'MARDÍA', AN EXTRA-LATE BLOOMING ALMOND CULTIVAR

INTRODUCTION

The almond (*Prunus amygdalus* Batsch) breeding program of the CITA of Aragón aims to develop new self-compatible and late-blooming cultivars to solve the main problem detected in Spanish almond growing, its low productivity, due to the occurrence of frosts at blooming time or later and to a deficient pollination (Felipe, 2000). The first three cultivars released from this breeding program were 'Aylés', 'Guara' and 'Moncayo' (Felipe and Socias i Company, 1987), 'Guara' having represented more than 50% of the new almond orchards in the last years (MAPA, 2002). Later three more cultivars were registered in 1998, 'Blanquerna', 'Cambra' and 'Felisia' (Socias i Company and Felipe, 1999), 'Blanquerna' being of very good productivity and kernel quality, and 'Felisia' of very late blooming time (Fig. 1). Two more cultivars 'Belona' and 'Soleta' were registered in 2005 (Socias i Company and Felipe, 2007), characterized by their high kernel quality and considered possible commercial substitutes for the two preferred cultivars in the Spanish market, 'Marcona' and 'Desmayo Largueta'. The last release from this breeding program is 'Mardía', recently registered because of its good horticultural and commercial traits.

ORIGIN

'Mardía' (selection G-2-25, clone 541) comes from the cross of 'Felisia', a self-compatible and late-blooming release of the Zaragoza breeding program of small kernel size (Socias i Company and Felipe, 1999), and 'Bertina', a late-blooming local selection of large kernel size (Felipe, 2000). This cross was made with the aim of utilizing two late blooming almond cultivars, one of them carrying the late-bloom allele *Lb* (Socias i Company et al., 1999), of very different kernel size and genetically very distant, in order to avoid the problems related to inbreeding depression (Alonso and Socias i Company, 2007).

BLOOMING TIME

Blooming time has been a very important evaluation trait. As an average, its blooming time is 25 days later than 'Nonpareil', 20 days after 'Guara' and 13 days after 'Felisia', the latest blooming cultivar released so far (Fig. 1). The consistent late blooming time is due to very high chilling and heat requirements (Alonso et al., 2005; Alonso and Socias i Company, 2009), much higher than in any other almond genotype (Table 1). Flowers are of small size, white, with epistigmatic pistil, both on spurs and on one-year shoots. Bloom density is regular and high (Kodad and Socias i Company, 2008b).

Table 1- Chilling and heat requirements of 'Mardía' as related to other cultivars (Alonso et al., 2005; Alonso and Socias i Company, 2009).

Cultivar	Chilling requirements (CU)[z]	Heat requirements (GDH)[y]
Desmayo Largueta	428	5458
Marcona	428	6603
Nonpareil	403	7758
Belona	353	7741
Soleta	340	7872
Ferragnès	444	8051
Guara	340	8159
Felisia	329	9465
Mardía	503	10233

[z]Chilling units - [y]Growing Degree Hours in ºCelsius.

AUTOGAMY

Self-compatibility was tested as soon as the original seedlings produced the first flowers by examining the arrival or not of pollen tubes at the ovary after self-pollination (data not shown). Sets after self-pollination and autogamy were studied on three grafted trees of each selection during several years due to the large variability found between years in field trials for fruit set (Socias i Company et al., 2005). Average set after artificial self-pollination was 17.9%, higher than after cross-pollination, 15.7%, showing a good self-compatible behavior, although this difference was not statistically significant. Average set in bagged branches was 9.8%, higher than the threshold of 6% indicated by Grasselly et al. (1981) for autogamy, and 23.7% for open pollination. These sets (Kodad and Socias i Company, 2008a) are lower than those considered for a commercial crop in Californian cultivars (Kester and Griggs, 1959), but ensure a good crop level because of the high bloom density of this selection, resulting in a high productivity (Kodad and Socias i Company, 2006). Its *S*-allele genotype has been determined as S_6S_f (Kodad and Socias i Company, 2008a).

