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Argania spinosa as potential oilseed resource for the future: genotype impact in oil content and fatty acids composition

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ABSTRACT

Argania spinosa (L.) is one of the most economically and culturally important indigenous species in Morocco. Its seeds contain a vegetable oil, internationally known as argan oil, which is widely used in edible, cosmetic and pharmaceutical sectors. The aim of this study was to assess the levels of variation in oil content and fatty acid composition of eighteen trees to identify genotypes with desirable traits in terms of oil quantity, quality and industrial utilization. Oil yield of eighteen genotypes was determined after mechanical pressing, and fatty acid methyl ester analysis was carried out using gas liquid chromatography. Obtained results show that oil yields ranged between 37.2 to 43.8% and major fatty acids in the extracted oil were oleic (47.15%), followed by linoleic (31.57%), palmitic (14.24%) and stearic (5.8%) acid. Fatty acids composition was significantly different among genotypes tested. Significant correlations, both positive and negative were located between some fatty acids. The high variability observed between genotypes represents a very promising base to develop a new argan variety with high oil quality.

Keywords: *Argania spinosa*, genotype, oil yield, saturated acids, unsaturated acids

INTRODUCTION

Over the last few years, use and demand on plant oils in pharmaceutical and cosmetic sectors are increasing, as they are considered valuable natural sources of lipophilic compounds. In current cosmetic and medical sciences, the composition of oil ingredients is increasingly important due to the influence of two essential forces in the wellness strategy. Firstly, the therapeutic and cosmetic properties conferred by complex mixtures of ingredients from natural origin should be of high interest and the final products must be as compatible as possible with human physiology, with no toxic effects or minor allergies. Due to their beneficial effects, especially on the skin, fatty acids (FA) are of immense importance in cosmetology, becoming more and more commonly used in various cosmetic formulations for daily care of the face and body (Haseeb, 2019).

Among the oleaginous species with high gastronomic, pharmaceutical and cosmetic values, argan tree takes place. It's noticed that *Argania spinosa* (L.) is an endemic tree of Morocco with tropical affinities, which produces fruits containing kernels that are used to produce cosmetic and edible argan oils and plays an essential function in the sustainable development of the southwestern region. It's also observed that argan oil presents a rich and specific chemical composition of fatty acids, tocopherols, polyphenols, sterols, carotenoids, xanthophylls, squalene, melatonin and saponins (Guillaume and Charrouf, 2005;

Charrouf and Guillaume 2010; Venegas et al. 2011; Cabrera-vique et al., 2012) which fortify its potential for use in different domains. The value and properties of this oil have been reported since 1219 "the treatise of the simple" by the renowned Arab doctor, Ibn Baytar who was the first to write about the argan tree.

Some pharmacological and cosmetic effects of argan oil are probably due to its high unsaturated fatty acid content (Lopez-Huertas, 2010). The unsaturated fatty acids present an 80% of glyceridic fraction with 47% of oleic acid and 29 % of linoleic acid (Rahmani, 2005). However, the saturated fatty acids only represent 20%, mainly represented by stearic and palmitic acids (Cherki et al., 2005).

Oil composition, especially fatty acids, varies according to environmental factors, soil characteristics, seed, age, cultural applications and genotype. Genotype is the most important factor in determining the fatty acid composition, but the environmental factors, during the seed filling period, can widely affect the oil percentage and the unsaturated oil fatty acid composition (Knowles, 1988). Furthermore, the genotypic factors, not only affect the fatty acid composition, but also play an important role in the metabolic pathways, resulting in the fact that each genotype shows a different fatty acid composition and concentration.

In most of the previous studies about argan kernel oils, the genotype impact was not taken into account and some genotypes which are very promising for cultivation have not been examined so far in terms of fruit quality and fatty acid composition. Therefore, the present work research has been performed, in order to characterize the fatty acid composition of argan oil of the eighteen selected genotypes grown in Oued Grou (Rabat region). The genotypes were chosen according to their properties and to common quality criteria for the tree aspect, yield, fruits and nuts. These data can serve as a resource for assessment by nutritionists, breeders, growers and in the selection of the most useful genotypes for future commercial production in the region.

