

PREVALENCE OF CONSTIPATION IN MALAYSIA AND DECIPHERING PERCEPTION TOWARDS AGARWOOD LEAF PRODUCT AS REMEDY

KHAIRUNNISA ABDHUL MUTHALIB¹, BALKIS A TALIP^{1*}, NADIA NABILA MOHD KODEEM¹, JOHN KWONG SIEW SHIA², ABD. FATHUL HAKIM ZULKIFLI³, HAZIAN SALEH⁴ AND LATIFAH MD. ARIFFIN⁵

¹Department of Technology and Natural Resources, Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia, 84600 Pagoh, Johor, Malaysia. ²Department of Pharmacy Practice and Clinical Pharmacy, Faculty of Pharmacy, Universiti Teknologi MARA Selangor Branch, Puncak Alam Campus, 42300 Puncak Alam, Selangor, Malaysia. ³Centre of Automotive and Powertrain Technology, Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, 84600 Pagoh, Johor, Malaysia. ⁴Synergy One Holding Sdn. Bhd., Block 3A, MTDC-UTM Technology Centre Technology Park, 81300 Skudai, Johor, Malaysia. ⁵Faculty of Mechanical Engineering and Manufacturing, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, Malaysia.

*Corresponding author: balkis@uthm.edu.my

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Abstract: Agarwood leaves hold a significant potential for sustainable product development due to their beneficial bioactive compounds. Previous studies have investigated its leaf extract as a safe treatment for constipation. Constipation is a common malady of the digestive tract, but little is known about its incidence in Malaysia. Conventional remedies like laxatives often cause side effects such as cramping, diarrhoea, and nausea. Hence, this study examines the prevalence of constipation among Malaysians; its treatment approaches (medication, diets) and associated side effects. Additionally, this study also explores public perception and knowledge of agarwood leaves and evaluates their receptiveness to a novel product—a sustainable agarwood leaf extract to provide relief to constipation. An online survey was distributed via Google Forms on social media, which received a total of 413 responses. Results showed 73.8% of respondents reported experiencing constipation recently, with 56.1% saying they suffered negative effects after taking existing remedies. Notably, many respondents did not know about the benefits of agarwood leaf in relieving the condition, although up to 93% was receptive towards the proposed innovation. This survey provides valuable insights into the prevalence of constipation among Malaysians, its treatment methods and the level of public acceptance in consuming agarwood leaf extract to relieve the condition.

Keywords: Sustainability, agarwood leaf, constipation, laxative properties, perception.

Introduction

Agarwood refers to the thick, dark, and fragrant resinous hardwood from *Aquilaria* trees, produced as a stress response towards fungal or microbial infection, physical damage, and insect attacks (CITES, 2022). It is mostly valued for its medicinal properties and scent commodity (Tan *et al.*, 2019a). Agarwood is sometimes referred to as *gaharu* or *karas* (leaves) in Malaysia. *Aquilaria malaccensis* is the most common agarwood species in the country, as well as *A. subintegra*, *A. sinensis*, and *A. crassna* (Zahari *et al.*, 2020; Mokhtar *et al.*, 2021). Traditional medicine practitioners have been utilising *A. crassna*, *A. malaccensis*, and *A. sinensis* in their medication and herbal

concoctions. They are widely grown in southern China, India, and Southeast Asian nations (Wu *et al.*, 2023). Cultivating agarwood trees appears to be a promising venture, but the trees require extensive care until they are old enough for induction—a procedure that stimulates the production of agarwood resin, which usually occurs when the plants are between five and seven years old, and optimal resin production may take up to a decade (Syazwan *et al.*, 2019). The agarwood tree also provides high-yield raw products such as agarwood leaves, with possible economic rewards each year (Wu *et al.*, 2023).

Though not well known, agarwood leaves have been utilised as a traditional medicine in

many Southeast Asian countries (Anmol *et al.*, 2023). It has been used for various health ailments, including immunosuppression, cardiac conditions, digestive issues, respiratory disorders, and neurological problems (Sarmah *et al.*, 2022). Even though agarwood is in great demand, most of its leaves are discarded during the pruning process (Wangiyana *et al.*, 2021). In the 21st century, sustainability consciousness is essential as waste generation rises with an increasing human population and consumption of resources. However, many developing nations lack the knowledge and strategies to safeguard their natural resources. Raising awareness is essential to sustaining global efforts for the next generation, particularly in developing nations, including Malaysia (Azhar *et al.*, 2022). Agarwood leaves present a viable option as a sustainable raw material, offering potential for an eco-friendly product development. They contain a diverse range of chemical compounds, including 2-(2-phenylethyl) chromone, phenolic acids, steroids, fatty acids, benzophenones, xanthonoids, flavonoids, terpenoids, and alkanes, all mostly associated with their pharmacological properties.

