

## Evaluation of New Strains Produced From Pineapple (*Ananas comosus*) Var. Cayeen Treated with Colchicine

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**T**HIS STUDY was carried out during 2013 and 2014 seasons in order to evaluate 14 pineapple strains resulted from colchicine treatment of pineapple plants grown in the orchard of Horticulture Research Orchard, Agriculture Research Center. Giza. Egypt, in comparison with the original cultivar Cayeen. Fruit characteristics, as physical and chemical properties of fruit were recorded. Morphological characteristics for leaf edges, fruit, crown and flowers were, also, studied. Results demonstrated that, total fruit weight (fruit+crown) was the highest with strain no. 9 in comparison with other tested strains, as well as "Cayeen" cv. Regarding, fruit physical properties, strain no. 9 recorded the heaviest fruit weight 900 g as compared to 462.5g for the original cultivar (Cayeen) with an increase of 94.6% for fruit weight. Concerning fruit chemical properties, data indicated no significant differences in fruit juice T.S.S% and total sugars content. General evaluation revealed that strain no. 9 seemed to be the superior strain regarding fruit quality among all the tested strains, as it attained the uppermost score as compared with the standard cv." Cayeen". The morphological evaluation showed that it has smooth leaf. Dormant flowers were recorded in the inflorescences of some strains and the strains no. 17 and 31 were advised for further study in breaking dormant flowers.

Thus, It can be concluded that the selected strain no. 9 has good fruit quality for consumer and strains no. 17 and 31 needs further studies concerning flower dormant activation.

**Keywords:** Pineapple, Colchicine, Breeding, Strains.

World consumption of fresh pineapple has quadrupled in less than 10 years (Loeillet *et al.*, 2011). This phenomenal event started around 1996 when the first dedicated fresh market pineapple, '73-114', was released by Del Monte Inc. This was the culmination of somewhere in the vicinity of 34 years of breeding and selection and comprised 24 individual parent combinations (Anon., PRI breeding records). This demonstrates the difficulty of breeding new pineapple cultivars but also the value of a successful program. The success of '73-114' and the competitive nature of world pineapple markets have provided impetus for pineapple breeding programs. However, the highly heterozygous nature and self-incompatibility of pineapple limit breeding strategy options. (Sanewski *et al.*, 2011)

Polyploidy plants can be promising source for plant breeding. In this regard Hannweg *et al.* (2012). Polyploid plants can arise naturally from the duplication of chromosomes of a single species (autopoloidy) or the combination of two or more chromosome sets of different species (allopoloidy). Generally, induced autopolyploids are expected to have at least one of the following characteristics which would result in the improvement, or development of new economically important plants, larger tuber, rhizome or root size, increased fruit size, enhanced flower size and/or colour intensity, improved drought tolerance, increased biomass, improved photosynthetic capacity, larger and/or thicker leaves, dwarfism, increased secondary metabolite production e.g. medicinal compounds.

Ploidy manipulation is a renowned source of germplasm development for citrus crop improvement. *In vitro* culture offers the novel methods of creating polyploid plants (Hannweg, 1999, Starrantino, 1999, Ollitrault *et al.*, 2000 and Zhang *et al.*, 2007). Polyploids could be developed using strategies like *in vivo* and *in vitro* application of colchicine for doubling the chromosome number (Hannweg, 1999), interploid crossing followed by embryo rescue plantlets have been successfully recovered in several tree genera using endosperm culture *in vitro* including *Citrus* (Mooney *et al.*, 1996 and Ollitrault *et al.*, 1996a) *Malus* (Mu and Liu, 1979), *Prunus* (Liu and Liu, 1980), *Actinidia* (Gui *et al.*, 1982), *Pyrus* (Zhao, 1983) and *Morus* (Thomas *et al.*, 2000). The availability of limited gene pool and polyploidy germplasm for breeding and biotechnology programs suggests intensive research work in this important area. Therefore, both strategies were explored for polyploid development in elite citrus cultivars using colchicine application *in vivo* and endosperm culture *in vitro*. The generated polyploids will contribute towards enrichment of *Citrus* germplasm for future breeding and biotechnology applications. Scherer *et al.* (2015), The ‘Gigante de Tarauacá’ is a native pineapple that produces large fruits (as much as 15 kg) in the region of Tarauacá, Acre State, Northern Brazil. Hypothesizing that this feature is related with polyploidy.

In Egypt many publications reported that pineapple fruits was too small to be recommended in cultivation (Nady, 2010).

The aim of this study was to produce and evaluate new strains for fresh market with improved fruit quality through inducing polyploidy plant by using colchicine.

### Materials and methods

This study was carried out in Giza governorate during the period of (2011-2015) to induce (by colchicines treatments) and evaluate new strains of pineapple produced from the original cultivar Cayenne.

