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ASSESSING THE QUALITY CHARACTERISTICS OF ARECA NUT (*ARECA CATECHU* L.) LEAF SHEATH WASTE TO FIND ITS SUITABILITY FOR BIO-COMPOSTING

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Abstract: Arecanut palm leaf sheath is serving as a potential eco-friendly alternative for plastic and paper products such as plates, food container and spoon, etc. Increased usage of these areca products is resulting in high amount of wastes in urban centres of India. Biodegradation of these wastes is slow due to its high lignin (17.12 per cent) and cellulose (64.48 per cent) content. Hence an attempt was made to characterize these wastes to find its amenability for bio-composting. The nutritive and non-nutritive characteristics were analyzed using ICP-MS and standard methodologies. It was observed that this waste contains all macro and micro nutrients required for plant growth with a high carbon to nitrogen ratio. Blending with suitable nitrogen rich wastes such as cow dung and poultry manures with effective microbial cultures will enhance its biodegradation.

INTRODUCTION

Arecanut palm (*Areca catechu* L.) belongs to the family Arecaceae grown since Vedic period known as betel nut or supari or paakku indigenously. It is a long duration crop intercropped with cocoa and pepper vine. Arecanut is grown commercially in 12 Asian countries with 1.2 million tonnes of nut yield annually and about 10 million farmers are depending on these plantations for their livelihood (Deshmukh *et al.*, 2019). India stands first in cultivation and production of arecanut in the world. In state wise cultivations, Karnataka and Kerala contribute around 70 per cent area and production (Ramappa, 2013).

The by-products of Arecanut palm tree are the various products made from leaf and leaf sheath. The leaf sheaths of Arecanut palm is converted to value added products such as plates, spoons, cup, cap, bowl, food container and also utilized in paper industries. Arecanut leaf sheath is one of the hard materials with good flexibility and low calorific value (Nikhil *et al.*, 2018). The arecanut leaf sheath is complex material made up of lignin, cellulose and hemicellulose with some amount of wax. The composite material from the arecanut leaf sheath are used as additives in plastic for improved compounding technology and coupling agent leads to reduce the petroleum based plastics usages (Jothibasu *et al.*, 2020). The arecanut leaf sheath fibres have excellent mechanical properties to hybridization fibre matrix (Nagaraja *et al.*, 2014). Around 5.5 to 6 tonnes of wastes are produced per hectare of areca palm plantations (Raghupathy *et al.*, 2002) and as these waste materials are having macro and micro nutrients required for plant growth, it could be effectively utilized for composting and convert to valuable organic manure.

MATERIALS AND METHODS

The experiment was conducted in the Department of Environmental sciences, Tamil Nadu agricultural University, Coimbatore. Arecanut leaf sheath wastes (Fig. 2) were collected from a plantation (Fig. 1) at Vedapatti village and an Areca leaf sheath plate making Industry(Fig. 3) in Coimbatore district, Tamil Nadu, India.

pH

pH of arecanut leaf sheath waste was measured using pH meter in 1:10 sample to distilled water ratio (Falcon *et al.*, 1987).

EC

Electrical Conductivity of arecanut leaf sheath waste was measured using conductivity meter in 1:10 sample to distilled water ratio (Falcon *et al.*, 1987). The results are expressed in terms of dsm^{-1}.

Organic Carbon

Organic carbon content of the sample was analyzed by Walkley black method (Walkley and Black, 1934).

Total nitrogen

Total nitrogen was analyzed using Micro Kjeldahl method (Yuen and Pollard, 1953). The diacid digested samples were titrated against 0.02N sulfuric acid with the end point indicated by the red wine color.

Micronutrient

The micronutrient content of arecanut leaf sheath waste was analyzed using Atomic Absorption Spectrophotometer (AAS). The samples were digested with triacid and made the volume to 100 ml with distilled water. The digested sample was fed to the AAS and calculated the concentration (Lindsay and Norwell, 1978).

ICP-MS

Inductively Coupled Plasma Mass Spectroscopy was used to analyse the natural minerals present in Arecanut leaf sheath waste (Lü and Wu, 2019).

RESULTS AND DISCUSSION

The nutritive and non-nutritive characteristics of the arecanut palm leaf sheath wastes were analyzed to find its amenability and suitability for bio-composting. The chemical and non-nutritive properties are presented in Table 1. The pH of the areca nut leaf sheath was 6.26 which was slightly acidic. The chemical composition of plants influences pH and pH influences the degradation and nutrient availability when return to the soil.

The Electrical Conductivity (1.59 dsm^{-1}) of the areca nut leaf sheath waste indicates the presence of high amount of salts. The ash content of Arecanut Leaf Sheath Waste was 4.59 per cent. The ash content mainly depends and vary based on the plant type, waste type, soil and climate conditions and sample collections (Etiegni *et al.*, 1991).

