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Effect of Some Natural Extracts as an Alternative to Chemical Growth Regulators on Rooting of the Terminal Stem Cuttings of *Codiaeum variegatum* "Gold Dust" Plant

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ABSTRACT

An investigation was consummated under propagation greenhouse conditions at Al-Zohriya Garden, Hort. Res. Inst., Giza, Egypt during 2018 and 2019 seasons to study the effect of immersing the terminal stem cuttings of *Codiaeum variegatum* (L.) A. Juss. "Gold Dust" plant in the following solutions: distilled water (as control), the aqueous solution of cabbage leaf extract at 50 and 75% concentrations, the aqueous solution of molasses at 50 and 75% concentrations and that of indole-3-butyric acid (IBA) at 1500 and 3000 ppm concentrations for either 15 or 30 minutes on rooting % and the initial growth traits of the produced transplants and chemical composition of their leaves. The obtained results indicated that various rooting solutions used in this study significantly increased the mean values of rooting% with the superiority of submersing in the cabbage extract solution at 75% concentration, which gave the highest percentages in the two seasons over control and all the other treatments. Elongating immersing time from 15 to 30 min. significantly improved the percent of rooting. Thus, combining between immersing in cabbage extract solution and immersing time of 30 min. recorded the highest rooting percentage in both seasons. This combined treatment also attained the highest mean values of transplant growth characters (transplant length, number of both leaves and roots/ transplant, root length and fresh and dry weights of top growth and roots) compared to the individual and other combinations in the two seasons. Similarly, were those results of total chlorophyll (a + b), carotenoids, N, P, K, total carbohydrates, total indoles and total antioxidants concentrations in the leaves of the new formed transplants. However, the highest concentrations of both total phenols and total flavonoids were acquired by control treatment, but the different rooting solutions employed in such study significantly reduced their concentrations to reach the minimal values by soaking in 75% cabbage extract solution treatment relative to all the other ones. Accordingly, it is advised to soak the terminal cuttings of *Codiaeum variegatum* "Gold Dust" plant in the aqueous solution of cabbage leaf extract (75% concentration) for 30 minutes as natural growth regulator to score the highest rooting rate and the best growth performance of the resulted transplants.

Keywords: *Codiaeum variegatum* "Gold Dust", rooting%, natural extract, cabbage leaf extract, molasses, IBA.

1. Introduction

Codiaeum variegatum 'Gold Dust' is an evergreen shrub growing to 3 m tall and has large, thick, leathery, shiny evergreen leaves, alternately arranged. The stems contain milky sap that bleeds from cut stems. Croton 'Gold Dust' is a compact plant with elliptical to oval leaves which are medium green and liberally dusted with paint-like specks of yellow. Crotons grow best in well-drained soil. The leaves extract of crotons are reported to have many medicinal properties including purgative, sedative, antifungal, antiamoebic and anticancerous activities (Deshmukh & Borle, 1975; Kupchan et al., 1976). It is native to southern India, Sri Lanka, Indonesia, Malaysia, and the western Pacific Ocean islands, growing in open forests and scrub (Huxley, 1992).

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Codiaeum variegatum cv. Gold Dust commonly known as Croton and sometimes called Joseph's coat, belongs to the Family Euphorbiaceae, is one of the most popular ornamental indoor plants because of colorful foliage colors and various leaf shapes. This plant is essential in decoration for purifying interior air (Esmail, 2008). It with variation of leaf types are one of the most popular plants in Egypt. It is one of the beautiful indoor and outdoor plants need extensive agriculture development (Ibrahim *et al.*, 2010). Croton can be propagated by various methods such as cuttings, grafting, air layering and from shoot tip cuttings (Sana *et al.*, 2012).

The medicinal value of Croton is due to the presence of some chemical substances that produce are alkaloids, carbohydrates, glycosides, steroids, flavonoids, coumarins, saponins, fatty acids, tannins, protein and amino acids, mucilage, terpenoids, anthroquinones and phenols. These chemicals can be exploited to synthesize future drugs (Bijekar and Gayatri, 2014). *Codiaeum variegatum* has a flexible response to various levels of light intensity. In different light intensity it shows different leaf colours. The shaded leaves are greener than the leaves exposed to sun. The mosaic pattern on the leaves may also be influenced by light intensity (Jena, 2016).

The outer leaves of cabbage (waste) that are peeled off before cabbages are distributed in the market were used as the raw material to produce bio-extract as a natural fertilizer on Mentha plant. Cabbage is a sulfur-rich plant because the glucosinolate accumulated in cabbage is able to breakdown to produce elemental sulfur, so, cabbage is a sulfur-rich plant. In this respect, cabbage waste contains minerals (N, P, K, Ca, Mg, and S), vitamins, and amino acids (aspartic, tryptophan, glycine, etc.), (Sitthithaworn *et al*., 2011).

Nutrients and phytochemicals raw cabbage contain 92% water, 6% carbohydrates, 1% protein, negligible fat, raw cabbage is a rich source of vitamin C and vitamin K, containing 44% and 72% DV, respectively. Cabbage is also a moderate source (10–19% DV) of vitamin B6, folate and indole-3-carbinol (Wikipedia site, 2021).

