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A preliminary Study on Genetic Diversity Among Different Genotypes of Manfalouty Pomegranate Cultivar A- Morphological and Fruit Physico-Chemical Characteristics

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POMEGRANATE (*Punica granatum L.*) genetic variability was investigated among Manfalouty pomegranate (the most distributed commercial cultivar in Egypt) grown at a private farm located in Badari – Assuit Govemorate, Egypt. Four promising pomegranate genotypes were selected after preliminary surveys for 5 years in the field among Manfalouty cultivar, whereas they proved to have desired characteristics and were named differently by the farmers (1- Abo- Shelh, 2-Almekhtat, 3-Abo-Shoka, and 4- Genah Aldabor). Each of the selected genotype was investigated in two successive seasons (2012 & 2013) for flowering, yield and fruit quality characteristics. It is interesting to note that, genotype no. (3) had the maximum records in both total no. of flowers and hermaphrodite (perfect) flowers (%), however, it recorded the minimum male flowers (%). The opposite trend was shown in genotype no. (2). Genotype no. (3) followed by genotype no. (4) reached flowering and fruit maturity stages earlier than Manfalouty cv as well as genotypes no. 1 & 2 (about 1 month earlier for flowering date & 1.5 – 2 months for maturity stage). Whereas, genotype no. (2) was the latest in this concern. A considerable variation was observed in fruit yield characteristics of the studied new Manfalouty genotypes. However Manfalouty cv. produced the maximum yield (112.7 & 103.9 kg/tree), it had the least marketable fruits (%) which as a result it had the highest tendency to fruit cracking (20.60 & 22.90%) and sun-burnt fruits (10.70 & 11.40 %) in both studied seasons, respectively. The opposite results were recorded in genotype no. (2) whereas it achieved the highest marketable fruits (%) as it recorded (97.40 & 97.20%), the lowest percentages of cracked fruits (2.60 & 2.80 %) and (0.00 %) sun-burnt, but it produced the minimum yield (43.00 & 48.57 kg/tree). Among the studied genotypes, (no. 1) had the most desirable fruit physical characteristics (weight, circumferences, length, volume & aril weight %) as well as total juice anthocyanin (%) and (no. 4) was the richest in reducing-sugars, total sugars & tannins (%). Manfalouty fruit juice had the maximum values of T.S.S., acidity (%) &Vitamin (C) as mg ascorbic acid/100ml juice.

Generally, under the same conditions of this study, we can recommend genotypes no. (3&4) as early cultivars and genotype no. (2) for the least percentage of cracking and sunburnt fruits as well as the maximum marketable fruits (%). Genotype no (1) for the most desirable fruit physical characteristics and total juice anthocyanin (%) while no. (4)

the richest in reducing-sugars & total Sugars. Manfalouty cv. can be recommended for the maximum yield, however, it had the least marketable fruits (%).

Pomegranate is a fruit tree which recently has seen a great expansion in several countries, especially those with a Mediterranean-like climate, where fruit of excellent quality can be obtained. There is growing interest in this fruit not only because it is pleasant to eat, but also because it is considered to be a functional product of great benefit in the human diet, as it contains several groups of substances that are useful in disease prevention (Mustafa *et al.*, 2008). Pomegranate fruit is rich in vitamins, macro & micronutrients as well as it is a good source of antioxidants, polyphenols, fibers and low in calories (Neveen *et al.*, 2012). It has always been allocated for fresh consumption, but recently there is a huge demand for industrial processing. The evolution of exporting companies and their significance in global exportation, have led to a certain specialization in the last few seasons concentration. Pomegranate increased in Egypt in recent years in both growing area and total production due to the suitable climatic conditions and pronounced increase of its fruit consumption in the foreign and local markets. However, its recent development may generate genetic erosion. The evolution and importance of this crop has led to selection and breeding for a large number of valuable cultivars concerning quality fruit production. New methods must be developed for cultivar identification, improvement and genetic resources management. Plant material interchange and evaluation should be established at a regional level (Rao & Subramanyam, 2010). For improvement purposes, future works have to be oriented to colonel selection within local material which is assessed, mainly, for important fruit physico-chemical characteristics to obtain a high quality product with economical interest. Genetic studies are lacking entirely in pomegranate because it has not been subjected of much scientific investigations. Genetic diversity is defined as variations in the genetic composition of individual within or among species. The richness of landraces diversity is enormous and this contains sources of useful genes for tolerance to physiological and ecological stresses, diseases/pests etc. and good quality traits (Malik & Singh, 2006). When these varieties or populations of these species are destroyed, the genetic diversity within the species is diminished. In many cases, habitat destruction has narrowed the genetic variability of species lowering the ability to adapt to changed environmental conditions. The greater the variability of species, the more is the ecosystem stability. Thus, exploring mutants is one of the most important breeding methods to obtain new cultivars with superior traits in pomegranate. Mutations occurred spontaneously in buds and limbs, representing the main natural source of new cultivars (Spiegel-Roy & Goldschmidt, 1996). When these bud sports are vegetative propagated by clonal techniques, the new phenotype is generally maintained, leading to a new variety. Mutants are generally detected by the growers themselves in branches of trees showing altered horticultural traits, such as maturity and flowering time or fruit characteristics (Bernet & Asins, 2003). Morphological evaluation especially fruit characteristics, juice parameters and soluble solids/acidity ratio which are stable across environments, are important traits for discriminating the cultivars and also to discriminate to some degree the homonymy, but they are not reliable markers for identification of synonymous genotypes (Durgaç *et al.*, 2008). *Therefore*, this paper

aimed to clarify morphological and important fruit physico-chemical characteristics of four promising pomegranate genotypes which have been selected after a preliminary survey in the field among Manfalouty cultivar which is considered one of the most important pomegranate cultivar grown successfully in Egypt.

