ANALYZING CONSUMER PERCEPTION FOR ALGAL CANDIES THROUGH CONJOINT ANALYSIS

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DEDICATION

This thesis is dedicated to my parents, whose love and unwavering support have been a constant source of strength. To Dr. Muhammad Waqas Alam Chattha, my supervisor, for his invaluable guidance and encouragement throughout this journey.

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LIST OF SYMBOLS, ABBREVIATIONS AND ACRONYMS

SP: Stated Preference

RP: Revealed Preference

CO_2: Carbon dioxide

CA: Conjoint Analysis

SPSS: Statistical Package for the Social Sciences

NUST: National University of Sciences and Technology

TFQM: Total Food Quality Model

WTP: Willingness to Pay

RPL: Random Parameter Logit

GM: Genetically Modified

PGI: Protected Geographical Indication

CLA: Conjugated Linoleic Acid

MNL: Multinomial Logit

ABSTRACT

This study investigates consumer perceptions and preferences for Spirulina-enriched algal candies, combining sensory analysis and conjoint analysis (CA) to provide comprehensive insights. The sensory analysis evaluated four key attributes: color, flavor, smell, and overall acceptance, while the CA examined consumer preferences based on texture, brand presence, health claims, and price. The study involved 230 participants from the National University of Sciences and Technology (NUST), who assessed these attributes through a structured survey.

The sensory analysis revealed that consumers generally favored the overall acceptance and flavor of the candies, though the smell was less well-received, suggesting areas for product improvement. The CA identified health claims, particularly those related to vitamins and antioxidants, as the most influential factors driving consumer preferences. Brand presence also significantly impacted choices, reflecting the importance of brand trust in consumer decisions. Texture was valued but less critical, and while price was a factor, it was the least influential in comparison to other attributes.

The findings suggest that to enhance market acceptance, manufacturers should focus on promoting the health benefits of Spirulina, ensuring product texture aligns with consumer preferences, and leveraging brand strength. Additionally, competitive pricing, although less critical, remains important in the overall marketing strategy. This research contributes valuable insights for product development and marketing of functional foods, particularly in the context of health-oriented confectionery products.

Key words: Choice experiment, Spirulina-enriched algal candies, Consumer perception, Consumer behavior, Conjoint analysis, Sensory analysis, Health claims, Brand presence, Texture presence, Price sensitivity, Ranking

1 INTRODUCTION

1.1 Background of the study

The acceptance and adoption of new food products in the market depend upon consumers' preferences, as well as the perception of risks and benefits associated with the product (Cranfield et al., 2011). Neophobia, the fear of consuming novel food, is quite common among individuals. It is one of the major reasons why consumers are reluctant to purchase some novel product, especially when it comes to food. Due to lack of research in understanding consumer preferences and high competition in the market, around 70% of novel food products fail to perform and exit the market within two years (Ballco & Gracia, 2020). This highlights the need to study consumer preferences and behaviour before the launch of a new product.

Food shortages and the limitations of natural resources are critical challenges facing humanity in the 21st century. Issues such as climate change, decreasing arable land, and scarce potable water have exacerbated these problems, making traditional nutrient sources unsustainable. The growing global population drives the urgent need for sustainable, safe, and alternative nutrient sources to meet food demand. Microalgae have emerged as a promising alternative due to their high content of macro- and micro-nutrients and their environmentally friendly properties, such as CO2 consumption and the lack of need for arable land or drinkable water. Additionally, the health benefits of bioactive compounds derived from microalgae are increasing the popularity of microalgal supplements. However, several obstacles hinder the integration of microalgae into foods. The first challenge is the sensory attributes of many microalgae species, such as their fishy taste, odor, and color, which are unappealing to many people. The second issue is the high costs associated with downstream processing and harvesting. The third challenge involves legislative hurdles related to incorporating novel microalgae species into food products. (Hosseinkhani et al., 2022).

Functional foods are type of foods, composed of ingredients that provide the consumers with health benefits beyond basic nutritional functions. The demand for functional foods is rising globally, as they add value by providing numerous health benefits and promoting overall well-being. Due to escalating healthcare costs, and the desire among older adults for a better

quality of life in their later years, the demand for functional foods is rising. Today foods aim not only to satisfy hunger and supply essential nutrients but also to help prevent diseases and enhance the physical and mental well-being of consumers (Siró et al., 2008). As individuals are becoming more health conscious, the effect of food on health is becoming a dominant factor in the choice of food. Keeping this in view, confectionary industry is also constantly evolving to provide healthier alternatives. One such example is Spirulina-enriched algal candies. This study focuses on analyzing consumer preferences for algal candies, blending the nutritional richness of Spirulina algae with the indulgence of confectionery. These candies were developed in Turkey as part of a collaborative project between the Durukan Industry and National University of Sciences and Technology (NUST), Pakistan. The reason for choosing candies as a medium was that they are well-liked across different age groups, making them an excellent choice for delivering the health benefits of Spirulina. Their widespread appeal can attract a broad range of consumers, including those who may not usually seek out health-oriented products.

FIGURE 1.1: SPIRULINA ENRICHED ALGAL CANDY

Algae are microorganisms classified as microalgae and macroalgae. This classification is based on the organizational structure and organelles present. Microalgae grow and reproduce on land, water, and harsh conditions, with limited amount of nutrients and water as compared to plants grown on land. This makes microalgae a valuable source of nutrition that does not require extended period of growth. The microalgal industry is producing commercial food products such as food supplements and additives. The most consumed algae are Spirulina Platensis and Chlorella Vulgaris. The adaptation to a healthy diet and lifestyle in recent years has increased the demand for innovative new food products. Functional food research has focused on extracting organic value components from high-nutritional foods. Microalgae have potential as a functional food due to their antioxidants, anticancer and anti-inflammatory activity. Food manufacturing with microalgae to produce products has resulted in the incorporation of algae in candy bars, gums, snacks, pasta and beverages (Goh et al., 2009). Confectionaries with visual attractiveness, texture and taste always remain popular among consumers of all ages. The addition of functional foods to confectionary products elevates their nutritional value.

