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Evaluation of the Pomological Characteristics of Olive Fruits (Olea Europaea L.) of Five Varieties Grown in the Beni-Mellal Region (Morocco)

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ABSTRACT

The objective of this study is to evaluate the pomological characteristics of five Olea europea L., varieties grown in the Beni-Mellal-Khénifra region of Morocco. The measurements were focused on fruit and stone lengths, their widths, Fruit and stone shape index (length/width), fruit and stone weights and the fruit water contents. The results obtained indicated that the Picholine and Haouzia varieties recorded the best significant values, around 20 mm, for length and width of fruits whereas Arbequina and Arbosana showed the lowest values, 15.01 and 15.43 mm respectively. For the stone length and width, the Haouzia variety showed the highest values of 16.89 mm and 8.81 mm respectively. However, the lowest values were observed in Arbosana and Arbequine varieties. Our results indicated also that the weights of fruits and stones were high in Picholine and Haouzia varieties 435,33g and 335,10 g for fruit weights and 91,37 and 80,46 g for stone weights respectively. The same trend was observed for the fruit water contents with values of 67.07% in Picholine and 64.43% in Haouzia.

Keywords: *Olea europea L., Pomological characteristics, Fruit water content*

INTRODUCTION

Olive growing is of great socio-economic importance in many Mediterranean countries (Mahhou, 2012). It is gaining more and more the interest of both communities of scientists, nutritionists, as aestheticians (Benlamaalam et al., 2016). The content of fruit in omega-3 fatty acids, protein, vitamins and trace component such as phenolic compounds and minerals provide to this species nutritious and therapeutic virtues (Ferreira et al., 2007; Leouifoudi, 2014; Elbir et al., 2015). The world's olive-growing heritage contains a fairly large number of olive trees in the order of 850 million trees occupying an area of about 8.7 million hectares (Gharsallaoui et al., 2018). However, the evolution of the socio-economic processes caused a genetic erosion of this specie in some countries (Jaouadi, 2009). In Morocco, it occupies an area of 1.000.000 ha (Ouazzani, 2014). It is considered one of the main sectors of Moroccan agriculture where it has grown rapidly from 350,000 ha in 1992 to 930,000 ha in 2011 (MAPM, 2011).

The tree is present throughout the national territory because of its ability to adapt to different bioclimatic stages, ranging from mountain areas (1200 mm) to arid and saharan areas, less than 200 mm (Berrichi, 2002). It ensures, as a result, multiple functions of erosion control, development of agricultural land and stability of populations in marginal areas.

In the Beni Mellal-Khénifra region, the olive tree is an undeniable heritage and an essential component of the agricultural landscape that deserves special attention in order to better preserve it for the next generations, especially in the face of the multiple constraints related to poor rainfall, cultural techniques that are often traditional, and poorly modernized infrastructure (Mahhou, 2012).

In this context, this study aims at comparing the behavior and performance of five varieties of olive trees (Moroccan *Picholine*, *Menera*, *Haouzia*, *Arbequina* and *Arbosana*) conducted in the Béni Mellal-Khénifra region and under local pedoclimatic conditions. The pomological characteristics of fruits and their water contents were evaluated.

MATERIAL AND METHODS

Site of Study

Our study was carried out during the 2015/2016 agricultural campaign in three potentially olive-growing stations in the Béni Mellal-Khénifra region, *SIDI JABER*, *OULED HATTANE*, *SOUK SEBT*. The geographical position of the region of Beni Mellal-Khénifra, allows it a climatic diversity which varies from a humid climate (tops of the chain of the High Atlas and the Middle Atlas) to a sub-arid climate in the lowland areas of the mountain massifs. However, continental-type climate is dominant, very hot in the summer (up to 40°C) and very cold in the winter (2 ° C).

The 2015/2016 agricultural campaign was generally characterized by favorable temperatures for the development and normal growth of the olive tree except for three days of the *Chergui* (a hot and dry wind coming from the Sahara desert) recorded during the month of May 2016 (ORMVAT, 2016). The total rainfall recorded in 2015/2016 was 184.6 mm (ORMVAT, 2016).

This low rainfall had a negative effect on the development of crops on the one hand, and on the reduction of water resources on the other hand which led to very significant yield reductions in Bour and less important the irrigated area.

