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Consumer knowledge and perception of 3-MCPD and glycidyl esters in food and edible oils

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Author contributions
This manuscript is collaboratively written with Ain, Raseetha who contributed in designing experiments, analysing data, manuscript writing, and Ali, who provided critical insights and guidance throughout the research process, who offered valuable feedback on manuscript drafts.

Competing interests
The authors declare no conflicts of interest.

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Abbreviations
2-MCPD, 2-Monochloropropane-1,2-diol; 3-MCPD, 3-Monochloropropane-1,2-diol; EC, European Commission; EFSA, European Food Safety Authority; FAO, Food and Agriculture Organization; GEs, Glycidyl Fatty Acid Esters; GLCs, Government-Linked Companies; IARC, International Agency for Research on Cancer; MCPD, Monochloropropanediol. PORAM, Palm Oil Refiners Association of Malaysia. SPM, Sijil Pelajaran Malaysia (Malaysian Certificate of Education); STPM, Sijil Tinggi Persekolahan Malaysia (Malaysian Higher School Certificate); UiTM, Universiti Teknologi MARA. WHO; World Health Organization.

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Abstract
Background: In today's context, vegetable oils, commonly used in culinary practices such as frying and baking, are integral to numerous daily dietary choices. Palm oil, a frequently employed vegetable oil, raises concerns surrounding food safety, thus presenting a significant challenge. **Methods:** This research aims to enhance consumer awareness regarding the potential health risks associated with 3-monochloropropane-1,2-diol (3-MCPD) and glycidyl fatty acid esters (GEs) commonly found in food and edible oil products. The study endeavours to apprise consumers of these health risks through a comprehensive survey. The survey enlisted the participation of 120 respondents within the age bracket of 18 years to those above 36 years (capped at 50 years). **Results:** Strikingly, a significant proportion, ranging from 88% to 89%, demonstrated a lack of awareness concerning the potential risks associated with 3-MCPD and GEs in food products. **Conclusion:** This study underscores the urgency of augmenting consumer's awareness levels regarding 3-MCPD and GEs. Furthermore, it promotes a more detailed examination of Malaysian edible oils and food products available in the market to establish an appropriate Tolerable Daily Intake for the Malaysian population. This research contributes to the broader discourse on food safety and public health by highlighting these crucial facets.

Keywords: vegetable oils; 3-Monochloropropane-1,2-diol; glycidyl fatty acid esters; consumer awareness; food safety

Background

The presence of fatty acid esters, especially 3- and 2-monochloropropanediol esters (3- and 2-MCPD esters) and glycidyl fatty acid esters (GEs), as food process contaminants have been recognised as a consequential outcome of the high-temperature refining process applied to edibles oils. This refinement at temperatures reaching 200°C, eliminates undesirable tastes, colours, odours, and components that may compromise the edible oil's shelf stability and nutritional value [1]. Initial instances of 3- and 2-MCPD and their corresponding fatty acid esters merged in the composition of hydrolysed vegetable protein of glycidol during the late 1970s, with a notable connection to both the formation and decomposition of 3- and 2-MCPD. Furthermore, cooking methods, such as baking and frying, have also produced these contaminants in food products containing vegetable oils [2].

Upon ingestion, the fatty acid esters of MCPD and glycidol undergo efficient hydrolysis, liberating the "free" forms of MCPD and glycidol. Internal exposure is believed to be comparable for both esterified and free forms. Extensive research has explored the toxicological effects of 3-MCPD, revealing its substantial impact on the kidneys, liver, and reproductive organs [3]. Previous studies indicated fatty acid esters of 3-MCPD and glycidol leads to harmful health consequences [4–11]. While less is known about 2-MCPD's toxicity, it has demonstrated effects on the heart and muscles [12]. Notably, the risk attributed to these contaminants stems from their free form, as animal studies have demonstrated that free 3-MCPD is generated from its esters with 86% efficiency during digestion, with even efficiency for GEs. As such, assessing the "bound MCPD" and "bound glycidol" content, representing the quantity released upon complete hydrolysis of esters, remains pivotal [13]. To manage exposure, The Joint Food and Agriculture Organization/World Health Organisation Expert Committee on Food Additives has recommended a maximum tolerable daily intake of 3-MCPD esters set at 4 mg/kg body weight per day.

In the context of Malaysia, palm oil occupies a significant role in everyday dietary consumption, thereby necessitating regulation through the Malaysia Food Acts and Regulations 1985 and importing country standards. The Malaysian palm oil industry aligns with these regulations, especially those imposed by the European Commission (EC) to address 3-MCPD esters and GEs contaminants [14]. However, research investigating the associated health risks of 3-MCPD and GEs remains scarce, impeding public awareness. The absence of recent data further exacerbates the lack of information concerning these contaminants in refined vegetable oils and food products, contrary to The European Food Safety Authority (EFSA) findings.

Moreover, researchers such as, have identified MCPD esters and GEs as process contaminants in thermally processed foods, particularly those prepared via frying and baking techniques that involve vegetable oils [15]. Nevertheless, a dearth of comprehensive research data worldwide has hindered a complete understanding of MCPD esters and GEs formation in the food chain. Given the prevalence of 3-MCPD esters and GEs in common food items, a detailed understanding of the fatty acid esters in common vegetable oils is crucial. Malaysia's palm oil industry diligently adopts precautionary measures to ensure safety and adherence to a 2500 g/kg 3-MCPD limit within a year [16].

This study addresses this knowledge gap by raising awareness about 3-MCPD and GEs in food samples and oil products, particularly their significance in processed edible oils due to their formation during oil processing. Moreover, the study capitalises on the broad utilisation of palm oil in Malaysia, acknowledging its versatility, nutrition, and market prominence. Thus, conducting a survey to assess awareness about 3-MCPD and GEs among consumers contributes valuable insights to the palm oil industry's ongoing efforts to ensure the safety of palm oil and related by-products, especially in food production.