PERFORMANCE

Field behavior has been evaluated with three grafted trees in an experimental plot and in three external trials. One of the most important points considered was the behavior in relation to spring frost injury. Especially important were the observations in 2003 and 2004, with severe frosts in most almond growing regions of Spain. Whereas cultivars considered as resistant to frosts such as 'Guara' (Felipe, 1988) suffered important yield reductions, 'Mardía', due to its extremely late blooming season, did not suffer any damage (Kodad and Socias i Company, 2005).

Tree training has been easy because of its slightly upright growth habit (Kodad and Socias i Company, 2008b), without the problem of bending branches of 'Guara'. Thus, induction of lateral branching is recommended during the first years. Adult trees show an intermediate vigor and branching intensity, as well as a good equilibrium between vegetative growth and production, thus allowing reduction of pruning. Field observations in the different locations showed its tolerance to *Polystigma* and other fungal diseases.

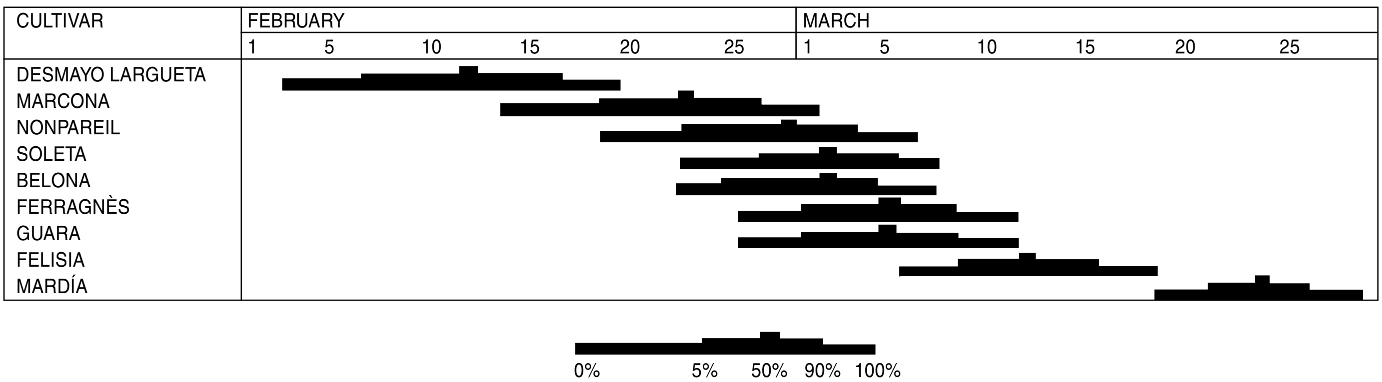
Ripening time is early, although later than in 'Guara', which allows the succession of harvest. Nut fall before harvest has been very low, but nuts fell easily when shaken. Yield rating has been slightly lower than for 'Guara' (7 vs. 8 in a 0-9 scale).

Table 2 - Chemical composition of 'Mardía' as compared to other cultivars.

Cultivar	Protein (% DW[z])	Oil (% DW[z])	Oleic acid (% oil)	Linoleic acid (% oil)	Oleic/linoleic acid ratio	α-tocopherol (mg·kg^{-1} oil)	γ-tocopherol (mg·kg^{-1} oil)	δ-tocopherol (mg·kg^{-1} oil)	Total tocopherol (mg·kg^{-1} oil)
D. Largueta	24.5	57.35	70.65	20.55	3.44	304.3	15.3	1.66	321.3
Marcona	23.8	59.10	71.75	19.40	3.70	463.3	18.5	1.87	483.7
Nonpareil	13.0	60.47	67.72	23.28	2.91	400.0	27.8	1.57	429.4
Belona	16.4	65.40	75.60	12.73	5.94	418.4	15.4	2.18	436.0
Soleta	20.0	61.80	69.20	19.70	3.51	214.0	13.3	1.51	228.8
Ferragnès	25.4	57.53	70.20	20.10	3.49	377.5	18.7	1.84	398.0
Guara	29.3	54.33	63.10	25.70	2.46	385.4	15.7	1.76	402.9
Felisia	27.0	56.32	68.05	22.10	3.08	250.6	18.2	1.73	270.6
Mardía	19.8	59.10	74.95	16.55	4.53	201.5	12.1	1.23	214.8

[z]Dry weight.

