

## Promoting Awareness in Handling of Used Cooking Oil for Biodiesel Production in Bintulu Sarawak, Malaysia

Nor Shafinaz Azman<sup>1</sup>, Nurul Husna Che Hamzah<sup>1</sup>,  
Nozieana Khairuddin<sup>1\*</sup>, Tengku Sharifah Marliza<sup>1</sup>, Azira  
Sanusi<sup>1</sup>, Azizul Hakim Lahuri<sup>1</sup> and Md Bazlul Mobin  
Siddique<sup>2</sup>

<sup>1</sup>Department of Science and Technology, Faculty of Humanities, Management and Science, Universiti Putra Malaysia Bintulu Sarawak Campus, 97008 Bintulu, Sarawak, Malaysia.

<sup>2</sup>Faculty of Engineering, Computing and Science, Swinburne University of Technology Sarawak, 93350 Kuching, Sarawak, Malaysia.

\*Email correspondence: nozieana@upm.edu.my

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### Abstract

The persistence of inappropriate dumping of used cooking oil (UCO) containing triglyceride into water flow has become a significant complication for the purification process in wastewater treatment. UCO conversion using transesterification process still conquer as famous method to produce biodiesel especially in an industrial scale. This study was conducted to reveal the awareness in food premises in Bintulu, Sarawak, Malaysia, in the handling of UCO and support toward biodiesel production. A questionnaire was distributed to 200 owners of various food premises which were randomly selected regardless of gender or occupation. It was found that 13.1% of the participants generate 5 L of UCO per day, demonstrating promising frequency. The survey revealed that 8.4% of respondents discarded the UCO into the dustbin, while another 9.2% and 18.3% discarded the UCO into soil and drainage system, respectively. The remaining 48.1% sold the UCO and or completely consumed it during cooking. It is worth nothing that only 24% of respondents were expressed the interest to donate UCO for free by collecting from their premises. Meanwhile, 64% were reluctant to send UCO to the biorefinery centre due to the location distance of their premises. This study reveals a lack of awareness among local respondents regarding efficient UCO management, mandating the implementation of a proper UCO management workshop.

**Keywords:** Triglyceride, Wastewater Treatment; Municipal Waste Management; Used Cooking Oil; Food Premises; Respondent

## Introduction

Most Malaysians consume cooking oil in daily food preparation and for reheat food purposes (Kabir et al., 2014). It helps to enhance the food taste, presentation, and aromatic value. The predominant users of cooking oil usually generate used cooking oil (UCO) from household, restaurant, and the food industry, which could lead to wastewater management if good practices are unimplemented. Used cooking oil (UCO) is a low-carbon feedstock that really can successfully address biofuel standards. It can be used to produce biofuels, plunge renewable diesel, and hydro treated esters and fatty acids (HEFA), a type of jet fuel (Kristiana & Baldino, 2021). The chemical properties of biodiesel indicate it is non-toxic, biodegradable, and more feasible for combustion due to the emission of fewer particulate matter (Ahmad et al., 2019). Currently, the abundance of UCO creates serious issues since the recycling of UCO for food preparation by illegal recyclers poses inconsiderable harm to human health and food safety issues. Hence, the attention was paid by the government and public concerning this issue is essential (Liu et al., 2018). The conversion of UCO to biofuel helps to support economic viability and technological feasibility (Hussain et al., 2016). Moreover, it ensures environmental safety, creates awareness on renewable fuels utilisation, and prevent of "gutter oil" from becoming a major source of human food nutrition issues (Zhang et al., 2015b).

Kristiana et al., (2022) in their review on the current collection ranges and estimations of six countries namely China, India, Indonesia, Japan, Malaysia, and Republic of Korea reported that 100 % of the collection potential will come from urban restaurants, 50 % from urban residences, and 100 % from food processing across the country.

The obstacles reported by de Feo et al. (2020) in particular suggest that maintaining a consistent UCO collection technique from 2015 to 2019 was difficult. Few studies have been done on the potential of UCO in the restaurant industry, particularly for medium-to-large businesses. Despite this, researchers estimated that Indonesia produces 2.16 kg of UCO per capita per year by dividing our estimate of total potential production from Indonesian restaurants by the country's urban population. The researchers then used that per capita figure to calculate UCO production from Malaysian urban restaurants (O'Neill, 2021b). Because the two countries have similar culinary cultures, UCO generation per capita would be similar in Malaysia and Indonesia.