*In vitro* Cayenne pineapple in shooting stage was employed for this study, pineapple shoots clusters were planted on a medium comprised of Murashige and Skoog (MS) (1962) salts with 0.5 mg<sup>-1</sup> thiamine HCl, 0.5 mg<sup>-1</sup> pyridoxine, 0.5 mg<sup>-1</sup>

nicotinic acid, 100 mg<sup>-1</sup> myo-inositol, and 30 g<sup>-1</sup> sucrose. This medium was supplemented with 2 mg<sup>-1</sup> BA and 0.7% (w/v) Difco agar. The pH was adjusted before agar addition to 5.6 with either 0.1 M KOH or 0.1 M HCl. Media were autoclaved for 15 min at 121 °C and 103 kPa. Explants were cultured in 300 ml glass jars containing 50 ml media. Cultures were maintained at 27 ± 3°C under 3000 lux from cool white fluorescent tubes with a 16 hr photoperiod.

*The treatments:* colchicine was added to the medium before autoclaving in concentrations of 5, 10 and 15 ppm.

Produced plants were acclimatized and grown in greenhouse until suitable size then transplanted in sandy soil prepared especially in the open field.

**TABLE (A) strains produced from colchicine concentrations.**

Colchicine concentrations	Strains produced
5 ppm	4, 9, 11, 15, 1
10 ppm	17, 23, 31, 32 34, 33, 26, 36, 35
15 ppm	51, 53, 40, 42, 47

*Experimental design and measurements:* The randomized complete design was adopted for this experiment. Three jars, each containing six clusters of five shoots evenly spaced within the jar, were used for each treatment. At the end of the experiment the following data were taken, physical and chemical properties of fruits. Representative fruits were taken at full ripe stage. Fruit evaluation included weight of both fruit, crown and peel, fruit dimensions, and pulp% were measured. Total soluble solids T.S.S % in the pulp using a hand refractometer. Acidity was determined according to the method described in the A.O.A.C (1985). Total and reducing sugars content were determined according to Lane & Eynon volumetric procedure as outlined in A.O.A.C. (1985).

**Vitamin C determination:** 5 ml of juice of ripen pineapple fruits were mixed with 5 ml of 2% oxalic acid in test tube and titrated with 2, 6 dichlorophenol indophenol (50mg/250ml of warm distilled water) until rosy colour appeared (y ml). Titrations repeated with 10 ml from vitamin C solution 10mg/250 of 2% oxalic acid (x ml). Vitamin C concentration, according A.O.A.C. (1960), in mg/100ml of juice calculated according to the following equation:

$$\text{Vitamin C} = 8Y \div X = \text{mg Vitamin C/100ml of juice}$$

*Statistical analysis:* The statistical analysis of the collected data were carried out according to Snedecor and Cochran (1980). Means were compared using the new L.S.D. values at 5% probability level. Percentages were transformed to arcsines prior to the statistical analysis.

The final evaluation of any tested strains was calculated on the basis of 100 units (Hussein *et al.*, 1982) which were shared between fruit weight (50 units) and fruit quality (50 units). The latter units were divided on the basis of 10 units for each of Vit C, pulp%, T.S.S and total sugar percentage and the percentage of acidity.

Each pineapple strain that gave the best results in any character got the maximum value specified for this character, while each of the other tested strains took lower units equal to their quality. For instance if strain no. 9 produced the highest yield it will have the 50 units specified for this character accordingly by units of any other tested pineapple strains for the same character could be calculated as follows:

$$\frac{50 \times \text{fruit weight of tested strain}}{\text{Fruit weight of strain no. 9}}$$

Similarly, units for any concerned character were calculated in the same way.

## Results and Discussion

### *Physical fruit properties*

Data in Table 1 show a comparative study for physical fruit properties of various strains resulted from colchicine treatments. Data clearly showed that:

Fruit length: strain no. (9) was significantly the tallest fruits (9 cm) followed by strain no. 11 (7.5 cm), the length of strains no. 4, 23 and 26 was 7 cm, the other strains were shorter than 7 cm.

Fruit diameter: the strain no. 11 recorded the highest significant value for fruit thickness. It reached (9.5 cm) in diameter followed by the strains no. 9 and 26 the fruit diameter was (9 cm) while for all other strains the values were thinner.

Total fruit weight: it is clear from the data in Table 1 that strain no. 9 had the heaviest fruit weight (900g) followed by strain no. 4 (694g) while all other strains showed a smaller fruit weight values ranged from 295 to 490g.

Fruit weight: the strain No. 9 was the heaviest fruit (703 g) followed by strain No. 4 (494 g). All other strains showed a smaller fruits ranged from 244 to 425g.

Crown weight: the largest crowns (200g) recorded for the strain no. 4 followed by (197g) for the strain no. 9. The other strains crowns were smaller and ranged from 60 to 150g.

Berries number: highest berries number (45) was recorded for the strains no. 9 followed by 39, 38, 33, 31 and 30 for strains no. 11, 23, 36, 26 and 33, respectively. All other strains showed a smaller number of berries.

TABLE 1. Physical fruit properties for various strains resulted from 5, 10 and 15 ppm treatments.