Fig. 1. Mean flowering time of 'Mardía' as related to other cultivars (7-years average). Percentages refer to the amount of flowers opened.



The external trials have shown their good adaptation to different growing and weather conditions, maintaining a high level of bud density in all locations (Kodad and Socias i Company, 2008b). A trial in Aniñón (Zaragoza) at 730 m above sea level and of very cold climate has had good production even in years with late frosts. A trial in El Pinós (Alacant), at 575 m above sea level but with a milder climate, has shown their very good production as well as vegetation (G. Valdés, unpublished). Blooming and ripening dates observed in these locations have been, as expected, earlier in El Pinós than in Zaragoza, but later in Aniñón.

INDUSTRIAL QUALITY AND COMPOSITION

Nut and fruit evaluation has been done through seven years according to the IPGRI and UPOV descriptors. Nuts show a very good aspect and good size (4.9±0.5g). Shell is hard (shelling percentage of 24%), adapted to the Spanish industry. Kernels also show a very good aspect and good size (1.2±0.2g), heart-shaped, without double kernels (Fig. 2). Industrial cracking has been carried out by the Cooperative “Frutos Secos Alcañiz” and has shown very good results, without presence of double layers in the shell. Kernel breakage at cracking has been low, with 86.2% of whole kernels.

The chemical composition of the kernels has been determined in order to establish their best utilization opportunities. The content in protein is medium and that of oil is high, similar to that of ‘Marcona’ (Table 2), a very interesting trait for “turrón” (nougat) production. The percentage of oleic acid, that of higher quality for fat stability and nutritive value in the lipid fraction, is especially high (Kodad and Socias i Company, 2008c), close to 75% (Table 2). The content in linoleic acid, of lower quality than the oleic acid, is low, showing a very high ratio of oleic/linoleic acids (4.5), as another index of high oil quality. The amount of tocopherol is lower than in other cultivars (Kodad et al., 2006), indicating the need for a rapid processing of kernels after cracking.

Roasting has been tested by the industry “Almendras Castillo de Loarre” for appetizer use. Behaviour has been good, although less than in the favorite one in the Spanish market, ‘Desmayo Largueta’. Kernel taste, both raw and roasted, is excellent.

DESCRIPTION

Origin: ‘Felisia’ x ‘Bertina’. Selection number: G-2-25. Clone 541. Number of register in OEVV 20074764 (11 December 2007). Number of register in CPVO (European patent): 2009/0306 (18 February 2009). Number of trade mark register: M 2872613 (8) class 31 (21 April 2009).

Fig. 2. Nut and kernel of ‘Mardía’.

Tree: Semi-erect growth habit. Intermediate vigour.

Flower: Extremely late blooming time, 20 days after ‘Guara’. White flowers, of intermediate to small size, both on spurs and on one-year shoots. High bloom density.

Pollination: Autogamous, does not require cross-pollination, but could be cross-pollinated with simultaneous blooming cultivars if available. Only tested with selections of similar blooming time.

Fruit: Hard shell, without layers, heart-shaped. Shelling percentage 24%.

Kernel: Heart-shaped. Mean weight of 1.2 g. Good taste. Easy blanching.

Observations: The latest blooming almond cultivar so far released. Flower morphology allows self-pollination. Easy tree formation. Pruning requires some rejuvenation. Interesting for the quality and composition of the kernel. The intermediate ripening time may allow a progressive harvesting with other cultivars.

REGISTER AND AVAILABILITY

‘Mardía’® (M 2872613 [8] class 31) has been presented to patent on 11 December 2007 at the Spanish Registry of Protected Cultivars and on 18 February 2009 at the Community Plant Variety Office. It is available to nurseries through provisional licenses by Geslive, A.I.E. (C. Juan de Mena 19-3°-D, 28014, Madrid, Spain).