We multiplied the total number of urban households from the Malaysian Department of Statistics (2020) by a Malaysian household generation rate of 2.34 kg per month (Kabir et al., 2014). The use of UCO in the production of biodiesel as a mitigating measure for bad habits (e.g poor disposal of UCO) could help boost rural economic development (César et al., 2017). This is due to the high demand for biodiesel in the residential area, as well as the use of a generator to provide electricity. There is a data scarcity in Malaysia. Nonetheless, because crude palm oil is the primary feedstock for Malaysia's biodiesel programme, we assume that only a small amount of UCO is used in domestic biofuel. However, the UCO biodiesel is under the same HS Code category as biodiesel from other feedstocks, for example palm biodiesel in Indonesia, so it is difficult to track the precise amount of export of UCO biodiesel only. Table 2 summarises our current estimates of UCO collected, as well as imports, exports, and biofuel consumption.

In Malaysia, the Cooking Oil Stabilization Scheme (COSS) is a subsidy programme aimed at lowering the cost of cooking oil. It all started in 2006, when the price of crude palm oil skyrocketed (Ministry of Domestic Trade and Consumer Affairs Malaysia, 2021; C4Center, 2015). The subsidy is for cooking oil packaged in a 1 kg polyethylene bag and sold at a

reasonable price to consumers in order to prohibit them from buying illegal gutter oil (Ministry of Domestic Trade and Consumer Affairs Malaysia, 2021). In 2021 alone, the Malaysian government has set aside RM 600 million for the subsidy (Ministry of Domestic Trade and Consumer Affairs, 2021). According to MPOB (2008), the subsidy scheme is funded by a fee collected from oil palm farms, estate firms, and their owners.

**Table 2:** Estimated current UCO collection, including imports, exports, and biofuel use in kilotonnes per year. [cite: (Kristiana et al., 2022)]

Country	Estimated current collection	Imports in 2019 (from Comtrade)	Total collection + imports	Exports in 2019 (from Comtrade)	Biofuel	Total export + Biofuel use	Net of totals	Reference
China	3086 – 4097	42	3128 – 4139	737	918	1655	1473 - 2484	USDA (Chase Mcgrath 2020; USDA 2020); Joseph 2021) (Megawati 2018; Ramli 2020; Rusdianto 2019) USDA (Chase Mcgrath 2020; USDA 2020); Joseph 2021) (Shin et al. 2018; Korea Bioenergy Association 2021)
India	224-326	49	273-375	9	65	74	199-301	
Indonesia	182-266	9	191-275	148	0.66	149	42-126	
Japan	70-122	9	79-131	84	22	106	(27)-25	
Malaysia	48-71	208	256-279	321	n.a	321	(65)-42)	
Republic of Korea	88-107	62	150-169	7	161	168	(18)-1	

Meanwhile, demand for UCO for biofuel production is rising in Asian countries that produce large amounts of it, and regulatory incentives exist in the United States. California's Low Carbon Fuel Criteria (LCFS), which aims to reduce the carbon intensity of transportation fuels (California Air Resources Board, 2020), is one example in the United States; UCO is an appealing alternative for meeting this standard. Huang & Wu (2008) stated that the biodiesel trade in Malaysia desires huge public support and recognition due to the general resident perception of palm biodiesel that is still considered low. Most individuals are unaware of or have little awareness of palm biodiesel. However, appropriate platforms, such as attractive infographics on UCO handling via mass media, can be used to promote understanding. Humanity must switch attention to enabling renewable energy sources for the sake of green earth emission. As stated within by Lim & Teong (2010), the power of public assistance

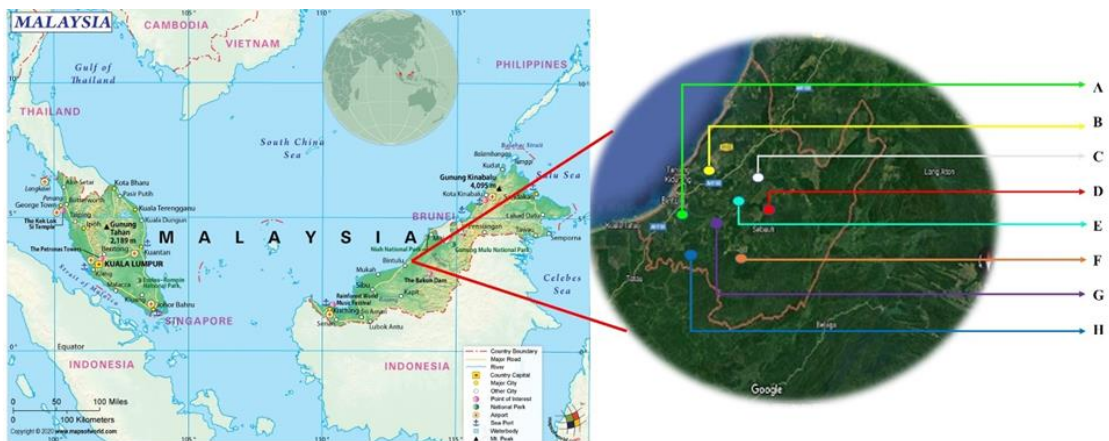
ought to further inspire and stabilise the palm biodiesel industry. It is, therefore, a significant challenge to promote public commitment to the growth of the biodiesel industry in Malaysia.

