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Do Consumers Have the Willingness to Try Microalgae as an Alternative Protein Source?

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Abstract. The increasing consumption needs of society have led to a rise in food demand, which continues to grow along with the population increase. Every year, the government implements various efforts to meet these growing consumption demands. Using alternative food sources can meet the public's dietary needs. One such alternative is microalgae, which is considered a promising food source. However, it is still relatively unfamiliar to the public, necessitating strategies to raise awareness about this ingredient. Several factors can influence customer attitudes, making them more open to trying new things, thereby positively affecting consumer willingness to try microalgae as an alternative food source. This study aims to investigate the influence of environmental concerns, health interests, food neophobia, and knowledge on consumer attitudes toward trying microalgae as a preferred alternative protein source. It also examines whether consumer attitudes influence willingness to try microalgae moderated by self-efficacy. The research employed a quantitative approach, with a sample size of 400 respondents determined using multistage sampling. Primary data were collected through a closed questionnaire. Data analysis was conducted using descriptive statistical analysis and SEM-PLS (Structural Equation Modeling-Partial Least Square) with the WarpPLS 8.0 software. The results indicate that environmental concern, health interest, and knowledge have positive and significant effects on consumer attitudes, while neophobia has a negative and insignificant effect. Furthermore, consumer attitudes influenced willingness to try, with self-efficacy strengthening the relationship between attitudes and willingness to try microalgae as a preferred alternative protein source.

Keywords: alternative protein source; consumer attitudes; multistage sampling; self-efficacy

INTRODUCTION

The significant increase in food demand is driven by global population growth, changing lifestyles, and rising wealth in society (Bouyssou et al., 2024; Rozi et al., 2023; Fukase & Martin, 2020). According to data from Indonesia's Central Bureau of Statistics (BPS) (2023), protein consumption in Indonesia increased by 0.1 grams/day between 2022 and 2023, which has led to a higher demand for protein to meet the dietary needs of the population. This rising food demand annually necessitates sustainable solutions to help society fulfill daily nutritional requirements (Erhard et al., 2023).

Various alternative foods can serve as a sustainable solution, offering an alternative source of energy (Helmy et al., 2023). However, alternative foods are still relatively new and unfamiliar to consumers, making it crucial to provide information about these options to encourage consumers to try them. One such alternative is a protein derived from microalgae (Wassmann et al., 2024). Microalgae-based food products are considered beneficial as a source of nutrition for both humans and the environment (Esakkimuthu et al., 2024; Wassmann et al., 2024). Microalgae provide protein, unsaturated fatty acids, and carbohydrates with significant potential health benefits (Canelli et al., 2020). These microorganisms include approximately 200,000 species of photosynthetic and heterotrophic microorganisms with diverse genetic, morphological, and physiological characteristics (Torres et al., 2020). Species such as *Spirulina maxima* (Koyande et al., 2019), *Chlorella vulgaris*, and *Chlorella pyrenoidosa* contain up to 70% dry cell weight in protein, making them viable as alternative protein sources (Helmy et al., 2023). Microalgae grow effectively using CO2 as a carbon source (Qiu et al., 2018), playing a critical role in carbon capture while producing alternative proteins for food production. Previous research recorded 13,090 microalgae-based products on the market from 2015 to 2019, consisting of 79% food and 21% beverages (Boukid &

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Castellari, 2021). These products include health supplements, animal feed, and foods such as meat analogs and chocolate bars (Oliveira & Bragotto, 2022).

However, limited knowledge about microalgae among Indonesians has resulted in low willingness to try it as an alternative protein source (Oliveira & Bragotto, 2022). The public's inclination to adopt microalgae in their diet remains low, as they consider various factors before trying unfamiliar products. Information and promotion are essential for building trust in new foods (Lopez et al., 2021), making them necessary tools to encourage consumer engagement and participation in trying these foods (Manohar et al., 2021). The acceptance process for new foods is challenging, as they are not easily integrated into dietary habits (Lopez et al., 2021; Wardania & Rachmina, 2024). Human preferences for food products are shaped by complex factors such as culture, experience, and personal characteristics (Erhard et al., 2023; Soeyatno et al., 2024).

Food acceptance is measured by willingness to eat and is influenced by food neophobia. Food neophobia refers to a reluctance or avoidance of trying new foods (Thamara et al., 2020). Foods unfamiliar to the public often face high rejection during the acceptance process. Rejection can stem from cognitive factors like food perception, categorization, emotions, and feelings related to food (Costa et al., 2021; Espinoza-Bernardo et al., 2022), as well as social and environmental factors, including past experiences, surroundings, and the impact of social facilitation (Lafraire et al., 2016). Therefore, promoting attributes of health and naturalness is essential to engage potential consumers interested in new experiences (Lopez et al., 2021). Additionally, consumer willingness to try new foods in daily life is influenced by factors such as environment, health, and knowledge about the food (Stone et al., 2023). Environmental concern in this context involves consumers' efforts to protect the environment by consuming natural or environmentally friendly food products (Talwar et al., 2021; Sharma et al., 2021). This approach emphasizes environmental balance in consumption, which is expected to benefit both the environment and provide sustainable advantages.

