Biodegradable Detergents from *Azadirachta Indica* (neem) Seed Oil

Alewo Opuada AMEH [*], Muhammed Tijani ISA and Ebenezer Konyeni UDOKA

[1] *Department of Chemical Engineering, Ahmadu Bello University Zaria, 810261 Zaria, Nigeria.*
E-mail(s): alewooameh@yahoo.com, mtisaz@yahoo.com, udoka000@yahoo.com
([*] Corresponding author)

Abstract

The production of biodegradable detergent from *Azadirachta Indica* (neem) seed oil was studied in this work. The synthesized detergent was characterised and compared with commercially available detergents. 33g of biodegradable detergent was produced from 30ml of the oil. In the foamability test, the height of liquid and foam of detergent rose to 3cm in a 250ml beaker thus indicating its effectiveness since it compared favourably with the foam heights of commercial detergents. The surface tension of solution of 5g of the synthesized detergent in 100ml of water determined to be 0.00523 N/m was found to be better that of the commercial detergent of same concentration. The oxygen demand for a solution of the synthesized detergents over a five day period found to be 0.4ppm indicated it was biodegradable.

Keywords

Biodegradable; Detergent; *Azadirachta Indica* (neem) seed; Oil.

Introduction

In the past, cleaning of clothes was done by beating them wet on rocks near a stream. By so doing water washes away the stains. However, oily soils were difficult to remove this way which led to the use of soap (sodium salts of a long chain fatty acid). The wash performance of soap decreases in hard water, due to the formation of insoluble salts of the fatty acid (primarily calcium and magnesium). The needs for detergents are from the drawbacks associated with the use of soap.

Detergents are amphipatic molecules that contain both polar (COO^-) and hydrophobic(R) groups. Soaps and detergents have the general formula RCOOX. The core component of modern detergents is surfactants such as linear alkyl benzene sulfonate [1-3]. Others are builders and co-builders, bleach and bleach activator, and special additives such as fluorescent brightener, filler, corrosive inhibitor, antifoaming agents and enzymes [4]. Some of the builders such as phosphates are found to be excellent fertilizer to growth of algae in rivers and oceans. Therefore are replaced with other builders such as effect ethylenediaminetetraacetic acid (EDTA) acid and its derivatives, the effect of EDTA and its derivative on the environment are reported in [5-6], which indicated that they have poor biological degradation.

Biodegradable has been defined as: the process of rapid decomposition as a result of action of micro-organism [7]. As a result of concerns about the environment, there is growing interest in the use of biodegradable materials. For example, it is agreed that the poor biodegradability of some surfactants (e.g. linear alkyl benzene sulfonate LABS, traditionally used for detergent production) under anaerobic condition may sometimes result in a high surfactant sludge load [1-3, 8-13]. Therefore the need to source for an easily biodegradable detergent arises. A biodegradable detergent is one obtained from biologically, renewable resources and it is capable of decaying through the action of biological agents such as bacteria [14]. Major sources of biodegradable detergents are fats and oil and natural polymers. Research into the biodegradability of alkyl based detergents showed that branched molecules are indigestible to the bacteria of decomposition. Vegetable oil derived detergents contain straight chained linear alkyl sulfonate, LAS, making them suitable for detergents production [15].

Neemseed plant is known to be abundant in the country such as Nigeria and the oil makes up 50% of the kernel. As such large quantity of oil say 45% can be obtained from much available seed [16-17].

Therefore, because of availability and the environmental friendliness of this oil, this work is aimed at producing detergent from neemseed oil, characterization of the detergent produced and comparing the results with some commercial products in Nigeria.

This work is aimed at producing detergent from Nigerian *Azadirachta Indica* seed oil, characterization of the detergent produced and comparing the results with some commercial products.

Material and Method

Production of Biodegradable Detergent

30ml of neemseed oil was heated to 313.15K. Sodium hydroxide solution was prepared by dissolving 40g of sodium hydroxide pellets in 100ml of water and this was added to the neem oil already warmed. The mixture was stirred in a fume cupboard. 10ml of 18M sulphuric acid was added and the resulting reaction monitored by using a pH metre model Kent EIL 7055. Sulphuric acid (BDH 98%) was added until the pH was between 9 and 9.5. 25ml of 18M sulphuric acid was added to adjust the pH to 9.3. 10ml hydrogen peroxide was then added to aid formation of a homogenous mixture. 2.5g each nitriloacetic acid (builder) and carboxymethyl cellulose (anti-redeposition agent) were added and the resulting mixture stirred. The mixture was cooled and dried naturally. After three days the detergent prepared was scooped out and weighted.