This study examines the attitudes and practices in food premises in Bintulu, Sarawak, Malaysia, in the handling of UCO and support towards biodiesel production. Bintulu was selected for the survey study due to strategic location as it is well known by the Oil and gas industrial town in Sarawak, Malaysia and Universiti Putra Malaysia becomes the collection hub for the UCO which estimated distance of nearby town is in average of range 10- 15 KM. Information on the current state of UCO from restaurants in the Bintulu district was collected and analysed to obtain a clearer view of their understanding. The results of this study will enhance the current government policies on the management of UCO and promote the development of biodiesel production in the industrial district.

**Methods and Materials**

**Study Area**

Figure 1 illustrates that the study was conducted in the Bintulu districts areas. These districts were based on seven (7) main divisions located in Assyakirin Commercial Centre, Bintulu Central, Medan Jaya, Parkcity, Old town Market, Tanjung Kidurong, and Junction 5 Central based on registered food premise with the highest frequency found in the database of Bintulu Development Authority.



Bintulu Maps Main town division area:

A. Parkcity and The spring	B. Tanjung Kidurong and housing.	C. Assyakirin Commercial Center	D. University Putra Malaysia Bintulu Campus
E. Bintulu Central.	F. Medan Jaya Commercial Centre.	G. Time Square and Junction 5	H. Paragon, Old town, and Wet market

Figure 1. Map of study area (Source: Google map)

**Investigation method**

A survey questionnaire was administered to 200 owners of food premises registered with the Bintulu Development Authority (BDA) in Bintulu, Sarawak, Malaysia. However, only 130 out of the total premises participated due to the non-operationality of the rest of the registered premises, in which this work adopted the method from Kirama & Mayo (2016) where collection of their respective license and premise type information can be retrieved from the BDA website for easy to reach by telephone number or email.

Observations were made to assess the mindset of the respondents on their attitudes and practices towards UCO management. The questionnaire form comprised of two sections: A) Premise information; and B) Solid waste management, personal data, race, gender, and profession of participants, which were recorded as other facts. The overall data obtained was through face-to-face interviews to assist old-age premise owners to fill in the hardcopy forms and online Google form. The Google form then generates a summary of each questionnaire reply and converted it into statistical analysis. The results were tabulated as follows: 1) Table 1: The distribution of food premises in Bintulu's main town complex; 2) Table 2: Demographic information; (i) Result of generation of UCO; (ii) Their awareness and enthusiasm towards UCO management. The investigation was conducted from 10 July to 30 November 2019.

### Survey sample

The sample size of food premise owners who responded in this research survey is 65% (roughly converted into a simple percentage %), which is relevant enough for analysis using statistical method. The reliability and sample size validity from the collected data were calculated using the formula provided (Equation 1) below from Calculator.net (i.e., among the trusted online calculator website, where this calculator is convenient and regularly used for social technology research) (Amzat et al. 2017; Nakku et al. 2020; N. Othman & Nasrudin, 2016). Basically, this online calculator normally calls for inputs for a study's self-assurance level, the margin of error and populace length to calculate the minimal range of samples needed.

$$\text{Sample size}(finite\ population) = \frac{n}{\left(1 + \frac{z^2 \times p(1-p)}{\epsilon^2 N}\right)} \dots \dots (1)$$

From the equation, the best sample size (i.e., recommended value) that must be achieved in this survey is 128, where the confidence level used is 95% and the margin of error is 4.86%.