Additionally, recognising that 3-MCPD and GEs are fat-soluble compounds formed from substances inherently present in all vegetable oils, the study underscores how specific fatty acid compositions impact their formation. Fats and oils underscore how specific fatty acid compositions impact their formation. Fats and oils consist of fatty acid molecules, categorised into saturated, monosaturated and polyunsaturated types based on their chemical structure. Notably, oils abundant in specific fatty acids, like palm and coconut oils, are prone to higher levels of 3-MCPD and GEs formation during processing [17].

Consumers are unaware of this newly found food process contaminant involving all age groups, including babies, children, adolescents, teenagers and adults. To our knowledge, awareness about 3-MCPD and GEs in food samples and oil products remains limited. Therefore, this study aims to provide such awareness while laying the foundation for further exploration of fatty acid esters in commonly used vegetable oils, with potential implications for public health and the palm oil industry's practices.

Limitations

Despite the meticulous design and execution of the survey, certain limitations existed, such as selection bias of online survey and self-selection bias, in which individuals who do not have online access or are not comfortable with technology may be excluded. Elderly or low-income people, for example, may be underrepresented. Those who respond may have different characteristics, opinions, or experiences than those who do not respond. For example, people with strong opinions on a topic may be more likely to respond, resulting in an over representation of their views.

The survey methodology employed in this study harnessed the power of a well-structured questionnaire administered through a Google Form platform to comprehensively assess awareness levels regarding 3-MCPD and GEs in selected food samples and oil products. This approach ensured a diverse pool of respondents and generated valuable insights into the knowledge and perceptions of these compounds among the target population.

Materials and methods

Survey of awareness 3-MCPD and GEs on selected food samples and oil products

A robust methodology was employed to comprehensively assess awareness levels regarding 3-monochloropropanediol (3-MCPD) and GEs in selected food samples and oil products. The study used a survey approach, with a well-structured questionnaire as the primary tool for data collection. The questionnaire was administered via an online platform, specifically Google Forms, offering convenience and accessibility to various respondents.

Sampling. Respondents were selected randomly to ensure a representative cross-section of the population. The sample encompassed individuals spanning the age spectrum from 18 to those above 36 (capped at 50 years), thereby capturing diverse perspectives and experiences. A hundred and twenty participants were used in this study, and the study area was comprised of participants from Selangor state within Malaysia. The sampling was conducted between February 2023 and July 2023.

Questionnaire design. The questionnaire was carefully crafted to elicit information pertinent to the research objectives. Structured questions were used to develop the information regarding food products being purchased, mainly related to palm oil/vegetable oils. From here, the postulation regarding awareness and familiarity of 3-MCPD and GE by consumers was determined. These questions originated from several discussions with the Palm Oil Refiners Association of Malaysia (PORAM), which strives for all palm oil industrialists to maintain the 2500 g/kg 3-MCPD limit set by the Malaysian government. English language was used in this questionnaire as it is the prime language among Malaysians. Participants who had trouble understanding were helped and guided one-to-one to complete the survey. Participants pre-tested the questionnaire to determine its accessibility before it was distributed. It encompassed three main categories of data as follows.

Socio-demographic information. This section captured essential details about respondents, including age, gender, educational

background, and occupation. These parameters aided in understanding the characteristics of the participants' pool.

Community spending information. Insight into spending habits and patterns within the community was sought. This encompassed inquiries about types of food products commonly purchased, frequency of consumption, and preferences related to edible oils. This segment provided context for the subsequent awareness-related queries.

Knowledge of 3-MCPD and GE. This critical section delved into the heart of the study by evaluating respondents' familiarity with 3-MCPD and GEs. Questions were formulated to gauge their awareness, comprehension, and perception regarding these compounds, their health implications, and their occurrence in food samples and oil products.

Questionnaire administration. The questionnaire was made accessible through a Google form.

Data collection. Responses were collected over a defined period, allowing for a substantial dataset to be accumulated. As data flowed in, it was systematically organised for subsequent analysis.

Ethical consideration. Ethical guidelines were adhered to throughout the research process. All collected data were anonymised, ensuring respondent confidentiality. Moreover, participants were informed about the purpose of the study and provided their informed consent before engaging in the questionnaire.

Data analysis. The data collected through the questionnaire underwent a rigorous analysis process. Descriptive statistical techniques were employed to summarise socio-demographic characteristics, spending patterns, and awareness levels. The data obtained from the survey were subjected to comprehensive statistical analysis. Mean values were calculated and presented along with their corresponding standard deviations, offering a clear understanding of the tendencies and variability within the dataset. The analytical process involved utilising the Statistical Package for Social Science software version 16, a robust tool renowned for its proficiency among the various variables. A one-way analysis of variance was executed to enables the exploration of potential variations in means across different groups or categories, ultimately illuminating trends and patterns within the dataset. Notably, the significance level was set at 5% ($P < 0.05$), in line with conventional practice in statistical analysis. Differences in means that surpassed this threshold were regarded as statistically significant, highly key insights and outcomes gleaned from the data.

Results and discussion

Survey of awareness 3-MCPD and (GE) on selected food samples and oil products.

Based on the findings presented in Figure 1, 120 respondents completed the survey. Among these participants, the gender distribution exhibited 62.5% female and 37.5% male respondents. A noteworthy trend in age groups emerged, with 45% of respondents falling within the 24 to 34 age bracket, constituting the largest segment. Conversely, 25.8% of the surveyed population were above 36 (capped at 50 years), while 29.2% were between 18 and 23. This distribution highlights a relatively higher representation of individuals in the mid-range age spectrum.

