



EXPLORING THE KNOWLEDGE AND AWARENESS OF EMULSIFIERS IN FOOD AND NON-FOOD PRODUCTS AMONG THE COMMUNITY IN BRUNEI DARUSSALAM

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ABSTRACT

The demand for halal products in both food and non-food sectors is directly correlated with the growth of the Muslim population, which encompasses the prerequisite for utilising halal ingredients in producing the final product. Furthermore, there is a growing trend in the use of emulsifiers as a key ingredient in food and non-food products, which warrants an investigation on their public exposure. This research aims to investigate the level of knowledge and awareness among the community in Brunei Darussalam about the presence, source and health consequence of emulsifiers in food and non-food items. A quantitative approach was executed in this study. An online questionnaire was developed and distributed to the general public of Brunei Darussalam via social media platforms. The data obtained from participants was recorded and analysed using SPSS Statistics version 23. Overall, the sample population was predominantly comprised of females, youths of aged 18-24 years old, students, individuals with a Bachelor's degree and Muslims. The results showed that the participants, particularly females and current students were significantly more knowledgeable of emulsifiers in food than non-food products. However, the overall knowledge degree of the ingredient among the participants was moderate. Moreover, most responses exhibited a poor awareness level regarding the sources of emulsifiers and an uncertainty of their effects on human health. In conclusion, the findings of the present study will benefit particularly Muslim consumers to make informed decision on their product purchasing as the information provided in the research enables them to distinguish between halal and non-halal products.

Keywords: Awareness, Emusifier, Halal, Health, Knowledge

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INTRODUCTION

It is estimated that the 2 billion world Muslim population has spent an approximate total of US\$2.29 trillion in 2022 across the food, pharmaceutical, personal care products, fashion, travel, and media sectors—totally influenced by ethical consumption requirements derived from the Islamic faith (State of the Global Islamic Economy Report, 2023). Furthermore, the global market of halal ingredients would increase from estimated US\$330 billion in 2023 to US\$345 billion in 2024 at a compound annual growth rate of 3.6% (Halal Ingredients Global Market Report, 2024). One of the main factors fueling the expand of market place demand for halal ingredients is the rise in the number of Muslim population. Halal-certified ingredients are referred to any substances or components that are utilised for manufacturing a product according to Islamic law, for example, food additives such as emulsifiers, starches, sweeteners, hydrocolloids and acidulants (Halal Ingredients Global Market Report, 2024). Therefore, all the components and materials are required to be halal-certified to comply with Islamic law before the final product can be claimed halal.

There has been a rising popularity of the consumption of food additives in recent decades, mostly due to the increasing desire for food and beverages to acquire a more prolonged shelf life as well as improve preservation for optimising their safety, freshness, flavour, texture and appearance. This

development has led to a worldwide increase in the intake of ultra-processed food (Cox *et. al.*, 2021). Ultra-processed food includes any method of processing that modifies food from its original form, including drying, freezing, grinding, canning, or incorporating sugar, salt, fat or additional ingredients for taste or for the purpose of preservation (Monteiro *et. al.*, 2019).

Emulsifiers are a type of food additives that have been approved by the US Food and Drug Administration (FDA), which function to facilitate in the stabilising process of products that contain immiscible ingredients namely oil and water (Cox *et. al.*, 2021; US Food & Drug Administration, 2023). They can be derived synthetically or naturally, either from plants or animals. Furthermore, the usage of emulsifiers has expanded to encompass not only the production of food and beverages but also cosmetics and pharmaceuticals. Therefore, its comprehensive application in the daily products are required to be regulated for its halal status. Moreover, the overconsumption of emulsifiers has been linked to several adverse health conditions such as cardiovascular diseases and type 2 diabetes (Salame *et. al.*, 2024; Sellem *et. al.*, 2023). Hence, it is important for consumers to increase their knowledge in the ingredients, specifically the types of emulsifiers that are being used in their products. The Muslim community particularly is required to increase their awareness on the source of origin and health effects of emulsifiers, thus preserving the halal and thayyib aspects.