### Results and Discussion

#### Food premise distribution in the main town of Bintulu

Table 3 shows that the food premises run in the Bintulu district comprised of small-, medium-, and large-sized food production. To simplify, the frequency of restaurant and catering premises in town is high (67.7%), followed by fast food (15.3%), food stall (13%), homemade kitchen and catering (3.0%), and lastly, bakery (0.8%), from which Bintulu residents prefer to dine in and take away fresh, hot cooked food.

**Table 3:** Survey sample of number of food premises and distribution in the main town complex of Bintulu.

Type of premises	Division							Total	(%)
	Assyakin commercial centre	Bintulu Central	Medan Jaya	Park City	Oldtown market	Tanjung Kidurong	Juncton 5		
1. Bakery	0	1	0	0	0	0	0	1	0.8
2. Fast food	4	2	3	5	2	2	2	20	15.3
3. Food stall	2	1	1	4	5	2	2	17	13.0
4. Homemade kitchen and catering	2	0	0	0	0	2	0	4	3.01
5. Restaurant and catering	13	17	20	20	4	7	7	88	67.7
<b>Total</b>								<b>130</b>	

### Socio-demographic

Table 4 shows a combination of the socio-demographic characteristic of residents in Bintulu, Sarawak, Malaysia. In terms of age, youth aged 21–30 is the largest group who owns food premises (46%) due to their high ability to produce more varied and interesting choice of meals compared to groups aged 31–40 (20%), 41–50 (18%), and above 50 (6%) years.

Next, the residents were grouped based on gender, where females (55%) conquer for most of the businesses compared to the males (45%) in Bintulu. Apart from that, three (3) race classifications were identified from the survey, which revealed that the highest participation came from Bumiputera residents (80%), followed by non-Bumiputera comprising Chinese and Indians (14%), and lastly, the non-Malaysian citizens (6%). The educational background analysis shows that in majority, university/college/vocational graduates (52%) are the largest group of owners of food premises due to their more advanced knowledge and skills preparation of trending food and promotional value compared to other groups. This is followed by secondary school leavers (39%), while others occupy the least share. The tabulated data shows the highest standard deviation of the race (52.78), whereas the lowest is from gender (8.49).



**Table 4:** Socio-demographic characteristics of residents in Bintulu, Sarawak, Malaysia.

Class	Batch	Unit percentage (%)	Frequency	Average value	Standard deviation
Age	15–20	10	13	26	20.36
	21–30	46	60		
	31–40	20	26		
	41–50	18	23		
	> 50	6	8		
Gender	Female	55	71	65	8.49
	Male	45	59		
Race	Bumiputera	80	104	43.33	52.78
	Non-Bumiputera	14	18		
	Non-Malaysian	6	8		
Educational level	Others	1	1	26	27.98
	Primary	6	8		
	Secondary	39	51		
	Matriculation/ Foundation	2	2		
	University/college/ vocational graduate	52	68		

#### Age Factor, Educational Level, and Background

Based on the survey conducted, youth aged 21–30 years (46%) and 31–40 years (20%) dominates the food industry. Since the food industry is developing tremendously due to variety of menu, dish plate served restaurant and coffee shop theme, the youth can attract people to their premises to enjoy the daily trending foods. Thus, there is a mass production of UCO that could potentially benefit the national economy. For trends regarding citizens aged between 41–50 (17.6%) years and above 50 years (6.15%), there is a decrease in value due to the abovementioned groups' lower ability to mass produce various foods, thereby resulting in a lower generation of UCO.

