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THE PRODUCTION OF CARBON BLACK FROM THE UNRIPE PEELS OF PLANTAIN (*MUSA PARADISIACA*) IN NIGERIA

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ABSTRACT
Carbon black (CB) is an intensely black, finely divided form of amorphous carbon. It is usually obtained as soot from the partial combustion of hydrocarbons and has found many industrial uses such as reinforcing agents in automobile tires, black pigments printing ink, paint, carbon paper, etc. Although it can be obtained as a by-product of petroleum production, it can also be produced from indigenous materials of plant origin. This work demonstrated how CB can be obtained from the peels of unripe plantain. Seventy kilogram of wet peels of black plantain was collected from the local women, cut into smaller portions and sundried for seven days to obtained fifty three kilogram of the dried peels which were then carbonization by heating in an air-tight metal kiln for an hour. The carbonized peels were later pulverized and then filtered with sieve of mesh size 212um to give very fine filler particles of carbon black. The finished product was test run as a refill toner powder for HP Laser Jet Professional P 1606dn and using it to print some documents. The result of this work exhibited the implications for reusing plantain peels (a common solid waste in Nigeria) to produced CB.

Keywords: *Carbon black, Plantain peels, Toner powder, Musa paradisiaca*

1. INTRODUCTION

Carbon black is any of a group of intensely black, finely divided forms of amorphous carbon, usually obtained as soot from partial combustion of hydrocarbons. It has found many industrial uses principally as reinforcing agents in automobile tires and other rubber products but also as extremely black pigments of high hiding power in printing ink, paint, and carbon paper. Carbon black is also used in protective coatings, plastics, and resistors for electronic circuits [1]. As reinforcing filler; it greatly increases resistance to wear and abrasion. About one fourth of the weight of a standard automobile tire is carbon black. Carbon black is added to make the rubber electrically conducting, especially for vehicle tires such as oil trucks and hospital operating carts on which it is necessary to avoid building up an electrostatic charge [2-3].

Among the most finely divided materials known, carbon blacks vary widely in particle size depending on the process by which they are made. The varieties include Channel or impingement black made by the impingement of smoky flames from tiny jets on iron channels; the deposited black which is scraped off by moving the channels over stationary scrapers. Others are furnace blacks made in refractory chambers by incomplete combustion of any of various types of gaseous or liquid hydrocarbons; Thermal blacks are produced in the absence of air when hydrocarbons are decomposed by contact with heated refractory and Lampblack, the oldest known black pigment which is produced by burning oil, usually coal-tar creosote, in shallow pans, in a furnace with the draft regulated to give a heavy smoke cloud. Acetylene black is produced in refractory chambers in the absence of air by the decomposition of acetylene gas preheated to 800° C (1,500° F). It is used in applications requiring high electrical conductivity, such as dry cells [4-6].

Usually, carbon black is produced by the incomplete combustion of heavy petroleum products such as fluidized catalytic cracking (FCC) of decants oil or tar, coal tar, ethylene cracking tar, and a small amount from vegetable oil. Carbon black is a form of amorphous carbon that has a high surface-area-to-volume ratio, although its surface-area-to-volume

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ratio is low compared to that of activated carbon. It is dissimilar to soot in its much higher surface-area-to-volume ratio and significantly lower PAH (polycyclic aromatic hydrocarbon) content. However, carbon black is widely used as a model compound for diesel soot for diesel oxidation experiments [5].

Carbon Black is well recognized as the best reinforcing material in rubber compounds. The tire industry, in particular, consumes around 80 percent of the total Carbon Black. Presently about nine million metric tons of Carbon Black are manufactured annually worldwide, resulting in the consumption of 20 million metric tons of Carbon Black oil. There is a limit to the hardness and modulus that can be achieved in rubber by vulcanization alone. It is therefore necessary to add material, which will increase the hardness and modulus to the level deserved. These materials are known as fillers. They constitute the second largest material in terms of quantity in a rubber compound after the rubber. Carbon black fillers are the most popular filters used and it is expensive since it is imported. Fillers may also be used as pigments [6].

In Nigeria, industrial carbon black is produced in oil refineries as by-products of petroleum. The downstream industry in Nigeria is well established through the Nigerian National Petroleum Company (NNPC) which has three refineries, at Kaduna, Port Harcourt and Warri. These refineries have a combined installed capacity of 445,000 bpd and have therefore been common sources of carbon black production in the country [7].