Many ornamental plants are propagated by cuttings to get a great bulk of homogenous and identical progeny having the same characteristics of the parent plant suitable for importing and exporting purposes. However, success of this method mainly depends on the rapid generation of the new adventitious roots on cuttings, which are necessary for uptaking water and essential nutrients needed for promoting growth of the lateral buds on the cutting (Hartmann *et al.*, 2002; Araya, 2005; Bester, 2013). Rooting success of stem cutting depends on many factors, amongst them using the rooting growth regulators, especially auxins that have been successfully employed in many plant species to improve the root ability of stem cuttings (Soundy *et al.,* 2008; Singh *et al.*,2011 ; Saglam *et al.*, 2014). These facts are documented by the results of Baldotto *et al.,* (2012) on croton and Chinese hibiscus, El-Fouly *et al.,* (2009) on *Ficus deltoidea*, El-Sayed *et al.,* (2010 a) on Chinese hibiscus, El- Sayed *et al.,* (2010 b) on *Bougainvillea glabra*, Balestri *et al.,* (2012) on *Ammophila arenaria* and *Sporobuls virginicus*, Sevik *et al.,* (2015) on *Schefflera arboricola*, Mabizela *et al.,* (2017) on honeybush (*Cyclopia subternata*), Goda *et al.,* (2018) on *Phytolacca dioica* and Abdel- Rahman (2020) who found that cuttings of *Conocarpus erectus* treated with IBA at 100 ppm concentration produced the highest rooting percentage (42.9%) than 50 ppm (36.3%), 200 ppm (36%) and untreated cuttings (23.1%). Root number, root length, stem length, branch number and leaf number of the resulted transplant were also the best by the same treatment.

Natural root promoting extracts as costless, safe and the most effective and convenient method is widely used at present for rooting rather than the synthetic hormones. Extracts of some natural resources like coconut water, willow leaf water, honey, molasses, humic acid, seaweed extract, *Aloe vera*, cinnamon powder, garlic and cabbage are considered ideal, non- chemical alternatives for rooting of cuttings (Rajan and Singh, 2021). It this regard, Dunsin *et al.,* (2016) indicated that moringa leaf extract gave significantly higher total number of roots, total length of roots and length of the longest root in semi-hardwood cuttings of *Parkia biglobosa* (African locust bean tree) than pure honey and coconut water treatments, while coconut water was significantly higher in terms of rooted cuttings % and number of cuttings with callus due to the presence of auxins and cytokinins. Pure honey gave the least records. Likewise, Massoud *et al.,* (2017) reported that the highest means of all vegetative and root growth parameters, as well as chemical constituents of rosemary (*Rosmarinus officinalis*) were attained by treating terminal cuttings with coconut milk at 75% rate, except for fresh weight of shoots obtained by treating the terminal cuttings with seaweed extract at 50% rate and total phenols % which were obtained from untreated cuttings. In general, using natural products, such as coconut milk,

seaweed and yeast extracts and bee honey were better than using the chemical growth regulator (IBA) for enhancing rooting, growth and active constituents in rosemary terminal cuttings.

Similar observations were also revealed by Eid *et al.,* (2018) and Gad and Ibrahim (2018) on *Picual* olive, Gomes *et al.,* (2018) on *Passiflora actinia*, Al-Habib and Yousif (2020) on *Cassia*, *Ficus*, *Lantana*, *Punica* and *Myrtus*, Hameed and Adil (2020) on *Melaleuca viminalis*, Ibrahim (2020) on *Dracaena marginata,* Pacholczak and Nowakowska (2020) on ground cover roses Elfrid " Kormuse" and Weisse Immensee "Korweirim" and El Botany and Saleh (2018) who noticed that licorice extract at any concentration caused closely near effect to that of IBA in promoting the rooting of grape rootstock (Dog Ridge) since both treatments increased root number/ cutting, transplant height, leaf number and leaf fresh and dry weights, while seaweed extract enhanced root length and leaf area than IBA did. IBA and licorice (100%) recorded the highest IAA values and the lowest ABA values, but slightly improved N, P and K contents. So, licorice and seaweed extracts might be used for rooting grape rootstock (Dog Ridge) as a cheap and clean alternative for IBA. Further, Abdel-Rahman *et al.*, (2020) recommended to treat tip cuttings of *Conocarpus erectus* with either coconut water for 1 hour or seaweed, extract as drench combined with IBA for enhancing rooting %, root and shoot growth traits, as well as concentration of endogenous root promoting substances.

However, this study aims to find out the role of both cabbage leaves extract and molasses aqueous solution at various concentrations and immersing times on rooting of Gold Dust croton terminal cuttings rather than IBA chemical hormone.

2. Materials and Methods

The current work was conducted under greenhouse conditions at Al-Zohriya Garden, Hort. Res. Inst., Giza, Egypt throughout the two successive seasons of 2018 and 2019 to determine the response of terminal stem cuttings of croton "Gold Dust" to the different immersing time in solution of some natural substances as cheap, safe and more effective alternatives for the synthetic hormone IBA.