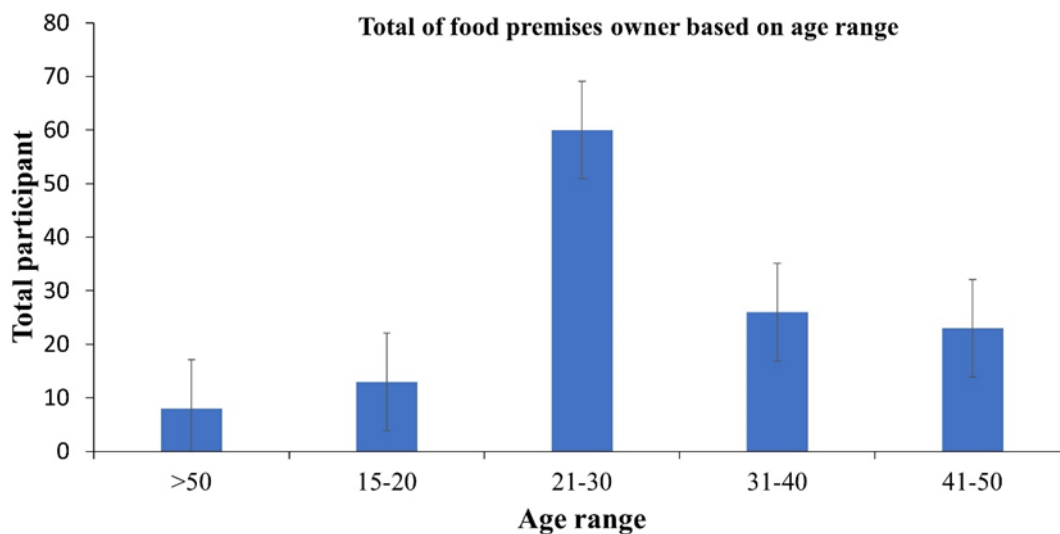


Figure 2. Age factor in food premise owners' participation

#### Level of Education Background

Based on Figure 3, most premise owners are university/college/vocational graduates (52.3%), followed by secondary school leavers (39.2%). The findings support the statement that there is a high awareness of UCO management in the Bintulu district (Figure 3). These graduates have been exposed to formal, scientific education on environment management, especially on water pollution caused by illegal waste oil dumping into the water bodies. Hence, there is awareness of the ability to convert UCO into biodiesel, the UCO collection, and the selling programme. Furthermore, knowledge on the advantages of biodiesel blending applied into diesel engines is well documented on the infographic video made by Malaysian Palm Oil Board - MPOB TV titled: B20 kinetic distributed in all mass media platforms. It supported the fact that the usage of used cooking oil to be transformed into biodiesel had been explored by research in university/ college/ vocational graduates. The other level occupied by primary (6.15%) and Malaysian Higher School Certificate (STPM) (1.53 %) shows less participation in the industry in Bintulu.