The factors mentioned above can influence consumer attitudes toward trying new foods. Attitude refers to consumer reactions to specific issues, reflecting a tendency to act based on their evaluations (Sharma et al., 2021; Nystrand & Olsen, 2020). Consequently, attitudes are formed through consumer assessments and evaluations (Szczepanski et al., 2024). These attitudes can subsequently lead to behaviors such as willingness or unwillingness to engage in specific actions. This study examines self-efficacy as a variable that can influence the relationship between attitude and consumer willingness to try new foods. Previous research by Salleh et al. (2018) investigated the moderating effect of self-efficacy on the relationship between attitude and consumer willingness to adopt healthy foods. Self-efficacy plays a role in strengthening consumer attitudes toward willingness to try healthy foods (Nystrand & Olsen, 2020).

The public is generally unfamiliar with microalgae as an alternative protein source (Wahyuningtyas et al., 2024). This is due to limited available information and the fact that few microalgae cultivation initiatives in Indonesia produce ready-to-eat products. As a result, many people are unaware that microalgae can be consumed daily, such as as an ingredient in snack foods. This research is highly important considering the potential for developing microalgae and microalgae-infused foods, which hold significant opportunities as an alternative protein source. Therefore, this study aims to examine how environmental concerns, health interests, neophobia, and knowledge influence consumer attitudes toward trying microalgae. And whether self-efficacy can moderate the relationship between consumer attitudes and their willingness to try microalgae as an alternative protein source?

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METHODS

Method of collecting data

This is an explanatory quantitative study aimed at analyzing causal relationships between the variables under observation. The research was conducted between August and December 2024 in five regencies/cities in East Java, including Banyuwangi, Jember, Situbondo, Probolinggo, and Malang. The location selection for this study employed the purposive area method, which is a method used to determine research objects based on the research objectives (Jayanti Mandasari et al., 2019). This consideration was made due to the potential and opportunities for developing microalgae cultivation as an alternative protein source for daily consumption in the waters of these areas.

The types of data used include both primary and secondary data. Primary data were collected through closed questionnaires, while secondary data were obtained from literature reviews used to explain the primary data collected. The researchers set several criteria for respondents, including being over 15 years of age and having tried at least one new food item. The requirement to have tried at least one new food ensures that the respondents have some experience with unfamiliar foods. This study uses data collection done through an online closed questionnaire. The questionnaire used a 5-point Likert scale for measurement. The questionnaire was created using Google Forms and distributed online. The sample determination in this study used the probability sampling method with a multistage technique. This approach makes the sampling process more efficient and practical without compromising the principles of probability (Imran, 2017). The stages in determining the sample using the multistage technique are as follows: Stage 1 (selection of regions), Stage 2 (selection of villages/sub-districts), Stage 3 (selection of respondents), and sample proportion. Furthermore, the total sample size used in this study was 400 respondents (rounded from 394.96) based on the Lameshow formula as shown in Equation 1.

$$n = \frac{N.Z^2.p.(1-p)}{(N-1).E^2+Z^2.P.(1-p)} \quad 1)$$

$$n = \frac{5.623.092.\ 1.96^2.0.5.(1-0.5)}{(5.623.092-1).0.05^2+1.96^2.0.5.(1-0.5)}$$

$$n = \frac{2.600.417.5568}{14.058.6879}$$

$$n = 394.96$$

Information:
n = Number of samples required, Z = The z score for the desired confidence level (1.96 for a 95% confidence level), P = Estimate the proportion of the population that has the same characteristics as the sample (50%), E = The desired margin of error is 5%, N = The population size of East Java in 5 districts/cities over 15 years is 5.623.092 people.

A research instrument is considered valid if it can measure what it intends to measure and reveal data from the studied variables. On the other hand, the reliability test results are used to determine whether the instrument is valid.

Table 1. Validity test results

Coefficient Value	No Item		
	1	2	3
Environmental Concern	0.000	0.002	
Health Interest	0.000	0.000	0.001
Neophobia	0.000	0.001	
Knowledge	0.001	0.002	0.001
Attitude	0.000	0.000	
Self-Efficacy	0.000	0.001	
Willingness To Try	0.000	0.000	0.001
Validity Test Criteria	< 0.05	< 0.05	< 0.05
Information	Valid	Valid	Valid

*coefficient <0.05 = valid, Source: Primary Data Processed (2024)

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Based on Table 1, the validity test analysis results show that all question items for all variables have a coefficient value of less than 0.05, thus being declared valid. Therefore, the questions in this research questionnaire can be used to measure the research variables. This aligns with the statement by Solimun et al. (2017), which states that if the coefficient value is less than 0.05, the statistical test can be considered valid.

