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Effect of roasting on some nutrients of hazelnuts (*Corylus Avellena* L.)

Murat Özdemir *, Filiz Açkurt, Mustafa Yildiz, Gül Biringen, Türcan Gürcan, Mahmut Löker

Food Science and Technology Research Institute, TUBITAK-Marmara Research Center, PO Box 21, 41470, Gebze, Kocaeli, Turkey

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Abstract

Changes in total amino acid composition, thiamine and riboflavin contents, peroxide value and free fatty acid contents were determined in roasted Giresun and Akçakoca hazelnuts. The results showed that roasting significantly affected peroxide value, free fatty acids, thiamine, riboflavine and total amino acid composition of Akçakoca and Giresun hazelnuts. Riboflavin level decreased by almost 30% in Akçakoca hazelnuts and 18% in Giresun hazelnuts. Above 120°C, more than 50% of thiamine was lost. Amino acid levels in Akçakoca and Giresun hazelnuts generally decreased as the roasting temperature increased. Lysine diminished $<6\%$ in samples of roasted Giresun hazelnuts. In Akçakoca hazelnuts, a higher lysine loss was observed (31%) in the sample roasted at 126°C for 45 min.

1. Introduction

Turkey is the main hazelnut producer of the world with about 600 000 ton per year, followed by Italy, USA, and Spain. Total export revenue of Turkey from hazelnut and hazelnut products is about 1 billion US$ annually (Akova, 1998). Roasting is the main process of hazelnut manufacturing, as with other nuts and beans. Flavour, colour, texture and appearance of nuts are significantly enhanced by roasting. Compared to raw nuts, the roasted product has a delicate, uniquely nutty and widely appreciated taste. Roasting also removes the pellicle of hazelnut kernels, inactivates enzymes, and destroys undesirable microorganisms and food contaminants (Atakan & Bostan, 1998; Buckholz, Daun & Steir, 1980; Eichner, Schnee & Heizler, 1994; Hashim & Chaveron, 1996; Jayalekshmy & Mathew, 1990; Jinap, Wan-Rosli, Russly & Nordin, 1998; Jung, Bock, Back, Lee & Kim, 1997; Köksal & Okay, 1996; Mayer, 1985; Moss & Otten, 1989; Özdemir & Devres, 2000a, 2000b, 2000c; Pattee, Giesbrecht & Isleib, 1995; Perren & Escher, 1996a, 1996b; Richardson & Ebrahem, 1996; Sanders, Vercelotti, Blankenship, Crippen & Civille, 1989; Shimoda, Nakada, Nakashima & Osijima, 1997).

Thermal treatment of nuts in roasting processes leads to changes in the carbohydrates, proteins, fats or physiologically active substances, such as vitamins or essential amino acids in accordance with the temperature–time treatment of the product. Proteins and amino acids can be cross-linked or decomposed; fats can be decomposed or oxidised; nutritional substances, such as vitamins and amino acids, may be destroyed or they can be blocked by reactions with other ingredients during roasting. Oligosaccharides can react twice, decompose hydrolytically or caramelise. Amadori compounds, reaction products of carbohydrates with amino acids, are built as precursors of the Maillard reaction. All chemical reactions contribute to the change in the original quality properties of a dry product, e.g. colour, texture, aroma, nutritional value and shelf-life (Ames, 1988; Buckholz et al., 1980; Gardner, 1979; Jinap et al., 1998; Kato, Doi, Tsuhgita, Kosai, Kamiya & Kurata, 1981; Labuza & Braisier, 1992; Lund, 1977; Mayer, 1985; Moss & Otten, 1989; Muller and Bauer, 1990; Nicoli, Elizalde, Pitotti & Lerici, 1991; O'Brien & Morrissey, 1989; Perren & Escher, 1996a, 1996b; Troller, 1989).

Although effects of roasting conditions on the oil stability, colour and moisture content of roasted hazelnut

* Corresponding author.
E-mail address: muratozdemire@usa.net (M. Özdemir).