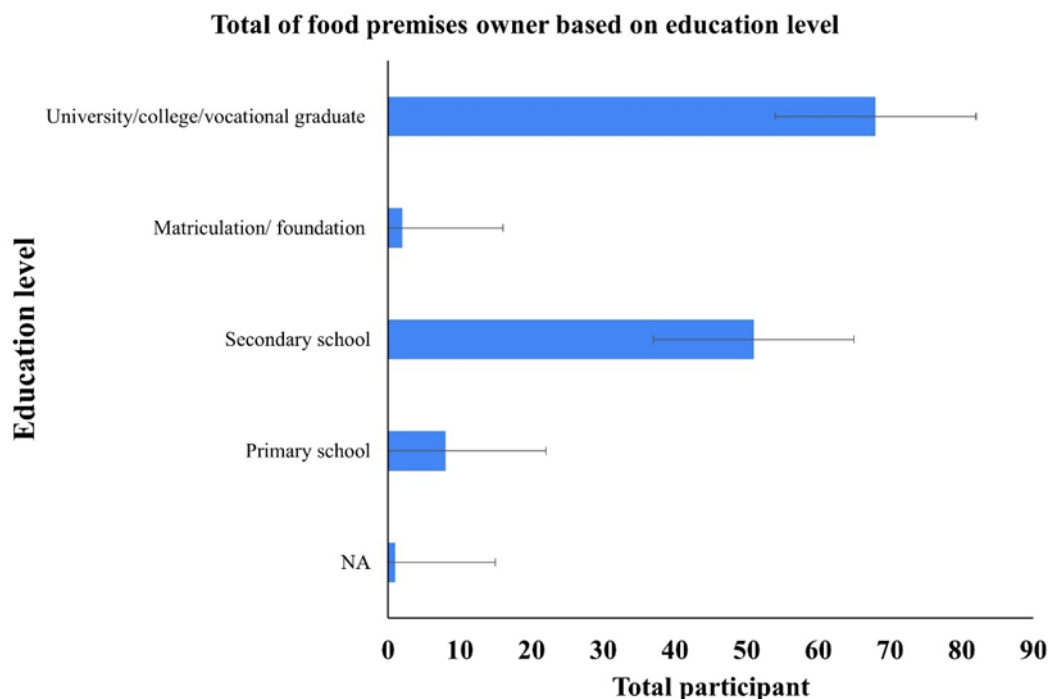


Figure 3. Educational background level

### Used Cooking Oil Collection Production Volume

Aside from the relatively high UCO production rate (77 % vs. 57 % in Indonesia), another reason for the relatively high UCO production rate is cooking habits. According to a survey conducted in Malaysia, nearly half of all household's discard UCO after only two uses (Kabir et al., 2014). Around 65% of Indonesians use it three times, with the remaining 35% using it more than three times or until there is none left (Sudaryadi et al., 2021). We believe that these cooking habits have an impact on the amount of leftover UCO. From Figure 4, most premises stated that the monthly average UCO production ranged 6–10 kg (37%), while others range from 1–5 kg, depending on the size of the food premise. The findings were verified with the modern survey via way of means of statistics from the Ministry of Health and the Domestic Trade, Cooperatives, and Consumerism (KPDNKK). Statistics from the authorities demonstrate that Malaysians feed on a mean of 1.45 kg of cooking oil, which totals to approximately 45 million kg of cooking oil monthly (Farid et al. 2020). The findings indicate that local business operators can process 20 to 3,000 tons of UCO into biodiesel monthly (Alias & Hasan, 2018). According to Silva et al. (2016) the smaller the restaurant, the lower the UCO generated in separate equipment. Hence, local municipalities are required to promote the establishment of private collaborations between certified UCO and biodiesel manufacturers to promote the recycling of UCO. The objective is to lower the expenses of daily discharges and lack of space. In addition, collection contracts have been signed to prioritise the need for safe disposal of UCO. Lastly, the conditions and agreement contracts required for food business start-up should be standardised in accordance with the planned market size or scale of production.

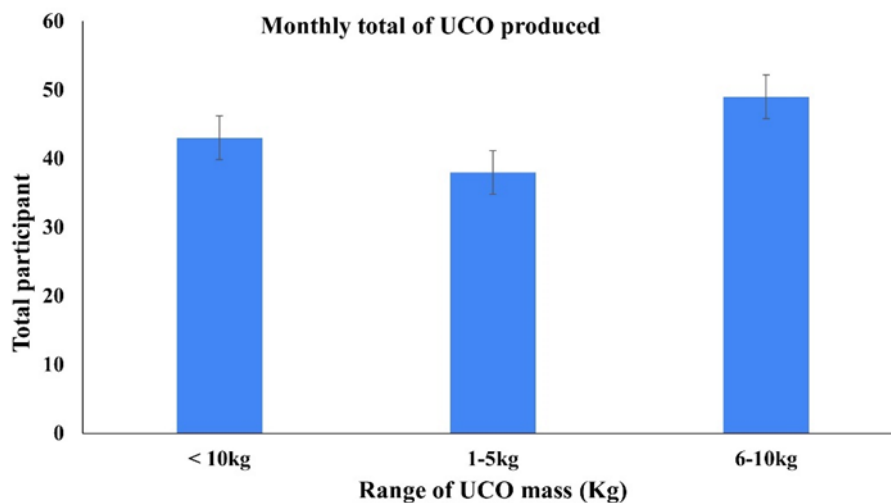


Figure 4. Monthly UCO generation

### Management of UCO Collection

Based on Figure 5, most premises have sold or sent UCO to recycle centres (47%) for RM1.00–RM2.00 per kg for financial gain without identifying the identity or activities of UCO collectors. From the literature review (Farid et al., 2020), in the past, the prices of UCO ranged from RM0.30–RM0.50 per kg. However, the high demand and support for the UCO selling campaign by well-known collectors, such as Fathopes Energy Sdn. Bhd., Fatbusta Asia Pacific Sdn. Bhd., and Kris Biofuels Sdn. Bhd. (KBSB) in Peninsular Malaysia. Sekitar Bumi Hijau in Desa Senadin from Miri, Sarawak, increased the rate of UCO to 85%, which ranged from RM1.50 to RM2.00 per kg. Researchers assume that the amount of residual UCO is influenced by these cooking habits. The increase in UCO biodiesel production is not likely to be linked to Malaysia's domestic biodiesel programme. The current Malaysian biodiesel blend standard is 10%. (B10). Because of COVID-19, the government decided to postpone B20 (Wahab, 2021). Almost all biodiesel producers in Malaysia use crude palm oil as a feedstock for the country's biodiesel programme, and we expect UCO biodiesel to be largely exported. Nevertheless, the excessive demand, (41%) of the food premises clearly discard UCO into rubbish bins. Several techniques may be enforced to sustain the delivery of UCO for sustainable biodiesel production via three several steps: 1) Mandate all registered food premises business to deal with local official UCO collector which can be verified by respective city council; 2) Prepare strategies for collectors to accumulate UCO from strata blocks, public residence, and villages, this is due to varied building structures and concerns with distance; 3) Promote infographic digital banners throughout the town and local media information channel about the fixed collecting tentative system for UCO, which could cover many residential areas, restaurants, and Food & Beverage (F&B) premises using smart trucks to ease the UCO suction attachment channel for storage; and 4) Develop a smart UCO collective hub system equipped with Internet of Things (IoT) in town for convenience to roadside or moving food stalls, as their daily UCO generation might be less than 10 litres, in which the smart UCO tank will automatically update the qualitative (Kg/Litre) and collector information on new refill of UCO to the UCO system website. Furthermore, there is also an urgent need to improve the understanding of proper handling