Table 2. Reliability test results

Variable	Cronbach's Alpha Based On Standardized Items	Number of Items	Information
Environmental Concern	0.825	2	Reliable
Health Interest	0.733	3	Reliable
Neophobia	0.861	2	Reliable
Knowledge	0.733	3	Reliable
Attitude	0.861	2	Reliable
Self-Efficacy	0.746	2	Reliable
Willingness To Try	0.812	3	Reliable

Source: Primary Data Processed (2024)

Based on Table 2, the reliability test results for all variables show that Cronbach's Alpha value is greater than 0.7. A good composite reliability coefficient is ≥ 0.70, although it is not an absolute standard (Solimun et al., 2017). Thus, it can be concluded that the questionnaire for these seven variables is reliable and can be used for further data analysis.

This study examines the factors influencing consumers' willingness to try microalgae as an alternative protein source based on the Theory of Planned Behavior (TPB), with factors such as environmental concern, health interest, neophobia, and knowledge affecting consumer attitudes. These attitudes then influence their willingness to try microalgae, with self-efficacy acting as a moderating factor according to Bandura's Self-Efficacy Theory. The hypothesis testing used a two-tailed test with a significance level of 0.05, where the hypothesis is rejected if the p-value > 0.05 and accepted if the p-value ≤ 0.05 (Handayani, 2021).

Data analysis methods

The descriptive statistical test is helpful in transforming data into a more easily understood form, providing more concise information (Ashari et al., 2017). Descriptive statistical analysis is supported by the presentation of calculations of data distribution, including minimum and maximum values, as well as averages of the variables used in the study. SEM-PLS (Structural Equation Modeling-Partial Least Squares) analysis is employed using WarpPLS 8.0 analysis software to analyze the complex relationships between variables. The SEM-PLS analysis method using WarpPLS has two structural models: the outer and inner models. The outer model measures the relationships between the latent variables and the indicators for each variable in the study (Budiarsi, 2020). This model is used for testing validity and reliability, including convergent validity, discriminant validity, and composite reliability. The inner model is a measurement model used to describe the relationships between latent variables based on the study's theoretical framework (Solimun et al., 2017). In this model, measurements are performed to test the relationships between latent constructs. Several tests in the inner model include evaluating R-Square values, estimates for path coefficients, and goodness of fit (Semuel & Putra, 2018).

Thus, this research model, as shown in (Figure 1) explains the factors influencing the willingness to try through the variables

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of attitude and self-efficacy. The contributing factors include Environmental Concern (X1), Health Interest (X2), Neophobia (X3), and Knowledge (X4), each with its respective indicators. These factors contribute to the formation of attitude (Z1), which then affects the willingness to try (Y1). Additionally, self-efficacy (Z2), which also has its indicators, also plays a role as a moderating variable between attitude and willingness to try. This model illustrates the complex interaction between internal factors (such as attitude and self-efficacy) and external factors that influence an individual's behavior in trying something new.