A research has shown that extracts from *Aquilaria* leaves possess multiple pharmacological properties such as anti-diabetic and laxative effects (Ito & Ito, 2022). In vivo analyses, agarwood leaf extract has been shown to possess a laxative potential in treating constipation by enhancing intestinal contractions (Hara *et al.*, 2008; Mokhtar *et al.*, 2021). Toxicity studies of *Aquilaria* leaves revealed varied outcomes as reviewed by Mokhtar *et al.* (2021). Methanol extracts of *A. malaccensis* leaves demonstrated cytotoxicity in human cells, causing DNA fragmentation at a high dose of 4,537 mg/kg (IC₅₀ value of 24.5 mg/ml).

However, in the same study, extracts obtained using hexane and essential oils did not exhibit cytotoxicity as the methanol extract, as their cell viability remained above 50%. Apart for that, *A. sinensis* and *A. crassna* leaves (aqueous extract) also exhibited no signs of toxicity in mice, even at high dosages of 2,000

mg to 15,000 mg/kg. Additionally, extracts of *A. subintegra* leaves also showed no cytotoxicity in human cell lines. These findings highlighted the importance of extraction methods and species-dependent toxicity, as well as the need for specific dosage studies, indicating the potential for developing a range of products through comprehensive research (Mokhtar *et al.*, 2021).

Constipation is a common gastrointestinal disorder that has substantial impact on the quality of life. This condition can cause a variety of symptoms such as bloating, stomach discomfort, hard stool, prolonged straining, and infrequent bowel movements. Constipation is deemed a chronic condition in cases where the signs and symptoms last more than a month (Al-Nou'mani *et al.*, 2023). Factors that may contribute to chronic constipation include advanced age, gender (mainly females), dehydration, a diet low in fibre, insufficient physical activity, the use of certain medications (including sedatives, opioids, antidepressants, or blood pressure medications), and mental health conditions such as anxiety or eating disorders (Walke & Sakharkar, 2021). The prevalence of constipation varies worldwide, ranging from 0.7% to 79%, with a median of 16% overall and 33.5% among the elder population (Mugie *et al.*, 2011; Walke & Sakharkar, 2021). However, there is currently a lack of data on constipation cases in Malaysia (Mohamad, 2017). According to Hasim (2017), elderly individuals self-report experiencing constipation 24% to 37% of their time and take laxatives 60% of the time. Current laxative medication and supplements are prone to cause powerful purgative effects such as diarrhoea and cramping (Tabrizi *et al.*, 2020). Taking this into consideration, this study outlines agarwood leaf extract as a new product concept for constipation relief.

A thorough understanding of the current market and demand landscape is essential in developing of a new product. Conducting a study plays a crucial role in assessing market dynamics, public perception, and sustainability of innovative products. Market research not only helps to mitigate risks and uncertainties, but also anticipates market trends that provide a solid

foundation for strategic decisions (Shatawani *et al.*, 2014; Nordin & Raval, 2023). The array of information enables researchers to first evaluate the product for improved effectiveness, sustainability and market perception, before investing more resources in marketing and commercialisation (Frazier & Yang, 2023). In addition to insights gained, the market study also aims to provide information about current problems related to the product. In the context of the development of the agarwood leaf extract remedy, the survey in this study includes questions on respondents' experiences with constipation and its association with demographic information, coupled with an in-depth market study on the new product concept and its perception. The results collected will help gather statistical data on people struggling with constipation and to determine the respondents' receptiveness to agarwood leaf extract as a remedy.

Materials and Methods

Development of Questionnaire

In this study, a survey was conducted to ascertain consumer perceptions on the new product and to analyse respondents' current problems related to constipation. The survey was carried out through a questionnaire developed exclusively for this project. The instrument contained three sections to collect data: (A) Demographic information, (B) constipation experience, and (C) new product concept to relieve the condition (effervescent granules of agarwood leaf extract).