of UCO for biofuel by visiting biofuel factories, which would reshape their behaviours. Lastly, scheduled training could enhance these premise owners' knowledge of biofuel process handling.

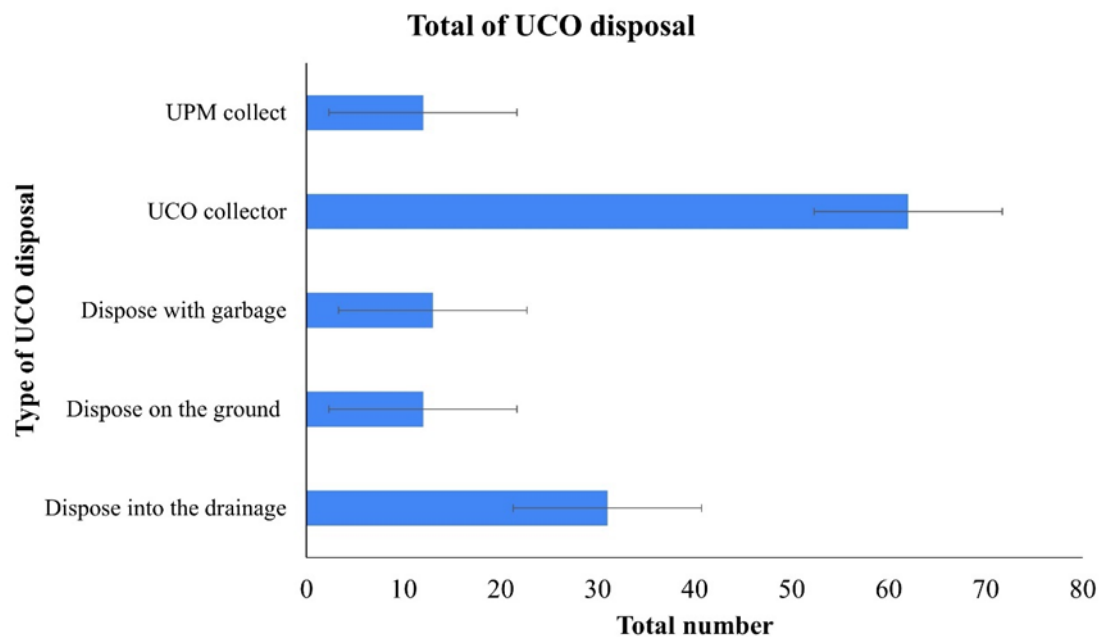


Figure 5. Method of UCO disposal

#### **Awareness and willingness factor**

##### **Awareness about UCO for biodiesel production**

Figure 6 shows that most premise owners admitted (77% agreed to 'Yes') on awareness of the importance of UCO for biodiesel production. This is due to the infographic video broadcasted by the mass media of MPOBTV and the on-going UCO collection programme for cash. However, 23% of respondents were unaware or ignored the Ministry of Environment's recommendations. In particular, the compulsory legislation can influence the habits of smaller restaurant owners. The penalties for breaking the law are insufficient to limit any restaurant owners from committing offence due to monetary interests. Therefore, it is critical to increase the severity of punishment towards restaurant owners promoting UCO to unofficial collectors or pouring it directly into the drains. The proposed measures, for example, are inclusive of fines for offering the UCO to uncertified collectors, disclosure of practice of restaurant owners to the public, and limitation of credit to companies which can impact their ability to do so.

