Research

Dr. Amiril Sahab produces 5 products from Tamanu tree seeds

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PEKAN, 19 October 2022 - Tamanu tree (*Bintangor Laut*) is a common plant on the east coast as it grows abundantly along the east coast of Peninsular Malaysia.

This project is easily implemented at Universiti Malaysia Pahang (UMP) because the readily available resource of Tamanu fruit trees around UMP can be harvested throughout the year.

Starting from this finding, the lecturer of the Faculty of Manufacturing and Mechatronic Engineering Technology (FTKPM), Dr. Amiril Sahab Abdul Sani, 38, has produced five products for different uses that include commercial and industrial uses resulting from the extract of Tamanu tree oil.

The five products are virgin oil (lamp oil, traditional massage oil), natural rubber-free oil (lamp oil, pharmaceuticals), low-acid oil (pharmaceuticals), Tamanu biodiesel (B100), and synthetic ester oil (manufacturing industry lubricant).

MODIFIED TAMANU PLANT-BASED OIL AS METALWORKING FLUIDS (MWFs)

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Patent: IP APPLICATION IN PROGRESS

Product Background

The modified Tamanu oil (MTO) were produced in-house from crude Tamanu oil (CTO), which copiously obtained from Tamanu plants in Pahang, Malaysia.

Product: MTO



The stages of preparing the CTO

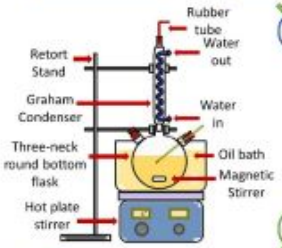


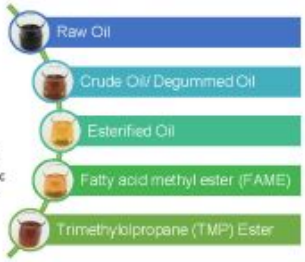
Crude Tamanu Oil able to produce:
1. MTO or TMP-ester can be used as metalworking fluid.
2. CTO can be used as medication, comestic and oil massage.
3. FAME or B100 biodiesel for diesel engine.
4. Glycerol excess from base esterification can be made into candle wax and soap.

State of the Art/ Methods

The crude Tamanu oil had undergone chemical modification comprises of esterification processes to expand its lubrication potentials.

Acid esterification → Base esterification → Base transesterification





Product Characteristics/Results

Novelty/ Originality/ Inventiveness

MTOs were produced using 'green' resources that are easy to procure locally in Malaysia. Thus, this lubricant have many great benefits to offers:

- ✓ Abundance and renewable resources
- ✓ Biodegradable and environmental friendly
- ✓ Good plant-based alternative lubricant oil
- ✓ Low production cost
- ✓ Has high viscosity, flash point and acid value compared to other non-edible oils.

Sustainability Concern: To replace the heavy dependencies of mineral-based oils in the lubricant industries (e.g. metalworking fluids, diesel, and etc.).

Environmental Impact: Implication of Mineral Oil



Constant usage of mineral oils had caused depletion.



Pollution of soil and water cause by mineral oil wastages.



Mineral oil spills caused disruption to marine ecosystems and terrestrial.

CHANGE TO A GREEN ALTERNATIVE





As metalworking fluid, MTO is able to:
1. Reduce the needs for mineral-based lubricant (Annualy 100 kg nuts/tree and yields 5kg of oil on average).
2. Green alternative oil that provide the same lubricant functionality, but more beneficial in terms of physicochemical and tribological properties.
3. Enhance the performance of machining process in terms of cutting force and cutting temperature.
4. It is recommended for machining application such as, drilling, turning and milling.

Benefits/Usefulness/Applicability

"Kenal pasti sumber alternatif pendapatan selain balak, lombong."

- Pemangku Raja Pahang, Tengku Hassanal Ibrahim Alam Shah Al-Sultan Abdullah Ri'ayatuddin Al-Mustafa Billah Shah (Taken from news article, Astro Awani, Bernama on July 7th, 2021)

BENEFIT TO PAHANG

Recently, Pemangku Raja Pahang had expressed his wishes on finding new alternative sources of income for Pahang.

In accordance to his wishes, we would like to propose the lubricant products of MTO to be the new central industry for Pahang, as this green resource doesn't bring harm to the environment and able to compete with other metalworking fluids in the market with its enriched properties.

Achievement/Award

- GOLD CITREX, UMP, 2022

Publication

1. Calophyllum-Inophyllum from Pahang Malaysia as Bio lubricant Feedstock for Industrial Application, Recent Trends in Manufacturing and Materials Towards Industry 4.0, Springer, pp. 441-449, 2020 (Scopus).
2. Comparative Evaluation of Crude Tamanu Oil Performance as Metalworking Fluids, Materials Today Proceedings, 48, 6, pp. 1783-1788, 2022 (Scopus / WoS).

Marketability & Commercialisation

Marketability
- The market potential for industries utilize on metalworking fluid in conventional, non-conventional and precision machining application.

Availability
- The lubricant is made from an non-edible plant resource, which are abundance and easily renewable.

Affordability
- The simple production method allow for lower costs in term of lubricants preparation.

Green Alternative
- Extracting oil from plant, which pose low environmental and health risks, as oppose to mineral-based lubricant.

