

Comparative Study on Normal and Nubbin Fruits of Some Mango Cultivars

¹Shaban, A.E.A. and ²Ibrahim, A.S.A.

¹Pomology Department, Faculty of Agriculture, Cairo University, Egypt.

²Plant Physiology Division, Agricultural Botany Department, Faculty of Agriculture, Cairo University, Egypt.

Abstract: This study was carried out during 2007 and 2008 seasons on 20 years old trees of Ewais, Hindi Bisinnara, Hindi Khassa and Bullocks Heart mango cultivars. The study aimed to compare between normal and nubbin fruits of the studied cultivars. Results indicated that the highest percentage of nubbin fruits was recorded with Bullocks Heart cultivar followed by Ewais and Hindi khassa cultivars. Meanwhile the lowest percentage was achieved with Hindi Bisinnara cultivar. Number of normal fruits was higher than the nubbin fruits for all tested cultivars. Ewais trees produced the maximum number of nubbin fruits comparing to the other tested cultivars. Trees of the four tested cultivars produced higher significant yield of normal fruits than nubbin fruits. Bullocks Heart and Ewais trees produced higher yield of normal and nubbin fruits than the other tested cultivars. Fruit length, width and thickness were significantly of grater values for normal fruits than for nubbin fruits. Normal fruits recorded higher fruit and pulp weight than the nubbin fruits. Meanwhile, the pulp stone ratio was higher in nubbin fruits than the normal fruits. The normal fruits contained higher acidity than the nubbin one. The nubbin fruits were higher in their TSS, total sugars and TSS/ acid ratio than the normal fruits. Nubbin fruits recorded higher weight loss and decayed earlier than the normal fruits when kept at room temperature for two weeks. Analysis of endogenous hormones revealed that, the normal fruits contained higher concentrations of gibberellins and cytokinins and lower concentrations of auxins and abscissic acid comparing to the nubbin fruits. These findings explain the reasons of making mango nubbin fruits have a slower growth rate than the seeded one and small in size, and most of these fruits dropped and fail to reach full size.

Key words: Mango, *Mangifera indica*, Nubbin fruit, Gibberellins, Cytokinins, Auxins, Abscissic acid, Yield, Fruit weight, TSS.

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important horticultural crops in Egypt. Seedless or nubbin fruit occurs for some mango cultivars such as Ewais, Hindi Khassa and Hindi Bisinnara (Shaban, 2005a). Also Boshra (2005) induced nubbin fruits of Ewais mango cultivar under environmental conditions of Assiut governorate. These seedless fruits in Egypt are called Fass. Mango seedless fruits have a slower growth rate than the seeded one and generally become misshapen, and fail to reach full size (Litz, 1997). Seedless fruit is caused by embryo abortion and is not a result of failure of fertilization (Ram *et al.*, 1976). In general, this phenomenon differ from year to year according to the changes in temperature during flowering, pollination and fruit set. Moreover, Thimmappaiah and Harmail (1983) suggested, that low temperature during flowering reduce activity of pollinators and that absence of pollinating trees and natural selfing contributed to parthenocarpy in mango cv. Dashehari. There were no reports on the endogenous hormonal content of pulp for both normal and nubbin fruits. Therefore, this study was carried out to compare the concentration of the endogenous hormones and physical and chemical properties in normal and nubbin fruits of Ewais, Hindi Bisinnara, Hindi Khassa and Bullocks Heart mango cultivars.

MATERIALS AND METHODS

This study was carried out during 2007 and 2008 seasons on Ewais, Hindi Bisinnara, Hindi Khassa and Bullocks Heart mango cultivars grown in a private orchard under Giza governorate conditions. Trees were about 20 years old, planted in sandy soil at 6 meters apart, similar in vigor and subjected to the same cultural practices. The completely randomized block design was used, where each cultivar was replicated three times; with one tree for each replicate. When the fruit reached to the stage which can differentiate between the nubbin

Corresponding Author: Ayman Shaban, Pomology Department, Faculty of Agriculture, Cairo University, Egypt.
E-mail: aymsh70@yahoo.com

and normal fruits by making cross sections, the nubbin fruits were found to have a shriveled seed with a hollow cavity, while seed of the normal fruit was fully developed and almost filled the whole seed cavity. In this stage samples of about 10 g were taken from the stone (embryos) of normal fruit and the pulp of both normal and nubbin fruits for all tested cultivars. These samples were used for determination the concentrations of endogenous gibberellins, auxins (IAA), cytokinins and abscisic acid ($\mu\text{g/g}$ f.w.). For hormonal analysis, 10 g of the fresh plant material were cut to small pieces, extracted twice with 96% methanol then twice with 40% methanol, each for 24 hours at 4°C (Sadeghian, 1971). The methanolic extract was filtered and evaporated in a rotary evaporator at 40°C to an aqueous solution. The solution was adjusted to pH 8.6 and extracted 4 times with 100 ml ethyl acetate. The alkaline ethyl acetate solutions were mixed together and purified with anhydrous sodium sulphate (one tea spoon /100ml). The ethyl acetate fraction was filtered and evaporated to dryness; the residue was dissolved in 4 ml absolute methanol. This extraction was used for the determination of cytokinins (as zeatin) by Gas-Liquid Chromatography (GLC) according to El-Ghamrawy and Neumann (1977) and Ibrahim (1997).

