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EVALUATION OF FOUR NEWLY INTRODUCED MANGO (*MANGIFERAINDICA* L.) CULTIVARS GROWN UNDER EL-GIZA CONDITIONS

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Abstract

Mango *Mangifera indica* L., is the third major fruit crop of Egypt. Four newly introduced mango cultivars, namely Aya, Kasturi, Maya and Omer grown in a private mango orchard at El-Giza region, were evaluated during two successive seasons of 2018 and 2019. Flowering and harvesting dates, growth characters, yield per tree, biennial bearing index and fruit physical and chemical properties were determined. The evaluation indicates that Omer *cv.* was the earlier cultivar in terms of flowering date, while Aya and Kasturi *cvs.* were observed to be the earlier cultivars of harvest date. The highest significant values of leaf area and the number of panicles per 10 branches were recorded with Omer *cv.* Omer *cv.* also recorded the highest yield per tree. The four cultivars under study were regular in bearing since the highest percentage of the biennial bearing index was only (8.59 %). The highest values of pulp percentage were recorded with Omer and Kasturicvs. Maya cultivar showed the heaviest seed followed by Kasturi cultivar during the two seasons. As for fruit pulp firmness, Aya *cv.* recorded the highest significant values at the maturity and the ripe stagesin the two seasons. Omer *cv.* recorded the lowest total acidity percentages in both seasons. The highest value of T.S.S. in the fruit juice (19.07 %) was recorded for Maya *cv.* in the two seasons. Maya *cv.* also exhibited the highest significant values of total sugars, total phenols and vitamin C during both seasons. The study revealed the important of these cultivars for mango breeding to satisfy the local and export market requirements.

Key words: *Mangiferaindica* L., Mango cultivars, Newly introduced, Evaluation.

Introduction

Mango (*Mangiferaindica* L.) is one of the most popular and favourite fruits in Egypt. It contains a high percentage of sugar, protein, fats, salts, vitamins. It has been considered "the king of fruits" and is widely planted in tropical and subtropical regions. In 2018, the world production of mango was around 50 million tonnes (FAOSTAT, 2020). It is known to have been cultivated in Egypt since 1825. Currently, mango is one of the main fruit trees in Egypt. It occupies third place after citrus and grapes. According to the Egyptian Ministry of Agriculture and Land Reclamation of Egypt, the production of mango is 961, 431.000 tonnes. Because of its nutritious and bioactive properties, global mango consumption has increased significantly (Poovarodom *et al.*, 2010).

Many factors influence the growth, yield, maturity and quality of fruits. One of the key factors that can influence the characteristics of grown cultivars is the growing area. Previous studies have shown that growth and fruiting behaviours vary widely between different mango varieties grown under different climatic conditions. (Abutiate, 1987; Hussein *et al.*, 1989; Avilan *et al.*, 1998; Ahmed *et al.*, 1998; Dod *et al.*, 1999; Hammam, 2000; da Silva *et al.*, 2009; Serry, 2010; Abourayya *et al.*, 2012; El-Khawaga and Maklad, 2013; Wang *et al.*, 2013; da Silva *et al.*, 2014; Ahmed *et al.*, 2016; El-Agamy *et al.*, 2018; Souza *et al.*, 2018; Igbari *et al.*, 2019). Some previously introduced mango cultivars of excellent fruit quality were successfully grown under different regionconditions in Egypt such as Keitt, Kent, Heidi, Naomi and Tommy Atkins cultivars (Abourayya *et al.*, 2012; Ahmed *et al.*, 2016; El-Agamy *et al.*, 2018). New imported mango cultivars are important for crop improvement programs in different climates conditions. The characterization is an important part of tracking the

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success of the cultivars studied which would help to introduce, select and improve the existing mango varieties. Hence, the main objectives of the present study were to evaluate and describe the main characters of trees and fruits of four newly introduced mango cultivars grown in the governorate of El-Giza, Egypt.

