Food Chemistry 48 (1993) 411–414

RESEARCH NOTE

Influence of variety and geographical origin on the lipid fraction of hazelnuts (*Corylus avellana* L.) from Spain: I. Fatty acid composition

J. Parcerisa,[a] J. Boatella,[a] R. Codony,[a] A. Farràn,[b] J. Garcia,[c] A. Lopez,[d] M. Rafecas[a] & A. Romero[e]

[a] *Food Science and Nutrition Unit, Department of Human Physiological Sciences and Nutrition, University of Barcelona, Barcelona,* [b] *IRTA—Cabrils, Barcelona,* [c] *Agricultural and Food Laboratory, Generalitat of Catalonia, Barcelona,* [d] *Department of Food Technology, University of Lleida, Lleida, and* [e] *IRTA—Màs Bové, Reus, Tarragona, Spain*

(Received 25 May 1992; revised version received and accepted 3 March 1993)

The aim of this paper is to study the influence of geographical origin, variety and year of harvest on the fat content, moisture and fatty acid composition of hazelnuts (*Corylus avellana* L.) from Spain. We analyzed 24 samples corresponding to four different varieties (T. Romana, Pauetet, Gironell and Negret) and to two geographical origins (Reus and Falset), both situated in the region of Tarragona, Spain. The study covered three consecutive harvests (1990, 1991 and 1992).

INTRODUCTION

Tarragona is the largest (80%) hazelnut-producing region in Spain, which represents about 4% of the world production (FAO, 1990). In this region there are two areas of hazelnut production (Reus and Falset); their geographical situations and climates are well differentiated. Among the varieties of hazelnut cultivated in this region, the native cultivar Negret accounts for 80%. The rest correspond to other native varieties such as Pauetet, Gironell, Cuplà and Morell, and varieties of Italian origin (Tonda Romana and Tonda di Giffoni) have also been introduced in the last few years. Hazelnut cultivation in this region is a source of controversy; it is generally understood that certain native varieties have a different content of specific fatty acids, which determines the commercial value of the product. This misunderstanding has motivated the deliberate introduction of foreign varieties with the aim of improving the quality of the product. The purpose of this study is to attempt to establish the extent of the influence on fatty acid content of each of the following factors: variety, environment, growth conditions, and harvest conditions. In further papers we will give the results of our studies on the influence of other lipid components.

There are few conclusive data on the variability of hazelnut fat composition in relation to different factors such as variety, geographical origin and cultivation conditions (Beringer & Dompert, 1976; Garcia *et al.*, 1979; Gargano *et al.*, 1981; Hadorn & Zurcher, 1967; Hadorn *et al.*, 1977; Hottelier & Delaveau, 1972; Karaali & Yazicioglu, 1983; Neubeller, 1990; Zurcher & Hadorn, 1975). Knowledge of the influence of these factors on fat composition (especially linoleic acid and tocopherol contents) and enzymic activity is needed to assess hazelnut quality and stability during its processing, commercialization and shelf-life.

MATERIALS AND METHODS

Samples

Four varieties of hazelnut were studied: Tonda Romana (Italian variety), Pauetet, Gironell and Negret. From 1990 to 1992, samples were taken from the same cultivar trees in each geographical origin (Reus and Falset). The total number of samples for the analysis was 24, corresponding to 4 varieties × 3 years × 2 origins. All fruits were picked up from under the trees by (IRTA)

