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Effect of Treatment with Some Eco-Friendly Natural Extracts on Growth Quality and Anthocyanin Pigment in *Alternanthera dentata*, *Gynura aurantiaca* and *Tradescantia pallida purpurea*

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Abstract: This investigation was carried out at Ornamental Plants Research Department, Horticulture Research Institute, Giza, Egypt in the nursery in the two seasons of 2018/2019 and 2019/2020 to study the effect of foliar spraying with different concentrations of aloe leaves gel extract, licorice and moringa leaves aqueous extract at 0.0, 3.0, 6.0 and 9.0 % respectively on the growth and some chemical constituents of *Alternanthera dentata*, *Gynura aurantiaca* and *Tradescantia pallida purpurea*. The obtained results can be summarized as follows: The highest values of plant height, plant fresh and dry weight, root length, roots fresh weight, roots dry weight, the content of anthocyanin in the leaves, total carbohydrates in the leaves and some macro (N, P and K) and micro elements (Fe, Zn and Mn) were obtained with Licorice roots extract, followed by moringa leaves extract and finally aloe leaves gel extract in both seasons, whereas the lowest values of all recorded characters were resulted in control treatment in both seasons.

Abbreviation: *Glycyrrhiza glabra* (*G. glabra*), *Aloe vera* (*A. vera*), *Moringa oleifera* (*M. oleifera*), *Alternanthera dentata* (*A. dentata*), *Gynura aurantiaca* (*G. aurantiaca*) *and Tradescantia pallida purpurea* (*T. pallida purpurea*)

Key words: Licorice roots extract · Moringa extract · Aloe extract · *Alternanthera dentata* · *Gynura aurantiaca and Tradescantia pallida purpurea* · Anthocyanin pigment

INTRODUCTION

Alternanthera dentate L. plants belongs to family Amaranthaceae. The plant is a perennial shrub, evergreen, which has white small flowers, in cluster. The plant has a purple foliage and leaves are simple and opposite, it is suitable for pots, it used as a small hedge plant, its natural colored pigments are ecofriendly, cheap and easily available [1].

Several species of the genus Tradescantia (Commelinaceae family) are additionally, used for medicinal and ornamental purposes. The polyphenolic compounds are the most important functional components found in *Tradescantia pallida purpurea* L. plants. The aqueous extracts are rich with flavonoids which are generally known for their coloring power when they are applied to textile materials. *Tradescantia pallida purpurea* gives a pH dependent color. It is red at pH 3 and yellow at pH 8 [2, 3].

Gynura aurantiaca (Blume) DC "purple passion", or "purple velvet" plant, it is a member of the family Asteraceae. It is an important ornamental foliage plant; it is a perfect choice for hanging baskets. Its purple-colored leaves contain stable polyacylated anthocyanins which have potential to be natural food colorants. Natural colored pigments are ecofriendly, cheap and easily available. They also give a sharp color change in neutralisation titrations and can replace the conventional acid-base indicators [4, 5].

LD50 value of extracts refers to the dose which has proved to be lethal (causing death to 50 % of the tested group of animals) Ogbuehi *et al*. [6], also, Kasthuri and Ramesh [7] showed that the LD50 values of the tested leaf extracts *of Alternanthera bettzickiana* were more than

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2000 mg/kg dwt. So, no toxicity related symptoms were observed in different doses of leaf extract treated mice groups.

Aloe vera is a succulent plant. It contained, anthraquinones, enzymes, vitamins (A, B, C, E, choline, B12, folic acid), polysaccharides, salicylic acid, saponins and steroids. Moreover, it contains Auxins and gibberellins, mono polysaccharide (cellulose, glucose, mannose, aldopentose) and lignin. It also contains all the essential amino acids, i.e. isoleucine, leucine, lysine, methionine, phenylalanine, threonine, valine and tryptophan. Moreover, it contains few other non-essential amino acids, which are alanine, arginine, asparagine, glutamic acid, glycine, histidine, proline, serine, tyrosine, glutamine and aspartic acid [8].

Extract of licorice roots (*Glycyrrhiza glabra*) contains some compounds, which have similar effect to that of growth promoters, a wide range of minerals (calcium, potassium, magnesium, iron, zinc and phosphorus), amino acids (alanine, histidine, leucine, lysine, arginine, alanine, threonine aspartic, glutamic acid, serine, proline, glycine, valine, isoleucine, tyrosine and phenylalanine) vitamins (B1, B2 and B6), carbohydrates and nitrogen. It also contains mevalonic acid used in gibberellins synthesis. The chemical analysis of *G. glabra* root extract showed the existence of triterpenes (glycyrrhizin, glycyrrhetinic acid and liquirtic acid) and flavonoids (liquirtin and formononetin) [9-12].

Moringa (*Moringa oleifera*) leaves are a source of amino acids, essential minerals (K, Ca and Fe) and vitamins (A, B and C). It contains, powerful natural antioxidants (ascorbate and phenolics). Moreover, moringa leaves extract is enriched with growth substances like auxins, cytokinins and abscisic acid [13-15].

The aim of this study is to achieve two goals: the first goal, improving growth quality and anthocyanin pigment of *Alternanthera dentata, Gynura aurantiaca* and *Tradescantia pallida Purpurea* by cheap nature extracts price and the second one, producing cheap, easily available, sustainable and environmentally friendly dyes from these plants as mentioned before for safety and healthy colored foods.

