Comparison of physical and tribological properties of coconut oils extracted from dry and wet processing

D. Gasni*, I. H. Mulyadi, Jon Affi

Mechanical Engineering Department, Andalas University, Kampus Limau Manis, 25163, Padang, Indonesia.

*Corresponding e-mail: d.gasni@ft.unand.ac.id

Keywords: Coconut oils; wear; coefficient of friction

ABSTRACT – Due to less water content during its processing, RCO would have a good physical and tribological properties. However, the information related to lubrication capability of RCO is still limited. In addition, abundant source of coconut oil in Indonesia can be exploited to develop bio-lubricant for industrial usage. Thus, this present study was conducted to investigate the benefit of dry processing in extracting coconut oil and to compare coconut oil extracted through wet processing. The result highlighted that dry processing could be able to improve lubricating capabilities of coconut oil.

1. INTRODUCTION

The environmental and resource problem triggered by the use of mineral oils and synthetic lubricants has escalated the environmental awareness in limiting its usage as well as its composition. Thus, development of vegetable oil has become the focus recently in seeking environmentally friendly lubricant for industry [1]. The vegetable oil possesses comparable physical properties to petroleum-based lubricants. In addition, its unique chemical structure and its biodegradability make it a decent candidate as bio-lubricant over mineral-based lubricants [2]. However, a disadvantage of vegetable oil for industrial application is due to its inferior characteristics (e.g. low oxidation stability and low-temperature properties [2]) that are important to overcome by conducting an extensive research for all possible vegetable-based oils. Meanwhile, research on vegetable oil as lubricant is limited to such: jatropha oil, soybean oil, rapeseed oil, sunflower oil, and castor oil.

Indonesia as a tropical country has abundant sources of vegetable oil that can be developed as a bio-lubricant such as coconut oil. Although, coconut oil has a lower friction coefficient in comparison to palm oil [3] but extracting methods could probably improve its lubrication capability due to having less water content. Meanwhile, the research in this area is limited. Thus, the aim of this research is to investigate coconut oils produced by different methods such as dry and wet processing, especially on its physical and tribological properties.

2. METHODOLOGY

2.1 Wear and Friction Tests

Wear and friction test were conducted in accordance to ASTM standard G99 using a pin on disc test apparatus. The apparatus enables in determining the wear magnitude by calculating the volume of material lost as a result of rubbing a pin (probe) against the flat face of a rotating disc. Further, the coefficient of friction was determined from the ratio of the frictional forces measured by using strain gauges attached to a flexible arm and the loading forces determined from the weight loaded on the pin.

2.2 The Test Specimens

The test specimen comprised of a 6 mm diameter pin and a 100 mm diameter disc. Furthermore, the flat faces of AISI 1015 disc were ground to have a surface finish of 0.73μm CLA (Center Line Average) meanwhile 440C stainless steel was turned into a pin. The measured surface hardness of the pin and the disc were 627 BHN (Brinnel Hardness Number) and 145 BHN respectively.

2.3 Lubricant Samples Preparation

Lubricant samples were prepared by through wet and dry processing. Dry processing required the meat to be peeled out from its shell and dried to become a copra (e.g. dried meat or kernel). The copra was then pressed to extract the Refined Coconut Oil (RCO). The all-wet processes were using raw coconut that was extracted to oil emulsion and water. The prolonged boiling was utilised to recover oil from the emulsion thus producing a Hydrogenated Coconut Oil (HCO). Virgin Coconut Oil (VCO) was extracted from fresh coconut meat by grating of the coconut and mixing it with water, then squeezing out the oil. The oil was supplied to the rubbing contact with a drip-feed system.

3. RESULTS AND DISCUSSION

3.1 Physical Properties of Coconut Oils

Table 1 Physical properties of coconut oils.

Parameters	Wet		Dry	Error
	HCO	VCO	RCO	
Viscosity at 28°C, cSt	36.3	43.0	55.6	All measurements were repeated 5 times with standard deviation 2%
Viscosity at 40°C, cSt	32.4	25.2	42.9	
Viscosity Index	175	101	169	
Flash point, °C	310	308	150	
Pour point, °C	20	19	13	

The physical properties of coconut oils extracted through dry and wet processing are depicted in Table 1. From Table 1, it is revealed that coconut oil extracted through dry processing (i.e. RCO) possess a good

© Malaysian Tribology Society

physical properties compared to that of through wet processing. In addition, dry processing also augments the kinematic viscosity value either at 28 ºC or at 40 ºC in comparison to the average value of general coconut oil found by Mia and Ohno [4]. It is conceivable that less water content involved during the extracting process. However, as a consequence of having a lower flash point, this type of coconut oil has a risk of flammable.

3.2 Wear and Friction Properties

Wear and friction coefficient of coconut oils extracted through different processing method are shown in Fig. 1 and Fig. 2. Fig. 1 exhibits wear progression of the disc used in this study upon a sliding time. Wear volume increases as sliding time progresses. From Fig. 1, it is revealed that the volume of material removed from the disc under RCO lubrication is lower than HCO and VCO. This occurred in the operating condition of 1,200 rpm and 30 N of loads.