Strains	Fruit length (cm)			Fruit diameter (cm)			Total fruit weight (g)			Fruit weight (g)			Crown weight (g)			beers number			Beal weight			Bulb %		
	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.
	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.	2013	2014	Av.
1	4.4	4.6	4.5	5.6	6.4	6	250	160	205	210	140	175	40	20	30	10	22	16	24	36	30	88.57	74.28	81.4
4	7.4	6.6	7	7.5	7.3	7.4	704	684	694	474	514	494	230	170	200	31	27	29	97	93	95	79.53	81.90	80.7
9	8.7	9.3	9	8	10	9	934	866	900	717	689	703	217	177	197	40	50	45	146	136	141	79.63	80.26	79.9
11	7.8	7.2	7.5	10	9	9.5	502	568	535	381	469	425	121	99	110	35	43	39	67	59	63	82.41	87.42	84.9
15	5	6	5.5	6.7	6.3	6.5	384	354	369	281	227	254	103	127	115	22	30	26	39	47	43	86.12	79.29	82.7
17	6.2	5.8	6	7.4	7	7.2	309	411	360	261	339	300	48	72	60	17	35	26	52	34	43	80.07	89.97	85.0
23	7.8	6.2	7	6.5	6.7	6.6	482	498	490	317	363	340	165	135	150	32	44	38	71	59	65	77.60	83.74	80.6
26	5.9	8.1	7	8.7	9.3	9	465	405	435	393	357	375	72	48	60	34	28	31	61	55	58	84.47	84.59	84.5
33	6.6	7	6.8	7.1	6.3	6.7	532	426	479	362	296	329	170	130	150	38	22	30	48	32	40	86.74	89.18	87.9
34	5.2	5.8	5.5	6.5	6.5	6.5	357	431	394	214	274	244	143	157	150	22	36	29	33	47	40	84.57	82.84	83.7
35	4.8	4.2	4.5	6.3	5.7	6	63	107	85	55	95	75	8	12	10	18	30	24	14	26	20	74.54	72.63	73.5
36	6	7	6.5	7.3	7.7	7.5	259	331	295	243	307	275	16	24	20	31	35	33	42	38	40	82.71	87.62	85.1
51	6	6.4	6.2	7.3	7.7	7.5	427	511	469	325	393	359	102	118	110	21	27	24	61	55	58	81.23	86.00	83.6
53	4.9	4.3	4.6	6.1	5.5	5.8	100	124	112	88	112	100	12	12	12	17	23	20	22	28	25	75	75	75
Cayenn	6.5	6.3	6.4	7.5	7.7	7.6	455	470	462	214	232	223	241	238	239	46	49	47	60	68	64	71.9	70.6	71.3
L.S.D	1.22	1.28		0.8	0.7		41	35		30	17		15	19		12	9		6.5	7.3		3.4	4.2	

Peel weight: highest peel weight (141g) was recorded for the strains no. 9 followed by 95g for the strain no. 4, the other strains peel weight ranged from 40 to 65g.

Bulb %: there were no significant differences among the studied strains. The highest value (87.9%) was recorded for the strain no. 33. whereas, the lowest values (73% and 75%) were recorded for the strains 35 and 53, respectively. All other strains were in range of 79.9% to 86.1%. Hannweg *et al.* (2012) mentioned that induced autopolyploids, expected to have at least one of the following characteristics, larger tuber, rhizome or root size, increased fruit size, enhanced flower size and/or colour intensity, improved drought tolerance, increased bio-mass, improved photosynthetic capacity, larger and/or thicker leaves, dwarfism, increased secondary metabolite production e.g. medicinal compounds. Scherer *et al.* (2015) mentioned that the 'Gigante de Tarauacá' is a native pineapple that produces large fruits (as much as 15 kg) in the region of Tarauacá, Acre State, Northern Brazil.

Hypothesizing that this feature is related with polyploidy, ploidy levels identified in the histograms by flow cytometry revealed the triploid nature of the 'Gigante de Tarauacá' ( $2n = 3x = 75$ ) and the diploid status of 'Pérola' ( $2n = 2x = 50$ ). To the best of our knowledge this is the first report of the triploid nature of the 'Gigante de Tarauacá'.

Cabral *et al.* (2009) mentioned that the main constraint of the pineapple crop in Brazil, with good fruit quality and spineless leaves. Cabral and Matos (2009) stated that the 'Imperial' pineapple plant is of intermediate height with spineless dark green leaves. The fruit is small and cylindrical. The following characteristics may be considered as unfavourable: slow plant growth, peduncle with small diameter, small fruit (1.6 kg),

#### *Chemical fruit properties*

Data In Table 2 showed a comparison among various strains resulted from *in vitro* colchicine treatments in chemical fruit properties.