Table 1. Fat content, moisture and fatty acid composition of hazelnut samples

Variety	Location	Harvest	Fat (%)	Moisture (%)	Fatty acid composition (% of fat)						
					$C_{16:0}$	$C_{16:1}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$	$C_{20:1}$
T. Romana	Reus	1990	57·6	4·6	5·7	0·2	1·8	76·2	16·0	0·1	0·1
		1991	62·5	5·2	7·2	0·3	2·0	80·4	10·0	0·1	0·2
		1992	50·6	6·3	5·6	0·3	1·6	74·7	17·5	0·1	0·2
	Falset	1990	61·4	4·8	6·4	0·3	2·1	85·3	5·7	0·1	0·1
		1991	76·8	5·2	6·7	1·0	2·1	83·5	6·4	0·1	0·2
		1992	56·5	5·0	6·4	0·3	2·2	84·0	6·9	0·1	0·2
Pauetet	Reus	1990	61·0	4·7	6·3	0·3	1·6	74·0	17·6	0·1	0·2
		1991	61·5	4·8	6·1	0·3	1·7	74·3	17·4	0·1	0·1
		1992	53·6	5·6	6·0	0·3	1·6	73·7	18·1	0·1	0·2
	Falset	1990	61·1	5·2	6·1	0·3	2·1	83·4	7·9	0·2	0·1
		1991	62·0	5·1	6·2	0·3	2·0	82·4	8·9	0·1	0·2
		1992	55·4	5·6	5·9	0·3	2·0	76·4	14·6	0·1	0·2
Gironell	Reus	1990	60·4	4·2	5·1	0·2	2·0	75·6	16·9	0·1	0·2
		1991	53·6	5·4	5·9	0·3	2·0	74·2	17·3	0·1	0·2
		1992	46·9	5·8	5·4	0·3	1·3	70·5	22·2	0·2	0·2
	Falset	1990	64·2	4·5	5·7	0·2	2·4	84·0	7·4	0·1	0·1
		1991	71·5	5·1	5·9	0·2	2·1	83·5	8·1	0·0	0·2
		1992	46·7	6·1	5·1	0·3	1·5	75·2	17·5	0·1	0·2
Negret	Reus	1990	61·9	4·8	6·1	0·3	1·8	76·6	15·1	0·2	0·0
		1991	66·7	5·5	6·0	0·3	1·9	73·6	18·0	0·1	0·2
		1992	52·0	5·0	5·6	0·3	1·6	71·9	20·4	0·1	0·2
	Falset	1990	69·6	4·9	5·9	0·2	2·1	82·8	9·0	0·2	0·1
		1991	60·2	4·7	6·2	0·1	2·3	81·1	10·1	0·1	0·3
		1992	60·3	4·4	5·3	0·3	1·7	77·5	15·0	0·1	0·2

trained workers during the second half of September. Samples were stored unshelled at 0°C until analysis.

Water content

Moisture was determined by weight loss after heating in an oven at 105°C in accordance with AOAC method 27005 (AOAC, 1984).

Total fat content

This was determined in accordance with AOAC method 27006 (AOAC, 1984).

Fatty acid composition

Fatty acid methyl esters were prepared from nut oils using BF_3/CH_3OH as reagent (Slover & Lanza, 1979). In order to prevent alterations, oils were pressed (300 kg cm^{-2}) from ground hazelnuts.

Fatty acid methyl esters were determined by gas chromatography using a capillary column coated with 100% cyanopropylpolysiloxane as stationary phase (CP Sil-88, Chrompack).

All determinations were performed on a Perkin–Elmer Sigma 2000 gas chromatograph coupled to a PE Nelson integrator.

RESULTS AND DISCUSSION

Results obtained for moisture (g/100 g), total fat content (g/100 g), and fatty acid composition (expressed as normalized weight) in hazelnuts are shown in Table 1.

