Available online at www.ijournalse.org

Emerging Science Journal

(ISSN: 2610-9182)

Vol. 9, No. 5, October, 2025

Innovation Adoption and Resistance of Functional Postbiotics: Consumer Intentions for Sleep and Mental Wellbeing

Chawin Piyapinyo [1], Nuttapol Assarut [2*], Chaleeda Borompichaichartkul [3]

[1] *Technopreneurship and Innovation Management Program, Graduate School, Chulalongkorn University, Bangkok, Thailand.*

[2] *Faculty of Commerce and Accountancy, Chulalongkorn University, Bangkok, Thiland.*

[3] *Department of Food Technology, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand.*

Abstract

This study investigates the key factors influencing consumer purchase intention toward functional postbiotic beverages designed to enhance sleep quality and mental health. It focuses on perceived innovation characteristics (PIC), innovation resistance (IR), attitude, and the moderating role of product knowledge. Data were collected through a structured questionnaire from 400 health-conscious Thai consumers aged 18–65 with prior experience in functional foods. The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to assess the relationships among PIC, IR, attitude, and purchase intention, including the moderating effect of product knowledge. The findings reveal that relative advantage, compatibility, and attitude positively influence purchase intention, while the claim skepticism barrier has a negative impact. Complexity and trialability were found to be non-significant. Additionally, compatibility significantly influences attitudes across high- and low-product-knowledge consumers. However, product knowledge did not moderate the direct relationship between PIC and purchase intention. Attitude emerged as a key mediator. This study contributes to innovation adoption theory by highlighting the roles of compatibility and attitude while introducing trust and claim skepticism as critical resistance factors. It offers actionable implications for marketers aiming to enhance consumer trust and align products with daily routines.

Keywords:

Innovation Adoption;
Perceived Innovation Characteristics;
Innovation Resistance;
Postbiotics;
Functional Foods.

Article History:

Received:	30	April	2025
Revised:	09	August	2025
Accepted:	14	August	2025
Published:	01	October	2025

1- Introduction

In the rapidly evolving health and wellness market, consumer preferences are increasingly driven by a demand for products that offer more than basic nutrition, aligning with global projections of significant growth in the sector from USD 5.5 trillion in 2023, it is anticipated to grow to USD 9.2 trillion by 2033 [1]. Functional foods designed to support sleep quality and mental health have gained substantial traction as consumers seek natural, non-pharmaceutical solutions to manage stress, anxiety, and sleep disorders [2, 3]. This rising interest highlights a growing awareness of the gut-brain axis, which connects diet, gut health, and mental well-being [4-6]. The COVID-19 pandemic further amplified the prevalence of mental health concerns, with studies indicating a 27.6% increase in incidents of depressive disorder and a 25.6% increase in anxiety globally in 2020 [7, 8].

Within this context, postbiotics, non-viable microbial cells or their metabolic byproducts, have emerged as a promising innovation in the functional food industry [9, 10]. Unlike probiotics, which require live organisms to confer health benefits, postbiotics offer similar advantages without concerns related to product stability and shelf life,

* **CONTACT**: nuttapol@cbs.chula.ac.th

DOI: http://dx.doi.org/10.28991/ESJ-2025-09-05-018

positioning them as a potentially disruptive force in the market [11, 12]. Research has demonstrated that postbiotics can enhance gut health, immune function, and mental well-being, with growing evidence suggesting their role in modulating mood, reducing stress, and improving sleep quality through the gut-brain axis [4, 13, 14]. Functional compounds produced by postbiotics, for instance, Gamma-Aminobutyric Acid (GABA) and short-chain fatty acids (SCFAs), have been linked to enhanced cognitive function, alleviation of depressive symptoms, and improved sleep regulation [15-17].

Despite abundant research on the functional benefits and efficacy of postbiotics, there remains a significant gap in understanding consumer perceptions and adoption behaviors regarding postbiotic-based products [18-20]. While the health benefits are well-documented, limited studies have explored how consumers perceive these products, what drives their purchase decisions, and what barriers may hinder adoption [21, 22]. Given the competitive landscape of health-related functional foods, it is crucial to investigate consumer insights to inform product development, positioning, and market entry strategies. Previous studies have examined innovation adoption in products, primarily using the Diffusion of Innovation Theory [23], which suggested that perceived innovation characteristics—relative advantage, compatibility, complexity, trialability, and observability—play a key role in consumer adoption of new products. Factors such as perceived complexity [24], lack of product knowledge [25], and resistance to innovation [26] can influence consumer adoption of novel products, emphasizing the need for effective marketing strategies that communicate benefits while addressing potential concerns [27]. Furthermore, the Theory of Planned Behavior (TPB) highlights the role of attitudes in shaping consumer purchase intentions, making it essential to examine how attitudes mediate the relationship between perceived innovation characteristics and adoption behavior [28].

To address the research gaps, this study investigates the drivers and barriers influencing consumer adoption of functional postbiotic beverages for sleep quality and mental well-being. While prior research has primarily focused on perceived innovation characteristics (PIC) using frameworks such as the Diffusion of Innovation (DOI) [23] and Theory of Planned Behavior (TPB) [28], few studies have integrated resistance factors in the context of functional foods [26, 27]. Furthermore, the potential moderating role of product knowledge remains underexplored, despite its relevance in shaping consumer responses to health claims and innovation attributes [29, 30]. To bridge these gaps, this study addresses the following research questions: How do perceived innovation characteristics affect consumer attitudes and purchase intention toward functional postbiotic beverages? How does innovation resistance influence consumer attitudes and purchase intention? What is the role of attitude in mediating the relationship between perceived innovation characteristics and purchase intention? How does product knowledge moderate the relationships between PIC, innovation resistance, attitude, and purchase intention?

This study aims to provide constructive insights into the factors that shape consumer purchase intentions regarding functional postbiotic beverages by investigating these questions. By applying established theories from consumer behavior and innovation management, this research contributes to academic knowledge and practical industry applications. A deeper understanding of consumer decision-making in response to innovative products like postbiotics can inform strategic marketing approaches, product positioning, and innovation adoption models. These insights are essential for companies seeking to commercialize postbiotic-based functional foods and successfully navigate the expanding wellness market. Furthermore, this study addresses a critical gap in the current literature by focusing on consumer behavior in the postbiotic market, offering actionable recommendations for marketers, product developers, and industry stakeholders.

This article's structure follows a literature review, namely the Diffusion of Innovation theory, Innovation Resistance Theory, and the Theory of Planned Behavior, from which key hypotheses are derived. Following this, the research methodology includes the design of the structured questionnaire, sampling, and data collection process. The exploratory approach is employed to validate the constructs, beginning with principal component analysis (PCA) to refine measurement dimensions. The study then applies Partial Least Squares Structural Equation Modeling (PLS-SEM) to test hypothesized relationships among perceived innovation characteristics, resistance factors, attitude, and purchase intention. In addition, multi-group analysis is conducted to assess the moderating role of product knowledge. The findings are interpreted considering existing literature to highlight theoretical contributions and strategic implications. The article concludes and further discusses limitations and proposes directions for future research, including the potential integration of behavioral tracking and longitudinal designs to enhance understanding of functional food adoption dynamics.

2- Literature Review

Consumer adoption of functional postbiotic beverages for sleep and mental health is shaped by perceived innovation characteristics (PIC), innovation resistance, attitude, and purchase intention, with product knowledge as a moderating factor. This review integrates Rogers' Diffusion of Innovation (DOI) theory [31], Ram and Sheth's innovation resistance

framework [32], and Ajzen's Theory of Planned Behavior (TPB) [28] to examine adoption drivers and barriers. It also explores attitude as a mediator and product knowledge as a moderator, guiding theoretical framework development and hypothesis formulation.

2-1- Perceived Innovation Characteristics

Rogers' Diffusion of Innovation (DOI) theory explains consumer adoption behavior through five perceived innovation characteristics (PICs): relative advantage, compatibility, complexity, trialability, and observability [31]. This framework is widely regarded as crucial for explaining and predicting both consumer and organizational behaviors prior to making adoption decisions regarding new technologies and practices [33]. These attributes help predict innovation adoption across various sectors, including technology and functional foods [27, 34]. Miller [35] reported that PICs collectively explain approximately 49-87% of the variation in adoption rates [27].

2-1-1- Relative Advantage

Relative advantage refers to the perceived benefits and superiority of a new product over existing alternatives [36]. The worth of an innovative product is defined by its relative economic, social, and technical benefits compared to existing alternatives [37]. For functional beverages, relative advantage typically refers to health-related benefits, including improved digestion, enhanced immune support, and overall well-being [38].

Studies have shown that consumers are more likely to develop a positive attitude and intention toward functional foods when they perceive them as providing specific health benefits. For example, consumers who believe that functional foods can reduce the risk of heart disease or improve mental well-being are more likely to form a willingness to pay for these products. [34, 39-41]. Based on insights from previous research, the following hypotheses were developed:

H1a: Relative advantage has a positive effect on attitude towards postbiotic products.

H1b: Relative advantage has a positive effect on purchase intention towards postbiotic products.

2-1-2- Compatibility

Compatibility assesses the degree to which a product aligns with consumers' values, experiences, and needs [36]. Innovations that fit well with a consumer's lifestyle or beliefs are more readily accepted. For instance, research on meat substitutes highlights that perceived alignment with current dietary habits is critical for acceptance, especially among consumers who heavily rely on meat and may initially resist food innovations [42]. Verbeke [43] observed that health-conscious individuals with favorable attitudes toward functional foods are more likely to perceive such products as fitting with their lifestyle.

Moreover, compatibility significantly influences attitudes and purchase intentions across various innovation adoption contexts. A strong product-consumer fit for commodity goods enhances positive attitudes and drives purchase and recommendation intentions [44]. In technology adoption, compatibility improves willingness to pay [45] and in mobile banking, compatibility influences adoption, with attitude partially mediating this effect [46]. Thus, the following hypotheses are proposed:

H2a: Compatibility has a positive effect on attitude towards postbiotic products.

H2b: Compatibility has a positive effect on purchase intention towards postbiotic products.

2-1-3- Complexity

Complexity or the perceived difficulty of understanding and using a product can inhibit adoption [36]. Perceived complexity significantly impacts consumer attitudes and purchase intentions, varying across product categories. In consumer goods, visual complexity in packaging influences brand personality and consumer responses, with effects differing by product type, such as in ice cream, soda, and dishwashing liquid [47]. Similarly, in functional postbiotics, complex health claims or unclear usage instructions may hinder adoption [48]. Similarly, research on packaging complexity suggests that simple designs enhance conceptual fluency, improving brand attitudes and purchase intentions [49].

Complexity is also critical in other sectors such as healthcare and ICT. In healthcare, complex information, such as antimicrobial susceptibility testing, can lead to information overload, affecting physicians' prescribing decisions [50]. In ICT adoption, the specificity of attitudes toward technology influences behavioral intentions, with

complexity potentially leading to varied outcomes [51]. Given these insights, reducing complexity in postbiotic products may enhance consumer attitudes and increase purchase intentions. Thus, the following hypotheses are proposed:

H3a: Complexity has a negative effect on attitude towards postbiotic products.

H3b: Complexity has a negative effect on purchase intention towards postbiotic products.

2-1-4- Trialability

Trialability refers to the extent to which a product can be tested on a limited scale before full adoption, serving as a crucial factor in minimizing consumer uncertainty and encouraging adoption [36]. High trialability accelerates market acceptance [37, 52]. This is particularly relevant for functional foods and beverages, where providing samples enables consumers to experience the benefits with minimal financial or time commitment.

In the context of genetically modified foods, trialability helps consumers assess potential benefits and mitigate perceived risks, strengthening their intention to adopt such innovations [53]. Similarly, in healthcare, animated computer simulations used to trial process improvements have been shown to enhance staff confidence and accelerate the adoption of system implementation, further demonstrating trialability's effectiveness in driving innovation acceptance [54]. Thus, the following hypotheses are proposed:

H4a: Trialability has a positive effect on attitude towards postbiotic products.