Material and Methods

Plant materials

Four promising pomegranate genotypes of Manfalouty cultivar (the most distributed commercial cultivar in Egypt), were selected for flowering, yield and molecular studies after preliminary surveys for 5 years in the field whereas they proved to have desired characteristics and were called by the farmers with different names:

Genotype no. (1): Abo- Shelh
Genotype no. (2): Almekhtat
Genotype no. (3): Abo-Shoka
Genotype no. (4): Genah – Aldabor

The selected trees were of the same age (15 years – old), grown at a private farm located in El-Badari – Assuit Governorate, Egypt. Plant spacing is 6 x 6 m. The soil texture is heavy clay and flood irrigation system was applied from Nile water. The trees were grown in the same orchard and subjected to the same standard cultivation practices (according to the Ministry of Agriculture and reclamination lands recommendations).

Each of the selected genotype was investigated in two successive years (2012 & 2013) for the followings:

Flowering characteristics

No. of flowers: In each season of study, 16 twigs of each genotype were selected at random (4/each direction) and tagged for measuring flowering characteristics. At the time of growth (March), the previously selected twigs were measured for no. of total, male and hermaphrodite (perfect) flowers/twig and percentages of male and hermaphrodite flowers were calculated relative to total number of flowers/twig.

Dates of flowering & maturity and fruit set (%)

The beginning of flowering dates was recorded. Date of fruit maturity of each tested cultivar was also recorded. The number of hermaphrodite flowers which succeeded to set fruits was also counted and labeled and fruit set (%) was calculated.

Fruit set (%) was calculated using the following equation:

$$\text{Fruit set (\%)} = \frac{\text{No. of fruit set/tree x 100}}{\text{No. of hermaphrodite flowers/tree}}$$

Yield and fruit quality characteristics

Yield and marketable fruits/tree (%)

Pomegranate fruits were harvested from Sept. – Oct. (depending on genotype). Total yield/tree was calculated as yield weight kg/ tree and total fruit number/tree was recorded. No. of cracked & sunburned fruits /tree were counted and their percentages and marketable fruits/tree (%) was calculated.

Quality characteristics of the fruits

A sample of ten ripped fruits were randomly collected per genotype and transferred to laboratory for determining the following physical and chemical properties:

Physical properties of the fruits

Fruit weight (g), length & circumference (cm) and volume (cm^3) were recorded. Selected fruits were peeled by hand in the laboratory, then, their rind were separated and capillary membranes (non-edible part) weighted, thus calculating the aril (edible part) weight/fruit by the difference between total fruit and non-edible part weights. Then aril weight /fruit weight and non-edible part ratios were calculated.

Fruit juice chemical composition

Total soluble solids content (TSS %) in fruit juice was measured using an Atago N-20 refract meter at 20°C. The acids in a 10 ml juice sample was neutralizing with 0.1 NaOH N and phenolphthalein as an indicator then expressed it as gram citric acid / 100 ml juice as described in (A .O .A .C., 1985) then, T.S.S./acid ratio was calculated. Total sugars and reducing & non-reducing sugars percentages were determined according to the method described by Dubois *et al.*, (1956), the amount of the estimated sugars in each sample was calculated in term of glucose. Vitamin (C) content (mg) ascorbic acid /100 ml juice by (A .O .A .C., 1985). Total anthocyanin (mg /100 ml) content in fruit juice and rind were measured as described by Hsia *et al.*, (1965). Tannins content was determined refer in fruit juice by the method described by Winton and Winton (1945).

Statistical analysis

The obtained results were submitted to analysis of variances according to Snedecor and Cochran (1980) and means were differentiated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

Flowering characteristics

No. of flowers (total, male and hermaphrodite):

Table 1 shows noticeable variations between selected genotypes of Manfalouty cultivar and even between two seasons in all studied flowering characteristics, which may be due to changes in environmental conditions. In this concern, the total no. of flowers (male and hermaphrodite) ranged from 476 & 599 in genotype no. (2) to reach 1110 & 1176 in Manfalouty cv. and 1158 & 1040 in genotype no. (3), in both seasons, respectively. It is also interesting to note that, however, genotype no. (3) had the maximum records in both total no.

of flowers & hermaphrodite (perfect) flowers (%), it recorded the minimum male flowers (%). The opposite trend was shown in genotype no. (2).

TABLE 1. Flowering characteristics of the four studied pomegranate genotypes and Manfalouty pomegranate cv under Assuit governorate conditions during 2012 & 2013 seasons.