Inquiries were made concerning their employment, including affiliations with either the government or private sector and their roles as students, retirees, or the unemployed, to ascertain the occupational and educational backgrounds of the participants. Notably, the survey revealed a substantial proportion of respondents, precisely 43.3%, identified as students, underlining the inclusion of a younger demographic. Conversely, 39.2% of respondents were employed within the private sector, reflecting a diverse range of ownership of businesses and affiliation with Government Linked Companies (GLCs), underscoring the multifaceted nature of the participant pool. These results offer a comprehensive snapshot of the respondent group's demographic distribution and occupational diversity, furnishing a solid foundation for subsequent analyses and insights.

Furthermore, the educational composition of respondents is depicted in Figure 2, encompassing varying levels of attainment, including SPM, Diploma, Bachelor's degree and Master's degree or higher education. Notably, the survey results showed a significantly higher prevalence of respondents with a Bachelor's degree, constituting a significant 63.3% of the participant pool. In contrast, 16.7% possessed an SPM qualification, and 13.3% a Diploma. Additionally, some respondents indicated qualifications in STPM and matriculation, reflecting the diversity of educational backgrounds within the surveyed group.

Turning to the exploration of household income, as highlighted in Figure 2, participants were presented with four income categories for optional responses: less than RM2,500, RM2,500–4,800, RM4,800–6,500, and more than RM6,500. A substantial proportion of 46.7% of respondents reported household incomes less than RM2500, while 24.2% fell within the RM2,500–RM4,800 range. Notably, 12.5% of respondents indicated an income surpassing RM6,500, while 10.8% reported earnings between RM4,800 and RM6,500. A fraction of respondents noted specific income levels, such as RM1,500 and RM1,800, alongside respondents "none". This comprehensive portrayal of educational backgrounds and household income cohort. These findings provide contextual nuances that enrich the subsequent analyses and interpretations of awareness levels regarding 3-MCPD and GEs.

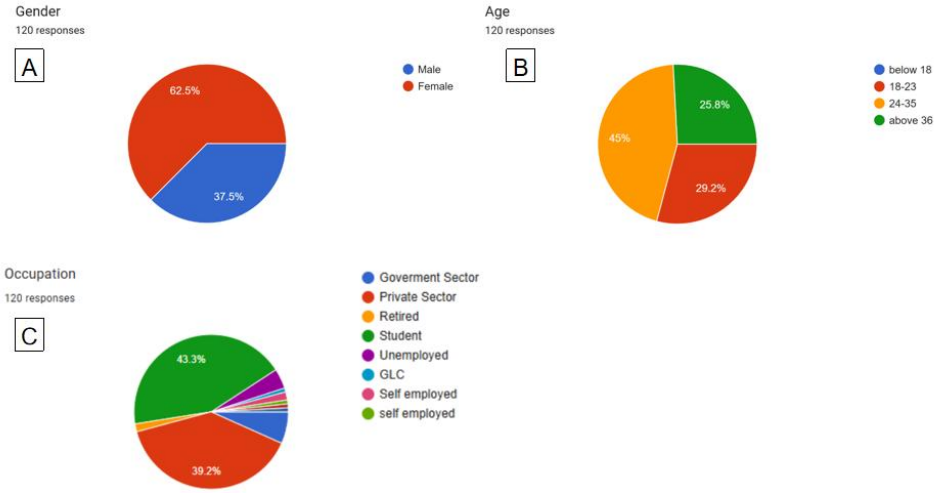

Figure 1 Socio-demographic information of gender (A), age (B) and occupation (C)

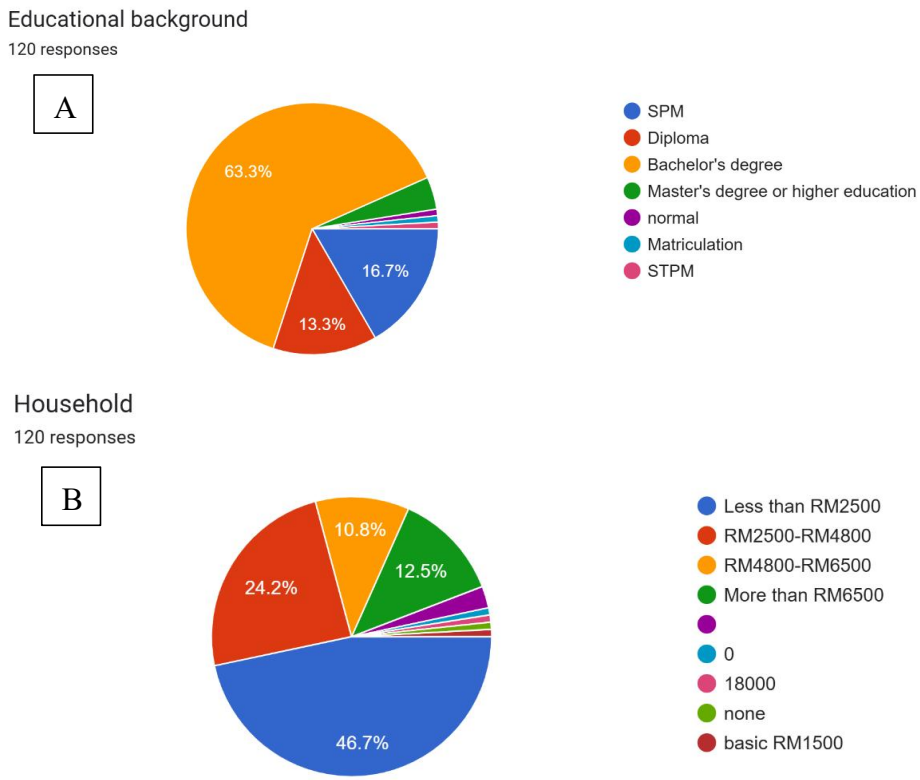

Figure 2 Socio-demographic information of educational background (A) and household income (B)

