Palm Kernel Shells as a Dust Control Palliative on an Unpaved Road

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Abstract

An assessment of the effectiveness of the use palm kernel shells as a dust control palliative on an unpaved road has been carried out. The palm kernel shells were able to reduce the quantity of dust generated from the road to about 75% a few days after the application. It was then suggested that with the absence of funds for road maintenance works organic materials like palm kernel shells could be used as palliatives.

Keywords

Dust control, Palliative, Palm kernel shells, Unpaved roads

Introduction

Oil palm is a common name for an ornamental and economically valuable palm tree, native to West Africa and widespread throughout the tropics. It grows to about 9m in height, with a crown of feathery leaves that are up to 5m long. Flowering is followed by the development of a cluster of egg shaped red, orange or yellowish fruits each approximately 3cm long. Palm oil is extracted from the fruit pulp and used mostly in the manufacture of soap and candles. Palm oil is also the largest source of palmitic acid, a fatty acid used in numerous commercial purposes. The more valuable palm kernel oil is obtained from the seed kernels of the fruit. This white oil has a pleasant odour and nutty flavour and is used in making margarine as well as soap and candles. In Nigeria and some other African nations this oil can also be used for medicinal purposes [1].

The road dust problem has generated a lot of interest of late. Traffic on unpaved roads has been reported to produce about 35% of atmospheric pollution world wide. Of this 28% is from dust while 7% is from exhaust fumes [2]. Unpaved roads comprise the major part of most road networks amounting to 81% of all roads in a major survey carried out by the World Bank in 1997. The percentage of unpaved roads in Africa was put at 90% and about 70% in Asia and the Middle East [3]. They provide vital links between people in the hinterlands, agricultural produce and people and markets in urban settings. During the dry season the dust from these roads can constitute a health hazard to the populace living close to them. The dust generated from these roads equally reduces visibility and vehicle efficiency during the hot dry season [4]. Accidents on these roads usually lead to damages to agricultural produce, industrial raw materials and even economic instability [5].

Methods of quantifying dust emission from these roads have been a subject of controversy. It has been reported that the most common method involves measuring the silt content from road surfaces by vacuuming paved roads or sweeping unpaved ones [6, 7]. Stationary devices have also been used, which characterize road dustiness at a particular point [8]. This method was extensively used in quantifying materials lost from selected unpaved roads in Kenya [9]. No matter the method used, the fact remains that materials are being lost from the unpaved roads during the dry season and in the wet season, these road become impassable, having lost most of the smaller particles that would have acted as fillers and hence, stabilizers. The question that arises is, in the absence of funds for upgrading of these roads to paved ones, are there any short term measures that could be carried out to reduce the amount of dust being lost? It is in this light that this work was undertaken, to determine the effectiveness of palm kernel shells as a dust control palliative.

Various palliatives ranging from use of local materials such as grass, cottonseed, animal fats to palm and vegetable oils have been proposed [9]. Dust control palliatives have been grouped into chemical-organic compounds, bitumen, tar, resinous adhesives, lignin derivatives, mechanical materials, road fabric, chemical inorganic compounds and calcium chloride [10].

Palm kernel shells have been used by some villagers in the oil palm growing regions of Nigeria and Cameroon to protect the surface of the unpaved roads. The method looks crude but somehow, it reduces drastically, the quantity of dust lost from these roads during dry season and ensures passability during the rainy season. This paper aims at showing the effectiveness of the shells as a dust control palliative.

Materials and Methods

Location of study area

Minna is located within latitude 10˚30’ N and longitude 6˚30’E in the Guinea Savannah region of Nigerian at 283.00m above mean sea level. The road chosen for this investigation is a 6km long unpaved road linking Saukakahuta, a suburb in Minna to some villages away like Lapaingwari. The road has an average width of 3.6m. The road serves an area with a population of 500 inhabitants.

Vehicle characteristics

A Peugeot 504 saloon car weighing 1350kg having zigzag tyre threading with tyre pressure of 40kg/cm2, 0.25m clearance with exhaust pipe pointing horizontally backwards was chosen for this research. It is a very common car used in the rural areas of Nigeria and assembled by Peugeot Automobile of Nigeria (PAN).

Environmental conditions

The average environmental conditions were 35.75C temperature, 11.0 solar radiation, 24.5% relative humidity, 3.3km/h wind speed in a north eastern direction were all gotten from the meteorological station at the Minna International Airport about 8km away.

Sourcing and preparation of palm kernel shells

Ripe palm fruits were bought from the local market and kept for about a week to rot. They were then carefully washed to obtain the shells in a fresh state. These were then sun dried for four weeks. Samples were then collected and taken to the laboratory for impact value and water absorption tests.

Collection of dislodged materials

Surface materials were collected from the entire length of the road. Sections with similar properties were chosen for the investigation. Four sections each measuring 5m were carefully selected to allow for vehicles to run and attain the required speed for the investigations.