Genotype no.	Total flowers/ twig		Male flowers (%)		Hermaphrodite (perfect) flowers (%)	
	2012	2013	2012	2013	2012	2013
Manfalouty	1110.0A	1176.0A	70.59B	69.97B	29.41C	30.03C
(1)	561.3C	644.3D	68.89C	69.56B	31.11B	30.44C
(2)	476.0D	599.0D	72.91A	75.14A	27.09D	24.86D
(3)	1158.0A	1040.0B	66.97D	58.25 D	33.03 A	41.75 A
(4)	787.7B	864.3C	69.10C	68.34C	30.90B	31.66B
L.S.D at 5 %	78.14	63.91	1.441	1.018	1.438	1.014

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

Pomegranate is characterized by having two types of flowers on the same tree, hermaphroditic bisexual flowers and functionally male flowers (Madlen *et al*., 2011). This is defined as functional andromonoecy, can result in decreased yields resulting from the inability of male flowers to set fruit. Although this crop has been grown as an agricultural crop since antiquity, scientific literature on many fundamental aspects of pomegranate development and physiology, a clear understanding of male and female flowering is still lacking (Hazel, 2011). The hermaphroditic flowers have well-formed female (stigma, style, ovary) and male (filaments and anthers) parts and have been referred to as "fertile" and "bisexual" flowers. Because the hermaphroditic flowers are the type that set fruit, they are commonly referred to as "female" flowers, albeit with some inaccuracy. The male flowers produce well-developed male parts, but on closer examination of the pistil contain reduced female parts. Thus, their role is more accurately depicted as functionally male flowers (*i.e.,* flowers are not strictly male), but rather have degenerated female parts. Male flowers typically drop and fail to set fruit (Holland *et al.,* 2009). With andromonoecy, the ratio of bisexual and male flowers can change with season, plant age, position within the plant, and environment (Miller & Diggle, 2007 and Holland *et al*., 2009).

Dates of flowering, maturity and fruit set (%)

With regard to dates of flowering and fruit maturity (Table, 2), it is worthy to mention that, genotype no. (3) followed by genotype no. (4) reached flowering and fruit maturity stages earlier than Manfalouty cv and genotypes no. 1 & 2 (about 1 month earlier for flowering date & 1.5 – 2 months for maturity date). In this concern, genotype no. (3) was the earliest, whereas, genotype no. (2) was the latest. Fruit development can generally be considered to occur in four phases:

fruit set, a period of rapid cell division, a cell expansion phase, and ripening/maturation. The expression of quality traits normally is coordinately regulated and peaks at ripening. Fruit set is normally dependent on pollination. The percentage of flowers that are male in pomegranate can be significant and more than 60% to 70% depending on variety and season (Mars, 2000). The male types drop and rarely set fruits leaving the hermaphrodite type to produce the majority of the crop. A positive correlation was found between the bearing capacity and the percentage of perfect flowers (Chaudhari and Desai, 1993). Furthermore, having high numbers of male flowers can be a way to spread genes, because pollen spread is more efficient with more male flowers (Oukabli, *et al*., 2004 and Dhinesh, 2010).

TABLE 2. Flowering and fruit maturity dates and fruit set (%) of the four studied pomegranate genotypes and Manfalouty pomegranate cv under Assuit Governorate conditions during 2012 & 2013 seasons.

Genotype no.	Flowering date		Fruit maturity date		Fruit set (%)	
	2012	2013	2012	2013	2012	2013
Manfalouty	8/4	10/4	2/9	10/9	95.83 A	92.95 A
(1)	1/4	5/4	30/8	3/9	92.91 A	93.00 A
(2)	9/4	13/4	8/9	15/9	79.97 B	88.93 B
(3)	1/3	5/3	5/7	5/7	95.89 A	92.13 A
(4)	5/3	10/3	20/7	15/7	96.16 A	91.90 AB
L.S.D at 5 %					0.055	0.058

*Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

Yield and fruit quality characteristics

Yield and marketable fruits/tree (%)

Although, Manfalouty cv produced the maximum yield (112.7 & 103.9 kg/tree), it had the least marketable fruits (%) due to the highest tendency to fruit cracking (20.60 & 22.90%) and sun-burnt fruits (10.70 & 11.40 %), respectively, in both studied seasons (Table, 3). The opposite results were recorded in genotype no. (2) whereas it achieved the highest marketable fruits (%)recording (97.40 & 97.20%), but it produced the minimum yield (43.00 & 48.57 kg/tree), the lowest percentages of cracked fruits (2.60 & 2.80 %) and (0.00 %) sun-burnt which considered the genotype no. 2 as a desirable genotype for exporting. Our results were previously confirmed by Madlen *et al*. (2011), they found that, Manfalouty cv surpassed other studied cultivars in sun-burnt and cracked fruits (%). (El-Khawaga, 2007) proved that, a complex of environmental, practical and genetically factors is effective in the genesis of this disorder. It may also be caused as a result of hormonal effect. Cracked fruit skin and seed had lower level of auxin. The gibberellins, cytokines and abscisic acid (ABA) levels were higher in skin, seed and aril of cracked fruit (Yilmaz and Ozguven 2004). Fruit peal browning

(sunburn) and cracking in Manfalouty pomegranate are serious disorders and can reach from 10-20 % in Assuit region Hegazi *et al*. (2005).