MATERIEL AND METHODS

Vegetal materiel

In the present research study, eighteen genotypes of *Argania spinosa* (L.) were selected from Tsili forest, Oued Grou region, Khemisset province, Morocco. Tsili is located in the valley of the Middle Grou at 33°28'N latitude, 6°23'W and 300 m height above sea level and characterized by a Mediterranean climate (Table 1).

In the first step, selections were done according to tree yield and morphological descriptors. The seed genotypes with different shape and size were selected and collected at the same maturity stage. The second step consists of extracting the oil from the selected individuals. The cosmetic argan oil used in this study was extracted by a mechanically cold pressing process from unroasted seeds of each genotype. The samples were stored away from the light in amber-colored glass bottles at 4 °C.

Fatty Acid Methyl Esters Determination

The fatty acid profile was determined with a direct method of extraction and methylation adopting the official method of International Olive Oil Council (IOC, 2001). Analysis by gas chromatography Fatty Acid Methyl Esters (FAMEs) were performed with a gas chromatograph (Varian CP 3380) fitted with a flame ionization detector and using a Varian CP-Select CB capillary column. Fatty acid identification was carried out by comparing their retention times against fatty acid methyl standards. Results for each fatty acid were expressed as a percentage of the sum of total FAs, and saturated FAs, monounsaturated FAs, and PUFAs were calculated.

Statistical analysis

In regard to the statistical analysis, results are presented as means ± standard deviation from three replicates of each genotype. The p-value <0.05 was used to denote significant differences between mean values determined by the one-way analysis of variance (ANOVA). Post-hoc multiple comparisons by Duncan's multiple range test using the Statistica 10.0 software was performed to provide significance levels for the difference between

Table 1. Climatic characteristics of Oued Grou region

Month	Average temperature (°C)	Minimum temperature (°C)	Maximum temperature (°C)	Average precipitation (mm)
January	12	8	17	82
February	13	8	18	58
March	15	10	20	57
April	16	11	21	49
May	18	13	23	24
June	21	16	25	7
July	22	18	27	5
August	23	18	28	6
September	21	17	26	24
October	19	14	24	45
November	15	11	21	79
December	13	9	18	91

pair of means. Pearson's correlation analysis was used to test associations between fatty acids.

RESULTS AND DISCUSSION

The multifaceted characteristic of argan oil such as the color, aroma, nutritive and cosmetic properties differentiate it from other vegetable oils. These attributes were influenced by many factors essentially the genotype, ecology, morphology, physiology and agronomic practices.

The seed oil yield is usually the main goal of management, due to economic reasons; therefore, this measurement was the first stage of the present study. The oil yield in kernels recovered from various argan genotypes ranged from 37.2 to 43.8%. Table 2 showed significant differences among genotypes, the lowest oil yields were obtained from seeds of OG7 and OG11 trees. Considerably higher oil yields were noted for OG4 and OG10 genotypes. These results were in agreement with the results of Taribak et al. (2013), who has reported that the total oil content pressed from argan kernels ranged around 45%. On the other hand, Belcadi-Haloui et al. (2015) reported that the total oil content is of 41%. In addition to the genotype, the oil content also depends on the environment and the extraction method. In fact, the solvent extraction gave a higher yield of the order of 57% (Belcadi-Haloui et al., 2008), 59,25% (Belcadi-Haloui et al., 2015), 51-57% (Ait Aabd et al., 2013) 61,3% (Hanana et al., 2018).

Triglycerides are important components of oil in oleaginous plants. There are three main types of fatty acids that can be present in a triglyceride which is saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) with two or three double bonds. Analysis of fatty acid peaks of 18 genotypes revealed dominance of the unsaturated fatty acid (UFA) with a percentage ranging between 77.64 and 81.62%. These percentages are in agreement with those reported by previous studies, in fact, Hilali et al. (2005) and Kouidri et al. (2015) showed that the unsaturated fatty acid content of oils obtained from unroasted seeds fluctuates around 80%. On the other hand, saturated fatty acids were present in the analyzed samples with a percentage varying from18.09 to 22.37% concomitant a predominance of palmitic and stearic acids.