Soil Ph and Electrical Conductivity

Soil samples were taken randomly from each site at a depth of 20 cm and a surface area of 500 cm^2. The soil pH was measured using a pH meter after 30 minutes of agitation of a mixture consisting of 10 g of the soil sample and 25 ml of distilled water.

The electrical conductivity was measured using a conductivity meter after one hour of agitation of a mixture consisting of 10g of the soil sample and 50 ml of distilled water.

Plant Material

The plant material used in the study consists of 150 fruits per variety. Three Moroccan varieties, *Moroccan Picholine*, *Menara* and *Haouzia* and two Spanish varieties, *Arbequina* and *Arbosana* (Table 1) were focused. These varieties, with the implementation of the Green Morocco Plan, have undergone a rapid development at production and valuation levels. The sampling technique considered is based on zigzag with avoiding the trees of the borders. The samples were taken at the mature stage during the months of November and December 2016. Samples of olives were hand-picked randomly on different branches. The samples were put in plastic bags and stored during the same day at 7 ° C for analyzes at the laboratory.

Table1. *Harvest date of the five olive varieties studied*

Variety	Harvest date
Picholine	02/12/2016
Menara	01/12/2016
Haouzia	26/11/2016
Arbequina	26/11/2016
Arbosana	26/11/2016

Pomological Characteristics

The studied pomological characteristics measured are shown in Table 2. The fruit and stone length and width (mm) were measured using an electronic digital caliper on a representative sample of 150 fruits taken randomly. Fruit and stone shape index (length/width) were calculated. The stone was then removed and flesh and stone were weighed separately.

Table2. *The pomological characteristics measured*

Organ	Character
Fruit	Fruit lenght (mm) Fruit width (mm) Fruit lenght / Fruit width Fruit weight (g)
Stone	Stone lenght (mm) Stone width (mm) Stone lenght / Stone width Stone weight (g)

The Fruit Water Content (FWC)

The water content of fruits was determined with samples of 90 fruits. The samples were weighed for determination their fresh weights. They are then dried in an oven set at 80 ± 2 ° C for 48 hours or until the weight is stabilized and their dry weighed was measured.

The FWC was calculated using the following formula:

FWC (%) = [(Fresh weight - Dry weight) / Fresh weight] * 100

Statistical Analysis of Data

Statistical analysis of the measured data was performed through the descriptive statistics using the statistical software SPSS version 10.0. Pomological measurements were performed on 150 samples. The values are expressed in mean ± standard deviation.

Results And Discussion

Soil Ph and Electrical Conductivity (EC)

The values of the pH and the electrical conductivity of soils where the olive trees were grown are indicated in table 3. The pH analysis showed that the soil of all focused sites is close to neutrality. The values recorded were 7.70, 6.76 and 7.77 for *SIDI JABER*, *OULED HATTANE* and *SOUK SEBT* respectively. The pH is an important parameter of the soil dynamics. The degree of acidity or basicity plays a very important role on the assimilation of nutrients by the plant. The pH influences three important components of soil fertility: nutrient bioavailability biological activity, and structural stability. The variation of pH is dependent on seasonal variation and soil buffering capacity (the concentration of ions in reserve on the clay-humic complex.), the soil water status, its temperature and the presence or absence of a culture during an active growth period (Dinon and Gerstmans, 2008)

Table3. *pH and electrical conductivity (EC) of soils from studied sites*

Site	pH	EC (µs/cm)
SIDI JABER	7,70	190,7
OULED HATTANE	6,76	1143
SOUK SEBT	7,77	256

Values are means of three replicates

As for the EC, the results showed that the soil of *SIDI JABER* is characterized by a poor electrical conductivity (190,7µs / cm). The soil from *SOUK SEBT* site has showed a EC of 256 µs/cm. While, the EC recorded in soil from *OULED HATTANE* was the highest one 1143µs/cm. This highest EC has no negative effect on growth and development of olive tree (Tabatabaei, 2006; Aliniaeifard, 2016)

Pomological Characteristics of Olive Fruits

The results of the ***Pomological characteristics of olive fruits*** are shown in figure 1. The average values for fruit length vary between 20.01 mm and 15.01 mm. The *Picholine* and *Haouzia* varieties recorded the best significant values ($P < 0.05$), around 20 mm, whereas *Arbequina* and *Arbosana* showed the lowest values, 15.01 and 15.43 mm respectively. The *Menara* variety had an intermediate value (17.46 mm).