TABLE 3. Yield characteristics of the four studied pomegranate genotypes and Manfalouty pomegranate cv. under Assuit governorate conditions during 2012 & 2013 seasons.

Genotype no.	Fruit number / tree		Fruit yield/tree (kg.)		Cracked fruits (%)		Sun-burnt fruits (%)		Marketable fruits (%)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Manfalouty	312.0B	328.0B	112.7A	103.9A	20.60A	22.90A	10.70A	11.40A	68.70C	65.70C
(1)	162.0D	182.3D	80.23BC	87.47B	9.30C	9.70C	4.90B	4.90B	85.90B	85.40B
(2)	116.0E	132.3E	43.0D	48.57D	2.60D	2.80D	00.00C	00.00C	97.40A	97.20A
(3)	365.7A	401.3A	86.67B	69.93C	13.50B	14.20B	4.50B	4.90B	82.00B	80.90B
(4)	234.7C	251.0C	75.43C	62.40CD	8.10C	9.40C	5.40B	6.20B	86.50B	84.30B
L.S.D at 5 %	29.27	28.52	11.18	16.4	0.017	0.019	0.0199	0.0207	0.0554	0.0607

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

Fruit quality characteristics

Fruit physical properties

It can be seen in Table 4 and Fig. 1 that, the maximum values of all the studied parameters were recorded in genotype no. (1), however, genotype no. (3) recorded the minimum values. In this respect, fruit circumference ranged from 9.80 & 9.60 cm to 6.63& 6.27 cm and fruit length ranged from 9.40 & 9.27 to 6.33 & 6.17cm, respectively in both seasons. Moreover, values of both fruit volume (cm^3) and weight (g) about doubled in genotype no. (1) in 1^{st} season and about triple in 2^{nd} season when compared with genotype no. (3).

In Table 5 the genotype no (1) showed its superiority with respect to the studied fruit quality parameters except for aril weight (%), while genotype no. (3) was the worst in weight of rind and capillary membranes (non-edible part) and aril (edible part). Values of non-edible part in genotype no. (3) were 85.40 & 60.77(g), while, reached 198.0 & 196.7(g) in genotype no. (1). Similarly, aril weight/fruit ranged from 297.0 & 232.0 (g) to 161.0& 130.0 (g). Large fruit, thin and red colored skin, and soft abundant juicy, no fruit cracking, high and regularly bearing, early, medium and late seasonal ripening, sweet, sour and sour-sweet tasted juice are considered among the desired fruit and plant characteristics for pomegranate evaluation effort (Muradoglu *et al*., 2006).

TABLE 4. Fruit circumference (cm), length (cm), volume (cm^3) and weight (g) of the four studied pomegranate genotypes and Manfalouty pomegranate cv. under Assuit governorate conditions during 2012 & 2013 seasons.

Genotype no.	Fruit circumference (cm)		Fruit length (cm)		Fruit volume (cm^3)		Fruit weight (g)	
	2012	2013	2012	2013	2012	2013	2012	2013
Manfalouty	8.80 B	8.27BC	8.10B	7.67B	353.3C	343.3C	373.6B	314.7C
(1)	9.80 A	9.60A	9.40A	9.27A	560.0A	550.0A	495.1A	480.2A
(2)	9.27AB	8.73B	8.47B	7.93B	403.3B	393.3B	370.2B	364.9B
(3)	6.63 D	6.27D	6.33D	6.17C	265.0D	186.7E	246.4D	174.1E
(4)	8.10 C	7.67C	7.23C	6.53C	350.0C	256.7D	318.4C	248.4D
L.S.D at 5 %	0.684	0.63	0.7095	0.5984	34.72	37.46	21.74	21.59

*Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

TABLE 5. Weight of rind and capillary membranes (non-edible part) and aril (edible part) of the four studied pomegranate genotypes and Manfalouty pomegranate cv. under Assuit governorate conditions during 2012 & 2013 seasons.

Genotype no.	*Rind and capillary membranes fresh weight /fruit (g)		**Aril weight/fruit (g)		*Rind and capillary membranes weight (%)		**Aril weight (%)	
	2012	2013	2012	2013	2012	2013	2012	2013
Manfalouty	125.2B	116.0B	235.2C	198.7B	34.81B	37.68B	65.19B	62.32A
(1)	198.0A	196.7A	297.0A	232.0A	40.02A	47.19A	59.98C	52.81B
(2)	113.3C	106.9C	258.6B	218.1AB	30.51C	36.19B	69.49A	63.81A
(3)	85.40D	60.77E	161.0E	130.0D	34.65B	34.58B	65.35B	65.32A
(4)	113.0C	83.43D	208.4D	156.4C	35.18B	34.82B	64.82B	65.18A
L.S.D at 5 %	8.09	8.92	19.4	19.73	2.649	2.881	2.591	2.806

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test. *Rind and capillary membranes (non-edible part). **Aril (edible part.

