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Brief Report

Flowering, a Critical Phenological Stage as a Limiting Factor for Almond Native Ecotypes Cultivation in Eastern Morocco

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This study concerns (i) Botanical characterization of local almond ecotype named "Beldi" based on flowering period and flowers color measurements (ii) Chemical characterization of almond oil such as acidity and peroxide index and specific UV absorbance values (K232 & K270). The color results of 100 flowers analyzed by chromameter shows two different color categories. The first is very light pink to whitish (L*=81.58, a*=7.43, b*=8.06). The second is a dark pink (L*=71.64, a*=18.34, b*=4.97) with a difference in color between the two categories ΔE=15.07. Compared to Ferragnes/Ferraduel varieties, Beldi almond kernel has almost a comparable oil yield but different acidity and peroxide values which are 0.81%, 8.12 meq/O_2/kg and 0.40%, 16.39 meq/O_2/kg respectively.

Key Words: Almond, Flowers color, Almond oil

INTRODUCTION

Almond is the most important nut crops in Morocco with an area of 151 kha and an average production of 99,000 tons (Houmy et al., 2016; MAPM, 2014). Almond Branch in eastern Morocco is supported by a Belgium program for agriculture and rural development (PROFAO 2011-2017). The aim of this project is to expand the growing area of the almond tree by planting 6,000 ha of new orchards and by installing new units for crushing almonds in shell. Ferragnes/Ferraduel (F/F) is the main couple of new introduced varieties due to their late blooming in March permitting to escape the adverse effects of January and February frosts.

Currently, this region benefits from another project which is considered a continuation of the PROFAO and aims to develop the almond sector by the characterization of cultivated varieties and the valorization of their final products. Thus this preliminary study concerns (i) the observation of two biological parameters of local ecotypes "Beldi" which are typically considered to be early flowering almond trees. (ii) Due to their small size and narrow shape, these local almond nuts are mainly used to produce almond oils for cosmetic uses. Thus because the fruits of these Beldi almond ecotypes are mainly used for almond's oil extraction, we compare the oils of these Beldi almonds to those of the newly introduced varieties "Ferragnes/Ferraduel".

MATERIALS AND METHODS

Flower Color

Color is a distinctive characteristic of plant species used to distinguish between different species varieties and also to evaluate fruit maturity and quality (Wu & Sun, 2013). The study aimed to characterize the local almond ecotype named Beldi by comparing color of the flowers according to the system CIE L*a*b The color measurements have been done using a chromameter C-410. CIELAB color space diagram (Fig. 1) as described by Liu et al. (2014) shows the following parameters. L* axis indicates the lightness of a color; a* axis is the ratio redness/greenness; b* axis is the ratio blueness/yellowness. The ratio of the a* value and the b* value defines an angle which quantifies one of the hue (H), (e.g. red,

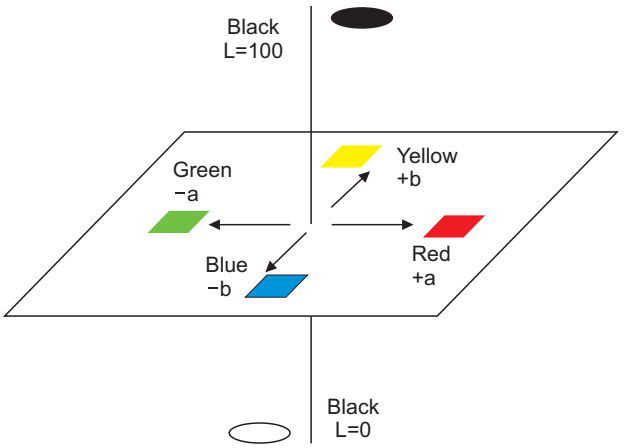

Fig. 1. CIELAB color space diagram.