Therefore, terminal cuttings were taken from ripe and healthy shoots of *Codiaeum variegatum* "Gold Dust" plants on mid of July for every season at a length of 12-15 cm, many basal leaves were removed leaving only 4-5 leaves on the cutting. The cuttings were well washed under tap water, then sterilized with a mixture of Topsin (70 %) and Rizolex (50%), manufactured by Submitomo Chemical Co., Ltd., Osaka, Japan at the rate of 0.5 g/l for each and thereafter immersed for either 15 or 30 minutes in one of the following solutions:

1- Distilled water without any additives as control.
2- Aqueous solution of cabbage leaves extract (*Brassica oleracea* L. var. Capitata) was prepared by following the method of Cheema and Khaliq (2000) method as follows, 100gm of crumbled fresh cabbage external leaves are taken in a glass jar and then poured on it 1liter of boiled distilled water (1:10 w/v) and kept at room temperature for 24 hours, then the solution was filtered through a screen to obtain the purified extract for use as a stock solution (100%).
3- Aqueous solution of molasses (100 %). The two previous solutions were diluted with distilled water to prepare the final immersing solution at two levels as follows:
a- 75 ml of either cabbage leaves extract (100 %) or molasses (100 %) + 25 ml of distilled water to get 75 % aqueous solution from each.
b- 50 ml of either cabbage leaves extract (100 %) or molasses (100 %) + 50 ml of distilled water to get 50 % aqueous solution from each.
4- Aqueous solution of indole-3-butyric acid (IBA, 98 %, M.P. 124-125.5 °C, M.W. 203.24) a product from Aldrich Chemical Co. Ltd., Gillingham, Dorest-England at the concentrations of 1500 and 3000 ppm, prepared by dissolving 0.375 and 0.75g of IBA powder (solubel in water) in 250 ml distilled water for the two abovementioned concentrations, respectively.

Some active components were determined in the two used natural extracts and illustrated in Table (a).

5- Each level of natural extracts (cabbage and molasses) and IBA was combined with the two immersing times to create 12 interaction treatments.

Immediately after termination of immersing time, the treated cuttings and those of control were inserted for 3-4 cm in 8-cm-diameter plastic pots (one cutting/pot) filled with a mixture of peat moss

and sand for rooting (2: 1, by volume). The physical and chemical properties of the peat moss and sand used in the two seasons are shown in Tables (b) and (c), respectively.

Table a: Some active components in cabbage leaves extract and molasses used in the two experimental seasons (2018 and 2019).

Active components in cabbage extract					Active components in molasses				
Total amino acids (%)	**Gibberellic acid (mg/l)**	**ABA (mg/l)**	**IBA (mg/l)**	**Cytokinin (mg/l)**	**Total amino acids (%)**	**Gibberellic acid (mg/l)**	**ABA (mg/l)**	**IBA (mg/l)**	**Cytokinin (mg/l)**
0.16	185.0	19.2	14.5	25.5	0.15	370.0	30.4	190.4	102.3

Table b: The physical and chemical properties of the peat moss used in 2018 and 2019 seasons.

Organic matter	**90-95 %**	**Salinity**	0.3 g/l	**Mn**	27 ppm
Ash	5-10 %	**N**	1.09 %	**Mg**	346 ppm
Density (vol. dry)	85 mg/l	**P**	0.23 %	**Zn**	41 ppm
pH volume	3.5	**K**	1.77 %	**Cu**	8.8 ppm
Water relation capacity	60-75 %	**Fe**	421 ppm	**B**	3.5 ppm

Table c: The physical and chemical properties of the sand used in 2018 and 2019 seasons.

Season	**Particle size distribution (%):**				**S.P.**	**E.C. (dS/m)**	**pH**	**Cations (meq/l)**				**Anions (meq/l)**		
	Coarse sand	**Fine sand**	**Silt**	**Clay**				**Ca^{++}**	**Mg^{++}**	**Na^{+}**	**K^{+}**	**HCO_3^-**	**Cl^-**	**SO_4^{--}**
2018	89.03	2.05	0.40	8.52	23.01	3.56	7.9	7.50	1.63	33.60	0.50	3.20	22.00	18.03
2019	84.76	6.29	1.50	7.45	21.87	3.71	7.8	19.42	8.33	7.20	0.75	1.60	7.80	26.30

The lower part of pots was buried in the wet soil of greenhouse and the cuttings received all the other agricultural practices whenever needed. The mean of temperatures inside the greenhouse during the course of this study ranged between 26-37 °C (day/night) ±2°C, while relative humidity ranged between 65-75 %. The layout of the experiment in the two seasons was a complete randomized design in factorial experimental type (Mead *et al.,* 1993) with 3 replicates, as each replicate contained 10 cuttings (one cutting/pot).

Two month later (on September, 7th), number of the rooted cuttings was counted for each treatment and the rooting percentage was calculated from the following equation: Rooting % = No. rooted cuttings / total No. cuttings in the treatment x 100. At the same time, the rooted cuttings were transplanted into 14-cm-diameter plastic pots containing about 1.2 kg of the same rooting mixture mentioned before. After other two months (on October, 15th), the produced transplants were gently lifted and the following data were recorded: transplant length (cm), number of leaves/transplant, the longest root length (cm), number of roots/transplant and top growth and roots fresh and dry weights (g).