MATERIALS AND METHODS

This investigation was carried out at Ornamental Plants Research Department, Horticulture Research Institute, Giza, Egypt in the nursery, in the two seasons of 2018/2019 and 2019/2020. Rooted cuttings 15-20 cm long of *Alternanthera dentata*, *Tradescantia pallida purpurea* and *Gynura aurantiaca* plants were planted in 1st March in 35 cm diameter pots filled with a mixture of nursery soil, sand and peat moss at 1:1:1 (v:v:v). The application of natural extracts (*A. vera*, *G. glabra* and *M. oleifera*) started after two weeks from planting and was repeated every four weeks for 6 months in the two seasons.

Preparation of Extracts: Extracts of each aloe, licorice and moringa were prepared as follows:

Extract of Aloe (*Aloe vera*): One kg. of fresh leaves was used and the two side margins were removed and the remainder was cut to pieces and blended in a blender. The blend was removed in a gauzemesh and squeezed powerfully. The juice was collected in a glass beaker and used at 0.0, 3.0, 0.6 and 9.0% [16].

Licorice (*Glycerrhiza glabra* L.): Dried licorice roots were ground and sifted. Proper quantity of the fine powder (100 g) was mixed for 15 min. with 1 liter of a tap water at a temperature of 50°C in a mixer to get the required concentrations of (0.0, 3.0, 6.0 and 9.0 % respectively). Thereafter, the mixture was left for 24 hours to settle and filtered several times [17].

Moringa (*Moringa oleifera*): The aqueous extract of *M.oleifera* leaves were prepared by soaking 100 g powder, of air-dried moringa leaves in one liter of water for 24 hours and filtered out, then diluted with water in the following concentrations: 0.0, 3.0, 6.0 and 9.0% [15].

The following parameters were recorded to evaluate the tested treatments:

Vegetative Growth:

- Plant height (cm).
- Plant fresh weight (g).
- Plant dry weight (g).
- Root length (cm)
- Roots fresh weight (g.)
- Roots dry weight (g).

Chemical Constituents: Chemical characteristics were determined in the two seasons as follows:

- Total carbohydrates (mg/ g d.w.) according to Herbert *et al*. [18].
- Anthocyanins (g/100 g f.w.) according to Hsia *et al*. [19].

Table 1: Some characteristics of the experimental soil

	Chemical composition					Mechanical composition			Texture
pH	EC dSm^{-1}	Organic matter %	Mineral nitrogen mg/kg	Phosphorus mg/kg	Available potassium mg/kg	% Clay	% Silt	% Sand	Clay sand
7.4	1.54	1.95	40.00	8.86	314.00	57.86	10.23	31.91	

- Nitrogen content (%) in leaves according to method of Jackson [20].
- Phosphorus content (%) in leaves was estimated calorimetrically as recommended by Troug and Meyer [21] by spectrophotometer.
- Potassium content (%) in leaves was determined by flame photometer 410 (Brown and Lilliland [22].
- The contents of Iron, Zinc and Manganese in leaves (ppm): were determined by using atomic absorption Spectrophotometer (Pyeunican SP1900), according to Brandifeld and Spincer [23].
- Experimental design:

A factorial experiment in a randomized complete block design was applied with two factors, (1) three natural extracts of *A. vera*, *G. glabra and M. oleifera*, (2) four concentrations i.e. 0.0, 3.0, 6.0 and 9.0 % of each treatment in 12 treatments with five replicates, each replicate contained five pots (35 cm). Thereafter, experiment contained 300 pots for each season, Duncan's multiple range test was used for the comparison between means of the treatments, according to Snedecor and Cochran [24].

RESULTS AND DISCUSSIONS

Effect of Extract Type and Concentrations % on Vegetative Growth and Chemical Composition of *Alternanthera dentata*, *Gynura aurantiaca* and *Tradescantia pallida purpurea* Plants

Effect on Vegetative Growth: Results pertaining vegetative growth traits (Tables 2, 3, 4, 5, 6 and 7) demonstrated that the foliar application with the different extracts (aloe, licorice, moringa) had a significant effect on the studied vegetative growth traits, where all treatments significantly increased the plant height, fresh and dry weight per plant, root length, root fresh and dry weight, compared to control. The highest values of the three plants in this study were produced with using licorice extract followed by moringa and aloe extract. Actually the interaction between extracts type and its concentrations had a significant effect on increasing vegetative growth traits as compared with the control in both seasons. Also, the data in the same tables showed that the best concentration was 9.0 % in each extract.

These results were in harmony with many studies experimented the foliar spraying with licorice extract as Al-Sahaf and Al-Marsoumi [25]; Al-Ajeeli [26]; Alabdaly [27]; Moses [9]; Badr *et al*. [10] and Massoud *et al*. [12] they confirming that licorice (*G. glabra*) extract has attracted attention to its possible use as a plant biostimulant and plant extract could potentially provide a safe alternative to chemical fertilizers and plant regulators, its cheap price in case other materials are unavailable. The raw herb licorice contains protein, fat, fibers, carbohydrates, silica, many minerals such as K, P, Mn, Fe, many biological compounds such as, glycerrhzel, glescerzin and other compounds having similar effects like growth regulators , amino acids, vitamins and growth stimulating phyto-hormones which have similar effect to GA_3 as glycyrrihyzic acid is first synthesized from mevalonic) which increase the activity of apical meristem tissue resulting in more cell division and elongation and consequently improve vegetative growth characteristics.

Many researches proved that the foliar application of *M. oleifera* can be used as bio stimulants for vigor growth and its leaf extract contains growth enhancing substances [13-15, 28].

The aforementioned results were in harmony with many studies experimented foliar spraying with *A. vera* extract [29, 8].