Table 1. Main stages of flowering (Stage 6), according to the BBCH scale

60	The first flowers are open
61	Beginning of blooming: almost 10% of open flowers
62	20% of open flowers
63	30% of open flowers
64	40% of open flowers
65	Full bloom: at least 50% of open flowers, first petals fall
67	The flowering is completed: most petals have fallen
69	Blooming end: all petals have fallen

BBCH, Biologische Bundesanstalt, Bundessortenamt und CHemische Industrie.

orange, green). The chroma (C) is the distance from the central axis and is a measure of the vividness of a color (Van Eck & Franken, 1994). The color system as recognized by the "Commission International de l'Eclairage" is chosen because its color space is more symmetrical than other color systems (Van Eck & Franken, 1994; Wyszecki & Stiles, 1982).

The different parameters (L*, a*, b*, H°, C) are calculated from more than 100 collected flower of the ecotype Beldi in the area of Sidi Bouhria (34°44'13.6"N, 002°20'15.0"W), in order to distinguish sub-varieties on the basis of color of flowers and period of flowering.

Phenological Study of Flowering

The aim is to indicate the different stages of flowering in order to determine the flowering period of each "Beldi" ecotypes and F/F. The flowering is characterized according to the BBCH scale (Table 1) which is used to identify the phenological development stages of a plant, with an uniform coding and description system (Lancashire et al., 1991).

Characterization of Almond Oils

Small size, narrow shape or damaged almond kernels of Beldi and F/F were triturated using a mechanical oil press. Almond oils were analyzed to determine some chemical characteristics in order to suggest new end uses culinary and cosmetic applications with the best commercial added value. Almond's oil yield, acidity, peroxide index and specific UV absorbance values (K232, K270) were determined according to classical standard methods.

Table 2. Color parameters of flowers (whitish and pinkish flowers) of two Beldi almond ecotypes

	Mean values of color parameter	
	Group 1 with whitish flowers	Group 2 with pinkish flowers
L* (lightness)	81.58±1.07	71.64±0.45
a* (redness)	7.43±0.35	18.34±0.79
b* (yellowness)	8.06±0.65	4.97±0.28
H (hue)	47.24±1.71	15.23±0.03
C (chroma saturation)	10.97±0.43	19.01±0.69

Values are presented as mean±standard deviation.

Table 3. Physico-chemical characterization of almond oils of Beldi native ecotypes and Ferragnes/Ferraduel (F/F) newly introduced varieties in eastern Morocco

Physico-chemical parameter	Beldi (B)	Ferragnes/ Ferraduel (F/F)
Yield (%)	50.00±0.99	57.00±0.79
Acidity (%)	0.40±0.007	0.81±0.008
Peroxide index (meq O_2/kg)	16.39±2.95	8.12±2.81
K232	1.85±0.01	1.505±0.01
K270	0.09±0.002	0.12±0.006

Values are presented as mean±standard deviation.

RESULTS AND DISCUSSION

Our results, for more than one 100 flowers color measurement of the local Beldi almonds trees, show the presence of at least two different almond ecotypes of Beldi (native genotypes) with clear differences in flower colors. The first ecotype (Group 1, Table 2) with a whitish color shows a Hue and Chroma mean values which are respectively H=47.24° & C=10.97. However the second ecotype (Group 2, Table 2), with a pinkish color shows a lower Hue value (H=15.23) and a highest chroma value (C=19.01). This diversity could be related to natural hybridization between the natives almond trees. The flowering of the Beldi ecotypes begin in February however the new introduced varieties F/F start in the last week of March.

The Beldi almond nuts are generally used for almond's oil extraction. Table 3 shows physico-chemical parameters of this almond's oil of the Beldi in comparison with the F/F varieties. When compared to F/F, Beldi almond oil shows similar characteristics but with a slightly lower "almond oil" yield.

Despite the advantages of F/F, we believe that for the diversity of crops and the conservation of biodiversity it is important to characterize this Beldi native ecotype and to conserve them for the future needs or uses in new programs of almond plantation in response to climate change.

CONCLUSIONS

The characterization of local wild almonds ecotypes could be a contribution to the conservation of biodiversity. Equally the characterization of almond's oils allows the comparison of performance of almonds varieties and to determine the performance of F/F in this region in relation to their original sites. On the other side, these results allow the valorization of final products derived from almonds.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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