The questionnaire encompassed a segment dedicated to understanding community spending patterns in foodstuffs. This insight sought to delve into respondents' willingness to allocate funds to various food items for daily consumption. This line of enquiry gains significance due to the context of Malaysia's palm oil refiners contending with elevated costs to adhere to the EU's food safety regulations. The European Union has established limits for Ges. It is poised to set analogous limits for 3-MCPD ester compounds generated during the refining process of processed vegetable oils with potential health implications. The government's concern regarding Total Daily Intake within the Malaysian population stems from the desire to prevent unwarranted price surges in palm oil and its derivatives, especially cooking oil, a staple in baking and frying for Malaysian consumers. Consequently, the survey aimed to shed light on the expenditure patterns of respondents, considering the backdrop of potential price fluctuations. Figure 3 indicates the monthly amount spent on products such as vegetable oils, baby formula, dairy products, cereals, fast food, snacks, supplements, etc. In total, 32.5% of respondents reported allocating more than RM200 per month to these product purchases. In contrast, 21.7% allocated less than RM50 for food expenses, while 27.5% budgeted around RM100. A smaller proportion, constituting 15%, allocated RM200 for food expenditures. Noteworthy outliers included respondents who reported significantly higher spending for food items, such as RM600 and RM1,000.

Moreover, respondents' willingness to allocate funds for their food consumption was explored. The results revealed that 39.5% of respondents expressed their readiness to spend around RM100, significantly higher than the other amounts. Meanwhile, 25.2% were inclined to allocate less than RM50. Additionally, 18.5% of respondents indicated a willingness to spend beyond RM200, whereas 15.1% reported a desire to allocate precisely RM200. These findings resonate strongly with Malaysia's pursuit to strike a balance between adhering to food safety standards, averting price escalations, and consumers' financial comfort. The data from this segment underscores the intricate interplay of economic considerations and provides valuable insights into consumer spending behaviour and its implications for the industry.

The survey delved into respondents' expenditure on a diverse range of food items, encompassing vegetable oils like olive oil and palm oil, food supplements, chocolates, snacks, fast foods, dairy products including milk, yogurt, and cheese, cereal products, and baking essentials like margarine and butter Figure 4 presents an insightful snapshot of respondents' spending habits in these categories. Remarkably, the graph highlights that over 75% of respondents allocated less than RM50 towards the purchase of items such as vegetable oils (olive oil, palm oil, etc.), chocolates, snacks, fast foods, dairy products, cereal products, margarine, and butter for culinary purposes. Conversely, less than 25% of respondents reported spending beyond RM200 in these categories.

The data also uncovers the frequency of consumption for these items. Over 40% of respondents reported a daily consumption of vegetable oils, a monthly intake of food supplements, a bi-weekly indulgence in chocolates, snacks and fast foods, a weekly consumption of dairy products, a monthly consumption of cereal products, and a bi-weekly use of margarine and butter for baking and cooking. In contrast, less than 20% of respondents indicated bi-weekly consumption of vegetable oils and food supplements, dairy products, cereal products, margarine, and butter, underscoring a diversity of dietary practices. The insights derived from Figure 4 offer a comprehensive view of respondents' spending and consumption behaviours, shedding light on the intersection of preferences, affordability, and frequency of intake across various food categories. This acknowledgment contributes significantly to understanding consumers' attitudes toward different products and their consumption patterns.

The insights from Figure 5 illuminate respondents' perspectives and practices concerning the scrutiny of food labels. A majority, comprising 66.7% of respondents, consistently reviewed food labels before purchasing, indicating their dedication to informed consumption. Conversely, 19.2% responded with a "maybe", suggesting that their adherence to label examination varies, possibly influenced by factors like time constraints or familiarity with certain products. Notably, 14.2% of respondents responded with a definitive "no," indicating that they do not typically consider food labels when

purchasing.

Driving deeper into respondents' behaviour, 42.5% of the surveyed group reported constantly examining ingredient lists and nutritional information before purchasing food products. In contrast, 34.2% adopted a variable approach, alternating between glancing at labels and not, depending on the circumstance. Conversely, 23.3% expressed a consistent lack of attention to ingredient and nutritional details. Recognising that food labels are a legal requirement, serving multifaceted purposes is crucial. They empower consumers to make informed decisions about their purchases, ensure the safe storage and consumption of products, and contribute to reducing food waste [18]. Since 2016, regulatory mandates have compelled food manufacturers to display nutritional information on packaging, a pivotal step toward promoting healthier lifestyles and combatting food-related health issues. In the face of an escalating prevalence of diet-related ailments, customers exhibit a heightened interest in nutritional information, seeking more nutritious alternatives to safeguard their well-being [19].

The data from Figure 5 underscores the pivotal role of food labels in consumer choices and public health. It reflects diverse attitudes and behaviours, thereby contributing to an enriched understanding of the factors influencing label scrutiny among respondents.

