Effect of Cultivar and Year on the Quality of Hazelnut Fruits (*Corylus avellana* L.)

A.P. Silva, F. Santos, E. Rosa and A. Santos
CECEA-Research Centre for Agricultural
Sciences and Engineering
University of Trás-os-Montes è Alto Douro
Apt. 1013
5000-911 Vila Real
Portugal

B. Gonçalves
CETAV-Centre for Technological,
Environmental and Live Studies
University of Trás-os-Montes e
Alto Douro, Apt. 1013
5000-911 Vila Real
Portugal

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Abstract

Several studies have shown that hazelnut consumption may play an important role in human health protection, based on the levels of antioxidant compounds contained in the fruit. Since cultivar and year are likely to influence nut composition, a study was designed to evaluate the effect of year (2001, 2002) and cultivar ('Ennis', 'Butler', 'Grossal', 'Segorbe', 'Merveille de Bollwiller' and 'Fertile de Coutard') on trees from an orchard located in Vila Real, in the northeast of Portugal. Nuts were evaluated for free α-amino acids, protein, total lipid, starch and fiber. Fruit, kernel and shell weight, blank occurrence and yield were also determined. Free α-amino acids were quantified by HPLC. Crude protein (CP) and crude fat (CF) were determined according to the procedures of AOAC (1990), whilst for neutral detergent fiber (NDF) and starch the methods described by Van Soest et al. (1991) and Salomonsson et al. (1984), were followed respectively. Both cultivar and year induced significant differences in the content of the total amino acids and in most of the individual amino acids identified. Climatic conditions induced significant reduction of amino acids when the plant was submitted to stress. Cultivars also induced significant differences in CP, CF, starch and NDF whilst years had no influence. Fruit weight (kernel and shell) and blank fruit production was significantly affected by cultivar and year.

INTRODUCTION

Hazelnut fruits have been reported to be a good source of natural antioxidants, particularly vitamins, monounsaturated fatty acids, sterols, dietary fibre and phenolics. Consumers have been showing an increased interest in food composition, beyond the data usually available in food composition tables (Souci et al., 1994; Holland et al., 1998). Amino acid composition in such tables is limited and mostly given as both free and bound amino acids. Free amino acid composition has a relevant interest since these compounds have been identified as the precursors of secondary plant metabolism and are involved in the production of compounds which directly or indirectly play an important role in the plant-environment interaction and in human health (Gomes and Rosa, 2000).

Since cultivar and year, and particularly climatic conditions, are likely to influence nut composition, a study was envisaged to evaluate the effect of both on physical and chemical parameters of hazelnut fruits.

MATERIALS AND METHODS

A screening plot with sixteen cultivars of hazelnuts was set up in March 1990, at Vila Real, in the northeast region of Portugal, at 470 m above sea level, 41°19' N and 7°44' W, on a Typic Dystrochrept silt loam soil. The regional climate is a transition from Csb to Csa of Köpen. The average annual rainfall is about 1000 mm, mainly between October and April. The warmest months are July and August and the coldest December and January, with average temperatures of 21-22°C and 6-7°C, respectively. According to the 30-year period (1960-1990) for the region, the average annual sunshine is 2,392 h, the lowest (100 h) occurring in December and the highest (342 h) in July.

The aim of this study was to evaluate the effect of cultivar ('Butler' - B, 'Ennis' - E, 'Fertile de Coutard' - FC, 'Grossal' - G, 'Merveille de Bollwiller' - MB and 'Segorbe' - S) and year (2001 and 2002) on the quality of hazelnut fruits.

Nuts were evaluated for free α-amino acids, protein, total lipid, starch and fiber. Fruit, kernel and shell weight, blank occurrence and yield were also determined. Free α-amino acids were determined by HPLC using C18 columns of 150 mm length and a UV/VIS detector set at 340 nm, after precolumn derivatisation with o-phthaladehyde/2-mercaptoethanol, following a combined procedure described by Gomes and Rosa (2000). Crude protein (N x 6.25; CP) and crude fat (CF) were determined according to the procedures of AOAC (1990), neutral detergent fiber (NDF) was measured by the procedures of Van Soest et al. (1991) and starch using the methodology described by Salomonsson et al. (1984).