Materials and Methods

Plant materials

The present study was carried out to evaluate four newly introduced mango cultivars namely Aya, Kasturi, Maya and Omer grown in a private orchard located at the side of Alexandria desert road (Cairo-Alexandria Road, Km. 62), at El-Giza governorate during the two successive seasons of 2018 and 2019. The experimental trees were 8-year-old grafted on Sukkary root stock, planted at 2.5×4 meters in sandy soil and irrigated by the drip irrigation system. All trees received the recommended orchard management. The experiment was designed with three replicates and three trees/replicates in a completely randomized design. Twenty-four fruits from each cultivar were taken randomly for determining the physical and chemical characteristics. The data were recorded during the two successive seasons of study to evaluate the tested cultivars as follows:-

The dates of the beginning of flowering and the start and end of harvest were observed. Leaf area was measured according to Ahmed and Morsy (1999). L.A. = 0.70 (L × W) – 1.06. Where: L.A = leaf area (cm^2), L and W = maximum leaf length and width (cm), respectively. Number of panicles per 10 bearing branches on each tree, panicle length and width (cm), number of laterals (secondary stem) per panicle, initial fruit set per panicle, final fruit number per panicle at harvest were determined. The yield per tree and biennial bearing index were calculated as reported by El-Agamy *et al.,* (2018) and Serry (2010):

$$Biennial\ bearing\ index = \frac{Differencebetweentwo\ yields}{Sumof\ two\ yields} \times 100$$

Fruit parameters (twenty-four fruits of each cultivar) were estimated at maturity stage as: [fruit length (cm), fruit width (cm), fruit weight (g), peel (%), pulp (%), seed length (cm), seed width (cm), seed weight (g), firmness at maturity and ripe stages and shelf-life (days) in carton boxes with the temperature at 25 ± 1^0C and 65% RH]. Fruit quality attributes were estimated at the ripe stage as: [total acidity (%) by following the A.O.A.C. (2000) methods, T.S.S. (%) using refractometer at room temperature, total sugar (%) according to Tasun *et al.*, (1970), total phenols (%) according to Daniel and George (1972) and vitamin C (mg/100g pulp) by following the A.O.A.C. (1990) methods].

Statistical analysis

The treatments (cultivars) were arranged in completely randomized design and data were statistically tested by analysis of variance (ANOVA) using the general linear models "GLM" procedure of the SAS software (version 9.0; SAS Institute, Cary, NC). The mean was calculated from three replicates per treatment. The significance of cultivars' differences was evaluated with the Duncan range test at 5 % level (Duncan, 1955).

Results and Discussion

Table 1 indicates the observed dates for the beginning of flowering and the beginning and end of the harvest season. Omer was the earlier cultivar in terms of flowering date (2nd week Feb) in both study seasons, while Aya and Kasturi were observed to be the earlier cultivars of harvest date (4th week Jul) and (3rd week Jul) in both seasons, respectively. It was observed that Omer was the last harvested cultivar (1st week Sepand 3rd week Aug) during the two seasons, respectively. The data cleared that, the period from the beginning of flowering to the ending of the harvest period in the four mango cultivars under this study ranged approximately between 21 and 28 weeks through the two seasons. Omer cultivar recorded the longest period (26 and 28 weeks) during the two seasons, respectively, while the shortest period was gained by Kasturi and May a cultivars (21 weeks) of each cultivar in both seasons, respectively. These results are in agreement with El-Agamy *et al.*, 2018 and Serry, 2010 on different mango cultivars.

Table 1: Beginning of flowering and harvest period of four newly introduced mango cultivars grown under El-Giza conditions.

Parameters	Cultivars			
	Aya	Kasturi	Maya	Omer
	2018 season			
Beginning of flowering	3rd week Feb	3rd week Feb	1st week Mar	2nd week Feb
Beginning of harvest	1st week Jul	1st week Jul	3rd week Jul	2nd week Aug
Ending of harvest	4th week Jul	3rd week Jul	1st week Aug	1st week Sep
	2019 season			
Beginning of flowering	3rd week Feb	3rd week Feb	1st week Mar	2nd week Feb
Beginning of harvest	1st week Jul	1st week Jul	4th week Jul	1st week Aug
Ending of harvest	4th week Jul	3rd week Jul	1st week Aug	3rd week Aug

The data in table 2 indicated that the leaf area was not significantly varied

Table 2: Morphological parameters of four newly introduced mango cultivars grown under El-Giza conditions.