Section A contained four questions on gender, age, race, and occupation. Section B posed four questions regarding the respondent's frequency in experiencing constipation, the medications or dietary measures employed to alleviate their condition, and any adverse effects of the medication they used. Section C included eight questions regarding the consumption of agarwood leaf products, their types and awareness of health benefits. It also explored respondents' perception of the agarwood leaf extract remedy, including the likelihood

of purchasing, utilising and recommending the product, as well as the main criteria for choosing a new supplement and the appropriate price range. Five experts from different backgrounds were appointed to review and evaluate the questionnaire. This team included three academic experts, one industry expert, and one medical expert. Based on their feedback, the items in the questionnaire were constantly improved.

Sample Size Determination

The questionnaire was administered to a convenience sampling method, which was selected based on accessibility and willingness to participate in the study (Macena *et al.*, 2021). Respondents in this sampling method were relatively simple to recruit and generalisations on estimations of demographic variations could be avoided. They may also be beneficial in exploratory inquiries (Guine, 2020). Although not directly applicable, the sample size calculation was a useful indication for this type of study. In this situation, the indicative size was determined using a 95% confidence interval, a level of significance of 5%, and a z-score of 1.96 (Macena *et al.*, 2021). Malaysia's population was recorded at 34,467,965 in 2023, according to the Worldometer's elaboration of the most recent United Nations statistics (Worldometer, 2023). In this study, the Cochran's finite proportion formula was used to calculate sample size as stated in Equation 1 (Aliyu *et al.*, 2021; Pansakun *et al.*, 2024).

$$n = \frac{\left[\frac{Z^2 \times p \times (1-p)}{E^2} \right]}{1 + \left[\frac{Z^2 \times p \times (1+p)}{E^2 \times N} \right]} \quad (1)$$

where n is required sample size, N is total population size, Z is z-score corresponding to the desired confidence level (approximately 1.96 for a 95% confidence level), p is estimated proportion of the population with a particular characteristic [assuming 0.5 (50%) for maximum variability], and E is margin of error (precision) of 0.05 (5%).

Research Ethics

Ethics approval for this study is obtained from Research Management Centre (RMC) of Universiti Tun Hussein Onn Malaysia (UTHM) with reference number UTHM/RMC/100-9/139 Jld. 3 (43).

Conducting the Survey

The questionnaire was prepared in Google Forms and distributed via social media. The inclusion criteria for respondents were as follows: Malaysian citizens who had Internet access and were willing participate in this study. Permission was obtained from parents or guardians of respondents under 18.

Survey Data Analysis

Data was compiled using IBM SPSS Version 27 (IBM Corp, Armonk, NY, USA). The chi-square test and crosstabs were used to explore the correlation between categorical variables. The Cramer's V coefficient value was used to describe the strength of association between variables. This coefficient ranged from 0 to 1 and had the following meaning: $V \approx 0.1$ indicating weak association; $V \approx 0.3$ indicating moderate association; and $V \approx 0.5$ and above, indicating significant association. Chi-square tests were performed using the following null and alternative hypotheses:

Null hypothesis (H0): There are NO significant differences between groups regarding measured variables.

Alternative hypothesis (H1): The differences between groups are significant.

In every instance, H0 was accepted if the p -value was greater than 0.05. If the p -value was less than 0.05, H0 was rejected, and H1 was accepted.

Results and Discussion

Demographic Information

Table 1 shows the demographic information of the survey. From a total of 413 respondents, 64.9% were female and 35.1% were male. The Cochran's finite proportion formula calculated a sample size of 384 respondents for this study to be representative. Respondents' age groups were as follows: Under 12 (1.0%), 12 to 17 (2.9%), 18 to 24 (31.5%), 25 to 34 (35.1%), 35 to 44 (12.3%), 45 to 54 (12.8%), 55 to 64 (3.4%), and above 64 (1.0%). The respondents were predominantly Malays (85.7%), followed by Indians (5.8%), Chinese (4.1%), and others (4.4%). In terms of occupation, the highest percentage was students (38.3%), followed by civil servants (8.5%), private sector employees (34.6%), self-employed (12.8%), and statutory corporation workers (0.2%). The respondents also comprised housewives (3.6%), the unemployed (1.5%), and retirees (0.5%).

Experience of Constipation

Section B of the questionnaire contained items on personal experiences of constipation. According to Mohamad (2017), there were no conclusive statistics about the prevalence of constipation in Malaysia. Data concerning the number of respondents who suffered from constipation might be inferred and calculated from the responses received.

