Scientific Journal of Agricultural Sciences

Print (ISSN 2535-1796) / Online (ISSN 2535-180X)

Utilization of Some Organic Wastes as Growing Media for Improving Plant Growth and Chemical Compositions in Madagascar Periwinkle

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Citation: Ahmed A. El-Tantawya, Hend M. Swaefy, Amal Heikal (2023). Utilization of Some Organic Wastes as Growing Media for Improving Plant Growth and Chemical Compositions in Madagascar Periwinkle. Scientific Journal of Agricultural Sciences, 5 (3): 38-51. https://doi.org/10.21608/sjas.2023.222011.1319 .

Publisher :
Beni-Suef University, Faculty of Agriculture

Received: 9 / 7 / 2023
Accepted: 5 / 9 / 2023

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ABSTRACT

Madagascar periwinkle plant (*Catharanthus roseus*) is well known for its high medicinal value due to the presence of anti-cancer alkaloids as active substances in the tissues. Growing the plants in different media led the researchers to look for less costly prepared media from the organic wastes, which were mostly disposed of burning, leading to high environmental pollution. In addition, this organic waste is rich in nutrients, and hormones that are necessary for plants. In this research, rice husks, corn cobs, peanut shells, and hay were used as planting media after mixing them with peat moss at a ratio of 1 for the studied medium: 1 peat moss: 1 sand, to test the extent of the ability of these media to improve the vegetative growth and the chemical content as a prelude to working on using them alternatively to the expensive peat moss. The results indicate that the treatment with peanut shells gave the best results compared to the control. In addition, treatments were carried out by spraying the algae extract on the leaves with three concentrations, namely, 0, 250, and 500 ppm. We found that the highest concentration (500 ppm) gave the best results in terms of vegetative growth and chemical contents. The treatment with algae extract helped to improve the plant growth planted in corn cob medium, which gave the lowest records. The results of the present work gave great hope in finding cheap and effective alternatives to the expensive planting media to increase the production of periwinkle plants.

KEYWORDS: *Catharanthus roseus*, rice husks, corn cob, peanut shells, Algae extract

1. INTRODUCTION

Periwinkle, i.e. *Catharanthus roseus*, family Apocynaceae, is a semi-evergreen ornamental plant because of its woody stems. It grows under harsh and dry conditions as well as high temperatures (Huxley *et al.*, 1992). It is considered one of the most important medicinal plants as a source of anti-cancer agents due to its contents of vinblastine and vincristine, as they are biosynthesized in the plant from the conjugation

of the alkaloids canthaxanthin and violin (Kumar *et al.,* 2021). Vinblastine has been used as an active ingredient in anti-lung cancer drugs (Mohseni *et al.,* 2016). Moreover, it has an important role in the treatment of Hodgkin's disease, non-Hodgkin's lymphomas, bladder cancer, kidney cancer, testicular cancer, and germ cell cancer of the testicle (De Luca and St. Pierre 2000). Vincristine is used to treat pediatric lymphocytic leukemia, lymphomas, cancer-non-small cell lung cancer, breast cancer, cervical cancer, and brain tumors.

The use of organic waste as plant-growing media is one of the powerful solutions to the crisis of air pollution resulting from burning these wastes, as well supplying plants with the required nutrients, which leads to an increase in the percentage of dispensing with chemical fertilization. Also, recycling agricultural waste to be used as an alternative growing medium for other growing media like peat moss, perlite, and vermiculite reduces the growing medium preparation cost. In this context, a variety of wastes are generated by different agricultural activities including crop residues in the form of straw, firewood, heels, the biomass of uncultivated grass species, and forest biomass (Chatterjee *et al.,* 2017). In Egypt, the total amount of waste resulting from different crop residues produced annually is about 38.7 million tons of cultivated areas, that is, about 3.7 million hectares (8.8 million feds) (El-Feki *et al.,* 2017). Biological waste is common in most third-world countries because it results from the cultivation of the most economic crops that save people from poverty and hunger. Average Peanut Shell Waste of 1 kg/ Yield 35-40%. The annual biological yield of corn is 8-10 tons/ ha but only 30% of these huge quantities are grain and the remaining 70% is corn waste (Farghly *et al.,* 2020). It was also reported that 18% of agricultural waste is used directly as fertilizer and 30% as animal food but more than 50% of this waste is burned directly in fields or used for heating in small villages using low-efficiency stoves (Al-Mashhad *et al.,* 2003). Similarly, rice husk, a by-product of the rice milling industry, is recorded as 20% of the whole rice grain (Esa *et al.,* 2013). The annual yield of rice husks in Egypt is about 960,000 tons (one ton of rice yields results 200 kg of the husk). However, the amount of rice husk available far exceeds any domestic uses, and therefore, disposal problems have been posed. So, the organic wastes that were chosen in this work to be used as a precursor due to their granular structure, insoluble in water, chemical stability, high mechanical strength, and local cheap availability. Also, scientists and farmers were encouraged to use these wastes as an environmentally friendly alternative planting media in many horticultural crops, such as the red radish plant, where peanut heels and corn cobs were used as a growing medium, and the nutrient content was tested in them compared to the peat moss media (Farghali *et al.,* 2020). Also, *Gerbera jamosenii* plants were grown in different growing media containing rice husks and corn cobs (Meng *et al.,* 2012). Moreover, peanut peels were used as a nutrient fertilizer due to their high content of macronutrients (Rusdiyana *et al.,* 2022). It has been also found that many of these residues can increase the antioxidants in plants (Meng *et al.,* 2012) and salinity resistance (Fall *et al.,* 2018) in addition to providing high porosity to the soil (Turkaschvand *et al.,* 2015).