Brunei Darussalam is a small nation situated in Borneo Island, Southeast Asia, with a Muslim population of 365,6000 which accounts for 82% of the total population in 2022 (Ministry of Finance and Economy, 2022). Despite being a Muslim-majority country, the extend of the community's understanding of emulsifiers in everyday products is still warranted. The aim of the present study is to investigate the level of knowledge and awareness among the community in Brunei Darussalam regarding the presence and source of emulsifiers in both food and non-food products, as well as their association with potential health risk. Moreover, no study has been performed on the public knowledge and awareness of emulsifiers in Brunei Darussalam and notably, no similar study is available specifically on non-food products in other countries. The findings of the study will ultimately provide benefit to the community to make informed decision when purchasing their everyday products, and relevant authorities to spread awareness on halal ingredients and educate the community on ingredients and labelling.

LITERATURE REVIEW

Halalan Thoyyiban Concept

The word 'halal' is an Arabic term exclusively used in Islam which means lawful, acceptable, and permissible. Halal refers to something that is permissible by Allah for humans to act, utilise, consume and so forth. In addition, this permissibility is aligned to the Islamic context as per guidance from the Holy Quran and Sunnah. Furthermore, the term thayyiban or thayyib is derived from the word 'taba' in the Arabic word which means, something good. It has an identical concept as halal, which means that it is good for the human body and does not harm the human mind or spirit (Khan & Haleem, 2016; Mustafa, 2019). Muslims are obliged to consume and utilise only halal products in their entire life. This is supported with the commandment by Allah Subhanahu wa Ta'ala, "O humankind ! Eat from what is lawful and good on the earth and do not follow the footsteps of Evil. He is your truly sworn enemy" (Quran 2:168). This verse mentioned that mankind needs to focus on both aspects; halal and good things (thayyiban) when utilising products, which include both consumable and non-consumable materials.

For the purpose of these materials to be regarded as legalised by religion and hence certified as halal, the products need to be permitted by hukm syarak and accomplish the subsequent the requirements. Firstly, non-permissible animals for Muslims should not be incorporated partially or wholly in the product materials, for instance pigs. Secondly, it does not partially or wholly contain any animal materials that are not slaughtered based on the hukm syarak. Thirdly, the products must not be comprised of any impure (filthy or unclean) materials based on the hukm syarak. Furthermore, it is crucial to confirm that the products are safe, favourable and not hazardous, and do not include any physical, chemical, biological or microbial risks that may cause any negative effects to human health



physically or spiritually (Duraseh, 2020; Khan & Haleem, 2016; Nafis, 2019). Therefore, the halalan thayyiban concept must be emphasised in the application of halal-certified materials or ingredients such as food additives.

Food Additives

As stated by the World Health Organisation (WHO), food additives are substances primarily introduced to processed and unprocessed food produced on a commercial range for practical reasons (World Health Organisation, 2023). There are various purposes for using additives, which include extending product shelf life and freshness, preventing product quality deterioration, enhancing product appeal, achieving desired texture, ensuring specific product functionality, streamlining the production process, reducing production costs, and strengthening the nutritional content of products (Amit et. al., 2017). Furthermore, food additives have been incorporated into food during preparation, transportation, packaging, and storage, and these additives ultimately become a component of the food products (European Commission, 2024). Importantly, these additives are also integrated in non-food products.

Emulsifiers

Emulsifiers are one of the types of additives and they are commonly found in butter, milk, mayonnaise, shampoos, toothpastes and cleaning agents. They play a critical role as stabilisers in emulsion formulations, promoting the ease of emulsion formation and the functional characteristics of the final product (Cox et. al., 2020). Consequently, when creating emulsion-based goods, choosing the right emulsifier is essential to enhance stability. Generally, emulsifiers function to lessen the interfacial tension on oil or water surfaces that will lead to the formation of a homogeneous emulsion and the stability phase between oil and water (Cox et. al., 2020).

There are two categories of emulsifiers, namely natural and synthetic. Naturally, emulsifiers can be sourced from plants such as flour, starch, pectin, carragean, cellulose, while lecithin, gelatin, glycerin, egg yolks, crustacean shells and microorganisms are based on animals. Whereas, some examples of synthetic emulsifiers include diacetyl tartaric acid esters of mono- and diglycerides of fatty acids, polyglycerol ester of fatty acid, ammonium phosphatides, sodium lauryl sulphate (SLS) and sorbitan fatty acid esters (Cox et. al., 2021; Terrell, 2021).