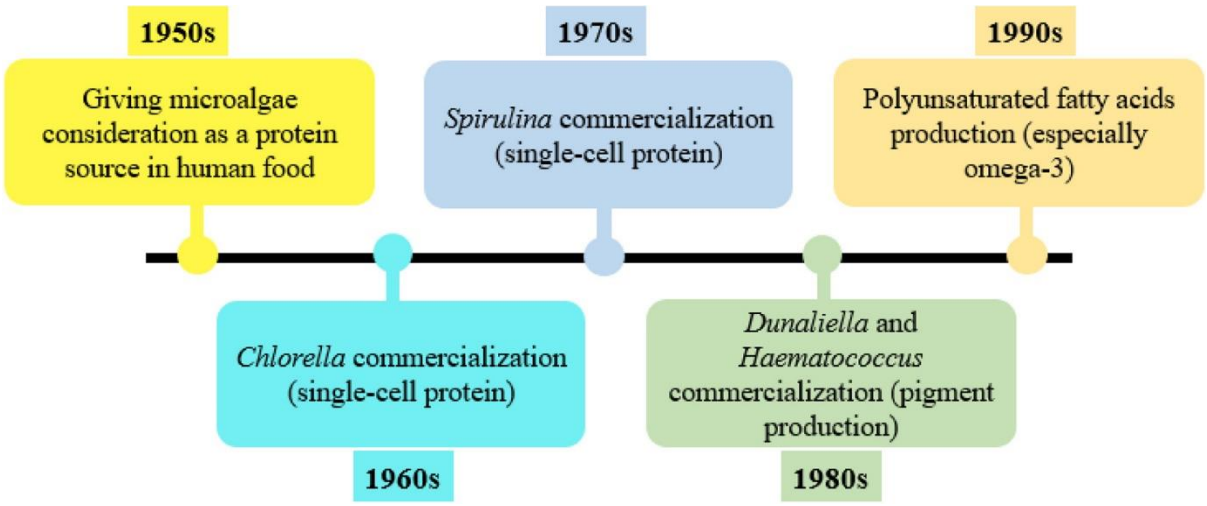

FIGURE 1.2: COMMERCIALISATION OF MICROALGAE FOR FOOD CONSUMPTION

Algal candies are enriched with a genus of microalgae, Spirulina, which is considered safe for human consumption. They are well-known for producing the following compounds, providing enormous health benefits:

- Proteins
- Long-chain polyunsaturated fatty acids

- Sterols
- Phenolic compounds
- Volatile compounds
- Vitamins (Andrade et al., 2018)

Consumer acceptance is essential for the success of functional foods and is influenced by multiple factors, such as primary health concerns, the nature of the product, and how health benefits are communicated. Consumers often have limited knowledge about the health benefits of functional ingredients, making effective communication strategies vital to inform them. While functional benefits add value to a product, they cannot replace the importance of good taste. Surveys indicate that consumers primarily evaluate functional foods based on their food qualities, with functional benefits serving as an additional value rather than a substitute for sensory appeal (Siró et al., 2008).

Food purchase decisions are a mixture of intrinsic attributes (e.g. taste) and extrinsic attributes (e.g. brand, price). Various factors play a role in making consumer's demand and food choices, with price, quality, health, sensory properties, risk perception, and convenience being the most significant ones (Boccia & Punzo, 2021). Consumers' perceptions are heterogeneous, and thus, the food demand varies among individuals. Price is one of the attributes that consumers are particularly interested in. Moreover, health, presence of a known brand, and sensory attributes play a crucial role in the choice of food, as they strongly influence preference. Taste, flavour, and odour have been found to be one of the strongest drivers of individuals' choices in food (Baba et al., 2016).

Sensory analysis reveals the sensory elements that influence consumer liking by evaluating the properties of food, such as taste, texture, appearance, etc., of a product through the senses. On the other hand, many studies use the technique of conjoint analysis (CA), as they effectively present the scenario of purchasing products in real market conditions by manipulating key attributes of the product. The popularity of CA in marketing research has been increasing in the recent years. CA is a statistical technique used in market research to understand consumer preferences. It is a form of stated preference technique which depends on individuals' expressed evaluations of different hypothetical scenarios. CA helps individuals make trade-offs by evaluating various hypothetical scenarios. It employs three

primary approaches to gather well-ordered preferences: ranking, rating, and discrete choices. This technique, known as conjoint measurement, was initially developed in the 1960s by American mathematical psychologist Duncan Luce and statistician John Tukey. In the early 1970s, Green and Rao applied conjoint measurement to marketing research to understand and predict consumer behavior, and it has since become widely used in that field. (Al-Omari et al., 2022). It helps determine how consumers value different attributes of a product by presenting them with various combinations of attributes. By analyzing the choices made, it identifies the most important attributes and the preferred levels of these attributes. This method provides valuable insights for designing products that better meet consumer needs and preferences. However, this method does not consider the impact of the product's sensory attributes on purchase decisions. Typically, the purchase process can be divided into three stages: 1) purchase, 2) consumption, and 3) re-purchase. According to the Total Food Quality Model (TFQM), when a new product is introduced in the market, consumers have certain expectations from it based on extrinsic properties. These expectations are a result of available information or some relevant past experience. Once tasted, the expectations are converted into experience. Experience obtained from tasting has been found to play an important role in determining consumers' perceptions and re-purchase decisions. Both expectations and experienced quality combined form a basis for consumer satisfaction or dissatisfaction, which may or may not lead to re-purchase. (Baba et al., 2016).

Sensory studies help us to assess consumer liking score for different parameters of the product under review, while CA gives an insight into general consumer preferences in the real market situation. This study has utilized both rank-based CA and sensory analysis for the best understanding of consumer behaviour towards algal candies.

The study's main objective is to analyze the consumers' preferences for algal candies. The study was conducted on a sample of students 230 from the National University of Sciences and Technology (NUST). A systematic random sampling method was employed for data collection to ensure that each student within the university has an equal chance of being selected. First, sensory analysis was performed to assess the liking score for different properties of the product among consumers, followed by rank-based CA in the end to investigate what consumer preferences would be in the market. Four attributes were selected for sensory analysis of the candies: color, flavor, smell, and overall acceptance. For CA, four

attributes were selected: texture, brand, health claims, and price. Texture had two levels: soft, and hard. Brand had two levels: yes, and no. Health claims had three levels: none, high in antioxidants, and high in vitamins. Price also had three levels: Rs. 20, Rs. 30, and Rs. 40. Paired T-test and Conjoint Plan syntax in SPSS were used to analyze the data from sensory and conjoint experiment respectively.

Many studies have determined the consumer perception of different food products using conjoint experiment and sensory analysis. However, no such previous study has been done on algal candies. To fill this gap, this study analyzes consumer's perception of algal candies.

1.2 Rationale

The aim of the study is to comprehensively understand consumer perception and preferences for algal candies through sensory analysis and conjoint experiment. The research explores how variations in different product attributes influence consumer choices. This approach provides a perspective on consumer behavior, contributing valuable insights for effective market strategies and product development.

1.3 Significance of the study

This study has a great significance, impacting both academic understanding and practical application in the realms of consumer behavior and product development.