Algae extract is an important group of microorganisms capable of fixing nitrogen in the atmosphere, and soil, moreover, algae extract naturally contains auxin, cytokinin, and gibberellic acid (Crouch and Van Staden 1991). Auxin and cytokinin stimulate root hair formation and elongation, and gibberellins stimulate lateral growth (Devlin and Jackson 1961). Abdel-Maguid *et al.,* (2004) reported that the treatment with algae extracts increased the vegetative growth of the olive tree. Gobara (2004) and Hegab *et al.,* (2005) reported that foliar application of algae extracts significantly improved leaf area and increased nitrogen content in palms and orange trees. In addition, the foliar application of algae extracts on some economical crops improved their total yield as recommended by Abd El-Dayem (2018) in artichoke, Safinaz and Raga (2013) in *Zea mayz*, and Osman *et al.,* (2020) in broad bean. The current study aims to verify the use of corn cob, peanut heels, rice husks, and hay as planting media as well as foliar application with algae extract at different concentrations in cultivation of *Catharanthus roseus* plants.

2. MATERIALS AND METHODS

2.1.Plant materials and location

This research was carried out during two successive seasons of 2020 and 2021 at the experimental Nursery of Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, in Giza Egypt using periwinkle plant (*Catharnthus roseus*) to study the effects of different organic media type and algae extract foliar treatments on vegetative growth, and chemical components including alkaloids content. Periwinkle seeds were collected from the main mother plants grown in peatmoss: perlite: sand at the rate of 2:1:1 grown in the Department of Ornamental Horticulture Nursery, Faculty of Agriculture, Cairo University, Egypt at the end of autumn season. The seeds were sown in a plastic sterilized tray in a mixture medium containing 2 peat moss: 1 perlite: 1 sand in 1st April during both seasons. After one month, the seedlings were transplanted to 30 cm plastic pots under field conditions in the used media types as refereeing in the following task.

2.2.Growing media preparation and treatments

The different organic substances like rice husk, corn cob, peanut shells, corn cob, and hay were collected from different farms in Egypt followed by washing by tap water and ground to fine particles, then each ingredient was mixed with peatmoss and sand as follow:

1. Peat moss medium (control): 2 peat moss: 1 sand
2. Rice husk medium: 1 rice husk: 1 peat moss: 1 sand
3. Corn cob medium: 1 corn cob: 1 peat moss: 1 sand
4. Peanut shells medium: 1 peanut shells: 1 peat moss: 1 sand
5. Hay medium: 1 hay: 1 peat moss: 1 sand

The physical and chemical characteristics of the studied media were measured as shown in Table A. The studied media were filled in 30 cm plastic pots and then cultivated with seedlings of *C. roseus*, one seedling per pot. The seedlings were planted on May 1st and harvested on October 30th, during both seasons.

2.3.Algae extract foliar application

Commercial algae extracts, called OligoX©, were applied as foliar application at the rates of 0.0, 250 and 500 ppm). The extract of algae was sprayed twice at 30 and 60 days of transplanting of the seedlings. Chemical composition of the algae extract product is shown in Table B.

2.4.Experiment layout

The treatments were organized as a factorial in a randomized complete block design (RCBD) which consists of two factors and three replicates (5 × 3 × 3). The first factor is the five types of growing media, whereas the second factor is 3 levels of the algae extract concentrations, and three replicates for each treatment.

Table A. Physical and chemical characteristics of peat moss, Rice husk, corn cob, peanut shells, and hay media.