Parameters	Cultivars			
	Aya	Kasturi	Maya	Omer
	2018 season			
Leaf area (cm^2)	44.73 b	43.48 b	46.19 b	57.04 a
Number of panicles/10 branches	8.00 b	5.67 c	4.33 d	9.33 a
Panicle length (cm)	29.67 ab	34.30 a	33.80 a	26.33 b
Panicle width (cm)	19.47 a	17.50 a	16.13 a	17.53 a
Number of laterals/panicle	24.37 a	29.43 a	24.53 a	26.37 a
Initial fruit set/panicle	4.57 b	8.43 a	6.67 a	8.30 a
Fruit number/panicle at harvest	1.45 a	1.76 a	1.83 a	1.83 a
	2019 season			
Leaf area (cm^2)	43.04 b	40.07 b	46.48 b	64.41 a
Number of panicles/10 branches	8.00 b	5.33 c	4.67 c	9.67 a
Panicle length (cm)	28.67 bc	34.67 a	32.43 ab	25.97 c
Panicle width (cm)	18.00 ab	19.17 a	16.23 b	18.07 ab
Number of laterals/panicle	24.23 b	28.13 a	24.47 b	26.20 ab
Initial fruit set/panicle	5.47 b	7.07 a	6.67 ab	7.33 a
Fruit number/panicle at harvest	1.33 a	2.00 a	1.52 a	1.52 a

Means with the same letter within the same row are not significantly different at $p < 0.05$.

among the three mango cultivars Aya, Kasturi and Maya. In contrast, the highest significant values were recorded with Omer *cv.* (57.04 and 64.41 cm^2) in the first and second seasons, respectively. Abourayya *et al.*, (2012); Ahmed *et al.*, (2016); El-Khawaga and Maklad (2013); Majumder *et al.*, (2011) also reported the variation of leaf area among the different mango varieties. Omer *cv.* recorded the highest significant values of the number of panicles per 10 randomly selected branches (9.33 and 9.67) during the 2018 and 2019 seasons, respectively. Kasturi *cv.* recorded the highest values of panicle length (34.30 and 34.67 cm) during the two seasons, respectively. No significant differences were noted between the four studied cultivars concerning panicle width and the number of laterals per panicle in the first season, while Kasturi *cv.* recorded the highest significant values of panicle width and number of lateralsper panicle (19.17 cm and 28.13), respectively, compared to the other three cultivars in the second season. Aya *cv.* gave the lowest significant initial fruit set per panicle (4.57 and 5.47) compared to the other cultivars during the two seasons, respectively. There were no differences between the four studied cultivars for fruit number per panicle at harvest through the two studied seasons.

Table 3: Yield and biennial bearing index of four newly introduced mango cultivars grown under El-Giza conditions.

Parameters	Cultivars			
	Aya	Kasturi	Maya	Omer
	2018 season			
Yield/tree (kg)	43.06 b	35.26 bc	27.03 c	60.20 a
	2019 season			
Yield/tree (kg)	37.90 a	35.49 a	23.38 a	50.68 a
Biennial bearing index (%)	6.37	0.33	7.24	8.59

Means with the same letter within the same row are not significantly different at $p < 0.05$.

Tabulated results in table 3 illustrate that the yield per tree ranged from 27.03 to 60.20 kg in the first season and from 23.38 to 50 kg in the second season. Omer *cv.* recorded the highest values (60 and 50 kg) during the two seasons, followed by Aya *cv.* (43.06 and 37.90 kg) during the 2018 and 2019 seasons, respectively. The lowest values were recorded on the mango *cv.* Maya (27.03 and 23.38 kg) during 2018 and 2019 seasons, respectively. Moreover, the calculated biennial bearing index ranged between 0.33 and 8.59 % under this study. Kasturi *cv.* gave the lowest percentage (0.33 %), while Omer *cv.* gained the highest percentage (8.59 %). This means that the four mango cultivars under study were regular in bearing according to Serry, 2010 and El-Agamy *et al.*, 2018, since the tree is in regular bearing (on-year) if the index is less than 50 %, whereas the tree is in alternate bearing (off-year) if the index is more than 50%.