As shown in Figure 1 (a), 73.8% of total respondents reported experiencing constipation. According to Patimah *et al.* (2017) and Walke and Sakharkar (2021), self-reported instances of constipation ranged from 1.4% to 32.9% in Asia and from 0.7% to 79% worldwide. In Figure 1 (b), the majority of respondents turned to herbal products or supplements as a remedy.

Table 2 represents the cross-tabulations between demographic variables and experiences of constipation by respondents. There were significant differences between constipation experience and gender and race, even though the correlations were weak ($V=0.209$ and $V=0.161$). On the other hand, age and occupation showed

Table 1: Demographic variable

Demographic Variable		Frequency (n = 413)	Percentage (%)	
Gender	Female	268	64.9	
	Male	145	35.1	
Age (years old)	Under 12	4	1.0	
	12-17	12	2.9	
	18-24	130	31.5	
	25-34	145	35.1	
	35-44	51	12.3	
	45-54	53	12.8	
	55-64	14	3.4	
	Above 64	4	1.0	
Race	Malay	354	85.7	
	Indian	24	5.8	
	Chinese	17	4.1	
	Other	Malabari	15	3.6
		Indian Muslim	2	0.5
Iban		1	0.2	
Occupation	Student	158	38.3	
	Civil servants	35	8.5	
	Private sector employees	143	34.6	
	Self-employed	53	12.8	
	Other	Housewife	15	3.6
		Unemployed	6	1.5
		Retired	2	0.5
	Statutory corporation workers	1	0.2	

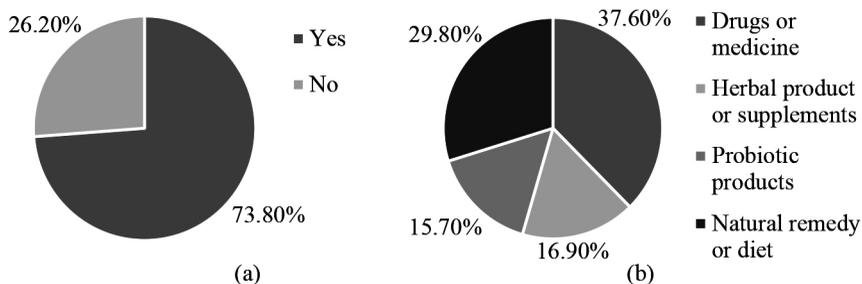


Figure 1: Pie charts showing responses to two questions related to constipation: (a) 'B1: Have you ever experienced constipation?' highlighting the proportion of respondents who answered 'Yes' and 'No' and (b) 'B4: What kind of medication or diet do you consume?' illustrating the distribution of preferences across the given categories

no significant differences with constipation experience. According to the survey, a majority of the respondents had experienced constipation. Out of the 73.8% of respondents who reported yes, 0.6% reported having it on a daily basis, 11.4% a few times a week, 19.7% a few times a month, 19.3% less than three times a month, and 48.9% a few times in a year. The cross-tabulations between the demographic variables and the frequency of constipation are shown in Table 2.

Significant differences were shown only with p -value of 0.004, but the association was weak ($V = 0.223$). This indicated that while gender had some influence on constipation, it was not a strong predictor. Previous research revealed that women were two times more probable to having constipation and around twice as prone as men to experience chronic constipation (Werth & Christopher, 2021).

Several factors might contribute to the higher rates of constipation observed in females, including susceptibility to pelvic floor muscle and nerve injuries, and the influence of sex hormones on gastrointestinal motility and the autonomic nervous system. Research had highlighted that elevated progesterone levels during the luteal phase of the menstrual cycle and pregnancy might prolong gastrointestinal transit time (Iraji *et al.*, 2012; Alqudah *et al.*, 2022). As shown in Table 2, there was no significant difference between age group and experience in constipation, which was similar to studies that showed no clear association between younger and older age groups in terms of frequency. In addition, previous research also showed that there were no significant differences between groups such as employment status and ethnicity with constipation issues (Werth & Christopher, 2021).

A total of 58% of respondents who experienced constipation did take medication or changed their diet to relieve the problem. However, Table 2 displays the lack of significant differences in the correlation between respondents' demographic factors and their utilisation of medication or diet to relieve

constipation. These findings suggested that demographic factors were not associated with remedial actions. Remedial actions were divided into several categories as shown in Figure 1 (b): Drugs or medicine (37.6%), herbal products or supplements (16.9%), probiotic products (29.8%), and natural remedies or diet (29.80%). As reported by Bruce (2022), there were several medications to treat constipation such as fibre supplements (calcium polycarbophil, methylcellulose, psyllium, and wheat dextrin), osmotic supplements (magnesium citrate, magnesium hydroxide, lactitol, and polyethylene glycol), and stimulants like bisacodyl and sennosides.