The aqueous solution was acidified to pH 2.6-2.8 and extracted with ethyl acetate as described above, this extraction was used for the determination of gibberellins (as gibberellic acid, GA_3), abscisic acid (ABA) and auxins (as indole-3-acetic acid, IAA) by (GLC) according to the method described by Vogel (1975) and Ibrahim (1997). Methylation with diazomethane was performed as follows: plant hormone fractions and standards of the authentic substances were dissolved in a little anhydrous ether and the ethereal solution of diazomethane was added in small portions until gas evolution caused. The mixture acquired a pale yellow colour indicated the addition of excess diazomethane. The reaction mixture was left for 10 min. and ether was distilled off using a water bath at 40°C and the residue was dissolved in a minimal amount of absolute methanol and used for GLC analysis. The GLC analyses were carried out with an ATi-Unicam GC gas chromatography equipped 610 Series, with a dual flame ionization detector and the glass column (1.5 m x 4 mm) was packed with 1% OV-17. The GC conditions for the determination of acidic fraction (GA_3 , ABA, and IAA) were 260°C for the injector, 300°C for the detector and the column initially for 3 min. at 200°C then increased to 220°C (rate 20°C /min.) for 4 min. then increased again to 240°C (rate 20°C /min.) for 6 min., flow rates carrier gas (N_2 special) 30ml /min., hydrogen special 33ml /min and synthetic air 330ml /min and the chart speed 1 cm/min. For cytokinins, the temperature of the column was adjusted to initial temperature 220 for 3 min then increased to 250 °C (rate 30°C/min.) for 8 min. At harvest time (12 and 20 July for Hindi Bisinnara, 21 and 27 July for Hindi Khassa, 5 and 10 August for Ewais and 1 and 7 September for Bullocks Heart in 2007 and 2008 seasons respectively), number of normal and nubbin fruits per tree were counted. Tree yield of normal and nubbin fruits (Kg) was estimated by multiplying number of fruits per tree X the average of fruit weight. Also, percentage of nubbin fruits was determined as follows:

Nubbin fruit (%) = No. of nubbin fruits per tree at harvest X 100

Total number of fruits per tree at harvest

Ten mature fruits for both normal and nubbin fruits were taken randomly from each tree for determining fruit length (cm), fruit width (cm), fruit thickness (cm), fruit index (length/width ratio), fruit weight (g), stone weight (g), pulp weight (g), pulp/stone ratio, total soluble solids (%), acidity (%) and total sugars (%). Samples of 15 fruits from both normal and nubbin fruits were taken from each cultivar and kept on room temperature for two weeks to determine the fruit weight loss (%) and decay percentage for normal and nubbin fruit during storage. Data were tabulated and statistically analyzed according to Snedecor and Cochran (1980) and mean values were compared by Duncans multiple range test at 5% level of probability (Duncan, 1955).

RESULTS AND DISCUSSION

Nubbin Fruit Percentage:

Fig. (1) showed the nubbin fruit percentage of Ewais, Bullocks Heart, Hindi khassa and Hindi Bisinnara mango cultivars during 2007 and 2008 seasons. The highest percentage was recorded with Bullocks Heart cultivar followed by Ewais and Hindi khassa cultivars. Meanwhile the lowest percentage was achieved with Hindi Bisinnara cultivar. The differences between the four tested cultivars were significant in both seasons of study. These results are in line with Sukhvibul *et al.* (2000) who found significant differences between mango cultivars in the percentage of nubbin fruits produced out of the total fruit set; these percentage were 38.3% for Nam Dok Mai, 21.4% for Kensington and 6.8% for Irwin. Also Sukhvibul *et al.* (2005) recorded significant differences in nubbin fruit percentage for mango cultivars Nam Dok Mai (21%), Kensington (20%) and Irwin (3%).

Number of Normal and Nubbin Fruits:

Data presented in Table (1) showed that number of normal fruits was higher than the nubbin fruits and the differences were significant in both seasons. Concerning normal fruits it was noticed that Hindi Khassa gave the highest number followed by Ewais and Hindi Bisinnara, meanwhile Bullocks Heart recorded the lowest number. The differences between all tested cultivars were significant in both seasons. In addition to the number of nubbin fruits Ewais trees produced the maximum significant number comparing to the other tested cultivars. On the other hand, Hindi Bisinnara cultivars produced the lowest number of nubbin fruits in both studied seasons. In this concern Chacko and Singh (1969), Kulkarni and Rameshwar (1978), Shaban (2005b) produced seedless fruits of some mango cultivars.

