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Some properties of Cassava Mesocarp carbohydrates-low density polyethylene blends

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Cassava mesocarp carbohydrate and its modified form were used as fillers in low density polyethylene to give plastic films that were biodegradable. It was found that the tensile strength of the films decreased with an increase in the amount of the filler incorporated. The water absorption results of the films showed that modification of the cassava mesocarp carbohydrate made it hydrophobic and therefore more compatible with the polyethylene. © 1998 Elsevier Science Ltd. All rights reserved

INTRODUCTION

Polymers filled with starch or its derivatives are receiving attention mainly because of their biodegradability. Native and modified starch have been used as fillers in polyurethane (Bennett *et al.*, 1967), poly vinyl chloride (Westhoff *et al.*, 1974), and polyethylene (Otey *et al.*, 1980).

Cassava (Manihot) tuber, which contains mainly starch, is an important source of staple food in most African countries. The use of native and/or modified cassava starch as fillers in polymer systems will affect the availability of cassava starch for the food industry. A literature review revealed that cassava peel which is a major waste emanating from the processing of cassava tuber has been used in domestic farms as feeds to raise pigs, sheep and goats (Montilla, 1977; Adebowale, 1985; Fetuga and Tewe, 1985; Tewe, 1987). However, the results were not encouraging when compared with other feedstuffs. This has been attributed to the high toxicity of the peel due to its high level of hydrocyanic acid (Conn, 1979). Cassava wastes have been carboxymethylated and used as thickeners in latex paints (Odozi *et al.*, 1986). The objective of the present study was to determine the suitability of cassava mesocarp carbohydrate and its chemically modified form as fillers in low density polyethylene blends. It was also aimed at producing biodegradable polyethylene films.

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EXPERIMENTAL

Materials

The cassava mesocarp used in this study was obtained from the cassava peels. The epicarp of the cassava peels were carefully removed and the mesocarp thoroughly washed with water and oven-dried at 60°C for 8 h. The dried cassava mesocarp was cut into small pieces and ground using a food blender. The resultant product was sieved through a 45 μm sieve to obtain a cream coloured powder. The carbohydrate (holocellulose) content of the cassava mesocarp was found to be 91.2% using the method described by Allens *et al.* (1974). It have been reported that cassava peel contains crude protein 4.9-5.8%, crude fibre 18.8-22.7%, crude fat 1.0-1.4% and carbohydrates 65.1-68.7% (Ofuya and Obilor, 1993 and Conn, 1979). Low Density Polyethylene was obtained from Comfort Plastics Ltd., Port Harcourt.

Chemical modification of Cassava Mesocarp powder

To 200 ml of glacial acetic acid in a 500 ml conical flask, 4 ml of concentrated H_2SO_4 and 60 ml of acetic anhydride were added. Thereafter, 5 g of cassava mesocarp powder was added and the entire mixture stirred to ensure complete wetting of the powder. The flask was stoppered and left to stand for 24 h. The resulting solution was slowly poured into a 2-litre beaker half-filled with water. The acetate formed precipitated out as a white mass. It was filtered, washed and dried. An acetyl content of 40.3% was obtained for the product using the method described by the American Society for Testing and Materials (ASTM, 1976).

Preparation of polyethylene-Cassava Mesocarp blends

Both the modified and the unmodified cassava mesocarp carbohydrates were incorporated into the Low Density Polyethylene, in turn, by blending in a two-roll mill at 140° C. Films containing 0-25 wt% of the modified or unmodified cassava mesocarp carbohydrate were prepared by compression moulding. Films of 0.56 mm thickness were produced and used for the tests.

Characterisation of the films

Tests were carried out on films of the compression moulded LDPE-Cassava mesocarp blends. The tests included determination of the tensile strength, hydrophobicity (water absorption test) and a preliminary test for biodegradability.

Tensile strength

An Instron 1026 was used to determine the tensile strength of the films. The films were cut out into test samples and conditioned at a temperature of 23±0.5° C and a relative humidity of 50±2%. The test was carried out at a speed of 50 mm/min. Each tensile strength value reported is an average of five samples.

Water absorption test

Test Samples (2×2.5 cm) of the various films were cut out. Each sample was weighed and immersed in a given volume of distilled water for 10 h, thereafter it was wiped dry, reweighed and percentage water absorption calculated. Five test samples were used for each blend and the average value reported.

Biodegradability test

Films of each LDPE-Cassava mesocarp blend were innoculated with Aspergillus niger on a medium and incubated in an incubator for three weeks. Thereafter the films were examined for evidence of colony growth.

RESULTS AND DISCUSSION

Tensile strength

The effects of the incorporation of cassava mesocarp carbohydrates on the tensile strength of the polyethylene films are shown in Table 1. The decrease in tensile strength observed for the films containing the fillers as the addition level increases has been attributed to a possible increasing filler-filler interactions at the expense of filler-polymer interactions. The results showed that the decrease in tensile strength was more rapid with the unmodified cassava mesocarp carbohydrate than with the modified form. This suggests a greater intermolecular attractive forces between the polyethylene and the modified cassava mesocarp carbohydrate leading to a higher degree of compatibility.

Water absorption

Table 1 shows the effect of cassava mesocarp carbohydrate content on the water absorption of the films. A polyethylene film recorded a 0.2% water absorption. At 25% addition level of the modified cassava mesocarp carbohydrate, the water absorption capacity of the films increased from 0.2 to 2.3%. This increase in water absorption has been attributed to the fact that the modified cassava mesocarp carbohydrate was not 100 percent hydrophobic in nature. Secondly, though the modified form of the filler showed greater compatibility with the polyethylene films, its incorporation into the films may have created some void spaces in the blend leading to entrapment of water molecules. The incorporation of 25% of the unmodified form, into the films increased the water absorption from 0.2 to 12.5%. This showed that apart from the possible entrapment of water molecules in the void spaces in the polymer films, the unmodified filler absorbed a reasonable amount of water.

Biodegradability

Preliminary tests on the biodegradability of the films showed that the films were biodegradable. The growth of colony increased with increase in the filler content of the films. Polyethylene films containing the unmodified filler were more susceptible to biodegradation. Pure polyethylene films showed no evidence of biodegradation.

In general, from the results so far obtained it may be tentatively concluded that chemical modification of the cassava mesocarp carbohydrate imparted hydrophobicity into it and thereby improved its compatibility with polyethylene.

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