- *Market Insight for Product Launch*: By analyzing consumer preferences, this research provides critical insights for the successful market introduction of Spirulina-enriched algal candies. Understanding which attributes consumers value most ensures that the product is tailored to meet consumer expectations, increasing the likelihood of market acceptance and success.
- *Contribution to Health Trends*: The study aligns with the growing trend towards healthier eating habits. Spirulina, known for its high nutritional value, offers numerous health benefits. By incorporating Spirulina into a widely accepted form like candy, this study promotes a healthier alternative to traditional sweets, encouraging better dietary choices.
- *Support for Sustainable Food Practices*: Spirulina is an environmentally sustainable source of nutrition, requiring fewer resources to produce compared to traditional

animal-based proteins. By promoting algal candies, the study supports sustainable food practices and contributes to environmental conservation efforts.

- *Innovative Approach*: This research explores a novel product category—Spirulina-enriched candies—which stands out in the confectionery market. The findings can guide further innovation and development of health-oriented food products, providing a roadmap for future product launches that cater to health-conscious consumers.
- *Consumer Behavior Insights*: The study enhances understanding of consumer behavior, particularly in the context of health-focused food products. Insights into how consumers prioritize different product attributes and make trade-offs in their purchasing decisions contribute to the broader literature on consumer preferences and decision-making processes.
- *Practical Implications for Businesses*: The results offer actionable recommendations for food manufacturers and marketers. By identifying key attributes that drive consumer preferences, businesses can refine their product development and marketing strategies to better align with consumer needs, ultimately enhancing their competitive edge in the market.

1.4 Objectives

1. Conduct a sensory analysis to evaluate a mean consumer liking score for color, flavor, smell, and overall acceptance of algal candies.
2. Use rank-based CA to comprehend how consumers make tradeoffs between various product attributes and to determine the best combination of attributes that maximizes the consumer preference.
3. Determine the relative importance of various attributes in consumer decision-making for algal candies.

1.5 Research Questions

- What are the sensory perceptions (color, flavor, smell, and overall acceptance) of Spirulina-enriched algal candies?
- How do the attributes (texture, brand, health claims, and price) influence consumer preferences for Spirulina-enriched algal candies?

2 LITERATURE REVIEW

2.1 Functional foods

2.1.1 Definition

Functional foods are a type of food designed to offer health benefits that go beyond basic nutritional needs. The idea of functional foods originated in Japan in 1984 through extensive government-supported research initiatives. Since then, these foods have become increasingly popular and are projected to continue growing in the market (Lafarga et al., 2020).

2.1.2 Concept and Market Growth

The creation of functional foods is driven by a better understanding of how nutrition impacts health. These foods are designed to enhance overall well-being and lower the risk of diseases. The market for functional foods is substantial, particularly in the United States, Japan, and Europe.

2.1.3 Market Potential

Functional foods can provide significant public health benefits by potentially reducing healthcare costs, extending life expectancy, and enhancing the quality of life for older individuals. The market for these foods is expanding as more consumers become health-conscious (Siró et al., 2008).

2.2 Microalgae as functional food

Algae, especially microalgae, are regarded as promising alternative food sources due to their high nutritional content and environmental advantages. They provide essential nutrients like proteins, lipids, vitamins, and minerals without needing arable land or potable water, offering a sustainable solution amidst global food shortages and environmental issues. Microalgae are packed with essential amino acids, polyunsaturated fatty acids (PUFAs), vitamins, minerals, and bioactive compounds that help prevent chronic diseases such as cardiovascular disease, diabetes, and certain cancers. These compounds offer various health benefits, including anti-inflammatory, antioxidant, and cholesterol-lowering properties. However, a significant challenge to consumer acceptance is the sensory characteristics of microalgae, such as their fishy taste and odor. These features can be unappealing, and incorporating microalgae into

foods at levels that maintain nutritional benefits without compromising taste and smell is difficult (Hosseinkhani et al., 2022)

2.2.1 Spirulina

Spirulina is a type of cyanobacteria or blue-green algae and it as been used as a food source in various cultures for centuries. It is available in forms such as capsules, tablets, and powder, and is often added to foods and beverages like energy bars, popcorn, and smoothies. Numerous suppliers worldwide advertise Spirulina's health benefits. Spirulina thrives in extreme environments that are unsuitable for most other aquatic organisms. It is typically cultivated in man-made or natural lakes, then harvested and freeze-dried. Spirulina is noted for its high protein content, comprising 60% protein, making it richer in protein than most vegetables. Additionally, it is a good source of beta-carotene, several minerals, and gamma-linolenic acid, an essential fatty acid (*By the Way, Doctor*, 2006). It also contains a variety of carbohydrates and a moderate amount of fats, including omega-3 and omega-6 fatty acids. Spirulina is abundant in vitamins A, B1, B2, B3, B6, B9, C, D, and E, with a particularly high content of vitamin B12, making it especially beneficial for plant-based diets. Additionally, Spirulina is a good source of essential minerals such as calcium, iron, magnesium, phosphorus, potassium, and zinc (Lafarga et al., 2020).

Complete nutritional profile of Spirulina is (Soni et al., 2017) :

Proteins and Carbohydrates:

- Proteins: Spirulina is predominantly composed of proteins, making up 60-70% of its dry weight, which positions it as an excellent protein source.
- Carbohydrates: It provides essential carbohydrates that serve as an energy source.

Fats:

- Essential Fatty Acids: Spirulina includes important fats like γ-linolenic acid (GLA), contributing to its health benefits.

Vitamins:

- Vitamin A (Provitamin A): Crucial for vision and immune health.

- Vitamin C: Supports the immune system and skin health.
- Vitamin E: Acts as an antioxidant, protecting cells from oxidative damage.

Minerals:

- Iron: Important for producing red blood cells and transporting oxygen.
- Calcium: Essential for strong bones and proper muscle function.
- Chromium: Helps regulate carbohydrate and lipid metabolism.
- Copper: Necessary for iron metabolism and maintaining neurological health.
- Magnesium: Involved in over 300 enzymatic reactions in the body.
- Manganese: Important for bone health and metabolic processes.
- Phosphorus: Key for bone and teeth formation.
- Potassium: Vital for heart and muscle functions.
- Sodium: Helps maintain fluid balance in the body.
- Zinc: Essential for immune function and DNA synthesis.

Pigments:

- Chlorophyll a: Known for its detoxifying properties and antioxidant effects.
- Phycocyanin: Has anti-inflammatory and antioxidant properties.
- Carotenes: Important antioxidants and precursors to vitamin A.

Additional Nutrients:

- Antioxidants: Spirulina contains various antioxidants that help reduce oxidative stress.
- Polysaccharides: The cell wall of Spirulina consists of easily digestible polysaccharides.

The main antioxidant vitamins present in Spirulina are B-carotene, carotenoids, and Vitamin E.