**Poll observation survey in the awareness of proper UCO management**

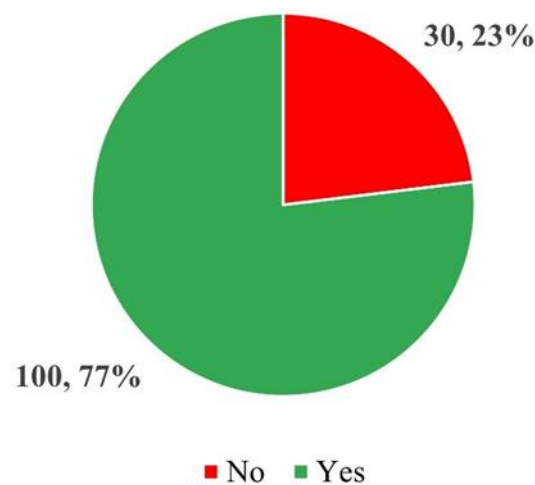
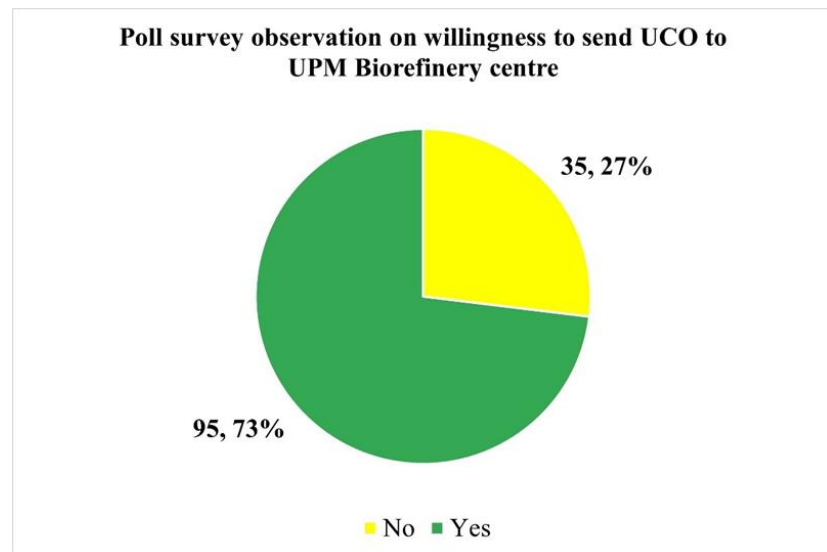


Figure 6. Awareness of UCO management

**Willingness of sending UCO to authorised collection hub**

Most premise owners (64%) who chose 'No' are unwilling to send UCO to the Universiti Putra Malaysia (UPM) Biorefinery Centre for RM1.00 per kg. This is due to the distance factor of the collection hub from their premises. Furthermore, there is a lack of strict enforcement from local municipal districts for this campaign, whereby rare campaign promotion activity also leads to loss of interest of premise owners to sending UCO to registered collector. This leads to these owners taking the easy way out to sell the UCO to illegal collector. Besides that, no official collection hub is present in the district to help premise owner dispose the UCO properly. However, 24% of respondents showed interest to support the UCO programme and willingness to donate UCO for free as long as it is collected from their premises. The promotion of economic benefits, such incentive schemes as discounts, tax incentives, or gift exchange for food products, have mostly encouraged restaurant owners. Appreciation gift and business tax exemption may also give a way to successfully deal with this policy deficiency. Various selected mechanisms can be investigated on its implementation in China, as reported by Silva et al. (2016). For instance, authorised collectors may collect UCO by providing rewards that are greater than the benefits of selling the UCO to informal collectors.

**Figure 7** : Willingness to send UCO to UPM Biorefinery Centre for RM1.00 per kg

### Conclusion and Recommendation

In summary, this survey revealed an observation of public awareness via questionnaire, where there is a low awareness of handling of UCO in Bintulu, Sarawak. Further access to society is required due to this lack of awareness and information. Thus, a rapid method of information transfer is necessary to avoid the harmful practice that which an inadequate UCO management could impact the environment negatively. Awareness may be reinforced on high school students and guardians. Toxicity awareness of UCO in food can be initiated with the help of medical doctors and initiative from hospitals. More studies could be conducted to obtain a more significant outcome from the questionnaire so it (the outcome) can be made a guideline for improving the social community behaviour in the handling of UCO. The major commodity export forecast estimates that year 2021 onwards will be a trigger year for the palm oil sector in Malaysia. This is due to higher operating costs and growing sensitivity regarding to oil palm sector, which requires more support for the strategic collection utilisation of UCO. Large stocks of UCO collected could then serve as cheap raw materials as biodiesel upgrade. Lastly, the distribution, pleasant assurance, protection, and consumer literacy involvement ought to be addressed to efficaciously put in force the biodiesel programme.

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