Effect on Chemical Composition: Evidently, data of the effect of natural extracts on some chemical traits of the three plants Tables (8, 9, 10, 11, 12 and 13) and Fig. 1 and Fig. 2 showed that all extract types (aloe, licorice, moringa) had a significant effect on most of mineral contents (N, P and K%), (Fe, Zn and Mn ppm) and (anthocyanins mg/100 g f.w. and total carbohydrates mg/100 g d.w.) as compared with control treatment. The highest values of these components were produced with using licorice followed by moringa then aloe. The interaction between extracts type and their concentrations indicated that there were gradual increased in the bioactive substances as compared with the control in both seasons. Also, the data in the same tables showed that the best concentration of each extract was 9.0 %.

Table 2: Effect of extract type and concentration (%) on plant height (cm) of *A. dentata*, *G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	Plant height (cm)									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	46.32 j	60.26 i	65.13 h	68.23 g	59.99 C	51.23 j	63.00 i	68.42 g	74.23 c	64.22 C
Glycerrhiza glabra	45.63 l	72.50 e	78.52 b	87.23 a	70.97 A	50.43 l	75.12 e	76.53 b	84.65 a	71.68 A
Moringa oleifera	46.03 k	71.89 f	73.23 d	77.25 c	67.10 B	51.00 k	68.23 h	70.29 f	72.56 d	65.52 B
Mean A	45.99 D	68.22C	72.29 B	77.57A		50.89 D	68.78 C	71.75 B	77.15 A	
	G. aurantiaca									
Aloe vera	59.07 j	62.33 h	70.18 f	77.18 e	67.19 B	61.02 l	64.20 k	75.18 g	80.80 e	70.30 C
Glycerrhiza glabra	58.62 k	89.39 c	90. 70 b	94.85 a	83.39 A	64.23 j	92.30 c	94. 60 b	98.02 a	87.29 A
Moringa oleifera	54.52 l	61.98 i	64.06 g	78.63 d	64.80 C	65.13i	69.00 h	77.06 f	89.63 d	75.21 B
Mean A	57.40 D	71.23 C	74.98 B	83.55 A		63.46 D	75.17 C	82.28 B	89.48A	
	T. pallida purpurea									
Aloe vera	41.53 k	51.23 i	55.26 g	59.52 e	51.89 C	46.23 l	55.33 h	56.70 g	51.82 i	52.52 C
Glycerrhiza glabra	42.00 j	58.23 f	60.20 d	64.50 a	56.23 A	49.11 j	60.20 e	64.57 a	63.23 b	59.28 A
Moringa oleifera	40.15 l	55.23 h	60.52 c	62.23 b	54.53 B	47.12 k	58.52 f	62.83 c	60.75 d	57.31 B
Mean A	41.23 D	54.90 C	58.66 B	62.08 A		47.49 C	58.02 B	61.37 A	58.60 B	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

Table 3: Effect of extract type and concentration % on plant fresh weight (g) of *A. dentata*, G. *aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	Plant fresh weight (g)									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	19.23 l	22.18 i	26.00 h	30.14 g	24.39 C	22.96 l	26.16 j	30.14 h	33.14 g	28.10 C
Glycerrhiza glabra	20.56 k	39.22 d	42.65 b	48.12 a	37.64 A	25.14 k	36.85 f	47.52 c	50.23 a	39.94 B
Moringa oleifera	21.15 j	36.25 f	38.18 e	40.25 c	33.96 B	26.18 i	41.25 e	47.18 d	48.25 b	40.72 A
Mean A	20.31 D	32.55 C	35.61 B	39.50 A		24.76 D	34.75 C	41.61 B	43.87 A	
	G. aurantiaca									
Aloe vera	31.45 k	40.11 h	48.96 g	50.21 f	42.68 C	33.00 k	46.13 h	44.15 i	47.63 g	42.73 C
Glycerrhiza glabra	33.26 j	50.21 f	59.61 c	67.14 a	52.56 A	35.00 j	49.80 f	58.00 d	69.25 a	53.01 B
Moringa oleifera	34.10 i	52.65 e	58.90 d	60.50 b	51.54 B	31.01 l	57.13 e	60.50 c	64.12 b	53.19 A
Mean A	32.94 D	47.66 C	55.82 B	59.28 A		33.00 D	51.02 C	54.22 B	60.33 A	
	T. pallida purpurea									
Aloe vera	40.85 l	50.85 i	53.47 h	58.85 g	51.01 C	47.52 j	52.75 i	56.45 h	62.15 g	54.72 D
Glycerrhiza glabra	44.23 j	73.52 d	82.63 b	87.14 a	71.88 A	45.23 l	76.61 d	84.60 b	89.14 a	73.90 A
Moringa oleifera	41.52 k	66.85 f	68.47 e	75.85 c	63.17 B	46.23 k	63.55 f	67.95 e	78.65 c	64.10 B
Mean A	42.20 D	63.74 C	68.19 B	73.95 A		46.33 D	64.30 C	69.67 B	76.65 A	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

