‘Vialfas’ Almond

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The almond (*Prunus amygdalus* Batsch) breeding program of the Centro de Investigación y Tecnología Agroalimentaria de Aragón (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 many years (Socias i Company et al., 2011). 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. Two more cultivars, Belona and Soleta, were registered in 2005 (Socias i Company and Felipe, 2007). These were characterized by their high kernel quality and considered possible commercial substitutes for the two preferred cultivars in the Spanish market, Marcona and Desmayo Langueta, respectively. The last release from this breeding program has been Mardía, probably the latest blooming cultivar then released (Socias i Company et al., 2008). Now ‘Vialfas’ is being released because of its good horticultural and commercial traits, as well as its late-blooming time.

Origin

‘Vialfas’ (selection I-3-27, clone 546) 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). Consequently, ‘Vialfas’ is a full sib of ‘Mardía’. This cross was made with the aim of using 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, to avoid the problems related to inbreeding depression (Alonso and Socias i Company, 2007).

Blooming Time

Blooming time has always been a very important evaluation trait in the CITA breeding program. As an average, ‘Vialfas’ blooming time is 22 d later than ‘Nonpareil’, 17 d after ‘Guara’, 10 d after ‘Felisia’, and 3 d before ‘Mardía’ (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). Chilling requirements are similar to those of ‘Mardía’, but with slightly lower heat requirements (Table 1), which could explain the difference in blooming time.

Flowers are of mean size, white, with peristigmatic style, both on spurs and on 1-year shoots. Bloom density is high and consistent (Kodad and Socias i Company, 2008b).

Autogamy

Self-compatibility was tested as soon as the original seedling 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 during 4 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 16.2%, not significantly different from cross-pollination, 16.9%, showing a good self-compatible behavior. 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_βS₁₁* (Kodad and Socias i Company, 2008a).

Performance

Field behavior has been evaluated with three grafted trees in an experimental plot and in six trees 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, ‘Vialfas’, due to its very 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’ (Fig. 2). 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 for at least 4 years showed its tolerance to *Polystigma* and other fungal diseases, such as *Taphrina* and *Coryneum*.

Ripening time is early, ≈9 d later than ‘Guara’, the earliest ripening cultivar, thus allowing the succession of harvest. Nut fall before harvest has been very low, but nuts fell easily when shaken. Yield rating in a trial where different late-blooming cultivars and

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Table 1. Chilling and heat requirements of ‘Vialfas’ as related to other cultivars.

Cultivar	Chilling requirements (CU) ²	Heat requirements (GDH) ³
Desmayo Langueta	428	5,458
Marcona	428	6,603
Nonpareil	403	7,758
Belona	353	7,741
Soleta	340	7,872
Ferragnès	444	8,051
Guara	340	8,159
Felisia	329	9,465
Vialfas	503	10,066
Mardía	503	10,663

²Chilling units.

³Growing degree hours in °C.

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

Table 2. Protein and fat composition of 'Vialfas' kernels as compared with other cultivars.

Cultivar	Protein (% DW ²)	Oil (% DW ²)	Oleic acid (% oil)	Linoleic acid (% oil)	Oleic/linoleic acid ratio	Palmitic acid (% oil)	Stearic acid (% oil)	Palmitoleic acid (% oil)
Desmayo Langueta	24.5	57.35	70.65	20.55	3.44	7.08	2.09	0.51
Marcona	23.8	59.10	71.75	19.40	3.70	6.15	2.09	0.52
Nonpareil	15.0	53.47	67.72	23.28	2.91	6.34	1.44	0.52
Belona	16.4	65.40	75.60	12.73	5.94	5.29	2.40	0.42
Soleta	20.0	61.80	69.20	19.70	3.51	6.40	1.65	0.60
Ferragnès	25.4	57.53	70.20	20.10	3.49	5.57	2.05	0.41
Guara	29.3	54.33	63.10	25.70	2.46	6.01	3.17	0.38
Felisia	27.0	56.32	68.05	22.10	3.08	5.90	1.75	0.60
Vialfas	18.8	57.37	77.97	12.32	6.33	5.70	2.48	0.58
Mardía	19.8	59.10	74.95	16.55	4.53	5.60	2.10	0.50

²Dry weight.

Table 3. Tocopherol composition of 'Vialfas' kernels as compared with other cultivars.

Cultivar	α -Tocopherol (mg·kg ⁻¹ oil)	γ -Tocopherol (mg·kg ⁻¹ oil)	δ -Tocopherol (mg·kg ⁻¹ oil)	Total tocopherol (mg·kg ⁻¹ oil)
Desmayo Langueta	304.3	15.3	1.66	321.3
Marcona	463.3	18.5	1.87	483.7
Nonpareil	400.0	27.8	1.57	429.4
Belona	418.4	15.4	2.18	436.0
Soleta	214.0	13.3	1.51	228.8
Ferragnès	377.5	18.7	1.84	398.0
Guara	385.4	15.7	1.76	402.9
Felisia	250.6	18.2	1.73	270.6
Vialfas	222.5	14.0	1.53	238.0
Mardía	201.5	12.1	1.23	214.8

The external trials have shown its 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 Caspe (Zaragoza), at 100 m above sea level and with a milder climate, has shown their very good production as well as vegetation. Although 'Vialfas' showed similar unshelled nut production than 'Guara', the kernel production was slightly lower due to the lower shelling percentage of 'Vialfas' (Alonso et al., 2015). Blooming and ripening dates observed in these locations have been, as expected, earlier in Caspe than in Zaragoza, but later in Aniñón.