In fresh samples, total chlorophyll (a + b) and carotenoids concentrations, as mg/g f.w. were determined according to the method of Sumanta *et al.,* (2014), while in dry ones, the percentages of nitrogen, potassium, phosphorus and total carbohydrates were measured using the methods described by Blacke (1965), Jackson (1973), Herbert *et al.,* (1971) and Wide *et al.,* (1985), successively. Moreover, in methanolic extraction colorless, total indoles, total phenols, total flavonoids and total antioxidants were evaluated by the methods explained by Larsen *et al.,* (1962) modified by Salim *et al.,* (1978), Singleton *et al.,* (1999), Woisky and Salation (1998) and Prieto *et al.,* (1999), successively .

Data were then tabulated and statistically analyzed using the Assistant Software Program of Silva and Azevedo (2016), which was followed by Duncan's New Multiple Range t-Test (Steel and Torrie, 1980) to compare means of treatments.

3. Results and Discussion

3.1. Effect of rooting treatments, immersing time and their interactions on

3.1.1. Rooting percentage and growth of the new formed transplants

It is obvious from data presented in Table (1) that means of rooting (%) was greatly improved by the different rooting treatments used in this study with various significant differences as compared to control treatment, which gave only 22.5 and 30.00% rooting in the first and second seasons, respectively. The highest percent, however was attained by immersing in cabbage extract solution (75%) that increased mean values of this character to 98.50 % in the first season and to 99.00% in the second one, followed by immersing in the same extract solution at 50% concentration that hastened rooting% in the 1st season to 97.50% and in the second one to 98.00%. Immersing in IBA solution at 1500ppm recorded also good results, as it gave in the 1st season 97.00% rooting and in the 2nd one 98.00%.

On the other hand, elongating immersing time from 15 to 30 min. significantly exceeded rooting (%) from 80.14 to 82.14% in the 1st season and from 82.14 to 84.29 % in the 2nd one. Thus, combining between immersing in either cabbage extract solution (at any concentration) or IBA solution (at 1500ppm concentration) and immersing time for 30 min. gave in both seasons the highest rooting percentage at all (100%). This may be due to lumping between the positive effects of either cabbage extract or IBA and subjecting the cuttings to longer period of immersing enough to absorb higher amount of rooting promoters.

Table 1: Effect of rooting treatments, immersing time and their interactions on rooting percentage, plant length and number of leaves of the resulted *Codiaeum variegatum*(Gold Dust) transplants during 2018 and 2019 seasons.

Immersing time (min.)	Rooting (%)			Transplant length (cm)			No. of leaves / transplant		
	15 min.	30 min.	Mean	15 min	30 min	Mean	15 min.	30 min.	Mean
Rooting treatments	**First season 2018**								
Control	20.00k	25.00j	22.50G	18.03k	16.50l	17.27G	10.67l	14.67k	12.67G
IBA (1500 ppm)	94.00d	100.0a	97.00C	25.67f	27.53e	26.60D	25.33f	25.67j	25.50D
IBA (3000 ppm)	90.00f	85.00g	87.50E	24.70g	22.60h	23.65E	23.33g	21.00h	22.17E
Cabb. ext. (50%)	95.00c	100.00a	97.50B	29.13c	32.63b	30.88B	27.33d	29.00c	28.17B
Cabb. ext. (75%)	97.00b	100.00a	98.50A	32.50b	35.13a	33.82A	30.33b	33.67a	32.00A
Molasses (50%)	92.00e	95.00c	93.50D	28.33d	29.20c	28.77C	26.67e	27.00de	26.83C
Molasses (75%)	73.00h	70.00i	71.50F	21.50i	19.97j	20.73F	19.67i	17.67j	18.67F
Mean	80.14B	82.14A		25.70B	26.22A		23.33B	24.10A	
	Second season 2019								
Control	25.00j	35.00i	30.00F	20.70i	23.13h	21.92F	14.33j	17.00i	15.67G
IBA (1500 ppm)	96.00c	100.00a	98.00B	27.60ef	28.50e	28.05D	28.00e	29.33d	28.67D
IBA (3000 ppm)	91.00e	88.00f	89.50D	27.97e	26.93f	27.45D	26.33f	26.33f	26.33E
Cabb. ext. (50%)	96.00c	100.00a	98.00B	33.37c	35.13b	34.25B	31.67c	34.33b	33.00B
Cabb. ext. (75%)	98.00b	100.00a	99.00A	35.00b	40.33a	37.67A	34.00b	36.33a	35.17A
Molasses (50%)	94.00d	96.00c	95.00C	29.97e	30.80d	30.38C	29.33d	31.33c	30.33C
Molasses (75%)	75.00g	71.00h	73.00E	25.20g	23.67h	24.43E	23.33g	18.33h	20.83F
Mean	82.14B	84.29A		28.54B	29.79A		26.71B	27.57A	

* Means within a column or row having the same letters are not significantly different according to Duncan's New Multiple Range t-Test at 5 % level.