H4b: Trialability has a positive effect on purchase intention towards postbiotic products.

2-1-5- Observability

Observability relates to how the benefits or usage of an innovative product are visible to others [36]. When individuals can observe positive outcomes from an innovation, it enhances positive perception and intention, as a powerful social cue reinforcing credibility and desirability. While extensively studied in technology and eco-friendly product adoption, its application to food innovation remains relatively unexplored [37, 55, 56].

Research suggested that social and peer influence significantly drive healthy food adoption, as individuals are more likely to choose foods they see others consuming [57]. This effect is similar to electric vehicle adoption, where frequent exposure to EVs positively enhanced attitudes, which in turn supported behavioral intention [37]. Flight et al. [58] highlighted observability's role in making innovations visible and understandable, easing adoption despite not explicitly linking it to attitude. Based on insights from previous research, the following hypotheses were developed:

H5a: Observability has a positive effect on attitude towards postbiotic products.

H5b: Observability has a positive effect on purchase intention towards postbiotic products.

2-2- Innovation Resistance

Despite the benefits, innovation resistance remains a challenge in functional food adoption, even when the innovation is perceived as beneficial and necessary. Addressing these barriers is crucial for businesses to craft strategies that encourage acceptance and facilitate the integration of these products into daily dietary habits, thereby mitigating the risk of product launch failures due to innovation resistance. Ram & Sheth [32] defined innovation resistance as consumers' reluctance to adopt new products, stemming either from a preference for maintaining the status quo or from conflicts with their existing belief systems. The study examined key barriers to the adoption of postbiotic products, including usage barriers, value barriers, risk barriers, tradition barriers, and image barriers. Thus, drawing on insights from multiple studies provides a thorough understanding of these challenges.

2-2-1- Usage Barriers

Usage barriers emerge when consumers view a product as challenging to use or incompatible with established routines [32]. These barriers are particularly significant in the context of functional foods, as they often require changes to daily dietary practices. Menrad [39] emphasized that effective information campaigns should emphasize conveying the health advantages of such products in a simple and understandable manner, making it easier for consumers to incorporate them into their regular diets. Verbeke [43] further highlighted that products seamlessly aligned with existing dietary habits are more likely to gain acceptance. For instance, functional beverages, such as smoothies or ready-to-drink options, which can be conveniently integrated into daily routines, tend to face fewer usage barriers and achieve higher adoption rates. Based on previous research, the following hypotheses were proposed:

H6a: Usage barrier has a negative effect on attitude towards postbiotic products.

H6b: Usage barrier has a negative effect on purchase intention towards postbiotic products.

2-2-2- Value Barrier

Value barriers occur when consumers perceive insufficient benefits when selecting a new product over existing alternatives. This is especially relevant in the functional food market, where the health benefits must be persuasive enough to warrant the cost. Effective communication of both health benefits and cost-efficiency is crucial in overcoming this barrier [59]. Research indicated that consumers are willing to pay a premium for functional foods that feature labeled health benefits and offer tangible dietary improvements to their diet, compared to conventional foods, and the willingness to pay is higher with more liking [60]. Verbeke [43] further noted that products perceived as "too expensive" experience reduced consumer acceptance, emphasizing the need for pricing strategies that balance affordability with perceived value to drive the adoption of postbiotic products. Thus, the following hypotheses are proposed:

H7a: Value barrier has a negative effect on attitude towards postbiotic products.

H7b: Value barrier has a negative effect on purchase intention towards postbiotic products.

2-2-3- Risk Barrier

Risk barriers refer to uncertainties that discourage consumers from adopting new products, often prompting them to delay until they gain sufficient information or confidence [32]. These barriers can be categorized into four types: functional, physical, economic, and social risks. Functional risk arises from doubts about a product's ability to meet expectations, particularly for functional foods, where skepticism is often on the authenticity of health claims. Physical risk involves concerns about potential adverse effects when trying new foods, such as side effects or allergic reactions. Economic risk relates to hesitation due to higher prices compared to conventional foods, with some consumers prefer to wait for more affordable alternatives. Social risk reflects fears of negative judgment or disapproval, particularly when a product lacks widespread acceptance.

In the functional food and postbiotic beverage sectors, perceived risks significantly delay consumer adoption. Research by Siegrist [61] and Urala & Lähteenmäki [62] highlighted the negative impact of these factors on purchase decisions. Among these, physical and functional risks are particularly critical for food product innovations and are a primary focus of this study. Thus, the following hypotheses are proposed:

H8a: Risk barrier has a negative effect on attitude towards postbiotic products.

H8b: Risk barrier has a negative effect on purchase intention towards postbiotic products.

2-2-4- Tradition Barrier

Tradition barriers refer to resistance arising from cultural norms, social values, or family traditions that contradict consumers' established beliefs and experiences [32]. In the case of functional foods, consumers may be reluctant to adopt them if they view these products as deviating from traditional dietary practices. For instance, Botonaki, et al. [63] found that consumers who are satisfied with conventional products often lack the awareness or incentive to transition to alternatives, such as organic foods. Overcoming these barriers requires integrating functional foods into cultural diets and aligning them with familiar tastes and preferences. By tailoring functional foods to consumers' current dietary habits, acceptance and adoption are likely to improve [33]. Thus, the following hypotheses are proposed:

H9a: Tradition barrier has a negative effect on attitude towards postbiotic products.

H9b: Tradition barrier has a negative effect on purchase intention towards postbiotic products.

2-2-5- Image Barrier

Image barriers arise when a new product or innovation is linked to an unfavorable identity based on factors such as brand, product category, or country of origin, resulting in negative consumer perceptions [32]. For functional foods, these barriers can arise if consumers perceive the product as misaligned with their personal identity or social norms, which in turn hinders adoption. Siegrist [61] found that consumer trust in company promises plays a crucial role, with higher trust levels correlating with increased intention to purchase functional foods. Misra & Singh [64] noted that consumers of organic food often experience doubt, confusion, or mistrust regarding product quality, which can similarly affect functional food adoption. Thus, the following hypotheses are proposed:

H10a: Image barrier has a negative effect on attitude towards postbiotic products.

H10b: Image barrier has a negative effect on purchase intention towards postbiotic products.

2-3- Attitude and Purchase Intention

Attitude plays a crucial role in consumer behavior and the adoption of innovation, including functional foods. According to the Theory of Planned Behavior (TPB) [28], attitude is formed through an individual's evaluation of the outcomes associated with a behavior, making it a key predictor of purchase intention. Positive attitudes significantly enhance consumers' willingness to adopt products, especially when these products offer significant health benefits, and consumers' attitudes toward adoption become more favorable [65]. Positive attitudes are more likely to form when individuals perceive benefits such as efficiency or relative advantage, while negative outcomes like complexity or unreliability increase resistance. Supported by Bharti, et al. [66] demonstrated that attitude significantly mediates the relationship between green marketing and consumers' purchasing intention, highlighting the broad applicability of attitudes as a mediator in adoption innovation. In the context of functional foods, factors such as trust, emotional engagement, and perceived benefits significantly influence consumer attitudes, which are closely linked to higher purchase intention and actual behavior [67, 68]. This evidence underscores the hypothesis that a positive attitude enhances purchase intention for postbiotic products. Attitude's mediating role highlights its significance in linking perceived innovation characteristics, resistance, and purchase intention.

Purchase intention represents a consumer's willingness or likelihood of buying a product in the future, indicating their inclination to make a purchase [69, 70]. This concept is essential for innovative products like functional foods, such as postbiotic drinks, as it acts as a key predictor of consumer adoption and market success. Grounded in the theory of planned behavior, purchase intention is shaped by attitudes, subjective norms, perceived behavioral control, and individual motivations. For functional foods featuring novel ingredients and health claims, purchase intention indicates the probability of consumers incorporating these products into their routines [28]. Product knowledge also plays a critical role, with informed consumers being more likely to adopt [71]. Chiang et al. [72] and Siegrist [61] emphasized health consciousness, clear communication of benefits, and trust as strong predictors of purchase intention for functional foods, which are further discussed in this article. Key drivers of purchase intention for functional foods include perceived health benefits, product effectiveness, safety, and value. Positive consumer attitudes significantly enhance purchase likelihood, while factors like price sensitivity can deter intention if perceived value is low [43, 61, 73]. Therefore, the hypothesis was proposed:

H11: Attitude has a positive effect on purchase intention towards postbiotic products.

2-4- Moderating Effect of Product Knowledge

Product knowledge is the accumulated information stored in memory, along with an individual's perceived level of understanding [74, 75]. This is a key determinant in the adoption of innovative products, including functional foods such as postbiotic drinks. Fu & Elliott [76] emphasize that well-informed consumers are more likely to view innovations positively, facilitating adoption. Product knowledge facilitates decision-making by allowing consumers to assess the features and advantages of new products more effectively.

Product knowledge directly influences consumers' intention and adoption in the functional food sector. Various research on organic food has shown that greater product knowledge significantly enhances the likelihood of adoption [67, 77, 78]. Similarly, Wansink et al. [71] discovered that consumers who link attribute-specific knowledge (e.g., health benefits) with consequence-related knowledge (e.g., improved health) are more inclined to consume functional foods. Increasing awareness of production processes and benefits can also reduce adoption barriers. For instance, Vittersø & Tangeland [79] found that educating consumers about organic farming enhances their understanding and acceptance of premium pricing.

Low product knowledge can reduce consumer confidence and trigger the need for additional information before purchasing [29]. Since functional foods, such as postbiotic drinks, are relatively new, consumers often have limited awareness, which can pose a barrier to adoption. Effective communication is essential for building understanding, trust, and attitude [80, 81]. Marketers influence consumers by enhancing product knowledge to increase the adoption of innovative functional foods.

Building on previous research, this study tested the moderating effect of product knowledge on the influence of perceived innovation characteristics, innovation resistance, attitudes, and purchase intention.

2-5- Research Framework

From the proposed hypotheses, the research framework is presented in Figure 1.