Table 4: Effect of extract type and concentration % on Plant dry weight (g) of *A. dentata*, *G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	Plant dry weight (g)									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	6.14 l	10.08 i	11.25 h	13.05 g	10.13 D	9.94 l	11.32 j	13.05 h	14.34 g	12.16 C
Glycerrhiza glabra	7.52 j	16.98 d	18.46 b	20.83 a	15.95 A	10.03 k	15.95 f	20.57 c	21.74 a	17.07 B
Moringa oleifera	6.89 k	14.39 f	16.53 e	17.42 c	13.81 B	11.52 i	17.85 e	20.42 d	20.88 b	17.67 A
Mean A	6.85 D	13.82 C	15.41 B	17.10 A		10.50 D	15.04 C	18.01 B	18.99 A	
	G. aurantiaca									
Aloe vera	13.61 l	17.36 i	21.19 h	21.73 g	18.47 C	14.28 l	19.97 h	19.11 i	20.62 g	18.50 C
Glycerrhiza glabra	14.53 k	23.88 e	25.80 c	29.06 a	23.32 A	15.63 k	21.56 f	25.10 d	29.97 a	23.07 B
Moringa oleifera	15.63 j	22.79 f	25.49 d	26.19 b	22.53 B	16.52 j	24.73 e	26.19 c	27.75 b	23.80 A
Mean A	14.59 D	21.34 C	24.16 B	25.66 A		15.48 D	22.09 C	23.47 B	26.11 A	
	T. pallida purpurea									
Aloe vera	13.68 l	18.01 i	20.14 h	23.47 g	18.83 B	15.57 l	17.83 j	19.43 h	21.90 g	18.68 B
Glycerrhiza glabra	14.86 k	26.82 d	29.77 b	36.72 a	27.04 A	16.75 k	28.16 d	31.62 b	33.58 a	27.53 A
Moringa oleifera	16.53 j	23.94 f	26.64 e	27.83 c	23.74 B	18.52 i	22.51 f	24.41 e	29.04 c	23.62 B
Mean A	15.02 D	22.92 C	25.52 B	29.34 A		16.95 D	22.83 C	25.15 B	28.17 A	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

Table 5: Effect of extract type and concentration (%) on root length /plant (cm) of *A. dentata*, *G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	Root length / plant (cm)									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	9.78 l	10.14 k	10.80 h	10.22 j	10.24 B	9.82 l	10.51 k	11.24 i	11.53 h	10.78 B
Glycerrhiza glabra	10.52 i	11.79 f	13.61 b	14.78 a	12.68 A	11.23 j	14.15 c	15.34 b	15.91 a	14.16 A
Moringa oleifera	12.56 d	11.71 g	12.09 e	12.96 c	10.33 B	12.52 f	12.22 g	13.50 e	13.80 d	13.01 B
Mean A	10.95 D	11.21 C	12.17 B	12.65 A		11.19 D	12.29 C	13.36 B	13.75 A	
	G. aurantiaca									
Aloe vera	12.47 l	14.42 j	16.98 h	20.43 g	16.08 B	14.89 k	15.67 h	15.16 i	19.92 g	16.41 B
Glycerrhiza glabra	15.64 i	24.08 e	25.25 c	29.81 a	23.70 A	15.12 j	22.47 d	23.78 c	27.24 a	22.15 A
Moringa oleifera	13.53 k	23.37 f	24.65 d	25.92 b	21.87 B	14.00 l	22.32 e	20.41 f	24.11 b	20.21 B
Mean A	13.88 D	20.62 C	22.29 B	25.39 A		14.67 D	20.15 B	19.78 C	23.76 A	
	T. pallida purpurea									
Aloe vera	20.15 l	30.92 i	32.17 h	35.04 f	29.57 B	22.76 k	28.47 i	29.66 h	36.89 e	29.45 C
Glycerrhiza glabra	23.23 j	42.87 c	47.13 a	45.71 b	39.74 A	23.52 j	39.13 d	42.72 b	50.54 a	38.98 A
Moringa oleifera	22.31 k	32.46 g	37.48 e	39.41 d	32.92 B	20.23 l	35.01 g	36.49 f	40.21 c	32.99 B
Mean A	21.90 D	35.42 C	38.93 B	40.05 A		22.17 D	34.20 C	36.29 B	42.55 A	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

Table 6: Effect of extract type and concentration (%) on root fresh weight /plant (g.) of *A. dentata*, *G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	Root fresh weight /plant (g.)									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	11.20 k	12.12 j	13.05 h	13.63 g	12.50 B	13.20 k	15.12 i	16.05 g	15.63 h	15.00 C
Glycerrhiza glabra	12.20 i	14.26 f	18.59 c	19.98 a	16.26 A	13.00 l	24.26 e	25.59 b	26.98 a	22.46 A
Moringa oleifera	10.14 l	17.85 e	18.78 b	18.25 d	16.26 B	14.55 j	23.85 f	24.78 d	25.25 c	22.11 B
Mean A	11.18 D	14.74 C	16.81 B	17.29 A		13.58 D	21.08 C	22.14 B	22.62 A	
	G. aurantiaca									
Aloe vera	10.56 j	13.25 h	14.56 f	15.03 e	13.35 C	8.26 l	12.26 i	16.85 f	17.41 e	13.70 C
Glycerrhiza glabra	11.52 i	15.62 d	16.90 b	17.25 a	15.32 A	9.22 j	18.82 b	17.70 d	19.33 a	16.27 A
Moringa oleifera	9.56 k	14.01 g	15.03 e	16.54 c	13.79 B	8.95 k	13.63 h	16.74 g	18.01 c	14.33 B
Mean A	10.55 D	14.29 C	15.50 B	16.27 A		8.81 D	14.90 C	17.10 B	18.25 A	
	T. pallida purpurea									
Aloe vera	13.26 k	15.45 i	16.05 h	16.96 g	15.43 C	16.45 j	17.06 i	18.96 g	20.70 d	18.29 B
Glycerrhiza glabra	12.00 l	20.46 c	23.93 b	25.50 a	20.47 A	23.23 b	22.98 c	24.50 a	26.00 a	24.18 A
Moringa oleifera	14.85 j	17.19 f	18.02 e	18.96 d	17.26 B	20.22 d	19.23 e	17.56 h	19.11 f	19.03 B
Mean A	13.37 D	17.70 C	19.33 B	20.47 A		19.97 D	19.76 C	20.34 B	21.94 A	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