Characteristic	Peat moss	Rice husks	Corn cob	Peanut shells	Hay
PH	6.20	7.35	6.38	7.21	7.20
Electron Conductivity (EC) (ds/m)	4.61	1.55	0.32	1.24	1.42
Total nitrogen (%)	0.75	1.26	0.33	0.98	1.31
Total phosphorus (%)	0.06	0.12	0.24	0.79	0.14
Total potassium (%)	0.04	0.27	0.31	0.30	0.29
C/N ratio	75	61.25	166.21	48.35	55.14
Organic carbon (%)	52.11	48.14	45.31	51.63	48.52
Bulk density ($g \cdot cm^{-3}$)	0.37	0.22	0.20	0.28	0.24

Table B. Chemical characteristics of algae extract

Ingredient (%)	Value
Oligosaccharides	3
Alginic acid	5
Zeatin	0.003
Mannitol	0.001
Potassium oxide	12
Zinc (Zn)	0.3
Iron (Fe)	0.2
Manganese (Mn)	0.1
Cytokines	0.001
Betanin	0.02
Indole acetic acid (IAA)	0.0002

2.5.Growth parameters analyses

Data parameters on *C. roseus* growth were collected after six months of planting the seeds. Then, the plant height (cm), branch number/plant, and flower number/plant have been recorded. The plants were harvested at the end of each season. After that, plants were sampled for fresh herb measurements i.e. herb and root fresh weight (g). The leaves were removed for leaf area (mm) measurement. Samples were air dried under shade to measure herb dry weight (g), and root dry weight (g).

2.6.Total chlorophyll, carbohydrate determination

Total chlorophyll and total carbohydrate determinations were performed according to Netto *et al.*, (2005) and Herbert *et al.*, (1971), respectively.

2.7.Total alkaloid measurement

The total alkaloid content was determined according to Ajanal *et al.*, (2012). The dried shoots were crushed to prepare powder drug, then weighed one gram and transferred to a 50 ml beaker. Methanol was added for extraction for 24 hours then, the extract was filtered after evaporation of the methanol using a rotary evaporator. Alkaloid was detected by Dragendroff's method (Raal et al 2020) which the samples showed the presence of alkaloid dissolved in 2N HCL. After filtration, 1 ml of this solution was transferred to a separatory funnel and washed with 10 ml chloroform three times, then, the pH was adjusted. Five ml of BCG solution and Phosphate-Buffered Saline (PBS), respectively were added to this solution. The mixture was shaken and complex extracted with 1, 2, 3 and 4 ml chloroform by vigorous shaking, the extract was then collected in a 10 ml volumetric flask and diluted with chloroform. Caffeine was used as standard and the total alkaloids amount was calculated from the regression equation of the standard (Y=93.207×+ 1.9691, r2= 0.9941), then the result was expressed in g/100 g of samples. The absorbance of the complex in chloroform was measured at a spectrum of 470 nm in UV-Spectrophotometer (Jenway, England).

2.8.Percentages of Nitrogen, phosphorus, and potassium contents

The samples were at 70°C for 72 hours. Nitrogen was determined by modified micro-Kjeldahl method as described by A.O.A.C. (1980), whereas phosphorus was measured using the ammonium molybdate method according to Murphy and Riley (1962). Potassium content was determined using the flame photometric method as described by Cottenie *et al.*, (1982).

2.9.Statistical analyses

The collected data for both seasons were recorded and the obtained results were analyzed using MSTATC software (Bricker 1991). Means were compared using LSD test at 0.05 level according to Snedecor and Cochran (1968).

3. RESULTS

3.1.Growth parameters

Fresh samples were used for measuring the different growth parameters and determination of the dry weight as shown in Table 1. Significant differences among all records showing positive effects of medium type, foliar application of algae extracts on *Catharanthus roseus* growth parameters. We found a positive relationship between algae extract concentration and all measured growth parameters. Results show that the peanut shells medium significantly recorded the highest value in all vegetative growth parameters. For plant height, the values in both seasons were 64.31 and 55.56 cm, respectively. While corn cob medium was recorded as the lowest value (36.26 and 29.84 cm during both seasons) compared with the peat moss medium which is considered a control (44.77 and 37.82 cm for both seasons). Also, the interaction effect of algae extracts foliar application with the medium type shows a positive effect on plant height indicating a successive enhancement of growth under different growing media.