Organic carbon of arecanut leaf sheath was observed as 57 per cent with a low nitrogen content of 0.7 per cent. From the organic carbon and total nitrogen content of the arecanut leaf sheath wastes, C: N ratio works out to be 81.42. The higher C:N ratio needs to be lowered for effective bio-composting. The areca leaf sheath waste C:N ratio was initially around 96-98:1 (Nagaraja *et al.*, 2014).

It was found that the Areca leaf sheath waste contains high lignin content (17.12 per cent) (Table 1). Plant with high lignin content (>25 per cent) will not degrade in short period of time (den Camp *et al.*, 1988) and 98 per cent of lignin contained materials were disposed by incineration. But, the degradation of lignin can be enhanced by employing group of multiple enzymes capable of depolymerizing the lignin bonds (Longe *et al.*, 2018).

Table 1. Chemical and non-nutritive properties of arecanut leaf sheath wastes

S. No	Parameters	Concentration
1.	pH	6.26
2.	EC	1.59 dsm^{-1}
3.	Moisture content	12 per cent
4.	Calorific Value	4540 k cal /kg
5.	Ash content	4.59 per cent
6.	Volatile Matter	80.43 per cent
7.	α cellulose	64.48 per cent
8.	Hemi cellulose	9.81 per cent
9.	Lignin	17.12 per cent
10.	Crude Fat	30.65 per cent
11.	Crude protein	2.98 per cent
12.	Crude fiber	46.90 per cent
13.	Biomass extractives	92 per cent

The major constituents of collected areca leaf sheath waste were Cellulose(64.48 per cent), Hemicellulose (9.81 per cent) and Lignin (17.12 per cent). Inoculating with lingo-cellulolytic microbial culture would accelerate the biodegradation process of these compounds. The increase in temperature during the degradation process of waste is essential for rapid degradation of lignocellulose (Tuomela *et al.*, 2000). It was also reported that lignin and other Complex organic compounds are mainly degraded by thermophilic, micro fungi and actinomycetes. The ideal temperature in the compost pile for thermophilic fungi is 40–50 °C and which is also the optimum temperature for lignin degradation in compost (Tuomela *et al*., 2000).

The crude fiber, crude protein and crude fat of the waste material were 46.90 per cent, 2.98 per cent and 30.65 per cent, respectively (Table 1). The concentration of biomass extractive was 92 per cent. These results indicate that the areca leaf sheath waste has the potential to be utilized as biomass fuel.

The macro and micro nutrient concentrations are presented in Table 2 and 3. The concentration of primary macro nutrients were nitrogen (0.7 per cent), phosphorus (0.18 per cent) and potassium (0.85 per cent). The low initial nutrient content of arecanut husk residue increased after composting to nitrogen around 1.4 per cent, phosphorus around 0.7 per cent and potassium around 1.4 per cent which substantiates that the compost made from areca waste will be of good organic manure.

Table 2. Macro nutrients of arecanut leaf sheath wastes

S. No	Parameters	Concentration
1.	Organic carbon	57 per cent
2.	Total Nitrogen	0.7 per cent
3.	C:N ratio	81.42
4.	Total Phosphorus	0.18 per cent
5.	Total potassium	0.82 per cent
6.	Calcium	0.62 per cent
7.	Magnesium	0.35 per cent

Table 3. Micronutrients of arecanut leaf sheath wastes

S. No.	Parameters	Concentration (mg/kg)
1.	Copper	30.64
2.	Zinc	21.79
3.	Nickel	34.83
4.	Boron	42.93
5.	Aluminum	138.77
6.	Silicon	161.29
7.	Manganese	498.7
8.	Ferrous	1237.37

Besides the primary macro nutrients, the areca leaf sheath waste contains essential plant micronutrients such as copper (30.64 mg/kg), zinc (21.79 mg/kg), nickel (34.83 mg / kg), boron (42.93 mg/kg), aluminium (138.77 mg/kg), silicon (161.29 mg/kg), manganese (498.7 mg/kg) and ferrous (1237.37 mg/kg) also present. These micronutrients play a vital role in various plant physiological and metabolical mechanisms. Zinc is an essential micronutrient and it regulates the growth,

Fig. 1. Arecanut palm plantation

Fig. 2. Arecanut leaf Sheath wastes collected from arecanut plantation

Fig. 3. Waste collected from arecanut leaf sheath plate and spoon making industry

development and yield parameters (Mousavi, 2011).

CONCLUSION

The present study reveals that the arecanut leaf sheath waste contains required plant nutrients in reasonable concentrations. Harnessing the nutrient potential of these waste materials by converting into organic manure through bio-composting will be a viable option for better management of areca nut leaf sheath waste and to meet out the growing organic inputs demand of present agricultural scenario. For effective bio-composting, the wider C:N ratio of areca leaf sheath waste (about 80 – 85:1) needs to be adjusted and inoculated with lignocellulolytic microbial culture.

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