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UTILIZATION OF LOW COST ADIPOSE TISSUE WASTE AS A SOURCE OF STEARIC ACID FOR USE IN RUBBER ACTIVATION

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Abstract— **Stearic acid was extracted from adipose tissue which was obtained from a waste heap from a local tannery. The waste adipose tissue was prepared for use by cutting, mixing, cleaning and refrigeration. By solvent extraction using methyl ether, a solid fat was obtained which was then hydrolyzed using water at 60°C and heterogeneous catalyst stones of calcium and magnesium oxide. Chemical characterization of stearic acid white flakes for parameters such as the melting point, specific gravity, iodine value, acid value and copper and manganese content was performed. A fatty acid yield of 68% was obtained. The iodine value of 10.02 and the melting point of 50.3 °C show a reasonable degree of saturation and stability. A high level of 198.89 acid value was obtained. The absence of copper and manganese, content which were determined qualitatively, indicates the suitability of the extracted stearic acid for rubber compounding without being a catalyst of ageing. Its specific gravity of 0.8533 indicates its lightness in respect to rubber compounding. Physical tests on the rubber compounded with the stearic acid were performed according to SATRA standards for general product safety. Simulated vulcanization tests on the rheometer were within 2 minutes, which is suggestive of activation. The rubber had a tensile strength of 6.527 x 10^3, abrasion resistance of 0.96 and hardness of 75, which are all indicative of a good service life of rubber compounded with the stearic acid.**

Keywords: stearic acid; style; waste adipose tissue; rubber; vulcanization)

1. INTRODUCTION

Waste adipose tissue is obtained from a tanning process known as fleshing which is done to remove the flesh side of the hide using a fleshing machine at a local leather industry. The tannery processes an average of 6000 kg of hides a day, yielding approximately 200 kg of fleshing daily destined for the landfill. The manufacture of stearic acid using fat extracted from the waste adipose tissue serves as a major waste management program. While there is significant motivation for such a project from a job creation point of view, especially in a developing region such as Zimbabwe, there is also significant scientific motivation for undertaking a project of this nature.

The flesh side (adipose tissue) contains excess fat, flesh and connective tissues, which must be removed before the addition of tanning chemicals to reduce wastage of the chemicals.[1] The fat is removed from the adipose tissue by solvent extraction using a soxhlet extractor and serves as the raw material in the manufacture of stearic acid.

Stearic acid is the most common occurring fatty acid in animal and vegetable fat.[3] Pure stearic acid is a white, waxy solid material, which is odourless and tasteless.[3] However, because of its natural origin pure stearic acid is hard to obtain. Instead stearic acid usually includes minor amounts of other fatty acids of different carbon length. These trace impurities can cause the acid to vary in molecular weight, solubility, melting point, colour, odour and other physical and chemical properties.[2]

The stearoyl residues or fatty acids can be removed from the glycerol backbone in the fat through a variety of techniques, which include hydrolysis when refluxed with acids or bases or when acted upon enzymatically by the enzyme lipase. They can also be hydrogenated from other unsaturated fatty acids.[4]

The extracted stearic acid is widely used in rubber compounding as an activator for organic accelerators.[5] The activator system comprises of the stearic acid and zinc oxide, where the Zn^{2+} ions are made soluble by salt formation between the acid and the oxide.

$$ZnO_{(s)} + 2CH_3(CH_2)_{16}COOH_{(s)} \longrightarrow Zn^{2+} + 2CH_3(CH_2)_{16}COO^-_{(s)} + H_2O_{(l)} \quad (1)$$

This reaction accounts for the high concentration of Zn^{2+} ions formed thus increasing the overall rate of cross-link formation and the extent of cure. Stearic acid has other wide spread uses, for example, in lubricants, soaps, pharmaceuticals, cosmetics, shoe and metal polishes and food additives. [6]

The physical and chemical properties of stearic acid greatly affect the overal properties of rubber compounds, hence characterisation is done to verify if it meets the minimum requirements done on a compounded rubber to attest the quality of the stearic acid produced.[7]

In this work, utilization of stearic acid from adipose tissue waste and its suitability in rubber compounding is reported. The effectiveness of the extracted stearic acid is then compared against the commercial stearic acid being used for rubber compounding. The study is aimed at utilising the fleshing destined for the landfill in rubber compounding and hence is a major waste reduction program.formatter will need to create these components, incorporating the applicable criteria that follow.

2. MATERIALS AND METHODS