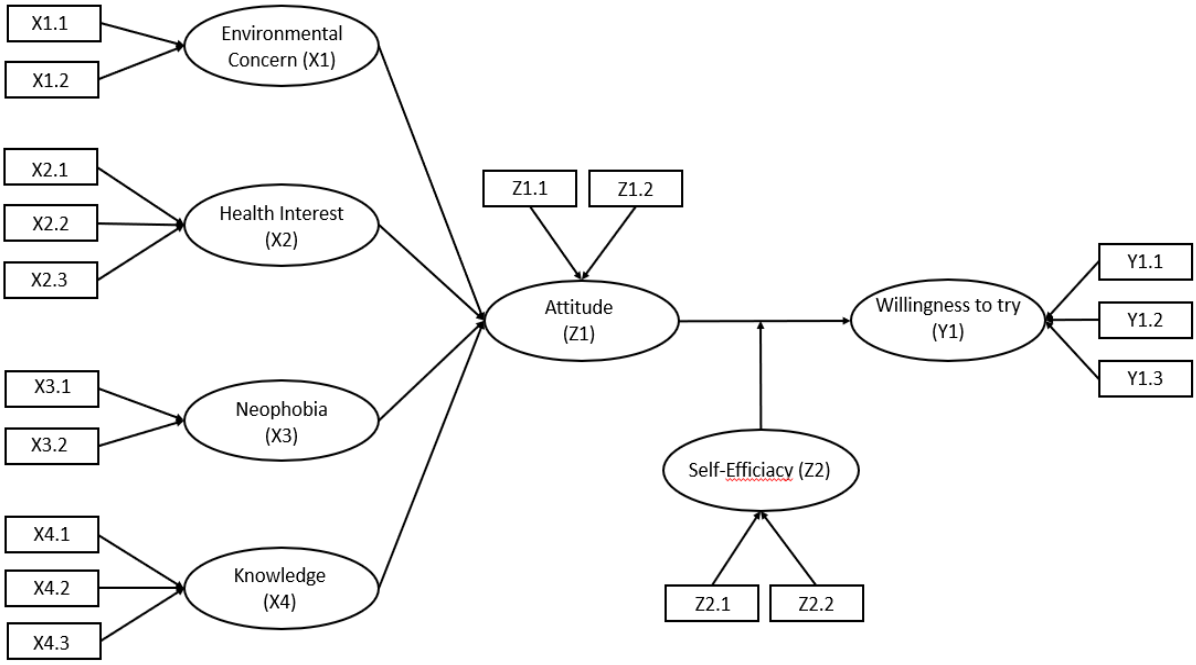

Figure 1. Research model

RESULTS AND DISCUSSIONS

Result in Characteristic of Respondents and Descriptive Statistical Analysis

The characteristics or criteria for respondents were determined as being over 15 years of age and having tried at least one new food item. The minimum requirement of having tried at least one new food ensures that the respondents have some familiarity with new foods. Therefore, the respondents who completed the questionnaire met the established criteria and were willing to participate.

Table 3. Characteristic of respondents

Category	Characteristic	Details
Demographic	Age	15-35 years
	Gender	Women (264 people) and men (136 people)
	Employment	Student (144 person), businessman (80 person), etc
Geographic	Residence	Malang (108 person), Situbondo (84 person), Probolinggo (80 person), Jember (68 person), and Banyuwangi (60 person)
Psychographic	Dietary Habit	Flexible (diet/no diet)

Source: Primary Data Processed (2024)

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Based on Table 3, the characteristics of respondents are that the dominant respondents in this study followed a flexible eating pattern, where they did not strictly adhere to a specific diet but adopted healthy eating habits situationally. They tend to be open to innovation and prioritize convenience over commitment to a particular diet, which fosters a positive attitude toward microalgae consumption (Lynch et al., 2018; Macdiarmid et al., 2019).

Table 4. Descriptive statistical analysis

	Min	Max	Mean	Std. Deviation
Environmental Concern (X1)				
X1.1	1	5	3.25	0.88
X1.2	1	5	3.85	0.62
Health Interest (X2)				
X2.1	1	5	3.99	0.67
X2.2	1	5	4.18	0.69
X2.3	1	5	3.86	0.82
Neophobia (X3)				
X3.1	1	5	3.68	0.86
X3.2	1	5	3.02	0.94
Knowledge (X4)				
X4.1	1	5	3.80	0.71
X4.2	1	5	3.46	0.76
X4.3	1	5	3.72	0.69
Attitude (Z1)				
Z1.1	1	5	3.89	0.64
Z1.2	1	5	4.13	0.74
Self-Efficacy (Z2)				
Z2.1	1	5	4.12	0.73
Z2.2	1	5	4.05	0.79
Willingness to try (Y1)				
Y1.1	1	5	3.99	0.67
Y1.2	1	5	3.66	0.69
Y1.3	1	5	3.73	0.77

Source: Primary Data Processed (2024)

Based on the data in the descriptive statistical analysis table (Table 4) show that the highest mean value is found in the "health interest" variable, with a mean of 4.18, which falls within the high category according to the stated criteria (Solimun et al., 2017). The variable with the lowest mean value is "food neophobia," which has a mean of 3.02, falling within the moderate category. Next, the data also shows the standard deviation values.

This value assesses the data spread within a sample (Hidayat et al., 2019). If the standard deviation is larger than the mean, it indicates the presence of outliers in the data. Based on the data in the table, it is evident that all standard deviation values for the variables are below the mean, suggesting that no outliers were found in the sample data.

SEM-PLS (*Partial Least Squares-Structural Equation Modeling*) analysis results

Outer Model

a) *Convergent Validity*

The first test conducted in the outer model analysis is the convergent validity test. The purpose of this test is to determine whether the variables used can be considered valid or not. Convergent validity is assessed by the correlation coefficient between the

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indicator scores and the latent variables used in the research. The validity is measured by the factor loading, where a factor loading value greater than 0.7 indicates that the variable is valid. If the value is less than 0.4, the variable must be removed. Based on the results of the convergent validity test, the values obtained are presented in Table 5.