2.3 Spirulina-enriched food products

(El Shafai, n.d.) explored the nutritional benefits of incorporating Spirulina into six food products for children: gelatin dessert (jelly cola), frozen yogurt, salted biscuits, wafer

biscuits, potato balls, and sushi. Spirulina-enriched products were found to improve the nutritional profile of children's snacks by boosting protein, lipid, and antioxidant content.

(Lafarga et al., 2020) reported that incorporating 2.6% Spirulina into snacks resulted in high sensory acceptance and increased protein levels. Yogurt enriched with Spirulina at concentrations of 0.3% to 0.5% exhibited higher protein and fiber content, improved water retention, and reduced whey separation during storage. Spirulina also enhanced the viability of probiotics in the yogurt, boosting its health benefits. Spirulina has been included in fresh pork sausages at levels up to 2%. Although it affects the color and texture, it significantly improves the nutritional profile, making these sausages a healthier alternative to traditional meat products. Adding Spirulina to ayran at concentrations of 0.2% to 0.5% increased its nutritional value without negatively impacting its sensory qualities. While, Cheese fortified with Spirulina at levels of 1% to 2% showed increased protein, carotenoid, and chlorophyll content. Spirulina has been added to various baked goods, including bread and cookies, in concentrations ranging from 1% to 3%. This addition enhanced their nutritional value by increasing protein and essential nutrient content.

(Lucas et al., 2018) evaluated the nutritional composition, physical attributes, and sensory qualities of snacks enriched with 2.6% Spirulina. Incorporating Spirulina led to substantial increases in the protein, lipid, and mineral content by 22.6%, 28.1%, and 46.4%, respectively. Additionally, the carotenoid content saw a significant rise.

(Hussien et al., 2021) focused on developing a functional pasta enriched with Spirulina platensis to boost its protein and antioxidant levels. The addition of Spirulina significantly elevated the protein content, reaching 17.03% in pasta with 10% Spirulina. There were also notable increases in fat, ash, and fiber contents, while the carbohydrate content decreased. Both the total phenolic content and antioxidant activity were enhanced with Spirulina, although the antioxidant activity was lower in cooked pasta compared to uncooked.

(Santos et al., 2016) focused on tackling nutritional deficiencies in the elderly by creating a chocolate-flavored shake fortified with Spirulina. The resulting shakes had about 42% protein and 46% carbohydrates. Moreover, the addition of Spirulina did not affect its acceptance as sensory analysis revealed that the shakes with and without Spirulina had high acceptance rates among the elderly, scoring 7.68 and 7.77 out of 9, respectively.

2.4 Understanding consumer preferences

Understanding consumer preferences is an essential part of product marketing. Many studies have been done on analyzing consumer preferences. Choice experiment is a widely used technique. A choice experiment enables the evaluation of several product attributes at once, aiding in the comprehension of how these attributes impact consumer satisfaction and their relative importance. It closely simulates actual buying situations, unlike surveys or hypothetical scenarios. Participants are given options that mirror real market conditions, which enhances the reliability of their responses.

2.4.1 Choice experiment studies

This section will provide a detailed outline of choice experiment studies that were performed to analyze consumer preferences for different set of attributes in the product.

(Gracia, 2014) examined consumer preferences for locally produced food, focusing on fresh lamb meat in Spain. Through a real choice experiment conducted in Zaragoza, the study sought to determine the willingness to pay (WTP) for two main attributes: "locally grown" and the type of lamb meat. Using a Random Parameters Logit (RPL) model, the study concluded that consumers place a positive value on locally grown lamb meat and are willing to pay a premium. On average, consumers are willing to pay 9% more for lamb labeled "Ojinegra from Teruel" and 13% more for "Ternasco" lamb.

(Gracia et al., 2009) used choice experiment to collect data from 400 respondents on how they value nutritional information on food products by taking breakfast cookies an example.

(Boccia & Punzo, 2021) investigated how consumers perceive and value three different generations of genetically modified (GM) foods. The study used a choice experiment approach, involving 1444 participants from London, Paris, and Rome. The research utilized a choice experiment to understand real-world purchasing decisions, focusing on how consumers balance different product attributes. Participants were given choice sets that included various combinations of price, brand, and GM traits (first, second, and third generations). A Random Parameter Logit-Error Component (RPL-EC) model was employed to account for variations in consumer preferences and to analyze correlations in utilities and taste parameters.

(Güney & Giraldo, 2019) investigated how consumers in Turkey feel about organic eggs, identifies different consumer profiles, and measures how much they are willing to pay (WTP) for various attributes of these eggs. The data were analyzed using ordered probit, conditional logit, and mixed logit models.

(Torquati et al., 2018) investigated whether tasting a new food product affected consumer preferences and their willingness to pay (WTP) for sustainable attributes. It focused on the introduction of tinned Chianina beef to the Italian market. Participants were shown different attributes of tinned Chianina beef, such as organic breeding, traditional rural landscape, Protected Geographical Indication (PGI), meat processing method, packaging, and price. They then made choices in hypothetical market scenarios using a discrete choice experiment.

(Baba et al., 2016) examined how tasting beef impacts consumer preferences for its various attributes, particularly focusing on beef enriched with omega-3 (n-3) and conjugated linoleic acid (CLA) fatty acids. Participants took part in a choice experiment before and after tasting beef samples. The choice experiment evaluated preferences for origin, animal diet, fat content, color, and price. Results showed that after tasting, consumers placed less importance on fat content, color, and origin, and more importance on the animal's diet.

2.4.2 Consumer's valuation of health benefits and nutritional information

Health benefits and presence of nutritional information are important attributes for selection in choice experiment studies. Following studies provide some examples of how they have been used.

(Gracia et al., 2009) examined how consumers in Spain perceive and value nutritional labels on food products, with a focus on breakfast cookies. The study aimed to understand consumer preferences for two types of nutritional labels: a comprehensive nutritional facts panel and a simpler nutritional claim like "light." A choice experiment was conducted to simulate real-world purchasing decisions, capturing how consumers make trade-offs between different product attributes. The study used two models for analysis: the Multinomial Logit (MNL) model and the Random Parameter Logit (RPL) model, to account for variations in consumer preferences. Consumers showed a stronger preference for detailed nutritional facts panels over simple nutritional claims. On average, consumers are willing to pay roughly twice as

much for breakfast cookies with a nutritional facts panel compared to those with a "light" claim.

According to (Güney & Giraldo, 2019), consumers preferred organic eggs over conventioal eggs due to health benefits and high nutritional content of organic eggs.

2.4.3 Consumer's valuation of brand

Presence of a known brand is also an important factor in determining consumer preferences for different products. Following studies have used brand as an attribute in choice studies:

Having a well-known brand markedly enhances consumer satisfaction. The research revealed that consumers experience greater enjoyment from breakfast cookies with a recognizable brand name compared to those from less familiar brands. This impact is notably strong, highlighting the importance of brand recognition in food purchasing decisions. Moreover, the study found that older consumers value well-known brands more than younger consumers do (Gracia et al., 2009).