Cardboard papers were joined together to form 5m by 5m grids and placed on both sides of the 3.6m wide road section. Also 3m by 5m grids were carefully placed in the centre of the road, leaving 30cm on both sides for the wheel tracks. The sections were made short so that the drivers will not veer off the wheel paths and to minimize wind effects.

The vehicles were made to run at a specified speed with over all the sections and the dust generated was collected on the cardboards. This was then poured out into polythene bags and weighed in the laboratory. The average for each speed over the sections was then obtained.

Palm kernel shells were then carefully placed on the sections to cover the 5m length. An average thickness of 30mm was gotten and well spread to cover the surface. The vehicle was then made to run the whole sections at the specified speeds and volume of dust generated were measured. The treated surface was monitored for 5 days on an hourly basis.

Results and Discussions

Strength properties of the palm kernel shells

The impact value obtained for the shells was 6% with a water absorption ratio of 2.5%. The BS 812 (1975) specifies an impact value of for coarse aggregate used in asphalt concrete for wearing courses of 20-30% and a water absorption rate of 0.5%. This implies that these values did not meet specifications. However, palm kernel shells are organic materials and are not being used entirely in a structural mix but in a type of surface dressing to reduce the impact of dislodged materials on the environment as well as reduce the rate of loss of materials from an unpaved road. Most of these roads are lightly trafficked.

Dislodged materials

The quantity of materials dislodged at the test speeds for both the untreated and treated surface and monitored for five days are shown in table 1.

Table1. Average quantity of dislodged material for the 5m length of road in grams

Speed (kph)	Untreated	Surface treated with palm kernel shells			
		Immediately	24 Hours	48 Hours	72 Hours
30	1.2	0	0.2	0.14	0.18
40	1.5	0	0.2	0.16	0.30
50	2.0	0	0.2	0.17	0.40
60	3.8	0.16	0.22	0.24	0.58
70	5.3	0.16	0.22	0.26	1.00
80	6.4	0.20	0.26	0.32	1.20

These materials were measured with an electronic sensitive balance. Cumulative values of the quantities lost to the environment were also calculated and results presented in Table 2.

Table 2. Cumulative average quantity of material dislodged from the road surface

Speed (kph)	Untreated	Palm kernel shells treated Surface			
		Immediately	24 Hours	48 Hours	72 Hours
30	1.2	0	0.2	0.14	0.12
40	2.7	0	0.4	0.30	0.48
50	4.7	0	0.6	0.47	0.88
60	8.5	0.16	0.82	0.71	1.46
70	13.8	0.32	1.04	0.97	2.46
80	20.2	0.52	1.30	1.29	3.66

The percentage in the quantity of material preserved as a result of applying the palm kernel shells was also calculated by comparing the quantity lost from the untreated surface which acted as a control and the quantity lost after placing the palm kernel shells. This is presented in Table 3.

Table 3. Percentage of Material preserved after applying palm kernel shells

Speed (kph)	Untreated	Palm kernel shells treated Surface			
		Immediately	24 Hours	48 Hours	72 Hours
30	1.2	100	83.0	88.3	75.0
40	2.7	100	86.7	89.3	80.0
50	4.7	100	90.0	91.5	80.0
60	8.5	95.8	94.2	93.68	84.7
70	13.8	97.0	95.85	95.1	81.0
80	20.2	96.9	95.9	95.0	81.25

From the tables it can be seen that for the untreated surface the quantity of material dislodged increases with a corresponding increase in speeds. Aerodynamic effects are responsible for this, as the tyres begin to act as fans at higher speeds fanning the dust from the road surface (9, 12). After placing the palm kernel shells and running the tests immediately, there was a marked reduction of between 95 and 100%. On subsequent days, some measurable quantities of dust appear. On the fifth day, at 72 hours material preserved were at almost 75% meaning 25% were lost. This can be attributed to the fact on day 1, after placing the palm kernel shells; the surface was completely covered so no dust was recorded after some speeds. At higher speeds however, some of the shells shifted, exposing parts of the surface again which released some dust. Subsequent days show some dust being generated at all speeds but still not as much as the quantity generated for the untreated surface. This can also be attributed to the fact that most of the shells had been embedded in the surface through the compactive action of the vehicle tyres, thus exposing more portions of the surface to vehicular action, which invariably led to more dust being generated.

Conclusions

1. This paper has shown that palm kernel shells could be used as a dust control palliative. This reduces the quantity of dust generated from the road surface.
2. The use of the shells will go a long way in reducing impact of dust on dust-sensitive vegetation, vehicular action, respiratory problems, complains from public road users and sedimentation in water bodies.
3. Immediate application of palm kernel shells reduced the dust produced from the road at some speeds to zero. The rate of preservation of materials was as between 75 and 100%.
4. Daily monitoring of the effectiveness of the palm kernel shells showed that vehicular compactive action which led to the embedding of some of the shells exposed the surface which released some more dust. More shells should be placed on the exposed surface.
5. With the paucity of funds in developing countries for construction purposes, use of these natural materials can be encouraged as these are readily available.

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