RESULTS AND DISCUSSION

A total of 16 amino acids, namely L-alanine (Ala), L-arginine (Arg), L-asparagine (Asn), L-aspartic acid (Asp), glycine (Gly), L-glutamic acid (Glu), L-glutamine (Gln), L-histidine (His), L-isoleucine (Ile), L-leucine (Leu), L-methionine (Met), L-serine (Ser), L-threonine (Thr), L-tryptophen (Trp), L-tyrosine (Tyr) and L-valine (Val), were identified in the 6 cultivars of hazelnuts. The essential amino acids Arg, His, Ile, Leu, Met, Phe, Thr, Trp and Val have also been reported in food composition tables (Souci et al., 1994).

Cultivars and years induced significant differences (P<0.001) in the content of the total amino acids and in most of the identified individual amino acids (Table 1). 'Fertile de Coutard' showed the highest levels (4.60 mmol/100 g DW) of total amino acid whilst 'Ennis' and 'Grossal' showed the lowest (1.99 and 2.04 mmol/100 g DW, respectively). The levels of total amino acids were consistently higher in 2001 than in 2002. These levels were generally dependent on the climatic conditions, as shown by the Y x C interaction (Table 1). Therefore in the year 2002 the low rainfall (< 50% than 2001) induced a stress situation that reduced the levels of total amino acids (Fig. 1). Similar results were reported by Gomes and Rosa (2000) in 11 broccoli cultivars. The major amino acid identified in the cultivars was Ala, representing 70% of total, whilst Met was the lowest (1.5% of total) (Fig. 2). Apart from being an important source of energy Ala is also responsible for an increase in immunity response and takes part in the metabolism of sugars and organic acids too (Rennie, 1995).

There were significant differences (P<0.001) in CP, CF, starch and NDF between cultivars but not between years (Table 2). The highest value of CP was identified in 'Merveille de Bollwiller' (17% DW), which showed the lowest NDF content (24% DW). The highest value of starch (2.4% DW) was observed in 'Butler', whilst 'Ennis' showed the highest NDF (36% DW) and 'Fertile de Coutard' the highest total CF (51% DW) (Fig. 1).

In relation to the physical parameters, cultivar and year had a significant influence on fruit weight, kernel and shell (P<0.001) (Table 2). Ennis showed the highest values (2001 - 4 g; 2002 - 3.9 g) whilst the lowest fruit weight was observed in 'Segorbe' (2001 - 2.4 g) and 'Grossal' cultivars (2002 - 2.4 g) (Fig. 3). Cultivar and year significantly affected the yield (P < 0.001) (Table 2). This parameter was strongly affected by climatic conditions, which is well represented by the large variations of 'Ennis' (Fig. 3). On the other hand, 'Butler' was more stable in relation to the influence of climatic factors on the yield. There were significant differences (P<0.001) between the six cultivars and years in blank fruits production (with a variation between 1 and 7% in 'Merveille de Bollwiller' and in 'Fertile de Coutard', respectively, in 2001, and between 3 and 9% in 'Ennis' and in 'Fertile de Coutard', respectively, in 2002).

CONCLUSIONS

The nutritional value of hazelnut fruits, particularly total and individual amino acids, crude protein, crude fat, fiber, starch, and the physical parameters, are affected strongly by the climatic conditions and cultivars.

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Tables

Table 1. Summary of ANOVA (F-test) for the different sources of variance.