(Boccia & Punzo, 2021) found that recognizable brands significantly boosted consumer satisfaction and trust. Participants preferred branded GM foods over those without a brand, demonstrating the importance of brand recognition in purchasing decisions.

(Güney & Giraldo, 2019) showed that consumers value branded eggs, especially local brands, which significantly increase their willingness to pay.

2.4.4 Consumer's valuation of price

Price plays an important role in preference of a product. Most of the studies report that price has a negative impact on consumer preference. Here are a few wxamples:

(Boccia & Punzo, 2021) found that price had a negative impact on utility. Higher prices led to decreased consumer utility, meaning that as the price of GM foods increased, the likelihood of purchase decreased. This trend was consistent across all three cities studied.

(Güney & Giraldo, 2019) reported that price remains the most significant barrier to increasing organic egg consumption. Higher prices reduce the likelihood of purchasing organic eggs.

According to (Torquati et al., 2018), higher prices reduced the likelihood of participants choosing the tinned Chianina beef.

(Baba et al., 2016) took price as a variable in his study. The β (beta) value for price was found to be -0.382 for beef. This indicated that higher prices generally led to a decreased likelihood of choosing the beef products.

2.4.5 Sensory analysis

Sensory analysis allows researchers to understand how consumers respond to the taste, texture, aroma, and appearance of food products. These sensory experiences are critical for accurately gauging preferences, as they cannot be fully captured through surveys or hypothetical questions alone. By having participants taste the products, researchers can evaluate overall acceptance and satisfaction. Sensory analysis provides direct feedback on how much consumers like or dislike specific product attributes, which is essential for understanding their market potential. Following studies have utilized sensory analysis:

(El Shafai, n.d.) assessed the sensory attributes of the products, such as color, flavor, aroma, and texture, using a score sheet ranging from 1 (low) to 9 (high) using a panel of ten experts from the Food Industries and Nutrition Division at the National Research Centre. The evaluation showed that the products, especially jelly cola, had acceptable levels in these sensory attributes, making them suitable for children.

(Lucas et al., 2018) performed a study in which s ensory analysis demonstrated high acceptance rates, with the Spirulina sample reaching an 82% acceptability index. Parameters such as flavor, color, texture, taste, overall acceptance, and purchase intention were evaluated using a 9-point hedonic scale. Although color was the only attribute significantly different between the Spirulina and Control samples, both formulations received high ratings for overall acceptance and texture.

(Hussien et al., 2021) evaluated the color, flavor, mouthfeel, elasticity, and overall acceptability of Spirulina-enriched Pasta on a 10-point hedonic scale. Evaluation was done using One-way ANOVA in SAS Systems for Windows software.

(Santos et al., 2016) conducted a sensory analysis for two types of shakes: one containing Spirulina and one without, on elderly participants, the target consumers for the product. Overall acceptance was measured using a nine-point hedonic scale ranging from "extremely dislike" (1) to "like very much" (9), while purchase intent was assessed on a five-point scale from "certainly would not buy" (1) to "certainly would buy" (5). The shake with Spirulina

received a mean score of 7.68, and the shake without Spirulina scored 7.77, both indicating a high level of acceptance. Notably, only 2% of the panelists expressed they would not purchase the shake without Spirulina, and none indicated a lack of purchase intent for the shake with Spirulina.

In a study by (Torquati et al., 2018), participants rated the tinned Chianina beef based on appearance, smell, flavor, texture, and overall liking using a 9-point hedonic scale.

(Baba et al., 2016) assessed some sensory attributes to collect participants' hedonic evaluations and to determine how their sensory experiences affected their preferences and willingness to pay for beef enriched with omega-3 (n-3) and conjugated linoleic acid (CLA) fatty acids. The attributes included appearance, smell, flavor, texture, and overall liking on a 9-point hedonic scale.

3 METHODOLOGY

3.1 Consumer behavior

Interest in the application of stated preference (SP) theory and methods has seen a significant rise in agricultural and food economics, environmental and resource economics, and health economics since the mid-1990s. SP methods are utilized to determine individuals' preferences for various "alternatives" such as goods, services, or courses of action within a survey setting. These methods for eliciting preferences contrast with traditional economic approaches, which rely on revealed preference (RP) data gathered from observing individual behavior in actual markets (Louviere et al., 2010). The core idea is that any product can be effectively described by its key characteristics and the specific levels of these characteristics, known as attributes. Consumer evaluations are based on these attribute levels. Properly selecting attributes and setting appropriate levels are crucial for ensuring the success and validity of an experiment.

A choice experiment is designed to examine the behavioral responses of consumers, households, or organizations across different sectors. This experimental method involves developing, testing, and optimizing a survey to gather data. Identifying the most significant attributes is essential, with price commonly included as one of the alternatives. Including the price attribute allows for the calculation of willingness to pay for each attribute. The design process of a choice experiment includes five key phases: defining the attributes and levels, evaluating the alternatives and experimental design, structuring the questionnaire, selecting the sampling strategy, and conducting interviews.

3.1.1 Conjoint analysis

When individuals make decisions, they consider multiple characteristics of the product. CA assumes that each of these characteristics holds a certain level of importance to individuals, who then make trade-offs between these characteristics to arrive at their decision. Unlike traditional questionnaires, conjoint analysis (CA) presents individuals with several hypothetical scenarios and asks them to rate, rank, or choose their preferred option (Al-Omari et al., 2022). This study has used a rank-based conjoint analysis. The five main stages of conjoint analysis are: identifying relevant attributes, assigning levels to these attributes, selecting scenarios, establishing preferences, and analyzing the data.

- Identifying relevant attributes: Attributes are the factors, features, or characteristics that are thought to influence individuals' preferences for a specific product or treatment. Identifying these attributes should be supported by evidence indicating the potential range of preferences and values that people may have (Al-Omari et al., 2022).
- Assigning levels: Each attribute is assigned different levels. Levels refer to the various options for each attribute and should be reasonable and capable of being compared and traded off against one another (Ryan, 1999).
- Selecting scenarios: After identifying the attributes and their levels, all possible scenarios are created by combining the levels of all attributes. As the number of attributes and levels increases, so does the number of possible scenarios. When a study involves many attributes, it can become difficult for participants to process all the scenarios. To address this, partial-profile choice experiments have been suggested to estimate preferences for a large set of attributes more manageably.
- Establishing preferences: Preferences for the developed scenarios can be determined using rating, ranking, or choice-based methods. The ranking method, as used in this study, asks respondents to order the scenarios based on their preference.
- Analyzing the data: Analysis is conducted to determine the relative importance of the attributes and the utilities (part-worths) of the levels. Part-worths are typically scaled to an arbitrary additive scale, while relative importance is expressed as percentage values assigned to each attribute. A higher percentage indicates greater importance to the respondents, and the total relative importance of all attributes sums to 100%.