Tree yield (kg):

Tree yield varied among all tested cultivars as shown in Table (2). Trees of all tested cultivars produced higher significant yield of normal fruit than nubbin fruit. Regarding normal fruit it was noticed that Bullocks Heart trees produced the highest yield followed by Ewais and Hindi Khassa cultivars in the first season. Meanwhile in the second season the highest yield was obtained from Ewais trees followed by Hindi Khassa and Bullocks heart. The lowest yield of normal fruit was recorded with Hindi Bisinnara cultivars in both seasons. Concerning the yield of nubbin fruit Bullocks heart trees produced the highest yield followed by Ewais and Hindi Khassa then Hindi Bisinnara which recorded the lowest values. The differences between all tested cultivars were significant in the first season only. The variation occurred in the yield among the tested mango cultivars was confirmed by Mohamed (2007) who recorded higher yield in Ewais than Hindi Bisinnara mango cultivar. Moreover, Shaban (2005b) induced nubbin fruits of Ewais, Hindi Khassa and Hindi Bisinnara by application of GA₃ and recorded the highest yield of nubbin fruits with Ewais cultivar.

Dimensions of Normal and Nubbin Fruits:

Data presented in Table (3) show the dimensions of both normal and nubbin fruits of Bullocks heart, Ewais, Hindi Khassa and Hindi Bisinnara mango cultivars. Fruit length, width and thickness were significantly higher in normal fruits than the nubbin fruits; this was noticed for all tested cultivars in both studied seasons. Regarding fruit length of normal fruits, the highest values was recorded with Bullocks heart cultivar in both seasons. Meanwhile, the shortest fruit was detected with Ewais in the first season and Hindi Khassa in the second one. Concerning the length of nubbin fruits, the highest values were found with Bullocks heart cultivar followed by Hindi Bisinnara then Ewais cultivars. On the other hand, the shortest nubbin fruit was obtained from Hindi Khassa cultivar.

Concerning fruit width, Bullocks heart cultivar recorded the highest width for both normal and nubbin fruits and the differences were significant comparing with the other tested cultivars. Conversely, Hindi Bisinnara cultivar gave the lowest width for normal fruits in both seasons as well as nubbin fruits in the first season only. Also, Hindi Khassa cultivar produced the lowest width of nubbin fruits in the second season. The highest significant fruit thickness was recorded with both normal and nubbin fruits of Bullocks heart cultivar followed by the normal fruits of Ewais and Hindi Khassa cultivars. On the other hand, Hindi Bisinnara cultivar recorded the lowest thickness of normal fruits. Regarding nubbin fruits, Bullocks heart cultivar gave the highest significant values followed by Hindi Bisinnara and Ewais cultivars. On the other side, Hindi Khassa cultivar produced the lowest thickness of nubbin fruits. In general, nubbin fruits of Bullocks heart cultivar recorded higher thickness than normal fruits of the other tested cultivars and the differences were significant in both seasons of study.

Regarding fruit index (length/thickness ratio) normal fruit recorded higher values than the nubbins although the differences were insignificant in both seasons of study. Hindi Bisinnara recorded the highest values for both normal and nubbin fruits. Meanwhile, Bullocks heart cultivar recorded the lowest fruit index for both normal and nubbin fruits this trend was noticed in both studied seasons. From the above mentioned results it could be concluded that nubbin fruits of Bullocks heart cultivar proved to be higher in their dimensions than the normal fruits of the other tested cultivars. In general, the variation in fruit dimensions may be related to both fruit types and cultivars. These results are in line with Whiley *et al.* (1988) who reported that the formation of seedless fruits occurs regularly in some mango cultivars. Also, Sukhvibul *et al.* (2005) reported that nubbin fruits of Nam Dok Mai, Kensington and Irwin mango cultivars were smaller in size than the normal ones. Moreover Boshra (2005) reported that the length, diameter and thickness were significantly higher in seeded fruits than the normal fruits of Ewais mango cultivar.

Physical Traits of Both Normal and Nubbin Fruits:

Data in Table (4) show a comparison for fruit weight, stone weight, pulp weight and pulp stone ratio of normal and nubbin fruits of Bullocks heart, Hindi Bisinnara, Hindi Khassa and Ewais mango cultivars in 2007 and 2008 seasons. Normal fruits recorded significant higher weight comparing to the nubbin fruits. The highest normal fruit weight was recorded with Bullocks heart followed by Ewais and Hindi Khassa then Hindi Bisinnara which recorded the lowest values. Concerning nubbin fruits the highest values was found with Bullocks heart cultivar followed by Hindi Bisinnara and Ewais cultivars. On the other hand, Hindi Khassa cultivar gave the lowest values in this regard. Nubbin fruits of Bullocks heart cultivar were significantly higher in their weight than the normal fruits of Hindi Khassa and Hindi Bisinnara in both studied seasons. Also the nubbin fruit of Bullocks heart cultivar was higher in its weight than the normal fruits of Ewais cultivar in the second season only.