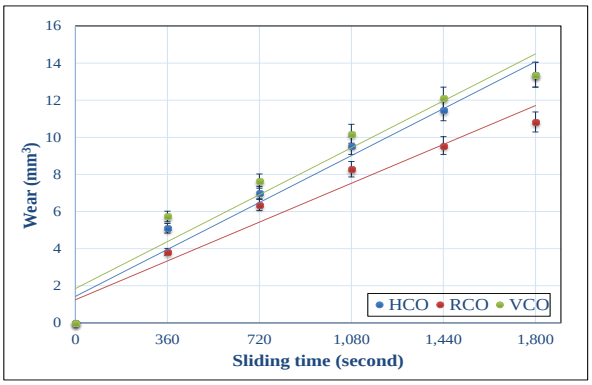

Figure 1 Wear progression of discs under different extracted methods of coconut oil at normal load of 30N.

Furthermore, RCO yet exhibits better lubrication capability under different loads as shown in Fig. 2. This is consistent with the results shown in Fig. 1. When wear can be reduced, thus the coefficient of friction would be low.

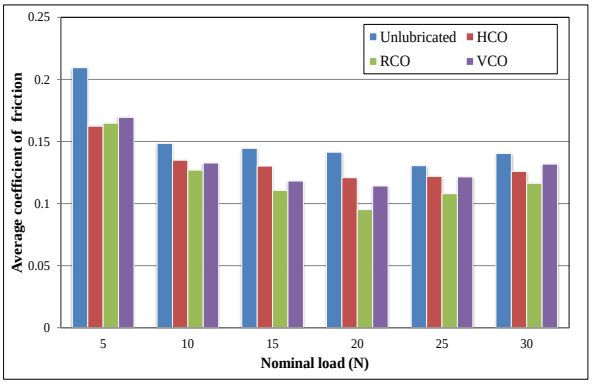

Figure 2 Effect of nominal load on coefficient of friction under different extracting methods of coconut oil.

Finally, in overall, from the results demonstrated in Fig. 1 and Fig. 2, it can be deduced that dry processing would improve lubrication capability of coconut oil thus preventing the material from surface wear and lowering its coefficient of friction.

3.3 Surface Texture Analysis

Applying RCO enable in reducing wear and increasing friction coefficient. Besides, the better performance is also indicated by worn surface created during this study (Fig. 3). Fig. 3(c) ascertains positive effect of employing RCO on the disc surface. RCO produces a smooth surface. This fact is due to oil creates a lubricating layer between asperity to prevent from exaggerated wear, hence sliding predominantly occurs than sticking. Meanwhile, for the surface that was pre-lubricated with coconut oils extracted through wet processing, results in a rough surface and creates a coherent profile (Fig. 3(a) and Fig. 3(b)).

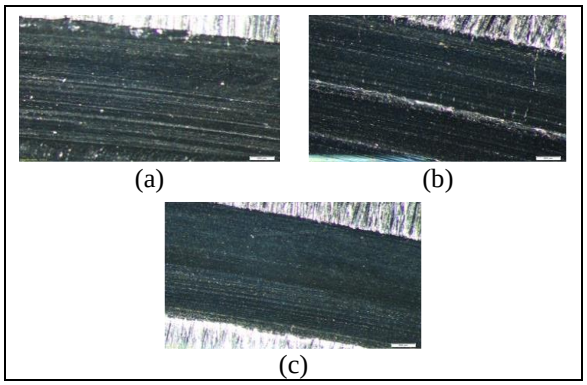

Figure 3 Worn surface of discs under different processing method of coconut oil; a) HCO, b) VCO and c) RCO.

4. CONCLUSION

The present study measured and examined the physical and tribological properties of coconut oils extracted through dry processing (i.e. RCO) and wet processing (i.e. HCO and VCO). It was revealed that good physical and tribological properties of RCO were contributed by having a high kinematic viscosity. In addition, less water content involved during the extracting. The process was responsible in providing better performances of RCO compared to VCO and HCO.

5. ACKNOWLEDGMENT

This work was funded by the Faculty of Engineering, AndalasUniversity through contract No. 009/PL/SPK/PNP/FT-Unand/2014 and supported by Directorate of Higher Education of Republic of Indonesia through the Fundamental Research Scheme No. 14/H.16/FUNDAMENTAL/LPPM/2015.

6. REFERENCES

[1] J. Salimon, N. Salih and E. Yousif, “Biolubricants: Raw materials, chemical modifications and environmental benefits,” *Eur. J. Lipid Sci. Tech.*, vol 112, pp. 519–530, 2010.

[2] K. Balamurugan, N. Kanagasabapathy and K. Mayilsamy, ”Studies on soya bean oil based lu-

bricant for diesel engine", *J. Scientific and Industrial Research*, vol. 69, pp. 794-797, 2010.

[3] Jagadeesh K. Mannekote and Satish V. Kailas, "Experimental investigation of coconut and palm oils as lubricant in four-stroke engine", *Tribology Online*, vol 6, pp. 76-82, 2011.

[4] S. Mia, and N. Ohno, "Prospect of Mustard and Coconut Oil as Environment Friendly Lubricant for Bangladesh," in *Proc. of International Conference on Environmental Aspects of Bangladesh* (ICEAB10), 2010, pp. 120–121.