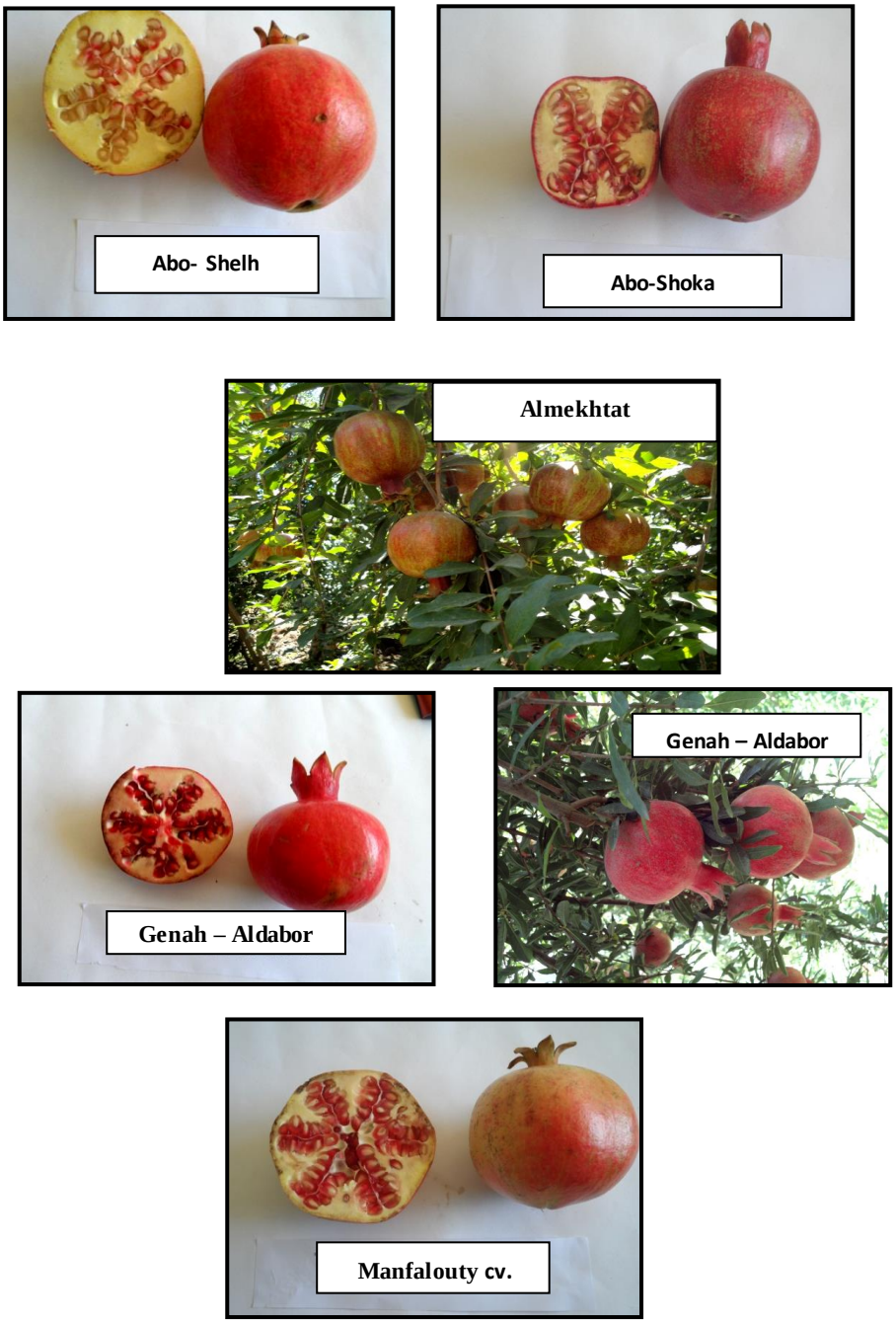

Fig. 1. Fruits of the four studied pomegranate genotypes and Manfalouty cultivar .

Fruit juice chemical composition

Compositional analyses in Table 6 revealed that, all the tested genotypes and Manfalouty cv. can be included in the group of "sweet cultivars" (acidity < 0.9%), according to Evreinoff (1957). Moreover, they had a TSS higher than the minimum threshold generally required for commercial purpose (12%). Furthermore TSS's values always fell in the range suggested by other authors (11-16%) (Ben-Arie *et al*., 1984). TSS/Acidity ratio was particularly high (12.75 & 13.09) in genotype no. (4) as a consequence of a high TSS, whereas TSS/Acidity ratio was especially low (10.66& 10.86) in genotype no. (2), in both seasons, respectively, as expected for low TSS in no (2). It is well-known that the sugar/acid ratio in many fruits is a primary driver of fruit quality (Mustafa *et al*., 2008). The amount of Vitamin (C) as mg ascorbic acid/100ml fruit juice showed a slight difference with a maximum of 34.3 & 33.3 (Manfalouty cv.) and a minimum of 31.7 & 30.7 (genotype no. 2).Vitamin C is also connected with the health of bones, teeth, hormones, collagen, and blood vessels. It plays an important role in absorbing other important substances, such as iron, calcium, and folacin, and it may help cataracts, cancer, and heart diseases (Disabled World, 2007) and as an effective antioxidant, acting to lessen oxidative stress, a substrate for ascorbate peroxidase, as well as an enzyme cofactor for the biosynthesis of many important biochemicals (Linus *et al*., 2007).