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have been previously studied (Köksal & Okay, 1996; Özdemir & Devres, 2000a, 2000b, 2000c; Perren & Escher, 1996a, 1996b; Richardson & Ebrahem, 1996), there are limited studies on the effects of roasting on nutritive value of hazelnuts (Kirbaşlar, 1998). This information is necessary for improvement/design of roasting processes for maximising nutrient retention (Ayatse, Eka & Ifon, 1983). Therefore, roasted Giresun and Akçakoca hazelnuts were analyzed in terms of total amino acid composition, thiamine and riboflavin contents, as well as peroxide value and free fatty acid (FFA) content.

2. Materials and methods

2.1. Sampling

Roasted Giresun and Akçakoca hazelnut samples were supplied from two different hazelnut processing factories, which were located in the Giresun and in the Akçakoca region of Turkey. Giresun hazelnuts are composed mainly of Tombul and Kalinkara varieties while Akçakoca hazelnuts are composed mainly of Tombul, Mincane, Foşa and Çakildak varieties (Özdemir & Devres, 1999). The roasting conditions of the samples are given in Table 1. Akçakoca hazelnuts were roasted with a industrial nut roaster, having one heating section (Proctor, Sweden). Giresun hazelnuts were roasted with a industrial nut roaster, having two heating sections so that two different roasting temperatures could be used during roasting. After steady state conditions were obtained during the roasting, samples of about 2 kg were taken from the roaster outlet.

2.2. Chemical analysis

Thiamin (Vitamin B_1) and riboflavin (Vitamin B_2) levels were determined by using a Technicon Autoanalyser A II according to the standard methods of the instrument. Oils were extracted from the samples as described in IUPAC (1979) using light petroleum ether (b.p. 40–60°C). The extracted oils were kept at −30°C until analysed. Peroxide value and free fatty acid content were determined by using standard methods of AOAC (1980). Total amino acid composition was determined with a Biotronik LC 5001 amino acid analyzer according to the standard methods of the instrument.

2.3. Statistical analysis

One way analysis of variance (ANOVA) and multiple range least significant difference (Duncan) test were carried out by using a statistical package program (SPSS ver. 5.0) for $P<0.05$ significance level.

3. Results and discussion

Results of peroxide value (PV), FFA content, thiamine and riboflavin contents are shown in Fig. 1 for Akçakoca and Giresun hazelnuts. ANOVA indicated that roasting conditions significantly affected PV ($P<0.009$) and FFA ($P<0.005$) of Akçakoca hazelnuts, and PV ($P<0.0001$) and FFA ($P<0.003$) of Giresun hazelnuts. As the degree of roasting increased, PV of Akçakoca hazelnuts generally decreased but their FFA increased (Fig. 1a). PV of Giresun hazelnuts decreased for roasting temperatures below 158°C but significant increase was observed at higher temperatures (Fig. 1a). FFA of Giresun hazelnuts decreased as the roasting temperature increased (Fig. 1b). Higher PV and lower FFA with increasing roasting degree were also observed in the study of Mostafa (1987) for peanuts. PV in the samples was considerably lower than the flavour quality endpoint (8 meq/kg) (Braddock, Sims & O'Keefe, 1995). FFA in the samples were lower than 0.7%, which was an indication of onset of rancidity (Hadorn, Keme, Kleinert & Zürcher, 1977; Keme, Messerli, Shejbal & Vitali, 1983; Radtke & Heiss, 1971).

PV and FFA are lipid oxidation products of the free radical reaction mechanism (autoxidation), or hydrolytic rancidity. Once initiated, the autoxidation reaction

Table 1
Roasting conditions, roasting degree, moisture and protein content of raw and roasted hazelnut samples

Region	Code	Roasting condition	Roasting degree	Moisture[a]	Protein[ab]
Akçakoca	Akça-0	Raw		1.38±0.22	14.7±0.2
	Akça-1	104°C—30 min	Peeling	1.25±0.23	13.0±0.1
	Akça-2	116°C—30 min	Peeling	0.67±0.12	13.5±0.2
	Akça-3	126°C—45 min	Pale yellow	0.07±0.01	12.8±0.1
Giresum	Gire-0	Raw		1.20±0.05	15.2±0.3
	Gire-1	121°C—10 min, 111°C—10 min	Peeling	0.86±0.10	14.8±0.2
	Gire-2	158°C—12 min, 148°C—12 min	Golden yellow	0.32±0.14	14.7±0.1
	Gire-3	162°C—14 min, 152°C—14 min	Dark	0.54±0.02	14.4±0.1