3.1.2 Data collection

The survey in this study aims to understand consumer behavior regarding the purchase of Spirulina-enriched algal candies. A questionnaire was administered to the students of National University of Sciences and Technology (NUST) to investigate consumer behavior. Primary data was collected from a sample size of 320 students by using a systematic random sampling technique. 32 students were randomly selected from 10 schools of NUST, giving a total of 320 students. Students from NUST were selected because they are knowledgeable and more aware of health concerns. Respondents completed the electronic questionnaire themselves between May 2, 2024, and July 2, 20204 while maintaining their anonymity. Data

was recorded carefully from each respondent to ensure accuracy. The survey exclusively used closed-end questions to ensure accuracy and consistency.

The first section of questionnaire gathered data on personal characteristics such as sex, age, education, and department. Second section was related to sensory analysis to assess overall liking score of candies. Third section included CA questions to assess consumers' attitudes toward the Spirulina-enriched algal candies. Participants provided informed consent before participating. Additionally, the questionnaire recipients were given a brief explanation of the research's overall purpose to capture their attention and motivate their participation.

3.2 Research design

3.2.1 Methodological framework

The methodological framework of this study is designed to analyze consumer preferences for algal candies through two primary methods: sensory evaluation and conjoint analysis. This framework ensures a comprehensive approach to understanding how various product attributes influence consumer choices. Following key steps were performed for this study:

- Data collection: To obtain detailed information from participants about their preferences for different characteristics of algal candies.
- Sensory analysis: To collect initial consumer reactions and preferences based on the sensory attributes of algal candies.
- Conjoint analysis: To quantify the importance of different attributes and their levels in shaping consumer preferences for algal candies.
- Interpretation and reporting: To interpret the findings from the data analysis to provide a comprehensive understanding of consumer preferences for algal candies.

3.2.2 Sensory analysis

The consumers liking score for algal candies was determined using a hedonic evaluation approach, in which the consumers are given a piece of candy and asked to rate certain characteristics of the product. Following set of characteristics were chosen for the analysis:

- Color
- Flavor
- Smell

- Overall acceptance

The respondents were asked to rate each characteristics on a scale of 1 to 9 after tasting. Where Where, 9 is like extremely, 8 is like very much, 7 is like moderately, 6 is like slightly, 5 is neither like nor dislike, 4 is dislike slightly, 3 isi dslike moderately, 2 is dislike very much, and 1 is dislike extremely. The overall liking of the algal candies will be determined using SPSS.

Sr. no	Question	1	2	3	4	5	6	7	8	9
1	Color									
2	Flavor									
3	Smell									
4	Overall acceptance									

FIGURE 3.1: SENSORY ANALYSIS

3.2.3 Conjoint analysis

This study employs a quantitative research design, specifically utilizing CA to investigate consumer preferences for algal candies. CA is a statistical technique used to understand how consumers value different attributes of a product. By presenting respondents with various product combinations, we can identify the most influential attributes and their levels in consumer decision-making. CA was selected to analyze the data because it allows for the decomposition of overall preferences into part-worth utilities for individual attributes and their levels. Participants were asked to select their preferred choice set across various hypothetical scenarios, where each scenario included different attributes of the product (such as price) with varying levels. The chosen product for this study was Spirulina-enriched algal candies. The response data were analyzed using a conjoint plan syntax, providing insights into the importance of the given attributes, their relative utility, the trade-offs participants were willing to make, and the overall satisfaction or utility derived from the product.

The attributes and their levels were selected based on the research objectives, existing literature. Four main attributes were included in the experimental design: texture, presence of known brand, health claims, and price. The texture attribute had two levels: soft and hard. The presence of a known brand attribute had two levels: yes, and no. Health claims attribute

had three levels: none, high in antioxidants, and high in vitamins. The price attribute was a quantitative variable with three levels, including Rs 20, Rs. 30, and Rs. 40. Figure 3.2 represents the attributes and their respective levels chosen for this study.

	Attributes	Levels		
1	Texture:	Soft & chewy	Hard & crunchy	-
2	Known brand:	Yes	No	-
3	Health claims:	No additional health benefits	High in antioxidants	High in vitamins & minerals
4	Price:	Low	Medium	High

FIGURE 3.2: ATTRIBUTES AND LEVELS FOR CONJOINT ANALYSIS

The next step in arranging the choice experiment was to specify the design structure, combining the levels of attributes to consider all possible product types. This full factorial design generated 36 potential combinations (2 × 2 × 3 × 3). However, to avoid overwhelming respondents with too many scenarios and to maintain accuracy, a fractional factorial (orthogonal) design was used, reducing the combinations to 9 (Gustafsson et al., 1999). SPSS software (version 26.0) was utilized for this purpose. Table 3.1 shows the 9 cards that were presented to respondents for ranking.

TABLE 3.1: CARDS PRESENTED TO RESPONDENTS

	Card ID	Texture	Brand	Health claims	Price
1	1	soft	no	high in vitamins	Rs. 20
2	2	soft	yes	none	Rs. 30
3	3	hard	yes	high in vitamins	Rs. 30
4	4	hard	yes	high in antioxidants	Rs. 20
5	5	hard	no	none	Rs. 40
6	6	soft	yes	high in vitamins	Rs. 40
7	7	soft	yes	none	Rs. 20
8	8	soft	yes	high in antioxidants	Rs. 40

	Card ID	Texture	Brand	Health claims	Price
1	1	soft	no	high in vitamins	Rs. 20
2	2	soft	yes	none	Rs. 30
3	3	hard	yes	high in vitamins	Rs. 30
4	4	hard	yes	high in antioxidants	Rs. 20
5	5	hard	no	none	Rs. 40
6	6	soft	yes	high in vitamins	Rs. 40
7	7	soft	yes	none	Rs. 20
8	8	soft	yes	high in antioxidants	Rs. 40
9	9	soft	no	high in antioxidants	Rs. 30

3.2.4 Characteristics of sample

Sample size for primary data collection was 230 respondents. All respondents successfully completed the survey. In the total sample, the gender distribution was even, with 50% male and 50% female participants. Age-wise, 45.2% of respondents were between 25-30 years old, while 54.3% were between 17-24 years old. Regarding educational levels, 47.4% of the respondents were undergraduate students, and 52.6% were postgraduate students. Representation from each department was equal, with each contributing 10% of the student sample. These socioeconomic characteristics reflect a balanced representation of the student population.