Table 7: Effects of extract type and concentration (%) on root dry weight /plant (g.) of *A. dentata*, *G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	Root dry weight /plant (g.)									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	3.41 j	3.69 i	3.97 h	4.15 g	3.81 C	4.02 j	4.60 g	4.88 e	4.76 f	4.57 C
Glycerrhiza glabra	3.23 k	4.34 f	5.66 c	6.08 a	4.83 B	4.20 i	7.68 b	7.26 c	8.21 a	7.84 A
Moringa oleifera	3.02 l	5.43 e	5.72 b	5.55 d	4.93 A	4.51 h	5.25 d	5.25 d	4.76 f	4.94 B
Mean A	3.22 D	4.49 C	5.12 B	5.26 A		4.24 D	5.84 B	5.80 C	5.91 A	
	G. aurantiaca									
Aloe vera	3.21 k	4.03 i	4.43 f	4.57 e	4.06 C	2.51 l	3.73 i	5.13 f	5.30 e	4.17 C
Glycerrhiza glabra	3.78 j	4.75 d	5.14 b	5.78 a	4.86 A	3.20 k	5.73 b	5.39 d	5.88 a	5.05 A
Moringa oleifera	4.06 h	4.26 g	4.57 e	5.03 c	4.48 B	3.70 j	4.15 h	5.09 g	5.48 c	4.61 B
Mean A	3.68 D	4.35 C	4.71 B	5.13 A		3.14 D	4.54 C	5.20 B	5.55 A	
	T. pallida purpurea									
Aloe vera	3.04 l	4.70 i	4.88 h	5.19 g	4.45 C	4.01 l	5.19 h	5.77 f	6.30 d	5.32 B
Glycerrhiza glabra	4.12 j	6.23 c	7.28 b	7.76 a	6.35 A	4.22 k	6.99 c	7.46 b	7.91 a	6.65 A
Moringa oleifera	3.96 k	5.23 f	5.48 e	5.77 d	5.11 B	4.69 i	4.64 j	5.34 g	5.82 e	5.12 C
Mean A	3.71 D	5.39 C	5.88 B	6.24 A		4.31 D	5.61 C	6.19 B	6.68 A	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

Table 8: Effect of extract type and concentration (%) on N content of *A. dentata*, *G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	N content %									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	1.65 l	2.31 i	2.33 h	2.36 f	2.16 C	1.93 l	2.45 i	2.60 f	2.63 e	2.40 C
Glycerrhiza glabra	1.92k	2.42 c	2.45 b	2.80 a	2.40 A	1.96 k	2.56 g	2.78 b	2.96 a	2.57 A
Moringa oleifera	1.72 j	2.35 g	2.39 e	2.40 d	2.25 B	2.02 j	2.49 h	2.64 d	2.68 c	2.46 B
Mean A	1.76 D	2.36 C	2.39 B	2.52 A		1.97 D	2.50 C	2.67 B	2.76 A	
	G. aurantiaca									
Aloe vera	1.03 l	2.25 i	2.28 h	2.31 g	1.97 C	1.52 l	2.59 i	2.61 h	2.78 d	2.38 C
Glycerrhiza glabra	1.56 k	2.52 c	2.76 b	2.89 a	2.43 A	1.65 k	2.74 e	2.83 c	2.98 a	2.55 A
Moringa oleifera	1.58 j	2.46 f	2.48 e	2.51 d	2.26 B	1.78 j	2.62 g	2.68 f	2.84 b	2.48 B
Mean A	1.39 D	2.41 C	2.51 B	2.57 A		1.65 D	2.65 C	2.71 B	2.87 A	
	T. pallida purpurea									
Aloe vera	1.20 l	2.12 i	2.24 h	2.38 g	1.99 C	1.66 l	2.25 i	2.46 g	2.57 f	2.24 C
Glycerrhiza glabra	1.25 k	2.70 c	2.73 b	2.78 a	2.37 A	1.96 j	2.79 d	2.81 c	2.92 a	2.62 A
Moringa oleifera	1.26 j	2.40 f	2.48 e	2.58 d	2.18 B	1.92 k	2.45 h	2.58 e	2.83 b	2.45 B
Mean A	1.24 D	2.41 C	2.48 B	2.58 A		1.85 D	2.50 C	2.62 B	2.77 A	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