Source	Asp	Glu	Asn	Ser	His	Gln	Gly	Thr	Arg	Ala	Tyr	Val	Met	Phe	Ile	Leu	Total
Year (Y)	NS	NS	NS	**	NS	NS	NS	***	***	***	NS	NS	***	NS	**	***	***
Cultivar (C)	***	***	NS	*	NS	NS	***	***	***	***	**	***	NS	*	***	**	***
Y x C	**	**	NS	NS	NS	NS	NS	***	***	***	NS	NS	NS	NS	NS	***	***

***, **, * Significant at 0.05, 0.01, 0.001 level
NS, non-significant ($P > 0.05$).

Table 2. Summary of ANOVA (F-test) for the different sources of variance.

Source	Crude protein	Crude fat	Starch	Neutral detergent fibre	Fruit weight	Kernel weight	Shell weight	Yield	Blank fruits
Year (Y)	NS	NS	NS	NS	***	***	***	***	***
Cultivar (C)	***	***	***	***	***	***	***	***	***
Y x C	NS	NS	NS	NS	***	***	***	**	NS

***, **, * Significant at 0.05, 0.01, 0.001 level
NS, non-significant ($P > 0.05$).

Figures

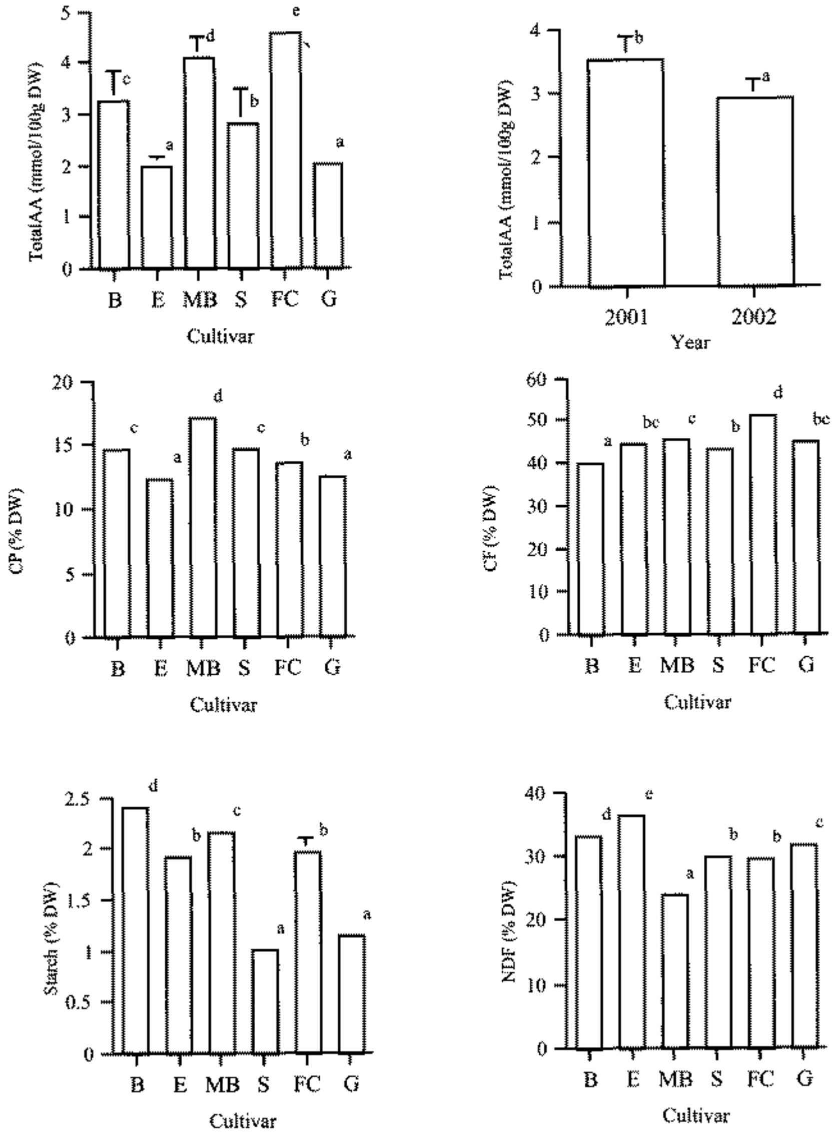
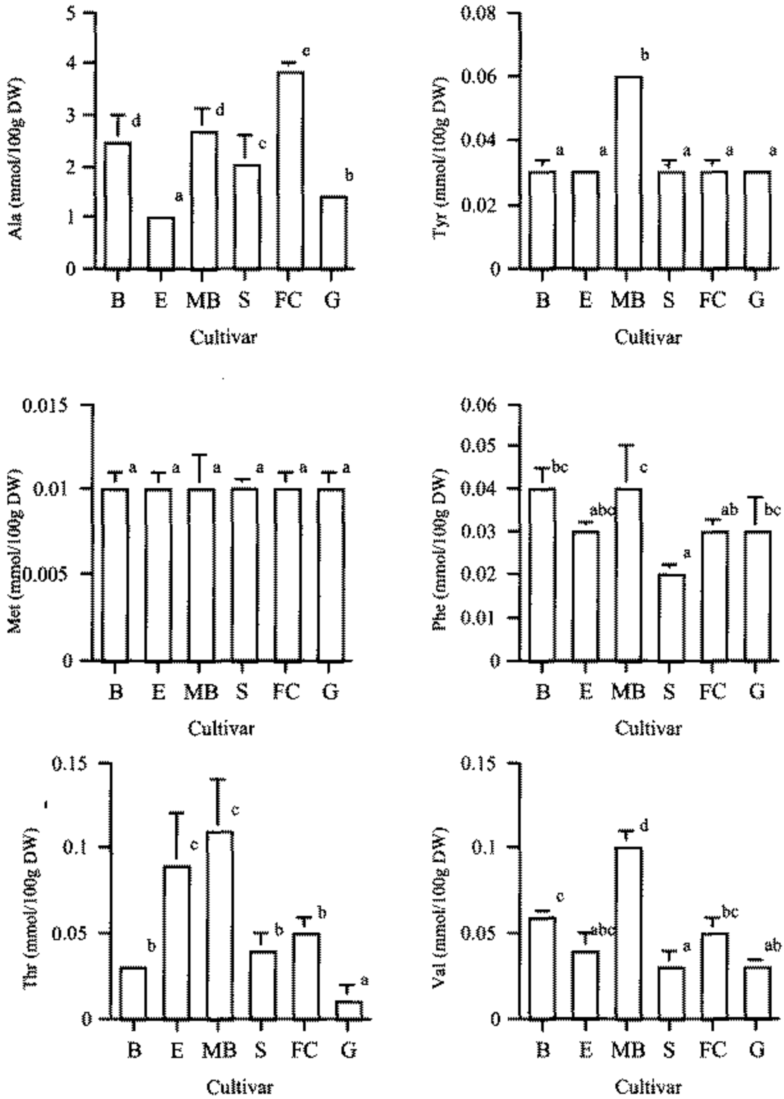


Fig. 1. Total amino acids (AA), crude protein (CP), crude fat (CF), starch and neutral detergent fiber (NDF) in the 6 hazelnut cultivars. Means ± SE ($n = 6$) followed by the same letter are not significantly different at $P < 0.05$ (Duncan's test). When SE bars are not shown, SE is smaller than the columns.



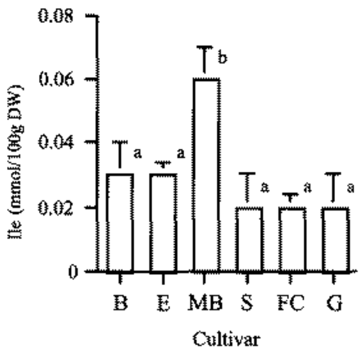


Fig. 2. Free amino acid concentrations (mmol/100 g DW) in the 6 hazelnut cultivars. Means ± SE (n = 6) followed by the same letter are not significantly different at $P < 0.05$ (Duncan's test). When SE bars are not shown, SE is smaller than the columns.