Table 5. *Convergent validity test results*

Indicator	*Factor Loading*	*P-values*
X1.1	0.766	<0.001
X1.2	0.766	<0.001
X2.1	0.716	<0.001
X2.2	0.824	<0.001
X2.3	0.791	<0.001
X3.1	0.794	<0.001
X3.2	0.794	<0.001
X4.1	0.810	<0.001
X4.2	0.837	<0.001
X4.3	0.757	<0.001
Z1.1	0.775	<0.001
Z1.2	0.775	<0.001
Z2.1	0.819	<0.001
Z2.2	0.819	<0.001
Y1.1	0.848	<0.001
Y1.2	0.820	<0.001
Y1.3	0.877	<0.001

Source: Primary Data Processed (2024)

Based on the convergent validity test results (Table 5), it can be seen that all the indicators for the variables used have factor loading values greater than 0.7. Therefore, it can be concluded that all the indicators used are valid, as their factor loadings are all above 0.7. This means that no latent variable used in the study is considered invalid. Consequently, all the variables used in this study are valid. In addition to factor loading, convergent validity can also be assessed using the Average Variance Extracted (AVE). If the AVE value is ≥ 0.5, it indicates that the latent variable adequately reflects the variance of the indicators used. However, if the AVE value is ≤ 0.5, the latent variable does not sufficiently represent the indicators, and another variable may better reflect the variance. Based on the test results, the AVE values obtained are as follows environmental concern (0.586), health interest (0.606), neophobia (0.630), knowledge (0.596), attitude (0.600), self-efficacy (0.671), and willingness to try (0.720). From these values, it is evident that all the variables in the study have AVE values ≥ 0.5. Therefore, it can be concluded that all the latent variables used in the study adequately explain more than half of the variance of the indicators used. As a result, all the indicators effectively represent their respective latent variables.

b) *Discriminant Validity and Reliability*

After analyzing the results of the convergent validity test, the next step is to analyze the results of the discriminant validity test. The discriminant validity test aims to assess whether the constructs used in the research properly reflect the phenomenon under study. Discriminant validity is tested by comparing the factor-loading values with the cross-loading values. If the loading value is greater than the cross-loading value, the indicator meets the discriminant validity requirement. Additionally, discriminant validity can be evaluated by comparing the

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square root of the AVE with the correlation coefficients of the other variables used (Solimun et al., 2017). If the square root of the AVE is greater than the correlation coefficients, it indicates that the questionnaire meets the discriminant validity criteria. Here are the results of the discriminant validity test, which are presented in Table 6.

Table 6. *Discriminant validity test results*

Indicator	X1	X2	X3	X4	Z1	Z2	Y1	Z2*Z1
X1	**(0.766)**	0.249	0.094	0.431	0.376	0.233	0.405	0.138
X2	0.249	**(0.778)**	0.209	0.295	0.436	0.204	0.438	0.098
X3	0.094	0.209	**(0.794)**	0.070	0.040	0.077	0.061	0.086
X4	0.431	0.295	0.070	**(0.772)**	0.522	0.280	0.442	0.228
Z1	0.376	0.436	0.040	0.522	**(0.775)**	0.335	0.540	0.097
Z2	0.233	0.204	0.077	0.280	0.335	**(0.819)**	0.220	-0.050
Y1	0.405	0.438	0.061	0.442	0.540	0.220	**(0.849)**	0.083
Z2*Y1	0.138	0.098	0.086	0.228	0.097	-0.050	0.083	**(1.000)**

Source: Primary Data Processed (2024)

Table 7. Reliability test results

Variable	*Composite Reliability*	*Alpha Cronbach*
Environmental Concern (X1)	0.739	0.672
Health Interest (X2)	0.821	0.673
Neophobia (X3)	0.773	0.604
Knowledge (X4)	0.814	0.655
Attitude (Z1)	0.750	0.740
Self-Efficacy (Z2)	0.803	0.622
Willingness to try (Y1)	0.885	0.805

Source: Primary Data Processed (2024)

Based on the data from the discriminant validity test results (Table 6), it can be seen that all correlation values among the AVEs of each variable are greater than the cross-loading values of the other latent variables used. Therefore, it can be concluded that the validity of all the latent variables used in this study is confirmed, meeting the requirements for discriminant validity. As shown in the table, for example, the variable X1 has a value of 0.766, the highest compared to X2, which has a value of 0.249. Similarly, the values for variables Z1 and Z2 are 0.775 and 0.335, respectively.

Next, reliability testing is conducted by assessing composite reliability and Cronbach's alpha values. According to Solimun et al. (2017), the composite reliability value should be ≥ 0.70, and Cronbach's alpha should be > 0.6 to pass the reliability test. The results of the reliability test are presented in Table 7.

Based on the reliability test results (Table 7), it can be seen that all variables used in this study pass the reliability test. This is evident from the composite reliability values, which are ≥ 0.70. Similarly, the Cronbach's alpha values for all variables are > 0.6. Therefore, it can be concluded that all the variables used in this study have passed the reliability test.