Regarding stone weight results showed that the normal fruit of Bullocks heart cultivar produced the highest stone weight followed by Ewais and Hindi Khassa then Hindi Bisinnara; although the differences between the last two cultivars were insignificant in both seasons. Concerning nubbin fruits Bullocks heart cultivar recorded the highest significant values followed by Hindi Bisinnara and Hindi Khassa cultivars. In the contrary, Ewais cultivar gave the lowest values in this regard.

Concerning pulp weight the normal fruits produced significant higher pulp weight than the nubbin fruits. Bullocks heart cultivar recorded the highest pulp weight of normal fruits followed by Ewais, then Hindi Bisinnara and Hindi Khassa cultivars. The highest pulp weight of nubbin fruits was obtained from Bullocks heart cultivar followed by Hindi Bisinnara and Ewais cultivars. Meanwhile the lowest pulp weight was recorded with Hindi Khassa cultivar this trend was noticed in both studied seasons.

Regarding pulp/stone ratio, nubbin fruits recorded higher significant values than the normal fruits. The highest pulp/stone ratio for normal fruits was detected with Bullocks heart cultivar followed by Ewais and Hindi Khassa cultivars. Meanwhile, the lowest ratio was achieved with Hindi Bisinnara cultivar. Concerning nubbin fruits, the highest pulp stone ratio was obtained from Ewais fruits followed by Bullocks heart then Hindi Bisinnara cultivar. On the other hand, the lowest ratio was recorded with Hindi Khassa cultivar; this was noticed in both studied seasons.

In general, the nubbin fruits recorded higher significant values of pulp/stone ratio comparing to the normal fruits; this was noticed with all tested cultivars in both seasons, except the normal fruits of Bullocks heart cultivar in the second season which produced higher pulp/stone ratio than the nubbin fruits of Hindi Khassa cultivar. From the above mentioned results, it could be concluded that nubbin fruits proved to be smaller in its weight comparing to the normal fruits but it produced greater pulp stone ratio than the normal fruits. The variation in the above physical fruit characteristics are in coincidence with those obtained by Salem (1993), Mohamed (1996) and Ahmed *et al.* (1998). Moreover, Ragab *et al.* (2002) produced higher pulp seed ratio in Ewais fruits than Hindi Bisinnara. Also, Shaban (2005a) and Boshra (2005) recorded higher pulp stone ratio in nubbin fruits than the normal fruits of some mango cultivars.

Chemical Traits of Both Normal and Nubbin Fruits:

Data in Table (5) indicated that the nubbin fruits contained higher total soluble solids (TSS) than the normal fruits however the differences between them were insignificant in both seasons. Ewais fruits contained the highest TSS followed by Hindi Bisinnara and Hindi Khassa. Meanwhile, Bullocks heart cultivar recorded the lowest values in this regard. This trend was detected for both normal and nubbin fruits in the two studied seasons.

Regarding fruit acidity, the normal fruits contained higher acidity than the nubbin one with insignificant differences between them (Table 5). Bullocks heart cultivar recorded the highest fruit acidity followed by Hindi Khassa and Hindi Bisinnara then Ewais which produced the lowest values. This trend was observed with both normal and nubbin fruits.

Concerning TSS/acid ratio it was significant higher in the nubbin fruits than the normal one. Ewais fruits produced the highest ratio for both normal and nubbin fruits followed by Hindi Bisinnara and Hindi Khassa. Meanwhile, Bullocks heart fruits recorded the lowest ratio; this trend was observed in both studied seasons. Concerning total sugars nubbin fruits contained higher amount than the normal fruits. Ewais cultivar gave the highest values followed by Hindi Bisinnara and Hindi Khassa then Bullocks heart fruits which recorded the lowest total sugars content this trend, was detected with both normal and nubbin fruits in the two studied seasons.

The above mentioned results showed that the nubbin fruits were higher in their TSS, total sugars and TSS/acid ratio than the normal fruits. These results are in agreement with Boshra (2005) on Ewais cultivar, Shaban (2005a) on Ewais, Hindi Bisinnara and Hindi Khassa mango cultivars, as they reported higher TSS,

total sugars and TSS acid ratio in nubbin fruits than the normal fruits. Moreover Dod *et al.* (1999) demonstrated that physical and chemical characteristics of mango cultivars differed according to cultivars. Similarly, Mohamed (1996), Hammam (2002) and Ragab *et al.* (2002) recorded higher fruit TSS, sugars and TSS acid ratio in Ewais than Hindi Bisinnara mango cultivars.