Table 1. Effect of a media type with or without algae extract foliar application on growth parameters of plant height, number of branches, leaf area, number of flowers in *Catharanthus roseus* plants

Media	Algae extract (ppm)	Plant height (cm)		No. Branches/ plant		Leaf area (mm)		No. Flowers/ plant	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Peat moss		44.77	37.82	12.34	11.04	12.31	11.68	25.55	20.11
Rice husk		47.51	40.58	15.11	13.22	14.81	14.23	29.22	24.02
Corn cob		36.26	29.84	9.66	8.72	9.86	9.32	23.14	17.92
Peanut shells		64.31	55.56	20.36	19.35	20.00	19.94	42.11	37.60
Hay		59.67	52.14	17.29	15.54	17.66	17.02	34.58	29.28
LSD at 0.05		0.908	1.316	0.434	0.749	0.410	0.467	0.582	1.053
	0	46.81	39.65	12.42	10.76	12.55	11.76	26.58	21.26
	250	50.49	42.93	15.01	13.62	14.91	14.49	30.39	25.46
	500	54.21	46.98	17.423	16.33	17.32	17.07	35.80	30.64
LSD at 0.05		0.704	1.020	0.336	0.580	0.317	0.362	0.451	0.816
	0	41.99	32.35	10.02	8.81	9.82	9.15	22.92	16.61
Peat moss	**250**	44.61	39.28	12.27	10.56	12.17	11.65	25.31	20.77
	500	47.71	41.81	14.72	13.75	14.93	14.24	28.43	22.96
	0	44.56	40.12	12.17	10.23	12.04	11.38	25.11	19.98
Rice husk	**250**	47.60	39.25	15.31	13.78	14.72	14.24	28.78	23.25
	500	50.36	42.35	17.85	15.66	17.66	17.05	33.78	28.82
	0	31.43	25.61	7.34	6.02	7.69	6.86	21.18	16.04
Corn cob	**250**	36.64	30.58	9.80	9.25	9.85	9.57	22.87	17.49
	500	40.69	33.34	11.84	10.88	12.04	11.51	25.36	20.22
	0	59.82	51.30	17.79	16.18	17.95	17.01	34.42	29.85
Peanut shells	**250**	64.81	53.39	20.59	19.33	20.05	19.94	40.66	36.48
	500	68.30	61.98	22.69	22.53	22.01	22.89	51.25	46.46
	0	56.24	48.88	14.76	12.58	15.24	14.37	29.25	23.81
Hay	**250**	58.81	52.12	17.09	15.19	17.77	17.05	34.34	29.31
	500	63.98	55.42	20.01	18.85	19.96	19.62	40.17	34.73
L.S.D. at 0.05		1.573	2.280	ns	ns	ns	ns	1.01	1.825

ns: non-significant

Plants grown on peanut shells and treated with algae extract foliar application at the concentration of 500 ppm significantly recorded the highest value (68.30 and 61.98 cm for both seasons). Growing the plants on the hay medium with 500 ppm algae extract came at the second place (63.98 and 55.42 cm for both seasons), showing a close significant difference with the peanut shells medium. Similarly, peanut shells medium recorded the highest value; for the two seasons, for branch number (20.36 and 19.35), leaf area (20.00 and 19.94 mm^2), and flower number (42.11 and 37.60). The interaction effect of algae extracts foliar application with the medium type, the algae extract concentration at the concentration of 500 ppm with peanut shells medium resulted in the highest value, in the first and second season giving 22.69 and 22.53 for the branch number, 22.01 and 22.89 mm^2 for leaf area, and 51.25 and 46.46 for the flower number. No significant differences were found among the interaction effect of algae extracts foliar application with the medium type in the case of branch number, and leaf area during both seasons.

The fresh and dry weight of herb and roots were also enhanced by algae extract foliar application with peanut shells medium, whereas the hay medium came to second place (Table 2). Significantly, the values of peanut medium supplied 500 ppm algae extract foliar application showed higher values than that of hay medium values for the herb fresh weight (134.90 and 127.32 g during both seasons) and dry weight (31.25 and 27.15 g during both seasons), whereas no significance was observed in root fresh weight whereas root dry weight showed significant differences among the values (Table 2).

3.2.Chemical composition

Total chlorophyll: The accumulation of total chlorophyll was significantly higher than the control. Data presented in Table 3 shows that the used media significantly affected the chlorophyll of *C. roseus* plant. The peanut shells medium gave the highest value of total chlorophyll content in both seasons (57.01 and 53.61 %), whereas the corn cob medium resulted in 42.31 and 38.25 % for the two seasons, respectively as compared to the control (46.56 and 42.28 % for the two seasons, respectively. Increasing algae extract concentrations (0, 250, and 500 ppm) in all studied growing media resulted in 46.89, 49.69, and 52.67 % for the first season, and 42.91, 45.61, and 48.75 % for the second season (Table 3). Regarding the interaction effect of algae extracts foliar application and the medium type, data presented in Table 3 show that growing the plants in peanut shells medium and treated with algae extract foliar application at the concentration of 500 ppm significantly increased total chlorophyll value to 61.38 and 57.79 % for both seasons. Reducing the concentration of algae extract to 250 ppm applied to the plants grown on the same medium resulted in 56.21 and 53.22 % for both seasons, followed by a non-significant decrease in the hay medium supplied with 500 ppm algae extract giving 55.75 % and 51.87 %, for the first and second season, respectively.