Inner Model

After performing the outer model testing, the next step is to test the inner model. The inner model testing can be done by examining the path coefficients, R-square values, and Goodness of Fit. The first inner model test is the path coefficient test. The path coefficient values indicate the direction of the relationship between the variables in this study. If the path coefficient is close to +1, the relationship between the variables is considered positive

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and significant. If the path coefficient is close to 0, the relationship between the variables is weak and considered insignificant. Based on the analysis, the path coefficients have been calculated and are shown in the structural model as shown in Figure 2.

Based on Figure 2, the path coefficients in the structural model (Figure 2) reveal that several variables have positive (+) path coefficients, while some variables have negative (-) values. The relationships between X1 and Z1, X2 and Z1, X4 and Z1, Z1, and Y1, and the moderation effect of Z2 on Y1 all show positive paths. However, the relationship between X3 and Z1 demonstrates a negative path. For instance, the relationship between X1 (environmental concern) and Y1 (attitude) has a favorable path coefficient, suggesting that a person's environmental concern positively influences their attitude. The path coefficients for environmental concern, health interest, and knowledge toward attitude are 0.12, 0.27, and 0.36, respectively, with p-values < 0.01. These values indicate that environmental concern, health interest, and knowledge positively and significantly influence attitude by 12%, 27%, and 36%, respectively.

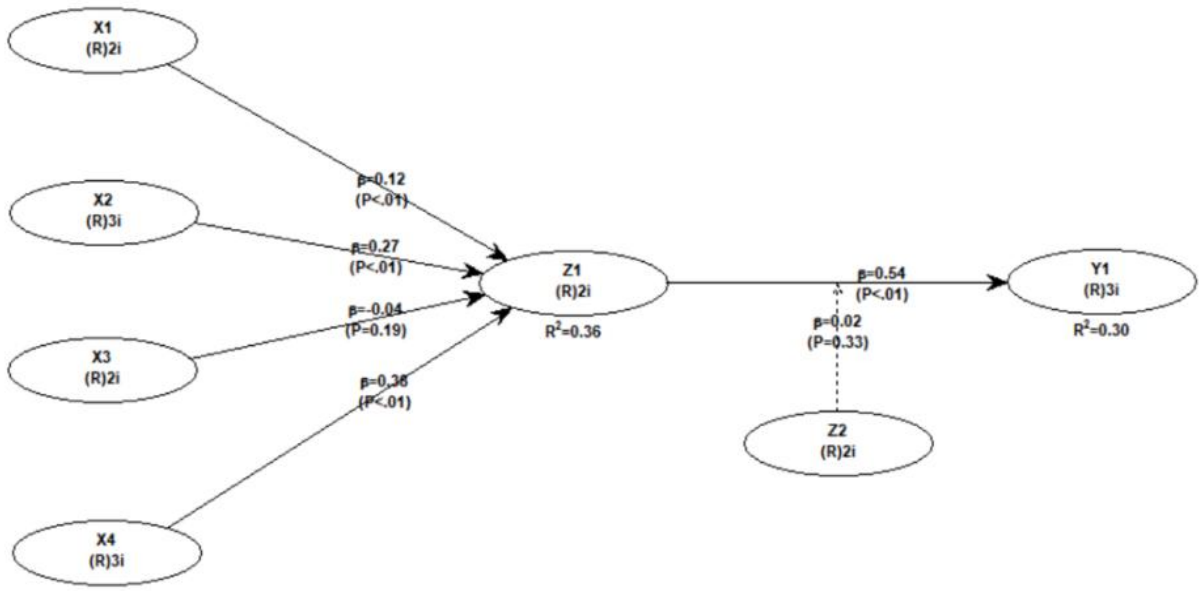

Figure 2. *Path Coefficients* values in structural models

The path coefficient for the relationship between attitude and willingness to try is 0.54 with a p-value < 0.01, which shows a positive and significant effect on willingness to try, explaining 54% of the variation. The path coefficient for self-efficacy toward willingness to try is 0.02 with a p-value of 0.33, indicating a small positive but insignificant effect of self-efficacy on willingness to try, explaining only 2%. Meanwhile, the path coefficient for neophobia toward attitude is 0.04 with a p-value of 0.19, which indicates a negative and insignificant effect of neophobia on attitude, explaining 4%.

Next, the analysis shifts to the R-square value or coefficient of determination. The R-square value is used to assess how well the independent variables explain the variance in the dependent variables. R-square values range from 0 to 1, where higher R-square values indicate higher accuracy, while lower R-square values (closer to 0) suggest lower accuracy. The R-square value depends on the research model's complexity, making it challenging to determine if the R-square value is acceptable. However, R-square values for latent endogenous variables in marketing-focused research have criteria starting from 0.25, 0.50, and 0.70.