Table 9: Effect of extract type and concentration (%) on P content of *A. dentata, G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	P content %									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	0.32 j	0.42 h	0. 45 g	0. 46 f	0.41 C	0.35 k	0.46 h	0.49 f	0.50 e	0.45 C
Glycerrhiza glabra	0.29 k	0. 54 c	0. 57 b	0. 59 a	0.50 A	0.36 j	0.52 d	0.55 c	0.59 a	0.51 A
Moringa oleifera	0.38 i	0. 48 e	0. 52 d	0. 57 b	0.49 B	0.40 i	0.47 g	0.52 d	0.56 b	0.49 B
Mean A	0.33 D	0.48 C	0.51 B	0.54 A		0.37 D	0.48 C	0.52 B	0.55 A	
	G. aurantiaca									
Aloe vera	0. 13 j	0. 15 i	0. 27 g	0. 32 f	0.22 C	0.15 k	0.20 h	0.36 g	0.39 f	0.28 C
Glycerrhiza glabra	0.15 i	0. 36 e	0. 45 c	0.50 a	0.37 B	0.18 j	0.39 f	0.49 c	0.56 a	0.41 A
Moringa oleifera	0.17 h	0.46 b	0.42 d	0.46 b	0.38 A	0.19 i	0.45 e	0.46 d	0.50 b	0.40 B
Mean A	0.15 D	0.32 C	0.38 B	0.43 A		0.17 D	0.35 C	0.44 B	0.48 A	
	T. pallida purpurea									
Aloe vera	0.22 l	0.32 h	0.29 i	0.36 g	0.30 C	0.25 k	0.38 g	0.37 h	0.45 e	0.36 C
Glycerrhiza glabra	0.26 j	0.56 c	0.57 b	0.58 a	0.49 A	0.29 i	0.57 c	0.58 b	0.59 a	0.51 A
Moringa oleifera	0.23 k	0.40 f	0.53 d	0.46 e	0.41 B	0.27 j	0.43 f	0.45 e	0.48 d	0.41 B
Mean A	0.24 D	0.40 C	0.46 B	0.47 A		0.27 D	0.46 C	0.47 B	0.51 A	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

Table 10: Effect of extract type and concentration (%) on K content of *A. dentata*, G. aurantiaca and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	K content %									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	1.20 i	1.25 h	1.28 f	1.29 e	1.26 B	1.44 k	1.54 h	1.69 d	1.73 c	1.60 C
Glycerrhiza glabra	1.26 g	1.30 d	1.34 b	1.34 b	1.31 A	1.49 j	1.64 e	1.69 d	1.76 a	1.65 A
Moringa oleifera	1.29 e	1.30 d	1.31 c	1.35 a	1.31 A	1.50 i	1.59 g	1.63 f	1.74 b	1.62 B
Mean A	1.25 D	1.28 C	1.31 B	1.33 A		1.48 D	1.59 C	1.67 B	1.74 A	
	G. aurantiaca									
Aloe vera	1.32 k	1.41 g	1.33 j	1.35 i	1.35 C	1.35 j	1.56 i	1.59 h	1.65 g	1.54 C
Glycerrhiza glabra	1.35 i	2.60 c	2.65 b	2.70 a	2.33 A	1.34 k	2.33 f	2.46 c	2.59 b	2.18 B
Moringa oleifera	1.37 h	1.50 f	2.45 e	2.48 d	1.95 B	1.56 i	2.35 e	2.43 d	2.65 a	2.25 A
Mean A	1.35 D	1.84 C	2.14 B	2.18 A		1.42 D	2.08 C	2.16 B	2.30 A	
	T. pallida purpurea									
Aloe vera	1.35 k	1.40 i	1.44 g	1.52 d	1.43 C	1.43 j	1.46 i	1.52 g	1.59 e	1.50 C
Glycerrhiza glabra	1.41 h	1.61 c	1.64 b	1.67 a	1.58 A	1.46 i	1.60 d	1.67 b	1.74 a	1.62 A
Moringa oleifera	1.39 j	1.44 g	1. 45 f	1.49 e	1.44 B	1.51 h	1.46 i	1.56 f	1.62 c	1.54 B
Mean A	1.38 D	1.48 C	1.51 B	1.56 A		1.47 D	1.51 C	1.58 B	1.65 A	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

Table 11: Effect of extract type and concentration (%) on Fe content of *A. dentata*, *G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	Fe content mg/kg									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	211.10 j	226.62 f	228.61 e	236.14 d	225.62 C	213.15 j	223.56 i	227.56 h	234.15 g	224.61 C
Glycerrhiza glabra	209.65 i	236.14 d	259.46 a	259.46 a	241.18 A	212.65 k	238.15 d	260.23 a	248.13 b	239.79 A
Moringa oleifera	212.65 g	236.14 d	239.52 c	250.12 b	234.61 B	210.65 l	235.16 e	234.23 f	246.12 c	231.54 C
Mean A	211.13 h	232.97 D	242.53 B	248.57 A		212.15 D	232.29 C	240.67 B	242.80 A	
	G. aurantiaca									
Aloe vera	208.34 l	236.14 i	240.12 h	246.13 g	232.68 C	210.13 l	239.45 i	243.65 h	248.32 g	235.39 C
Glycerrhiza glabra	211.53 k	267.14 d	270.12 b	278.16 a	256.74 A	214.23 k	270.65 c	273.12 b	279.46 a	259.37 A
Moringa oleifera	219.23 j	258.52 f	262.12 e	267.15 c	251.76 B	222.23 j	265.12 f	265.23 e	269.65 d	225.61 B
Mean A	213.03 D	253.93 C	257.45 B	263.81 A		215.53 D	258.41 C	260.67 B	265.81 A	
	T. pallida purpurea									
Aloe vera	176.52 k	199.65 i	214.23 h	220.32 g	202.68 C	182.23 j	200.10 i	221.52 h	223.26 f	206.78 C
Glycerrhiza glabra	165.23 l	239.14 f	245.62 d	258.32 a	227.08 A	178.23 k	242.52 e	255.62 b	260.41 a	234.20 A
Moringa oleifera	179.65 j	245.16 e	251.42 c	256.53 b	233.19 B	174.51 l	222.65 g	249.52 c	248.56 d	223.81 B
Mean A	173.80 D	227.98 C	237.09 B	245.06 A		178.32 D	221.76 C	242.22 B	244.08 A	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

