Waste Water Treatment Sludge as a Potting Media Component with Coir Dust for the cultivation of Ornamental Plant *Tagetes patula* (Antigua Yellow) and Leafy Vegetable *Ipomoea acquatica*(L)

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Abstract
The investigation was conducted to study the potential utilization of wastewater treatment sludge (WTS) in combination with coir dust as a growing medium for leafy vegetable *Ipomoea aquatica*(L) and ornamental plant *Tagetes patula* (Antigua Yellow). Wastewater treatment sludge was obtained from wastewater treatment plant situated in Moratuwa, Soyzapura, Sri Lanka. Five different potting media were prepared by mixing WTS and coconut coir dust (CCD) at ratios of 10%WTS+90%CCD, 25%WTS+75%CCD, 50%WTS+50%CCD, 75%WTS+25%CCD and 100%WTS. A mixture of top soil, compost and river sand ratio of 1:1:1 was used as the control. Then bulk density, true density, porosity, mean weight diameter, pH, organic matter, nitrogen, C:N ratio, electrical conductivity, phosphorous and potassium content of developed media were analyzed. Formulated 10%WTS+90%CCD potting medium gave the best growth and yield performance for *Ipomoea aquatic* and *Tagetes patula* which were not significantly differed compared to commercial potting medium (control). The highest plant height, shoot fresh weight and shoot dry weight of the *Ipomoea aquatica* were 116.5cm, 91.89g and 29.99g, respectively while the same parameters were recorded as 45.6cm, 69.84g and 16.46g, respectively for *Tagetespatula*. Therefore, formulated 10%WTS + 90%CCD potting medium can be recommended as an alternative substrate for the extensively used control.

Keywords: Leafy vegetable, Ornamental plant, Potting media, Sludge, Wastewater
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Introduction

In Sri Lanka, more than 80% of wastes is open dumped and wastewater (WW) has become a major problem because it does not bare any value. Therefore, value addition should be practiced through appropriate methods. At different levels of WW treatment processes, separate WW into two fractions; sludge and a dissolved fraction containing much of the water, organic material, bacteria and salts.

Often, sludge is not considered as a WW problem because community attention is solely focused on treating the remaining liquid fraction to a level which is not harmful. But, the careless disposal of sludge also has negative impacts on both human health and environment. Utilization of waste water treatment sludge (WTS) as a component of plant growth media to modify the properties of growth substrates can be considered as a method of disposing sludge in a proper way. The cost and the declining availability of growth media such as peat, perlite, Zeolite and Pumice justify the search of alternative growing materials (Abad *et al.*, 2001).

In coir industry, coir waste is finally screened to remove part or most of the fiber, and remaining product "coconut coir dust (CCD)" is dried and compressed into bricks or bales. CCD is used in tropics as a locally available material to prepare soilless growth media for containerized crop production. This study was carried out to evaluate the use of sludge made from municipal wastewater, in preparation of potting media for leafy vegetables and ornamental plants, and to determine if limitations any.

Methodology

The research was conducted in the Faculty of Agriculture, University of Ruhuna, Sri Lanka. WTS was collected from wastewater treatment plant in Moratuwa, Soyzapura, Sri Lanka. Sludge was air-dried for 7 days before utilization. Using WTS and CCD, five growing media were prepared (Table 1) and the commercial mixture of compost, topsoil and river sand at the rate of 1:1:1 was used as the control.

Pot experiments were conducted in a greenhouse to study the influence of prepared growing media on the growth and development of *Kankung* (*Ipomoea acquatica*) and French marigold (*Tagetes patula*). Container volume was 2.25L. All treatments were enriched with 5g of N: P: K (1:1:1) fertilizer to supply the minimum fertilizer requirement. Experimental design was completely randomized design with five replicates. Each pot was filled with air-dried substrate samples without unnecessary compaction and 1cm depth from the top of the pot was kept empty. Seven seeds were initially planted per pot and thinned out to five plants. 150mL water was added to each pot once a day.

Table 1: Compositions of growing media

Treatments	Formulation (v/v)
	WTS+CCD
T1	10% + 90%
T2	25% + 75%
T3	50% + 50%
T4	75% + 25%
T5	100%
T6 (Control)	Compost + Top soil + River sand (1:1:1)

WTS; wastewater treatment sludge, CCD; coconut coir dust

First and second harvest of *Kankung* was taken after 45 days and 85 days from seeding, respectively. French marigold was harvested after flower initiation. Data on plant height, fresh weight, dry weight of plants, number of flowers and seed germination were recorded.

Physical properties of growth media such as bulk density (BD), true density (TD) and porosity were determined in the laboratory according to Spomer (1990) and Pill *et a.* (1995). Particle size distribution and the mean weight diameter (MWD) were determined using a set of standard sieves.

pH and electrical conductivity (EC) of growing media were determined by using calibrated pH meter and conductivity meter. Nitrogen analysis was done by using Kjeldhal method while phosphorous concentration was determined by using a spectrophotometer. In addition, total organic carbon percentage was measured by using the Loss on ignition (LOI) method while heavy metals concentration was measured using an atomic absorption spectrophotometer.