Apart from the industrial production of carbon black in Nigeria, there are documented evidences that the product is being produced on a small scale using indigenous means. The raw materials include hardwood charcoal, kola-nut, yam flour and other agricultural products. Some of these indigenous factory can produce about 140 -800 metric Ton of carbon black per week [8-9].

This work is aimed at producing carbon black (CB) from the unripe peels gathered from used plantain of the *Musa species.* The term "plantain" is loosely applied to any banana cultivar that is usually cooked before it is eaten [10]. However, in botanical usage, the term "plantain" is used only for true plantains, while other starchy cultivars used for cooking are called "cooking bananas"[11-12]. The peels used in this work were collected from the unripened True Plantain *Musa paradisiacal* [13] which is a common species of plantain used as a staple food in Nigeria.

2. STUDY LOCATION

This study was carried out in Delta State Polytechnic, Otefe-Oghara, Nigeria. The plantain peels which were usually regarded as wastes were collected from the local peasant women in this community. The activity of carbon black production was then carried out in the Science Laboratory of the Polytechnic.

3. COLLECTION AND PROCESSING OF THE PLANTAIN PEELS

Step 1: Arrangements were made with the local women to empty their plantain peels waste into plastic containers given to them.

Step 2: The unripened plantain peels were sorted out, collected together and stored in a dry metal container.

Step 3: The peels were then cut into smaller portions for a quick and thorough drying.

Step 4: Seventy kilogram of the wet peels were spread out for sun drying.

Step 5: The peels were sundried for seven days by spreading them out during a sunny day using a thick and wide cardboard or carton material. Fifty three kilogram of the dried peels was obtained.

Step 6: The dried peels were then loaded into an air-tight metal kiln and heated for one hour. This process is called carbonization [9].

Step 7: The carbonized peels were pulverized using a mortar and pestle and then filtered with sieve of mesh size 212um to give very fine filler particles of carbon black.

Step 8: The finished product was test run as a toner powder for HP Laser Jet Professional P 1606dn by filling an empty canister with it and using it to print some documents.

4. RESULTS

The work yielded nine hundred and forty three (943g) gram of the carbon black. Indeed the fine and black powdery substance was produced though in a very small quantity. The product was poured into a transparent bottle, corked and labeled *carbon black* with date. Some portion of the finished product was used as a printer ink; and it showed a positive result by printing out legible letters.

5. DISCUSSION

This research work has shown that carbon black can be produced from local materials. It has shown that apart from the industrial production of carbon black in

Nigeria, it can also be produced from pineapple leaves as it with other raw materials such as hardwood charcoal, kola-nut and pounded yam [8]. With these findings the way is now open to improve on the uses of this raw material which is a common waste in the average Nigerian community. Secondly, this research has shown that black plantain peels which are common domestic waste products of many homes can be used for a good purpose instead of taking it as a nuisance. The collection and supply of this waste material could become a source of economic empowerment if thoroughly harnessed in the future.

Another angle to this work is the environmental benefits. Solid wastes management (SWM); and in fact all types of waste management has become the bane of modern society. Presently, SWM follows a hierarchy refers to as the "3 Rs" reduce, reuse and recycle, which classify waste management strategies according to their desirability in terms of waste minimization. The waste hierarchy remains the cornerstone of most waste minimization strategies. The aim is to extract the maximum practical benefits from products and to generate the minimum amount of waste; thereby representing the progression of a product or material through the sequential stages in waste management [14]. This work has shown that plantain peels can be reused for industrial purposes such as ink for printers and artist [5] which is cost effective with a lot of positive environmental benefits.

6. CONCLUSION

The relevance of carbon black in the present technological era cannot easily be overlook. It is quite interesting that this substance with immense benefits and relevance can be produced as a by-product of hydrocarbon. However, as the world is shifting away from hydrocarbon related products and their attendant environmental implications, the reuse of unripe plantain peels as raw materials is quite a welcome industrial venture. It is hoped that when fully exploited, the reuse of unripe plantain peels will not only provide ample supplies of raw materials for carbon black production but also assist in the managing plantain peels which are biodegradable solid wastes in many countries.

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