[a] % db Mean of the three determinations ± standard deviation.
[b] Nitrogen (%, db)×5.30.

is self-propagating, forming more hydroperoxide and more free radical and/or breakdown products, depending on conditions. The hydroperoxides are active oxidants and have a tendency to react with amino acids, proteins, vitamins, enzymes or other compounds during storage and processing to form carbonyl compounds such as mono-carboxylic acids, aldehydes, ketones, hydrocarbons, esters and lactones. The hydroperoxides are also not heat-stable and decomposed to carbonyls and hydroxy acids under heat treatment. Therefore, PV is subject to fluctuation during processing or storage. (Chang, Peterson & Ho, 1978; Gardner, 1979; Liu & White, 1992; Livingston, Catharina & Charlotte, 1973; Mostafa, 1987; St. Angelo & Ory, 1975; St. Angelo, Kuck & Ory, 1979; Stevenson, Genser & Eskin, 1984; Ünal & Işçioğlu, 1992). Moreover, reaction of the amino acids and proteins with these degradation products impairs flavour, and/or lowers nutritive value of food products and causes staling (e.g. reaction of lysine and threonine with the oxidized linoleic acid) and toughening (Anon., 1993; Gardner; Senter, Forbus, Nelson, Wilson & Horvat, 1984; St. Angelo & Ory, 1975; St. Angelo et al., 1979). They have also been associated with possible carcinogenic effects and many diseases (Duthie, 1993; Fourie & Basson, 1989; Pariza, 1990).

Hydrolytic rancidity involves enzyme-catalyzed (lipases, esterases and peroxidase) lipid oxidation reactions. Although roasting substantially reduces activity of lipase and eases activity of peroxidase (Grosch, Laskawy & Senser, 1983), esterase is heat stable and may be still active, even after roasting (Keme et al., 1983). Low FFA content, above a roasting temperature of 120°C for both Akçakoca and Giresun hazelnuts, can be attributed to inactivation of hydrolytic enzymes.

Thiamine content of Akçakoca and Giresun hazelnuts significantly decreased as the degree of roasting increased ($P<0.0001$; Fig. 1c). Above 120°C, 50% of thiamine was destroyed and even more at higher temperatures (Fig. 1c).

Riboflavin contents were also significantly affected by roasting degree for Akçakoca hazelnuts ($P<0.0001$) and Giresun hazelnuts ($P<0.015$). Riboflavin content decreased most (30%) in Akçakoca and 18% in Giresun hazelnuts. Duncan's test indicated that there was a significant difference between riboflavin contents of roasted Akçakoca hazelnuts (Akca-1, Akca-2, and Akca-3; Fig. 1d). There was, however, no significant difference between riboflavin contents of roasted Giresun hazelnuts (Gire-1, Gire-2, and Gire-3; Fig. 1d).

Losses in thiamine and riboflavin levels could be related to thermal destruction. Heat-lability of thiamine is higher (Ayatse et al., 1983). Decreases in thiamine (26.8%) and riboflavin (32.4%) contents were also

