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Comparative Analysis of the Effects of Coco Fibre on the Growth Performance of *Telfaira Occidentalis* Hook. f. (Ugwu) and *Capsicum annuum* L. (Pepper): An Approach to Sustainable Waste Management

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ABSTRACT

An investigation into the potentials of coco fibre as a growth enhancer/medium was carried out on a potted experiment with ugwu (*Telfairia occidentalis*) also known by many as fluted pumpkin and pepper (*Capsicum annuum*) as test plants. Growth indicators such as plant height and the number of leaves per plant were used as the basis for the comparison of coco fibre with the conventional soil (topsoil). The study was conducted at Kwara State University's Plant and Environmental Biology Screen house in Malete, Kwara State Nigeria. A sustainable substitute such as coco fibre was made from the husks of coconuts following standard methods. Data collected from both coco fibre cultivated plants as well as the topsoil were subjected to Analysis of Variance (ANOVA) to check the main and interactive effects of treatments using R Version 4.3.0. Post-hoc comparison of means was performed using the Eemeans package at a 0.05 level of Significance. Results showed that coco fibre-treated ugwu plants had higher plant height and number of leaves per plant across all the weeks at 0.05 level of Significance for the experiment while pepper grew more luxuriant in topsoil cultivation than coco fibre. To optimize nutrient delivery and evaluate long-term effects on plant health and yield, more research is recommended

Keywords: Ugwu, Pepper, Growth parameters, Coco fibre, Topsoil

INTRODUCTION

Food insecurity and climate change are major problems facing the world today. Food security is dependent on the number of people and the rate at which crops are produced to meet their needs for nourishment (Josephine *et al*., 2022). Generally, the media used for planting directly influences the growth and operation of root systems. A high-quality growing medium should give the plant enough anchoring or support, store nutrients, and water, distribute oxygen to the roots, and make it easier for gases to pass between the roots and their surroundings (Abad *et al*., 2002; Gruda *et al*., 2013). In many nurseries across the tropical region of the country, topsoil is frequently employed as a part of the growing media. On the other hand, the use of topsoil can be very challenging for the production of seedlings meant for final field transplant. Scarcity of high-quality topsoil, compaction, pathogen or weed seed introduction, low drainage pattern, inadequate nutritional content as well as moving big, cumbersome soil-filled containers are among the challenges identified (Gruda *et al*., 2013).

In plant growth and productivity, coco fiber has several benefits over topsoil, such as increased aeration, decreased infection risk, enhanced water retention, environmental sustainability, uniform quality, accurate nutrient management, ease of handling, and reusability (Tuckeldoe *et al*., 2023). The most famous fibrous waste product from the production of coconuts is coconut fiber. Coir, or coconut fiber, is an emerging trend in plant growth media since it is environmentally benign and sustainable. This natural substance, which is derived from coconut husks, is used extensively in horticulture and gardening. Its sustainability is among the strongest arguments in favor of using coconut fiber in gardening (Bui *et al*., 2020). Reusing coconut husks, a by-product

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of the coconut industry, as a growing medium reduces trash and its negative effects on the environment. Unlike some other growing mediums, coconut fiber is a renewable resource that does not pose a negative effect on the ecosystem or deplete natural peat bogs (Vieira, 2020). One of the most popular green vegetables grown in southern Nigeria is the fluted pumpkin (*Telfairia occidentalis* Hook. F), a member of the Cucurbitaceae plant family (Sakpere, 2019). But today, practically every region of the nation grows it (Igbozulike, 2015). Because of the extremely nutrient-dense leaves and seeds, many people in Nigeria place a high value on fluted pumpkins (Sakpere, 2019). The fruit's fluted shape gives rise to the plant's name. The plant is also known by the common names Fluted gourd, Fluted pumpkin, and Ugwu. These two vegetables used in this study are nutritious green vegetables that are widely prized in West African cuisine. Traditional soil-based farming has problems with irregular water retention and soil-borne infections.