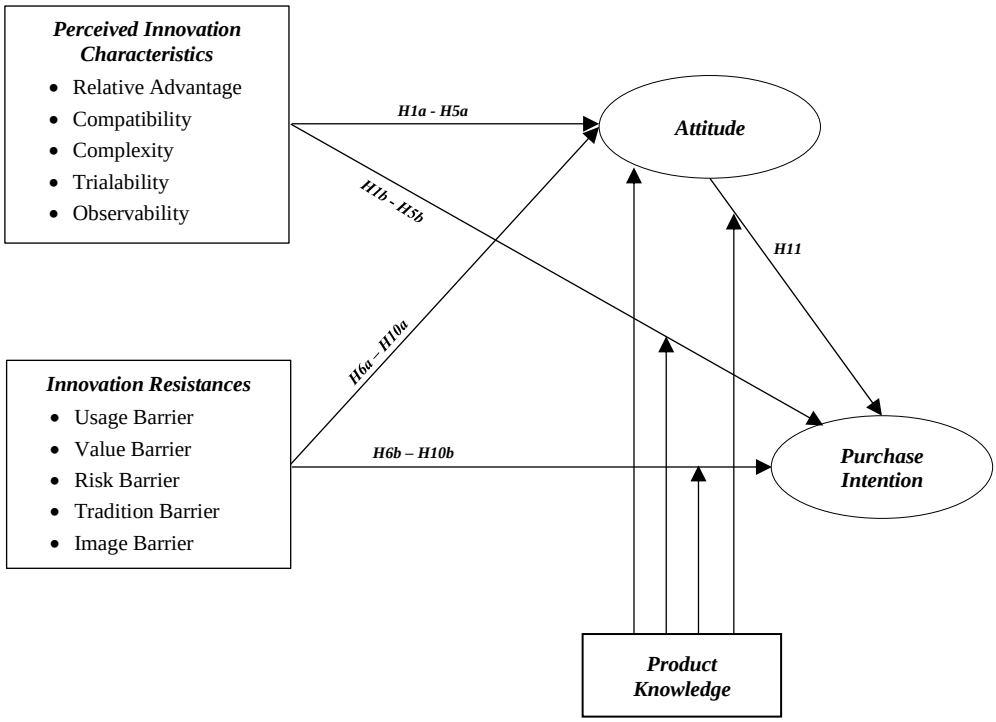

Figure 1. Conceptual Framework to study factors influencing customers' adoption of postbiotic products

3- Methodology

This study employed a quantitative research approach, using PLS-SEM to analyze the proposed hypotheses. The structured questionnaires were utilized to explore consumer behavior toward the functional postbiotic beverage. Data was collected with a face-to-face survey approach. The survey was designed to capture key variables related to perceived innovation characteristics, innovation resistance, attitude, and purchase intention, as well as the moderating effects of product knowledge on those factors. The total of 45 questions in this study were adapted from previous research, as shown in Table 1. A five-point Likert scale, serving as an interval scale, was employed for all measures, with response options ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

The study included a sample of 400 Thai consumers aged 18 to 65, all with prior experience in functional foods. The sample size was determined based on the requirements of Partial Least Squares Structural Equation Modeling (PLS-SEM) [82]. Given the complexity of this study's constructs, a sample size of 400 was sufficient to ensure robust statistical power and reliable estimates. A quota sampling method was employed to ensure a proportional representation of key demographic characteristics, specifically age and gender. Quotas were set to confirm diverse representations across demographic categories, as consumer perceptions of functional foods may vary significantly by age and gender. The methodological workflow of the study is shown in Figure 2.

Table 1. Questionnaire development

Constructs	Questionnaires	References
Relative Advantage	RA1 - Offers more health benefits compared to other alternative drinks in the market. RA2 - Easier to consume than others that meet similar needs. RA3 - Enhance my mental health and sleep quality.	Moon [37], Agarwal & Prasad [52], Flight et al. [58]
Compatibility	CPAT1 - Fits into my current diet lifestyle. CPAT2 - Fits into my self-image. CPAT3 - In line with my personal values. CPAT4 - Easier to get the nutrients and functional benefits for my health.	Moon [37], Flight et al. [58]
Complexity	CPLX1 - The concept behind this product is difficult for me to understand. CPLX2 - It takes a considerable amount of time to understand the health benefits of this product. CPLX3 - The product requires a high level of knowledge to use.	Moon [37], Flight et al. [58]
Trialability	TRAL1 - I can try this product before purchase. TRAL2 - I can use this product on a trial long enough to see its benefits. TRAL3 - I can properly try it out before deciding to use the product.	Flight et al. [58]; Agarwal & Prasad [52]
Observability	OBSV1 - I can observe this product being used by others before deciding to drink OBSV2 - I need a friend to tell me to try this product. OBSV3 - I need to see that experts have mentioned this product in online media. OBSV4 - I need to see someone I know recommending this product through online channels. OBSV5 - If I adopted this product, others could see me using it.	Flight et al. [58]

Usage Barrier	USE_B1 - Would require significant effort to change my habits and diet. USE_B2 - To consume the product, I have to change my routine at home.	Karahanna et al. [83]
Value Barrier	VAL_B1 - Too expensive given their claimed health benefits. VAL_B2 - Not economical. VAL_B3 - Has less value than other functional drinks.	Verbeke [43], Lian & Yen [84], Kushwah et al. [85]
Risk Barrier	RISK_B1 - Can cause serious unintended negative effects to my body. RISK_B2 - In some cases, may not be as effective as intended. RISK_B2 -The new properties of this product carry unforeseen risks.	Wiedmann et al. [86]; Urala & Lähteenmäki [62]
Tradition Barrier	TRDN_B1 - I find other functional drinks are more pleasant. TRDN_B2 - I prefer other functional drinks that are established in my routine. TRDN_B3 - I am so used to my routine of choosing beverages, that I would find it difficult to change to this postbiotic drinks.	Laukkanen et al. [26], Rammile & Nel [87]
Image Barrier	IMG_B1 - I don't trust the suppliers that produce and market the postbiotic drink. IMG_B2 - I have doubts towards the claim labelling. IMG_B3 - I have such an image that a functional drink is difficult to understand.	Mack [33]; Kushwah et al. [85]; Laukkanen [88]
Attitude	ATT1 - I find the postbiotic drink is positive. ATT2 - The postbiotic drink is good for my health. ATT3 - I think buying the postbiotic drink is a good choice.	Tudoran et al. [65]; Li et al. [67]
Purchase Intention	PI1 - I am happy to buy the postbiotic drink. PI2 - I plan to consume the postbiotic drink. PI3 - I intend to continue consuming the postbiotic drink in the future. PI4 - I will recommend others to consume the postbiotic drink.	Kushwah et al. [85], Hsiao et al. [89], Al-Ansi et al. [90]
Product Knowledge	PKNW1 - I know the postbiotic drink's specific beneficial health impact. PKNW2 - I am very knowledgeable about the postbiotic drink. PKNW3 - I have seen products containing postbiotics in other forms. PKNW4 - I have read articles about postbiotics through various online platforms. PKNW5 - I know more about the postbiotic drink than others. PKNW6 - I know how to distinguish the postbiotic drink from a non-functional drink.	Verbeke [43], Li et al. [67], Joshi & Rahman [78]

Figure 2. Methodological Workflow of the Study

3-1- Data Analysis

This study adopted a two-stage analytical approach, following the guidelines of Anderson & Gerbing [91]. The first stage involved evaluating the measurement model to ensure internal consistency reliability, convergent validity (assessed through outer loadings and average variance extracted, AVE), and discriminant validity (examined using the Fornell-Larcker criterion). The second stage involved assessing the structural model through the analysis of path coefficients. Given the exploratory nature of this research, Partial Least Squares-Structural Equation Modelling (PLS-SEM) was

employed to investigate the factors influencing consumer purchase intentions for functional postbiotic products, utilizing SmartPLS 4 [92] to conduct the statistical analysis.

PLS-SEM was believed to be a suitable analytical approach due to its advantages in exploratory research, handling complex models, and its predictive capabilities [93-95]. It is beneficial for theory development, enabling the exploration and extension of theoretical frameworks, especially in business research, and its ability to address small sample sizes and non-normal data distribution further justifies its selection over Covariance-Based Structural Equation Modeling (CB-SEM) [82, 96].

4- Results

4-1- Descriptive Statistics

The demographic profile of the respondents is summarized in Table 2. The respondents were equally divided among five age groups—18-25, 26-35, 36-45, 46-55, and 56-65 years, each representing 20.0% of the total sample. Gender distribution was balanced, with 50.0% male and 50.0% female participants. Regarding education, most respondents (67.8%) possessed a bachelor's degree, while 26.0% had an education below a bachelor's degree. Only 6.3% of respondents had a higher education level than a bachelor's degree. Monthly income levels varied across respondents, with the most significant proportion (27.0%) earning between 15,000 and 29,999 baht. Other significant income groups included 30,000–44,999 baht (19.8%) and 45,000–59,999 baht (18.8%). Smaller proportions of respondents reported earning <15,001 baht (13.5%) and incomes exceeding 90,000 baht. Regarding occupation, private employees constituted the largest group, accounting for 34.3% of respondents. Business owners followed at 27.0%. Other notable categories included students (9.0%), freelancers (9.3%), government sector employees (8.5%), and state enterprise employees (6.5%). Smaller groups included housewives (4.8%) and retirees (0.8%). The respondents were all individuals with prior experience in consuming or engaging with functional foods.

Table 2. Demographic Profile

	n	Percentage		n	Percentage
Age Range			***Education***		
18-25 years old	80	20.0%	Lower than bachelor	104	26.0%
26-35 years old	80	20.0%	Bachelor	271	67.8%
36-45 years old	80	20.0%	Higher than bachelor	25	6.3%
46-55 years old	80	20.0%			
56-65 years old	80	20.0%			
Gender			***Monthly Income***		
Male	200	50.0%	< 15,001 baht	54	13.5%
Female	200	50.0%	15,000–29,999 baht	108	27.0%
			30,000–44,999 baht	79	19.8%
Occupation			45,000–59,999 baht	75	18.8%
Student	36	9.0%	60,000–74,999 baht	34	8.5%
Freelance	37	9.3%	75,000–89,999 baht	23	5.8%
Government sector	34	8.5%	90,000–104,999 baht	17	4.3%
State enterprise	26	6.5%	105,000 baht or more	10	2.5%
Business Owner	108	27.0%			
Private employee	137	34.3%			
Housewife	19	4.8%			
Retired	3	0.8%			

4-2- Characteristics of Perceived Innovation Characteristics

The questionnaire was developed by adapting validated items from previous studies. To reconfirm the constructs, a principal component analysis (PCA) was conducted to refine the construct dimensions and establish a more cohesive factor structure. The questions related to perceived innovation characteristics were further analyzed with principal component analysis (PCA) with varimax rotation to identify the constructs underlying the measurements. Through PCA, items were retained based on factor loadings greater than 0.5 and further evaluated using eigenvalues greater than 1. From a total of 18 items, 10 items emerged from the analysis: two items for relative advantage, four items for compatibility, two items for complexity (reversed), and two items for trialability (Table 3).

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.745, indicating that the sample was adequate for PCA. The cumulative variance explained by the extracted components was 52.23%, which is acceptable in social sciences research. Communality values for all retained items were above 0.450. Items with low factor loadings (<0.500) were excluded from further analysis. The factor loadings for the remaining items were above 0.500, which meets the threshold recommended by Hair et al. [82] the findings demonstrate the measurement model's acceptable reliability, providing a strong foundation for examining the role of perceived innovation characteristics in influencing other constructs.

Table 3. Components of perceived innovation characteristics from the principal components analysis

Variables	Items	Factor Loadings	Communalities	Rotation Sums of Squared Loadings	% of Variance
Relative Advantage	RA1	0.787	0.707	1.664	11.884
	RA2	0.676	0.573		
Compatibility	CPAT1	0.756	0.595	2.095	14.964
	CPAT2	0.737	0.614		
	CPAT3	0.679	0.513		
	CPAT4	0.526	0.477		
Complexity (Reversed)	CPLX2	0.673	0.599	1.831	13.081
	CPLX3	0.791	0.643		
Trialability	TRAL1	0.758	0.656	1.723	12.304
	TRAL2	0.780	0.645		

Based on this, new hypotheses were proposed:

H1a: Relative advantage has a positive effect on attitude towards postbiotic products.

H1b: Relative advantage has a positive effect on purchase intention towards postbiotic products.

H2a: Compatibility has a positive effect on attitude towards postbiotic products.

H2b: Compatibility has a positive effect on purchase intention towards postbiotic products.

H3a: Complexity has a negative effect on attitude towards postbiotic products.

H3b: Complexity has a negative effect on purchase intention towards postbiotic products.

H4a: Trialability has a positive effect on attitude towards postbiotic products.

H4b: Trialability has a positive effect on purchase intention towards postbiotic products.

4-3- Characteristics of Innovation Resistance

Similar to perceived innovation characteristics, the items related to innovation resistance (IR) were also subjected to PCA with varimax rotation to minimize cross-loadings and enhance the distinction between constructs. A total of 14 items, eight items emerged from the analysis. Claim skepticism barrier was measured using two adapted items from established scales related to image and value barriers: "I have doubts towards the claim labelling" and "Too expensive given their claimed health benefits." These items reflect skepticism toward the credibility and perceived value of health claims. Trust barrier was formed from four items associated initially with image, risk, and value barriers, reflecting concerns about credibility, product risk, and comparative value. However, two items for the tradition barrier remained within a distinct construct (Table 4).

