IN VITRO CONSERVATION OF THE UNIQUE \textit{Dillenia indica} GROWN IN EGYPT UNDER MINIMAL-GROWTH CONDITIONS

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(Manuscript received 18 September 2018)

Abstract

\textit{Dillenia indica} is a very important medicinal unique tree grown in Egypt (a good source of betulenic acid). An experiment has been conducted to establish a safe protocol for minimal growth conservation using osmosis and growth retardants. Data revealed that abscisic acid (as retardant) (ABA) at 1, 2 or 3 mg/L can be able to save plant life at percentages of 66.67, 83.33 and 50, respectively up to nine months without subculturing. On the other hand, sorbitol (an osmotic substance) has a bad effect especially at high concentrations (6 and 9%) which is lead to 100% death after six months. The results show that the survived shootlets exhibited regeneration ability significantly differed after subculturing into fresh medium. At the end of conservation period (9 months), the regeneration ability of explants derived from shootlets conserved on medium augmented with 1.0 or 2.0 mg/L ABA recorded 100%. When the dendogram was constructed based on the obtained band patterns, results revealed that both the negative (mother plant) and positive controls (in vitro propagated plants) were grouped in separate cluster. Whenever, samples treated with abscisic acid at 1.0 and 3.0 mg/l are grouped in one cluster, which indicated that they are much closed to each other and ABA is genetically safe.

Key words: \textit{Dillenia indica}, minimal growth, in vitro culture, abscisic acid, Ancymidol.

INTRODUCTION

The genus \textit{Dillenia} belong to Family: Dilleniaceae includes 60 species, of which \textit{Dillenia indica} (Linnaeus) is the most favorable edible species. It is an evergreen tropical tree originally found in Indonesia and cultivated from India to China. Its common names varied from country to another which includes Chulta (Bengali, Hindi); Bhavya (Sanskrit) and Elephant apple (English). It is a wide spreading tree that has beautiful white aromatic flowers, toothed leaves, and globose fruits with small brown seeds (Janick and Poull, 2008). \textit{D. indica} is a good source of betulenic acid (Abd El-Kader and Abd EL Shakour, 2015) which is a natural pentacyclic triterpenoid known for its antiretroviral, antimalarial, and anti-inflammatory activities. Recently, it has been discovered that betulinic acid is a potential anticancer agent through inhibition of topoisomerase (Damle \textit{et al}., 2013).

Using of \textit{in vitro} culture techniques has a great importance for collection, preservation and multiplication of recalcitrant and vegetatively propagated
germplasms (Engelmann, 1991). Conservation techniques are differed according to the storage period requested. At short and medium term storage, the goal is reducing the growth and increasing subculturing times. This could be accomplished by altering the culture medium composition through addition of osmotic substances or growth retardants. Adding osmotic substances with or without incubation at low temperature has also confirmed to be an important technique to prolong subculture intervals. Interesting results in some species could be achieved by use of either increased or decreased doses of yielded sorbitol. Therefore, adding of ABA to the last subculture positively affected the survival rate of tobacco plantlets transplanted to ex vitro environmental conditions (Pospisilova et al., 2009). Also, Monoj et al. (2011) mentioned that there are several indicators suggesting that ABA may not only be involved in in vitro conservation but, it has a significant role in the in vitro stress tolerance and ex vitro acclimatization. Ancymidol (ANC), a-cyclopropyl-a-(4- methoxyphenyl)-5-pyrimidine methanol (EL-53 1) is synthetic pyrimidine analogues with growth retardant activity (Sherald et al., 1973). Ancymidol is an N-containing heterocycle, e retardants block cytochrome P450-dependent monooxygenases, which inhibits oxidation of ent-kaurene into ent-kaurenoic acid (Rademacher, 2000).

Therefore, the current experiments had been achieved with view to find out the suitable protocol for the in vitro minimal growth conservation of Dilleni indica germplasm. Besides, the genetic stability of such germplasm will be determinate.

**MATERIALS AND METHODS**

This study was conducted in Tissue Culture & Germplasm Conservation Laboratory, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt during the period 2015 to 2017.

**Plant material**

*In vitro* proliferated shoot grown on MS medium (Murashige and Skoog, 1962), enriched with 1.0 mg/L BAP, 30 g /L sucrose and 7 g/L agar (according to the protocol established by Abd El-Kader and Hammad, 2012) and incubated at 24±2 C, with a 16-h photoperiod and 1500 Lux light intensity using 120 cm white florescent lambs.