For the fruit width, the recorded values in Picholine *and Hoauzia* varieties were the highest ones ($P < 0.05$), 14.66 mm and 13.97 mm respectively. However, the *Arbequina* and *Menara* varieties recorded the lowest values of 11.63 mm and 11.89 mm respectively. The remaining variety, *Arbosan*, showed an intermediate value of 12.60 mm. The work reported by Hadiddou et al. (2013) on the olive fruit width in the region of Taounate and Ouezzane in Morocco are in agreement with our results with values ranging from 13.5 to 21.6 mm.

As for Fruit shape index (Fruit Length/ Fruit Width), the *Menara* and *Haouzia* varieties significantly ($P < 0.05$) showed the highest values (1.47 and 1.43 respectively). The ratios of 1.22 and 1.29 were noted in *Arbosana* and *Arbequin*. The *Picholine* variety showed the average value of 1.37. Working on the same parameter Mahhou et al. (2012) reported the closer results in the region of Meknes in Morocco, with values of 1.17 for *Arbequine*, 1.26 for *Haouzia* and 1.31 for *Menara*. This dissimilarity between varieties can be explained by the influence of the geographical site and the hydrous conditions. Indeed, Missat (2012) reported that the potential water requirements of the olive tree depend on the climate and soil type of the area, as well as the available water supply at the end of winter. Also, the study of the behavior of cultivars from a world collection of olive (*Olea spp*.) in Morocco indicated the vigor of *Haouzia* variety (El Oualkadi et al., 2018).

The data in figure 1 mentioned that the average values for stone length varied significantly between the focused varieties ($P < 0.05$). *Haouzia* and *Menara* varieties showed the highest values (16.89 mm and 15.57 mm respectively). The lowest value was observed in the *Arbosana* (9.71 mm) and the intermediate values were noted in *Picholine* and *Arbequine* (13.35mm and 10.51mm).Our results clearly showed the difference between the stone widths of varieties ($P < 0.05$). The highest width was observed in the *Haouzia* variety (8.81 mm), with a very slight difference compared to the *Menara*

variety (8.54 mm). On the other hand, *Arbequina* and *Arbosana* varieties have lowest values (6.28 mm and 6.42 mm).The weights of 100 olive fruits are recorded in table 4.