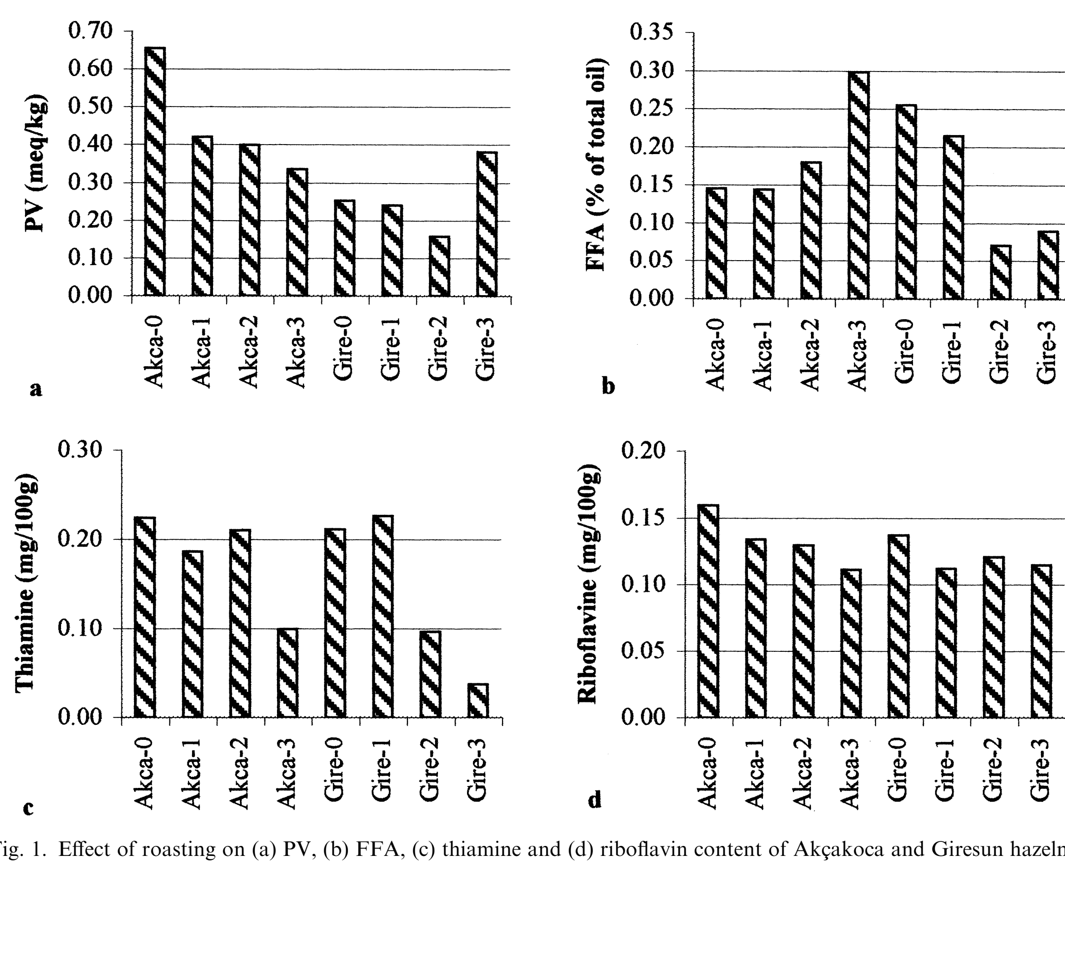

Fig. 1. Effect of roasting on (a) PV, (b) FFA, (c) thiamine and (d) riboflavin content of Akçakoca and Giresun hazelnuts.

reported for roasted maize by Ayatse et al., Livingston et al. (1973) reported 0–80% thiamine and 0–75% riboflavin losses during processing of foods. They also stated that low temperature–long time treatments caused less thiamine losses than high temperature–short time treatments.

Amino acid contents of Akçakoca and Giresun hazelnuts generally decreased as the roasting degree increased (Figs. 2 and 3). Only methionine content increased 154% in Akça-1 and 187% in Akça-3 treatments (Fig. 2a). Methionine levels increased 14% in Gire-1 treatment and 50% in Gire-2 treatment (Fig. 3a). Histidine and phenylalanine levels increased in only Akça-2 treatment (Fig. 2b). For Akçakoca hazelnuts, lysine loss was 31% in Akça-3 treatment. Except for methionine and histidine, losses in total amino acids of Giresun hazelnuts was below 10% (Fig. 3). In spite of higher roasting temperature, no marked losses of lysine (< 6%) were observed in Giresun hazelnuts, which may be due to the method of roasting (two stage roasting; Table 1).

The essential amino acid levels were higher than FAO reference values for Akçakoca and Giresun hazelnuts (Table 2). Cystine (278 mg/100 g in Giresun hazelnuts, and 228 mg/100 g in Giresun hazelnuts), has not been previously determined in Turkish hazelnuts (Baş, Ömeroğlu, Türdü & Aktaş, 1986).