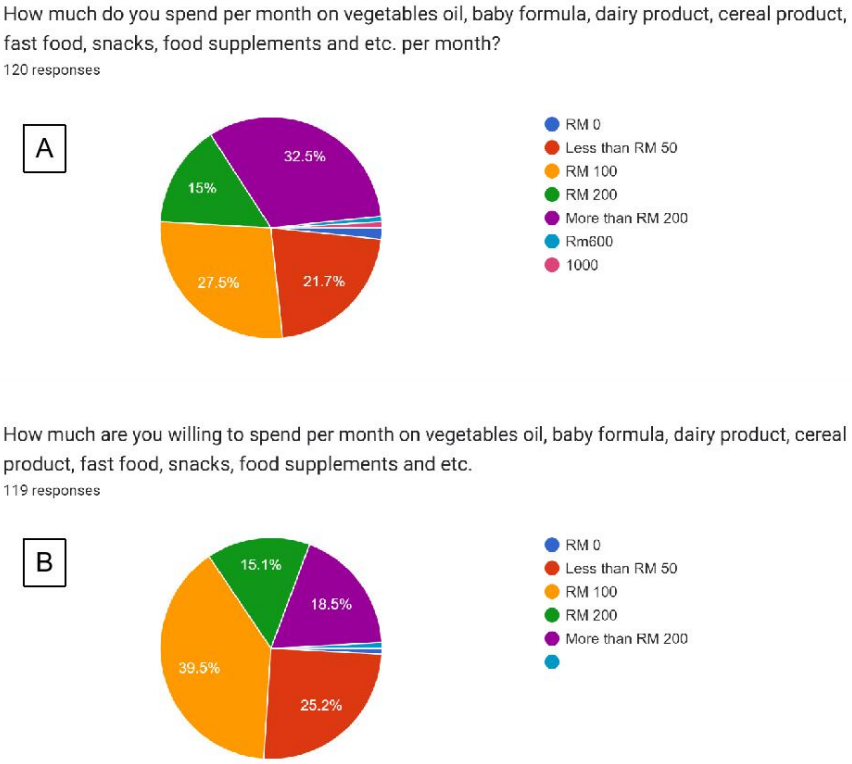

Figure 3 Community spending information (A) and (B)

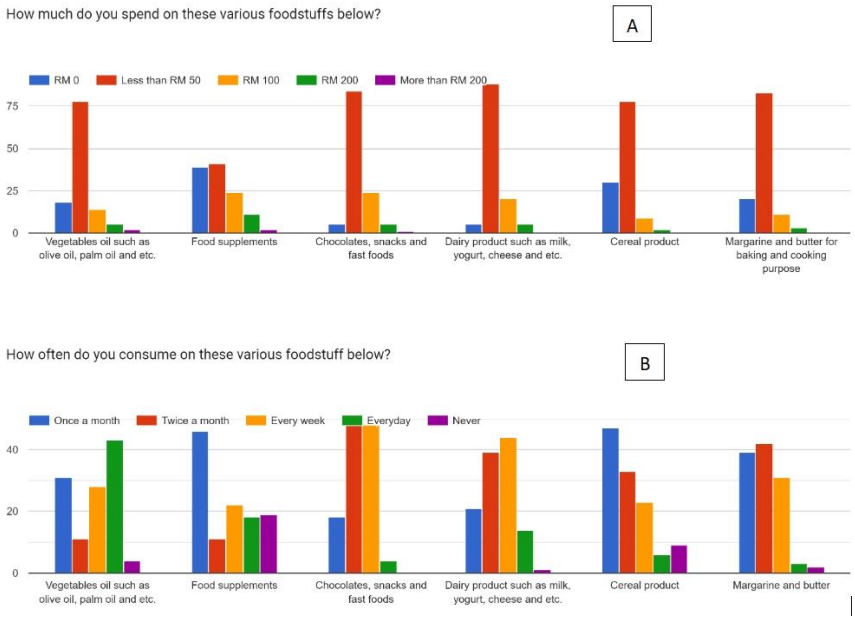

Figure 4 Community spending information (A) and (B)

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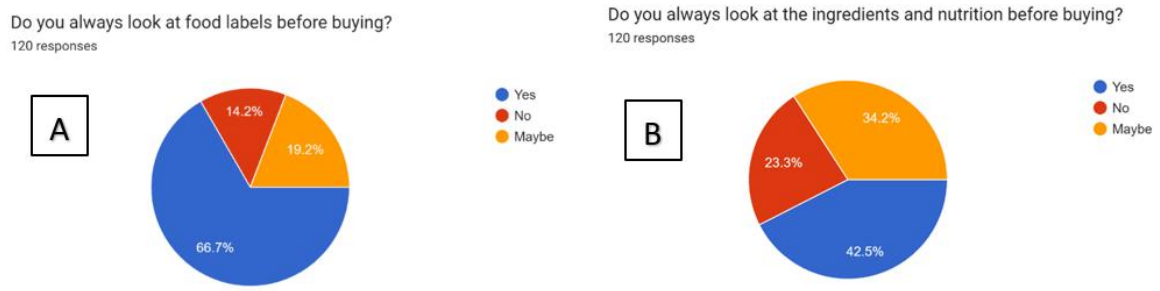

Figure 5 Community spending information (A) and (B)

The survey questionnaire also encompassed inquiries to gauge respondents' general awareness concerning 3-MCPD and GEs in various food products and commonly used edible oils. Regrettably, the majority of respondents displayed a lack of familiarity with these compounds, which have the potential to be sources of fat contamination and raise significant health concerns. The outcomes illustrated in Figure 6 highlight this deficiency in awareness, which portrays a pie chart reflecting respondents' knowledge. About 88.2% of respondents indicated unfamiliarity with 3-MCPD and GE, underscoring a lack of understanding of these chemical compounds. Thus, unawareness is significantly higher than awareness of these food process contaminants. A mere 11.8% demonstrated awareness of 3-MCPD and GEs. This observation aligns with the finding that 5% of respondents responded negatively to the survey question, affirming that most are not cognisant of the presence and implications of 3-MCPD and GEs.