Total carbohydrate: The values of the total carbohydrate percentage in relation to the growing media revealed that the peanut shells medium gave the highest level (25.67 and 21.69 % for both seasons), while the corn cob medium gave the lowest value (15.63 and 12.26 %) as compared to the control, which contained 17.36 and 14.12 % for the first and second season, respectively. On the other hand, total carbohydrate percentage showed a gradual increase with raising the concentration of algae extract (0, 250, and 500 ppm) for all studied growing media, which resulted in 17.91, 20.04, and 22.83 % for the first season, and 14.10, 16.94, and 18.84 % for the second season (Table 3). Regarding the interaction effect, the data presented in Table 3 showed that the highest value is that obtained from peanut shells medium combined with 500 ppm algae extract (29.02 and 25.24 % for both seasons), whereas the lowest values are determined in corn cob medium without algae extract (14.53 and 10.92 % for the both seasons). In the case of the application of 250 ppm, the values are 14.98 and 12.27 % for the two seasons.

Table 2. Effect of a media type with or without algae extract foliar application on growth parameters of different fresh and dry weights in *Catharanthus roseus* plants

Media	Algae extract	Herb fresh weight (g)		Herb dry weight (g)		Root fresh weight (g)		Root dry weight (g)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Peat moss		104.81	97.07	17.43	14.30	15.98	1185	3.19	3.23
Rice husk		115.85	108.47	21.19	17.49	18.37	14.41	4.01	3.16
Corn cob		102.72	94.60	17.37	12.72	14.25	10.04	2.37	1.41
Peanut shells		130.73	122.71	29.34	25.71	23.26	19.39	5.37	5.02
Hay		125.38	117.66	26.12	21.82	20.55	17.07	4.93	4.56
LSD at 0.05		1.003	1.199	0.722	0.813	0.478	0.600	0.252	0.384
	0	105.35	97.77	17.57	13.81	16.40	12.26	3.38	2.43
	250	118.34	110.10	22.31	18.48	18.39	14.49	3.97	3.63
	500	123.99	116.44	26.99	22.94	20.66	16.90	4.58	4.37
LSD at 0.05		0.777	0.929	0.559	0.630	0.370	0.465	0.195	0.297
	0	87.43	79.44	12.14	9.87	14.12	9.48	2.71	1.73
Peat moss	**250**	109.48	102.00	15.56	12.18	15.57	12.04	3.08	3.62
	500	117.51	109.78	24.58	20.85	18.25	14.01	4.09	4.34
	0	110.15	103.18	13.78	9.94	16.15	12.21	3.07	2.10
Rice husk	**250**	116.32	108.49	23.92	20.66	18.17	13.85	3.95	3.24
	500	121.07	113.75	25.88	21.86	20.80	17.18	5.01	4.13
	0	82.34	74.18	12.10	7.45	12.22	8.05	2.03	1.11
Corn cob	**250**	108.14	99.41	15.46	10.54	14.27	10.28	2.26	1.18
	500	117.68	110.20	24.55	20.16	16.25	11.80	2.82	1.95
	0	125.74	118.07	27.66	24.38	21.20	16.98	4.97	3.86
Peanut shells	**250**	131.55	122.73	29.12	25.59	23.29	19.10	5.39	5.15
	500	134.90	127.32	31.25	27.15	25.28	22.08	5.76	6.04
	0	121.10	113.98	22.18	17.40	18.29	14.61	4.12	3.35
Hay	**250**	126.21	117.86	27.48	23.41	20.66	17.18	5.14	4.95
	500	128.82	121.15	28.70	24.66	22.70	19.44	5.52	5.38
L.S.D. at 0.05		1.737	2.077	1.250	1.408	ns	ns	0.436	0.665

ns: non-significant

Using peat moss medium with no addition of algae extract solution, the values are 15.21 and 11.62 % for both seasons.

Total alkaloids: As shown in Table 3, the total alkaloids content in the dried herb increased significantly in relation to using plant medium type (peat moss, rice husk, corn cob, peanut shells, and hay media) in both two seasons. The highest alkaloids value was determined in plants grown in peanut shells medium giving 54.38 and 50.40 mg/100 g DW for both seasons, whereas the hay medium came at the second place giving 37.63 and 33.17 mg/100 g DW for both seasons. Rice husk, peat moss, and corn cob media are classified at the third, fourth, and fifth levels, respectively. Regarding the effect of algae extract foliar application, data presented in Table 3 show that the average total alkaloid content in green herb per plant increased significantly during the first season, as the concentration of the algae extract was increased which resulted in 28.72, 33.85, and 39.52 mg/100 g DW for 0, 250, and 500 ppm, respectively. In the second season, the algae extract foliar application at 0, 250, and 500 ppm resulted in 24.62, 29.62, and 35.64 mg/100 g DW, respectively. The interaction effect of algae extracts foliar application combined with the medium type as illustrated in Table 3, revealed