The correlation between the use of medication or diet to relieve constipation and side effects is shown in Table 3. The cross-tabulation analysis using the chi-square test indicated a significant correlation between the groups, with a p -value of less than 0.001 and a strong association as evidenced by Cramér's V of 0.785. A significant proportion of respondents who took medications (34.3%) and herbal supplements (15.7%) had suffered side effects such as diarrhoea.

As stated by Tabrizi *et al.* (2020), constipation treatment remained a significant clinical challenge. In a recent study involving 5,000 patients, approximately half of those taking medication for constipation had expressed dissatisfaction with their current treatment regimen. This arose from the side effects such as flatulence, stomach pain, crampy diarrhoea, and nausea (Bruce, 2022). Repeated doses of medications might have a purgative effect, potentially leading to colorectal dysfunction and enteritis (Tabrizi *et al.*, 2020). Apart from these, laxatives derived from crude extracts of senna, rhubarb, rose fruits, genka, and pharbitis seeds were also observed to have strong laxative effects that caused crampy diarrhoea (Hara *et al.*, 2008). These observations raised the need for therapies that had less side effects such as agarwood leaf-based remedies. Based on *in vivo* assessments from a few prior research, agarwood leaf extract had shown laxative properties in the treatment of constipation without leading to diarrhoea or

Table 2: Association between demographic variables and constipation

Question	Gender ¹		Age ¹										Race ¹					Occupations ¹				
	Female	Male	Under 12	12-17	18-24	25-34	35-44	45-54	55-64	Above 64	Malay	Indian	Chinese	Other	Student	Civil servant	Private sector employee	Self-employee	Other			
B1. Have you ever suffered from constipation?																						
a. Yes	52.3	21.5	0.7	2.7	21.5	26.9	9.4	9.2	2.9	0.5	65.6	3.6	1.9	2.7	28.8	6.8	26.4	7.5	4.4			
b. No	12.6	13.6	0.2	0.2	9.9	8.2	2.9	3.6	0.5	0.5	20.1	5.8	4.1	4.4	9.4	1.7	8.2	5.3	1.5			
<i>p</i> -value ²	<0.001		0.430																			
CC ³	0.209		0.130																			
B2. If your answer is 'Yes' in Question 1, how often do you experience constipation?																						
a. Everyday	0.3	0.3	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0			
b. A few times a week	9.8	1.6	0.3	0.3	3.6	3.3	1.6	1.6	0.7	0.0	9.8	1.0	0.3	0.3	3.9	1.6	3.6	0.3	2.0			
c. A few times a month	16.7	3.0	0.0	0.7	6.6	6.9	2.6	1.6	1.0	0.3	17.4	0.7	0.7	1.0	8.9	1.6	5.2	2.6	1.3			
d. Less than three times a month	13.4	5.9	0.3	1.0	5.2	8.2	0.7	3.3	0.3	0.3	15.7	2.3	0.7	0.7	7.5	1.0	8.9	1.3	0.7			
e. A few times a year	30.5	18.4	0.3	1.6	13.1	18.0	7.9	5.9	2.0	0.0	45.2	1.0	1.0	1.6	18.0	4.9	18.0	5.9	2.0			
<i>p</i> -value ²	0.004		0.816																			
CC ³	0.223		0.132																			
B3. If your answer is 'Yes' in Question 1, do you take any medication or diet to ease constipation?																						
a. Yes	42.6	15.4	0.3	3.3	16.4	20.3	8.9	5.9	2.3	0.7	50.2	3.3	2.3	2.3	22.0	4.6	20.7	6.6	4.3			
b. No	28.2	13.8	0.7	0.3	12.8	16.1	3.9	6.6	1.6	0.0	38.7	1.6	0.3	1.3	17.0	4.6	15.1	3.6	1.6			
<i>p</i> -value ²	0.235		0.130																			
CC ³	0.098		0.192																			

¹Percentages in column, ²*p*-value of chi-square test at significance level of 5%, ³Cramer's coefficients, *V*.