Notably, these compounds manifest as contaminants within refined vegetable oils, often employed as ingredients in various food products. This lack of awareness emphasises the necessity for education and information dissemination to empower consumers to make informed choices about their dietary selections. Nevertheless, a segment comprising 15% of respondents demonstrated an understanding of 3-MCPD and GEs, indicating the importance of raising awareness about these potential substances. These findings underscore the vital role of education in equipping consumers with the knowledge required to make health-conscious decisions, ultimately contributing to the population's overall well-being.

The widespread utilisation of palm oil as a domestic food product underscores its adaptability and nutritional attributes. This versatile commodity is extensively employed in various culinary applications, including frying, cooking, and baking, and is entrenched in local dietary practices. Remarkably, palm oil's ubiquity and competitive pricing render it a prominent fixture in the local market. The survey findings, encapsulated in Figure 7, resonate with this prevalence.

An overwhelming 88.2% of respondents reported using palm oil in their culinary endeavours, underscoring its integral role in their cooking routines. This is significantly higher compared to other oils. Conversely, 11.8% of respondents opted for olive oil as a cooking and frying medium. Meanwhile, 40% of respondents maintained their usage of oils exclusively for palm and olive oil. A minority within the respondent group explores other oil alternatives, such as canola, corn, coconut, and sesame, often for finishing touches on their prepared dishes. Insight from, underscores the significance of process contaminants, namely monochloropropanediol (MCPD) esters and glycidyl esters (GE), in frying and baking [14]. The survey in Figure 7 aligned with this observation. Notably, 37.5% of respondents indicated that they fried and baked foods weekly, while 34.2% reported engaging in these activities daily. In contrast, 13.3% practices frying and baking once a month, and 11.7% adopted a bi-weekly routine. A minority confessed to occasional or abstinent participation in frying and baking.

These findings aligned with research suggesting that refining processes yield MCPD esters and GEs, with subsequent food processing methods, particularly frying and baking, contributing to their concentration [20]. The implications of this data underscore the need for informed cooking practices that account for potential contaminants in the food preparation process. As consumers engage in diverse culinary practices, this awareness becomes paramount for promoting health-conscious choices. Ultimately, the survey in Figure 7 highlights the multifaceted nature of cooking oil, preferences and consumption patterns, reflecting the complex interplay between culinary practices, nutritional considerations, and awareness of potential contaminants.

Consequently, the outcomes from the survey underscore the prevalent lack of awareness regarding 3-MCPD and GEs as process contaminants inherent to frying and baking practices. Impressively, 88% of respondents indicated unfamiliarity with the fact that 3-MCPD and GEs can be generated during these culinary processes. Conversely, 12% of respondents exhibited awareness of these process contaminants, affirming their understanding of the potential risks associated with 3-MCPS and GEs.

These process contaminants, 3-MCPD and GEs, are implicated in deodorising refined edible oils used in diverse food products, including infant formula. This is noteworthy because these contaminants can be metabolised into free 3-MCPD and glycidol in rodents, thus presenting potential toxicological implications. The similarity in metabolic pathways between humans and rodents underscores the relevance of these findings [21]. Infant formula, a vital dietary component for infants up to six months of age, often incorporates vegetable oils as a source of essential fats. However, these oils may harbour monochloropropanediols (MCPD) and glycidol, further complicating the risk assessment in infant nutrition [22].

Interpreting the survey data presented in Figure 8, it becomes evident that about 89.2% of respondents lacked awareness regarding the presence of 3-MCPD and GEs in infants and toddlers. Conversely, 10.8% exhibited awareness of the high-risk implications associated with 3-MCPD and GEs in infant nutrition. This information highlights the importance of disseminating knowledge about the potential hazards in certain food products, particularly those consumed by the most vulnerable populations, such as infants. Informed consumers are pivotal in demanding higher safety standards and holding manufacturers accountable for producing safe and healthy food options.

As highlighted by, the recognition of 3-MCPD ester and GEs in vegetable oils is well established, although their presence in marine-origin oils remains relatively unexplored [23]. These oils, renowned for their elevated polyunsaturated fatty acid content, are particularly favoured for their potential health benefits. Intriguingly, these contaminants, well-known for their emergence during the processing of refined vegetable fats and oils, also extend their reach to contaminate processed marine oils and food supplements incorporating these oils.

Examining the survey results in Figure 9, 72.5% of respondents reported abstaining from consuming food supplements such as fish oils. In contrast, 27.5% indicated they include food supplements in their dietary regimens. Concerning this, an overwhelming 89.1% of respondents exhibited a lack of awareness concerning the processing contaminants 3-MCPS and GEs despite their documented presence in both refined vegetable fats and oils and processed marine oils, as well as in food supplements that comprise these oils. Conversely, 10.9% of the respondents were acquainted with this aspect.

The European Food Safety Authority (EFSA) published a pivotal

report in 2016 on the risk posed by 3-MCPS esters to human health, attributing them to kidney failure [24]. Depending on food type, these contaminants can manifest as free substances or esters coupled with fatty acids. Free 3-MCPD is categorised as group 2B, potentially carcinogenic to humans, and can affect the kidneys, male fertility, and renal function. In parallel, glycidol is classified as Group 2A. which is likely to be carcinogenic to humans [25].

The data in Figure 9 revealed that about 89.2% of respondents remained unaware of the potential health risks associated with 3-MCPD and GEs. In contrast, 10.8% exhibited awareness of the associated health risks. This discrepancy is aligned with the aforementioned classification, wherein 89.2% were unfamiliar with the impact of these contaminants on kidney health and male fertility. In comparison, 10.8% demonstrated comprehension of these potential health risks. Given these insights, it is imperative to prioritise continuous monitoring and detection of possible health concerns stemming from the consumption of contaminated foodstuffs and vegetable oils. Moreover, a robust implementation of mitigation measures by vegetable oil producers to minimise the presence of these contaminants is vital. Ignoring these aspects could compromise human health and well-being, underscoring the need for ongoing vigilance and proactive measures.