The use of coco fibre is greatly increasing which could be because of its various uses in agricultural productivity. It is therefore imperative to look for an alternative means of engaging in sustainable agriculture that is devoid of major environmental hazards that could culminate into a huge health risk for the huge populace of the inhabitants of the ecosystem. Coco fibre or coir is formed from pieces of coconut fibre known to be an organic hydroponic growing medium with a pH of 5.0 to 6.8 and is ideal for plant growth in all circumstances as a result of the fact that water is easily absorbed, and stored while allowing sunshine as well as air pass through it (Komariah *et al*., 2021). In the quest for a locally accessible substitute for topsoil in plant cultivation containers, coconut husk can be effortlessly transformed into a perfect growing medium (coco-fibre). It is worth noting that coconut kernels are utilized for food and fuel, and the spongy pericap, also known as husk, is a product that can be used for other agricultural purposes such as the rehabilitation of degraded land. This method goes from "waste to wealth". The approach of waste to wealth was employed in this research where pepper and Ugwu were used as test plants. We can encourage sustainable agriculture, lessen waste, and help build stronger, more resilient ecosystems by utilizing the potential of coir pith. Making the composting of coco-fibres a regular habit can help us move toward a more environmentally friendly and sustainable future (Anandhu, 2023). It's well recognized that vegetables are a significant source of nutrients that offer protection and according to reports available, vegetables are also a good source of minerals, oil, carbs, and vitamins (Nnamani *et al*., 2009; Adenipekun, 2010).

The principal vegetable and spice crop, capsicum (*Capsicum annum*), is grown all over the world for fresh, dried, and processed products; it originated in the American tropics and the significant variety in various features found in the genus Capsicum has sparked curiosity and fascination since it makes this crop incredibly adaptable and perfect for a variety of applications as both culinary and non-food products (Pasquale and Najeet, 2019) especially in this part of the country.

Telfairia occidentalis or Ugwu as popularly called in Nigeria is a significant crop farmed for its edible seeds and leafy greens. When compared to other popular tropical leafy vegetables, it ranks top among the vegetables that are consumed in Nigeria and yield favourable results meanwhile the predominance of traditional methods in its production and postharvest operations is currently impeding growers' ability to expand beyond what is already on the ground.

Coconut husks/fibre are currently disposed of as waste, which contributes about 80–90% of pollution in our ecosystem (Cimons, 2014). So, it becomes imperative therefore to put to good use what people tagged "waste" in coco fibre into something beneficial as a means of generating wealth as well as a green source of environmental clean-up processes. This research therefore aims to analyse how coco fibre affects productivity and growth of the two varieties of vegetables used in this research; *Capsicum annuum* (Pepper) and *Telfairia occidentalis* (Ugwu).

MATERIALS AND METHODS

Study area and Collection of Samples

The research was carried out at the screen house of the Department of Plant and Environmental Biology at Kwara State University, Malete, Nigeria. Seeds of Ugwu and Pepper were sourced from the Department of farms and produce at the Ministry of Agriculture, in Ilorin, Kwara State Nigeria while coconut husk was sourced from the fruit section of the popular Kodi area of Oja Oba market in Ilorin where it was being deposited for onward movement to the nearest disposal vehicle in that vicinity.

Coco Fibre Processing

The method adopted in this research is the method described by Anandhu (2023) with little modifications. Coconut husks were collected, gathered, and stored in large quantity in a hygienic location. The fibres were dried after removing them and a decent pair of scissors was used to chop or cut them into little pieces. The small pieces of coco fibre were soaked inside water for 36 hours to bring the pH down by reducing the salt content as well as to make it soft and suitable for planting. This was air-dried for

three days and subsequently the needed kg of the coco fibre was weighed into pots for planting.

Experimental Design

The screenhouse experiment consisted of two crop types; Ugwu and Pepper, and four levels of coco fibre (1000, 500, 250 kg/pot respectively), and 3 kg of topsoil only (control) to give a total of 8 treatment combinations, each replicated three times in a Randomized Complete Block Design. Three seeds each of either Ugwu or pepper were planted into poly-pots of 15×20cm dimension. Pots were watered as often as soil dryness was observed (this was after two days).

Determination of the growth parameters of the test plants

Plant height was measured using a measuring tape from the base of the plant to the tip of the highest leaf. Measurement commenced at 4 weeks after planting (WAP) and continued fortnightly till 8WAP. Differences in plant height obtained at 8WAP due to the application of different concentrations of coco fibre were compared using Analysis of Variance. Number of leaves was determined by counting the number of germinated leaves per plant in each pot from 4WAP till 8WAP. Differences in number of leaves obtained at 8WAP due to the application of different concentrations of coco fibre were compared using Analysis of Variance.

Data Analysis

All data collected were subjected to Analysis of Variance (ANOVA) to check main and interactive effects of treatments using R Version 4.3.0. Post-hoc comparison of means was performed using the Emmeans package at 0.05 level of significance. Values obtained with the Shapiro-Wilk's test on the residuals for plant height (p = 0.39) and number of leaves (p = 0.10) suggests normality. Graphs were drawn with Microsoft Excel 2016 version.