Ayatse et al. (1983) also reported a decrease in the levels of most amino acids, and an increase methionine (36%) and proline (15%) in roasted maize. Among the essential amino acids, lysine levels decreased 26.7% in roasted maize (Ayatse et al., 1983). Kirbaşlar (1998) reported a significant loss of total amino acids of hazelnuts roasted at 135°C for longer than 20 min. The losses were higher in essential amino acids than to non-essential amino acids. Losses in essential amino acids were 10 and 61.7% in 20 and 30 min roastings, respectively. Losses in non-essential amino acids were 5 and 22%, in 20 and 30 min roastings, respectively (Kirbaşlar, 1998).

A loss of nitrogen was also observed in Akçakoca and Giresun hazelnuts (given as protein levels in Table 1). Some amine nitrogen and, rarely, amide nitrogen loss may be expected during roasting, which may cause a slight increase in amino acid content per unit of total nitrogen (Ayatse et al., 1983). Only methionine and, in some samples, histidine and phenylalanine contents, increased but all the others decreased during roasting. The increase in methionine content was more than anticipated. These results were also supported by the results of Ayatse et al. (1983). Losses in hydrophilic amino acids could be due to thermal destruction (Ayatse et al., 1983). Kashani and Valadon (1984) reported that total amino acids of pistachios were not affected much during roasting but lysine, arginine and

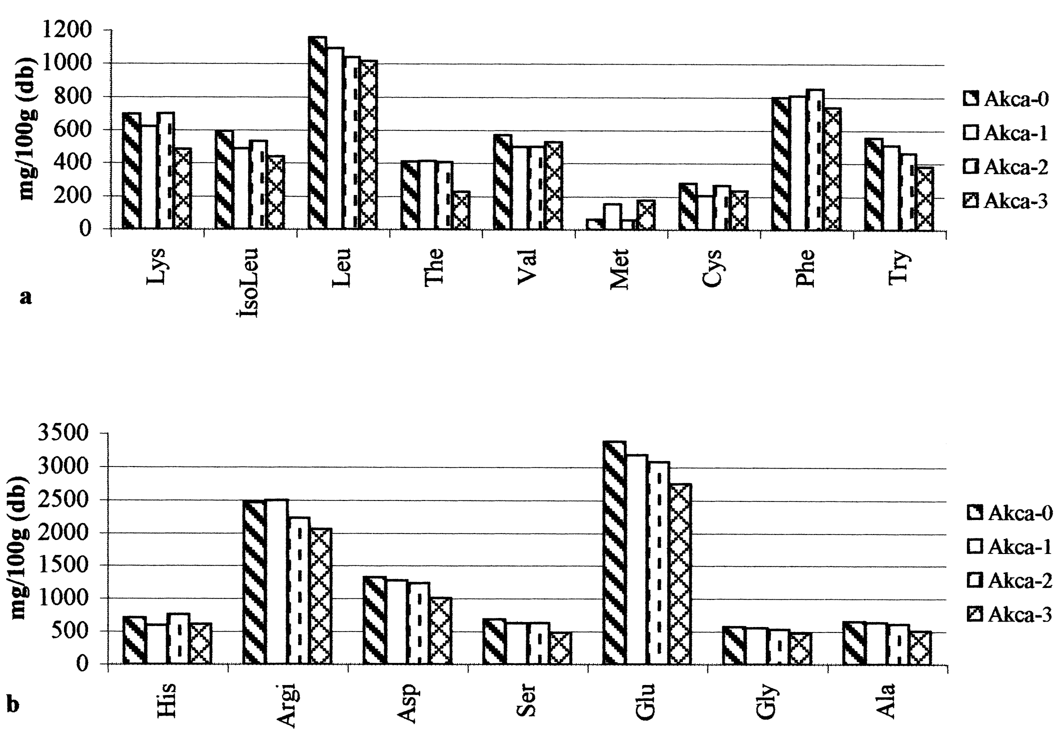

Fig. 2. Effect of roasting on (a) essential amino acid and (b) non-essential amino acid composition of Akçakoca hazelnuts.