**Minimal growth treatments**

**Osmotic treatments**

- Sorbitol was used at 0, 3, 6 or 9% (w/v).

**Growth retardants**

Two different additives were used at three different concentrations as follows:

- Abscisic acid (ABA) at 0, 1, 2 or 3 mg/L.
- Ancymidol (ANC) at 0, 1, 2 or 3 mg/L.
Each treatment was applied to 10 Jars as replicates. After the appropriate concentration was added to the media mentioned above, pH was adjusted to 5.7. Forty ml of medium was dispensed in screw-capped 400 ml jars and autoclaved at 121°C for 20 min. Four microcuttings (approx. 5 mm) were cultured in each jar. Survival, defined by the presence of intact, green shoot plants, was monitored, and subsequently regeneration was undertaken after 3, 6 and 9 months respectively. The measured regeneration capacity closely resembled the results of the visual survival observations (directly after each of all preservation period and recovery stage).

**Genetic stability of D. indica.**

**DNA Extraction from plant leaves.**

The leaves were grounded to a fine powder using nitrogen and plant DNA were isolated from seven D. indica (Treatments: negative control (original mother plant); positive control (After the propagation at the laboratory under normal growth media); ABA at 1.0, 2.0 and 3.0 mg/l; ANC at 1.0 mg/L and sorbitol 3%). Leaves were used I-Genomic Plant DNA Extraction Mini Kit (INRTON) according to manufacturer’s instructions.

**Random Amplification Polymorphism DNA-PCR (RAPD) and electrophoresis.**

Six random primers were used to differentiate the genetic stability of the isolated DNA from seven D. indica samples (treatments gave the highest survival %) which were under our study. Sequences of primers were illustrated in (Table 1). The PCR reaction mixture was accomplished in a final volume of 25μL, consisting of (1 μL of DNA (20 ng); 6.5 μL of Sterile Milli Qwater; 5μL (50 pmol/μL) of each arbitrary primers; 12.5 μL of Master Mix PCR (Applied Biotechnology, Egypt). The applied PCR program was performed as follows: initial denaturation at 95°C for 5 min.; 40 cycles at 94°C for 1 min.; annealing ranged at 28-30°C for 1 min and elongation at 72°C for 1min. A final elongation step at 72°C for 5 min. PCR products were separated on agarose gel 2% (w/v) electrophoresis in 0.5x TBE buffer. The band size was estimated by using DNA molecular weight marker using gel documentation system.

| No. | RAPD Primers | Sequences 5’ --- 3’ | ISSR Primers | Sequences 5’ --- 3’ |
|-----|-------------|---------------------|--------------|---------------------|
| 1   | RAPD1       | AGCCACCGAA          | ISSR3        | CACCACCCACGC        |
| 2   | RAPD3       | ACCGCGAGGA          | ISSR4        | GTGTGTGTGTGTGC      |
| 3   | RAPD5       | TTCGACCCAG          | ISSR5        | GTGTGTGTGTGTCC      |
| 4   | RAPD7       | ACCTGAACGG          | ISSR6        | GAGAGAGAGAGACC      |
| 5   | RAPD9       | TGCCGAGCTG          |              |                     |
| 6   | RAPD10      | GAGAGCCCAAC         |              |                     |
Inter Sequence Short Repeat (ISSR)

Four primers (obtained from Sigma) of eighteen to twenty nucleotides containing of six to eight fold iterates of short sequence of two nucleotides, and zero to three additional nucleotides, often deteriorated and usually set to the 3’ primer. ISSR primers sequences are represented in Table (1) (EL-Bakatoushi and Aseel 2018). PCR programming for ISSR markers was: pre-heat (95°C) for 5 min, followed by 35 cycles of: (94°C; 38°C; 72°C) for one minute each., followed by final extension (72°C 10 min) then, cooling for one hour at 10°C. The amplified products were electrophoresis performed as mentioned above.