RESULTS AND DISCUSSION

Table 1 shows the base line condition of the soil used for this research. The soil was analysed for various physicochemical parameters before the introduction of coir into the experimental soil. The parameters include; soil type, pH, total nitogen, calcium, phosphorus**,** magnesium,titratable acidity, potassium, sodium, organic carbon, organic matter, cation exchange capacity and electrical conductivity. The soil type is sandy loam which is the best soil type for the growth of *Telferia occidentalis*, while the soil pH is acidic (5.00), which is not too suitable for this *Telferia occidentalis* when compared to alkaline soil (Oluwole *et al*., 2020). The total organic matter in the soil is considerable low (3.46%).

Table 1: Physicochemical parameters of the soil used for the research

Parameters	Value
Soil type	Sandy loam
Ph	5.00
Total nitrogen (%)	0.14
Titratable acidity ((g/L)	0.10
Available phosphorous (mg/kg)	20.00
Electrical conductivity ((S/m)	1041
Total organic carbon (%)	2.03
Calcium (Ca) (mg/kg)	1.209
Sodium (Na) (mg/kg)	0.50
Magnesium (Mg) (mg/kg)	5.20
Potassium (K) mg/kg)	1.00
Cation exchange capacity (mg/kg)	9.03
Organic matter (%)	3.46