Table 3. Effect of a media type with or without algae extract foliar application on total chlorophyll, total carbohydrates, and total alkaloids of *Catharanthus roseus* plants

Media	Algae extract	Total chlorophyll (SPAD)		Total carbohydrate (%)		Total alkaloids (mg/100 g DW)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Peat moss		46.56	42.28	17.36	14.12	25.94	22.23
Rice husk		49.84	45.61	19.65	16.24	30.97	26.80
Corn cob		42.31	38.25	15.63	12.26	21.25	17.19
Peanut shells		57.01	53.61	25.67	21.69	54.38	50.40
Hay		53.03	49.01	22.50	18.82	37.63	33.17
LSD at 0.05		0.571	0.704	0.478	0.756	0.637	0.506
	0	46.89	42.91	17.9	14.10	28.72	24.62
	250	49.69	45.61	20.04	16.94	33.85	29.62
	500	52.67	48.75	22.54	18.84	39.52	35.64
LSD at 0.05		0.443	0.546	0.370	0.586	0.493	0.392
	0	43.98	39.30	15.21	11.62	20.60	17.06
Peat	**250**	46.48	42.22	17.81	15.10	26.02	21.95
	500	49.23	45.32	19.06	15.63	31.18	27.68
	0	47.24	43.10	17.38	13.75	25.97	21.74
Rice husk	**250**	49.38	44.82	19.71	16.59	31.27	27.08
	500	52.89	48.90	21.88	18.38	35.66	31.58
	0	39.65	36.02	14.53	10.92	16.88	13.08
Corn cob	**250**	43.16	38.88	14.98	12.27	21.19	16.70
	500	44.11	39.85	17.38	13.58	25.67	21.78
	0	53.44	49.83	22.25	17.58	46.95	42.55
Peanut shells	**250**	56.21	53.22	25.76	22.26	53.86	49.52
	500	61.38	57.79	29.02	25.24	62.34	59.12
	0	50.13	46.27	20.18	16.63	33.21	28.65
Hay	**250**	53.21	48.88	21.96	18.47	36.92	32.82
	500	55.75	51.867	25.37	21.36	42.75	38.03
L.S.D. at 0.05		0.990	1.220	0.828	1.309	1.10	0.877

that the highest value of total alkaloid content in the first season (62.34 mg/100 g DW), and second season (59.12 mg/100 g DW) were obtained from the plants growing in peanut shells medium and treated with 500 ppm algae extract.

Mineral contents: Nutritional elements like nitrogen, phosphorus, and potassium in the leaf tissues of *C. roseus*, were significantly enhanced by both the used media and algae extract treatments as shown in Table 4. Significant differences were obtained for all growing media as compared with peat moss medium in both seasons. Regarding algae extract treatments, the leaf content of NPK minerals was significantly increased as a result of using 500 ppm of algae extract solution. Combining algae extract at 500 ppm with peanut shells medium in most cases resulted in the highest values with no significant differences within all treatments except the total nitrogen content obtained in the first season, and the total potassium obtained in the second season.

4. DISCUSSION

Many reports studied the effects of the different growing media on various ornamental and medicinal plants. Different growing media for *C. roseus* showed that peat moss was the most effective medium in any mixture (Khalil *et al.*, 2009). Since the high price of peat moss, we needed to search for other organic cheaper media to decrease the use of peat moss.

Table 4. Effect of a media type with or without algae extract foliar application on mineral contents of *Catharanthus roseus* plants