According to Brunei's Law that has been specified in the Tenth Schedule under the Regulation 27(2) (Law of Brunei, 2001), only permitted emulsifiers and stabilisers can be used in the country's food production or importation. The Codex Alimentarius has developed an International Numbering System (INS) that would serve as a universally standardised numbering system for additives. In the European Union, the food additives are labelled according to an enactment based on a collection of designated 'E-numbers'. The E-numbers are presented as the codes for food additives as shown in the food labels or ingredients listed on the packaging (US Food & Drug Administration, 2023), whereby the classification of emulsifiers and stabilisers can be mostly identified from E400 until E495. The initiative aims to eliminate the need for food labels to include complex and long molecular names, which might perplex consumers (Cox et. al., 2020).

However, the E-numbers of emulsifiers show no information of their source whether they are plant- or animal-based. All plant-based emulsifiers are generally considered halal, nonetheless the ingredients are haram if they are derived from pork such as lard. It is also important to take into consideration the emulsifiers that are animal-based of unknown origin as they may fall under the syubhah (doubtful) status. Some E-code examples of the animal-based emulsifiers that consumers must be mindful are lecithin (E322), glycerin (E422), gelatin (E428), mono- and diglycerides of fatty acids (E471) and stearyl tartrate (E483) (Food Standards Agency, 2024; Majlis Ugama Islam Singapura, 2016).

Furthermore, a number of studies have shown that emulsifiers such as carrageenans and gums are linked to health conditions including inflammation of the gastrointestinal tract and metabolic syndrome (Chassaing et. al., 2015; Monteiro et. al., 2019). The overconsumption of emulsifiers has also been associated with disorders, for example cardiovascular diseases and type 2 diabetes (Salame et. al., 2024; Sellem et. al., 2023).



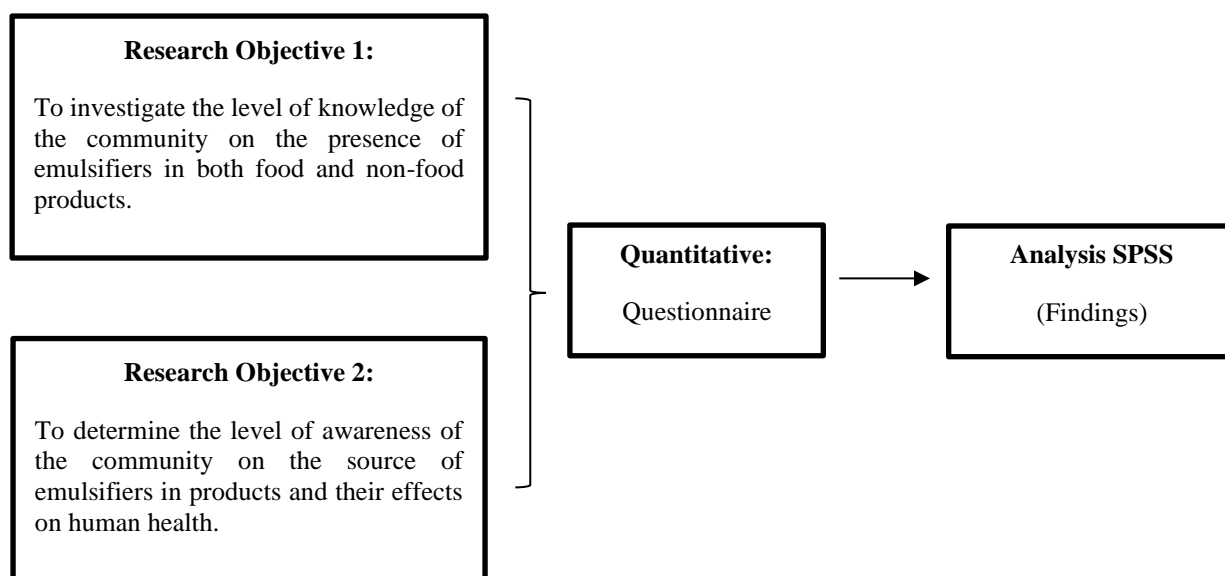
A previous study in Brunei Darussalam regarding a common food additive Monosodium Glutamate (MSG) exhibited that the public only possessed a basic knowledge and average awareness of the ingredient (Hamidun et. al., 2023), suggesting that the exposure of additives among the public is still not comprehensive. Consumers may be becoming progressively mindful of what they eat, drink and use. Nevertheless, it is still not known whether the consumers, especially in Brunei Darussalam know and realise the presence of less common additives such as emulsifiers in their daily use as well as their consequences to health. Overall, the present study has produced two research objectives, namely (1) to investigate the level of knowledge of the community on the presence of emulsifiers in both food and non-food products, and (2) to determine the level of awareness of the community on the source of emulsifiers in products and their effects on human health.