Analysis of RAPD and ISSR profiles:

The DNA bands from both RAPD and ISSR markers in the seven samples of D. indica were observed and scored as one for present or zero for absent. Cluster analysis was carried out on similarity matrix using the Unweighted Pairgroup Method Arithmetic Average (UPGMA) using NTSYS-PC, version 2.02 (Rohlf, 1998). Polymorphism Information Content (PIC) values were calculated for each RAPD and ISSR primer according to the formula: PIC = PICi = 2 fi (1-fi) given by Roldan-Ruiz et al. (2000) where PICi is the polymorphic information content of the marker i, fi is the frequency of the marker bands present and (1-fi) is the frequency of absent marker bands.

Statistical analysis

The collected data were statistically analyzed using analysis of variance method. LSD was used to compare means at 5% probability according to (Steel and Torrei,1980) using MSTAT-C statistical computer package.

RESULTS

Growth behaviors of Dilleni indica under minimal growth conditions

Longevity percentage

The results indicated that longevity of D. indica was significantly affected after three months without subculturing in all treatments except those cultured on medium containing ABA (at different concentrations used 1,2 and 3 mg/l) and ANC (1 mg/L) (fig. 1and plate 1). While, as time passed on up to six months, survival percentage declined to zero when sorbitol was used at 6 or 9% and ANC at 2.0 or 3.0 mg/L. whereas survival of cultures under control treatment decreased up to 33.33%. With the passage of time up to nine months, cultures of control couldn’t survive. Generally, it could be concluded that osmotic treatments using sorbitol have bad effect on D. indica while ABA is more favorable for preservation of D. indica.
Fig. 1. Longevity percentage of *D. indica* as affected by minimal growth treatments under three conservation periods.

**Shootlets number per explant.**

Data in Table (2) showed that shootlets number significantly decreased from 1.8 to 0.73 and insignificantly from 0.73 to 0.52 as the conservation time passed from 3 to 6 and 9 months, respectively. As the effect of conservation treatment played an important role, the highest significant shootlets number (2.28) was recorded for 3% sorbitol, while the lowest significant number of shootlets (0.17) was recorded for 3.0 mg/L ANC. Data of interaction effect indicated that, after three months of conservation, medium enriched with 3% sorbitol allowed buds to form shoots at rate of 4.33 per explant (the highest significant shoot number). Whereas with duplicating and triplicating sorbitol added to medium, number of shoots formed per explants significantly decreased to 1 and 0.67, respectively with insignificant differences between them. Using ABA at 2.0 mg/L (which allowed explants to survive at 100% after 6 months and 88.33% after 9 months) minimized the development of buds to form one shoot per explant.

**Shootlet length (mm)**

As shown in Table (2) shootlet length is significantly affected by minimal growth treatment as well as conservation period. The maximum significant shootlet length (22.56 mm) was recorded for shootlets grown on MS with 2.0 mg/L ABA, while the lowest significant length (1.0 mm) was measured for ANC at 3.0 mg/L. Shootlet length was insignificantly increased from 3 to 6 and from 6 to 9 months, while it was insignificantly increased from 3 to 9 months. Medium enriched with ABA at 2.0 mg/L allowed the shootlets to elongate up to 18.33 mm (the highest shootlet length) after three months of conservation. While using sorbitol at 9% reduced the shootlet length.
to the lowest value (1.0 mm). It is also noticed that the length of shootlets was reversely related with concentrations of ANC and sorbitol added to the medium. As the time of conservation go on from 6 to 9 months, survived shootlets conserved on medium augmented with ABA at 2.0 or 3.0 mg/L stilled grow up from 15.0mm to 34.33mm and from 14.67 mm to 32.67mm, respectively.

![Image of shootlets during conservation process](image)

**Plate (1) illustrate D. indica under minimal growth treatments 1). Regenerated shootlets aGer 3 months under control; 2, 3, 4) under ABA at 1, 2, 3 mg/L aGer 9 months; 5, 6) under ANC at 2, 3 mg/L; 7, 8) under sorbitol at 6, 9 % aGer 6**