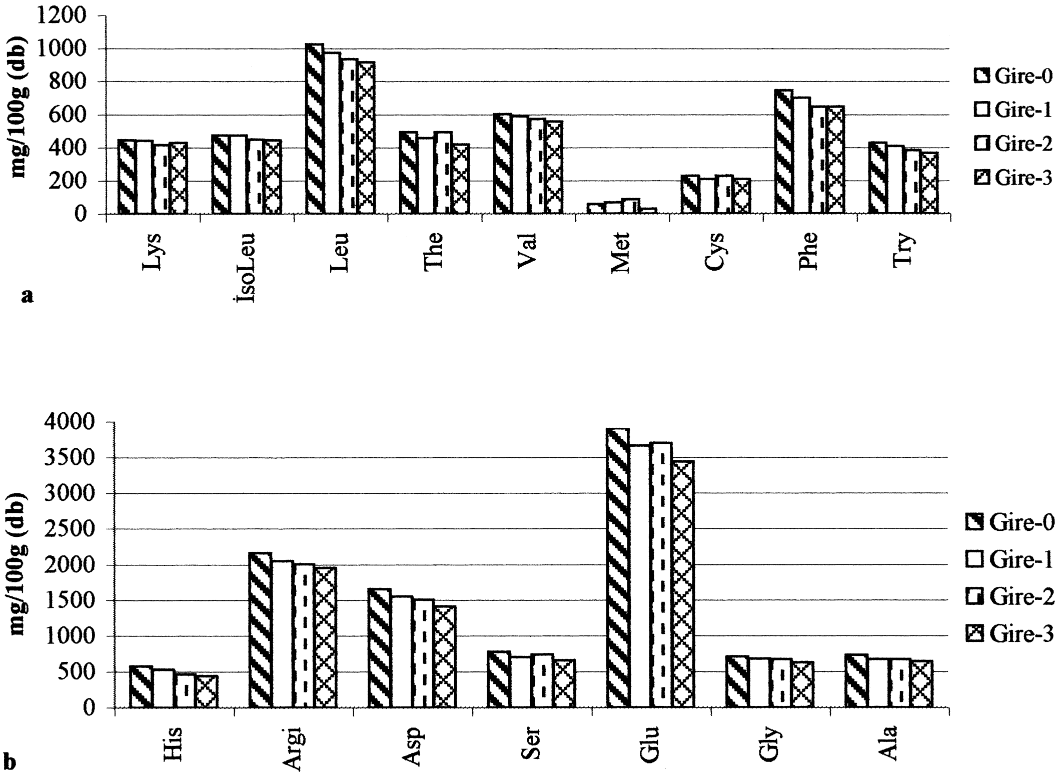

Fig. 3. Effect of roasting on (a) essential amino acid and (b) non-essential amino acid composition of Giresun hazelnuts.

Table 2
Some essential amino acids of raw and roasted hazelnut samples

	Akça-0	Akça-1	Akça-2	Akça-3	Gire-0	Gire-1	Gire-2	Gire-3	FAO[a]
Lys	697	621	699	484	443	441	415	428	344
IsoLeu	593	488	532	441	473	474	446	443	188
Leu	1158	1095	1040	1017	1027	975	935	916	407
The	410	415	408	228	491	456	493	418	250
Val	572	499	501	528	602	589	573	556	250
Met-Cys	339	360	326	408	286	275	316	237	219
Phe	1354	1320	1312	1120	1174	1110	1031	1016	313

[a] FAO (1981).

methionine were significantly involved in the reactions during roasting.

4. Conclusions

Roasting conditions significantly affected peroxide value, free fatty acid, thiamine, riboflavine contents and total amino composition of Akçakoca and Giresun hazelnuts. A higher roasting temperature resulted in higher destruction of thiamine. Giresun hazelnuts suffered less destruction of thiamine, riboflavine and total amino acids, including lysine, compared to Akçakoca hazelnuts. This may be due to the method of roasting (two-stage roasting) of Giresun hazelnuts.

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