Table 12: Effect of extract type and concentration (%) on Zn content of *A. dentata, G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	Zn content mg/kg									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	29.50 k	46.15 h	51.23 g	57.85 f	46.18 C	32.12 j	48.23 i	52.12 h	57.85 g	47.58 C
Glycerrhiza glabra	31.25 j	72.23 c	75.23 a	75.23 a	63.49 A	25.68 l	70.12 c	72.23 b	73.26 a	60.32 A
Moringa oleifera	33.52 i	65.12 e	70.52 d	75.14 b	61.08 B	29.45 k	59.23 f	65.14 e	66.12 d	54.99 B
Mean A	31.42 D	61.17 C	65.66 B	69.41 A		29.08 D	59.19 C	63.16 B	65.74 A	
	G. aurantiaca									
Aloe vera	26.51 k	40.52 h	45.65 g	49.62 f	40.58 C	24.53 l	38.23 i	44.23 h	45.23 g	38.06 C
Glycerrhiza glabra	27.15 j	83.12 c	87.65 b	89.12 a	71.76 A	28.15 j	80.65 c	83.12 b	84.12 a	69.01 A
Moringa oleifera	30.15 i	72.64 e	72.64 e	80.52 d	63.99 B	26.85 k	68.12 f	69.12 e	76.23 d	60.08 B
Mean A	27.94 D	65.43 C	68.65 B	73.09 A		26.51 D	62.33 C	65.49 B	68.53 A	
	T. pallida purpurea									
Aloe vera	22.50 l	35.13 i	38.65 h	40.14 g	34.11 C	26.23 k	35.12 i	40.84 h	42.23 g	36.11 C
Glycerrhiza glabra	25.86 k	58.12 d	59.50 b	61.23 a	51.18 A	24.23 l	55.12 d	60.96 b	64.23 a	51.14 A
Moringa oleifera	28.25 j	45.13 f	48.65 e	58.14 c	45.04 B	28.85 j	51.23 e	50.78 f	60.85 c	47.93 B
Mean A	25.54 D	46.13 C	48.93 B	53.17 A		26.44 D	47.16 C	50.86 B	55.77 A	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

Table 13: Effect of extract type and concentration (%) on Mn content of *A. dentata, G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

	Mn content mg/kg									
	First season					Second season				
	A. dentata									
	Concentration (%)					Concentration (%)				
Extract type	0.0	3.0	6.0	9.0	Mean B	0.0	3.0	6.0	9.0	Mean B
Aloe vera	35.50 l	45.00 i	46.50 h	53.00 g	45.00 C	38.14 j	48.23 h	50.12 f	56.13 e	48.16 C
Glycerrhiza glabra	38.14 k	76.23 d	79.65 b	85.24 a	69.82 A	46.12 i	75.12 c	76.12 b	84.12 a	70.37 A
Moringa oleifera	39.64 j	67.23 f	74.52 e	79.23 c	65.16 B	49.12 g	70.13 d	75.12 c	76.12 b	67.62 B
Mean A	37.76 D	62.82 C	66.89 B	72.49 A		44.46 D	64.49 C	67.12 B	72.12 A	
	G. aurantiaca									
Aloe vera	89.23 l	94.65 i	98.65 h	102.14 g	96.17 C	91.23 l	96.13 i	110.00 h	125.12 f	105.65 C
Glycerrhiza glabra	92.15 j	130.22 c	138.43 b	142.42 a	125.81 A	94.15 k	135.2 d	136.23 b	156.23 a	130.45 A
Moringa oleifera	90.16 k	107.15 f	125.23 e	130.20 d	113.19 B	96.12 j	122.32 g	129.23 e	135.23 c	120.73 B
Mean A	90.51 D	110.67 C	120.77 B	124.92 A		93.83 D	117.88 C	125.19 B	138.86 A	
	T. pallida purpurea									
Aloe vera	42.00 l	53.12 j	57.32 h	58.60 g	52.76 C	43.12 l	54.13 j	56.13 i	59.14 g	53.13 C
Glycerrhiza glabra	45.65 k	79.23 c	85.11 b	92.26 a	75.56 A	58.12 h	77.13 d	80.23 b	88.12 a	75.90 A
Moringa oleifera	57.16 i	60.53 f	63.23 e	68.12 d	62.26 B	54.11 k	72.12 f	75.12 e	79.19 c	70.14 B
Mean A	48.27 D	64.29 C	68.55 B	72.99 A		51.78 D	67.79 C	70.49 B	75.48 A	

Means having the same letters in a column are not significantly different according to Duncan's Multiple Range Test (DMRT)