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From the analysis, the R-square value for attitude is 0.361. This indicates that environmental concern, health interest, neophobia, and knowledge account for 36.1% of the variance in attitude, while other variables outside the model influence the remaining 63.9%. The R-square value for willingness to try is 0.305, meaning that attitude influences willingness to try by 30.5%, with the remaining 69.5% influenced by other variables outside the model.

Based on the results of the path coefficient analysis, it can be seen that objective one environmental concern has a positive and significant influence on consumer attitudes, especially when the food consumed is considered sustainable and eco-friendly. Health interest also has a positive effect, as the natural content of microalgae provides a sense of security for consumers. Conversely, neophobia does not have a significant impact, as health interest plays a more dominant role in influencing consumer attitudes. Knowledge has a positive effect because consumers can evaluate food based on nutritional information. Additionally, consumer attitudes positively and significantly influence their willingness to try microalgae, as consumers feel satisfied and recognize the benefits of consuming it.

Then, objective 2, the self-efficacy variable as a moderating variable, has an insignificant effect on the relationship between attitudes and the willingness to try. This may be influenced by a lack of self-confidence and the absence of strong or consistent motivation to try new foods. Moreover, limited knowledge about microalgae is also considered a factor that contributes to the insignificant effect of self-efficacy on attitudes toward the willingness to try. Instability in consumers' eating patterns further affects the role of self-efficacy as a moderating variable.

This aligns with the statement by Puspita & Rismawan (2019) that self-efficacy in food decision-making is higher if individuals follow a diet, as they have stronger motivation and experience in food selection. Therefore, several steps can be taken to improve self-efficacy, such as increasing knowledge about new foods, fostering positive perceptions of food benefits, and targeting consumers with specific health goals to enhance their willingness to try microalgae (Wulandari & Pratama, 2023; Yugharyanti et al., 2024). Thus, these factors are considered essential to strengthen the role of self-efficacy in moderating consumer attitudes toward the willingness to try microalgae-based foods as an alternative protein source.

Finally, evaluate the Goodness of Fit. The Goodness of Fit is an index that includes 10 indicators related to the relationships between variables and the assumptions in the model (Solimun et al., 2017). Table 8 shows the results for the Goodness of Fit measurement in this study.

Goodness of Fit (GoF) is a statistical measure that assesses how well a model fits the observed data. As shown in the goodness of fit indices results (Table 8), several indices are used to evaluate the model's quality and fit. The Average Path Coefficient (APC), Average R-Squared (ARS), and Average Adjusted R-Squared (AARS) indicate the model's explanatory power, all achieving significance at $p < 0.001$ meeting the required criteria (Kock, 2014; Solimun et al., 2017). The Average Block VIF (AVIF) and Average Full Collinearity VIF (AFVIF) confirm that multicollinearity is within acceptable limits. The Tenenhaus GoF (TGoF) value of 0.474 suggests a strong model fit (classified as large). Additional indicators such as the Sympson's Paradox Ratio (SPR), R-Squared Contribution Ratio (RSCR), Statistical Suppression Ratio (SSR), and Nonlinear Bivariate Causality Direction Ratio (NLBCDR) all meet or exceed the recommended thresholds reinforcing the model's robustness (Faizah et al., 2023; Puspitasari et al., 2019; Solimun et al., 2017). Collectively, these results indicate that the model effectively explains the relationships within the data and meets established fit standards.

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Next, hypothesis testing is conductedd to understand the relationship between variables. In the analysis with WarpPLS, the t-test criterion is used for hypothesis testing. The rule used in this research is that if the P-value ≤ 0.05 with an alpha value of 5%, then the hypothesis can be accepted. Based on the results of hypothesis testing, the operational hypothesis testing can be explained as follows:

H_0: Environmental concern has a negative effect on consumer attitudes

H_1: There is a positive effect of environmental concern on consumer attitudes

Table 8. *Goodness of Fit indices results*

No	*Model Fit and Quality Indices*	*Criteria Fit*	*Results*	*Information*
1.	Average Path Coefficient (APC)	p < 0.05	0.230 p < 0.001	Fulfilled
2.	Average R-Squared (ARS)	p < 0.05	0.333 p < 0.001	Fulfilled
3.	Average Adjusted RSquared (AARS)	p < 0.05	0.328 p < 0.001	Fulfilled
4.	Average Block VIF (AVIF)	Accepted if ≤ 5, ideally ≤ 3.3	1.196	Fulfilled
5.	Average Full Collinearity VIF (AFVIF)	Accepted if ≤ 5, ideally ≤ 3.3	1.397	Fulfilled
6.	Tenenhaus GoF (TGoF)	Small ≥ 0.1, medium ≥ 0.25, large ≥ 0.36	0.474	Large
7.	Sympson's Paradox Ratio (SPR)	Accepted if ≥ 0.7, ideally = 1	0.833	Fulfilled
8.	R-Squared Contribution Ratio (RSCR)	Accepted if ≥ 0.9, ideally = 1	0.988	Fulfilled
9.	Statistical Suppression Ratio (SSR)	Accepted if ≥ 0.7	1.000	Fulfilled
10.	Nonlinear Bivariate Causality Direction Ratio (NLBCDR)	Accepted if ≥ 0.7	0.917	Fulfilled

