

Studies on the use of Coconut Fibres as Carrier for Hydrocarbon Degrading Microbes in Remediation of Petroleum Polluted Soil

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Abstract

This study had as its objective to investigate the characteristics of coconut fibre, from the fruit disposed in the market place at Effurun, Delta State Nigeria to check the viability of application of the fibre as carrier for hydrocarbon degrading microorganism. The samples of the coconut fibre were collected, ground, macerated, sieved and stored. The particle size, available phosphorus, nitrogen content and moisture content of the coconut fibres were determined. The results showed that the coconut fibres have potential related to other natural fibers studied in literature, to be used as carrier for hydrocarbon degrading microorganisms in remediation of petroleum polluted soil.

Keywords: *Cocusnucifera, characterization of coconut fibre, hydrocarbon degrading microorganism, bioremediation.*

1.0 Introduction

In the Niger Delta area of Nigeria there has been several reported cases of oil spills which have led to the contamination of available land for arable farming. The oil exploration, producing and processing companies attempts in the past to clean and treat the contaminated soil have not yield the required result. The methods adopted are usually not friendly to the environment after treatment. However, due to the raise of environmental problems emerged from the processing or discard of petroleum and its products, there is the need to look for biodegradable and renewable raw materials (Ahmedna, et al, 2000).

In pursuance for new materials that could be used as an effective hydrocarbon degrading agent with little or no environmental problems, hence the interest in research for the development of compounds that use natural fibers as alternatives to replace products that damage the environment, (Agiri, et al., 2011)

The use of natural fibres is associated to the factor that they are biodegradable, less abrasive and have a low cost related to the synthetic fibres (Leite, 2010). The coconut fibres come from renewable sources, originating from the food industry and agricultural waste in the tropical countries, where the coconut water is consumed and the endosperm (edible coconut flesh) is used as food condiments. Coconut fibre is disposed indiscriminately and constitute nuisance to the environment. The purposeful use of coconut fibre collaborates in the reduction of solid waste that is issued in the environment (Harries, H. 1997).

Coconut fibres are already applied in the industry and agriculture, however the applicability of the fibres of the coconut bark is somewhat limited due to the high moisture of the barks (85%), and the fibres characteristics do not favour certain applications that are often employed with the dry coconut fibres (Tam, M. 1999). There are little or no reported cases of its use in the field of hydrocarbon degrading process. Its use by the fibers finishing industries is nothing because of the lack of knowledge on its properties (Rosaetal., 2001).

The coconut fibres are lingo cellulosic materials collected from the coconut meso carp, the coconut fruit (*Cocusnucifera*) mainly grown in the tropics. Celia, et al., (2013) quoting Leiteetal.,(2010) stated that the coconut fibres have hardness and mechanical resistance due to the high lignin, which also serves as a protection for the tissue against the action of

microorganisms. Therefore, the characteristics of the coconut fibres increase its possibilities of use in bioremediation, for the rigidity provided by the lignin gives a good resistance. Another important element found in these fibers is the preservation against the bacteria attacks, for the lignin has a high natural preservation towards other natural fibers already studied in literature (Martins et al, 2013).

The following reasons were given for selecting these agriculture harvest by-products as local cellulosic materials to serve as carriers: The agriculture harvest by-products selected are all available in large abundance locally. It is believed that the selected coconut fibres will not serve as nutrient source for the microorganisms thus helping to prolong the shelf lives of the immobilized microorganisms. The coconut fibres are easily biodegraded thus will not constitute waste problems after the microorganisms are spent, (Agiri, et al, 2011).

According to Wladyka et al., (2009), there are many general advantages of coconut fibres such as, being mooth proof, resistant to fungi and rot, provide excellent insulation against temperature, not easily combustible, flame retardant, unaffected by moisture and dampness, tough and durable, resilient spring back to shape even after constant use, totally static free and easy to clean.

2.0 Materials and methods

2.1 Collection of coconut fibre

Sample of coconut fibre husks were collected in disposal areas of market place, in the city of Effurun, Delta State. Coconut fibre was obtained from the fibrous husk (mesocarp) of the coconut (*Cocosnucifera*) fruit.

2.2 Size reduction

The individual fibre was pulled out from the husk and the residue was cut with knives then further reduced in size by use of scissors into un-equal size particles. The cuttings were then sun dried for a period of ten days at about 30°C and 65% relative humidity.

2.3 Dust thermal treatment

The coconut fibre was heated at 80°C for 24 hours for proper drying and to eliminate the microorganisms

2.4 Trituration

The residue obtained was cut by a roll of fixed knives, which shave the barks, and then goes through fixed hammers that are responsible for the product crushing.

2.5 Coconut fibre sieving

The brown colour powder was sieved through 0.80 mm, labeled Coconut Fibre (CF) and stored in a plastic container at room temperature in the laboratory.

2.6 Characterization of the coconut fibre

The coconut was characterized for its water content, nitrogen content, phosphorus content and pH.