Foamability Test of Detergents

2.0g of the detergent produced was various into 100m of water in a 500ml beaker and shaken vigorously for 2 minutes and the height of the foam monitored and recorded after 10 minutes. The same procedure was repeated for commercial detergents labelled A, B, C separately and the height of foam was recorded in each case.

Determination of Detergents Surface Tension

An equal quantity of the synthesized detergent as well as three commercial detergents (2g) was dissolved in water (100ml) and the surface tension of each solution was determined.

Biodegradability Test of Detergents

Five grams of various detergents was measured into BOD bottle into which was added hundred millilitres of tap water for dissolution. One millilitre of phosphate buffer, magnesium sulphate, calcium chloride, and iron (III) chloride were added to one litre of distilled water. This solution was added to top up the contents in the BOD bottle. This was left to stand for two hours and the dissolved oxygen was measured with the use of an oxygen meter. After five days the dissolved oxygen was also measured. The change in dissolved oxygen was then calculated.

Results

33 grams of detergent was produced from 30ml of the neem seed oil and the results of the tests carried out shown in the tables below. The results of the foamability test are presented in Table 1. The results of the biodegradability test are presented in Table 2. The commercial detergents are tagged A, B and C

Table 1. Height of Various Detergent Foams in Water for the foamability test

Detergent	Height of foam in water (cm)	
	Liquid + Foam	Liquid
A	3.30	2.20
B	3.20	2.20
C	3.20	2.10
Biodegradable	3.00	2.00

Table 2. Biological Oxygen Demand (BOD) for commercial detergent and produced biodegradable detergent

Detergent	BOD on day 0, (y)	BOD on day 5, (x)	(y – x)
A	2.0	1.7	0.3
B	1.9	1.7	0.2
C	2.0	1.8	0.2
Biodegradable	1.9	1.5	0.4

Discussion

As presented in Table 1, the powdered detergent obtained from the neemseed oil has high enough efficiency as seen from the result of the foamability test. Usually the efficiency of a washing powder is assessed through the amount of foam it is capable of producing. The presence of persistent foam exemplifies a good detergent [18]. The foam height of 3.00cm persisted for about ten minutes and it compares favourably with the height seen in detergents A, B and C.

The Biochemical oxygen demand (BOD) refers to the amount of oxygen utilized by micro-organisms within a 5-day period to convert organic matter in waste water (or substances) to carbon dioxide and water. The BOD can be used to establish the ease with which substances will biodegrade. From the values obtained from the BOD, the detergent which was easiest for micro-organisms to work on was the biodegradable detergent with a change in oxygen demand of 0.4. It means when this detergent if discharged would be

environment friendly since microbes can easily break it down into simpler compounds (CO_2 and water) compared to the other commercial detergents tested. The surface tension of a liquid is defined as the energy required to penetrate the surface. Liquids in which there are strong molecular interactions, such as water typically have high surface tensions. Water molecules are bonded to each other by virtue of an interaction between hydrogen atoms on one molecule and the oxygen atom of another-the process is referred to as 'hydrogen bonding.' The result is a kind of 'skin' on the surface of the liquid. The surface tension of water is dramatically reduced by the addition of detergent. This means that the surface tension is lower. Hence, wetting capacity of water is improved. The surface tension obtained for the biodegradable detergent (0.00523N/m) means that the surface tension of the water was reduced. Hence, this detergent is effective. When compared to the surface tension of the other commercial detergents (A, B, C of 0.00697 N/m, 0.00589 N/m and 0.00741N/m respectively), it was found to slightly better.

Conclusions

Detergent was produces from neemseed oil. After characterization the synthesized detergent was found to be more biodegradable when compared to some commercially detergents. The height of foam after ten minutes found to be 3.00cm compared well with the commercial detergents. The surface tension of the detergent determined as 0.00523N/m was found to be lower (and better) than those of the commercial detergents of similar concentrations.

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