Decay Percentage and Weight Loss of Fruits During Storage:

Data presented in Table (6) showed weight loss and decay percentages of normal and nubbin fruits of Ewais, Bullocks Heart, Hindi Bisinnara and Hindi Khassa mango cultivars during storage at room temperature. Nubbin fruits recorded higher significant weight loss percentage than the normal ones; this may be attributed to the smaller weight of nubbin fruits than the normal fruits. Both normal and nubbin fruits of Ewais cultivar recorded significant higher weight loss percentage than the other tested cultivars. Meanwhile, the highest weight loss percentage was detected with the normal and nubbin fruits of Bullocks Heart cultivar. In general, Ewais cultivar showed the highest fruit weight loss followed by Hindi Bisinnara and Hindi Khassa. On the other hand, Bullocks heart cultivar recorded the lowest fruit weight loss.

Concerning decay percentage, nubbin fruits decayed earlier than the normal fruits and the difference was significant in the first season only. Nubbin fruits of both Bullocks heart and Hindi Khassa cultivars showed higher decay percentage than Hindi Bisinnara cultivar. On the other hand, the lowest decay percentage was achieved with the normal fruit of Ewais cultivar. These differences between normal and nubbin fruits in their decay percentage during storage at room temperature may be related to disappearance of the stone in the nubbin fruits. In general, the nubbin fruits had a lower ability to be stored at room temperature where it decayed earlier than the normal fruits when kept at room temperature for two weeks. Also, there was a variation between the fruits of the tested cultivars in their weight loss and decay percentage. In this concern, several investigators recorded fruit weight loss and decay in different mango cultivars during storage (Joseph and Aworth 1992; Ashwani *et al.*, 1995; Zambrano and Manzano, 1995 and Suntharalingam, 1996).

Table 1: Number of normal and nubbin fruits of some mango cultivars in 2007 and 2008 seasons.

Cultivars	2007 season		2008 season	
	Normal fruit	Nubbin fruit	Normal fruit	Nubbin fruit
Ewais	205 b	18 e	219 b	14 e
Bullocks Heart	62 d	6 f	64 d	5 f
Hindi Khassa	230 a	9 f	242 a	7 f
Hindi Bisinnara	190 c	5 f	208.7c	4 f
Mean	171.8A	9.5 B	183.4A	7.5 B

Values followed by the same letter(s) in each column are not statistically different at 5% level.

Table 2: Tree yield (Kg) of normal and nubbin fruits of some mango cultivars in 2007 and 2008 seasons.

Cultivars	2007 season		2008 season	
	Normal fruit	Nubbin fruit	Normal fruit	Nubbin fruit
Ewais	49.05 b	1.17 f	53.19 a	0.83 d
Bullocks Heart	51.77 a	1.96 e	46.11 b	1.33 d
Hindi Khassa	47.54 c	0.47 g	47.20 b	0.33 d
Hindi Bisinnara	34.59 d	0.35 g	35.42 c	0.29 d
Mean	45.74A	0.98B	45.48A	0.700B

Values followed by the same letter(s) in each column are not statistically different at 5% level.

Table 3: Length, width, thickness and length thickness ratio (fruit index) of normal and nubbin fruits of some mango cultivars in 2007 and 2008 seasons.

Cultivars	2007 season		2008 season	
	Normal fruit	Nubbin fruit	Normal fruit	Nubbin fruit
Fruit length (cm)				
Ewais	10.6 b	6.6 d	11 b	6.4 e
Bullocks Heart	14 a	9.4 c	13.5 a	9.1 d
Hindi Khassa	11.4 b	6.2 d	10 c	5.3 f
Hindi Bisinnara	10.9 b	6.9 d	10.1 c	6.7 e
Mean	11.73 A	7.27 B	11.15 A	6.87 B
Fruit width (cm)				
Ewais	7.15 c	4.5 f	7.15 c	4.36 f
Bullocks Heart	11.3 a	8.86 b	10.6 a	8.3 b
Hindi Khassa	6.7 d	4.4 f	6.2 d	3.7 g
Hindi Bisinnara	5.9 e	4.15 f	5.4 e	4 fg
Mean	7.76 A	5.47 B	7.33 A	5.09 B

Table 3: Continued

Fruit thickness (cm)				
Ewais	6.15 c	3.9 e	5.9 c	3.8 f
Bullocks Heart	9.2 a	7.1 b	9.0 a	6.9 b
Hindi Khassa	5.6 d	3.4 f	5.4 d	3.2 g
Hindi Bisinnara	5.3 d	3.9 e	5.0 e	3.95 f
Mean	5.56 A	4.57 B	6.32 A	4.46 B
Fruit index (Length/ Thickness ratio)				
Ewais	1.5 bcd	1.46 cd	1.53cd	1.48 de
Bullocks Heart	1.23 ef	1.06 f	1.27f	1.09 g
Hindi Khassa	1.7 ab	1.4 de	1.61bc	1.43 e
Hindi Bisinnara	1.82 a	1.66 abc	1.87a	1.67 b
Mean	1.56 A	1.39 A	1.57 A	1.41 A

Values followed by the same letter(s) in each column are not statistically different at 5% level.