Similarly, were those results of the new formed transplants parameters shown in Tables (1, 2 and 3) and Fig. (1) , as the mean values of transplant length (cm), number of leaves/transplant, root length (cm), number of roots/transplant, as well as top growth and roots fresh and dry weights (g) were significantly increased in response to the various rooting natural and chemical promoters employed in such trial with the superiority of the aqueous solution of cabbage leaves extract at 75 % concentration treatment, which acquired the utmost high values over all the other treatments in the two seasons, and followed also by the same extract solution of cabbage leaves at 50% concentration treatment that deservedly occupied the second rank. This may be attributed to that the extract of cabbage leaves contains amino acids (0.16mg/l), gibberellic acid (185.0ppm), indole-3-butyric acid (145ppm) and cytokinins (25.5ppm) as shown in Table (a). These phytochemicals are useful in promoting root primordia, cell division and enlargement and nutritive for plants (Lun, 2016).

Table 2: Effect of rooting treatments, immersing time and their interactions on rooting length and number of roots of the resulted *Codiaeum variegatum* (Gold Dust) transplants during 2018 and 2019 seasons.

Immersing time (min.)	Root length (cm)			No. of roots/ transplant		
Rooting treatments	**15 min.**	**30 min.**	**Mean**	**15 min.**	**30 min.**	**Mean**
			First season 2018			
Control	3.40k	5.23j	4.32F	5.00l	8.33k	6.67G
IBA (1500 ppm)	10.97f	11.27ef	11.12C	18.00f	21.00d	19.50D
IBA (3000 ppm)	10.30g	10.23g	10.27D	15.00g	13.00h	14.00E
Cabb. ext. (50%)	11.60de	13.07c	12.33B	19.33e	24.67c	22.00B
Cabb. ext. (75%)	17.43b	19.30a	18.37A	26.33b	34.67a	30.50A
Molasses (50%)	10.83f	11.77d	11.30C	17.67f	24.33c	21.00C
Molasses (75%)	7.40f	6.37i	6.88E	12.00i	10.00j	11.00F
Mean	10.28B	11.03A		16.19B	19.43A	
			Second season 2019			
Control	4.00n	5.90m	4.95G	7.67k	10.67j	9.17G
IBA (1500 ppm)	12.00h	14.33e	13.17D	20.00f	25.00d	22.50D
IBA (3000 ppm)	10.80i	10.23j	10.52E	19.67f	16.33g	18.00E
Cabb. ext. (50%)	13.50f	17.07c	15.28B	25.00d	32.67b	28.83B
Cabb. ext. (75%)	20.30b	28.67a	24.48A	33.00b	42.00a	37.50A
Molasses (50%)	12.50g	15.97d	14.23C	21.33e	28.00c	24.67C
Molasses (75%)	9.60k	7.73l	8.67F	15.00h	11.67i	13.33F
Mean	11.81B	14.27A		20.24B	23.76A	

*Means within a column or row having the same letters are not significantly different according to Duncan's New Multiple Range t-Test at 5 % level.

In this regard, Paradikovic *et al.,* (2018) stated that the physiological effects of natural extracts depend on their composition as they contain various organic and mineral compounds which plants can use as metabolites, growth regulators and nutrients. So, they mostly enhance plant vigour, stimulate vegetative growth, improve nutrient acquisition and distribution within the plant, increase antioxidative capacity of plant tissues, contribute to higher stress tolerance and improve flower yield and quality. Abo El-Fadl *et al.,* (2020) indicated that moringa leaves extract showed high nutritional value and had the potential as good source of natural antioxidants which play a great protection role against oxidative stress. Recently, Rajan and Singh (2021) reported that organic rooting extracts of some natural substances, such as: coconut water, willow leaf water, honey, humic acid, seaweed extract, *Aloe vera*, cabbage outer leaves and cinnamon powder are considered ideal for rooting of cuttings because they reduce the synthetic hormone use (IBA and NAA) and improve the quality and quantity of roots of the rooted cuttings with increasing sustainability of the soil and make it more productive.

Regarding the positive effect of IBA on rooting and initial growth of the new formed transplants, it may be ascribed to the nia gene which encodes nitrate reductase that causes reinduction of nitrate,

forming the reduced N needed for lateral root formation and development. Thus, the nia gene is one of the genes expressed during the early stages of root meristem formation (Vuylsteker *et al.,* 1998). Besides, application of auxins (IBA or NAA) may cause a decrease in the level of zeatin-o-glucoside conjngates. Hydrolysis of these conjugates might deliver free zeatin-type compounds which activate the lateral root growth. The aqueous solution of IAA, IBA and NAA promotes lateral root number and elongates the primary root axis (Taylor and Sladen, 1998). In addition, Rajan and Singh (2021) suggested that IBA and NAA enhance the initiation of root primordia and growth through cell multiplication. Such hormones support mobilization of sugars and nutrients by the hydrolysis of starch at the base of the cuttings.