Table 3: Association between medications and diets used to ease constipation and the presence of side effects post-usage

Question		B5. Do you suffer from any side effect such as diarrhoea from the medication, herbal product, supplement, probiotic product, or diet? ¹			
		Yes	No	p-value ²	CC ³
B4. If your answer is 'Yes' in Question 3, what kind of medication or diet that you consume?	Drugs or medicine	34.3	3.4	< 0.001	0.785
	Herbal product or supplements	15.7	1.1		
	Probiotic products	2.2	13.5		
	Natural remedy or diet	3.9	25.8		

¹Percentages in column, ²p-value of chi square test at significance level of 5%, ³Cramer coefficients, *V*.

developing any negative side effects (Hara *et al.*, 2008; Kakino *et al.*, 2010; Ito *et al.*, 2012).

Knowledge about Agarwood and New Product Perception

In Section C of the questionnaire, respondents were asked on their knowledge about agarwood and their perception of agarwood leaf extract effervescent granules as a remedy for constipation. Based on the responses received in Figure 2 (a), only 8.2% of respondents had consumed agarwood leaf-based products, whereas 91.80% had not. This was despite the fact that agarwood had been valued for its

medical and religious uses for thousands of years. This showed that people were familiar only with agarwood chips, powder, and oil, which were used in perfumes, incense, and traditional medicine because the industry primarily focused on wood derivates of the tree (Adhikari *et al.*, 2021).

Of the respondents who consumed agarwood leaf products, the vast majority (94.1%) said they drank it as a beverage and the others said they consumed it from confectionery (5.9%) [Figure 2 (b)]. Agarwood leaves were valued for their diverse chemical constituents, which contribute to various pharmacological

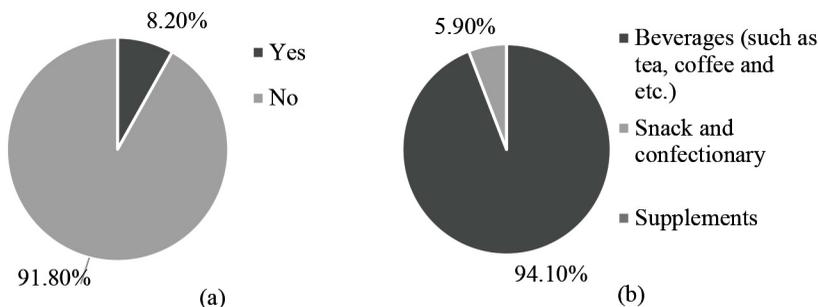


Figure 2: Pie charts showing consumer responses to two questions related to agarwood leaf-based products, (a) 'Have you ever consumed any agarwood leaf-based products?' illustrating the proportion of respondents who answered 'Yes' and 'No' and (b) 'What type of agarwood leaf-based product have you consumed?' depicting the distribution of product types (e.g., beverages, snacks and confectionary, supplements) among those who answered 'Yes' to (a)

effects (Wangiyana & Nikmatullah, 2022). There were several agarwood-based products were available under the Holistic Gaharu (HOGA) brand, marketed by Gaharu Technologies Sdn. Bhd., Malaysia's first organic and sustainable agarwood plantation located in Gopeng, Perak. The product range included agarwood herbal tea, cereal oat drink, coffee, health supplements, cooking ingredients, snacks and confectionery, cosmetics, hygiene products, and more (HOGA, 2023).

As displayed in Figure 3, a majority of 76.5% of respondents were unaware of the benefits of agarwood leaves. This lack of awareness might be attributed to the limited research and the scarcity of products in the market. According to Wangiyana *et al.* (2021), agarwood leaves are usually not utilised as the trees were mainly cultivated for their wood and resin.

The resin takes 10 years to produce whereas the leaves could be used when the tree reached about 3-year-old (Wangiyana *et al.*, 2021). Research on agarwood leaves of the *Aquilaria* species had discovered that these leaves contained a variety of compounds that might have therapeutic use. Unfortunately, limited study had been done on the bioactive components found in agarwood leaves (Zaki *et al.*, 2018). These opportunities should be utilised to diversify the agarwood leaf-based study and sustainable product development.

According to the results of the survey, data on the likelihood that respondents would consider utilising this new supplement to relieve constipation was gathered. Table 4 demonstrates the association between first reaction regarding

this new product with likelihood to purchase or recommend it to others, as well as a price range that they felt comfortable paying. The correlation between first reaction and likeliness to consume the supplement was significant ($p < 0.001$) with moderate association ($V = 0.345$). Most respondents indicated a likelihood to take this agarwood leaf-based supplement to ease constipation (total of 86.8%) with 14.4% extremely likely, 32.9% very likely, and 39.5% somewhat likely. Only 13.2% responded that they were not likely to take the supplement.