Media	Algae extract	Total Nitrogen		Total Phosphorus		Total Potassium	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Peat moss		2.09	1.59	0.33	0.29	1.10	0.86
Rice husk		2.30	1.79	0.44	0.40	1.16	0.93
Corn cob		1.87	1.37	0.22	0.18	1.04	0.80
Peanut shells		2.80	2.31	0.81	0.83	1.44	1.31
Hay		2.52	2.03	0.53	0.49	1.25	1.04
LSD at 0.05		0.031	0.031	0.010	0.097	0.010	0.031
	0	2.09	1.59	0.34	0.31	1.11	0.89
	250	2.32	1.82	0.47	0.43	1.20	0.99
	500	2.53	2.04	0.58	0.58	1.29	1.09
LSD at 0.05		0.024	0.024	0.007	0.075	0.007	0.024
	0	1.91	1.40	0.23	0.19	1.05	0.81
Peat moss	**250**	2.04	1.55	0.34	0.31	1.12	0.87
	500	2.32	1.82	0.42	0.38	1.12	0.88
	0	2.07	1.56	0.33	0.29	1.11	0.87
Rice husk	**250**	2.31	1.79	0.43	0.39	1.12	0.88
	500	2.51	2.01	0.55	0.52	1.26	1.03
	0	1.63	1.11	0.09	0.07	0.94	0.70
Corn cob	**250**	1.91	1.41	0.22	0.18	1.06	0.81
	500	2.06	1.58	0.34	0.30	1.11	0.88
	0	2.52	2.03	0.63	0.59	1.31	1.14
Peanut shells	**250**	2.83	2.32	0.81	0.75	1.43	1.31
	500	3.06	2.57	0.10	1.15	1.57	1.47
	0	2.32	1.86	0.43	0.39	1.12	0.92
Hay	**250**	2.52	2.03	0.54	0.50	1.28	1.04
	500	2.72	2.22	0.61	0.58	1.36	1.17
L.S.D. at 0.05		0.053	0.053	0.017	ns	0.017	0.018

ns: non-significant

The effects of peanut peel, rice husk, corn cob, and hay media on the growth of different horticultural plants have been scarcely investigated. In addition, there is no data available on the selected media for *Catharanthus roseus* except rice husk, which had been reported that charcoal produced from the heated rice husk has effect on plant growth (Komaki et al 2002). In other organic media, it has been reported that mushroom compost has positive effects on *C. roseus* growth (Khattak *et al.,* 2011). Also, the waste product of sugarcane plant could be used as a growing medium, which showed its role in nutrient release (Larsen and Moore 2016). In this work, the growth enhancement, as well as alkaloids production in *C. roseus* plants as a result of algae extract application under the condition of five organic media; i.e. peat moss which was used as a control, rice husk, corn cob, peanut shells, and hay media. The data showed that the peanut shells medium gave very good results regarding the vegetative growth and chemical composition of *C. roseus* plant. Recently, peanut shells medium has been recorded as a fertilizer's high influence on spinach plants' growth (Rusdiyana *et al.,* 2022). Similarly, peanut shell enhanced the growth of some Fabaceae trees as a result of improving soil fertility (Fall et al 2018). Also, it has been reported that compost of peanut shells is an appropriate alternative to peat moss as the growth medium of

some ornamental and vegetable plants (Torkashvand *et al.,* 2015; Farghaly *et al.,* 2020). The increase in nitrogen content in *C. roseus* leaf is also highly noted due to the increase of nitrogen provided by peanut shells medium as reported by Torkashvand *et al.,* (2015). Regarding the phosphorus content, it has been found that phosphorus content was lower in the peanut shells medium compared with the peat moss medium (control) due to not converting the phosphorus from organic to mineral forms (Torkashvand *et al.,* 2015; Farghaly *et al.,* 2020). In contrast, our results showed that the peanut shells medium increased the phosphorus content compared to the control. This might be explained that the peanut shells stimulated rhizobial and endo-mycorrhizal symbiosis as described by Fall *et al.,* 2018 who indicated that peanut peels could increase the phosphorus level with an optimum dose. Furthermore, peanut shells increased the potassium content in the leaf of *C. roseus* plant, in agreement with Torkashvand *et al.,* (2015), who reported the presence of high amount of potassium in peanut shells medium leading to higher absorption than in peat moss.

Total chlorophyll values in *C. roseus* varied among all treatments because of the medium type role (Khalil *et al.,* 2009). Our results showed that peanut shells medium contained the highest value, whereas corn cob medium gave the lowest value. Previously, it has been reported that there is a positive relationship between peanut shells portion in the medium and total chlorophyll of *Senegalia senegal* (L.), *Vachellia seyal*, and *Prosopis juliflora* seedlings (Fall *et al.,* 2018). The peanut shells medium resulted in the highest carbohydrate content as compared to the control. This result may be due to the fact that the peanut shell contains high percentage of organic carbon (51.63 %) as shown in Table A. Regarding the total alkaloids content, it was also noticed that peanut shells gave the highest value. It is clear that the high record for total chlorophyll and carbohydrate led to increasing the alkaloids contents. The alkaloid content of *C. roseus* plant differs according to the type of growing medium (Khalil *et al.,* 2009; Mishra *et al.,* 2018). Also, the peanut shells medium resulted in the highest values of NPK percentages. This result agreed with the fact that adding peanut shells can increase nutrient levels like NPK and reduce soil salinity (Mojiri *et al.,* 2011; Grigatti *et al.,* 2007). Although that, some other plant species showed a decrease in the available phosphorus when they were grown in peanut peel media assuming that microorganisms converted phosphorus from the mineral to organic form (Tokashvand *et al.,* 2018).