Table 4. Components of innovation resistance from the principal components analysis

Variables	Items	Factor Loadings	Commonalities	Rotation Sums of Squared Loadings	% of Variance
Trust Barrier	TRU-B1	0.690	0.492	3.680	30.663
	TRU-B2	0.573	0.515		
	TRU-B3	0.698	0.539		
	TRU-B4	0.720	0.544		
Claim Skepticism Barrier	CLM-B1	0.694	0.531	1.828	15.233
	CLM-B2	0.769	0.602		
Tradition Barrier	TRDN-B1	0.813	0.763	1.710	14.251
	TRDN-B2	0.889	0.825		

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.862, indicating that the sample was adequate for PCA. The cumulative variance explained by the extracted components was 60.15%, reflecting acceptable levels within social sciences research. Communality values for all retained items exceeded 0.450, confirming that the extracted factors accounted for a substantial variance in each item. Items with low factor loadings (<0.500) were excluded from further analysis. The factor loadings for the remaining items were all above 0.500, meeting the threshold recommended by Hair et al. [82]. These findings confirm the acceptable reliability of the measurement model for innovation resistance and reinforce it for further analysis alongside other constructs.

Based on this, new hypotheses were proposed:

H5a: Trust barrier has a negative effect on attitude towards postbiotic products.

H5b: Trust barrier has a negative effect on purchase intention towards postbiotic products.

H6a: Claim skepticism barrier has a negative effect on attitude towards postbiotic products.

H6b: Claim skepticism barrier has a negative effect on purchase intention towards postbiotic products.

H7a: Tradition barrier has a negative effect on attitude towards postbiotic products.

H7b: Tradition barrier has a negative effect on purchase intention towards postbiotic products.

4-4- Characteristics of Attitude and Purchase Intention

Along with PIC and IR, attitude and purchase intention constructs were similarly assessed. Attitude, a critical mediator in consumer behavior, and purchase intention, a key outcome variable, were subjected to PCA with varimax rotation to identify the constructs underlying the measurements. Three items for attitude remained without drop-off after PCA (Table 5). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy for attitude was 0.588, indicating that the sample was adequate for PCA. The cumulative variance explained by the extracted components was 55.37%.

Table 5. Components of attitude and purchase intention from the principal components analysis

Variables	Items	Factor Loadings	Commonalities	Rotation Sums of Squared Loadings	% of Variance
Attitude	ATT1	0.736	0.542	1.661	55.372
	ATT2	0.824	0.680		
	ATT3	0.663	0.440		
Purchase Intention	PI2	0.704	0.495	1.790	59.672
	PI3	0.796	0.634		
	PI4	0.813	0.661		

Four items were included for purchase intention, one was dropped, and three were retained from the analysis (Table 5). The KMO measure of sampling adequacy for purchase intention was 0.638, indicating that the sample was adequate for PCA. The cumulative variance explained by the extracted components was 59.67%.

Communality values for all remaining items for the two measurements exceeded 0.400, and the factor loadings were all above 0.500. The findings demonstrate the acceptable reliability of the measurement model [82].

Based on this, new hypotheses were proposed:

H8: Attitude has a positive effect on purchase intention towards postbiotic products.

4-5- Measurement Model

The measurement model was evaluated to establish internal consistency reliability (CR) and convergent validity of the constructs, which were confirmed using the partial least squares structural equation model (PLS-SEM). The results of internal consistency reliability and convergent validity are summarized in Table 6.

Table 6. Measurement model: Internal consistency reliability, and convergent validity

Construct	Items	Coefficients	t	Composite Reliability (CR)	Average Variance Extracted (AVE)
Perceived Innovation Characteristic					
Relative Advantage	RA1	0.775***	8.934	0.833	0.715
	RA2	0.911***	21.736		
Compatibility	CPAT1	0.737***	23.714	0.807	0.512
	CPAT2	0.765***	27.605		
	CPAT3	0.700***	19.679		
	CPAT4	0.654***	16.905		
Complexity (Reversed)	CPLX1	0.962***	3.518	0.766	0.634
	CPLX2	0.586**	2.126		
Trialability	TRAL1	0.932***	6.105	0.809	0.684
	TRAL2	0.706***	3.478		
Innovation Resistance					
Trust Barrier	TRU_B1	0.822***	4.289	0.812	0.524
	TRU_B2	0.806***	4.385		
	TRU_B3	0.591***	2.503		
	TRU_B4	0.649***	3.091		
Claim Skepticism Barrier	CLM_B1	0.929***	8.792	0.787	0.655
	CLM_B2	0.669***	3.434		
Tradition Barrier	TRDN_B1	0.610**	2.223	0.805	0.686
	TRDN_B2	1.000***	4.253		
Attitude	ATT1	0.678***	14.633	0.785	0.552
	ATT2	0.829***	42.023		
	ATT3	0.712***	21.307		
Purchase Intention	PI2	0.745***	24.476	0.815	0.595
	PI3	0.783***	28.355		
	PI4	0.786***	28.826		

*Note: *** = $p < 0.01$; ** = $p < 0.05$*

Internal consistency reliability was assessed using composite reliability (CR). CR values for all constructs exceeded the recommended threshold of 0.70, as proposed by Hair et al. [82] and Nunnally & Bernstein [97] this further confirmed strong reliability. The CR values of the constructs ranged from 0.766 to 0.833, demonstrating internal consistency.

Convergent validity was assessed using the factor loadings of items and the average variance extracted (AVE). All retained items had factor loadings above 0.60, meeting the acceptable threshold [98, 99]. The AVE values for all constructs were above the minimum recommended threshold of 0.50 [100]. These results indicate that the measurement model exhibits strong internal consistency reliability, and convergent validity, providing robust support for the reliability of the scale structures used in this study.

Discriminant validity refers to a construct that is differentiated from other constructs in the model, ensuring that each construct captures a unique concept [82]. The Fornell-Larcker criterion compares the square root of each construct's average variance extracted (AVE) with its correlations with other constructs. Discriminant validity is established if the square root of the AVE for each construct exceeds the correlations of the construct with other latent variables [100]. The results in Table 7 indicate that all constructs satisfy this criterion, with the square root of each AVE being greater than the correlations between constructs.

Table 7. Discriminant validity through the Fornell–Lacker criterion

Construct	Mean		ATT	CLM_B	CPAT	CPLX	PI	RA	TRAL	TRDN_B	TRU_B
Attitude	3.795	ATT	**0.743**								
Claim Skepticism Barrier	2.830	CLM_B	-0.038	**0.809**							
Compatibility	2.966	CPAT	0.463	-0.035	**0.715**						
Complexity (Reversed)	3.710	CPLX	-0.107	-0.272	-0.096	**0.796**					
Purchase Intention	3.698	PI	0.538	-0.152	0.446	-0.035	**0.772**				
Relative Advantage	3.716	RA	0.139	0.139	0.450	-0.031	0.217	**0.845**			
Trialability	3.600	TRAL	0.135	0.117	0.177	-0.225	0.069	0.169	**0.827**		
Tradition Barrier	3.339	TRDN_B	-0.064	0.146	0.027	-0.143	0.010	0.084	0.140	**0.828**	
Trust Barrier	3.201	TRU_B	-0.119	0.320	0.125	-0.150	-0.069	0.333	0.181	0.354	**0.724**

Note: italicized values on the diagonal are the square roots of the AVE (average variance extracted).

4-6- Structural Model and Hypothesis Testing

The structural model was analyzed to test the hypothesized relationships between constructs and assess their significance. Path coefficients, standard deviations (SD), t-statistics, and p-values were computed using the PLS-SEM bootstrapping procedure with 5,000 resamples. The hypothesis testing involved three models: first, overall results from all 400 participants were provided as baseline analysis, the second model was participants with high product knowledge to examine the moderating effects, and lastly, participants with low product knowledge to explore the impact of limited knowledge were introduced in the third model.

The results provided mixed support for the hypotheses. Compatibility emerged as the most influential factor, significantly and positively affecting both attitude ($\beta = 0.481$, $p < 0.01$) and purchase intention ($\beta = 0.210$, $p < 0.01$), supporting H2a and H2b. Relative advantage had no significant effect on attitude, leading to the rejection of H1a, but it positively influenced purchase intention ($\beta = 0.099$, $p < 0.05$), supporting H1b. Trust barrier negatively impacted attitude ($\beta = -0.188$, $p < .05$), supporting H5a, but did not significantly affect purchase intention, rejecting H5b. Similarly, claim skepticism barrier had no significant effect on attitude, leading to the rejection of H6a, but it negatively influenced purchase intention ($\beta = -0.133$, $p < 0.01$), supporting H6b. Attitude positively and significantly influenced purchase intention ($\beta = 0.422$, $p < 0.01$), supporting H8. Complexity (reversed), trialability, and tradition barrier had no significant effects on either attitude or purchase intention, resulting in the rejection of H3a, H3b, H4a, H4b, H7a, and H7b. Overall, compatibility was the most impactful factor, particularly in shaping positive attitudes, while other constructs showed mixed or limited effects (see Table 8 and Figure 3).

Table 8. Analysis results: overall sample of 400 participants

	Hypotheses	Path Coefficient	SD	t-statistics	Significant Difference (p<0.05)	Results
H1a	Relative Advantage → Attitude	-0.029	0.052	0.564	0.573	Not Support
H1b	Relative Advantage → Purchase Intention	0.099**	0.046	2.135	0.033	Support
H2a	Compatibility → Attitude	0.481***	0.049	9.863	0.000	Support
H2b	Compatibility → Purchase Intention	0.210***	0.056	3.774	0.000	Support
H3a	Complexity (Reversed) → Attitude	-0.073	0.055	1.335	0.182	Not Support
H3b	Complexity (Reversed) → Purchase Intention	-0.008	0.046	0.171	0.865	Not Support
H4a	Trialability → Attitude	0.074	0.045	1.632	0.103	Not Support
H4b	Trialability → Purchase Intention	-0.027	0.046	0.585	0.558	Not Support
H5a	Trust Barrier → Attitude	-0.188**	0.076	2.476	0.013	Support
H5b	Trust Barrier → Purchase Intention	-0.054	0.056	0.972	0.331	Not Support
H6a	Claim Skepticism Barrier → Attitude	0.019	0.046	0.415	0.678	Not Support
H6b	Claim Skepticism Barrier → Purchase Intention	-0.133***	0.049	2.691	0.007	Support
H7a	Tradition Barrier → Attitude	-0.032	0.058	0.553	0.580	Not Support
H7b	Tradition Barrier → Purchase Intention	0.064	0.062	1.038	0.299	Not Support
H8	Attitude → Purchase Intention	0.422***	0.049	8.619	0.000	Support

Note: *** = $p < 0.01$; ** = $p < 0.05$

Figure 3. Results of the overall sample of 400 participants; ***(Note: 1) The insignificant paths were omitted. 2) *** = p < 0.01; ** = p < 0.05)***

4-7- Moderating Effect Analysis

Product knowledge plays a critical moderating role in shaping the relationships between perceived innovation characteristics, innovation resistance, attitude, and purchase intention. The moderating effects of product knowledge were categorized by dividing participants into high (scores > 3.28) and low (scores ≤ 3.28) product knowledge groups, enabling a comparative analysis of its influence on consumer behavior. The study reveals distinct influence patterns by segmenting participants into high and low product knowledge groups.