Vitamin C: data clearly showed that there were no significant differences in vitamin C in various strains. The highest insignificant value (45 mg/100g) recorded for the strain no. 11, and the lowest value (32mg/100g) recorded for the strain no. 4. All other strains came in range of (34 to 43 mg/100g)

Although the range was wide but data were not significant that pineapple chemical fruit properties are hardly affected by climatic conditions Joomwong (2006) showed that the fruit harvested in winter had the highest content of total soluble solid (TSS) and titratable acids (TA), and the lowest TSS acid ratio than any other seasons. However, the correlation between development and sugar metabolism in the 'smooth cayenne' cultivated in the different harvest seasons is yet unknown.

Acidity: data clearly showed that there were no significant differences in acidity value. The highest value for acidity was (1220mg/100g), recorded for strain no. 11 and the lowest 711mg/100g for the strain no. 53. All other strains were in range of 800mg/100g to 1140mg/100g.

Total sugars: data showed that there were no significant differences among all studied strains. The highest value for total sugars 30 recorded for the strain no. 51 and the lowest value was 23 the strain no. 1 all other strains came in between they ranged from 24 to 26 in very narrow range.

Reducing sugars: it is clear from data in Table 2 show that there were no significant differences among all studied strains in reducing sugars. Data showed that highest value 9 recorded for the strain no. 15 and the lowest insignificant value 7.9 recorded for strains no. 53. Others strains were in narrow range of 8 to 8.4.

Non reducing sugars: data showed that there are no significant differences among all studied strains. Highest insignificant value for non reducing sugars 21.7 recorded for the strain no. 51 and the lowest insignificant value 14.1 recorded for the strain no. 1. All studied strains were in wide range of 14.1 to 21.6.

Fruit taste and quality depends on factors such as sugars, organic acids, firmness, amino acids and aromatic compounds. Sugars synthesized in source tissues are one of the most important sugars, which are transported into sink tissues such as fruit, shoots and other tissues (Itai and Tanahashi, 2008).

Joomwong (2006) stated that the fruit harvested in winter had the highest content of total soluble solid (TSS) and titratable acids (TA), and the lowest ratio of TSS: TA than any other seasons. However, the correlation between development and sugar metabolism in the 'smooth cayenne' cultivated in the different harvest seasons is yet unknown.

Zhang *et al.* (2011) mentioned that in pineapple fruits, sugar accumulation plays an important role in flavour characteristics, which varies according to the stage of fruit development. Metabolic changes in the contents of fructose, sucrose, glucose and reducing sugar related to the activities of soluble acid invertase (AI), neutral invertase (NI), sucrose synthase (SS) and sucrose-phosphate synthase (SPS) were studied in winter and summer

Cabral and Matos (2009) mentioned that the pulp of the 'Imperial' pineapple plant is high sugar content, moderate acidity, a high level of ascorbic acid and a very good flavour. Loison-Cabot and Lacoëuilhe (1990) mentioned that the aim of a pineapple breeding programme initiated in 1978 in Ivory Coast was to produce new cultivars for fresh and processed market with improved fruit quality (appearance, texture and taste).

TABLE 2. Chemical fruit properties for various strains resulted from 5, 10 and 15 ppm treatments.

Strains	Vit. C mg/100g			T .S. S			Acidity mg/100g			Total sugar			Reducing sugars			Non reducing sugars		
	2013	2014	AV	2013	2014	AV	2013	2014	AV	2013	2014	AV	2013	2014	AV	2013	2014	AV
1	32	44	38	22	28	25	955	1045	1000	30	16	23	9.1	8.7	8.9	20.9	7.3	14.1
4	34	30	32	21	31	26	803	757	780	21	29	25	6.6	9.4	8	14.4	19.6	17
9	41	31	36	21	25	23	1025	895	960	24	28	26	7.1	9.7	8.4	16.9	18.3	17.6
11	49	41	45	26	20	23	1285	1155	1220	27	23	25	9.4	8.6	9	17.6	14.4	16
15	40	48	44	21	29	25	921	1015	968	35	25	30	9.8	8.2	9	25.2	16.8	21
17	52	34	43	30	22	26	1097	1183	1140	25	27	26	10.3	7.7	9	14.7	19.3	17
23	41	29	35	27	23	25	1070	1130	1100	26	22	24	7.8	8.8	8.3	18.2	13.2	15.7
26	41	35	38	20	28	24	768	832	800	21	29	25	7.8	8.2	8	13.2	20.8	17
33	43	27	35	21	27	24	862	772	817	36	24	30	6.2	10.6	8.4	29.8	13.4	21.6
34	33	47	40	28	26	27	898	1042	970	27	21	24	10.3	6.9	8.6	16.7	14.1	15.4
35	29	41	35	22	24	23	868	802	835	22	26	24	9.3	6.7	8	12.7	19.3	16
36	44	40	42	27	23	25	986	1036	1011	21	27	24	6.4	10.4	8.4	14.6	16.6	15.6
51	41	35	38	30	24	27	993	1087	1040	37	23	30	8.36	8.24	8.3	28.64	14.76	21.7
53	31	37	34	25	29	27	633	789	711	29	21	25	6.5	9.3	7.9	22.5	11.7	17.1
Cayeen	26.3	16.9	21.6	24.9	26.9	25.9	1113	1068	1090	26.6	23.9	25.3	7.2	7.9	7.55	14.4	16.3	15.36
L.S.D	ns	ns		ns	ns		ns	ns		ns	ns		ns	ns		ns	ns	



*General evaluation and final conclusion*

Data tabulated in Table 3 showed that pineapple strain no. 9 seemed to be the superior strain in yield and fruit quality among all the tested pineapple strains, as they attained the uppermost score units (92.1) as compared with other strains standard. On the contrary, all studied strains showed less fruit weight and the same fruit quality.