As noticed before in case of rooting %, it was also noticed that protraction immersing time from 15 min. to 30 minutes significantly raised the mean values of different vegetative and root growth traits of the resulted transplants (Tables, 1, 2 and 3) due to giving the cuttings the proper chance to absorb enough volume from rooting solution that contains metabolites, growth regulator-like substances and nutrients necessary for good growth (Paradikovic *et al.,* 2018). So, interacting between soaking in cabbage extract solution at 75 % concentration and immersing time of 30 minutes registered the highest growth values relative to all the other interactions in both seasons, scoring the tallest plant, longest root, highest number of leaves and roots/transplant and the heaviest fresh and dry weights of top growth and roots. Furthermore, combining between immersing the cuttings in the same aforenamed solution at the same concentration and immersing time for 15 min. came in the second place. Also, a combination of submersing in cabbage extract solution at 50 % concentration for 30 minutes recorded better results in some growth traits. This may indicate the importance of connecting between more factors in the research trials, where each factor hastened the other one, as remarked in this study.

Table 3: Effect of rooting treatments, immersing time and their interactions on top growth and roots fresh and dry weights of the resulted *Codiaeum variegatum* (Gold Dust) transplants during 2018 and 2019 seasons.

Immersing time (min.)	**Top growth**						**Roots**					
	Fresh weight (g)			**Dry weight (g)**			**Fresh weight (g)**			**Dry weight (g)**		
	15 min.	**30 min.**	**Mean**	**15 min.**	**30 min.**	**Mean**	**15 min.**	**30 min.**	**Mean**	**15 min.**	**30 min.**	**Mean**
Rooting treatments	**First season : 2018**											
Control	8.29j	9.35i	8.82G	1.86g	1.94g	1.90F	0.20i	0.49g-i	0.35E	0.11i	0.24g-i	0.18E
IBA (1500 ppm)	12.62f	13.03e	12.82D	2.70de	2.76d	2.73D	0.75f-h	0.86fg	0.80D	0.27g	0.35fg	0.31D
IBA (3000 ppm)	12.51f	11.72g	12.11E	2.52e	2.24f	2.38E	0.59g-i	0.38hi	0.49E	0.26gh	0.14hi	0.20E
Cabb. ext. (50%)	15.23c	17.64b	16.44B	3.36c	3.49bc	3.42B	1.79cd	2.18bc	1.99B	0.73d	0.87c	0.80B
Cabb. ext. (75%)	17.49b	18.93a	18.21A	3.71b	4.36a	4.04A	2.49b	3.53a	3.01A	1.28b	1.42a	1.35A
Molasses (50%)	13.46h	15.13c	14.30C	2.91d	3.28c	3.10C	1.07ef	1.39de	1.23C	0.42ef	0.53e	0.47C
Molasses (75%)	10.56h	9.56i	10.06F	1.56h	1.32i	1.44G	0.35hi	0.26i	0.31E	0.15hi	0.12i	0.13E
Mean	12.88B	13.62A		2.66B	2.77A		1.03B	1.30A		0.46B	0.52A	
	Second season :2019											
Control	10.47m	11.31l	10.89G	2.03i	2.12hi	2.08F	0.54j	0.90j	0.72F	0.27h	0.32h	0.30F
IBA (1500 ppm)	14.78h	15.83f	15.31D	2.97ef	3.21e	3.09D	1.90fg	2.42de	2.16D	0.76f	0.95de	0.86C
IBA (3000 ppm)	14.13i	13.35j	13.74E	2.49g	3.20hi	2.35E	1.71gh	1.37hi	1.54E	0.74f	0.57g	0.66D
Cabb. ext. (50%)	18.17d	19.65c	18.91B	3.72d	4.68c	4.20B	3.15c	3.85b	3.50B	1.04d	1.58c	1.31B
Cabb. ext. (75%)	21.11b	24.64a	22.88A	5.28b	7.53a	6.40A	3.75b	4.52a	4.13A	1.94b	2.89a	2.42A
Molasses (50%)	15.31g	16.74e	16.03C	2.88f	3.71d	3.30C	2.20ef	2.77cd	2.49C	0.84ef	1.02d	0.93C
Molasses (75%)	12.18k	11.93k	12.05F	2.39gh	2.19hi	2.29E	1.47hi	1.29i	1.38E	0.58g	0.41h	0.50E
Mean	15.16B	16.21A		3.11B	3.66A		2.10B	2.44A		0.88B	1.11A	

* Means within a column or row having the same letters are not significantly different according to Duncan's New Multiple Range t-Test at 5 % level.

Fig. 1: Effect of the natural extracts treatments on rooting of the terminal stem cuttings of *Codiaeum variegatum*. Treatments from left to right: 1: control for 30 min. 2: IBA at 1500ppm for 30 min. 3: Cabbage leaves extract at 75% level for 30 min.