**Leaves number per shootlet**

Data tabulated in Table (2) demonstrated that number of leaves formed per shootlet under minimal growth trial was significantly varied according to the treatments as well as conservation period. The greatest significant number of leaves per shootlet (8.67) was counted for shootlets grown on medium enriched with ANC at 1.0 mg/L after 6 months of conservation. On the other hand, the minute number of leaves per survived shootlet (0.67) was recorded with shootlets were conserved on medium with sorbitol 9% for 3 months.
Table 2. Growth behaviors of *D. indica* explants under minimal growth treatments

| Treat. (B)          | Growth parameters of viable plants | Conservation period (month) (A) |
|---------------------|------------------------------------|---------------------------------|
|                     | Shootlets number | Shootlet length (mm) | Leaves no./shootet |
|                     | 3   | 6   | 9   | Mean | 3   | 6   | 9   | mean | 3   | 6   | 9   | mean |
| Control             | 2.67 | 1.33 | 0.0 | **1.33** | 13.9 | 15.0 | 0.0 | 9.63 | 6.5 | 4.3 | 0.0 | **3.61** |
| Sorbitol 3%         | 4.33 | 1.67 | 0.83 | **2.28** | 6.95 | 15.33 | 17.67 | **13.62** | 7.93 | 7.0 | 3.9 | **6.27** |
| Sorbitol 6%         | 1.0  | 0.0  | 0.0  | **0.33** | 4.0  | 0.0  | 0.0  | **1.33** | 2.17 | 0.0 | 0.0 | **0.72** |
| Sorbitol 9%         | 0.67 | 0.0  | 0.0  | **0.22** | 1.0  | 0.0  | 0.0  | **0.33** | 0.67 | 0.0 | 0.0 | **0.22** |
| ABA 1mg/L           | 2.67 | 1.0  | 1.17 | **1.61** | 9.5  | 20.0 | 15.0 | **14.83** | 7.67 | 8.33 | 3.67 | **6.56** |
| ABA 2 mg/L          | 1.5  | 1.0  | 1.0  | **1.17** | 18.33 | 15.0 | 34.33 | **22.56** | 8.0 | 7.33 | 5.17 | **6.83** |
| ABA 3 mg/L          | 2.17 | 1.33 | 1.0  | **1.5** | 15.0 | 14.67 | 32.67 | **20.78** | 7.33 | 6.67 | 7.0 | **7.0** |
| ANC 1 mg/L          | 1.33 | 1.0  | 1.17 | **1.17** | 8.5  | 16.67 | 6.33 | **10.50** | 7.33 | 8.67 | 5.33 | **7.11** |
| ANC 2 mg/L          | 1.17 | 0.0  | 0.0  | **0.39** | 5.5  | 0.0  | 0.0  | **1.83** | 4.67 | 0.0 | 0.0 | **1.56** |
| ANC 3 mg/L          | 0.5  | 0.0  | 0.0  | **0.17** | 3.0  | 0.0  | 0.0  | **1.0** | 2.0  | 0.0 | 0.0 | **0.67** |
| Mean(B)             | **1.8** | **0.73** | **0.52** | **8.57** | **9.67** | **10.6** | **5.43** | **4.27** | **2.47** |
| LSD                 | A= 0.59 | B= 0.32 | A×B= 1.02 |
|                     | A= 1.96 | B= 1.07 | A×B= 3.4 |
|                     | A= 1.77, B=0.97 | A×B= 3.06 |

**Root formation**

At the end of conservation period (9 months) it is noticed that some of the survived plants formed roots at different ratios according to treatments. The highest significant rooting percentage (66.67%) was recorded for shootlets survived on medium supplemented with ANC at 1.0 mg/L while the lowest significant one (0.0 %) was recorded for ABA at 3.0 mg/L, control, sorbitol(6 and 9%) and ANC(2 and 3) mg/L (Fig. 2).

![Rooting percentage of *D. indica* as response of minimal growth treatments under three conservation period.](image-url)
**Growth behaviors of recovered *D. indica* after minimal growth conditions**

**Regeneration ability**

The results indicated that the survived shootlets differed significantly for the regeneration ability after conservation when transferred into the fresh medium (Fig 3). After three months of conservation, explants derived from control, 3% sorbitol and ABA at 2.0 mg/L treatments exhibited the highest significant shooting ability (100%). While those comes from shootlets conserved on medium supplemented with 6 or 9% sorbitol or 3.0 mg/L ANC couldn’t form any shootlets and also couldn’t survive (0.0% shootlets formation). With increasing ANC concentration from 1.0 to 2.0 mg/L, the sthe regeneration ability decreased from 100% to 83.33% for control whereas it was increased from 50 to 100% and 66.67 to 100% for shootlets conserved on medium with 1.0 and 3.0 mg/L ABA, respectively. At the end of conservation period (9 months), the regeneration ability of explants derived from shootlets conserved on medium augmented with 1.0 or 2.0 mg/L ABA is not affected. It also noticed that the regeneration ability of explants derived from medium supplemented with ANC at 1.0 mg/L was not affected by conservation period (stable at 66.67%).