Table 4: Comparison of fruit weight (g), stone weight (g), pulp weight (g) and Pulp/ stone ratio of normal and nubbin fruits of some mango cultivars in 2007 and 2008 seasons.

Cultivars	2007 season		2008 season	
	Normal fruit	Nubbin fruit	Normal fruit	Nubbin fruit
Fruit weight (g)				
Ewais	239.2 c	65.3 g	242.9 c	59.7 g
Bullocks Heart	835 a	327 b	722.2 a	266 b
Hindi Khassa	206.7d	52.7 h	194.3 d	48.5 h
Hindi Bisinnara	182.1e	70.4 f	170.3 e	73.9 f
Mean	365.8A	128.9B	332.4A	112 B
Stone weight (g)				
Ewais	26 b	2.3 d	27.1 b	2.4 f
Bullocks Heart	84.1 a	20 c	29.3 a	16 d
Hindi Khassa	25.17b	3.7 d	24. c	3.2 ef
Hindi Bisinnara	23.7b	4.5 d	23.2 c	4.7 e
Mean	39.74A	7.62 B	33.4 A	6.57 B
Pulp weight (g)				
Ewais	201.5c	50.8 g	205.9 c	45.7 g
Bullocks Heart	785.7a	296 b	674.3 a	238.6 b
Hindi Khassa	174.8d	39.1 h	163.2 d	35.2 h
Hindi Bisinnara	154.1e	55.4 f	143.1 e	58.5 f
Mean	329 A	110.3B	296.6 A	94.5 B
Pulp / Stone ratio				
Ewais	7.74 e	22.08 a	7.59 f	19.10 a
Bullocks Heart	6.34 g	14.8 b	11.37 d	14.64 b
Hindi Khassa	6.93 f	10.76 d	6.8 g	10.96 e
Hindi Bisinnara	6.5 g	12.31 c	6.16 h	12.44 c
Mean	6.87 B	14.99 A	7.98 B	14.29 A

Values followed by the same letter(s) in each column are not statistically different at 5% level.

Table 5: Total soluble solids (%), acidity (%), TSS/Acid ratio and total sugars of normal and nubbin fruits of some mango cultivars in 2007 and 2008 seasons.

Cultivars	2007 season		2008 season	
	Normal fruit	Nubbin fruit	Normal fruit	Nubbin fruit
Total soluble solids (%)				
Ewais	10.4 b	11.0 a	10.2 b	10.87a
Bullocks Heart	7.8 f	8.2 de	8.0 f	8.36 e
Hindi Khassa	8.0 ef	8.4 d	8.4 e	8.9 d
Hindi Bisinnara	9.6 c	9.8 c	9.4 c	10.0 b
Mean	8.95 A	9.35 A	9.0 A	9.53 A
Acidity (%)				
Ewais	1.8 cd	1.6 e	2 bc	1.7 e
Bullocks Heart	2.3 a	2.1 b	2.2 a	2.0 bc
Hindi Khassa	2.1 b	1.9 c	2.1 ab	1.9 cd
Hindi Bisinnara	1.9 c	1.7 de	2 bc	1.8 de
Mean	2.02 A	1.82 A	2.07 A	1.85 A
TSS/Acid ratio				
Ewais	5.77b	6.78 a	5.1 c	6.35 a
Bullocks Heart	3.39f	3.90 e	3.64 g	4.30 e
Hindi Khassa	3.8 e	4.42 d	4.0 f	4.68 d
Hindi Bisinnara	5.05 c	5.76 b	4.7 d	5.55 b
Mean	4.5 B	4.98 A	4.36 B	5.22 A

Table 5: Continued

	Total sugars (%)			
Ewais	8.9 a	9.1 a	8.2 c	9.0 a
Bullocks Heart	7.0 e	7.5 d	7.1 g	7.5 f
Hindi Khassa	7.6 d	8.0 c	7.4 f	7.8 e
Hindi Bisinnara	8.2 c	8.6 b	8.0 d	8.4 b
Mean	7.92 A	8.3 A	7.67 B	8.17 A

Values followed by the same letter(s) in each column are not statistically different at 5% level.

Table 6: Weight loss (%) and decay (%) of normal and nubbin fruits of some mango cultivars after storage at room temperature for two weeks during 2007 and 2008 seasons.