TABLE 6. Some of fruit juice chemical composition of the four studied pomegranate genotypes and Manfalouty pomegranate cv. under Assuit governorate conditions during 2012 & 2013 seasons.

Genotype no.	T.S.S. (%)		Acidity (%)		T.S.S. / Acidity ratio		Vitamin (C) mg ascorbic acid/100ml juice	
	2012	2013	2012	2013	2012	2013	2012	2013
Manfalouty	15.97A	16.50A	1.273A	1.287A	12.55A	12.82AB	34.3A	33.3A
(1)	14.57B	14.30B	1.273A	1.273A	11.45B	11.23C	34.7A	32.7AB
(2)	13.50C	13.57C	1.267AB	1.250BC	10.66C	10.86D	31.7B	30.7B
(3)	14.77B	14.23B	1.237C	1.233C	11.94B	11.54C	34.0A	33.7A
(4)	15.97A	16.40A	1.253B	1.253B	12.75A	13.09A	35.0A	34.3A
L.S.D at 5 %	0.4763	0.5191	0.1458	0.1786	0.4375	0.5052	0.228	0.2063

Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

In Table 7 percentages of fruit juice tannins varied between 3.73 & 3.70 % (genotype no. 2) to 4.33 % (genotype no. 4). Great variation in the percentage of total anthocyanin was found, it ranged between 0.267 &0.287 % (genotype no. 2)

to 0.370 & 0.373 % (genotype no. 2). The previously mentioned genotype was the lowest in fruit juice reducing-sugars & total sugars %, however the opposite was true with non-reducing sugars (%). Anthocyanins are a member of phenolics compounds that contributes to the red, blue or purple color of many fruits including pomegranate juice and they are well known for their antioxidant activity. These color changes strongly affect consumer behavior and result in a loss of marketability of processed pomegranate products. The anthocyanin profile is highly consistent across varieties and geographic (Varasteh *et al*., 2009 and Ali *et al*., 2010). It has been reported that tannins play an important role in human health and are implicate with numerous biological properties. Tannins are high molecular weight phenolic compounds which are present in many plants, including pomegranate fruit pericarp (peels). Tannins are water-soluble polyphenolic polymers of relatively high molecular weight and have capacity to form complexes mainly with proteins, to a lesser extent with carbohydrates due to the presence of a large number of phenolic hydroxyl groups (Hassanpour *et al*., 2011a).

TABLE 7. Cont. some of fruit juice chemical composition of the four studied pomegranate genotypes and Manfalouty pomegranate cv. under Assuit governorate conditions during 2012 & 2013 seasons.

Genotype No.	Tannins (%)		Total Juice anthocyanin (%)		Reducing-sugars (%)		Non-reducing sugars (%)		Total Sugars (%)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Manfalouty	3.97BC	4.07AB	0.320B	0.310C	12.73C	12.19D	0.92B	0.81C	13.65C	13.00C
(1)	4.00B	3.93BC	0.370A	0.373A	12.46D	12.56B	0.89B	0.79C	13.35D	13.35B
(2)	3.73C	3.70C	0.267C	0.287D	11.05E	11.66E	1.10A	0.99A	12.15E	12.65D
(3)	4.40A	4.33A	0.317B	0.300CD	12.85B	112.45C	0.96B	0.90B	13.81B	13.35B
(4)	4.33A	4.33A	0.333AB	0.327B	13.59A	13.22A	0.91B	0.78C	14.50A	14.00A
L.S.D at 5 %	0.2561	0.2923	0.018	0.016	0.055	0.054	0.096	0.078	0.061	0.057

*Means in each season having the same letter/s are not significantly different at 5% level using Duncan's Multiple Range Test.

References

Ali T., Mehdi, Z., Zahra, N., Behnam, E. and Mohamed, R.V. (2010) Investigation of physico-chemical properties and antioxidant activity of twenty Iranian pomegranate cultivars. *Scientia Horticulturae,* **126** (2,13), 180-185.

ssociation of Official Agriculture Chemists (1985) "*Official Methods of Analysis*", A.O.A.C. 14th ed., Washington.

Ben-Arie, R., Segal, N. and Guefat-Reich, S. (1984) The maturation and ripening of the 'Wonderful' pomegranate. *J. Amer. Soc. Hort. Sci.,* **109**, 898-902.

Bernet, G.P. and Asins, M.J. (2003) Identification and genomic distribution of gypsy like retrotransposons in citrus and poncirus. *Theoretical and Appl. Genet.,* **108**, 121–130.

Chaudhari, S.M. and Desai, U.T. (1993) Effects of plant growth regulators on flower sex in pomegranate (Punica granatum L.). *Indian J. Agr. Sci.,* **63**, 34–35.

Dhinesh, K.B. (2010) Floral Biology of Pomegranate (Punica granatum L.). Fruit, Vegetable and Cereal Sci. and Biotech., Vol. 4 Special Issue 2. Pomegranate (pp 45-50).