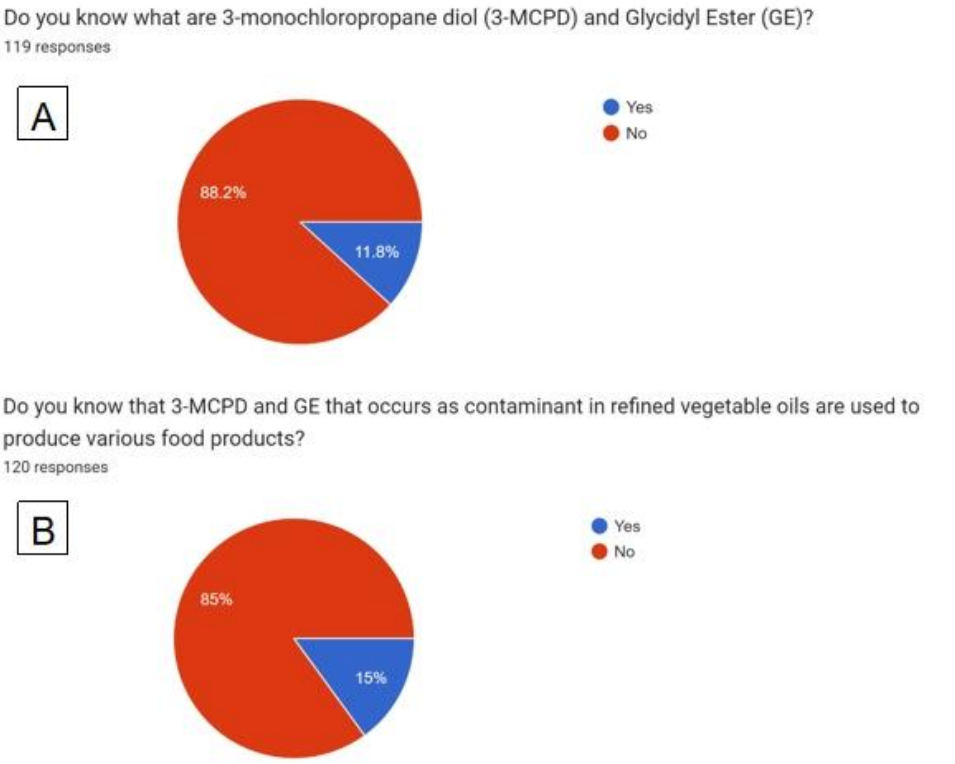

Figure 6 General knowledge about 3-monochloropropanediol (3MCPD) and Glycidyl Ester (GEs) (A) and (B)

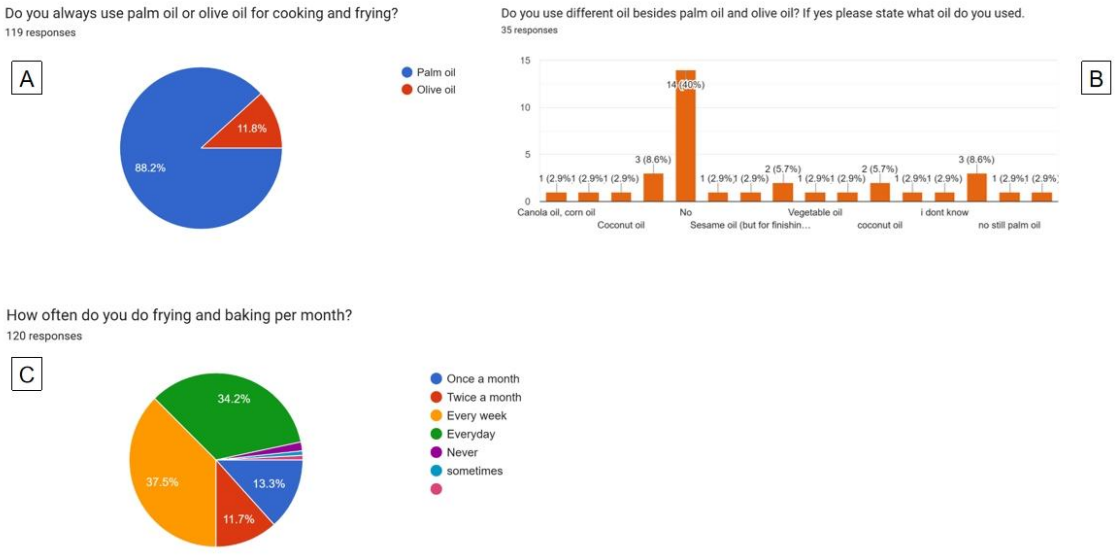

Figure 7 General knowledge about 3monochloropropanediol (3MCPD) and Glycidyl Ester (GE) (A), (B) and (C).