The results indicate several significant differences between respondents with high product knowledge (n=248) and low product knowledge (n=152). Regarding influence on attitude, for the high product knowledge group, compatibility positively influenced attitude ($\beta = 0.247$, $p < 0.01$), while complexity (reversed) negatively influenced attitude ($\beta = -0.298$, $p<0.01$). For individuals with low product knowledge, compatibility had an even stronger positive effect on attitude ($\beta = 0.485$, $p < 0.01$), indicating a moderating effect of product knowledge. However, complexity (reversed) was not significant in this group. For innovation resistance, trust barrier negatively influenced attitude for both groups, but the effect was stronger among those with low product knowledge ($\beta = -0.270$, $p < 0.01$) compared to those with high product knowledge ($\beta = -0.174$, $p < 0.05$). This suggests that trust concerns are more negative to attitude formation among low-knowledge consumers (see Table 9).

Table 9. Analysis results: moderating effects of high and low product knowledge

	High Knowledge (n = 248)			Low Knowledge (n = 152)			
Hypotheses	**Path Coefficient**	**SD**	**t-statistics**	**Path Coefficient**	**SD**	**t-statistics**	**Effect of product knowledge**
Relative Advantage → Attitude	-0.133	0.090	1.477	0.033	0.080	0.408	Moderate
Compatibility → Attitude	**0.247*** **	0.073	3.399	**0.485*** **	0.063	7.720	
Complexity (Reversed) → Attitude	**-0.298*** **	0.068	4.357	0.088	0.081	1.094	
Trialability → Attitude	0.083	0.110	0.753	0.068	0.065	1.044	
Relative Advantage → Purchase Intention	0.071	0.079	0.898	0.080	0.087	0.923	Not moderate
Compatibility → Purchase Intention	0.145	0.085	1.707	0.146	0.085	1.722	
Complexity (Reversed) → Purchase Intention	-0.072	0.067	1.087	-0.028	0.070	0.400	
Trialability → Purchase Intention	0.076	0.101	0.755	-0.003	0.069	0.039	
Trust Barrier → Attitude	**-0.174** **	0.073	2.379	**-0.270*** **	0.070	3.831	Moderate
Claim Skepticism Barrier → Attitude	0.121	0.067	1.816	-0.047	0.062	0.757	
Tradition Barrier → Attitude	-0.142	0.083	1.707	0.061	0.067	0.904	
Trust Barrier → Purchase Intention	**-0.256*** **	0.080	3.209	-0.007	0.076	0.097	Moderate
Claim Skepticism Barrier → Purchase Intention	-0.014	0.072	0.200	**-0.259*** **	0.073	3.552	
Tradition Barrier → Purchase Intention	0.088	0.106	0.835	-0.052	0.075	0.686	
Attitude → Purchase Intention	**0.234*** **	0.077	3.059	**0.521*** **	0.080	6.486	Moderate

*(Note: 2) 1) The insignificant paths were omitted. 2) *** = p < 0.01; ** = p < 0.05).*

Several factors significantly influenced purchase intention, varying based on product knowledge levels. Attitude was a significant predictor of purchase intention for both groups, with a stronger effect among low-knowledge consumers ($\beta = 0.521$, $p < 0.01$) compared to high-knowledge consumers ($\beta = 0.234$, $p < 0.01$), suggesting that product knowledge moderates this relationship. Regarding innovation resistance, the trust barrier significantly and negatively affected purchase intention for high-knowledge consumers ($\beta = -0.256$, $p < 0.01$), whereas the effect was not significant for low-knowledge consumers. Conversely, the claim skepticism barrier had a significant negative impact on purchase intention only for low-knowledge consumers ($\beta = -0.259$, $p < 0.01$), indicating that skepticism towards claims plays a more critical role in shaping purchase decisions when product knowledge is low (see Table 9).

The findings indicate that product knowledge has no moderating effect on the relationship between perceived innovation characteristics (relative advantage, compatibility, complexity (reversed), and trialability) and purchase intention in either the high or low knowledge groups. While some of these factors, such as compatibility, significantly influence attitude, their impact does not extend directly to purchase intention, suggesting that positive perceptions of innovation alone are insufficient to drive purchasing decisions. Likewise, trust barriers significantly influenced purchase intention for high-knowledge consumers but did not significantly affect low-knowledge consumers. Furthermore, tradition barriers did not significantly affect either attitude or purchase intention in either group for postbiotic products.

5- Discussion

The findings of this study provide valuable insights into consumer behavior toward functional postbiotic beverages, particularly in the context of sleep quality and mental health. Some constructs from the literature review were removed or merged with others due to their limited relevance to this specific product and market. The results align with, challenge, and expand existing research, offering a deeper understanding of the factors influencing consumer attitudes and purchase intentions in this emerging category.

Compatibility was identified as the most influential construct with a strong positive impact on attitude and purchase intention. The results on attitude were likewise found to be similar in moderating effects across product knowledge groups, which is discussed in a later section. This finding aligns with Rogers' Diffusion of Innovation (DOI) theory, which suggests that innovations perceived as compatible with existing values and needs are more readily accepted [35]. This finding is consistent with Verbeke [43], who noted that health-conscious consumers tend to favor products that align with their lifestyle choices. Similarly, Siró et al. [101] found it could be heightened when products align with societal trends like preventive healthcare and natural remedies.

Relative advantages positively influenced purchase intention but did not significantly enhance attitudes. This suggests that consumers may not prioritize comparative benefits over existing products when forming their perceptions of postbiotic products and highlights a more complex relationship between consumer perceptions and decision-making. The finding contrasts with a study by Menrad [39], who indicated that relative advantage drives the adoption of

functional foods. In addition, other research has shown consumers generally express higher adoption intentions for innovations perceived as suitable to their needs and offering clear relative advantages [102]. This highlights the complication of consumer behavior in the functional postbiotic beverages industry, suggesting that a greater focus on seamless integration into daily routines and lifestyle compatibility is needed over traditional measures of relative advantage.

While the model highlights the positive influence of perceived innovation characteristics, innovation resistance factors reveal a contrasting effect. This supports the work of Ram & Sheth [32], who identified innovation resistance or significant barriers to innovation adoption. Trust and claim skepticism barriers, identified through rotated Principal Component Analysis (PCA), significantly influenced consumer responses, underscoring their critical role as innovation resistance factors. Trust barriers significantly negatively impacted attitudes but did not affect purchase intention, suggesting that while consumers may distrust the product, it does not necessarily deter them from buying. Doney & Cannon [103] emphasized trust's role in consumer relationships, advocating transparent marketing and clear communication of scientific evidence to mitigate negative perceptions. Conversely, claim skepticism also emerged as a key barrier, significantly and negatively influencing purchase intention but not attitude. In a saturated health market, consumers scrutinize claims, discouraging adoption. This aligns with prior research suggesting transparent marketing and credible claims as essential strategies to overcome skepticism [88, 104].

The non-significant effects of complexity, trialability, and tradition barriers on attitude and purchase intention contrast with previous studies. For instance, prior research found that reducing complexity aids adoption, whereas this study found no significant impact [48]. Similarly, Flight et al. [58] and Moon [37] identified trialability as a key driver of innovation adoption, but not in this study. This could indicate that postbiotic consumers prioritize factors other than personal trial experiences, particularly in health-related products. While Botonaki et al. [63] emphasized tradition barriers as a significant obstacle to transitioning from conventional to functional foods, contrasting current findings. This suggests that resistance to change from conventional food products may not be a major obstacle for postbiotic adoption, as a possible explanation is that the growing awareness of gut health and mental well-being has made functional foods more acceptable, reducing the impact of tradition barriers. These inconsistencies may be due to differences in how consumers perceive postbiotic products compared to other innovations, such as technological systems, which were the focus of many prior studies. This suggests a potential shift in consumer evaluation processes or highlights the need for further research into how these factors influence attitudes and purchase intentions in the context of functional foods.

These findings reflect the nature of functional postbiotic beverages as low-involvement products, wherein consumers typically expend minimal cognitive effort during purchase decisions [105, 106]. This is consistent with prior studies indicating that in low-involvement contexts, such as beverage consumption that trialability and complexity become less influential [102]. A study found that complexity negatively influenced purchase intentions and trialability positively affected adoption for eco-labeled products [107]. In contrast, our study's non-significant results suggest that functional postbiotic beverages are perceived as simpler, low-risk products, thus reducing the relevance of complexity and trialability in consumer evaluations. Also, technological innovations often evoke strong emotional responses and require higher engagement [108], whereas functional beverages are simple with straightforward perceived benefits, thus diminishing the significance of complexity. Additionally, respondents in this study were familiar with functional foods, and basic product information was provided during the survey, further reducing the perceived complexity and necessity for extensive product trials. Consequently, the lack of significant effects for trialability and complexity likely reflects a reduced need for elaborate evaluation rather than inadequate consumer knowledge. This supports the idea that consumer involvement, rather than knowledge alone, is a more relevant factor influencing innovation adoption characteristics. Future research should investigate how varying involvement levels and consumer knowledge interact to shape adoption behaviors across diverse product categories.

The results confirm the mediating effect of attitude as the most impactful predictor of purchase intention across all groups in the relationship between perceived innovation characteristics and positively influences purchase intention. This aligns with Ajzen's Theory of Planned Behavior [28], which emphasizes that positive attitudes toward a behavior significantly increase the likelihood of acting on that behavior. This finding is supported by prior research from Patch et al. [109] and Tudoran et al. [65], further highlights the critical role of cultivating positive attitudes in driving purchase intentions. The strong positive coefficient highlights the importance of enhancing consumer attitudes to promote the successful adoption of postbiotic beverages.

In this study, a positive attitude reflected consumers' overall favorable evaluation of the product, particularly their belief that it supports mental well-being and provides health benefits. The most influential items in shaping attitude scores were statements such as "I find the postbiotic drink is positive" and "The postbiotic drink is good for my health." This suggests that a general perception of usefulness and health value is central to forming a positive attitude. While compatibility is a separate construct in the model, its influence on attitude highlights the importance of how well the product aligns with consumers' daily routines and health-related lifestyles.

Shaping consumer attitudes can be achieved through communication strategies highlighting health benefits and emotional appeal. Aligning the product with consumers' experiences fosters a favorable perception. Notably, attitude significantly influenced purchase intention across all groups, reinforcing its universal role. In contrast, other factors showed mixed support for product knowledge's moderating effects.

Product knowledge as a moderator provided valuable insights into consumer behavior differences. A key finding is the strong positive influence of compatibility on consumer attitudes across both high and low product knowledge groups. Notably, compatibility is more critical for low product knowledge consumers but remains significant for those with higher knowledge. However, product knowledge had a more substantial moderating effect on attitude. Interestingly, complexity (reversed) negatively impacted attitudes, particularly among high product knowledge consumers, contrasting with Rogers' Diffusion of Innovation Theory [99] suggests that simpler innovations drive adoption. In postbiotic products, however, this suggests that a more sophisticated or complex perception may appeal more to knowledgeable consumers, potentially enhancing their engagement with the product.

Surprisingly, product knowledge did not moderate the relationship between perceived innovation characteristics (PIC) and purchase intention, indicating that consumers' knowledge levels do not significantly alter their decision-making process. Furthermore, the absence of significant effects for relative advantage, trialability, and tradition barriers, even with moderation, suggests these factors may be less critical than previously assumed. This highlights the need for further research to determine under what conditions these factors might influence consumer behavior and whether other variables play a moderating role.

The findings reveal notable differences between high and low product knowledge consumer groups regarding product knowledge as a moderator of innovation resistance. Trust barriers significantly influenced attitudes and purchase intentions among high product knowledge consumers, indicating that informed consumers are more sensitive to credibility concerns. However, claim skepticism had no significant impact, suggesting these consumers rely on their understanding rather than marketing claims. In contrast, for low knowledge consumers, trust barriers negatively impacted attitude but did not significantly affect purchase intention, suggesting a disconnect between perception and behavior. Interestingly, claim skepticism did not affect attitude in the low knowledge group, yet it negatively influenced their purchase intention. This indicates that low knowledge consumers may be reluctant to buy when confidence in claims is lacking. These findings underscore the need for tailored strategies, such as building trust and transparency for high knowledge consumers, while focusing on credible claims and simplified messaging for those with lower product knowledge.