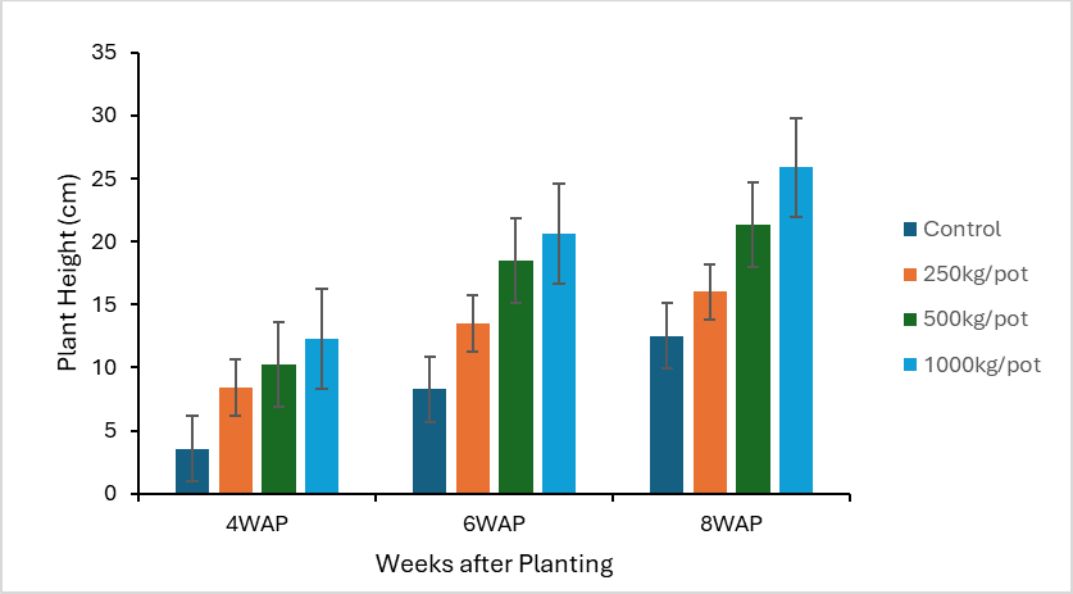


Figure 1: Effect of Coco Fibre on Plant Height of Ugwu after Planting

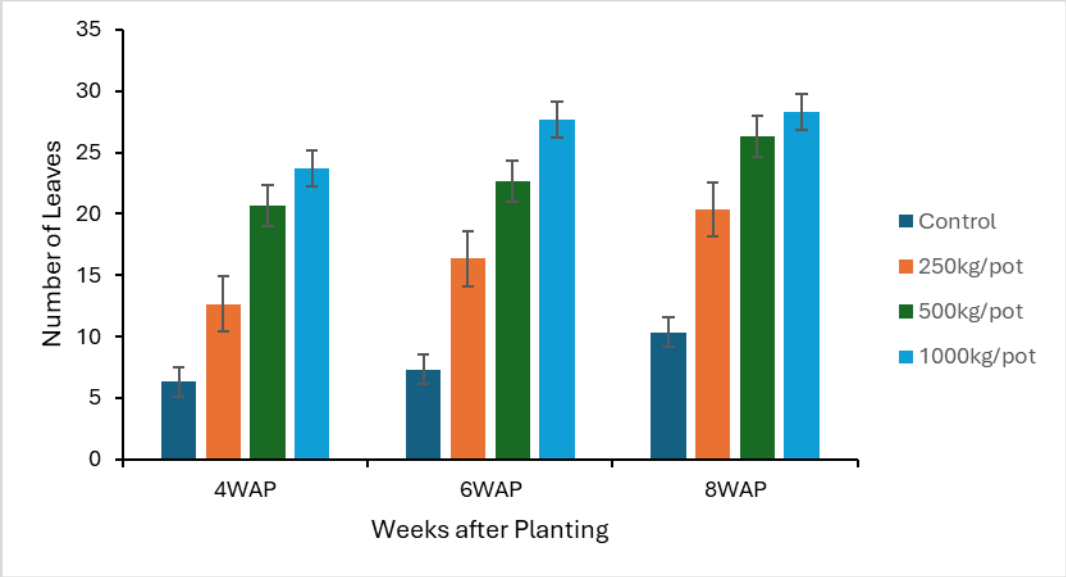


Figure 2: Effect of Coco Fibre on Number of Leaves of Ugwu after Planting

Growth parameters of pepper

The effects of coco fibre on the plant height and number of leaves of Pepper after planting are presented in Figures 3 and 4 respectively. Contrary to the results obtained with Ugwu plants, there was considerable increase in plant height and number of leaves of pepper grown in topsoil while there was inhibition of growth in pepper planted in the coco fibre media. The highest height of 15.57 cm and mean number of leaves of 18.00 was obtained in plants cultivated on soils at 8WAP. This result disagrees with the findings of Tuckeldoe (2023) where it was reported that the growth of sweet pepper was greatly enhanced with the use of coco coir as a growing media. The disparity in the results could be due to the difference in the variety of the pepper that was used as well as the prevailing environmental planting conditions of the above-mentioned authors and the present study. Plates 3 and 4 further show the fact that coco fibre was not good for pepper growth from the colour of the plant (yellow) while pepper grown in soils had greenish and luxuriant growth. There was also wilting of the pepper plant even as early as the fourth week in coco fibre pots. Pepper plants also performed well when grown on 1000 kg/pot coco fibre

but values were significantly lower at $P < 0.05$ than those obtained in soils (Tables 2 and 3).