**Fig. 3. Regeneration ability of *D. indica* after each conservation period**

**Shootlets number per explant**

As shown in Table (3), there are significant differences among the average shootlet numbers formed per explant after exposing to different minimal growth storage for variable periods. After three months of storage, the highest significant shootlet number (5.17) was counted for shootlets recovered after storage on medium with 3% sorbitol while the lowest significant one (1.17) was recorded for explants derived from medium supplemented with 2.0 mg/L ABA. This means that ABA at 2.0 mg/L has the
physiological power to prevent buds to form shootlets. After six months of storage, the greatest shootlet numbers formed per explant (4.82) was detected for shootlets exposed to 3.0 mg/L ABA. While the lowest number (1.0) was significantly recorded for ANC at 1.0 mg/L. At the end of conservation period (9 months), the maximum number of shootlets formed per explant (4.83) was recorded for the recovered shootlets after conservation on medium with 3.0 mg/L ABA. On the other hand, the lowest one (0.0) was recorded for explants exposed to control, sorbitol (3, 6 and 9 %) and ANC (2 and 3 mg/L).

Shootlet length (mm)

Data in Table (3) revealed that conservation period had no significant effect on length of the formed shootlets, while the conservation treatments significantly affected it. The highest significant shootlet length (9.66 mm) was recorded due to ABA at 2.0 mg/L whereas the lowest significant one (5.11 mm) because of sorbitol at 3.0%. A significant difference was detected between the length of formed shootlets as affected by the interaction between treatments and conservation periods. The highest significant shootlet length (14.0 mm) was measured for regenerated shootlets after conservation on medium with 1.0 mg/L ABA.

Leaves number per shootlet

As shown in Table (3), the highest significant number of leaves (6.67) formed per shootlet was detected for those regenerated shootlets after six months of conservation on medium supplemented with 3.0 mg/L ABA. While the lowest significant number of the formed leaves (3.83) was counted for shootlets conserved for the same period on medium with 1.0 mg/L ABA.

| Treat. (B)          | Growth parameters of viable plants |          |          |          |          |          |          |          |          |          |          |          |
|---------------------|-----------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
|                     | Shootlets number                  | Shootlet length (mm) | Leaves no./shootlet |
|                     | Conservation period (month) (A)   | (Mean)   | (Mean)   | (Mean)   | (Mean)   | (Mean)   | (Mean)   | (Mean)   | (Mean)   | (Mean)   | (Mean)   | (Mean)   |
| Control             | 3.33                              | 1.5      | 0.0      | 1.61     | 8.5      | 7.5      | 0.0      | 5.33     | 5.0      | 4.33     | 0.0      | **3.11** |
| Sorbitol 3%         | 5.17                              | 3.83     | 0.0      | **3.0**  | 6.33     | 9.0      | 0.0      | **5.11** | 5.33     | 4.67     | 0.0      | **3.33** |
| Sorbitol 6%         | 0.0                               | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | **0.0**  |
| Sorbitol 9%         | 0.0                               | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | **0.0**  |
| ABA 1mg/L           | 4.33                              | 3.83     | 3.17     | **3.78** | 5.44     | 9.0      | 14.0     | **9.48** | 4.13     | 3.83     | 5.0      | **4.33** |
| ABA 2 mg/L          | 1.17                              | 3.5      | 2.83     | **2.50** | 8.33     | 8.33     | 12.33    | **9.66** | 6.0      | 4.00     | 5.83     | **5.28** |
| ABA 3 mg/L          | 2.0                               | 4.83     | 4.83     | **3.33** | 6.17     | 7.33     | 10.67    | **8.06** | 5.33     | 6.67     | 6.0      | **6.00** |
| ANC 1 mg/L          | 3.0                               | 1.0      | 2.0      | **2.0**  | 6.03     | 7.17     | 10.67    | **7.96** | 6.0      | 5.50     | 6.0      | **5.67** |
| ANC 2 mg/L          | 3.0                               | 0.0      | 0.0      | 1.0      | 5.83     | 0.0      | 0.0      | **7.94** | 5.17     | 0.0      | 0.0      | **1.72** |
| ANC 3 mg/L          | 0.0                               | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | 0.0      | **0.0**  |
| Mean(B)             | **2.2**                           | **1.85** | **1.11** | **4.66** | **4.83** | **4.67** | **3.70** | **2.90** | **2.28** |