Table 2. Oil yield and fatty acids composition in 18 selected genotypes of argan tree

OG	Oïl yield	Monounsaturated	Polyunsaturated	Saturated	Unsaturated	Mono/poly
1	39.33^{a}	48.67±0.63^{a}	31.48±1.06	20.08±0.25^{a}	80.15±0.42^{a}	1.55
2	40.33^{b}	48.93±0.77^{b}	31.06±0.64^{a}	19.74±0.33^{b}	79.99±1.4^{b}	1.58
3	39^{bc}	48.30±0.68^{c}	32.94±0.55^{b}	19.99±0.17^{c}	81.23±0.78^{c}	1.44
4	43.68^{abcd}	45.72±0.02^{abcd}	32.13±0.58	22.37±0.52^{abcd}	77.85±0.60^{abcd}	1.42
5	38.7^{bde}	46.53±1.39^{abce}	31.11±0.69^{c}	22.26±0.35^{abce}	77.64±0.74^{abce}	1.50
6	42.7^{abcef}	47.83±1.09^{df}	30.22±0.65^{bd}	21.73±0.10^{abcf}	78.05±0.43^{acf}	1.59
7	37.4^{abcdfg}	47.46±0.06^{dg}	31.43±1.09	21.27±0.58^{abcdg}	78.89±1.15^{cg}	1.53
8	38.9^{bdfgh}	48.58±0.46^{deh}	31.87±1.04	19.15±0.40^{defgh}	80.45±0.57^{defh}	1.51
9	40.33^{cdefghi}	48.28±0.05^{dei}	33.35±0.03^{acde}	18.09±0.19^{abcdefghi}	81.62±0.01^{defgi}	1.45
10	43.8^{abceghij}	47.56±0.05^{dgk}	30.63±0.7^{bef}	21.97±0.66^{abchij}	78.19±0.65^{chij}	1.57
11	37.2^{abcdfhijk}	49.2±0.02^{dekl}	30.46±0.51^{beg}	20.39±0.56^{defhijk}	79.66±0.53^{e}	1.63
12	42^{abcdeghijkl}	48.11±0.06^{dem}	32.09±0.78	20.03±0.21^{defgijl}	80.20±0.82^{defk}	1.50
13	39^{bdfgijklm}	47.73±0.05^{d}	31.73±1.00	20.52±0.27^{defhim}	79.46±0.96^{i}	1.51
14	38.42^{bdfjln}	48.77±0.02^{den}	31.31±0.89^{h}	19.72±0.13^{defgijn}	80.09±0.9^{def}	1.55
15	42^{abcdeghijkmno}	48.42±0.04^{deo}	32.15±0.68	19.48±0.07d^{efgijmo}	80.58±0.65^{defjl}	1.50
16	40.67^{acdefghjklmnop}	47.99±0.06^{dep}	32.02±0.69	20.08±0.51^{defgijp}	80.02±0.75^{de}	1.50
17	38.8^{bdfijklop}	47.40±0.08^{bdl}	33.47±0.43^{acdfgh}	19.12±0.56^{defgijkmq}	80.88±0.37^{defjm}	1.42
18	38^{bdfijlop}	46.39±0.02^{abcfhilmnop}	31.72±0.20	21.82±0.1^{abchiklmnopq}	78.12±0.2^{achiklm}	1.46

GP: genotypes, ns: no significative, significant differences in the same fatty acid are indicated with same lowercase letters (P<0.05)