3.3 Data analysis

For sensory analysis, Descriptive Statistics and Paired-Samples T Test were used to analyze the data. Following six pairs were used for Paired-Samples T Test to compared the means of variables:

- Pair 1: Flavor and Color
- Pair 2: Flavor and Smell
- Pair 3: Flavor and Overall Acceptance
- Pair 4: Smell and Color

- Pair 5: Smell and Overall Acceptance
- Pair 6: Color and Overall Acceptance

For CA, data were analyzed using random utility theory, according to which an individual selects an alternative if it offers the highest perceived utility among the available options.Rankings provided by each respondent for the choice sets were entered into SPSS, ensuring that each response was correctly matched to its respective choice set. The SPSS conjoint plan syntax was used to analyze the data. This involved inputting the rankings to estimate part-worth utilities (importance scores) for each attribute level. The SPSS conjoint analysis results provided utility values for each attribute level, indicating the relative importance of each attribute in consumer preferences. Higher utility values signified greater preference for the corresponding attribute levels. These findings were interpreted to discern consumer priorities and trade-offs.

4 RESULTS

4.1 Sensory Analysis

The sensory analysis for the Spirulina-enriched algal candies was conducted to assess consumer preferences based on four key attributes: color, flavor, smell, and overall acceptance. This study involved 230 participants from the National University of Sciences and Technology (NUST) who rated each attribute on a 9-point hedonic scale, where 9 indicated "like extremely" and 1 indicated "dislike extremely." The frequency of each attribute rated is depicted below in the images:

