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Flammability Properties of Cheese Wood Stembark (*Alstonia Boonei)* Filled-Low-Density Polyethylene

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--Abstract--
Polymer composites were prepared from Cheese wood stem bark (alstonia boonei) filled-Low Density Polyethylene (LDPE) using the process of injection moulding and then compressed into a dumb-bell shape. It was found that the filler reduced the flammability of the composites. The mechanism of the flame-retardant effect of cheese wood stem barks is the oxidative degradation of the polymer to produce non-combustible products (carbon IV oxide and nitrogen oxides) at a rate sufficient to interfere with the normal combustion process in spite of the exothermicity of the oxidation degradation. The formation of non-combustible products was as a result of phosphorus and nitrogen contents of the filler. When the phosphorus burns, it produces char (carbon). The fillers used in blend proportion in the order: 100/0%, 99/1%, 98/2%, 97/3% and 96/4% LDPE-filler ratios. The 100% LDPE (unfilled) had glow time, burning time and flame propagation rate of 18 s, 50 s and 0.117 cm/s respectively. Hence, the glow time, burning time and flame propagation rate of the samples were all increased by cheese wood stem bark flame retardant.

Keywords: *Fillers, Reinforcement, Low Density Polyethylene, Flammability.*

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1. INTRODUTION

In our everyday life, Polymers are used massively due to their remarkable combination of properties such as ease of processing, light weight, just to mention a few. The hydrocarbon which is the predominant backbone of polymers makes it susceptible to relative high flammability, most often accompanied by the production of corrosive, toxic gases and smoke during the combustion process. Hence, the need to improve the flame retardant behaviour of polymers Reports had it that in the US every year, there were over 3 million fires leading to 29,000 injuries and 4500 deaths[1]. The direct properties lost exceed $8 billion and the total annual cost has been estimated to over $100 billion[1]. Severe personal losses occur in residence where furniture, clothes, wall coverings and household utensils are frequently the fuel. The course of a fire can be split into four stages, incipient, growth, fully developed and decay/combustio[2]. In order for a fire to start, three components must be present, vis: fuel, oxygen and energy are necessary[3, 4]. The combustion process cannot take place without them[5]. To provide additional protection from fires and to increase escape time when fire occurs, methods to enhance the flame retardance of consumer goods have been developed[6]. Halogenated flame retardant additives are being phased out for their proven or suspected adverse effect on the environment[7]. The parameters of fire demonstrate that the fire performance of a fuel is only partially characterized by its chemical and physical properties and is therefore not an intrinsic property of the material.

In this research project, efforts were made to use natural material as flame retardant for polyolefins. This was aimed at finding more economical, easily available, efficient and halogen free systems than currently known.The finding that the cheese wood stem bark served as a flame retardant did not come as a surprise as the wood forms soothes and extinguishes flame when used as fuel. The chemical composition of cheese wood stem bark extract was evaluated with a Soxlet extractor and the results are shown in table 1 below:

TABLE 1: CHEMICAL COMPOSITON OF CHEESE WOOD ALSTONIA BOONEI)

Element	***%Composition***
Phosphorus	1.18
Potassium	1.13
Nitrogen	1.32
Calcium	0.10
Sodium	0.08
Magnesium	0.03

II. EXPERIMENTAL

2.1 MATERIALS USED

- Low Density Polyethylene (LDPE) was obtained from Ceeplast Industry limited, Osisioma Industrial Layout, Aba, Abia, Nigeria.
- Alstonia boonei stem bark (ABSB) powder obtained from cheese wood in Umuevu, Okrika-Nweke, Ahiazu Mbaise local government of Imo State, Nigeria.
- Reagent grade chemical glycerol (plasticizer) was used and received from Fisher Scientific, Pittsburgh, PA

2.2 METHODS

2.2 DRYING

Cheese wood stem bark (alstonia boonei) was cut from the tree and dried under the sun for about three weeks.

2.3 GRINDING

The dried wood bark was ground with a cassava grater into pellet form and then reground with an electric grinder to obtain a very finely divided powder.

2.4 SIEVING

The finely divided filler in powdered form was taken to erosion control laboratory, Federal University of Technology Owerri, Nigeria where it was sieved with a 0.3 mm (300 µm) mesh size sieve.

2.5 WEIGHING

The filler particles and the Low Density Polyethylene (LDPE) were weighed with an electronic weighting machine according to the filler-polymer ratio used (1:99). The components of each composite batch were obtained using the formulations in the Table 2 and combinations were done in percentage weight.

TABLE 2: FORMULATIONS OF SAMPLES

SAMPLES	**ALSTONIA BOONEI STEM BARK (%)**	**LDPE (%)**
CT	0	100
B_1	1	99
B_2	2	98
B_3	3	97
B_4	4	96

2.6 PREPARATION OF LDPE COMPOSITES

The Low Density Polyethylene (LDPE) resins were mixed with different filler weights and glycerol was added as a compactibilizer. The mixture was then fed into the hopper of an injection moulding machine to form a homogeneous molten material. The molten mixture was transferred to a dumb bell mould and then compressed to form the dumb-bell shape. The dumb- bell shape was removed from the hand mould and labelled according to the filler weight contents. The control sample (unfilled) and the different samples were labelled CT, B1-B4 for each of the different filler weights. Samples B1-B4 are the ones reinforced with Cheese wood stem bark (alstonia boonei) according to filler loadings.

2.7 FLAMMABILTY TESTING
GLOW TEST

- **Materials used:** the labelled composite samples (C7, B1-B4)
- **Apparatus:** retort stand with clamp, metre rule, stop-watch and bursen burner.
- **Method:** the samples were vertically clamped at a constant distance of 5cm between

its lower tip of the sample and the light source.
The glow time was recorded as the time interval between striking of the light and a visible perceptible glow of light (flame) appearing on the sample.