Table 2. Statistical data: mean ($\bar{x}$), standard error of mean (S.E.) and significance level (*P*) for fat content, moisture and fatty acid composition between years and between geographical origins

	1990	1991	1992	S.E.	*P*	Reus	Falset	S.E.	*P*
	$\bar{x}$	$\bar{x}$	$\bar{x}$			$\bar{x}$	$\bar{x}$		
Fat	62·15	64·35	52·75	1·71	0·000 2	57·36	62·14	1·39	0·024 7
Moisture	4·71	5·13	5·48	0·16	0·009 0	5·16	5·05	0·13	N.S.[a]
$C_{16:0}$	5·92	6·26	5·65	0·16	0·041 4	5·90	5·94	0·13	N.S.
$C_{16:1}$	0·24	0·37	0·31	0·06	N.S.	0·28	0·33	0·05	N.S.
$C_{18:0}$	2·00	2·00	1·67	0·06	0·000 9	1·73	2·05	0·05	0·000 1
$C_{18:1}$	79·72	79·12	75·54	0·80	0·002 9	74·62	81·63	0·66	0·000 01
$C_{18:2}$	11·95	12·04	16·53	0·96	0·003 7	17·21	9·81	0·78	0·000 01
$C_{18:3}$	0·14	0·07	0·12	0·07	0·000 1	0·11	0·11	0·01	N.S.
$C_{20:1}$	0·11	0·20	0·19	0·02	0·001 7	0·17	0·17	0·01	N.S.

[a] N.S., Not significant.

Table 3. Correlations between fat content, moisture and fatty acid composition

		Moisture	$C_{16:0}$	$C_{16:1}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$	$C_{20:1}$
Fat	*r*	−0·479 6	0·461 7	0·348 5	0·663 6	0·621	−0·646 4	−0·353 4	−0·266 3
	p	0·023 9	0·030 6	N.S.[a]	0·000 8	0·002	0·001 2	N.S.	N.S.
Moisture	*r*		−0·058 2	0·196 2	−0·446 6	−0·310 6	0·300 5	−0·039 6	0·507 9
	p		N.S.	N.S.	0·036 7	N.S.	N.S.	N.S.	0·015 8
$C_{16:0}$	*r*			0·472 3	0·377 2	0·441 8	−0·517 8	−0·330 9	−0·201 5
	p			0·026 5	N.S.	0·039 5	0·0136	N.S.	N.S.
$C_{16:1}$	*r*				0·032 6	0·149 9	−0·209 4	−0·319 6	0·178 7
	p				N.S.	N.S.	N.S.	N.S.	N.S.
$C_{18:0}$	*r*					0·865 6	−0·870 5	−0·164 3	−0·349
	p					0·000 01	0·000 01	N.S.	N.S.
$C_{18:1}$	*r*						−0·995 6	−0·119 2	−0·323 2
	p						0·000 01	N.S.	N.S.
$C_{18:2}$	*r*							0·154 5	0·317 2
	p							N.S.	N.S.
$C_{18:3}$	*r*								−0·543 7
	p								0·008 9

[a] N.S., Not significant.

Statistical analysis of experimental results was performed by a two-way analysis of variance calculation (ANOVA). The data for means between years (1990, 1991 and 1992) and locations (Reus and Falset), standard error of mean (S.E.) and significance level (*P*) are shown in Table 2.

For the fat content, the total average value calculated is 59·75 with a standard error of 0·98. Significant differences were found between years ($P = 0·0002$) and between locations ($P = 0·0247$), but not between varieties (Table 2).

The values for moisture content show an average of 5·10 with a standard error of 0·09. Significant differences were found between years only (Table 2). These values are in the range accepted for a good storage stability of hazelnuts (Keme & Messerli, 1976; Rivella, 1984).

In fatty acid composition, significant differences were found between years for every fatty acid except $C_{16:1}$. Significant differences were found between locations for $C_{18:0}$, $C_{18:1}$ and $C_{18:2}$ ($P < 0·001$) (Table 2). No significant differences were found for any other unsaturated fatty acid.

Differences in linoleic acid content were reported by Zurcher & Hadorn (1975), who found higher levels of linoleic acid in Negret varieties than in other Spanish hazelnuts, which they called Montana, probably from a different geographical origin.

One-way ANOVA calculation was applied to check on whether there are significant differences between varieties. The only component that gives significant differences is $C_{16:0}$ ($P = 0·0122$).