The quality of mango depends significantly on the physical properties of the fruit. Fruit physical parameters of the four newly introduced mango cultivars are shown in table 4. Fruit length values ranged from 8.00 to 8.53 cm and 8.07 to 8.53 cm in 2018 and 2019, respectively. The longest fruit length was recorded with Maya *cv.* (8.53 cm) in each season, followed by Kasturi *cv.* (8.33 and 8.37 cm) during the two seasons, respectively. The lowest values were recorded on the mango *cv.* Omer (8.00 and 8.07 cm) during 2018 and 2019 seasons, respectively. With respect to fruit width and weight, no significant differences were observed between the four studied mango cultivars. Fruit width values ranged from 6.43 to 6.67 cm and 6.37 to 6.60 cm in 2018 and 2019, respectively. Fruit weight values ranged from 344.04 to 369.04 g and 343.44 to 358.33 g in 2018 and 2019, respectively. Aya *cv.* recorded the highest fruit width and weight values (6.67 cm and 369.04 g) in the first season, respectively. A similar trend in the second season, Aya

Table 4: Fruit parameters of four newlyintroduced mango cultivars grown under El-Giza conditions.

Parameters	Cultivars			
	Aya	**Kasturi**	**Maya**	**Omer**
	2018 season			
Fruit Length (cm)	8.23 ab	8.33 a	8.53 a	8.00 b
Fruit width (cm)	6.67 a	6.43 a	6.63 a	6.57 a
Fruit weight (g)	369.04 a	344.04 a	355.14 a	346.85 a
Peel (%)	20.90 a	11.29 b	16.35 ab	21.47 a
Pulp (%)	67.55 a	66.46 a	65.59 a	78.22 a
Seed length (cm)	7.03 b	8.41 a	7.20 b	7.87 a
Seed width (cm)	3.39 c	4.15 ab	4.08 b	4.36 a
Seed weight (g)	32.60 a	40.73 a	42.20 a	40.60 a
Pulp firmness at mature stage (lb/in^2)	15.82 a	14.13 c	14.12 c	14.80 b
Pulpfirmness at ripe stage (lb/in^2)	7.98 a	6.17 a	4.07 b	7.87 a
Shelf life (days)	13.00 a	7.67 c	7.00 c	10.67 b
	2019 season			
Fruit Length (cm)	8.23 bc	8.37 ab	8.53 a	8.07 c
Fruit width (cm)	6.60 a	6.37 a	6.60 a	6.40 a
Fruit weight (g)	358.33 a	343.44 a	350.00 a	344.66 a
Peel (%)	19.00 a	12.73 c	14.61 b	14.13 bc
Pulp (%)	70.65 ab	76.52 a	58.87 b	63.38 b
Seed length (cm)	7.31 bc	8.41 a	6.89 c	7.87 ab
Seed width (cm)	3.24 b	4.30 a	4.04 a	4.33 a
Seed weight (g)	29.97 a	40.47 a	40.87 a	36.53 a
Pulpfirmness at mature stage (lb/in^2)	15.70 a	14.28 b	14.40 b	14.82 b
Pulpfirmness at ripe stage (lb/in^2)	7.37 a	7.27 a	2.70 b	6.70 a
Shelf life (days)	12.67 a	7.33 c	7.00 c	10.67 b

Means with the same letter within the same row are not significantly different at $p < 0.05$.

Table 5: Chemical fruit properties at ripe stage of four newly introduced mango cultivars grown under El-Giza conditions.

Parameters	Cultivars			
	Aya	**Kasturi**	**Maya**	**Omer**
	2018 season			
Total acidity (%)	1.28 a	1.49 a	1.28 a	1.07 a
T.S.S. (%Brix)	15.30 b	18.70 a	19.07 a	16.17 b
Total sugar (%)	26.45 b	18.53 d	31.58 a	24.36 c
Total phenols (%)	0.15 b	0.09 c	0.16 a	0.06 d
Vitamin C (mg/100g)	32.02 b	29.27 c	41.47 a	19.59 d
	2019 season			
Total acidity (%)	1.71 a	1.71 a	1.51 a	1.28 a
T.S.S. (%Brix)	15.27 b	18.70 a	19.27 a	16.13 b
Total sugar (%)	25.95 b	17.50 d	30.78 a	23.57 c
Total phenols (%)	0.10 b	0.07 c	0.16 a	0.06 d
Vitamin C (mg/100g)	31.20 b	27.79 c	41.31 a	18.92 d

Means with the same letter within the same row are not significantly different at $p < 0.05$.