**TABLE 3. Digital evaluation for various strains resulted from 5, 10 and 15 ppm colchicine treatments.**

Strains	Fruit weight 50 units	Bulb % 10 units	Vit. C 10 units	T.S.S 10 units	Acidity 10 units	Total sugar 10 units	Sum 100 units
1	12.5	9.2	8.4	9.3	8.2	7.7	55.3
4	35.1	9.2	7.1	9.6	6.4	8.3	75.8
9	50.0	9.1	8.0	8.5	7.9	8.7	92.1
11	30.2	9.6	10.0	8.5	10.0	8.3	76.7
15	18.1	9.4	9.8	9.3	7.9	10.0	64.4
17	21.3	9.7	9.6	9.6	9.3	8.7	68.2
23	24.2	9.2	7.8	9.3	9.0	8.0	67.4
26	26.7	9.6	8.4	8.9	6.5	8.3	68.5
33	23.4	10	7.8	8.9	6.7	10.0	66.8
34	17.3	9.5	8.9	10.0	7.9	8.0	61.7
35	5.3	8.4	7.8	8.5	6.8	8.0	44.8
36	19.5	9.7	9.3	9.3	8.3	8.0	64.1
51	25.5	9.5	8.4	10.0	8.5	10.0	72.0
53	7.1	8.5	7.6	10.0	5.8	8.3	47.3
Cayeen	25.7	8.1	4.8	9.6	8.9	8.4	65.6

Thus, one can conclude that all the 14 studied strains are in a good fruit quality for consumer but only strain no. 9 showed the highest fruit weight.

Flowering characteristics: data in Table 4 showed the number of days from Ethrel treatment to flower differentiation and fruit harvest for 14 strains produced from colchicine treatments.

Days to flower differentiation: data showed that there were a significant differences in number of days to flower differentiation. The lowest significant number (28 days) was recorded for the original cultivar, other strains showed a wide range from 59 to 67 days from Ethrel application to the occurrence of floral differentiation. Days to harvest: data clearly showed that there is a significant difference in number of days to harvest. The lowest number of days to harvest (144) was recorded to original cultivar. All studied strains were harvested later than original cultivar as they spent 184 to 197 days from Ethrel treatment to harvest.

Morphological evaluation: morphological evaluation involved variation in fruit size crown size, shape and flower formation and characteristics and leaf edges spiny.

Data in Fig. (1, 2a and 2b) showed that:

- leaf edges: there were many strains of leaf edges some strains were hard spiny edges (strain 17 and 40), normal spiny (51,35, 31, 11 and 42), low spiny (46) while some strains have one leaf edge spiny and the other edge smooth (not spiny) the rest of strains were smooth leaf edges.
- Fruits: fruit varied in size and shape, the greatest were the strains (9) others were smaller and some of them have no fruits (40, 31, 32, 47 and 42).
- Crown: crown varied in shape and size some crowns were tall (4, 23, 51, 34,15 and 33) others were very short (36, 17,1 and 53) the rest of strains crown were intermediate.

Flower characteristics: many strains could not produce normal flowers that its inflorescence had only bracts and the flowers deformed (40, 31, 32, 42 and 47). Other strains contained normal flowers in addition to the deformed flowers (47). The rest of strains contained normal flowers. Two strains have a crown only with deformed bracts (32 and 47) the strain 31 showed a growth of vegetative buds from some bracts. They were flowers but converted into vegetative buds.