Disabled World (2007) Vitamins and Minerals A to K. http://www.disabled world.com/artman/publish/vitamins and minerals, 10-21.

Dubois, D., Gilles, K., Hamilton, J.K., Rebers, P.A. and F. Smith (1956). A calorimetric method for the determination of sugars and related substances. *Anal. Chem.,* **28**, p.350.

Duncan, D.B. (1955) Multiple Range and Multiple F. *Test. Biometrics,* **11**,1-42.

Durgaç, C., Özgen, M., Simsek, Ö., Aka Kaçar, Y., Kıyga, Y., Çelebi, S., Gündüz, K. and Serçe, S. (2008) Molecular and pomological diversity among pomegranate (Punica granatum L.) cultivars in Eastern Mediterranean region of Turkey. *African J. Biotech.* **7**, 1294-1301.

El-Khawaga, A.S. (2007) Reduction in fruit cracking in Manfalouty pomegranate following a foliar application with Paclobutrazol and Zinc Sulphate. *J. of Appl. Sci. Res.,* **3** (9), 837-840,

Evreinoff, V.A. (1957) Contribution to the study of Granadier. *J. Agric. trop. bot. appl. (Paris),* **4** (2), 3-4.

Hassanpour, S., Sadaghian, M., Maherisis, N., Eshratkhah, B. and Chaichi Semsari, M. (2011a) Effect of condensed tannin on controlling faecal protein excretion in nematode-infected sheep: in vivo study. *J. Amer. Sci.,* **7** (5), 896- 900.

Hazel, Y.W. (2011) A morphological and histological characterization of bisexual and male flower types in pomegranate. *J. Am. Er. Soc. Hort. Sci.,* **136** (2), 83–92

Hegazi, E.S., Yehia, T.A., Aboutaleb, S.M. and Aboulwafa, M. (2005) Effect of some treatments on improving pomegranate fruit quality. a-Effect of some orchard practices. *Egypt. J. Appl. Sci.,* **20** (6), 218-233.

Holland, D., Hatib, K. and Bar-Yaakov, I. (2009) Pomegranate: Botany, horticulture, breeding. *Hort. Rev. Amer. Soc. Hort. Sci.,* **35,** 127–191.

Hsia, C.L., Luh, B.S. and Chickester, C.O. (1965) Anthocyanin in Freestone peaches. *J. Food Sci.,* **30**, 5-12.

Linus, U.O., Majeed, R.A. and Yusra, S.A. (2007) Physico-chemical properties, vitamin C content, and antimicrobial properties of pomegranate fruit (Punica granatum L.). *Food and Agricultural Products,* **2** (3), 315-321.

Madlen, R.S., El-Bolok, K.T. and Safia, A.T. (2011) A comparative study on some pomegranate cultivars grown under the ecological conditions of Souhag governorate. *Agric. Res. J. Suiz Canal Univ.,* **11** (2), 101-116.

Malik, S.S. and Singh, S.P. (2006) Role of plant genetic resources in sustainable agriculture. *Indian J. Crop Sci.,* **1** (1-2), 21-28.

Mars, M. (2000) Pomegranate plant material: Genetic resources and contributing to sex determination in pomegranate. Optimizing breeding, *a review. Options Mediterranean's Serie A,* **42**,55–62.

Miller, J.S. and Diggle, P.K. (2007) Correlated evolution of fruit size and sexual expression in andromonoecious Solanum sections Acanthophora and Lasiocarpa (Solanaceae). *Amer. J. Bot.,* **94**, 1706–1715.

Muradoglu, F., Fikret Balta, M. and Ozrenk, K. (2006) Pomegranate (Punica Granatum L.) genetic resources from Hakkari, *Turkey. J. Agric. Biol. Sci.,* **2** (6), 520-525.

Mustafa, O., Coşkun, D., Sedat, S. and Cemal, K. (2008) Chemical and antioxidant properties of pomegranate cultivars grown in the Mediterranean region of Turkey. *Food Chemistry,* **111** (3),703-706.

Neveen A., Abeer A. Hassan, El-Halwagi and Sayed, H.A. (2012) Phytochemicals, Antioxidant and Chemical Properties of 32 Pomegranate Accessions Growing in Egypt. *World Appl. Sci. J.,* **16** (8), 1065-1073.

Oukabli, A., Bellaji, M., Chahbar, A., Elkacemi, A., Lahlou, M. and Allabou, M. (2004) Performance of local clones and imported varieties of pomegranate (Punica granatum L.) in the Meknes region. *Al Awamia.* **111** (15), 87-100**.**

Rao, K. and Subramanyam, K. (2010) Growth and yield performance of pomegranate varieties under scarce rainfall zone. *Agri. Sci. Digest,* **30** (1), 71-72.

Snedecor, G.W. and Cochran, W.G. (1980) " *Statistical Methods* ", Oxford and J. B. H. Bub Com., 7th Edition.

Spiegel-Roy, P. and Goldschmidt, E. (1996) "*Biology of Citrus*", Cambridge: Cambridge University Press.