The absence of significant effects for relative advantage, trialability, and tradition barriers, even with moderating effects across both knowledge groups, suggests that these factors may be less critical in shaping consumer behavior than previously assumed. This finding highlights the need for further research to identify the conditions under which these constructs may play a role and examine other variables for potential moderating influence.

6- Contributions

6-1- Theoretical Implications

This study contributes to innovation adoption theories, particularly Rogers' Diffusion of Innovation (DOI) theory [14], by confirming compatibility as a key factor influencing attitude and purchase intention. It reinforces the importance of aligning products with consumer values and lifestyles while suggesting further exploration of how compatibility interacts with other constructs, particularly within the functional food sector. The findings confirm attitude as a mediator in the relationship between perceived innovation characteristics and purchase intention, supporting Ajzen's Theory of Planned Behavior [17]. This highlights the importance of fostering positive attitudes to enhance purchase behavior. It also allows future research to explore additional mediators and their interplay with attitude in driving consumer decisions. By identifying trust barriers and claim skepticism barriers as significant obstacles, this study expands the understanding of innovation resistance in the context of functional foods. It highlights the need for future research to explore practical strategies for mitigating these barriers and their implications for consumer adoption. The moderating effects of product knowledge revealed in this study underscore its critical role in shaping attitudes and behaviors. High knowledge consumers prioritize trust and compatibility, while low knowledge consumers rely heavily on attitude. These findings invite further exploration of how varying levels of knowledge influence consumer decision-making across different product categories.

6-2- Practical Implications

Businesses should design marketing campaigns that emphasize the compatibility of postbiotic beverages with consumers' existing dietary habits and health beliefs. Highlighting how these products integrate seamlessly into daily routines, such as bedtime or meal preparation, can encourage trial and adoption. Addressing trust barriers is essential. Companies should prioritize transparency by providing clear, substantiated health claims, leveraging credible

endorsements, and engaging with consumers through educational campaigns to build trust and reduce skepticism. Educational awareness campaigns are vital to increase product knowledge and foster confidence among consumers. Interactive platforms, workshops, and informative content can help bridge knowledge gaps, particularly for low-knowledge consumers, and drive informed purchasing decisions. Claim skepticism can be mitigated by offering free trials or samples, allowing consumers to experience the benefits firsthand. This strategy reduces skepticism and builds trust through direct engagement with the product. Different levels of product knowledge on consumer behavior emphasize the importance of segmenting marketing efforts. For high knowledge consumers, campaigns should focus on building trust and addressing resistance factors, while for low knowledge consumers, messaging should simplify product benefits and emphasize emotional and lifestyle advantages. Additionally, involving regulatory authorities and healthcare professionals can significantly enhance the credibility of product claims. Recognition or endorsement from medical experts, combined with the display of official certifications or government-authorized quality marks, such as "Clinically Verified," "FDA Approved," or "Certified Functional Food", can increase consumer trust and reinforce the perceived authenticity of the product.

7- Conclusion

This study investigated the key factors influencing consumer purchase intention toward functional postbiotic beverages to improve sleep quality and mental health. Drawing upon the Diffusion of Innovation (DOI) theory, Innovation Resistance Theory, and the Theory of Planned Behavior (TPB), the research model incorporated perceived innovation characteristics (PIC), innovation resistance (IR), attitudes, and the moderating role of product knowledge. Data collected from 400 health-conscious Thai consumers were analyzed using Principal Component Analysis (PCA) and Partial Least Squares Structural Equation Modeling (PLS-SEM). The results confirmed that compatibility and relative advantage are significant drivers of purchase intention, with compatibility also shaping consumer attitudes. Notably, attitude emerged as a strong mediator in the relationship between innovation perceptions and intention. On the other hand, claim skepticism was identified as a key resistance factor that negatively affected intention, especially among consumers with low product knowledge. Complexity and trialability were found to be non-significant, suggesting that low-involvement contexts such as beverage consumption may reduce the impact of these innovation characteristics. These findings offer both theoretical and practical implications. Theoretically, the study extends innovation adoption models by integrating resistance constructs, particularly trust and skepticism, and confirming the mediating role of attitude. Practically, marketers should focus on enhancing perceived compatibility, simplifying communication, and building claim credibility to foster trust. Product education and targeted messaging may help address knowledge gaps and reduce skepticism. Future research should explore behavioral outcomes beyond intention, such as actual purchase behavior, using experimental trials or longitudinal tracking. Cross-cultural validation and exploration of other health-related product categories may further extend the applicability of these insights. Overall, the findings offer a foundation for designing more effective strategies to promote consumer acceptance of functional postbiotic innovations.

7-1- Limitations and Future Research

This study offers valuable insights; however, several limitations should be recognized. Firstly, the dependence on self-reported data presents the risk of biases, such as social desirability or recall inaccuracies, which could impact the validity of the findings. Secondly, although this study examines functional postbiotic beverages, the findings may not be entirely generalizable to other health-related innovations. Future research could bridge this gap by investigating adoption behaviors across a broader spectrum of health-focused products. Another limitation is the reliance on purchase intention as a proxy for actual behavior. While intention is a widely accepted predictor, it may not always translate into real-world actions. Future research should consider behavioral tracking or experimental studies to validate the intention–behavior link and observe actual consumption behavior.

Additionally, the cross-sectional design of this study restricts the ability to track changes in consumer attitudes and behaviors over time. Longitudinal studies could provide valuable insights into how perceptions and purchase intentions evolve, especially as awareness of postbiotic products increases. While the current sample comprised health-conscious individuals aged 18–65, this study did not analyze subgroup differences. Future research could examine whether demographic variables such as age or gender moderate the relationships between innovation perceptions, resistance factors, and purchase intention. Exploring these differences would provide more understanding of the target market. Furthermore, examining cross-cultural differences and the impact of demographic factors such as age, income, and education could provide deeper insights into consumer behavior across diverse markets. Finally, future studies could assess the long-term effects of various marketing strategies, particularly those aimed at building trust and enhancing product knowledge, to identify the most effective approaches for promoting functional postbiotic products.

8- Declarations

8-1- Author Contributions

Conceptualization, C.P. and N.A.; methodology, C.P. and N.A.; software, C.P.; validation, C.P., N.A., and C.B.; formal analysis, C.P.; investigation, C.P.; resources, C.P.; data curation, C.P. and N.A.; writing—original draft preparation, C.P.; writing—review and editing, C.P. and N.A.; visualization, C.P.; supervision, N.A. and C.B.; project administration, C.B. All authors have read and agreed to the published version of the manuscript.

8-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

8-3- Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

8-4- Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of the Second Allied Academic Group in Social Sciences, Humanities and Fine and Applied Arts, Chulalongkorn University (protocol code COA No. 053/68, date of approval: 24 February 2025).

8-5- Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

8-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

9- References

[1] Precedence Research. (2024). Health and Wellness Market Size, Share, and Trends 2024 to 2033. Precedence Research, Ottawa, Canada. Available online: https://www.precedenceresearch.com/health-and-wellness-market (accessed on September 2025).

[2] Fazira, E. (2024). Key Trends Shaping Food in Asia: 2024 and Beyond. Euromonitor International, London, United Kingdom. Available online: https://www.euromonitor.com/article/key-trends-shaping-food-in-asia-2024-and-beyond (accessed on May 2025)

[3] Grand View Research. (2022). Brain Health Supplements Market Size, Share & Trends Analysis Report by Product (Natural Molecules, Vitamins & Minerals), By Application (Memory Enhancement, Attention & Focus), By Region, and Segment Forecasts, 2023–2030. Grand View Research, San Francisco, United States. Available online: https://www.grandviewresearch.com/industry-analysis/brain-health-supplements-marke (accessed on September 2025).

[4] Carabotti, M., Scirocco, A., Maselli, M. A., & Severi, C. (2015). The gut-brain axis: interactions between enteric microbiota, central and enteric nervous systems. Annals of gastroenterology: quarterly publication of the Hellenic Society of Gastroenterology, 28(2), 203.

[5] Bagga, D., Reichert, J. L., Koschutnig, K., Aigner, C. S., Holzer, P., Koskinen, K., Moissl-Eichinger, C., & Schöpf, V. (2018). Probiotics drive gut microbiome triggering emotional brain signatures. Gut Microbes, 9(6), 486–496. doi:10.1080/19490976.2018.1460015.

[6] Marotta, A., Sarno, E., Casale, A. Del, Pane, M., Mogna, L., Amoruso, A., Felis, G. E., & Fiorio, M. (2019). Effects of probiotics on cognitive reactivity, mood, and sleep quality. Frontiers in Psychiatry, 10, 164. doi:10.3389/fpsyt.2019.00164.

[7] Santomauro, D. F., Mantilla Herrera, A. M., Shadid, J., Zheng, P., Ashbaugh, C., Pigott, D. M., Abbafati, C., Adolph, C., Amlag, J. O., Aravkin, A. Y., Bang-Jensen, B. L., Bertolacci, G. J., Bloom, S. S., Castellano, R., Castro, E., Chakrabarti, S., Chattopadhyay, J., Cogen, R. M., Collins, J. K., … Ferrari, A. J. (2021). Global prevalence and burden of depressive and anxiety disorders in 204 countries and territories in 2020 due to the COVID-19 pandemic. The Lancet, 398(10312), 1700–1712. doi:10.1016/S0140-6736(21)02143-7.

[8] WHO. (2022). Mental Health and COVID-19: Early evidence of the pandemic's impact. World Health Organization (WHO), Geneva, Switzerland.

[9] Vinderola, G., Sanders, M. E., & Salminen, S. (2022). The Concept of Postbiotics. Foods, 11(8). doi:10.3390/foods11081077.

[10] Żółkiewicz, J., Marzec, A., Ruszczyński, M., & Feleszko, W. (2020). Postbiotics—A Step Beyond Pre- and Probiotics. Nutrients, 12(8), 2189. doi:10.3390/nu12082189.

[11] Isaac-Bamgboye, F. J., Mgbechidinma, C. L., Onyeaka, H., Isaac-Bamgboye, I. T., & Chukwugozie, D. C. (2024). Exploring the Potential of Postbiotics for Food Safety and Human Health Improvement. Journal of Nutrition and Metabolism, 1868161. doi:10.1155/2024/1868161.

[12] Pristavu, M. C., Diguță, C., Coulibaly, W. H., Youte Fanche, S. A., Dopcea, G., & Matei, F. (2022). A Review of Postbiotics as New Health Promoters. AgroLife Scientific Journal, 11(2), 142–152. doi:10.17930/AGL2022219.

[13] Chowdhury, S. R. (2024). Psychobiotics and Gut–Brain Axis—A New Paradigm for Improving Mental Health. Probiotics, 146–158, CRC Press, Boca Raton, United States. doi:10.1201/9781003452249-7.

[14] Chakrabarti, A., Geurts, L., Hoyles, L., Iozzo, P., Kraneveld, A. D., La Fata, G., Miani, M., Patterson, E., Pot, B., Shortt, C., & Vauzour, D. (2022). The microbiota–gut–brain axis: pathways to better brain health. Perspectives on what we know, what we need to investigate and how to put knowledge into practice. Cellular and Molecular Life Sciences, 79(2), 80. doi:10.1007/s00018-021-04060-w.

[15] Jach, M. E., Serefko, A., Szopa, A., Sajnaga, E., Golczyk, H., Santos, L. S., Borowicz-Reutt, K., & Sieniawska, E. (2023). The Role of Probiotics and Their Metabolites in the Treatment of Depression. Molecules, 28(7), 3213. doi:10.3390/molecules28073213.