cv. also recorded the highest fruit width and weight values (6.60 cm and 358.33 g), respectively. Kasturi *cv.* recorded the lowest fruit width and weight values (6.43 cm and 344.04 g) in the first season, respectively. In the second season, a similar pattern was observed with Kasturi *cv.* fruit width and weight values equal to (6.37 cm and 343.44 g), respectively. The variations of fruit length, width and weight have also been reported by Abirami *et al.*, (2004); Bora *et al.*, (2017); El-Agamy *et al.*, (2018); Majumder *et al.*, (2011) while evaluating different mango cultivars. Genetic or physiological influences may be responsible for this variance. The data also showed that the fruit peel percentage ranged between (11.29-21.47 and 12.73-19.00%), while fruit pulp percentage ranged between (65.59-78.22 and 58.87-76.52 %) in the first and second seasons, respectively. Kasturi *cv.* recorded the lowest value of peel percentage (11.29 %), while Omer *cv.* gave the highest value of pulp percentage (78.22 %) in the first season. The second season results were observed that Kasturi *cv.* also recorded the lowest value of peel percentage (12.73 %); meanwhile, it gave the highest value of pulp percentage (76.52 %). The observations of Anila and Radha (2006); Bora *et al.*, (2017) are also in line with the current findings. Kasturi cultivar showed the longest seed (8.41 cm) followed by Omer cultivar (7.87 cm) in each study season. Omer *cv.* showed the widest seed (4.36 and 4.33 cm) among all the cultivars during the two seasons, respectively. Maya cultivar showed the heaviest seed (42.20 and 40.87 g), followed by Kasturi cultivar (40.73 and 40.47 g) during the 2018 and 2019 seasons, respectively.

Fruit firmness is one of the most important parameters; it was differed in the evaluated mango cultivars at the maturity stage and ranged between (14.12-15.82 and 14.28-15.70lb/in^2) during both seasons, respectively. Aya *cv.* recorded the highest significant fruit pulp firmness (15.82 and 15.70 lb/in^2) at the maturity stage during the 2018 and 2019 seasons, respectively. Fruit pulp firmness at the ripe stage ranged between (4.07-7.98 and 2.70-7.37lb/in^2) during both seasons, respectively. Aya *cv.* also recorded the highest significant fruit pulp firmness (7.98 and 7.37 lb/in^2) at the ripe stage in the two seasons, respectively. The highest significant shelf-life period, up

to 13 days, was observed with Maya cultivar, followed by Omer cultivar up to 10.67 days in the first season. A similar trend was noticed during the second season. Similar results were verified by Serry (2010).

Table 5 indicates the fruit chemical quality parameters of the four newly introduced mango cultivars at the ripe stage. Without significant differences between the four studied mango cultivars in the total acidity percentage in both seasons, Omer *cv.* recorded the lowest values (1.07 and 1.28 %) in both seasons, respectively. The highest value of T.S.S. in the fruit juice (19.07 %) was recorded for Maya cultivar in the first season, followed by Kasturi cultivar (18.70 %), whereas Aya cultivar gained the lowest T.S.S. (15.30 %). Similar results were obtained in the second season. Moreover, mango *cv.* Maya also exhibited the highest significant values of total sugars (31.58 and 30.78 %), total phenols (0.16 and 0.16 %) and vitamin C (41.47 and 41.31 mg/100 g pulp) during both seasons, respectively. These results partially are in agreement with those obtained by Ahmed *et al.*, (2016); Ara *et al.*, (2014); Bora *et al.*, (2017); Chovatiya *et al.*, (2015) da Silva *et al.*, (2009); El-Agamy *et al.*, (2018); Gunjate *et al.*, (2006); Leghari *et al.*, (2013); Majumder *et al.*, (2011); Serry (2010); Wang *et al.*, (2013). In Egypt, the fruit characteristics, particularly size and flavour, typically do not satisfy the requirements of the local and export market (El-Agamy *et al.*, 2018). Characterization is, therefore, an essential prerequisite for the initiation of a breeding programme.

Conclusion

Based on the results of the current study, it can be concluded that the four studied mango cultivars (Aya, Kasturi, Maya and Omer) are successfully grown under El-Gizaclimatic conditions. The four mango cultivars are partially different based on their flowering, yield and fruit quality parameters and could be used as breeding materials to improve the Egyptian mango germplasm.

Conflict of interest

The authors declare that they have no confiict of interest.

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