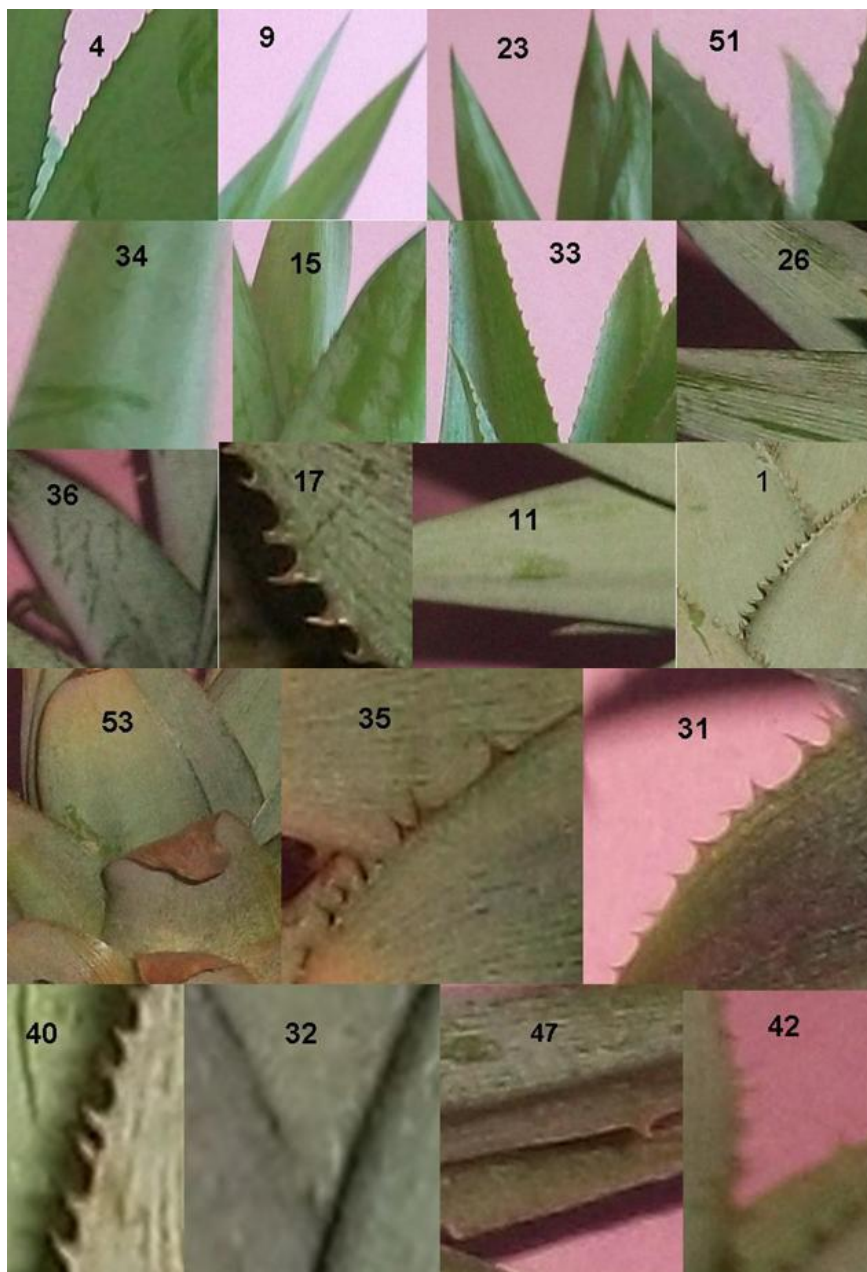
We can conclude that 17 and 31 could be used in further study in activating flowers in its bracts. Cabral *et al.* (2009) said that the main constraint of the pineapple crop in Brazil with good fruit quality and spineless leaves. Cabral and Matos (2009) reported that the 'Imperial' pineapple plant is of intermediate height with spineless dark green leaves. The fruit is small and cylindrical, with a yellow peel at ripening. The pulp is yellow, Cabral *et al.* (2009) both seedlings obtained from 'Perolera' have green leaves, one of them being spiny and the other spineless.

To conclude, among the tested strains, the strain no.9 proved to be the best as evidenced by its fruit weight 900 g and total sugars content. Strain no. 17 and 31 were advised for further study in activating dormant flowers.

It could be concluded that the selected strain no. 9 has good fruit quality for consumer and strains no. 17 and 31 are recommended to be studied in activating dormant flowers.

TABLE 4. Flowering properties for various strains resulted from 5, 10 and 15 ppm treatments.