METHODOLOGY

Sampling Technique

This study has implemented a quantitative approach to investigate the level of knowledge and awareness of the community in Brunei Darussalam on the presence and source of emulsifiers in food and non-food products as well as their impact on human health (Figure 1). The quantitative method used a questionnaire for obtaining primary data that can be analysed through statistics and numbers.

Figure 1. Research Design



Research Sample

About 100 participants were targeted to partake in this study, which mainly focused on the citizens of Brunei Darussalam from 18 years of age. Moreover, this research involved information from any people, whether Muslims population and non-Muslim population and this study took place in the four districts of the country, which are Brunei-Muara, Temburong, Tutong and Kuala Belait. The study population was invited to participate in the study voluntarily through social media platforms, such as WhatsApp, Instagram and Telegram for primary data collection using a questionnaire.

Research Instrument

The questionnaire contained three sections which were categorized as Section A, Section B and Section C. Section A required respondents to answer based on the socio-demographic matters. Section B was focusing on the knowledge of community in Brunei Darussalam of the presence of emulsifiers in food and non-food products. Lastly, Section C was emphasizing on the awareness of the community in Brunei Darussalam of the presence and source of emulsifiers in food and non-food products as well as their impact on human health. The closed-ended questions were equipped with preset responses to a 3-point Likert scale with the ratings as follows: 1=No, 2=Maybe and 3=Yes.

Reliability and Validity

A pilot study was conducted to pre-test the questionnaire on 30 participants, prior its distribution to the public. Comments and feedbacks were received to restructure some questions and rephrase any complicated terminologies. The reliability of the pilot study was tested using Cronbach's Alpha method. According to the method, in terms of reliability, an Alpha value closer to 1 indicates that it is "excellent", while a value of more than 0.8 is considered "good". A value between 0.6 and 0.8 implies the reliability is good and acceptable, whereas a value less of than 0.6 indicates an unacceptable finding. The responses from the pilot study were not included in the final results of the questionnaire. Additionally, the validity of the questionnaire was evaluated by three experts from Halalan Thayyiban Research Centre, Universiti Islam Sultan Sharif Ali.

Data Analysis

The data was analysed through the Statistical Package for the Social Sciences (SPSS) version 23 software. The method used was descriptive statistical in analysing the data to gain basic information and highlighting potential relationships between variables. Hence, this covered the participants' socio-demographic status, frequency, percentage response and mean score where applicable. The interpretation of the mean score for three-point Likert scale is shown in Table 1. Pearson chi-squared test was used to find the association between socio-demographic data and knowledge and awareness of the community on emulsifiers. A *p*-value of < 0.05 was considered statistically significant.

Table 1. Mean range for three-point Likert scale

Mean Range	Interpretation
2.34 – 3.00	High
1.67 – 2.33	Moderate
1.00 – 1.66	Low

RESULTS

Prior to commencing the main research, Cronbach's Alpha method was utilized in order to evaluate the degree of reliability for the items in the questionnaire. The reliability test was performed on Sections B and C of the questionnaire, which focused on the knowledge on emulsifiers, and awareness of emulsifiers in food and non-food products, respectively. A Cronbach's Alpha score of 0.93 was obtained for Section B with eight items, while a value of 0.72 was achieved for Section C with four items. This test showed that the overall questionnaire reliability outcome was excellent and acceptable for public distribution.

Socio-Demographic Profiles Of Participants

A total of 149 participants were recruited in this study. The socio-demographic profiles of the participants are presented in Table 2. The majority of the participants were among the females with 73.2%, individuals of aged from 18 to 24 years with 75.2% and the Muslim population with 99.3%. Most of the participants were among Bachelor's degree holders (35.6%) and were students (61.1%) during the recruitment period.