The previous results are in accordance with those revealed by Baldotto *et al.,* (2012) who concluded that application of either IBA (597mg/l) or HA (14mmol/l) accelerated rooting of *Codiaeum variegatum* cuttings and raised root dry matter to the maximum. Goda *et al.,* (2018) found that treating *Phytolacca dioica* cuttings with IBA at 4000ppm + NAA at 4000ppm gave the highest rooting% and root length. On rosemary (*Rosmarinus officinalis*), Massoud *et al.,* (2017) declared that treating terminal cuttings with coconut milk at the rate of 75 % attained the highest rooting %, root number and length with the greatest means of all vegetative growth parameters of the new transplants, except for shoot fresh weight that was obtained when terminal cuttings treated with seaweed extract at 50% rate. Using natural products such as coconut milk, seaweed extract, yeast extract and bee honey recorded, in general better rooting and growth results than IBA synthetic hormone. Similarly, Gomes *et al.,* (2018) found that immersing of *Possiflora actinia* stem cuttings in brown seaweed extract at a concentration of 40% increased rooting% to an average of 51.3% plus 15.6% increase in leaf retention, and that facilitate the species propagation. For rooting the medium cuttings of *Melaleuca viminalis*. Hameed and Adel (2020) mentioned that the rooting solution of 750ppm IBA + 750ppm NAA + 20ppm cinnamon extract acquired the highest rooting rate, length of vegetative growth and number of leaves when accompanied with wounding.

3.1.2. Chemical composition of the leaves:

An identical response to that of rooting percentage and vegetative and root growth characters of the resulted transplants was also obtained concerning the most chemical constituents concentrations determined in the leaves (Tables, 4, 5, and 6) where concentrations of total chlorophyll (a + b) and carotenoids (mg/g f.w.), the percentages of nitrogen, potassium, phosphorus and total carbohydrates, as well as total antioxidants and total indoles concentrations (mg/100g d. w.) were maximum by immersing in cabbage leaves extract solution at 75% concentration. Also, elongating the submersion time from 15 to 30 min. significantly increased the mean values of these constituents in most cases of the two seasons. Therefore, the combining between soaking the cuttings in solution of cabbage leaves extract (75% concentration) and immersing time of 30 minutes attained the utmost high concentrations of such chemical components over all individual and other combined treatments used in this study. This may be reasonable because the cabbage outer leaves extract is potential source of phytochemicals which could be useful ingredients for natural and effective nutrition method of plants (Lun, 2016). In this respect, Paradikovic *et al.,* (2018) stated that natural extracts of some plants have beneficial effects on plant growth and development, as they contain various organic and mineral compounds which plants can use as metabolites, growth regulators and nutrients. Thus, they can improve nutrient uptaking and distribution within the plants. Also, AboEl-FAdl *et al.,* (2020) concluded that moringa leaf extract showed a certain nutritional value and could provide healthy benefits to plants. Besides, Rajan and Singh (2021) proved that use of natural rooting extracts derived from coconut milk, willow leaf water, honey, humic acid, cabbage leaves, seaweed extract, *Aloe vera*, garlic, yeast and cinnamon powder are

ideal for rooting of cuttings and initial growth of the new formed transplants due to that they contain high amounts of growth regulator-like substances and minerals.

The results mentioned before can be supported by those detected by El-Fouly *et al.,* (2009) on *Ficus deltoidea*, El-Sayed *et al.,* (2010 a) on *Hibiscus rosa-sinensis*, El-Sayed *et al.,* (2010 b) on *Bougainvillea glabra*, Massoud *et al.,* (2017) on rosemary and Abdel-Rahman (2020) who revealed that IBA at 100 ppm recorded the highest endogenous contents of phenols, IAA and the lowest abscisic acid (ABA) content in tip cuttings of *Conocarpus erectus* planted in vermiculite substrate. Ibrahim (2020) affirmed that seaweed extract at 2 ml/l alone or combined with IBA (300 ppm) and phloroglucinol (300 ppm) increased total carbohydrates, but reduced total phenolics in the root zone tissues of *Dracaena marginata* air layers. Likewise, Pacholczak, and Nowakowska, (2020) reported that spraying foliage of Elfrid "Kormuse" and Weisse Immensee "Korweirim" roses cuttings with the commercial Goteo biostimulator (contains 1 % IBA + natural extracts) significantly increased chlorophyll (a + b) and total soluble sugars in the cuttings, but the levels of free amino acids and polyphenolic acids were decreased.

Table 4: Effect of rooting treatments, immersing time and their interactions on pigments concentration in the leaves of the resulted *Codiaeum variegatum* (Gold Dust) transplants during 2018 and 2019 seasons.

Immersing time(min.) / Rooting treatments	Total chlorophyll (mg/g f. w.)			Carotenoids (mg/g f. w.)		
	First season 2018					
	15 min.	30 min.	Mean	15 min.	30 min.	Mean
Control	0.473j	0.592i	0.532G	0.027l	0.051k	0.039G
IBA (1500 ppm)	1.261e	1.293de	1.277D	0.420fg	0.436ef	0.428D
IBA (3000 ppm)	1.195f	1.107g	1.151E	0.411gh	0.388h	0.400E
Cabb. ext. (50%)	1.385c	1.495b	1.440B	0.496d	0.530c	0.513B
Cabb. ext. (75%)	1.544b	1.789a	1.667A	0.572b	0.636a	0.604A
Molasses (50%)	1.342cd	1.380c	1.361C	0.450e	0.487d	0.469C
Molasses (75%)	1.091g	0.929h	1.010F	0.352i	0.244j	0.298F
Mean	1.184B	1.226A		0.390A	0.396A	
	Second season 2019					
Control	0.518i	0.636h	0.577G	0.074l	0.104k	0.089G
IBA (1500 ppm)	1.296e	1.336de	1.316D	0.439g	0.455fg	0.447D
IBA (3000 ppm)	1.287e	1.133f	1.210E	0.423h	0.402i	0.412E
Cabb. ext. (50%)	1.542c	1.662b	1.602B	0.531d	0.656c	0.593B
Cabb. ext. (75%)	1.715b	1.921a	1.818A	0.688b	0.870a	0.779A
Molasses (50%)	1.348de	1.389d	1.369C	0.469f	0.494e	0.482C
Molasses (75%)	1.126f	0.980g	1.053F	0.386i	0.313j	0.350F
Mean	1.262B	1.294A		0.430B	0.471A	