These results were confirmed when compared to those reported before (Khallouki et al., 2003; Yousfi et al., 2009). The observed differences in fatty acid composition were statistically significant (P≤0,001). It is clear that the type of genotype selected affected the fatty acid argan oil composition. Genetic factor influences the composition of the fatty acids in fruit kernel oils has been reported also in some drupes, as sour cherry (*Prunus cerasus* L.), sweet cherry (*Prunus avium* L.) and Almond (*Prunus amygdalus* Batsch) (Kodad and Socias I Company 2008; Górnaś et al. 2016a; Górnaś et al. 2016b). The ratios of fatty acids UFA/ SFA and MUFA/ PUFA in argan kernel oils were in the range of 3.49–4.44 and 1.42–1.63, respectively (Table 2). Similar findings illustrated the same variation in the ratio UFA/SFA values at several regions fluctuating around 4.42 in Morocco and 3.30 in Tunisia (Botanical Garden of "Institut National de Recherches en Génie Rural, Eaux et Forêts") for solvent extraction. On the other hand, the ratios with cold pressing are 4.21 in Morocco and 4.40 in Algeria (Belcadi-Haloui et al., 2008; El Monfalouti et al., 2010; Hanana et al., 2018). For that reason, lipids with high monounsaturated fatty acid content, argan seed oil in particular, are used in emollient skin care products, creams, bath oils, hair conditioners, and makeup (Goik et al., 2019).

To complete the present work search, fatty acid profiles were performed, including palmitic, palmitoleic, stearic, oleic, alpha linolenic, vaccenic, linoleic, arachidic and gadoleic acids. Mean Fatty acid Methyl Ester (FAME) composition of the oils obtained from the experimented eighteen genotypes is shown in Table 3.

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Table 3. Fatty acids composition in 18 selected genotypes of argan tree