Table 2. Socio-demographic profiles of participants (N=149)

Description	n (%)
Gender	
Male	40 (26.8)
Female	109 (73.2)
Age	
18-24	112 (75.2)
25-34	32 (21.5)
45-54	5 (3.3)
Religion	
Islam	148 (99.3)
Christianity	1 (0.7)
Highest Education Level	
SSSRU*	6 (4.0)
O'level	40 (26.8)
A'level	34 (22.8)
Bachelor's Degree	53 (35.6)
Master's Degree	3 (2.1)
Others	13 (8.7)
Employment status	
Student	91 (61.1)
Employed	34 (22.8)
Unemployed	20 (13.4)
Retired	4 (2.7)

*SSSRU, Sijil Sekolah-Sekolah Rendah Ugama or Religious Primary Schools Certificate (Primary VI)

Knowledge Level of Participants on Emulsifiers in Food and Non-Food Products

The knowledge level of participants on emulsifiers was examined by using a series of questions as presented in Table 3. According to the data obtained, majority of the participants were familiar with emulsifiers in general (54.4%), knew its presence in food and beverages (56.4%), and had seen emulsifier codes such as E471 and E322 labelled in the food ingredients (38.3%). Most of them however, did not know the function of emulsifiers in food products (41.6%). On the other hand, a significant proportion of the participants were not familiar with their presence in cosmetic and pharmaceutical products (40.9%), had not seen their scientific names on the packaging of non-food products (43.0%), and did not know the function of emulsifiers in non-food products (57.1%). Remarkably, majority of the participants were not sure of the halal status of emulsifiers (70.5%). Overall, it has been shown that most of the participants scored means (1.64 – 2.29) of a moderate level of knowledge on emulsifiers in both food and non-food products.



Further analyses were performed to find the association between socio-demographic variables and participant's knowledge of emulsifiers in food (Table 4) and non-food products (Table 5). In both food and non-food products, it was found that the females ($p=0.006$ and $p=0.024$, respectively) and student individuals ($p=0$ and $p=0.041$, respectively) were significantly associated with a higher knowledge level on the presence of emulsifiers. Furthermore, highest education level ($p=0.001$) exhibited a significant association with the extent of knowledge on emulsifiers' presence on food products only.

Table 3. Knowledge level of participants on emulsifiers

		No n (%)	Maybe n (%)	Yes n (%)	Mean	Standard deviation
B1	Do you know about emulsifiers?	49 (32.9)	19 (12.7)	81 (54.4)	2.21	1.88
B2	Do you know about emulsifiers are present in food and beverages?	41 (27.5)	24 (16.1)	84 (56.4)	2.29	1.92
B3	Have you seen emulsifier codes (E471, E322) labelled in the food ingredient?	48 (32.2)	44 (29.5)	57 (38.3)	2.06	1.70
B4	Do you know the function of emulsifiers in food products?	62 (41.6)	26 (17.4)	61 (40.9)	1.99	1.67
B5	Do you know about emulsifiers are present in cosmetics and pharmaceuticals?	61 (40.9)	37 (24.8)	51 (34.3)	1.93	1.60
B6	Have you seen the scientific names of emulsifiers listed on the packaging of non-food products?	64 (43.0)	50 (33.5)	35 (23.5)	1.81	1.44
B7	Do you know the function of emulsifiers in non-food products?	85 (57.1)	33 (22.1)	31 (20.8)	1.64	1.30
B8	Do you think emulsifiers are halal?	15 (10.0)	105 (70.5)	29 (19.5)	2.09	1.61



Table 4. Association between respective variables and participant’s knowledge on the presence of emulsifiers in food products