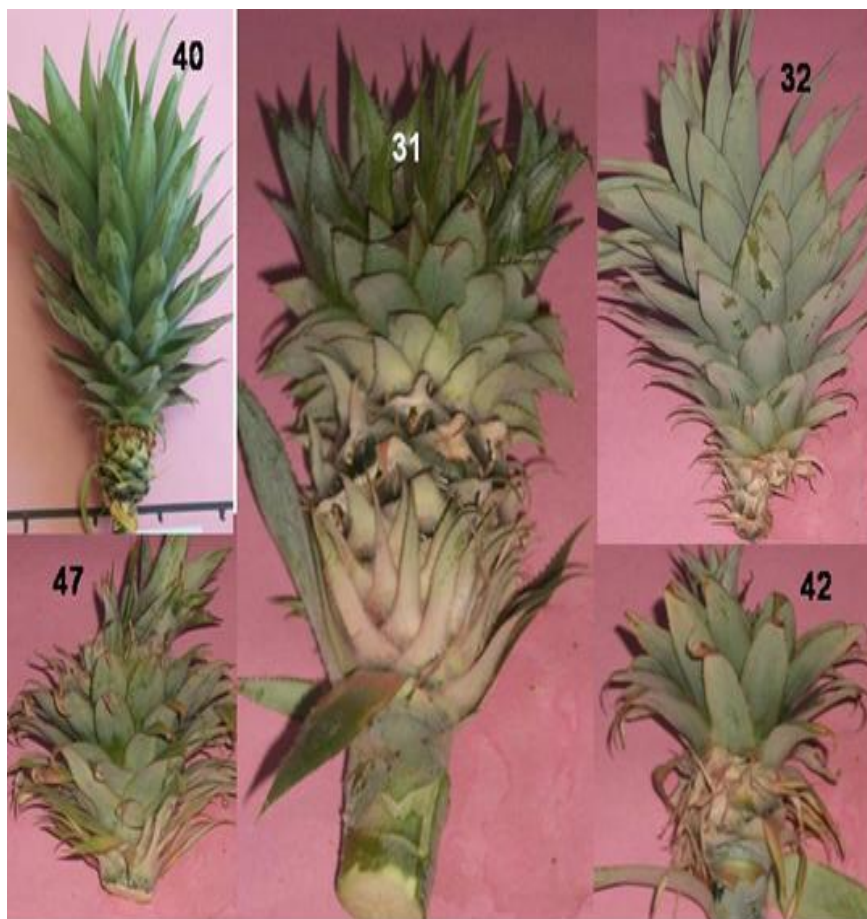
Strains	Season	Cayeen	1	4	9	11	15	17	23	26	33	34	35	36	51	53	L.S.D
Days to flower differentiation	2012	26	65	61	56	64	60	63	68	62	65	57	66	69	60	62	ns
	2013	30	66	62	57	58	69	67	65	68	60	68	64	66	55	56	ns
	Av	28	65.5	61.5	56.5	61	64.5	65	66.5	65	62.5	62.5	65	67.5	57.5	59	
Days to harvest	2012	138	193	191	192	185	197	180	192	187	181	188	186	183	189	190	ns
	2013	150	187	189	189	180	198	193	195	181	179	192	187	194	183	200	ns
	Av	144	190	190	190.5	182.5	197.5	186.5	193.5	184	180	190	186.5	188.5	186	195	



**Fig. 1.** Leaf evades morphological characteristics for various strains resulted from colchicine treatments.



Fig. 2a. Fruit, flowers and crown morphological characteristics for various strains resulted from colchicine treatments.



**Fig. 2b. Fruit, flowers and crown morphological characteristics for various strains resulted from colchicine treatments.**

#### References

- A.O.A.C. (1960)** "*Official and Tentative Methods of Analysis*", Washington A.D.C., USA.
- A.O.A.C. Association of Official Agricultural Chemists (1985)** Official methods of analysis (A.O.A.C.), Twelfth ed published by A.O.A.C, Benjamin Franklin Station, Washington D.C., USA, pp. 490-510.
- Cabral, J.R.S. and de Matos, A.P. (2009)** Imperial, a new pineapple cultivar resistant to fusariosis. *Acta Hort.* (ISHS), **822**, 47-51



- Cabral, J.R.S. and de Matos, A.P. (2009)** Imperial, a new pineapple cultivar resistant to fusariosis. *Acta Hort.* (ISHS), **822**, 47-51
- Cabral, J.R.S., de Matos, A.P., Junghans, D.T. and Souza, F.V.D. (2009)** Pineapple genetic improvement in Brazil. *Acta Hort.* (ISHS) **822**, 39-46
- Gui, Y.L., Gu, S.R. and Xu, T.Y. (1982)** Study on morphological differentiation of endosperm plantlets of Chinese gooseberry *in vitro* (in Chinese with English summary). *Acta Bot. Sinica*, **24**, 216-221.
- Hannweg, K. (1999)** Biotechnological techniques enhance existing citrus breeding. *Neltropika Bulletin*, **303**, 21-23.
- Hannweg, K., Penter, M. and Sippel, A. (2012)** Use of polyploidy in tropical and subtropical plant improvement programmes. *Acta Hort.* (ISHS), **935**, 67-73.
- Hussein, F., Dahshan, D.I., Gaafar, S.I. and Mousa, I.A. (1982)** Evaluation of some date palms grown at Ismailia governorate. *Fac. Agric., Zagazig Univ. Res. Bull.* No. 506.
- Itai, A., Tanahashi, T. (2008)** Inhibition of sucrose loss during cold storage in Japanese pear (*Pyrus pyrifolia* Nakai) by 1-MCP. *Postharvest Biol. Technol.*, **48**, 355-363.
- Joomwong, A. (2006)** Impact of cropping season in Northern Thailand on the quality of Smooth Cayenne pineapple. II. Influence on physicochemical attributes. *Int. J. Agric. Biol.*, **8** (3), 330-336.
- Liu, S.Q. and Liu, J.K. (1980)** Callus induction and embryo formation in endosperm culture of *Prunus persica*. *Acta Bot. Sinica*, **22**, 198-199
- Loeillet, D., Dawson, C. and Paqui, T. (2011)** Fresh pineapple market: from the banal to the vulgar. *Acta Hort.* (ISHS), **902**, 587-594.
- Loison-Cabot, C. and Lacoëuilhe, J.J. (1990)** A genetic hybridization programme for improving pineapple quality. *Acta Hort.* (ISHS), **275**, 395-400.
- Mooney, P.A., Watson, M. and Harty, A.R. (1996)** Globular embryoid development in Citrus. *Proc. Int. Soc. Citriculture*, **1**, 886-888.
- Mu, S.K. and Liu, S.Q. (1979)** Studies on initiation of apple endosperm callus and variation of chromosomal ploidy on callus cell of endosperm. *Acta Bot. Sin.*, **21**, 309-314.
- Murashige, T. and Skoog, F. (1962)** A revised medium for rapid growth and bioassays with tobacco tissue cultures. *Physiol. Plant.*, **15**, 473-497.
- Nady, N.H. (2010)** Pineapple floral differentiation as affected by climatic conditions, shading and plant size. *Egypt. J. Hort.*, **37** (1)103-112.
- Ollitrault, P., Dambier, D., Loftly, S., Rist, D., Mass, O., Luro, F. and Frolicher, Y. (2000)** Citrus germplasm exploitation by somatic hybridization. IX<sup>th</sup> ISC Congress Orlando Florida, 122 p.