Results and discussion

The particle size distribution of a substrate is important because it determines pore spaces, BD, air and water holding capacity of that substrate. Fraction smaller than 0.5mm, and in between 0.1 and 0.25mm, has the highest influence on porosity and water retention properties of a particular substrate. T5 gave the lowest percentage (20.94%) within this range while T6 (control) gave the highest percentage (77.87%) in this range. Mixing sludge with coir dust decreased the percentages of particles between 0.1 and 0.5 mm range.

BD of containerized substrates gives a good indication of porosity, which determines the rate at which air and oxygen can move through the substrate. BD values of all substrates were significantly different ($P < 0.05$) among treatments. T4 treatment having 75% sludge + 25% coir dust shows the highest BD value. Ideal substrate BD value for growth media should be less than 0.40gcm^{-3}(Abad *et al.*, 2001). With the exception of T6 all other substrates were within the ideal range. The lowest BD was reported in Tl and the highest was given by T6.Particle density values of all substrates were within the established ideal particle density limit of 1.4 - 2.0gcm^{-3}(Abad *et al.*, 2001). T4 and T5 treatments were within the range of ideal BD value. The highest value was reported in T6.Total porosity of an ideal substrate should be greater than 85% (de Boodt and Verdonck,

Table 2: Chemical properties of different media

	T1	T2	T3	T4	T5	T6	Ideal values
pH	6.53^{e}	6.66^{d}	6.94^{c}	7.15^{b}	6.22^{f}	7.54^{a}	5.30 - 6.50^{x}
EC (dSm^{-1})	0.01^{e}	0.02^{d}	0.03^{c}	0.03^{b}	0.04^{a}	0.003^{f}	<0.50^{x}
OM (gkg^{-1})	420.63^{b}	334.02^{c}	265.05^{d}	237.34^{d}	583.97^{a}	52.24^{e}	>800^{x}
C:N	12.69^{b}	6.15^{c}	3.77^{d}	3.12^{d}	7.08^{c}	16.65^{a}	20 - 40^{x}
C (gkg^{-1})	242.86^{b}	192.85^{c}	153.03^{d}	137.03^{d}	337.17^{a}	30.16^{e}	-
N (gkg^{-1})	13.17^{e}	31.30^{d}	40.57^{c}	43.89^{b}	47.61^{a}	1.81^{f}	-
P (gkg^{-1})	4.89^{a}	5.04^{a}	5.06^{a}	5.11^{a}	5.05^{a}	4.54^{a}	-
K (gkg^{-1})	9.82^{b}	10.92^{a}	3.59^{c}	2.55^{d}	3.78^{c}	2.68^{d}	-
Cu (mgkg^{-1})	2.98^{e}	5.90^{e}	21.82^{c}	67.4^{b}	87.92^{a}	12.89^{d}	500^{y}
Zn (mgkg^{-1})	1.15^{e}	7.55^{e}	38.73^{c}	99.01^{b}	186.95^{a}	29.91^{d}	1500^{y}
Cd (mgkg^{-1})	ND	ND	ND	ND	ND	ND	5^{y}
As (mgkg^{-1})	ND	ND	ND	ND	ND	ND	-
Cr (mgkg^{-1})	0.22^{d}	0.71^{d}	2.45^{c}	6.90^{b}	11.00^{a}	0.58^{d}	200^{y}
Pb (mgkg^{-1})	0.44^{e}	2.70^{d}	6.92^{c}	18.71^{b}	30.73^{a}	6.19^{c}	1000^{y}

Values are means ($n=3$)within each row, values followed by different letters are significantly different based on DMRT test ($P<0.05$).x and y: optimal ranges and limit according to Abad *et al.*,(2001).

1971). T4 and T5 were achieved 80.36% and 80.91% of porosity respectively. All media were below the established ideal range and not significantly different from the porosity value of an ideal substrate. Table 2 gives the different chemical properties of each media and ideal values.

T6 gave the best yield parameters for *Tagetes patula*, compared with all other treatments, the highest plant height, shoot fresh weight and shoot dry weight were obtained in T6, followed by T1. The lowest yield was given by T5.

T6 gave the best yield for *Ipomoea acquatica* and T1, T2 and T6 were not significantly different from each other. According to the first yield, the highest shoot fresh weight (54.97g) and dry weight (3.74g) were recorded in T1. According to the second yield, T6 and T1 showed the highest shoot fresh weight and dry weight, respectively. The lowest yield and plant height of *Ipomoea acquatica* were given by T5. The best yield performance was shown in T1 compared to T6.

Conclusion

Prepared potting media showed suitable physical and chemical properties for *Ipomoea aquatica*(L) and *Tagetes patula*(Antigua Yellow) cultivation. Formulated 10%WTS + 90%CCD potting medium gave the best growth and yield performance in *Ipomoea aquatica*(L) and *Tagetes patula* which were not significantly differed compared to T6; the commercial potting media (control: compost + Top soil + river sand; 1:1:1). Therefore, formulated 10%WTS + 90% CCD potting medium can be recommended as an alternative substrate for the widely used commercial potting medium. Further research should be conducted to study the nutrient composition of plant materials to observe any limitations compared to standard values.

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