Variable	n	Knowledge level on the presence of emulsifiers in food products			p-value
		No n (%)	Maybe n (%)	Yes n (%)	
Gender					
Male	40	16 (40)	10 (25)	14 (35)	0.006
Female	109	24 (22.0)	15 (13.8)	70 (64.2)	
Religion					
Islam	148	39 (26.4)	25 (16.9)	84 (56.7)	0.254
Christianity	1	1 (100)	0 (0)	0 (0)	
Age (in years)					
18-24	112	25 (22.3)	19 (17)	68 (60.7)	0.268
25-34	32	13 (40.6)	5 (15.6)	14 (43.8)	
45-54	5	2 (40)	1 (20)	2 (40)	
Highest Education Level					
SSSRU*	6	6 (100)	0 (0)	0 (0)	0.001
O-level	41	14 (34.1)	12 (29.3)	15 (36.6)	
A-level	34	9 (26.5)	5 (14.7)	20 (58.8)	
Bachelor's Degree	53	5 (9.4)	5 (9.4)	43 (81.1)	
Master	3	0 (0)	1 (33.3)	2 (66.7)	
Others	12	6 (50.0)	2 (16.7)	4 (33.3)	
Employment Status					
Student	91	12 (13.1)	13 (14.3)	66 (72.5)	0
Unemployed	20	11 (55)	5 (25)	4 (20)	
Employed	34	15 (44.1)	6 (17.6)	13 (38.2)	
Retired	4	2 (50)	1 (25)	1 (25)	

*SSSRU, Sijil Sekolah-Sekolah Rendah Ugama or Religious Primary Schools Certificate (Primary VI)
 p-values were calculated using Pearson Chi squared test.

Table 5. Association between respective variables and participant’s knowledge on the presence of emulsifiers in non-food products

Variable	n	Knowledge level on the presence of emulsifier agents in non-food products			p-value
		No n (%)	Maybe n (%)	Yes n (%)	
Gender					
Male	40	21 (52.5)	12 (30)	7 (17.5)	0.024
Female	109	38 (34.8)	26 (23.9)	45 (41.3)	



Religion					
Islam	148	58 (39.2)	38 (25.7)	52 (35.1)	0.464
Christianity	1	1 (100)	0 (0)	0 (0)	
Age (in years)					
18-24	112	40 (35.7)	30 (26.8)	42 (37.5)	0.190
25-34	32	18 (56.2)	7 (21.9)	7 (21.9)	
45-54	5	1 (20)	1 (20)	3 (60)	
Highest Education Level					
SSSRU*	6	5 (83.3)	0 (0)	1 (16.7)	0.354
O-level	41	20 (48.8)	11 (26.8)	10 (24.4)	
A-level	34	10 (29.4)	11 (32.4)	13 (38.2)	
Bachelor's Degree	53	16 (30.2)	11 (20.8)	26 (49.0)	
Master	3	1 (33.4)	1 (33.3)	1 (33.3)	
Others	12	7 (58.3)	4 (33.3)	1 (8.33)	
Employment Status					
Student	91	27 (31.9)	24 (25.5)	40 (42.6)	0.041
Unemployed	20	13 (65)	5 (25)	2 (10)	
Employed	34	17 (50)	8 (23.5)	9 (26.5)	
Retired	4	2 (50)	1 (25)	1 (25)	

*SSSRU, Sijil Sekolah-Sekolah Rendah Ugama or Religious Primary Schools Certificate (Primary VI)

p-values were calculated using Pearson Chi squared test.

Awareness Level of Participants on Emulsifiers in Food and Non-Food Products, and Their Impact on Human Health

The awareness level of participants on emulsifiers was explored by using a survey as shown in Table 6. The findings exhibited that most of the participants were aware of emulsifiers found in food and beverages (53.0%), but unaware of their presence in cosmetic and pharmaceutical products (37.6%). Moreover, the participants were predominantly unaware of the sources of emulsifiers (51.7%). Importantly, majority of the participants were not aware of neither the benefit or risk of emulsifiers on human health (45.0%). Overall, most of the mean scores (1.70 – 2.26) of the awareness level of the participants were considered moderate. Additional analysis presented no significant associations between socio-demographic variables and the awareness level of the participants on the impact of emulsifiers on human health (Table 7).