Cultivars	2007 season		2008 season	
	Normal fruit	Nubbin fruit	Normal fruit	Nubbin fruit
	Weight Loss (%)			
Ewais	18.2 b	25 a	17.93 b	28.7 a
Bullocks Heart	8.4 g	10.5 e	8.70 h	10.1 f
Hindi Khassa	9.4 f	11.7 d	9.10 g	15.5 d
Hindi Bisinnara	11.8 d	13.8 c	11.39 e	16.2 c
Mean	11.95 B	15.25 A	11.78 B	17.63 A
	Decay (%)			
Ewais	6.6 e	26.6 d	13.3 d	33.3 c
Bullocks Heart	33.3 c	53.3 a	40 bc	60.0 a
Hindi Khassa	40.0 b	53.3 a	46.6 b	60.0 a
Hindi Bisinnara	26.6 d	40 b	33.3 c	46.6 b
Mean	26.63 B	43.4 A	33.3 A	49.97 A

Values followed by the same letter(s) in each column are not statistically different at 5% level.

Endogenous Hormones of Both Normal and Nubbin Fruits:

The concentration of endogenous gibberellins (GA₃) in normal and nubbin fruits of Ewais, Hindi Bisinnara, Hindi Khassa and Bullock's Heart mango cultivars are shown in Fig (2). The stone of normal fruits contained higher gibberellins than the pulp of both normal and nubbin fruits. The highest gibberellins concentration was detected in Ewais stone followed by Bullock's Heart and Hindi Khassa meanwhile, the lowest gibberellins concentration was found in Hindi Bisinnara stone. The same trend was noticed for the pulp of both normal and nubbin fruits. Pulp of normal fruits recorded higher concentration of gibberellins than the pulp of nubbin fruits.

Concerning the concentration of endogenous auxins (IAA), the pulp of nubbin fruits recorded higher concentration than the pulp of the normal fruits. Meanwhile, the lowest auxins concentration was detected in the stone of normal fruits Fig. (3). Ewais fruits recorded the highest auxins concentration followed by Bullock's Heart and Hindi Khassa cultivars meanwhile the lowest auxins concentration was found in Hindi Bisinnara stone. This trend was noticed with pulp of normal and nubbin fruits as well as the stone of normal fruits.

Regarding the concentration of cytokinins (as zeatin), the obtained results Fig (4) showed that the highest values were found in the stone of all tested cultivars followed by the pulp of the normal fruits then the pulp of the nubbin fruits, which recorded the lowest values in this regard. Ewais cultivar contained the highest concentration of cytokinins in the stone and the pulp of both normal and nubbin fruits followed by Hindi Bisinnara and Bullock's Heart cultivars. On the other hand, the lowest concentration of cytokinins was found in the pulp of nubbin fruits of Hindi Khassa cultivar.

Abscisic acid was found to be higher in the pulp of nubbin fruits than the pulp of the normal fruits while, the stone of the normal fruits recorded the lowest values Fig. (5), and this finding may explain that the probability of abscission of the nubbin fruits is higher than the normal fruits. The stone of Ewais and Bullock's Heart cultivars contained traces of abscisic acid comparing with Hindi Khassa and Hindi Bisinnara cultivars. On the other hand, the highest abscisic acid value was found in the pulp of Hindi Bisinnara cultivar. Both Ewais and Bullock's Heart cultivars contained lower Abscisic acid than Hindi Khassa and Hindi Bisinnara cultivars. From the above mentioned results it could be concluded that the normal fruits contained higher amount of gibberellins and cytokinins and lower amount of auxins and abscisic acid comparing to the nubbin fruits. Therefore, these endogenous hormones appear to play an important role in development and growth of the nubbin fruits. Our results are in accordance with the findings of Ram (1983) who reported that the seed of Dasherhari mango fruit was the major source of gibberellin meanwhile, the pericarp contained only traces. cytokinin were found in both seed and pericarp. Moreover, Chen (1983) demonstrated that the cytokinin content of parthenocarpic fruits was extremely low as compared with that of fertilized fruits. Furthermore, the cytokinin activity decreased almost to zero at the marble stage this was combined with the heavy drop of

parthenocarpic fruits of mango at this stage. Hence, the high cytokinin activity of fertilized fruits may be considered as resulting merely from strong sink activity in these fruits. Also, Krisanapook *et al.* (2000) determined endogenous gibberellins and cytokinins in Khiew Sawoey mango fruits and they showed good relation between these two hormones and fruit development. In big fruit gibberellins and cytokinins were higher than the small fruits which showed their important role in fruit development. Also, gibberellins were higher than cytokinins in both big and small fruits which have no seed. Thus, this kind of fruit may lack the source of essential plant hormones which reasoned to unable to further their growth and all of these fruits dropped later. Furthermore, the lower concentrations of auxins, gibberellins and cytokinins as well as higher concentrations of abscisic acid in developing fruitlets and pedicels have been associated with fruit drop (Ram, 1992; Bains *et al.*, 1997). Also, increasing ethylene production was related to the abscission of seeded fruit, while parthenocarpic fruit abscised without an increase in the growth regulator in Tommy Atkins mango (Nunez-Elisea and Davenport, 1983). Finally, the obtained results in this study strongly explain the reasons of making mango nubbin fruits have a slower growth rate than the seeded one and small in size, and most of these fruits dropped and fail to reach full size.