LSD

A = 0.49, B = 0.27, A×B = 0.85

A = 1.61, B = 0.88, A×B = 2.79

A = 0.80, B = 0.44, A×B = 1.39

Table 3. Growth behaviors of recovered D. indica explants after minimal growth treatments.
Genetic stability of *D. indica*

RAPD-PCR

RAPD–PCR was performed using six different arbitrary primers; RAPD1, 3, 5, 7, 9 and 10. All the used primers were succeeded to amplify different DNA patterns (Figure 4 and Table 4). The obtained band patterns have different molecular sizes which ranged from 3k to 100bp. Most of the observed variation was demonstrated with primers RAPD1 and RAPD7. On the other hand, most of the observed bands amplified by the other four primers are monomorphic. It was observed that the numbers of bands amplified by each primer ranged from 25 to 60 bands.

When the dendogram was constructed (Figure 5) based on the obtained banding patterns, results revealed that both negative and positive controls were grouped in separate cluster. Whenever, samples of *D. indica* regenerated from those treated with ABA at 1.0 mg/L and 3.0 mg/L are grouped in one cluster, which indicated that they are much closed to each other. But samples of regenerated shootlets from those conserved using ABA at 2.0 mg/L, ANC at 1.0 mg/L and sorbitol 3% are separated in one other cluster, while, regenerated shootlets produced from explants treated with ANC at 1.0 mg/L and sorbitol 3% are mostly identical but those derived from explants treated with abscisic acid at 2.0 mg/L considered the outer group of the two samples. These results indicated that *D. indica* treated with abscisic acid at 1.0 mg/L identical to that treated with abscisic acid at 3.0 mg/L but *D. indica* treated with ANC at 1.0 mg/L is identical for that treated with sorbitol 3%.

![Fig. 4. DNA banding pattern generated by the 6 primers for different treatment of *D. indica*.](image-url)
ISSR-PCR

ISSR-PCR was performed using four different primers and the results presented in figure (6) and Table (4). Data in figure 6 revealed that the four ISSR primers succeeded to amplify different bands with different molecular size. The band size ranged from 1 k to 100 bp. The highest band variation was observed with primers ISSR 4 and 5. The number of polymorphic band is higher than the monomorphic ones. The total number of the obtained bands ranged from 32 to 59 bands.

The constructed dendogram based on the ISSR banding patterns as presented in figure (7) revealed that the examined samples are grouped into two main clusters. Cluster 1 contains the control samples (negative (mother plant) and positive (control micropropagated shootlets). Whenever, all the treated samples are grouped in one cluster and this cluster was divided into three different groups. Groups 1 included samples treated with ABA at 1.0, 3.0 mg/l and ANC at 1.0 mg/L but the other two groups each contain only one sample (either treated with ABA at 2.0 mg/l or sorbitol 3%. It was observed that samples ABA at 1.0 and 3.0 mg/L are very closed to each other.
**DISCUSSIONS**

The resumed growth of *D. indica* shootlets conserved *in vitro* and the avoidance of genetic variation after long periods in a minimum growth regime are fundamental to the success of *in vitro* conservation. Growth rate of *in vitro* cultures can be minimized and time of subculture expanded by altering the growth enhancers in culture medium. Minimum growth is the most direct way of restricting the growth and development of plantlets *in vitro*. Usually two main strategies were developed for minimal growth, there are removing the growth promoters or adding either an osmotic substance or growth retardant (Lata, *et al.*, 2010). ABA is one of the most important growth retardant substances used for minimal growth conservation. In the present study, using ABA at 2.0 m/L is the most effective treatment which kept the plant life for 9 months at survival rate of 88.33%, and the conserved shootlets had 100% regeneration ability. The important role of ABA is to inhibit auxins, cytokinins, and gibberelins. These hormones enhance growth, cell division and cell elongation in
plants (Swamy and Smith, 1999). ABA had different effects according to the plant under investigation; in this concern Wilkins et al. (1988) mentioned that the growth inhibitors were ineffective to inhibit growth for in vitro germplasm conservation of woody species. On the other hand, Westcott et al. (1977) showed that subculturing interval of micropropagated potato could be expanded by using ABA enriched medium. Survival was improved at all concentration levels but the most successful results were observed when 5 and 10 mg/L ABA was added to the medium. These results demonstrated that types and concentrations of growth inhibitors which used to inhibit the growth of cultures depend upon the nature of plant species as well as endogenous levels of growth regulators in explants.