Table 6. Awareness level of participants on emulsifiers

		No	Maybe	Yes	Mean	Standard deviation
		n (%)	n (%)	n (%)		
C1	Are you aware that emulsifiers present in food and beverages?	41 (27.5)	29 (19.5)	79 (53.0)	2.26	1.89
C2	Are you aware that emulsifiers present in cosmetics and	56 (37.6)	39 (26.2)	54 (36.2)	1.99	1.64



	pharmaceuticals?					
C3	Are you aware of the sources of emulsifiers?	77 (51.7)	40 (26.8)	32 (21.5)	1.70	1.35
C4	Are you aware of the benefit/non benefit of emulsifiers to human health?	67 (45.0)	47 (31.5)	35 (23.5)	1.79	1.43

Table 7. Association between respective variables and participant’s awareness on the impact of emulsifiers to human health

Variable	n	Awareness level on the impact of emulsifiers to human health			p-value
		No n (%)	Maybe n (%)	Yes n (%)	
Gender					
Male	40	19 (47.5)	15 (37.5)	6 (15)	0.278
Female	109	46 (42.2)	33 (30.3)	30 (27.5)	
Religion					
Islam	148	67(45.3)	48 (32.4)	36 (24.3)	0.522
Christianity	1	1 (100)	0 (0)	0 (0)	
Age (in years)					
18-24	112	46 (41.0)	34 (30.4)	32 (28.6)	0.270
25-34	32	17 (53.1)	12 (37.5)	3 (9.4)	
45-54	5	2 (40)	2 (40)	1 (20)	
Highest Education Level					
SSSRU*	6	2 (33.3)	4 (66.7)	0 (0)	0.480
O-level	41	19 (46.3)	15 (36.6)	7 (17.1)	
A-level	34	14 (41.2)	14 (41.2)	6 (17.6)	
Bachelor's Degree	53	22 (41.5)	11 (20.8)	20 (37.7)	
Master	3	2 (66.7)	1 (33.3)	0 (0)	
Others	12	4 (33.3)	6 (50)	2 (16.7)	
Employment Status					
Student	91	35 (38.4)	27 (29.7)	29 (31.9)	0.067
Unemployed	20	13 (65)	5 (25)	2 (10)	
Employed	34	14 (41.2)	15 (44.1)	5 (14.7)	
Retired	4	3 (75)	1 (25)	0 (0)	

*SSSRU, Sijil Sekolah-Sekolah Rendah Ugama or Religious Primary Schools Certificate (Primary VI)
 p-values were calculated using Pearson Chi squared test.



DISCUSSION

Knowledge on Emulsifiers Among The Community in Brunei Darussalam

The present study demonstrated that the participants were more familiar of emulsifiers in food than non-food products, but overall they exhibited moderate knowledge degree of the ingredient. This finding is comparable with a previous study which showed an average level of knowledge on common food additives acquired by the consumers (Januś *et. al.*, 2023). However, a study by Ismail *et. al.* (2017) indicated that the consumers had a limited knowledge on the functions of common food additives. Although these studies were only focusing on general food additives, the findings suggested that the knowledge of consumers on additives, especially emulsifiers warrants massive improvement.

Moreover, it is alarming to discover that the majority of participants were not sure on the halal status of emulsifiers. In Islam, the pursuit of knowledge and the acquirement of information are considered obligatory for every Muslim. Seeking knowledge on halal and haram can help and teach the individuals a way of life, whereby they are able to differentiate halal and haram rationally (Deuraseh, 2019). As Muslims, individuals must seek adequate information on halal products as mentioned in Surah Al-Maidah, verse 88, "Eat of the things which Allah has provided for you lawful and good; but fear Allah in Whom you believe" (Quran 5:88). Furthermore, this could be reflected with the availability of halal logo on the products which ultimately determined the halal status of the emulsifiers.

Additionally, female participants have been shown to be significantly associated with a higher knowledge level of emulsifiers. This supports the results of a prior research, which stated that females were likely to be more involved in food-related matters and more knowledgeable on food and nutrition (Manippa *et. al.*, 2017). Moreover, the association between students and good knowledge of emulsifiers was significant in this study. This may be due to the availability of relevant subjects and programmes on emulsifiers being taught in Brunei Darussalam such as Science in Sixth forms, Food Science and Technology at Universiti Teknologi Brunei and Halal Science at Universiti Islam Sultan Sharif Ali (Ministry of Education, 2024; Universiti Islam Sultan Sharif Ali, 2024; Universiti Teknologi Brunei, 2024). Nevertheless, information on emulsifiers taught in schools and institutions is at the basic level and details such as their functions in both food and non-food products should be included.