- Ollitrault, P., Dambier, D., Allent, V. and Luro, F. (1996a)** Haploid plantlets of *Citrus reticulata* (Clementine) obtained by induced gynogenesis. VIII ISC Congress Sun City Resort South Africa, 98 p.
- Sanewski, G.M., Smith, M.K., Pepper, P.M. and Giles, J.E. (2011)** Review of genetic improvement of pineapple. *Acta Hort.*, (ISHS). **902**, 95-108.
- Scherer, R.F., Olkosk., D., Souza, F.V.D., Nodar, R.O. and Guerra, M.P. (2015)** Gigante de Tarauacá: A triploid pineapple from Brazilian Amazonia, *Scientia Horticulturae*, **181** (2), 1-3.
- Snedecor, G.E. and Cochran, W.G. (1980)** "*Statistical Methods*" 7<sup>th</sup> ed., Iowa State Univ. Press, Ames.
- Starrantino, A. (1999)** Tacle a new triploid Clementine x Tarocco hybrid. *Rivista-di-Frutticoltura-edi-Ortofloricoltura*, **61**, 45-47.
- Thomas, T.D., Bhatnagar, A.K. and Bhojwani, S.S. (2000)** Production of triploid plants of mulberry (*Morus alba* L.) by endosperm culture. *Plant Cell Rep.*, **19**, 395-39.
- Zhang, X.M, Dou, M.A., Yao, Y.L., Du, L.Q., Li, J.G. and Sun, G.M. (2011)** Dynamic analysis of sugar metabolism in different harvest seasons of pineapple (*Ananas comosus* L. (Merr.) *African J. Biotechnology*, **10** (14), 2716-2723
- Zhang, J., Zhang, M. and Deng, X. (2007)** Obtaining autotetraploids *in vitro* at a high frequency in *Citrus sinensis*. *Plant Cell Tissue and Organ Culture*, **89**, 211-216.
- Zhao, H.X. (1983)** Plant regeneration from endosperm culture of pear. *Chinese Bull. Bot.*, **1**, 38-39.

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## تقييم سلالات جديده من الاناناس ناتجه من معامله الاناناس صنف كايين بالكولشسين

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هذه الدراسة نفذت خلال موسمي ٢٠١٣ و ٢٠١٤ لإنتاج وتقييم ١٤ سلالة من الأناناس من خلال معاملات الكولشسين وتنميتها بالحديقة البحثية لمعهد بحوث البساتين بمركز البحوث الزراعية الجيزة مصر مقارنة مع الصنف الاصلى كايين. متوسط نتائج الموسمين لصفات الثمار الطبيعية والكيميائية سجل بالاضافه إلى الصفات المورفولوجيه لحواف الأوراق والثمار والتيجان والإزهار درست أيضا. اكبر وزن ثمره سجل للسلالة ٩ وكذلك اكبر وزن لب. الصفات الكيميائية للثمار لم تظهر اى فروق معنوية بين السلالات. التقييم الرقمي اظهر أن السلالة ٩ هي الأفضل فى صفات الثمار من بين السلالات محل الدراسة وذلك لحصولها على اعلى نقاط تقييم. التقييم المورفولوجي اظهر ان السلالة المنتخبة ذات أوراق ناعمة (خالیه من الأشواك) كما اظهر وجود إزهار كامنة فى نوران بعض السلالات وتوصى الدراسة بدراسة السلالتين ١٧ و ٣١ لتنشيط الإزهار الكامنة.

يمكن التوصيه بزراعة السلالة ٩ كأفضل سلالة ناتجة من هذه الدراسة وأيضا التوصية بدراسة تنشيط الإزهار الكامنة للسلالتين ١٧ و ٣١ فى دراسة متقدمه هذا بالاضافه الى التوصية باستخدام الكولشسين فى تربية الأناناس للحصول على ثمار ذات حجم اكبر بنفس الصفات الكيميائية.