In addition, a statistical correlation study was performed between parameters (fat, moisture and fatty acids; Table 3). The statistical results for correlation coefficient (*r*) and significance level (*P*) are shown in Table 3. A strong correlation appears between fat content and $C_{18:0}$ ($r = 0·6636$), $C_{18:1}$ ($r = 0·6210$) and $C_{18:2}$ ($r = -0·6464$) ($P < 0·01$). There is a positive correlation between $C_{18:0}$ and $C_{18:1}$ ($r = 0·8656$, $P = < 0·001$). On the other hand, there is a negative correlation between $C_{18:0}$ and $C_{18:2}$ ($r = -0·8705$, $P < 0·001$) and between $C_{18:1}$ and $C_{18:2}$ ($r = -0·9956$, $P < 0·001$).

Our results indicate that the main factors related to the quality of the final product, such as moisture, fat content and unsaturated fatty acids, are strongly influenced by environmental and growing conditions, but scarcely by the variety of fruit.

ACKNOWLEDGEMENTS

This work was carried out thanks to the financial support of INIA (National Institute of Agricultural Research) and CIRIT (Generalitat of Catalonia).

REFERENCES

AOAC (1984). *Official Methods of Analysis*, 14th edn. Association of Official Analytical Chemists, Washington, DC.

Beringer, H. & Dompert, W. U. (1976). Fatty acid and tocopherol pattern in oil seeds. *Fette Seifen Anstrichmittel.*, **78**(6), 228–31.

FAO (1990). *Yearbook of Production*, Vol. **43**. FAO, Rome.

Garcia, R., Valls, C. & Diaz, A. (1979). Contribución al estudio de frutos secos Españoles. Características del aceite de avellanas de las distintas variedades de la Provincia de Tarragona (Campaña 1976). *Anales de Bromatologia*, **31**(2), 137–58.

Gargano, A., Magro, A. & Manzo, P. (1981). Caratteristiche chimique dei fruti di alcune delle principalli cultivar di nocciolo. *Industrie Alimentari*, **2**, 104–6.

Hadorn, H. & Zurcher, K. (1967). Beitrag zur Gaschromatographischen Untersuchung von Fetten und Oelen. *Mitt. Gebiette Lebens. Hyg.*, **58**, 351—85.

Hadorn, H., Keme, T., Kleinert, J., Messerli, M. & Zurcher, K. (1977). The behaviour of hazelnuts under different storage conditions. *Revue for Chocolate Confectionary Bakery*, **2**(2), 16—39.

Hottelier, F. & Delaveau, P. (1972). Huiles à intérêt pharmaceutique, diététique et cosmétologique—III. Amande (*Prunus amygdalus* Stokes *dulcis*), noyaux (*Prunus* divers), noisette (*Corylus avellana* L.). *Annales Pharmaceutiques Françaises*, **30**(7—8), 495—502.

Karaali, A. & Yazicioglu, T. (1983). On the fatty acid composition of Turkish vegetable oils. *Fette Seifen Anstrichmittel.*, **85**(1), 23–9.

Keme, T. & Messerli, M. (1976). Moisture determination in hazelnuts. *Revue for Chocolate Confectionary Bakery*, **1**(3), 6, 8–9.

Neubeller, J. (1990). Über die Inhaltsstoffe bei bershiedenen Haselnußsorten. *Mitt. Klosterneuburg*, **40**, 36–43.

Rivella, F. (1984). Qualità delle nocciole per l'utilizzacione industriale. *Rivista di Frutticoltura*, **11**, 26–31.

Slover, H. T. & Lanza, E. (1979). Quantitative analysis of food fatty acids by capillary gas chromatography. *J. Am. Oil Chem. Soc.*, **56**, 933–43.

Zurcher, K. & Hadorn, H. (1975). Qualitatsbeurteilung von Haselnußkernen. *Mitt. Gebiette Lebensm. Hyg.*, **66**, 191–224.