Awareness on The Sources and Effects of Emulsifiers Among The Community in Brunei Darussalam

The participants were largely unaware of the sources of emulsifiers. Emulsifiers can be derived naturally via plants and animals. Glycerine and fatty acids (E471) and lecithins (E322) are some examples of emulsifiers that can be sourced from either plants and animals (Food Standards Agency, 2024; Majlis Ugama Islam Singapura, 2016), therefore they can be categorised as syubhah especially when consumers are not aware of their origin. Therefore, the transparency of the source of ingredients can be confidently acquired through halal certification process.

Furthermore, majority of the participants were not aware of the effects of emulsifiers on human health. This is comparable with a study which exhibited the unnoticed harmful substances in everyday products among participants with limited knowledge of chemistry (Hartmann & Klaschka, 2017). Nevertheless, a study by Legesse *et. al.*, (2017) showed that most of the respondents were aware of the human health risks associated with food additives found in packaged food. This indicated the presence of an awareness gap between the effect of food additives, such as emulsifiers between food and non-food products. Importantly, there were researches on the usage of emulsifiers that was linked to negative effects to human health, particularly gastrointestinal and metabolic health (Chassaing *et. al.*, 2015; Monteiro *et. al.*, 2019). Some of the diseases correlated to the impaired gastrointestinal health caused by emulsifier usage include allergic reactions, autoimmune disorders and Inflammatory Bowel Diseases (Csáki, 2011; Lerner & Matthias, 2015). Moreover, a previous study showed that a high consumption of mono- and diglycerides of fatty acids (E471) is significantly linked to higher risks of cardiovascular disease, coronary heart disease and cerebrovascular disease (Sellem *et. al.*, 2023). Other study exhibited that there were significant associations between emulsifiers (carrageenan, arabic gum and guar gum) and type 2 diabetes (Salame *et. al.*, 2024).



Therefore, it is crucial for consumers especially among Brunei Darussalam to be aware on what they consume. A recent study conducted showed a greater proportion of food or beverage industrial products consist of at least one food additive (Chazelas *et. al.*, 2020). Hence, this shows that food sectors use at least one emulsifier in their food production. Therefore, food producers that use food additives, particularly emulsifiers, in producing their end products must provide the types of emulsifiers on food labels. According to the regulations in the laws of Brunei concerning public health (food), the ingredients used must be approved emulsifiers listed in the tenth schedule. Additionally, the package must bear a label that accurately states the chemical nature of the emulsifier (Laws of Brunei, 2001).

CONCLUSION

In conclusion, the present study has investigated the knowledge and awareness level of emulsifiers in food and non-food products among the community in Brunei Darussalam. The study revealed that more participants were familiar about emulsifiers in food compared to non-food products, although the overall degree of knowledge was only moderate. Furthermore, most responses demonstrated a lack of awareness regarding the sources of emulsifiers and an uncertainty of their positive or negative effects on human health. This study would contribute many benefits to interested academic researchers, food manufacturers and mainly Muslim consumers, as the information provided may enable them to distinguish between halal and non-halal ingredients, thus make informed decision when purchasing a product.

Considering that both of the knowledge and awareness on the presence of emulsifiers in food and non-food products were determined to be average, it is essential to put forth more effort to educate and spread awareness to the public. Relevant authorities such the Ministry of Health and Ministry of Religious Affairs can utilise mass media and social media to advertise the information on emulsifiers on television and radio, and provide the public with infographics on applications such as Instagram and Telegram. Furthermore, experts in the Ministry of Education and relevant institutions shall adopt educational initiatives. This is intended to provide clear and comprehensive information on emulsifiers and their impact on public health. Such programs can be in the form of a forum, discussion, roadshow or campaign.

In this study, there are several limitations to be acknowledged. Firstly, there is a little to no past literatures related to the knowledge and awareness of emulsifiers in food and non-food products in Brunei Darussalam. Remarkably, the study of knowledge and awareness of additives and emulsifiers in non-food products globally was very limited. Thus, researchers shall perform more studies focusing on emulsifiers in a larger scale in Brunei Darussalam, and emphasising on the topic of emulsifiers in non-food products in other countries in the future. Other limitation directed at the sample population size. Hence, by increasing the period of study and approaching participants physically in addition to social media distribution, more number of recruitments can be achieved to ensure the study sample is more representative of the whole population. Lastly, as the current study only executed a quantitative method, the future research shall implement a mixed-method approach of both quantitative and qualitative methods to expand the study reliability.

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