Varasteh, F., Arzani, K., Zamani, Z. and Mohseni, A. (2009) Evaluation of the most important fruit characteristics of some commercial pomegranate (Punica granatum L.) cultivars grown in Iran. *Acta Horticulturae,* **818,** 103-108.

Winton, A.H. and Winton, K.B. (1945) " *Analysis of Food* ", Wiley, New York. p. 572.

Yilmaz, C. and Ozguven, A.I. (2004) Hormone physiology of pre-harvest fruit cracking in pomegranate (Punica granatum L.). *ISHS Acta Horticulturae,* 727: X International Symposium on Plant Bio-regulators in Fruit Production.

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دراسة أولية عن التنوع الجينى بين أنماط وراثية مختلفة من صنف الرمان المنفلوطى
أ- الخصائص المورفولوجية و الفيزيائية والكيميائية للثمار

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أجريت دراسة الاختلافات الوراثية فى صنف الرمان المنفلوطى الأكثر انتشارا على المستوى التجاري فى مصر والمنزرع فى مزرعة خاصة بالبدارى - محافظة أسيوط – مصر بعد عملية مسح أولى لمدة خمس سنوات فى الحقل.
تم انتخاب أربعة أنماط وراثية واعدة لصنف الرمان المنفلوطى حيث أنها أثبتت أن لها صفات مرغوبة وأطلق عليها المزارعون أسماء مختلفة (١- ابو شلح ، ٢- المخطط ، ٣- أبو شوكة ، ٤- جناح الدبور).

أجريت الدراسة لمدة موسمين متتاليين (٢٠١٢- ٢٠١٣) من حيث التزهير، المحصول ، الخصائص الفسيولوجية والكيماوية للثمار.

ومن المثير للاهتمام ملاحظة أن النمط الوراثى رقم (٣) قد سجل أعلى القيم للعدد الكلى للأزهار والنسبة المئوية للأزهار الخنثى بينما سجل أقل القيم لعدد الأزهارالمذكرة. وعلى العكس من ذلك النمط الوراثى رقم (٢) . أما رقم (٣) يليه رقم (٤) وصلا الى مرحلة التزهير ونضج الثمار مبكرا عن صنف المنفلوطى والأنماط الوراثية الأخرى رقم ١، ٢ (حوالى شهر تبكير فى تاريخ التزهير و١,٥ – ٢ شهر بالنسبة لمرحلة النضج). بينما النمط الوراثى رقم (٢) كان الأخير فى هذا الأمر. وجدير بالذكر أنه لوحظ اختلاف فى خصائص محصول الثمار فى الأنماط الوراثية الجديدة موضع الدراسة حيث أعطى صنف المنفلوطى المحصول الأعلى (١٠٣,٩ – ١١٢,٧ كجم / شجرة) بينما أعطى أقل نسبة مئوية للثمار الصالحة للتسويق وذلك نتيجة ارتفاع نسبة الثمار المصابة بالتشقق (٢٠,٦٠ – ٢٢,٩٠ ٪) والمصابة بلفحة الشمس (١٠,٧٠ – ١١,٤٠ ٪) خلال موسمى الدراسة، على التوالى. وقد سجلت النتائج العكسية فى النمط الوراثى (٢) حيث أنها وصلت إلى النسبة المئوية الأعلى للثمار الصالحة للتسويق حيث سجلت (٩٧,٢٠- ٩٧,٤٠٪) ولكنها أعطت المحصول الأقل (٤٣.٠٠ - ٤٨,٥٧ ٪) وأقل نسبة للثمار المصابة بالتشقق (٢.٦٠ - ٢,٨٠ ٪) ،(٠,٠٠) للمصابة بلفحة الشمس. ومن بين الأنماط الوراثية موضع الدراسة فإن رقم (١) أعطى محصول من الثمار ذات الخصائص الطبيعية المرغوبة [النسبة المئوية للوزن ، المحيط ، الطول ، الحجم والحبوب (Aril) بالإضافة الى النسبة المئوية للأنثوثيانين الكلى أما النمط الوراثى رقم (٤) كان الأغنى فى النسبة المئوية للسكريات المختزلة والكلية والتانينات. عصير ثمار صنف المنفلوطى احتوى على أعلى قيمة للمواد الصلبة الذائبة الكلية والحموضة (٪) وفيتامين (c) كنسبة لحمض الاسكوربيك مجم/١٠٠ملى عصير.

عموما فإنه تحت نفس الظروف لهذه الدراسة يمكننا أن نوصى بالأنماط الوراثية رقم (٣ ، ٤) كأصناف مبكرة، والنمط الوراثى رقم (٢) لأقل نسبة للثمار المشققة وضربة الشمس كذلك للنسبة المئوية الأعلى للثمار الصالحة للتسويق أما الأنماط الوراثية رقم (٢) للثمار ذات الصفات الطبيعية المرغوبة مثل محتواها العالى من للأنثوثياثين الكلى والنمط الوراثى رقم (٤) للأغنى فى السكريات المختزلة والسكريات الكلية . كما يمكن أن يوصى بصنف المنفلوطى للحصول على أعلي محصول رغم انخفاض نسبة الثمار الصالحة للتسويق.