OG	C16:0	C16:1	C18:0 ns	C18:1 w9	C18:1 w7	C18:2	C18:3	C20:0	C20:1
1	13.90±0.10^{a}	0.26±0.07^{a}	5.57±0.44	47.87±0.66^{a}	0.16±0.01^{a}	31.29±1.06	0.18±0.03^{a}	0.33±0.09^{a}	0.39±0.03^{a}
2	14.03±0.14^{b}	0.11±0.02^{a}	5.64±0.45	48.44±0.75^{b}	0.14±0.04^{b}	30.91±0.67	0.14±0.05	0.31±0.02^{b}	0.28±0.03^{b}
3	13.82±0.32^{c}	0.16±0.01	5.65±0.47	46.81±0.67^{c}	0.10±0.05^{abc}	32.84±0.56	0.09±0.03^{b}	0.35±0.06^{c}	0.21±0.06^{c}
4	15.26±0.19^{abcd}	0.14±0.01^{a}	6.42±0.31	45.03±0.01^{abcd}	0.09±0.02^{abd}	32.02±0.57	0.08±0.02^{c}	0.38±0.02^{d}	0.44±0.01^{c}
5	15.26±0.14^{abce}	0.12±0.02^{a}	6.62±0.43	45.91±1.33^{be}	0.09±0.09^{abe}	31.02±0.7	0.09±0.04^{d}	0.39±0.05^{e}	0.40±0.06^{d}
6	14.60±0.20^{abcdef}	0.15±0.02	6.55±0.19	47.38±1.12	0.10±0.03^{abf}	30.12±0.66^{a}	0.10±0.05	0.43±0.02^{f}	0.52±0.05^{bcef}
7	14.90±0.03^{abcg}	0.15±0.04	6.04±0.64	46.66±0.01	0.10±0.02^{abg}	31.34±1.10	0.09±0.03^{e}	0.40±0.03^{g}	0.55±0.07^{bcg}
8	13.61±0.17^{bdefgh}	0.13±0.02^{a}	5.31±0.49	47.70±0.48^{d}	0.13±0.03^{deh}	31.66±0.99	0.17±0.02^{bcdef}	0.55±0.02^{abcdegh}	0.53±0.01^{bch}
9	12.63±0.19^{abcdefghi}	0.10±0.03^{a}	5.30±0.01	47.47±0.22^{d}	0.13±0.02^{cdefgi}	33.22±0.01	0.14±0.05	0.44±01^{i}	0.57±0.03^{bci}
10	15.16±0.03^{abchij}	0.17±0.01	6.40±0.66	46.92±0.12	0.10±0.04^{abj}	30.56±0.69	0.07±0.04^{afg}	0.42±0.03^{i}	0.37±0.04^{j}
11	14.79±0.04^{abchik}	0.14±0.02	5.39±0.57	48.44±0.33^{def}	0.11±0.05^{abk}	30.39±0.5	0.07±0.01^{afh}	0.33±0.03^{hi}	0.50±0.03^{bck}
12	14.02±0.07^{degijkl}	0.12±0.03^{ab}	5.46±0.24	47.45±0.78^{d}	0.15±0.03^{cdefgjkl}	31.91±0.80	0.22±0.02^{ghi}	0.32±0.01^{hi}	0.36±0.03^{l}
13	14.78±0.03^{abchilm}	0.13±0.02^{ab}	5.52±0.22	46.99±0.55	0.10±0.04^{abilm}	31.61±1.02	0.10±0.02	0.33±0.02^{hi}	0.50±0.07^{bcm}
14	13.76±0.09^{defgijkmn}	0.12±0.02^{ab}	5.37±0.01	47.89±0.18^{d}	0.14±0.04^{cdefgjkmn}	31.23±0.91	0.13±0.04^{afi}	0.61±0.05^{abcdefgij}	0.61±0.03^{abcdjln}
15	13.58±0.10^{defgijkmo}	0.11±0.03	5.52±0.04	47.89±0.47^{d}	0.14±0.01^{cdefgmo}	32.07±0.7	0.08±0.03^{afi}	0.31±0.02^{hj}	0.28±0.04^{efghikmno}
16	14.02±0.05^{degijkmp}	0.13±0.02^{a}	5.54±0.56	47.35±0.88^{d}	0.10±0.05^{abhilno}	31.95±0.67	0.08±0.04^{afi}	0.33±0.02^{hj}	0.40±0.06^{n}
17	13.43±0.07^{defgijklmq}	0.12±0.02	5.45±0.49	46.67±0.20	0.09±0.03^{abhilno}	33.39±0.44^{a}	0.07±0.02^{afi}	0.34±0.01^{hj}	0.50±0.08^{bco}
18	14.82±0.07^{abchilnopq}	0.12±0.01^{a}	6.60±0.01	45.79±0.33^{bf}	0.09±0.02^{abhilno}	31.64±0.2	0.08±0.01^{fi}	0.41±0.02^{hj}	0.39±0.01^{n}

OG: genotypes, ns: no significative, significant differences in the same fatty acid are indicated with same lowercase letters (P<0.05)

Results show that the major fatty acids in the extracted oil were oleic (47.15%), followed by linoleic (31.57%), palmitic (14.24%) and stearic (5.8%) acids. This corresponds to the result of the *de novo* fatty acid biosynthesis where palmitic acid is principally the first FA to be synthesized after a thioesterase activation on palmitoyl-ACP (*Palmitoyl-CoA*). Predominantly, palmitoyl-ACP is converted by a 3-Ketoacyl-ACP Synthase II (KAS II) to stearoyl-ACP (Ohlrogge and Browse, 1995) which is generally transformed to oleic acid (C18:1w9) due to a stearoyl-ACPΔ9-desaturase and a thioesterase releasing ACP moiety. The other acids studied were found in just low quantities. Values obtained are in agreement with previous works (Belcadi-Haloui et al., 2008; Ben Mansour et al., 2018). Fatty acid composition in kernel oils recovered from eighteen argan genotypes was significantly different ($P \leq 0.05$) in most cases with the exception of stearic acid.

Unsaturated oleic fatty acid content was significantly higher in seed oils extracted from the genotypes OG 2 and OG 11 when compared to those produced from OG 4, OG 5 and OG 18. Similar results were obtained by Kodad and Socias I Company (2008), and Górnaś et al. (2017) which indicated that samples of *Prunus amygdalus* batsch and *Prunus armeniaca* L., harvested on various genotypes contained a distinct oleic acid percentage ranging from 63% to 78% for *Prunus amygdalus* and 38.5% to 67.2% for *Prunus armeniaca* L..