2.7 Water content determination (oven drying method)

The water content also called the natural moisture content is the ratio of the weight of water to the weight of the solids in a given mass of the material. This ratio is usually expressed as percentage. A crucible, previously cleaned and oven dried, was weighed (W1). The crucible was then filled with the dried meal of the coconut fibres, and weighed (W2). The crucible containing the coconut fibres was then kept in an oven at a temperature between 105°C to 110°C for 24 hours. The final constant weight (W3) of the container with the dried sample were then determined. The water (moisture) content W (%) was determined from the relationship:

$$\text{Water (moisture) content } W (\%) = [(W2-W3)/(W3-W1)] \times 100$$

The result of the determination of water content is presented in Table 1.

2.8 Determination of total nitrogen (regular micro-kjeldahl method)

2.00 g of the ground coconut fibres was weighed. 9 ml of Conc. Sulphuric acid was added and the mixture was gently heated on a hot plate until white fumes was observed. It was allowed to cool, filtered and the filtrate was made up to 100 ml in a volumetric flask. 25 ml of the digest was taken from the flask and made up to 50 ml with distilled water. 5 ml of 12 M potassium hydroxide was added and the solution was filtered. 25 ml of the filtrate was taken and 1 ml of 10% sodium tartarate and 5 ml of Nessler's reagent were added. A blank sample with distilled water as the test sample was also prepared. Sample was allowed to stand for 15 minutes for colour development. Absorbance was read at 460 nm with a direct reading spectrophotometer (Hach Direct reading 2000 Spectrophotometer). The results are presented in Table 1.

2.9 Determination of phosphorus (ascorbic acid method)

1g of the dried and ground coconut fibres was weighed into a 250 ml conical flask and 4 ml of Perchloric acid, 2 ml of concentrated nitric acid and 2 ml concentrated Sulphuric acid was added in a fume chamber. The mixture was heated on a hot plate until dense white fumes was observed. It was then heated from medium to high heat for 30 seconds and then allowed to cool. 50 ml of distilled water was then added and the solution was boiled for 30 seconds. On cooling the solution was filtered with a Whatman No 42 filter paper and made up to 100 ml in a volumetric flask. 0.2112 g of ascorbic acid was weighed into a beaker and Phosphate reagent B was prepared by adding 40 ml of Phosphate reagent A to the Ascorbic acid. To 5 ml of the digest was added 10 ml of distilled water, 4 ml of reagent B and made up to 25 ml with distilled water. A blank with distilled water as the test sample was similarly prepared. Both were allowed to stand for 1 minutes for colour development and absorbance was read at 882 nm with a direct reading spectrophotometer (Hach Direct reading 2000 Spectrophotometer). The results of the determinations are presented in Table 1.

3.0 Results and discussion

3.1 Determined values of water content, available phosphorus, nitrogen content

For many cellulose materials, the water content, total nitrogen and available phosphorus are extremely important indices for establishing the relationship between the way the material behaves and its properties. The consistency of a fine cellulose material largely depends on these parameters. The determined water content of coconut fibres value of about 10.92% allows for effective adhesion of the microorganism without rotting. The determined values of available phosphorus and Nitrogen content of 14.65 mg/kg and 86.13 mg/Kg respectively are considered to be of importance in the condition for effective bioremediation process.

Chemical composition

The value of the total lignin present in the coconut fibres is approximately 44% according to the researched literatures. The high lign in favours the fibres flexibility and gives them a good resistance and a protection against microorganism attacks, crucial aspects for the use as carrier for hydrocarbon degrading microorganism.(Celia et al, 2013).

Optical microscopy

The optical microscopy consisted in analyzing the fibres surface, providing an image produced by the interaction between light and fibre, with a wide field of observation. Figure2 shows the optical microscopy done on the surface of the green coconut fibers, with a magnification of 20 times, and Figure 3 shows the same fibres with a magnification of 32 times. The superficial aspect is shaped like a "twisted shoelace", which gives the fiber a better rigidity.

4.0 Conclusion

The use of agricultural waste product could replace synthetic ones as carriers for hydrocarbon degrading microorganisms. The reported use of material such detergent, chemicals which are pollutant themselves and come from non-renewable raw materials are of grave danger to the environment. There is a trend in using natural materials in the hydro carbon degrading process because of its environmental friendliness problems created during the bioremediation processes. In this sense, the coconut fibres are being studied for the use as potent carriers for the hydro carbon degraders. From the obtained results, we can conclude that the high lignin in the coconut fibres provides a good flexibility and a natural protection against micro organism attacks. The pursuit for sustainable materials is important to application in sectors that need renewable raw materials and need to reduce their environmental pollution.

Appendix



Fig. 1 Coconut Fibre (0.80 mm)



Fig. 2 Coconut fiber (magnification 20x)

Source: Celia et al 2013



Fig. 3 coconut fibres



Fig. 4 Unequal sizes of coconut fibres

Table 1: Determined Values of Water Content, Nitrogen and available Phosphorous

Parameters	Coconut Fibre
Water Content, %	10.92
Available Phosphorus, mg/Kg	14.65
Total Nitrogen, mg/Kg	86.13
Naturalfiber	Total lignin (%)
Mature coconut	48,3 ± 1,9
Green coconut	44 ± 1,0
Banana tree	16,8 ± 1,0
Jute	15,9 ± 0,5
Sisal	12

Source: Celia et al, 2013

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