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ORIGINAL ARTICLE

Tribological Testing of Hemispherical Titanium Pin Lubricated by Novel Palm Oil: Evaluating Anti-Wear and Anti-Friction Properties

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Abstract In this study, the properties of hip implant material and lubricants were examined using a pin on disc apparatus, to compare the effect of metal-on-metal (MoM) contact with a bio-lubricant derived from palm oil. The behaviour of the lubricants was observed during the experiments, in which a hemispherical pin was loaded against a rotating disc with a groove. A titanium alloy was used to modify the hemispherical pin and disc. Before and after the experiments, the weight and surface roughness were analysed, to detect any degradation. The results were compared according to the different kinematic viscosities. The wear rates and level of friction with each lubricant were also examined. The lubricant with the highest viscosity had the lowest frictional value. Therefore, developing suitable lubricants has the potential to prolong the lifespan of prostheses or implants used in biomedical applications. The experiments collectively show that lubricants derived from palm oil could be used as efficient bio-lubricants in the future.

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1 Introduction

The oil palm (*Elaeis guineensis*) is one of two species of the Areacaceae or palm family, and was first documented in 1434 by a Gil Eannes, a Portuguese sailor [1, 2]. The oil palm tree is easily cultivated in Malaysia, can grow to a height of 20 m at favoured temperatures between 24 °C and 27 °C, and develops pinnate leaves that are 3-5 m long. The oil palm thrives in humid climates, cultivated palms bear fruit from the fourth year onward, and can be harvested for 40 to 50 years [1]. Palm oil is extracted from the fleshy part or mesocarp of the fruit of *Elaeis guineensis*. However, the *Tenera* palm, which is a hybrid of the *Dura* and *Psifera* species, is now a widely cultivated crop in Malaysia, due to greater commercial and processing viability, as the oil yield is higher, harvesting is easier as the trees shorter, and they produce larger bunches of mesocarps with thinner shells [3].

Palm oil has a wide range of applications, and about 80% of the harvest is used for food applications, such as cooking oil, margarine, and shortening. Some of the yield is used as feedstock for a number of non-food applications, such as in soap, detergent, and cosmetics [4]. Palm oil and its products have good resistance to oxidation and can produce heat at prolonged elevated temperatures [5]. Malaysian palm oil is also used in the manufacture of many other downstream oleo-chemical products, including palm fatty acids, and palm methyl esters [2].

Currently, palm oil is one of the main bio-lubricant contenders in medicinal and health-based applications. It is also the Malaysia vision to develop the industry, and it is already one of the largest palm oil producers in the world