On the other hand, the lowest and highest content of polyunsaturated linoleic acid were detected in OG 6 (30.12%) and OG17 (33.39%), respectively. Newly, palmitic acid, in moderated doses, has been shown to display an antioxidant and anti-atherosclerotic properties. The role of fatty acids in cosmetic technology was reported by kelm and Wickett (2017), including many product categories like skin care, makeup, shaving preparation, soaps and lotions, nail and hair products. The Highest concentration of palmitic acid was found in OG 4, OG 5 and OG10 (15%), whereas levels were found around 12% in the OG 9 genotype. Also, based on report of Hashempour et al. (2010) in olive cultivar, palmitic acid level varied between 14.05 and 17.26%, depending on cultivar, these concentrations are near to those observed in our argan samples. Stearic acid does not differ with genotypes, it is the main branch of the biosynthetic pathway generating the unsaturated fatty acids and also long chain fatty acids (Figure 1).

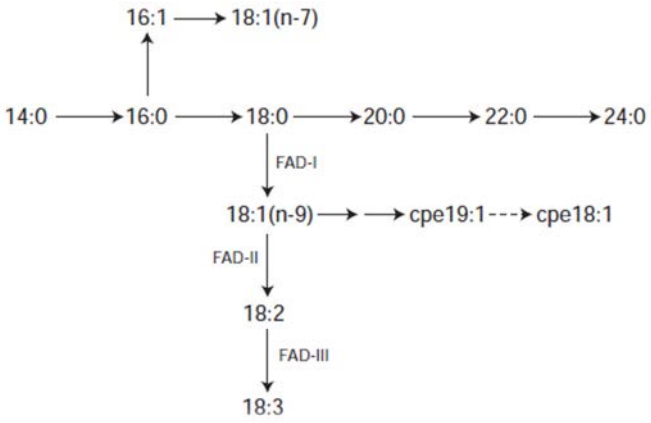

Figure 1. Simplified synthesis pathway of oilseed fatty acids

Minor content (below 1%) was noted for palmitoleic, vaccenic, linoleic, arachidic and gadoleic acids. Although these acids are found in small quantities, they play a structural role. Furthermore, argan oil promotes a proper supply of n-6 PUFA, principally constituted by the linoleic acid, precursor of the n-6 series with high pharmacological properties and protective effects against degenerative diseases such as cardiovascular disease and cancer (Soel et al. 2007). Rahmani (2005) reported that 17 to 21 g of argan oil confer the body's daily needs of acidic linoleic.

Correlation among the various fatty acids from *Argania spinosa* genotypes (Table 4) was performed to explore the trend of their associations. Palmitic acid was inversely associated with oleic ($r = -0.45^{***}$), vaccenic ($r = -0.49^{***}$), linoleic ($r = -0.47^{***}$) and Alpha linolenic ($r = -0.27^{**}$) acids. Hanana et al. (2018) stated that there is a negative correlation between palmitic and linoleic acids ($r = -0.97^{***}$), this result corroborates our findings. However, a positive correlation ($r = 0.94^{***}$) was found between palmitic and oleic acids. The association between palmitic and oleic acids was documented and reported in other oil crops like *Prunus scoparia* L. (Sorkheh et al., 2016), *Prunus dulcis* (Karatay et al. 2014), *Prunus amygdalus* batsch (Forcada et al., 2011), *Arachis hypogaea* (Wang et al., 2018).