*Means within a column or row having the same letters are not significantly different according to Duncan's New Multiple Range t-Test at 5 % level.

Table 5: Effect of rooting treatments, immersing time and their interactions on nitrogen, total carbohydrates (%) phosphorus and potassium concentration (average of both seasons) in the leaves of the resulted *Codiaeum variegatum* (Gold Dust) transplants.

Immersing time (min.)	N (%)			P (%)			K (%)			Total carbohydrates (%)		
Rooting treatments	**15 min.**	**30 min.**	**Mean**	**15 min.**	**30 min.**	**Mean**	**15 min.**	**30 min.**	**Mean**	**15 min.**	**30 min.**	**Mean**
Control	1.01j	1.44i	1.23G	0.219j	0.261i	0.240G	1.36i	1.95h	1.66E	9.20k	10.79j	10.00G
IBA (1500 ppm)	2.16f	2.24e	2.20D	0.386g	0.480f	0.433D	2.68d-f	2.74c-e	2.71C	17.25f	17.99ef	17.62D
IBA (3000 ppm)	2.12f	2.00g	2.06E	0.369g	0.333h	0.451E	2.51e-g	2.39g	2.45D	15.69g	15.31gh	15.50E
Cabb. ext. (50%)	2.47d	2.92b	2.70B	0.767d	0.865c	0.816B	2.82b-d	2.97bc	2.90B	19.48d	21.03c	20.26B
Cabb. ext. (75%)	2.96b	3.20a	3.08A	1.490b	1.860a	1.675A	3.03b	3.34a	3.19A	22.78b	24.38a	23.58A
Molasses (50%)	2.45d	2.66c	2.55C	0.660e	0.690e	0.675C	2.59d-g	2.76b-e	2.68C	18.18ef	19.08de	18.63C
Molasses (75%)	2.03g	1.87h	1.95F	0.320h	0.312h	0.316F	2.43fg	2.12h	2.28D	14.40hi	13.63i	14.02F
Mean	2.17B	2.33A		0.602B	0.686A		2.49B	2.61A		16.71B	17.46A	

* Means within a column or row having the same letters are not significantly different according to Duncan's New Multiple Range t-Test at 5 % level.

Table 6: Effect of rooting treatments, immersing time and their interactions on concentration of some constituents in the leaves of *Codiaeum variegatum* (Gold Dust) transplants as average of both seasons.

Immersing time(min.)	Total phenols (mg/100g d.w.)			Total indoles (mg/100g d.w.)			Total flavonoids (mg/100g d.w.)			Total antioxidant (mg/100g d.w.)		
Rooting treatments	**15 min.**	**30 min.**	**Mean**	**15 min.**	**30 min.**	**Mean**	**15 min.**	**30 min.**	**Mean**	**15 min.**	**30 min.**	**Mean**
Control	988.5a	724.3b	856.4A	21.95k	32.09j	27.02G	162.28a	137.18b	149.73A	751.9n	845.3m	798.6G
IBA (1500 ppm)	285.2g	230.1h	252.6D	69.15f	85.50e	77.33D	84.21g	79.60h	81.90D	1471.5g	1585.4f	1528.5D
IBA (3000 ppm)	382.3f	459.3e	420.8C	63.20g	53.72h	58.46E	90.23f	105.90e	97.07C	1336.8i	1207.6j	1272.2E
Cabb. Ext. (50%)	160.1k	134.5l	147.3F	117.40c	138.53b	127.96B	58.17k	50.60l	54.38F	1936.0d	2070.1c	2003.1B
Cabb. Ext. (75%)	113.9m	87.70n	100.8G	139.11b	200.55a	169.83A	41.32m	31.94n	36.63G	2441.0b	2813.2a	2627.1A
Molasses (50%)	206.9i	189.0j	198.0E	93.92d	113.09c	103.51C	72.57i	61.88j	67.22E	1386.8h	1806.3e	1596.5C
Molasses (75%)	591.0d	690.9c	641.0B	42.06i	37.67i	39.87F	113.99d	128.27c	121.13B	1142.4k	1075.7l	1109.0F
Mean	388.3A	359.4B		78.11B	97.45A		88.97A	85.05B		1495.2B	1629.1A	

* Means within a column or row having the same letters are not significantly different according to Duncan's New Multiple Range t-Test at 5 % level.

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