor the isomerization and oxidation of lycopene during dehydration (Shi *et al.,* 1999). Dewanto *et al.* (2002) stated that an increase in the extractable lycopene content in processed products when compared to fresh tomatoes is likely caused by lycopene being mostly attached to the skins and insoluble fiber portions of the tomatoes and that heat processing may cause an increased release of lycopene from the cell matrix.

As for the antioxidant activity measured with the FRAP method, the antioxidant activity as higher in the dried leeks than in the fresh samples (Tab. 3.). The antioxidant capacity decreased by more than 50% during the drying process of the leeks; this has also been observed by Kevers *et al.* (2007). While heat applied during the dehydration process is the main cause of the depletion of antioxidant compounds, heat can also induce the formation of compounds, such as melanoidins in the Maillard reaction, which can contribute to the antioxidant activity (Nicoli *et al.,* 1997; Anese *et al.,* 1999). Vegetables contain other antioxidants in addition to phenolic compounds and ascorbic acid, such as proteins, β-carotene, α-tocopherol, and lycopene, which may have a role in the increase of the total antioxidant activity. Moreover, heat application can increase the level of free flavonols with the antioxidant ef-

fect (Stewart *et al.*, 2000). Especially in the case of lycopene, recent studies have shown the potential antioxidant activity of this compound. Lycopene can almost prevent oxidative damage to DNA and liver necrosis in rats (Matos *et al.,* 2001), and it can reduce the risk of prostate cancer (Giovannucci *et al.,* 2002).

Conclusions

This study showed that hot air-dried leeks retained their antioxidant activity. Hot air drying also resulted in the degradation of heat-sensitive components leading to some physicochemical, sensorial, functional and nutritional quality losses. The dehydrated leeks showed a high color change particularly due to degradation of heat-sensitive colour compounds in addition to the browning reactions and pigment destruction. Fresh and dried leek samples exhibited antioxidant activity. However, the antioxidant capacity decreased by more than 50% in the dried leek samples. Fresh leeks had a much higher phenolic content as compared to the dehydrated leeks, which was mainly due to the breakdown of phenolics during dehydration.

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