Furthermore, the significant number of respondents eager to utilise the supplement indicated a strong market need and prospective demand for the product. The Malaysian Adults Nutrition Survey (MANS) of 2014 reported that 34% of adults in the general population used food supplements and 28.1% used multivitamin-mineral supplements. These figures represented an increase from the 2003 survey, where the respective percentages were 23.9% and 24.8% (Zaki *et al.*, 2018; Ashri *et al.*, 2021). In addition, it was estimated that approximately 80% of the global population relied on complementary and traditional medicine for health treatment and well-being (Jamaludin *et al.*, 2024). A prior survey revealed that the use of oral dietary supplements had increased from 47.7% before the COVID-19 pandemic to 55.3% afterwards, as individuals sought to safeguard their health (Lee *et al.*, 2021).

Apart from this, the initial reaction of respondents to this product was extremely positive, as well as the likelihood that they would purchase or recommend it to others. The correlation between initial reaction and

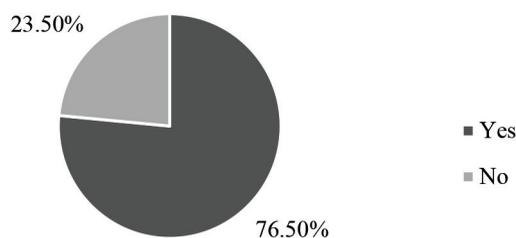


Figure 3: Pie chart showing consumer responses to the question 'C3: Are you aware of the health benefit of agarwood leaves?'. The chart emphasises the percentages of 'Yes' and 'No' answers

Table 4: Association between first reactions to the new product and willingness to take or recommend agarwood leaf extract effervescent granules as a remedy for constipation

Question		C5. What is your first reaction to this new product? ¹					p-value ²	CC ³
		Very Positive	Somewhat Positive	Neutral	Somewhat Negative	Very Negative		
C4. Will you consider taking agarwood leaf extract effervescent granules as supplement to ease constipation?	Extremely likely	11.1	2.2	1.0	0.0	0.0	< 0.001	0.345
	Very likely	13.6	15.5	3.6	0.2	0.0		
	Somewhat likely	4.4	16.7	17.9	0.5	0.0		
	Not so likely	0.7	2.9	6.5	0.5	0.0		
	Not at all likely	0.2	0.2	1.9	0.0	0.2		
C6. If this product is available in the market, how likely are you to purchase or recommend it to others?	Extremely likely	14.0	1.9	1.2	0.0	0.0	< 0.001	0.463
	Very likely	13.1	24.2	5.3	0.0	0.0		
	Somewhat likely	2.7	10.4	19.6	1.0	0.0		
	Not so likely	0.2	1.0	4.4	0.2	0.0		
	Not at all likely	0.0	0.0	0.5	0.0	0.2		

¹Percentages in column, ²p-value of chi square test at significance level of 5%, ³Cramer coefficients, *V*.

the likelihood of buying or recommending showed significant differences ($p < 0.001$) with a relatively strong association ($V = 0.463$) (Table 4). In terms of purchasing or recommending the new product, most respondents showed a strong likelihood: 17.2% extremely likely, 42.6% very likely, and 33.7% somewhat likely. This contrasted with the smaller percentages who were less likely, with 5.8% not very likely, and 0.7% not at all likely. These indicated that most respondents perceive this product positively and were likely to purchase it.

The findings underscored the favourable reception of the new product among respondents, with overwhelming majority showing openness towards purchasing or recommending it. Purchase intention was described as a person’s behavioural intention that is contingent upon their attitude towards behaviour and relative norms (Tan *et al.*, 2019b). An important variable in consumer research was purchase intention, which represented the purchase behaviour of

customers. It was often used to predict sales of currently offered goods and services, to determine the likelihood that a product would be purchased within a certain period of time. This limited set of variables was often used for a variety of research objectives (Peña-García *et al.*, 2020).