Table 4. Correlation among fatty acid component means

FA	C16:0	C16:1	C18:0	C18:1 w9	C18:1 w7	C18:2	C18:3	C20:0	C20:1
C16:0	1								
C16:1	0.08	1							
C18:0	-0.38	0.07	1						
C18:1 w9	-0.45 ***	-0.05	-0.38	1					
C18:1 w7	-0.49***	0	-0.38***	0.59	1				
C18:2	-0.47 ***	0.06	-0.01*	-0.21*	-0.08	1			
C18:3	-0.27 **	0.11	-0.28**	0.2	0.62	-0.07	1		
C20:0	-0.13	-0.29	0.01	0.07	0.1	-0.16	0	1	
C20:1	-0.1	-0.26	-0.01	-0.05	0	-0.02	-0.03	0.54***	1

*** Significant difference at $P<0.0001$ ** Significant difference at $P<0.001$ *Significant difference at $P<0.01$

Moreover, the palmitic acid was negatively associated with vaccenic and linolenic acids (r =-0.21*). In other words, when palmitic acid decreased, linoleic and linolenic acid increased, and vice-versa. This observation was in agreement with various reports on the seed oil composition available in safflower (Vosoughkia et al., 2011), cottonseed (Dowd et al., 2010; Bolek et al., 2016) and salvia species (Farhat et al., 2015). De novo synthesis of 18 carbon fatty acids is made from 16 carbon acyl chains, these chains are elongated by desaturation for the synthesis of 18-carbon fatty acids and this step plays a key factor in regulating the relative quantities of palmitic acid and the 18-carbon fatty acids (Brar, 1982). A defect in this stage leads to an increase in the palmitic acid and a decrease in the amount of the 18-carbon fatty acids. This can explain the observed negative correlations.

It was observed that there was an inverse relation between stearic acid and vaccenic (r =-0.38***), Alpha linolenic (r = -0.28**) acids. Unsaturated 18 carbon acids are derived from the desaturation of stearic acid. In plants, the soluble stearoyl acyl carrier protein desaturase (S-ACP-DES) are the only plant enzymes which catalyze conversion of C18:0 to C18:1 (Shanklin and Somerville, 1991). The members of S-ACP-DES are specific for particular substrate chain length and introduce double bond between specific carbon atoms (Wu et al., 2009). Then, the enzymatic protein of FAD2 converts C18:1 to C18:2 acid by introducing a double bond at the delta-12 position. The transition from 18:2 to 18:3 is done by the delta 6 desaturase. In fact, the negative correlation can be explained by the fact that stearic act as a direct precursor for C18 and indirect for C18:1 and C18:3 acids. Else ways, significant positive relations were often observed between neighboring fatty acids when the two acids were removed from pathway branch points (Figure 1). For example, levels of C18:1w7 and 18:3 were positively correlated as were levels of C20:0 and C20:1 (r = 0.54***).

The cosmetics domain was the fastest-growing branch of the natural personal care industry (Vermaak et al., 2011). It is clear that the customer's demand of products based on natural additives is increasing, usually favored over synthetic counter parts. Agro-industrial products are a great source of natural compounds, such as essential fatty. The fatty acid composition plays a fundamental role in the physicochemical properties of the oil. Furthermore, they are essential for the synthesis of the cell membrane and tissue regeneration. Because of its high level of unsaturated fatty acids and antioxidants, argan oil was used in the cosmetic and therapeutic sectors due to its skin revitalization properties (Goik et al., 2019).

Genotypes studied were found to be promising trees and it is suggested that they should be developed in a breeding program in the future according to their agricultural, physical and biochemical properties. The results reported in this paper confirm that argan trees are a rich source of a linoleic and many other fatty acids that appear to have a very positive effect on human health. Humans would most benefit from an increased understanding of the mechanisms of all the nutrients in argan oil.

CONCLUSION

Argan oil is one of the important products used recently for human diet and esthetic. It contains high levels of both oleic acid and linoleic acid, making it an excellent source of essential omega-6 polyunsaturated fatty acids. The results of this study illustrate the great genetic diversity existing among argan trees as a forest species and the role of genotype in the oil and fatty acid composition. The high variability observed between genotypes represents a very promising base to develop a new argan variety with high oil quality. More experimentation is needed to clarify the inheritance of fatty acids in argan tree and to determine the best breeding method to generate superior genotypes.

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