Based on the above, peanut peel medium is recommended for growing *C. resues* plants and for improving their chemical constituents like total alkaloids which are the sources of the most important anticancer drugs. Peanut peels contain many macro-nutrients which are necessary for vegetative growth (Rusdiyana *et al.,* 2022). On the other hand, corn cob gave the lowest values in all studied characteristics. These results agreed with that reported by Farghaly *et al.,* 2020, who tested the growth and chemical components of red radish grown in peanut shells and corn cob media. These results may be due to the recorded lowest NPK uptake in corn cob medium. Also, narrow interstitial distances of the corn cob decreased root growth (Farghaly *et al.,* 2020). It might be summarized that peanut shells compost increases the nitrogen uptake by plants as a result of decomposing organic material in the planting medium increasing the amount of available nitrogen to plants (Torkashvand*et al.,* 2015; Youssef and Eissa 2017).

Algae foliar application significantly increased the vegetative growth and chemical composition in *C. roseus* plants, leading to increase plant growth efficiency in the poor medium. Algae extract is considered a biostimulant in which the treated plant responds to algae activating different signaling pathways (Lee and Ryu 2021). It has been suggested that the cell components of algae can protect the plant against biotic and abiotic stresses by inducing physiological patterns and structural changes (Carillo et al 2020). This explains the significant increase in growth and chemical content obtained in *C. roseus* plants treated with the algae extracts. In addition, algae are rich in high content of protein being used as nitrogen biofertilizers (Geada *et al.,* 2021). Several investigations confirmed the results obtained from application of

algae extract (Abd El-Dayem *et al.,* 2018 in artichoke; EL-Sharnoby *et al.,* 2021 in sugar beet; El Sayed *et al.,* 2015 in moringa and alfalfa plants; Supraja *et al.,* 2020 in tomato).

5. CONCLUSIONS

The mixture of peanut shells medium is recommended as the best planting media for growing *Catharanthus roseus* plants compared to the other types. Algae extract foliar treatments improved the growth and chemical composition of the plants grown in the poor media. The obtained results lead to recommend replacing the peat moss with other cheaper organic media for *C. roseus* production saving the high cost of peat moss. Testing the mixture among the studied organic substances is needed as further work to achieve and evaluate the economic balance by using these materials as growing media.

6. CONFLICTS OF INTEREST

The authors declare no conflict of interest

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الملخص العربي

إستخدام بعض المخلفات العضوية كوسائط نمو لتحسين نمو النبات وتركيباته الكيميائية في نبات الونكا

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نبات الونكا (*Catharanthus roseus*) معروف بقيمته الطبية العالية بسبب وجود قلويدات مضادة للسرطان كمواد فعالة في الأنسجة. إن زراعة النباتات في أوساط الزراعة المختلفة قادت الباحثين إلى البحث عن أوساط محضرة بأقل تكلفة من المخلفات العضوية، والتي يتم التخلص منها في الغالب بالحرق، مما يؤدي إلى ارتفاع التلوث البيئي. بالإضافة إلى ذلك، فإن هذه النفايات العضوية غنية بالمواد المغذية، والهرمونات الضرورية للنباتات. تم في هذا البحث استخدام قش الأرز وأكواز الذرة وقشر الفول السوداني والتبن كأوساط للزراعة بعد خلطها مع البيتموس بنسبة ١ للوسط تحت الدراسة: ١ بيتموس: ١ رمل لاختبار مدى القدرة على استخدام هذه الوسائط لتحسين النمو الخضري والمحتوى الكيميائي تمهيداً للعمل على استخدامها بديلاً عن البيتموس الباهظ الثمن. أشارت النتائج إلى أن المعاملة بقشر الفول السوداني أعطت أفضل النتائج مقارنة بالكونترول. بالإضافة إلى ذلك تمت المعاملات عن طريق رش مستخلص الطحالب على الأوراق بثلاثة تتركيزات وهي ٠، ٢٥٠، ٥٠٠ جزء في المليون. ووجدنا أن أعلى تركيز (٥٠٠ جزء في المليون) أعطى أفضل النتائج من حيث النمو الخضري والمحتوى الكيميائي. ساعدت المعاملة بمستخلص الطحالب على تحسين نمو النباتات المزروعة في وسط كوز الذرة مما أعطى أقل النتائج. أعطت نتائج العمل الحالي أملاً كبيراً في إيجاد بدائل رخيصة وفعالة لوسائل الزراعة الباهظة الثمن لزيادة إنتاج نباتات الونكا.

الكلمات المفتاحية: الونكا، قشور الأرز، كوز الذرة، قشور الفول السوداني، مستخلص الطحالب