Cost Analysis

- RM900 per 1 kg (MTO) – lab production

Competitor

Synthetic Ester:
- Unist Coolube, UK (RM2400 ~ 4L)
- Unicut Jinen MQL (RM2500 – 4L)



Physicochemical Properties

Properties			Unit	Temp	MTO
Physical	Density, ρ	ASTM D4052	g/cm³	40°C	0.9087
				100°C	0.8659
	Kinematic Viscosity, ν	ASTM D445	mm²/s	40°C	16.856
				100°C	3.6701
	Dynamic Viscosity, μ	ASTM D445	mPa.s	40°C	15.317
				100°C	3.1778
	Viscosity Index, VI	ASTM D2270	-		101.53
Chemical	Total Free Fatty Acid	ASTM D6751	%		1.23
	Total Acid Number	AOCS Cx 3a-20	%		0.98

Four Ball Wear Test





Competitor did not provide excellent thin layer on metal surfaces during separation processes compared to MTO enriched with additives (ionic liquids) due to poor physicochemical and tribological performance.

Status of Innovation

- Market Ready (Biodiesel, TMP-Ester)
- TRL Level 6 to 7
- Product Ready to Use:
- Biodiesel B100, MQL lubricants

Collaboration/Industrial Partner

- Reger Tools Sdn Bhd.
- FRIM
- UTHM

This research also received the collaboration of lecturers and vocational training officers of FTKPM, UMP, University Tun Hussein Onn Malaysia (UTHM) lecurer, Ts. Dr. Norfazillah Talib, and UMP students under his supervision.

According to Dr. Amiril, this research is closely related to the sustainability of processes and materials in the manufacturing industry and the main goal of this research is related to the use of easily biodegradable and renewable green materials.

“The use of petroleum-based raw materials and mineral oils in the processing and production of lubricating oils for industrial use in manufacturing has a negative impact on the sustainability of the manufacturing industry ecosystem (increasing crude oil prices, high potential for getting skin cancer, bronchitis) and the survival of marine life due to disasters on the open seas (pollution from oil spills).

“Vegetable-based oils are the choice of researchers as an alternative source to the use of finite resources (petroleum).

“Inedible vegetable oils are the main ingredient compared to edible oils such as palm oil, corn and others.

“This project started in early December 2018, two weeks after I started my career as a lecturer at UMP,” he said.

Initially, he along with Dr. Ahmad Shahir Jamaludin and Dr. Ahmad Najmuddin Ibrahim formulated the idea almost a year before applying for the FRGS grant in 2019, which was approved in September of the same year and continues to be developed until now.

“Starting with the manual production process, this project has evolved and various machines have been successfully developed at FTKPM, UMP by students and produced more than ten undergraduate, master’s and doctoral theses as a result of a joint venture with research partners at UTHM.

“The oil project is expected to be fully completed by the end of 2022.

“My first visit as a UMP lecturer to the Forest Research Institute Malaysia (FRIM) in early 2019 was the starting point for this research,” he said.

He further added that this research is seen to provide its own benefits to the society, individuals and industries.

“The advice and guidance from FRIM were a tremendous help in further expanding the project.

“This year, a collaboration with the industry side, Reger Tools Sdn. Bhd. was initiated regarding the use of the oil to study the oil validity during the iron-cutting process,” he said.

Dr. Amiril explained the first, second and third products from Tamanu tree oil are natural oils from Tamanu seed extract and can be used traditionally and in the pharmaceutical field.

“The fourth product is Tamanu biodiesel (B100) from Tamanu oil extract with B100 biodiesel properties that meet international standards, namely ASTM D6751.

“The last product which is synthetic ester oil (manufacturing industry lubricant) from Tamanu oil extract is a vegetable-based synthetic ester that has been formulated to help smoothen the surface of iron when cut (metal separating process).

“Tamanu ester oil is sprayed using an aerosol spray machine called the minimum lubrication spray technique or minimum quantity lubrication (MQL) technique,” he said.

He added that the machines involved in the semi-automatic production of this oil are the heat-drying machine (drying the fruits and seeds), the machine for separating seeds from fruit (breaking the fruits and isolating the seeds) and the oil press machine.

“Tamanu fruit oil extract can be utilised by the local community when the fourth (biodiesel) and fifth (Tamanu-based synthetic esters) products are successfully commercialised.

“This commercialisation not only helps the economy of the community, but also promotes community involvement in producing world-class local products.

“The manufacturing of automatic machines can also be utilised by the community with involvement in developing more established products,” he said.

“In addition, natural Tamanu oil can be utilised for traditional uses and in the pharmaceutical field.

“I am certain that the results of research on new sources of renewable energy from Tamanu trees can still be further developed because there are several other functions that can be utilised from Tamanu fruits and leaves such as the production of compressed charcoal, activated carbon-based additives and others.

“The sales cost for each product is RM350/kg for virgin oil (lamp oil), RM450/kg for rubber-free natural oil (lamp oil, pharmaceuticals), RM500/kg for low-acid oil (pharmaceuticals), RM750/kg for Tamanu biodiesel (B100) and RM900/kg for synthetic ester oil (manufacturing industry lubricant),” he said.

According to him, industrial collaboration and UMP would enable the commercialisation of the products and machines developed in this project.

“The local community can be equally involved in economy generation with the production of Tamanu fruit and tree crops which are synonymous with the coastal environment of Pekan, Pahang,” he said.

This research won a gold medal in the Creation, Innovation, Technology and Research Exposition (CITREx) 2021.

The research also won a gold medal at the International Invention, Innovation and Technology Exhibition (ITEX) 2022 which took place at the Kuala Lumpur Convention Centre (KLCC) on 26 and 27 May 2022.

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TAGS / KEYWORDS

Tamanu tree seeds

- 341 views

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