Customer perception when purchasing nutraceutical products could be influenced by various factors as described in some articles; health benefits, safety, price, reason of use, ease in usage, taste, nutritional content, and quality (Teoh *et al.*, 2020; Salman *et al.*, 2022). For this market survey the factor as listed as such; easy to consume, health benefit, nutritional content, phytochemical content, quality, packaging type, weight of product, effectiveness, and price. The outcome, as demonstrated in Figure 4, shows a large number of respondents choosing health benefit, with 238 responding that the criteria was important in purchasing supplements. In line with this, Teoh *et al.* (2020) also stated

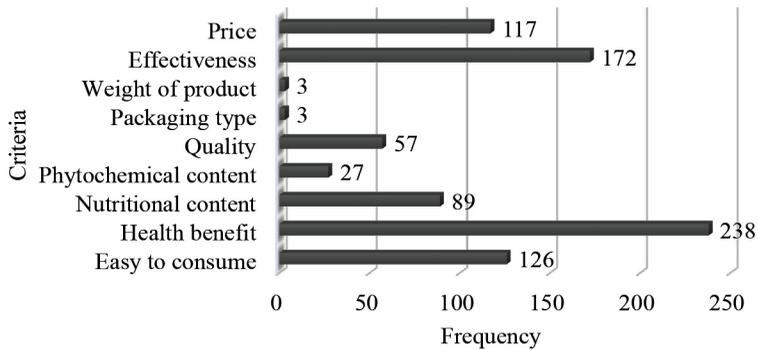


Figure 4: Chart showing consumer responses to the question ‘C7: When considering new supplements, which criteria play the most important role in your choice?’. The chart illustrates the distribution of preferences among the listed criteria

health benefits as a critical component in determining the intention to use nutraceutical products. The second most important criterion was efficacy (172 responses), followed by ease in consuming (126), price (117), nutritional content (89), quality (57), phytochemical content (27), and product presentation and quantity (3, respectively). These findings provided significant insights into customer preferences and priorities, as well as crucial assistance for manufacturers and marketers looking to efficiently adjust their product offerings to match consumer needs.

The final question in this market survey addressed the suitable price range of the agarwood leaf extract effervescent granules that respondents preferred based on the current market as shown in Figure 5. More than half of respondents (53%) chose between RM15.00 and RM24.00. The next, 30% chose

between RM25.00 and RM34.00, followed by 10.9% between RM35.00 and RM44.00, 4.6% between RM45.00 and RM54.00, and 1.5% between RM55.00 and RM64.00. Based on a variety of customer expectations, these findings provided practical advice for pricing methods. Nutraceutical product prices must be affordable for participants to continue utilising the product. Based on a survey carried out by Teoh *et al.* (2020), respondents indicated that cost was a crucial factor in selecting nutraceuticals, and it must be reasonable. Overall, from this survey it could be perceived that majority of respondents took the concept of this new product development positively with high percentage in purchasing. Therefore, this study might not be generalised to all people. For instance, some of respondents had no medical condition and a few who did not take nutraceutical products probably had different preferences (Teoh *et al.*, 2020; Salman *et al.*, 2022).

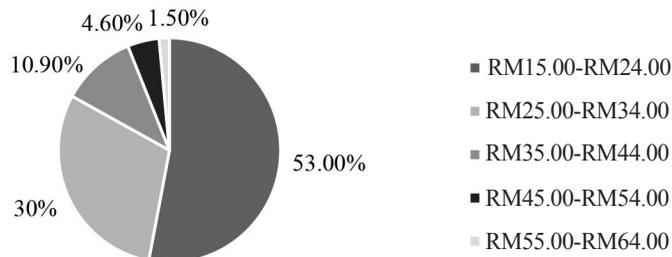


Figure 5: Pie chart showing consumer responses to the question ‘C8: What price range do you consider appropriate for the agarwood leaf extract effervescent granules (1 pack of 10 sachets)?’. The chart displays the proportion of preferences on different range of price

Conclusions

In summary, our survey found a considerable prevalence of constipation in different demographic groups. Statistical analysis revealed significant associations between constipation, gender and race. The majority resort to medication or natural diets, which they reported often came with side effects such as diarrhoea. The positive response to our agarwood leaf extract effervescent granules with laxative properties signalled a promising market entry with a focus on sustainability. Remarkably, almost 100% of respondents were unaware of agarwood leaf products, indicating an untapped market. This provided an opportunity to introduce agarwood leaf-based products in various sectors. The study also highlighted the potential to introduce new agarwood leaf-based remedy, which were in line with the increasing demand for health-promoting dietary supplements. Agarwood leaves were thus a promising sustainable raw material for future research and product development, meeting the criteria that consumers considered crucial when choosing dietary supplements.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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