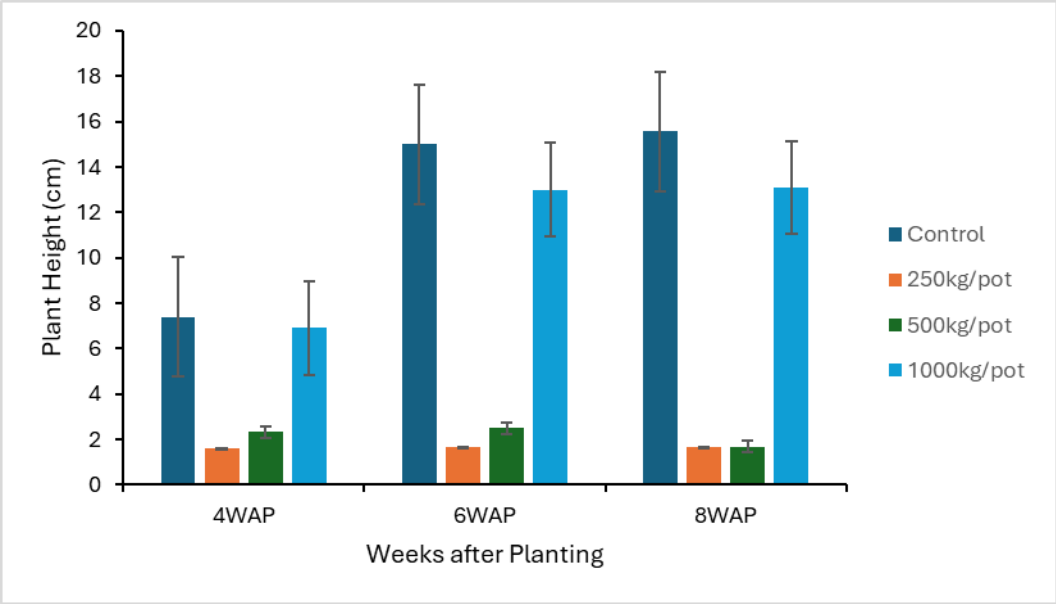


Figure 3: Effect of Coco Fibre on Plant Height of Pepper after Planting

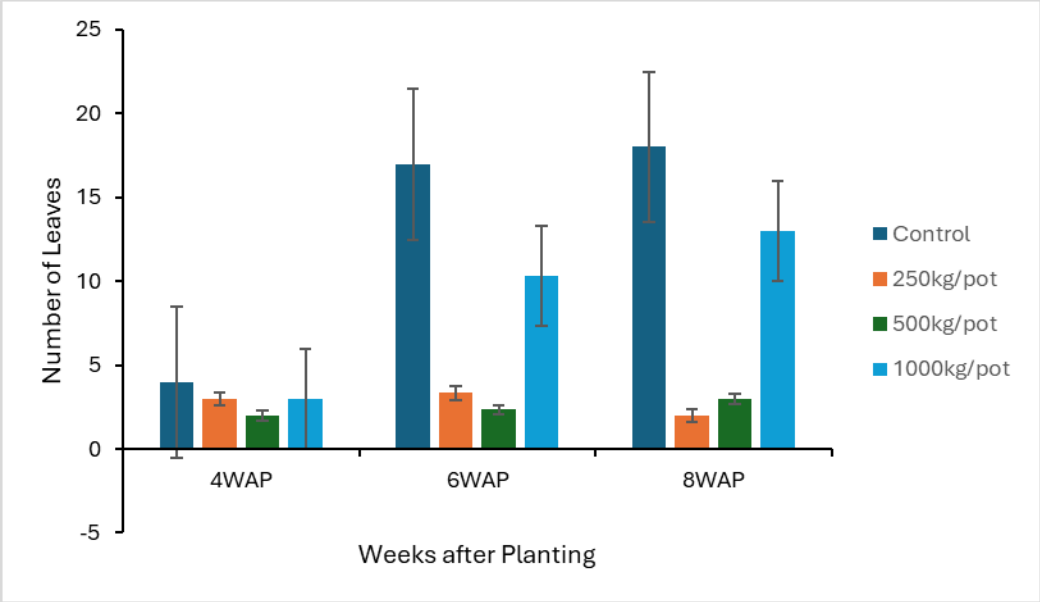


Figure 4: Effect of Coco Fibre on the Number of Leaves of Pepper after Planting

Table 2 shows the effects of crop type and treatments, and their interactions on plant height. Since the interactions are highly significant, the main effects of crops and treatments were ignored as this means that none of the main effects act alone. The means of the interaction between treatment and crop type are presented in Table 3.

Table 2: Interaction between crop type and treatment for Plant Height

Treatment	Crop type	Means
1000 kg/pot	Ugwu	25.87 ± 1.03 a
500 kg/pot	Ugwu	21.33 ± 1.53 b
250 kg/pot	Ugwu	16.00 ± 1.00 c
Control	Pepper	15.57 ± 0.21 c
1000 kg/pot	Pepper	13.09 ± 0.24 d
Control	Ugwu	12.50 ± 0.50 d
250 kg/pot	Pepper	1.67 ± 0.29 e
500 kg/pot	Pepper	1.67 ± 0.15 e

Means followed by the same letter are not significantly different from each other at $p<0.05$ The main effects of crop type and treatments, and their interactions on the number of leaves as the response variable are presented in Table 3 Since the interactions are highly significant, the main effects of crops and treatments were ignored. Table 3 shows the means of the interaction between treatment and crop type.

Table 3: Interaction between crop type and treatment for number of leaves

Treatment	Crop type	Means
1000kg/pot	Ugwu	28.33 ± 0.58 a
500kg/pot	Ugwu	26.33 ± 0.58 b
250kg/pot	Ugwu	20.33 ± 0.58 c
Control	Pepper	18.00 ± 1.00 d
1000kg/pot	Pepper	13.00 ± 1.00 e
Control	Ugwu	10.33 ± 0.58 f
500kg/pot	Pepper	3.00 ± 1.00 g
250kg/pot	Pepper	2.00 ± 1.00 g

Means followed by the same letter are not significantly different from each other at $p<0.05$.

It is safe to state that, the use of coco fibre treatment for Ugwu plant performed better than topsoil based on the results obtained in this research. Conversely, out of the two-growing media, topsoil proved to be the most effective for pepper as it helped to maintain the seedlings even without the addition of any organic manure or nitrogen supplement/ fertilizer. This research, therefore, concludes that Ugwu plants can be grown with coco fibre while pepper should not be grown with coco fibre especially in this part of the world because its growth was not enhanced by the coco fibre, but it was luxuriant and green in topsoil.

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