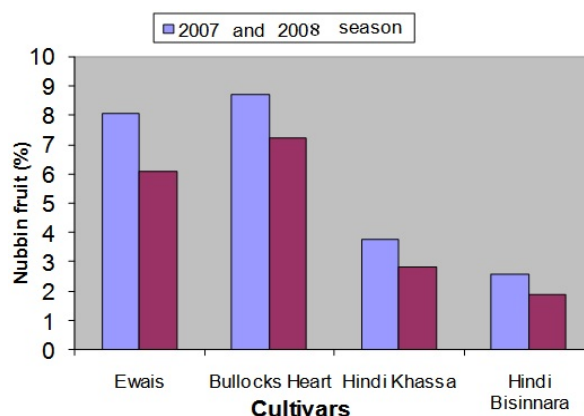


Fig. 1: Nubbin fruit (%) of some mango cultivars in 2007 and 2008 seasons.

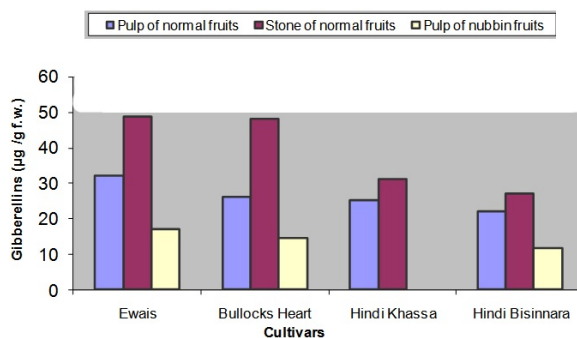


Fig. 2: Endogenous gibberellins in normal and nubbin fruits of some mango cultivars 2008 season.

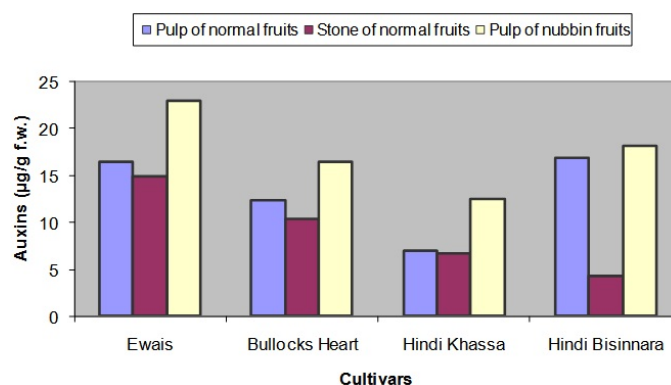


Fig. 3: Endogenous auxins in normal and nubbin fruits of some mango cultivars in 2008 season.

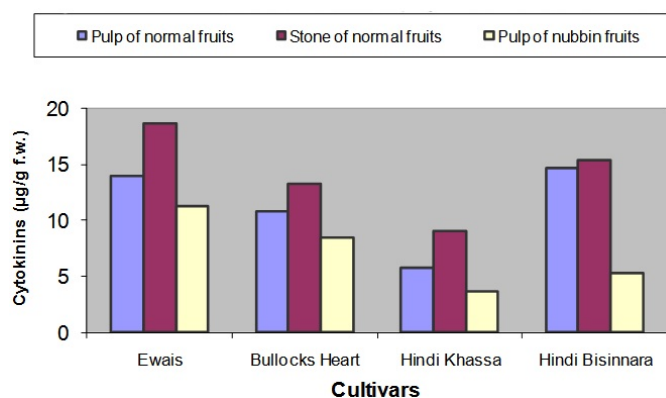


Fig. 4: Endogenous cytokinins content in normal and nubbin fruits of some mango cultivars in 2007 season.

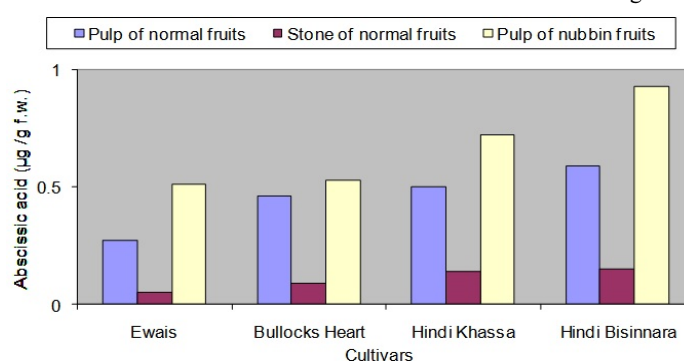


Fig. 5: Endogenous abscisic acid in normal and nubbin fruits of some mango cultivars in 2007 season.

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