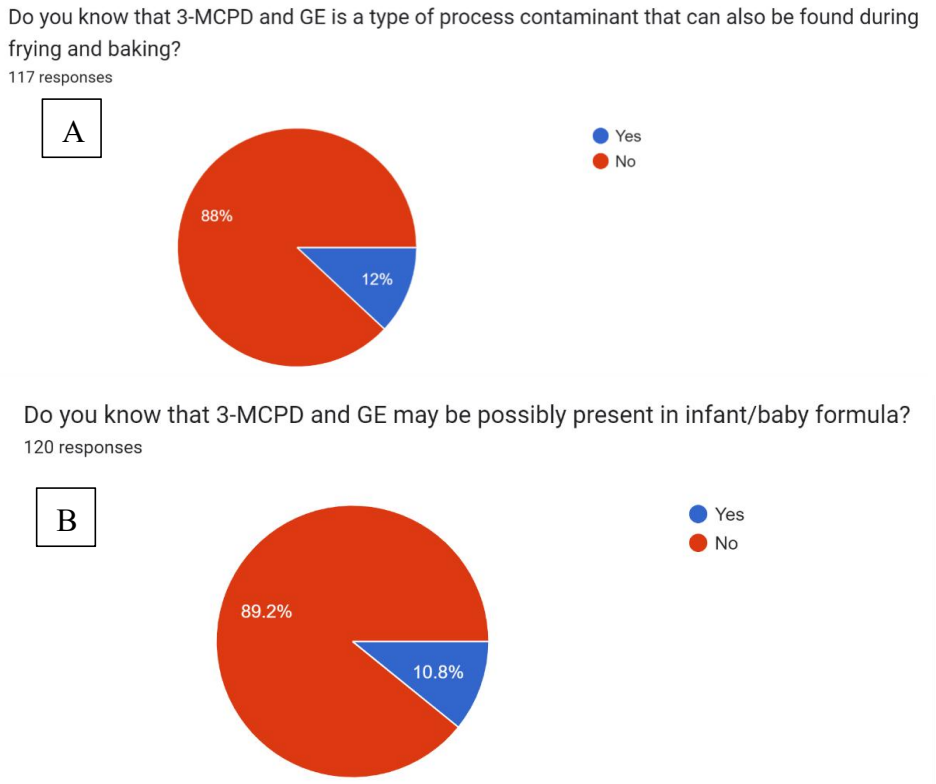

Figure 8 General knowledge about 3-monochloropropanediol (3MCPD) and Glycidyl Esters (GEs) (A) and (B)

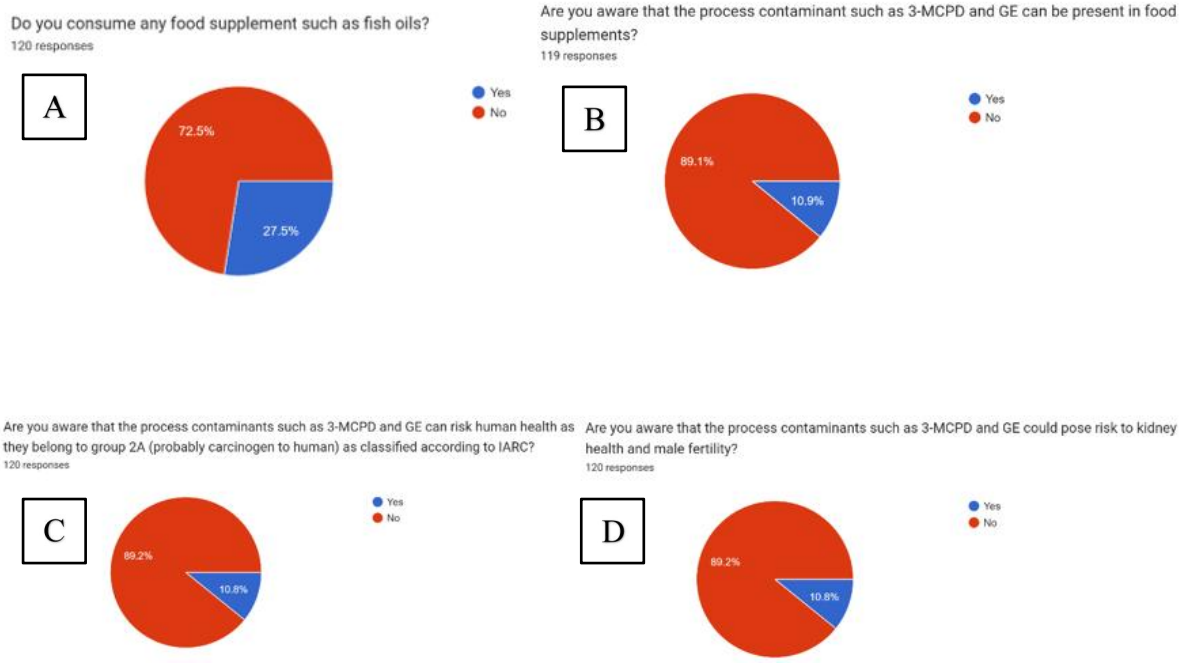

Figure 9 General knowledge about 3-monochloropropanediol (3MCPD) and Glycidyl Esters (GEs) (A), (B), (C) and (D)

Conclusion

In summation, the comprehensive survey in the current study engaged a cohort of 120 respondents in the state of Selangor, Malaysia, underscoring a notable lack of awareness among respondents concerning the potential health risks posed by 3-MCPD and GEs. Despite the prevalent lack of understanding of these contaminants, they are known to impact various food products, including refined vegetable oils, marine-origin oils, and even food supplements containing these oils. The implications of this study extend beyond consumer awareness, delving into the potential health consequences of 3-MCPD and GEs exposure, as elucidated by EFSA's risk assessment. This study highlights the urgency of educating consumers about the hidden risks in commonly consumed food products. The data underscores the need for awareness campaigns and regulatory measures to ensure the safety of dietary choices, particularly given the intricate relationships between contaminants, processing methods, and human health. Educating consumers through informative campaigns, clear product labelling, and mass media is crucial.

Ultimately, the results of this study must prompt further research, discussions, and actions aimed at safeguarding consumer health and fostering informed decision-making in food consumption.

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