[16] Lee, H. J., Hong, J. K., Kim, J. K., Kim, D. H., Jang, S. W., Han, S. W., & Yoon, I. Y. (2021). Effects of probiotic nvp-1704 on mental health and sleep in healthy adults: An 8-week randomized, double-blind, placebo-controlled trial. Nutrients, 13(8), 2660. doi:10.3390/nu13082660.

[17] Haarhuis, J. E., Kardinaal, A., & Kortman, G. A. M. (2022). Probiotics, prebiotics and postbiotics for better sleep quality: a narrative review. Beneficial Microbes, 13(13), 169–182. doi:10.3920/BM2021.0122.

[18] Zhao, X., Liu, S., Li, S., Jiang, W., Wang, J., Xiao, J., Chen, T., Ma, J., Khan, M. Z., Wang, W., Li, M., Li, S., & Cao, Z. (2024). Unlocking the power of postbiotics: A revolutionary approach to nutrition for humans and animals. Cell Metabolism, 36(4), 725–744. doi:10.1016/j.cmet.2024.03.004.

[19] Teame, T., Wang, A., Xie, M., Zhang, Z., Yang, Y., Ding, Q., Gao, C., Olsen, R. E., Ran, C., & Zhou, Z. (2020). Paraprobiotics and Postbiotics of Probiotic Lactobacilli, Their Positive Effects on the Host and Action Mechanisms: A Review. Frontiers in Nutrition, 7. doi:10.3389/fnut.2020.570344.

[20] Constantino, J., Mamede, H. S., & da Silva, M. M. (2024). Adopting ISO 20022: Opportunities, Challenges, and Success Factors for Corporations in Payment Processing. Emerging Science Journal, 8(4), 1402–1419. doi:10.28991/ESJ-2024-08-04-010.

[21] Vera-Santander, V. E., Hernández-Figueroa, R. H., Jiménez-Munguía, M. T., Mani-López, E., & López-Malo, A. (2023). Health Benefits of Consuming Foods with Bacterial Probiotics, Postbiotics, and Their Metabolites: A Review. Molecules, 28(3), 1230. doi:10.3390/molecules28031230.

[22] Darwish, M. S., Qiu, L., Taher, M. A., Zaki, A. A., Abou-Zeid, N. A., Dawood, D. H., Shalabi, O. M. A. K., Khojah, E., & Elawady, A. A. (2022). Health Benefits of Postbiotics Produced by E. coli Nissle 1917 in Functional Yogurt Enriched with Cape Gooseberry (Physalis peruviana L.). Fermentation, 8(3). doi:10.3390/fermentation8030128.

[23] Rogers, E. M., Singhal, A., & Quinlan, M. M. (2014). Diffusion of innovations. An integrated approach to communication theory and research, Routledge, Milton Park, United Kingdom.

[24] Fürst, A., Pecornik, N., & Hoyer, W. D. (2024). How product complexity affects consumer adoption of new products: The role of feature heterogeneity and interrelatedness. Journal of the Academy of Marketing Science, 52(2), 329–348. doi:10.1007/s11747-023-00933-7.

[25] Wulan, I. A. D. P. (2017). The Food Label, Knowledge, Trust and Experience on Adoption of Functional Food. Review of Integrative Business and Economics Research, 6(3), 287.

[26] Laukkanen, T., Sinkkonen, S., Kivijärvi, M., & Laukkanen, P. (2007). Innovation resistance among mature consumers. Journal of Consumer Marketing, 24(7), 419–427. doi:10.1108/07363760710834834.

[27] Claudy, M. C., Garcia, R., & O'Driscoll, A. (2015). Consumer resistance to innovation—a behavioral reasoning perspective. Journal of the Academy of Marketing Science, 43(4), 528–544. doi:10.1007/s11747-014-0399-0.

[28] Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179–211. doi:10.1016/0749-5978(91)90020-T.

[29] Aertsens, J., Mondelaers, K., Verbeke, W., Buysse, J., & van Huylenbroeck, G. (2011). The influence of subjective and objective knowledge on attitude, motivations and consumption of organic food. British Food Journal, 113(11), 1353–1378. doi:10.1108/00070701111179988.

[30] Bettman, J. R., & Park, C. W. (1980). Effects of Prior Knowledge and Experience and Phase of the Choice Process on Consumer Decision Processes: A Protocol Analysis. Journal of Consumer Research, 7(3), 234. doi:10.1086/208812.

[31] Rogers, E. M. (1962) Diffusion of Innovations. Free Press, New York, United States.

[32] Ram, S., & Sheth, J. N. (1989). Consumer resistance to innovations: The marketing problem and its solutions. Journal of Consumer Marketing, 6(2), 5. doi:10.1108/EUM0000000002542.

[33] Mack, F. (2018). Factors influencing consumers' adoption of and resistance to functional food product innovations: an impirical investigation into adoption and resistance to functional food product innovations among German customers, to provide new opportunities in health claims regulated markets. Master Thesis, University of Twente, Enschede, Netherlands.

[34] Verhoef, P. C., & Langerak, F. (2001). Possible determinants of consumers' adoption of electronic grocery shopping in the Netherlands. Journal of Retailing and Consumer Services, 8(5), 275–285. doi:10.1016/s0969-6989(00)00033-3.

[35] Miller, R. L. (2015). Rogers' innovation diffusion theory (1962, 1995). In Information seeking behavior and technology adoption: Theories and trends. IGI Global Scientific Publishing, 261-274. doi:10.4018/978-1-4666-8156-9.ch016.

[36] Rogers, E. M. (1961). Bibliography on the Diffusion of Innovations. Department of Agricultural Economics and Rural Sociology, Ohio State University, Columbus, United States.

[37] Moon, S. J. (2020). Integrating Diffusion of Innovations and Theory of Planned Behavior to Predict Intention to Adopt Electric Vehicles. International Journal of Business and Management, 15(11), 88. doi:10.5539/ijbm.v15n11p88.

[38] Siegrist, M., Stampfli, N., & Kastenholz, H. (2008). Consumers' willingness to buy functional foods. The influence of carrier, benefit and trust. Appetite, 51(3), 526–529. doi:10.1016/j.appet.2008.04.003.

[39] Menrad, K. (2003). Market and marketing of functional food in Europe. Journal of Food Engineering, 56(2–3), 181–188. doi:10.1016/S0260-8774(02)00247-9.

[40] Nguyen, N., Nguyen, H. V., Nguyen, P. T., Tran, V. T., Nguyen, H. N., Nguyen, T. M. N., Cao, T. K., & Nguyen, T. H. (2020). Some key factors affecting consumers' intentions to purchase functional foods: A case study of functional yogurts in Vietnam. Foods, 9(1), 24. doi:10.3390/foods9010024.

[41] Osunsanmi, A. S., Ayandibu, A. O., & Heeralal, S. (2024). Assessing the factors that influence consumer's purchase behaviour towards functional foods. International Journal of Research in Business and Social Science, 13(2), 39–49. doi:10.20525/ijrbs.v13i2.3192.

[42] Fetscherin, M., Kiefer, K., & Braun-Herr, A. N. S. (2024). Meatless Revolution: Exploring Consumers' Perception of Meat Alternatives. Journal of Food Products Marketing, 30(5), 154–169. doi:10.1080/10454446.2024.2377542.

[43] Verbeke, W. (2005). Consumer acceptance of functional foods: Socio-demographic, cognitive and attitudinal determinants. Food Quality and Preference, 16(1), 45–57. doi:10.1016/j.foodqual.2004.01.001.

[44] Saputri, M. D., & Soepatini, S. (2023). The Effect of Customer-Product Compatibility on Intention to Purchase and Intention to Recommend Influencers with Attitude as an Intervening Variable. International Conference on Digital Advance Tourism, Management and Technology, 1(2), 411–427. doi:10.56910/ictmt.v1i2.107.

[45] Tan, C. C., Islam, M. S., Sinha, R., Shehata, A. E., & Selem, K. M. (2025). Compatibility as a pivotal design factor for digital concierge apps: exploring hotel guests' socio-psychological dynamics. Kybernetes, 54(8), 4275-4299. doi:10.1108/K-12-2023-2658.

[46] Kıymalıoğlu, A., Akıncı, S., & Alragig, A. (2024). Linking consumer compatibility and bank reputation to intention to use mobile banking. Managerial Finance, 50(2), 417–433. doi:10.1108/MF-05-2023-0304.

[47] Huard Nicholls, B. (2020). Brand Personality as a Mediator of Visual Complexity Effects on Consumer Responses to Packaging. Master Thesis, Concordia University, Irvine, United States.

[48] Baker, M. T., Lu, P., Parrella, J. A., & Leggette, H. R. (2022). Consumer Acceptance toward Functional Foods: A Scoping Review. International Journal of Environmental Research and Public Health, 19(3), 1217. doi:10.3390/ijerph19031217.

[49] Xia, T., Fan, X., Zhang, J., & Liu, T. (2023). Influence of Complexity in Low-Fat Food Packaging on Chinese Consumers' Purchase Intentions. Sustainability (Switzerland), 15(4), 3697. doi:10.3390/su15043697.

[50] Wang, Y., Zhang, X., Zhou, Q., Xu, X., Liu, X., & Lu, S. (2021). Information Complexity and Behavior Intention to Prescribe Antibiotics Based on the Antimicrobial Susceptibility Testing Report: The Mediating Roles of Information Overload and Attitude. Frontiers in Pharmacology, 12, 778664. doi:10.3389/fphar.2021.778664.

[51] Zhang, P., & Sun, H. (2009). The Complexity of different types of attitudes in initial and continued ICT use. Journal of the American Society for Information Science and Technology, 60(10), 2048–2063. doi:10.1002/asi.21116.

[52] Agarwal, R., & Prasad, J. (1997). The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. Decision Sciences, 28(3), 557–582. doi:10.1111/j.1540-5915.1997.tb01322.x.

[53] Alalwan, A. A., Abu-Romman, S., Al-Weshah, G., Dwivedi, Y. K., & Albanna, H. (2023). Examining the key determinants of the jordanian customer's adoption of genetically modified food. Heliyon, 9(6), e16920. doi:10.1016/j.heliyon.2023.e16920.

[54] Hayes, K. J., Eljiz, K., Dadich, A., Fitzgerald, J. A., & Sloan, T. (2015). Trialability, observability and risk reduction accelerating individual innovation adoption decisions. Journal of Health Organization and Management, 29(2), 271–294. doi:10.1108/JHOM-08-2013-0171.

[55] Hosseinikhah Choshaly, S. (2019). Applying innovation attributes to predict purchase intention for the eco-labeled products. International Journal of Innovation Science, 11(4), 583–599. doi;10.1108/ijis-04-2019-0038.

[56] Dilotsotlhe, N. (2021). Factors influencing the green purchase behaviour of millennials: An emerging country perspective. Cogent Business and Management, 8(1), 1908745. doi:10.1080/23311975.2021.1908745.

[57] Templeton, E. M., Stanton, M. V., & Zaki, J. (2016). Social norms shift preferences for healthy and unhealthy foods. PLoS ONE, 11(11), 166286. doi:10.1371/journal.pone.0166286.

[58] Flight, R. L., D'Souza, G., & Allaway, A. W. (2011). Characteristics-based innovation adoption: Scale and model validation. Journal of Product and Brand Management, 20(5), 343–355. doi:10.1108/10610421111157874.

[59] Laureati, M., De Boni, A., Saba, A., Lamy, E., Minervini, F., Delgado, A. M., & Sinesio, F. (2024). Determinants of Consumers' Acceptance and Adoption of Novel Food in View of More Resilient and Sustainable Food Systems in the EU: A Systematic Literature Review. Foods, 13(10), 1534. doi:10.3390/foods13101534.