Tree vigor, shown as trunk cross sectional area (TCSA) is low. Consequently, it could be better adapted to high density plantings than more vigorous cultivars. As a result of this low vigor, 'Vialfas' is in the group of cultivars with the highest productivities, 86 g of kernel/cm² TCSA, similar to the most productive cultivar, Guara (Alonso et al., 2015).

Industrial Quality and Composition

Nut and fruit evaluation has been done through 7 years according to the IPGRI (International Plant Genetic Resources Institute, now Bioversity) and UPOV (Union pour la Protection des Obtentions Végétales) descriptors. Nuts show a very good aspect and

Fig. 2. 'Vialfas' tree in full production.

Fig. 3. Nut and kernel of 'Vialfas'.

breeding selections were evaluated has been slightly lower than for 'Guara', 7.5 vs. 9 in a 0–9 scale (Alonso et al., 2015), considering that Guara is a very high-yielding cultivar and rated as 9 in this scale (Alonso et al., 2012).

Table 4. Phytosterol composition of 'Vialfas' kernels as compared with other cultivars.

Cultivar	Kernel phytosterol content (mg·kg ⁻¹ kernel)	Oil phytosterol content (mg·kg ⁻¹ oil)	β-Sitosterol (% phytosterols)	Δ ⁵ -Avenasterol (% phytosterols)	Campesterol (% phytosterols)	Other phytosterols (% phytosterols)
Desmayo Langueta	1,445	2,559	75.64	15.43	3.32	5.62
Marcona	2,260	3,515	74.69	13.95	2.11	9.24
Nonpareil	1,891	3,060	75.35	13.33	3.52	7.80
Belona	1,848	3,076	74.37	16.93	1.79	6.91
Soleta	1,991	3,321	68.44	22.40	1.80	7.37
Ferragnès	1,911	2,963	73.94	15.03	2.47	8.57
Guara	1,506	2,772	71.89	19.24	2.95	5.92
Felisía	1,613	2,792	69.72	17.74	3.64	8.91
Vialfas	1,458	2,589	68.65	19.35	3.36	8.63
Mardía	1,531	2,863	72.01	19.24	3.52	9.40

Table 5. Mineral composition of 'Vialfas' kernels as compared with other cultivars.

Cultivar	Fiber (% DW ²)	Ash (% DW ²)	K (% DW ²)	Ca (% DW ²)	Mg (% DW ²)
Desmayo Langueta	4.74	3.39	0.84	0.23	0.29
Marcona	4.39	3.09	0.75	0.19	0.28
Belona	4.43	2.67	0.82	0.10	0.26
Soleta	4.78	2.76	0.78	0.18	0.22
Ferragnès	5.60	3.46	0.86	0.27	0.27
Guara	4.58	3.28	0.85	0.25	0.28
Felisía	5.25	3.10	0.85	0.21	0.24
Vialfas	5.56	3.38	0.87	0.28	0.25
Mardía	5.54	3.17	0.86	0.29	0.24

²Dry weight.

good size (4.7 ± 0.5 g), with a high number of small points, between elliptic and heart shaped (Fig. 3). The shell is hard, adapted to the Spanish industry, with low shelling percentage (25%). However, the kernel percentage over the total fruit dry weight is 22.1%, quite high when compared with other cultivars: 23.1% for 'Guara', with the highest kernel percentage, and slightly less than 10% for 'Marcona', 'Desmayo Langueta' and 'Nonpareil' (Alonso et al., 2012). Kernels also show a very good aspect and good size (1.2 ± 0.2 g), heart-shaped, without double kernels (Fig. 3). Industrial cracking has been carried out by the Cooperative "Frutos Secos Alcañiz" and has shown very good results, despite the presence of double layers in the shell. The chemical composition of the kernels has been determined to establish their best utilization opportunities. The content in protein is low and that of oil is medium, 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 Socías i Company, 2008c), close to 78% (Table 2). The content in linoleic acid, of lower quality than the oleic acid regarding oil stability, is low, showing the highest ratio of oleic/linoleic acids than any other cultivar (6.3), as another index of high oil quality. The amount of tocopherols (Table 3) is lower than in other cultivars (Kodad et al., 2006), indicating the need for a rapid processing of kernels after cracking. The level of phytosterols (Table 4) is also low as compared with other cultivars (Fernández-Cuesta et al., 2012).

The amount of fiber in kernel is particularly high, as well that of ash, being in both cases close to the highest amount of all cultivars analyzed (Table 5). Likewise, the

presence of mineral elements is very high for K and Ca, and average for Mg (Table 5)

Availability

This cultivar has been presented to patent on 16 Dec. 2013 at the European Community Plant Variety Office and is available to nurseries though provisional licenses by Geslive (C. Antonio Maura 7-1°-I, 28014, Madrid, Spain; Tele. +34 913605870; E-mail: administracion@geslive.com).

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