2.8 BURNING TEST

- **Materials Used:** the labelled composite samples (C7, B1-B4)
- **Apparatus:** retort stand with clamp, stopwatch and stove for light source.
- **Method:** the samples were vertically clamped at a constant distance of 5cm between its lower tip and the light source. The burning time was recorded as the time interval between the striking of the light and the time the samples begin to burn.

2.9 FLAME PROPAGATION RATE TEST

- **Materials Used:** the labelled plastic composite samples made up of low density polyethylene and filler weights of kola nut and Alstonia boonei stem barks, (C7, B1- B4)
- **Apparatus:** retort stand with clamp, metre rule, stop watch and light source.
- **Method: a** mark was made on the dumb-bell 3cm from its end. The sample was then clamped vertically and ignited in a draft free room. The time for the flame to reach the mark was recorded. The flame propagation rate (FRP) was calculated as the fixed length of char front divided by the time used to burn off the marks.

FPR = Char Front Length / Time.

III. RESULTS AND DISCUSSION

3.1Flammability Results
3.1 Glow Test Results

The glow time for the control was 18 s. The glow time increased with increase in filler weight, i.e it took the composites longer to show afterglow.

Sample ID	Time (s)
CT	18
B_1	35
B_2	54
B_3	60
B_4	70

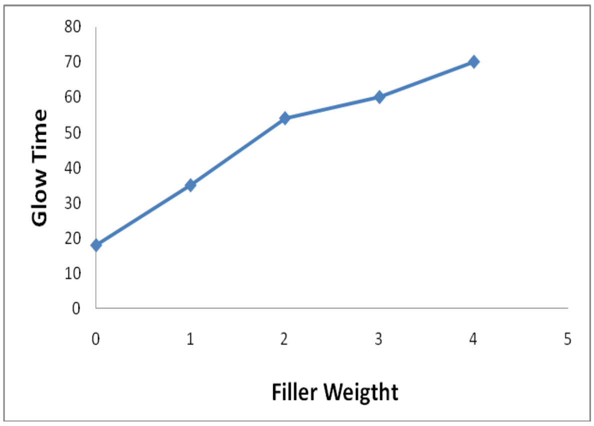

Fig 1: Graph of Glow Time against Filler weight

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3.2 Burning Test Results

Sample ID	Time (s)
CT	50
B_1	105
B_2	116
B_3	129
B_4	138

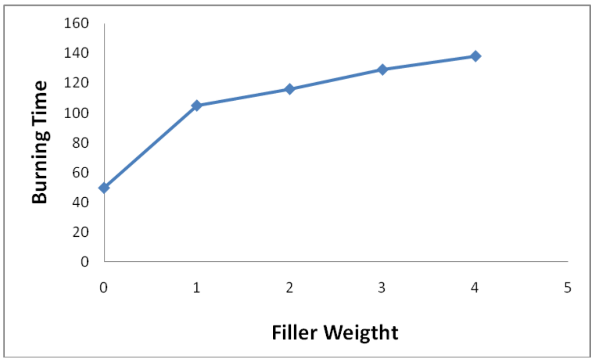
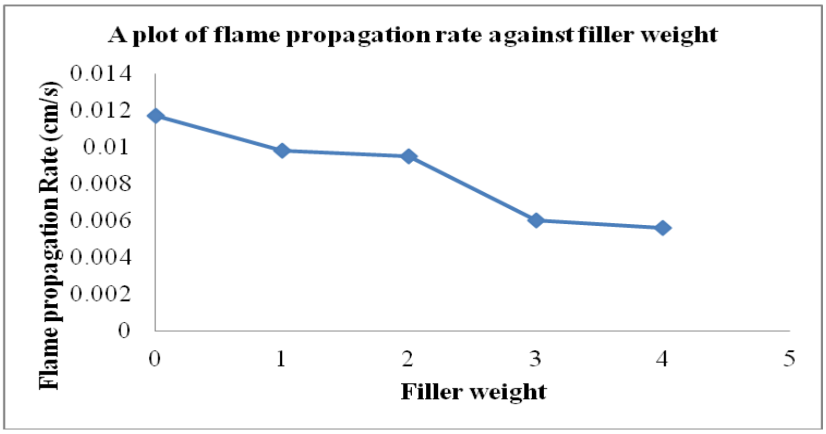


Fig.2: Graph of Burning Time against Filler Weight

3.3 Flame Propagation Rate (FPR) Results

Length of Char Front = 3 cm

Sample ID	Time (s)	FPR
CT	257	0.0117
B1	305	0.0098
B2	315	0.0095
B3	503	0.0060
B4	540	0.0056



IV. CONCLUSION

From the results obtained, it follows that cheese wood filler can be used to reduce the flammability of Low Density Polyethylene. The different flammability properties studied, the additive had an impact on the polyolefin, with the effect being more intense in that direction with increasing filler loadings.The glow time, burning time and flame propagation rate tested were increased with increasing filler loadings in the composites. The high ignition time of Low Density polypropylene reinforced with cheese wood stem bark suggests that improvement in flame retardancy of LDPE can be achieved by a synergy of excess phosphorus with nitrogen compounds in the matrix. Flame propagation results revealed that the LDPE composites formed with Cheese wood showed reduction in the flame propagation rate with increasing filler content when compared with the unfilled LDPE. For all the parameters tested to assess the relative flame retardant effect of the filler in 100%

Low Density Polypropylene, the effect of phosphorus was well noted. Whether phosphorus and nitrogen are present in the lignin or proteins, their presence increased the resistance to flammability of unfilled LDPE.

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