[60] Bower, J. A., Saadat, M. A., & Whitten, C. (2003). Effect of liking, information and consumer characteristics on purchase intention and willingness to pay more for a fat spread with a proven health benefit. Food Quality and Preference, 14(1), 65–74. doi:10.1016/S0950-3293(02)00019-8.

[61] Siegrist, M. (2008). Factors influencing public acceptance of innovative food technologies and products. Trends in Food Science and Technology, 19(11), 603–608. doi:10.1016/j.tifs.2008.01.017.

[62] Urala, N., & Lähteenmäki, L. (2004). Attitudes behind consumers' willingness to use functional foods. Food Quality and Preference, 15(7-8 SPEC.ISS.), 793–803. doi:10.1016/j.foodqual.2004.02.008.

[63] Botonaki, A., Polymeros, K., Tsakiridou, E., & Mattas, K. (2006). The role of food quality certification on consumers' food choices. British Food Journal, 108(2), 77–90. doi:10.1108/00070700610644906.

[64] Misra, R., & Singh, D. (2016). An analysis of factors affecting growth of organic food: Perception of consumers in Delhi-NCR (India). British Food Journal, 118(9), 2308–2325. doi:10.1108/BFJ-02-2016-0080.

[65] Tudoran, A., Olsen, S. O., & Dopico, D. C. (2009). The effect of health benefit information on consumers health value, attitudes and intentions. Appetite, 52(3), 568–579. doi:10.1016/j.appet.2009.01.009.

[66] Bharti, K., Agarwal, R., & Satsangi, A. K. (2024). Behavioral Intention of Consumers for Green Marketing in India: The Mediating Role of Consumer Environmental Attitude. Jindal Journal of Business Research, 22786821241256188. doi:10.1177/22786821241256188.

[67] Li, L., Wang, Z., Li, Y., & Liao, A. (2021). Consumer innovativeness and organic food adoption: The mediation effects of consumer knowledge and attitudes. Sustainable Production and Consumption, 28, 1465–1474. doi:10.1016/j.spc.2021.08.022.

[68] Hung, Y., de Kok, T. M., & Verbeke, W. (2016). Consumer attitude and purchase intention towards processed meat products with natural compounds and a reduced level of nitrite. Meat Science, 121, 119–126. doi:10.1016/j.meatsci.2016.06.002.

[69] Fishbein, M., & Ajzen, I. (1975). Strategies of Change: Active Participation. Belief, attitude, intention, and behavior: An introduction to theory and research, Addison-Wesley, Boston, United States.

[70] Morwitz, V. (2014). Consumers' purchase intentions and their behavior. Foundations and Trends in Marketing, 7(3), 181–230. doi:10.1561/1700000036.

[71] Wansink, B., Westgren, R. E., & Cheney, M. M. (2005). Hierarchy of nutritional knowledge that relates to the consumption of a functional food. Nutrition, 21(2), 264–268. doi:10.1016/j.nut.2004.06.022.

[72] Chiang, A., Schnettler, B., Mora, M., & Aguilera, M. (2018). Perceived quality of and satisfaction from sweet cherries (Prunus avium L.) in China: Confirming relationships through structural equations. Ciencia e Investigacion Agraria, 45(3), 210–219. doi:10.7764/rcia.v45i3.1930.

[73] Ares, G., Giménez, A., & Gámbaro, A. (2008). Influence of nutritional knowledge on perceived healthiness and willingness to try functional foods. Appetite, 51(3), 663–668. doi:10.1016/j.appet.2008.05.061.

[74] Rao, A. R., & Sieben, W. A. (1992). The Effect of Prior Knowledge on Price Acceptability and the Type of Information Examined. Journal of Consumer Research, 19(2), 256. doi:10.1086/209300.

[75] Sujan, M. (1985). Consumer Knowledge: Effects on Evaluation Strategies Mediating Consumer Judgments. Journal of Consumer Research, 12(1), 31. doi:10.1086/209033.

[76] Fu, F., & Elliott, M. (2013). The moderating effect of perceived product innovativeness and product knowledge on new product adoption: An integrated model. Journal of Marketing Theory and Practice, 21(3), 257–272. doi:10.2753/MTP1069-6679210302.

[77] Testa, F., Sarti, S., & Frey, M. (2019). Are green consumers really green? Exploring the factors behind the actual consumption of organic food products. Business Strategy and the Environment, 28(2), 327–338. doi:10.1002/bse.2234.

[78] Joshi, Y., & Rahman, Z. (2017). Investigating the determinants of consumers' sustainable purchase behaviour. Sustainable Production and Consumption, 10, 110–120. doi:10.1016/j.spc.2017.02.002.

[79] Vittersø, G., & Tangeland, T. (2015). The role of consumers in transitions towards sustainable food consumption. the case of organic food in Norway. Journal of Cleaner Production, 92, 91–99. doi:10.1016/j.jclepro.2014.12.055.

[80] Boobalan, K., Nachimuthu, G. S., & Sivakumaran, B. (2021). Understanding the psychological benefits in organic consumerism: An empirical exploration. Food Quality and Preference, 87, 104070. doi:10.1016/j.foodqual.2020.104070.

[81] Shao, J. (2019). Sustainable consumption in China: New trends and research interests. Business Strategy and the Environment, 28(8), 1507–1517. doi:10.1002/bse.2327.

[82] Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. European Business Review, 26(2), 106–121. doi:10.1108/EBR-10-2013-0128.

[83] Karahanna, E., Agarwal, R., & Angst, C. M. (2006). Reconceptualizing compatibility beliefs in technology acceptance research. MIS Quarterly: Management Information Systems, 30(4), 781–804. doi:10.2307/25148754.

[84] Lian, J. W., & Yen, D. C. (2013). To buy or not to buy experience goods online: Perspective of innovation adoption barriers. Computers in Human Behavior, 29(3), 665–672. doi:10.1016/j.chb.2012.10.009.

[85] Kushwah, S., Dhir, A., & Sagar, M. (2019). Understanding consumer resistance to the consumption of organic food. A study of ethical consumption, purchasing, and choice behaviour. Food Quality and Preference, 77, 1-14. doi:10.1016/j.foodqual.2019.04.003.

[86] Wiedmann, K. P., Hennigs, N., Pankalla, L., Kassubek, M., & Seegebarth, B. (2011). Adoption barriers and resistance to sustainable solutions in the automotive sector. Journal of Business Research, 64(11), 1201–1206. doi:10.1016/j.jbusres.2011.06.023.

[87] Rammile, N., & Nel, J. (2012). Understanding resistance to cell phone banking adoption through the application of the technology acceptance model (TAM). African Journal of Business Management, 6(1), 86. doi:10.5897/ajbm11.635.

[88] Laukkanen, T. (2016). Consumer adoption versus rejection decisions in seemingly similar service innovations: The case of the Internet and mobile banking. Journal of Business Research, 69(7), 2432–2439. doi:10.1016/j.jbusres.2016.01.013

[89] Hsiao, C. H., Chang, J. J., & Tang, K. Y. (2016). Exploring the influential factors in continuance usage of mobile social Apps: Satisfaction, habit, and customer value perspectives. Telematics and Informatics, 33(2), 342–355. doi:10.1016/j.tele.2015.08.014.

[90] Al-Ansi, A., Olya, H. G. T., & Han, H. (2019). Effect of general risk on trust, satisfaction, and recommendation intention for halal food. International Journal of Hospitality Management, 83, 210–219. doi:10.1016/j.ijhm.2018.10.017.

[91] Anderson, J. C., & Gerbing, D. W. (1988). Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach. Psychological Bulletin, 103(3), 411–423. doi:10.1037/0033-2909.103.3.411.

[92] Ringle, C. M., Wende, S., & Becker, J. (2024). Smart PLS 4: Bönningstedt: SmartPLS. SmartPLS GmbH, Bönningstedt, Germany. Available online: https://www.smartpls.com (accessed on September 2025).

[93] Hair, J., & Alamer, A. (2022). Partial Least Squares Structural Equation Modeling (PLS-SEM) in second language and education research: Guidelines using an applied example. Research Methods in Applied Linguistics, 1(3), 100027. doi:10.1016/j.rmal.2022.100027.

[94] Vukovi´c, M. (2024). CB-SEM vs PLS-SEM comparison in estimating the predictors of investment intention. Croatian Operational Research Review, 15(2), 131–144. doi:10.17535/crorr.2024.0011.

[95] Narimawati, U., & Sarwono, J. (2024). Theoretical Approaches Review on Covariance Based SEM Using LISREL, Partial Least Based SEM Using Smart PLS and Component Based SEM Using GESCA. American Journal of Applied Mathematics, 12(5), 133–140. doi:10.11648/j.ajam.20241205.13.

[96] Astrachan, C. B., Patel, V. K., & Wanzenried, G. (2014). A comparative study of CB-SEM and PLS-SEM for theory development in family firm research. Journal of Family Business Strategy, 5(1), 116–128. doi:10.1016/j.jfbs.2013.12.002.

[97] Nunnally, J. C., & Bernstein, I. H. (1994). Psychometric theory (3rd Ed.). McGraw-Hill, New York, United States.

[98] Chin, W. W., Gopal, A., & Salisbury, W. D. (1997). Advancing the Theory of Adaptive Structuration: The Development of a Scale to Measure Faithfulness of Appropriation. Information Systems Research, 8(4), 342–367. doi:10.1287/isre.8.4.342.

[99] Hair Jr., J. F., Matthews, L. M., Matthews, R. L., & Sarstedt, M. (2017). PLS-SEM or CB-SEM: updated guidelines on which method to use. International Journal of Multivariate Data Analysis, 1(2), 107. doi:10.1504/ijmda.2017.10008574.

[100] Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. Journal of Marketing Research, 18(1), 39–50. doi:10.1177/002224378101800104.

[101] Siró, I., Kápolna, E., Kápolna, B., & Lugasi, A. (2008). Functional food. Product development, marketing and consumer acceptance-A review. Appetite, 51(3), 456–467. doi:10.1016/j.appet.2008.05.060.

[102] Arts, J. W. C., Frambach, R. T., & Bijmolt, T. H. A. (2011). Generalizations on consumer innovation adoption: A meta-analysis on drivers of intention and behavior. International Journal of Research in Marketing, 28(2), 134–144. doi:10.1016/j.ijresmar.2010.11.002.

[103] Doney, P. M., & Cannon, J. P. (1997). An Examination of the Nature of Trust in Buyer–Seller Relationships. Journal of Marketing, 61(2), 35–51. doi:10.1177/002224299706100203.

[104] Cicciù, B., & Carmona, L. J. D. M. (2024). The impact of consumer skepticism on perceived value and purchase intention of organic food. Revista de Administração Da UFSM, 17(2), e8. doi:10.5902/1983465985505.

[105] Petty, R. E., & Cacioppo, J. T. (1986). The Elaboration Likelihood Model of Persuasion. Advances in Experimental Social Psychology, Amsterdam, Netherlands. doi:10.1016/s0065-2601(08)60214-2.

[106] Krugman, H. E. (1965). The impact of television advertising: Learning without involvement. Public Opinion Quarterly, 29(3), 349–356. doi:10.1086/267335.

[107] Hosseinikhah Choshaly, S., & Mirabolghasemi, M. (2022). The role of viral marketing strategies in predicting purchasing intention of eco-labelled products. Journal of Islamic Marketing, 13(5), 997–1015. doi:10.1108/JIMA-04-2020-0102.

[108] Wood, S. L., & Moreau, C. P. (2006). From fear to loathing? How emotion influences the evaluation and early use of innovations. Journal of Marketing, 70(3), 44–57. doi:10.1509/jmkg.70.3.44.

[109] Patch, C. S., Tapsell, L. C., & Williams, P. G. (2005). Overweight consumers' salient beliefs on omega-3-enriched functional foods in Australia's Illawarra region. Journal of Nutrition Education and Behavior, 37(2), 83–89. doi:10.1016/S1499-4046(06)60020-1.