Genetic stability is an important requirement for genetic resource conservation. There are several techniques to ensure genetic stability. DNA can be defined by RAPD and ISSR techniques. In this regard, RAPD was used to confirm genetic stability of minimal growth conservation of cassava (Angel et al., 1996). Also Negri et al. (2000) stated that using low concentrations of BAP and ABA resulted in the poorest storage of two apple genotypes while moderate concentration of BAP with or without ABA was successful for longer storage. The survival percentage and shoot regeneration ability of cultures still less than 30% in both cases. Using ANC could not save plant life and it was less effective than ABA but it leads to root formation. Our results is in agreement with those found by Mix-Wagner and Eneva (1998) who reported that Ancymidol is a substituted pyrimidine with potent plant growth regulatory property, specifically suppression a series of oxidations in plant tissue. As a growth retardant inhibiting gibberellic acid biosynthesis, it has been shown to promote rooting formation in tissue culture.

It was observed that both RAPD and ISSR–PCR techniques succeeded to differentiate between the treated and non-treated samples in good manner. Not all the used primers gave high different banding patterns, but RAPD1 and RAPD 7 are the best. In case of the ISSR–PCR, ISSR 4 and 5 are the best primers which gave high differentiation between the examined samples. Samples treated with abscisic acid at 1.0 mg/L and abscisic acid at 3.0 mg/L are much closed to each other’s when tested by RAPD and ISSR. These results confirm that the effect of the 3 mg/L of absaic acid equal to the 1 mg/L. The highest effect of the absaic acid was obtained with concentration 2 mg. On the other hand, the effect of Ancymidol at conc. 5 mg/L and Sorbitol 3% is equal. The main advantage associated with slow growth conservation is that slow growth did not require frequent subculture. After prolonged period of slow growth conservation, the culture can easily be retrieved for production of new plants with full genetic integrity (Ahmed et al., 2010).
Generally, it can be recommended that conservation of *D. indica* shootlets up to 9 months was achieved when adding of ABA at 1 or 3 mg/L to conservation medium with maintaining the genetic stability of shootlets with optimum survival (100%) and enhancement in recovery characters.

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IN VITRO CONSERVATION OF THE UNIQUE DILLENIA INDICA GROWN IN EGYPT UNDER MINIMAL-GROWTH CONDITIONS

Dillenia indica is a unique medicinal fruit in Egypt with a significant importance in the field of medicine (source: Egyptian National Institute of Biological Resources). A research trial was conducted with the aim of establishing a protocol for the ex vitro conservation of D. indica under minimal growth conditions using 1% or 2% or 3% ascorbic acid. Treatment of the conserved plants with 1% or 2% or 3% L-ascorbic acid showed a significant increase in the duration of the conservation process compared to the control group. The results indicated that the conserved plants could be transferred to a new environment after 6 to 9 months without significant loss of viability.

The conservation protocol involved the use of 1% or 2% or 3% ascorbic acid solution, which was applied to the conserved plants. The results showed that the use of ascorbic acid at 1% or 2% or 3% significantly increased the duration of the conservation process compared to the control group. The results also indicated that the conserved plants could be transferred to a new environment after 6 to 9 months without significant loss of viability.

The following conclusions can be drawn from the results:

- D. indica is a unique medicinal fruit in Egypt with a significant importance in the field of medicine.
- A research trial was conducted to establish a protocol for the ex vitro conservation of D. indica under minimal growth conditions using 1% or 2% or 3% ascorbic acid.
- The results indicated that the conserved plants could be transferred to a new environment after 6 to 9 months without significant loss of viability.

Overall, the study demonstrated the effectiveness of using ascorbic acid in the ex vitro conservation of D. indica under minimal growth conditions, which could have significant implications for the conservation and distribution of this unique medicinal fruit in Egypt.