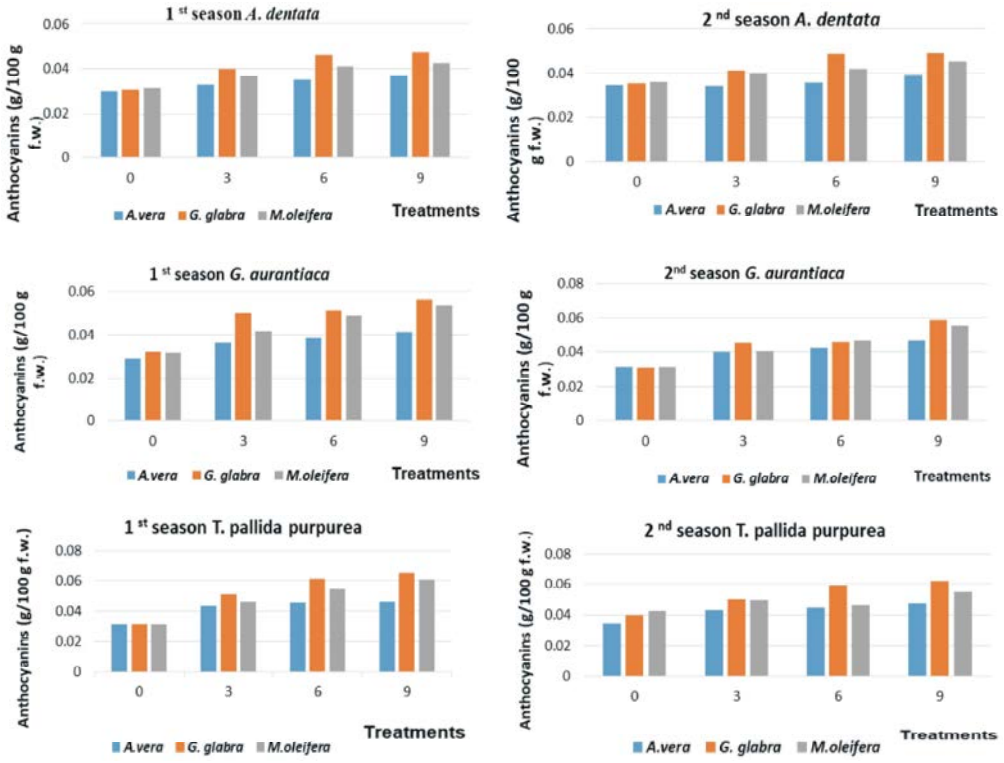

Fig. 1: Effect of extract type and concentration (%) on anthocyanins (g/100 g f.w.) of *A. dentata*, *G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

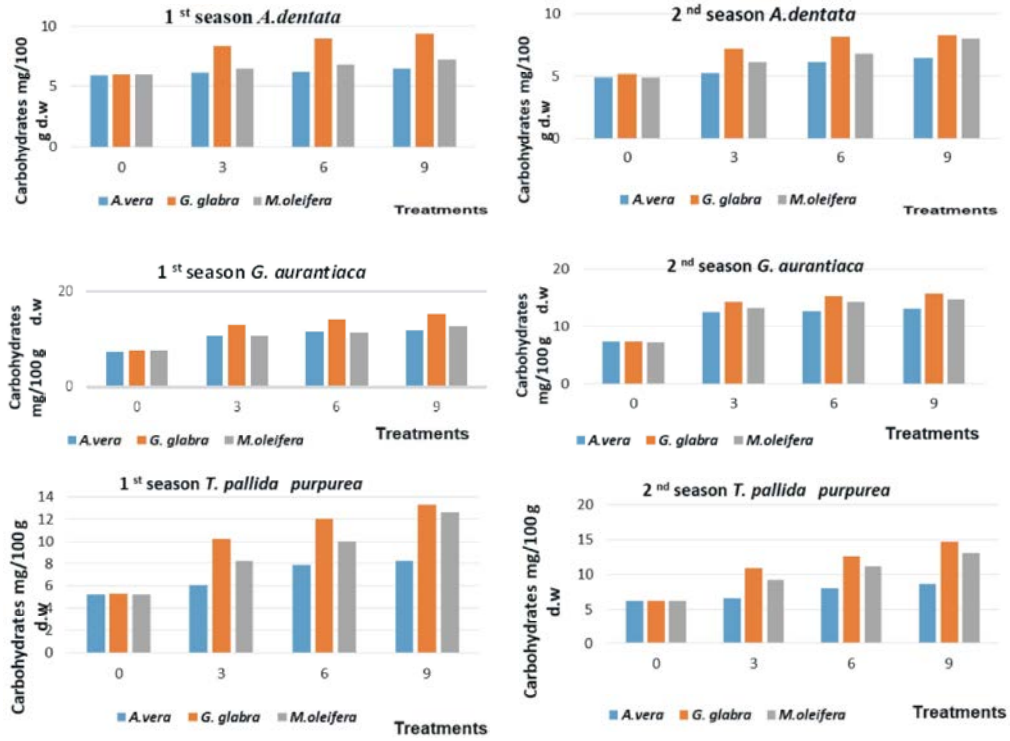

Fig. 2: Effect of extract type and concentration (%) on total carbohydrates mg/100 g d.w of *A.dentata*, *G. aurantiaca* and *T. pallida purpurea* plants during the seasons of (2018/2019 and 2019/2020)

The increase in all macro elements may be due to the direct or indirect effect of the use of natural extracts on the absorption and/or translocation of these minerals within the plants. These results are supported by the findings of other workers as Al-Sahaf and Al-Marsoumi [25]; Badr *et al*. [10]; Babilie *et al*. [30]; Elrys and Merwad [31] and Al-Snafi [11] who reported that licorice extract contains many minerals such as (potassium, phosphorus, magnesium and iron) and other growth stimulants as well as saccharides that are absorbed by the leaves during spraying which increase growth activities and consequently increase vegetative growth and chemical composition in plants.

These results are in conformity with those of Tiwari and Upadhayay [8] who revealed that *Aloe vera* extract contains macro nutrients (N, P and K), secondary nutrients (Mg and Ca), micro nutrients/trace elements (Zn, Fe, Mn and Cu) that are absorbed by the leaves during foliar spray which increase growth and chemical composition in plants.

CONCLUSION

To obtain the best growth quality and good anthocyanin content of each *Alternanthera dentata, Gynura aurantiaca* and *Tradescantia pallida Purpurea*, it should be foliar spraying with *G. glabra* extract at 9 % started after two weeks from planting and was repeat it every four weeks for 6 months.

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