ACKNOWLEDGMENTS

The long-term work to develop this cultivar has been funded by successive research projects, most recently AGL2007-65853-C02-02 of the Spanish CICYT, and the activity of the Consolidated Research Group A12 of Aragón. We appreciate the technical work of J.M. Ansón, M.T. Espiau, J. Búbal and A. Escota, as well as the collaboration of the industries “Frutos Secos Alcañiz” and “Castillo de Loarre”, the growers of the external trials, mainly J.L. Sánchez and J.A. Espiau, and the collaboration of J.L. Espada and P. Castañer (Centro de Transferencia Agroalimentaria de Aragón) and G. Valdés (Estació Experimental Agrària, Elx) in the experimental orchards.

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THE EFFECT OF SOME ECOLOGICAL FACTORS ON ALMOND (*PRUNUS AMYGDALUS* L.) HULLS BIO-ANTIOXIDANT CONTENT AND ANTIRADICAL ACTIVITY FROM DIFFERENT GENOTYPES AND SPECIES

ABSTRACT

The effect of four ecological factors including precipitation, annual water cycle, soil texture and sun light were investigated in this study. Therefore, 20 genotypes of *Amygdalus communis* L. and 4 species of wild Azarbaijanian almonds present in Azarbaijan region of Iran were selected from Esfahlan, Khosroshahr, Shabestar, Mamagan, Sofian and Shahindezh. The fruits of these almonds were collected; their hulls were separated, dried, ground and then a methanolic extract was prepared from powdered hulls. Total phenolic content, extracts' reducing power and scavenging capacity were evaluated. Significant differences were found in phenolic content, reducing power and radical scavenging capacity of hulls among almond genotypes and species of different regions. The values of almond hull's total phenolic content showed that collected almond fruits from Esfahlan and Shahindezh had a high total phenolic hull content. Results of this investigation showed that among the ecological factors studied, sun light in relation to tree spacing among different almond orchards and annual water cycle can affect almond hull's total phenolic content.

INTRODUCTION

Nuts are traditionally food associated with the Mediterranean-type diet. Their regular consumption, in moderate doses, is related to a lower risk of cardiovascular diseases. The anticancer activity of nuts has also been demonstrated in experiments with animals. These beneficial effects are mainly attributed to their lipid profile, arginine, fiber, and vitamin E contents as well as to other compounds with antioxidant properties, such as polyphenols (Monagas et al., 2007).

Almonds (*Prunus amygdalus* Batsch) are one of the most popular tree nuts on a worldwide basis and rank number one in tree nut production. They belong to the *Rosaceae* family that also includes apples, pears, prunes, and raspberries (Sang et al., 2002a; Wijeratne et al., 2006; Jahanban Esfahlan et al., 2009). Although the exact origin of almonds has been difficult to determine, it has been suggested that almonds are native to the temperate, desert areas of western Asia, from where they gradually spread to other regions of the world. Domesticated almonds have

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been documented from Bronze Age sites in Greece and Cyprus and were common in Palestine by 1700 BC. In addition to cultivated almond, *Prunus dulcis*, >30 wild or minor cultivated almond species are known to exist (Sathe et al., 2002). Almonds are typically used as snack foods and as ingredients in a variety of processed foods, especially in bakery and confectionery products (Wijeratne et al., 2006; Jahanban Esfahlan et al., 2009). The United States is the largest almond producer in the world and most of the US almonds are grown in California in an area that stretches over 400 miles from Bakersfield to Red Bluff (Sang et al., 2002b).

Almond fruit consists of an outer hull with an intermediate shell that contains a kernel or edible seed covered by a brown skin. The hull splits open when maturity is reached and is then separated from the shelled almond (whole natural almond). During some industrial processing of almonds, the skin (seed coat) is removed from the kernel by blanching and then discarded. For roasted almonds and other appetizers, skins are not removed. The skin, which has very low economic value, represents 4% of the total almond weight but contains 70–100% of total phenols present in the nut. By products derived from almond industrial processing (skins, shells, and hulls) are normally used for livestock feed and as raw material for energy production (Monagas et al., 2007). However, over the past few years, research has been conducted to evaluate the possible use of these by-products as sources of compounds/fractions with antioxidant properties that could be used to control the oxidative process in the food industry or as functional ingredients for the elaboration of nutritional supplements (Siriwardhana et al., 2006). Extracts of whole almond seed, brown skin, shell and green shell cover (hull) possess potent free radical scavenging capacities (Siriwardhana and Shahi-