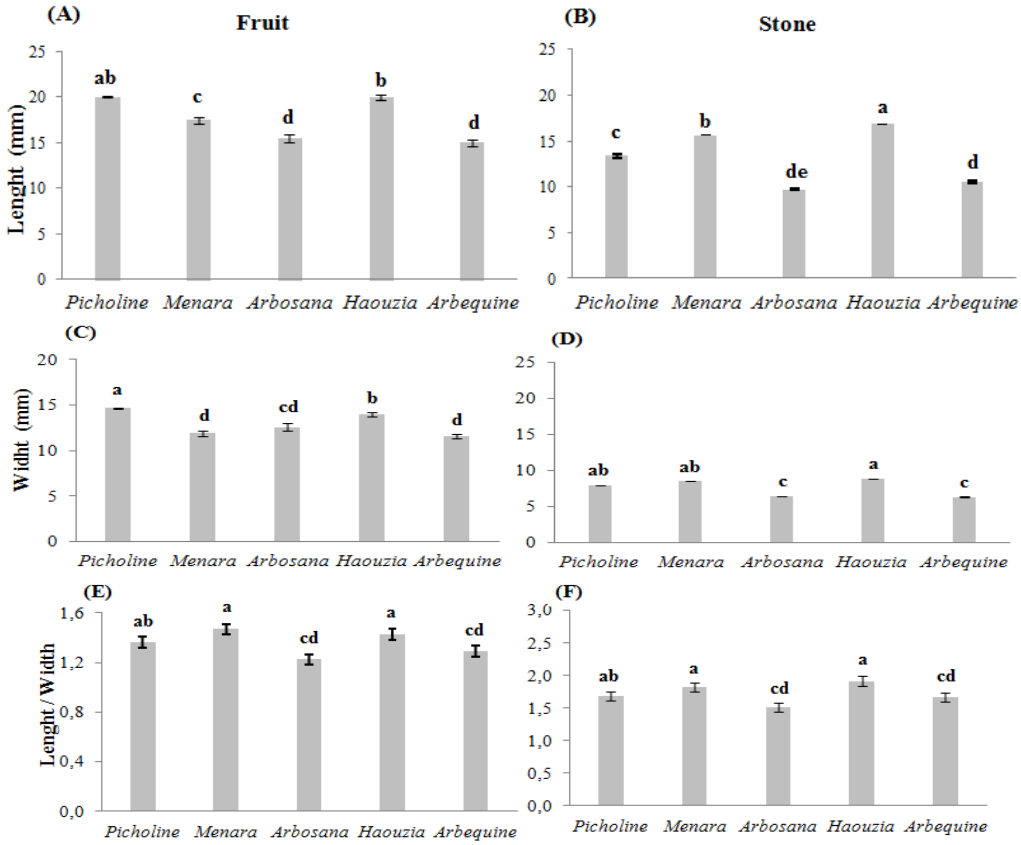

Figure 1 . *Pomological characteristics of fruits and stones of five varieties studied. Fruit and stone lengths (A & B), Fruit and stone widths (C & D) and Length/ width of fruits and stones (E&F). Values are means of 150 replicates and bars are SE. The histograms with the same small letters are not significantly different according Student-Newman-Keuls test (P>0.05).*

The best values were recorded in *Picholine* and *Haouzia* varieties (435.33g and 335.10g respectively), whereas the *Arbequine* variety had the lowest fruit weight (195,92g). The other varieties had intermediate values of 295.35g and 206.16g for *Menara*, *Arbosana* and respectively. Leouifoudi et al. (2014) reported that the two varieties *Haouzi*a and *Menara*, being similar to the *Picholine* could present performance in adaptation to rainfed conditions. Moreover, such a similarity between these three varieties confirms that the two varieties *Haouzia* and *Menara* are selected varieties derived from the *Picholine* (Leouifoudi et al., 2014).

Table4. *Fruit and stone olive weights in five studied varieties of Olea europea L., Results are means of three replicates of 100 fruits or stones for each*

Variety	Fruit weight g	Stone weight g
Picholine	435,33a	91,37a
Menara	295,35c	73,57c
Arbosana	206,16d	45,945d
Haouzia	335,10b	80,46b
Arbequine	195,92d	45,365d

The columns with the same small letters (a-d) are not significantly different according Student-Newman-Keuls test (P>0.05).

The same trend was observed for the stone weights, the average values varied from 45.94g for *Arbequin* to 91.37g for *Picholine*. Hadiddou et al. (2013) reported that the olive weight is affected by the irrigations and type of variety. The low weight of *Arbequina*, *Menara*, *Arbosana* may be due to lack of irrigation water.

The Fruit Water Content

Based on the results mentioned in table 5 and according to the classification proposed by Del Río and Caballero (1994) for the water content of olives, the varieties *Arbosana*, *Arbequine* and *Menara* were considered varieties with high water contents (72.93%, 73.2% and 70.8% respectively). The lowest water contents were observed in *Picholine* (67.07%) and *Haouzia* (64.43%). The work conducted by Mahhou et al. (2012) on the water content of fruits in three varieties grown in the Meknes region showed the same fruit water contents for *Haouzia* variety (58 to 65 %). However, the authors

noted the values ranging from 56% to 61% in *Arbequine* and 56 to 65% in *Menara.*

Table5. *Fruit water contents (%) in five studied varieties of Olea europea L.*

Variety	FWC%
Picholine	67,07 ± 2.52
Menara	70,80 ± 0.85
Arbosana	72,93 ± 1.58
Haouzia	64,43 ± 1.45
Arbequine	73,2 ± 2.28

Values are means of three replicates ± standard errors

CONCLUSION

We conclude that the pomological characteristics significantly varied between the studied varieties. Thus, the *Haouzia* and *Picholine* varieties recorded the best significant values, for length and width of fruits whereas *Arbequina* and *Arbosana* showed the lowest values. The same two varieties showed the highest fruit and stone weights and lowest fruit water contents.

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