Source: Primary Data Processed (2024)

Based on the results of the hypothesis testing analysis, the coefficient value was 0.12, and the p-value for the first hypothesis was <0.001. These results indicate that the p-value ≤ 0.05, making the results significant, and the obtained coefficient is positive. Therefore, it can be concluded that H0 is rejected and H1 is accepted, meaning there is a positive effect of environmental concern on consumer attitudes. Thus, an increase in environmental concern will also improve consumer attitudes.

H_0: Health interest has a negative effect on consumer attitudes

H_2: There is a positive effect of health interest on consumer attitudes

Based on the results of the hypothesis testing analysis, the coefficient value was 0.27, and the p-value for the second hypothesis was <0.001. These results indicate that the p-value ≤ 0.05, making the results significant, and the obtained coefficient is positive. Therefore, it can be concluded that H0 is rejected and H2 is accepted, meaning there is a positive effect of health interest on consumer attitudes. Thus, an increase in health interest will also improve consumer attitudes.

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H_0: Neophobia has a negative and insignificant effect on consumer attitudes
H_3: There is a positive and significant effect of neophobia on consumer attitudes

Based on the results of the hypothesis testing analysis, the p-value for the third hypothesis was 0.19, and the coefficient value was -0.04. These results indicate that the p-value ≥ 0.05. Thus, H0 is accepted, and H3 is rejected, which means there is a negative and insignificant effect of neophobia on consumer attitudes. Therefore, an increase in neophobia will reduce consumer attitudes.

H_0: Knowledge has a negative effect on consumer attitudes
H_4: There is a positive effect of knowledge on consumer attitudes

Based on the results of the hypothesis testing analysis, the p-value for the fourth hypothesis was <0.001, and the coefficient value was 0.36. These results indicate that the p-value ≤ 0.05. Thus, H0 is rejected, and H4 is accepted, which means there is a positive and significant effect of knowledge on consumer attitudes. Therefore, an increase in consumer knowledge will improve consumer attitudes.

H_0: Attitudes have a negative effect on willingness to try
H_5: There is a positive effect of attitudes on willingness to try

Based on the results of the hypothesis testing analysis, the coefficient value was 0.54, and the p-value for the fifth hypothesis was <0.001. These results indicate that the p-value ≤ 0.05, making the results significant, and the obtained coefficient is positive. Therefore, it can be concluded that H0 is rejected and H5 is accepted, meaning there is a positive effect of consumer attitudes on willingness to try. Thus, an increase in consumer attitudes will also increase their willingness to try.

H_0: Self-efficacy does not moderate the effect of consumer attitudes on willingness to try new food
H_6: Self-efficacy significantly moderates the relationship between consumer attitudes and willingness to try

Based on the results of the hypothesis testing analysis, the coefficient value was 0.02, and the p-value for the sixth hypothesis was 0.33. These results indicate that the p-value ≥ 0.05, making the results not significant, and the obtained coefficient is positive. Therefore, it can be concluded that H0 is accepted and H6 is rejected, which means that self-efficacy does not moderate the relationship between attitudes and willingness to try.

CONCLUSION

Using a quantitative approach with SEM-PLS analysis, this study successfully identified several factors that influence consumer willingness to consume microalgae. Overall, the analysis revealed that environmental concern, health interest, and knowledge positively influence consumer attitudes. An increase in these factors is likely to enhance consumer attitudes, thereby increasing their willingness to try microalgae as an alternative protein source. In contrast, neophobia has a negative influence on attitudes, indicating that higher levels of neophobia among consumers can reduce their willingness to try microalgae. Furthermore, self-efficacy does not moderate the relationship between attitudes and willingness to try microalgae as an alternative protein source.

The findings of this study highlight the importance of educational initiatives or providing clear information about new foods when introducing them to the public. Informative efforts are considered effective in shaping consumer attitudes, ultimately influencing their willingness to try new foods. Thus, selecting an appropriate approach strategy is crucial when introducing foods perceived as novel. This study focused on consumers who had previously tried new foods and gathered their responses regarding their willingness to consume microalgae. Future research is recommended to explore taste-testing sessions with microalgae-based food samples, enabling consumers to provide

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direct evaluations and feedback on the offered products.

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