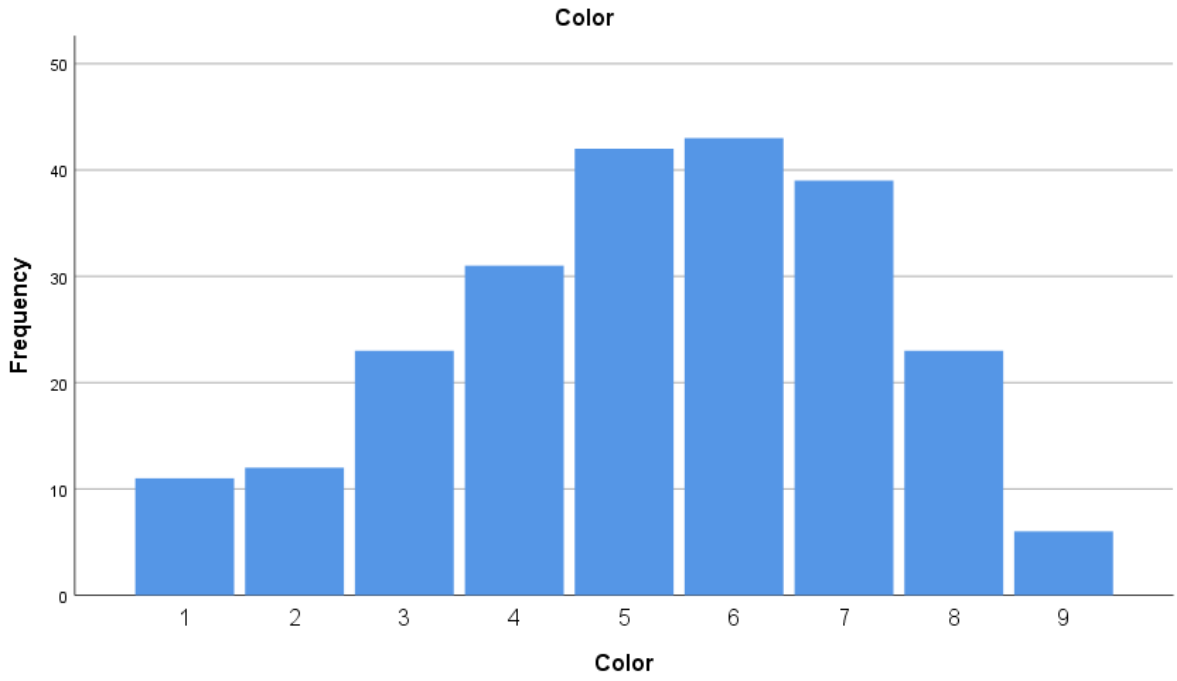

FIGURE 4.1: FREQUENCY OF COLOR RATING

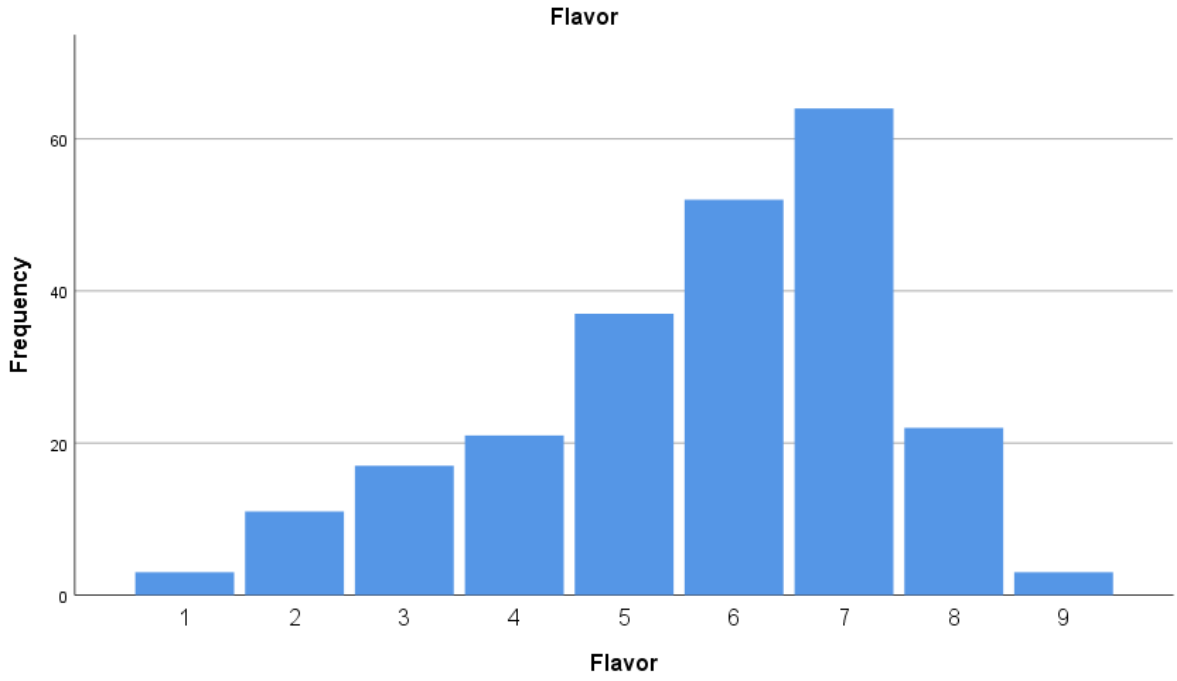

FIGURE 4.2: FREQUENCY OF FLAVOR RATING

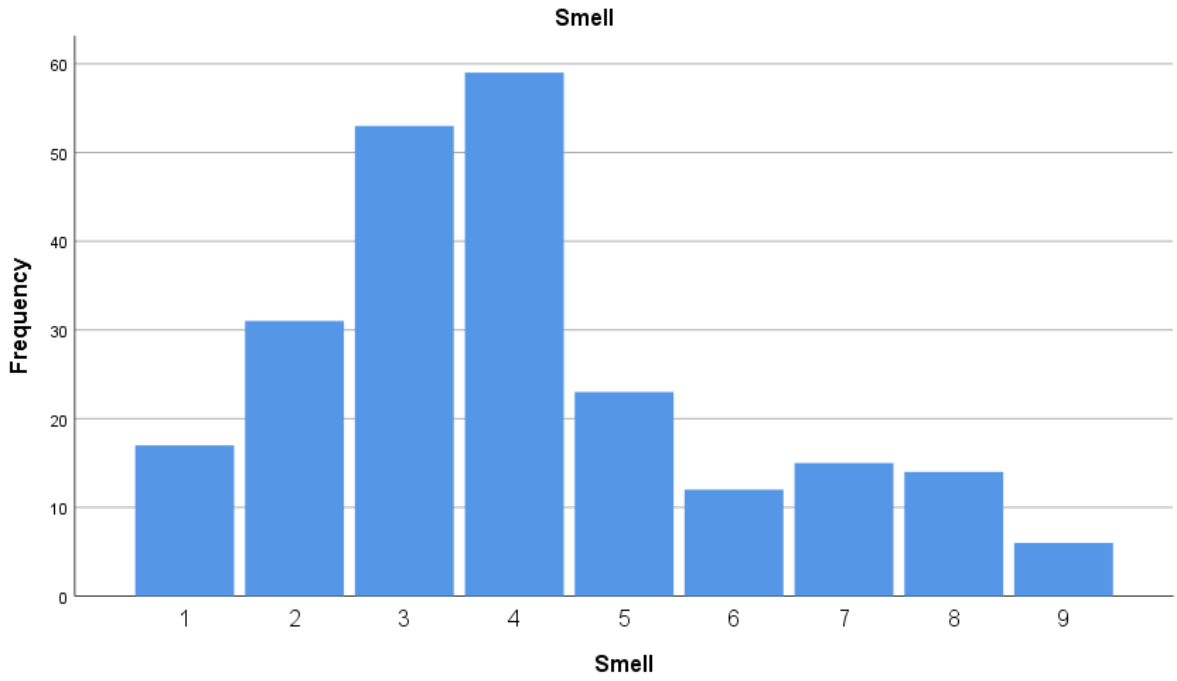

FIGURE 4.3: FREQUENCY OF SMELL RATING

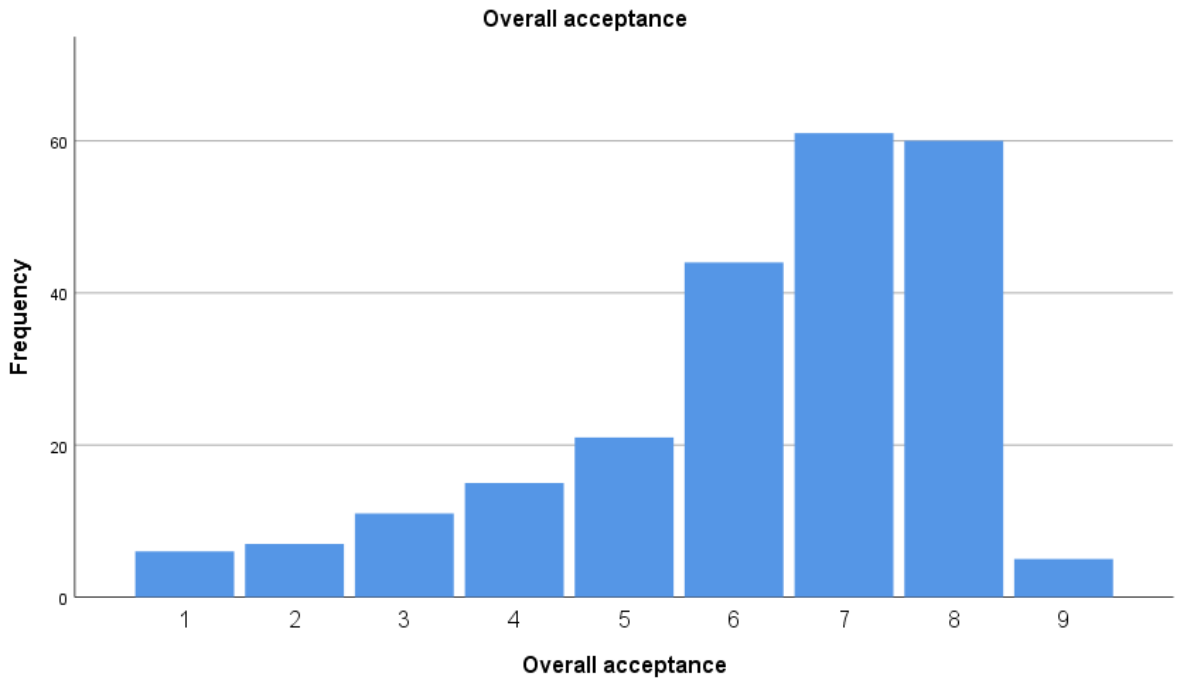

FIGURE 4.4: FREQUENCY OF OVERALL ACCEPTANCE RATING

Table 4.1 shows the descriptive statistics for sensory analysis.

TABLE 4.1: DESCRIPTIVE STATISTICS FOR SENSORY ANALYSIS

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Color	230	1	9	5.25	1.977
Flavor	230	1	9	5.69	1.725
Smell	230	1	9	4.05	1.993
Overall acceptance	230	1	9	6.23	1.840
Valid N (listwise)	230				

1. **Color:** The mean score for color was 5.25, with a standard deviation of 1.977. The ratings ranged from 1 to 9. This indicates that the participants had a moderate preference for the visual appearance of the Spirulina-enriched candies.

2. **Flavor:** Flavor received a mean score of 5.69, with a standard deviation of 1.725. Ratings for this attribute also ranged from 1 to 9. The score shows that the taste of the

candies was generally acceptable to the participants. This supports previous research suggesting that flavor is a key determinant of consumer acceptance for functional foods.

3. **Smell:** The mean score for smell was the lowest, being 4.05, with a standard deviation of 1.993, and ratings ranged from 1 to 9. The mean score was slightly lower than for color and flavor. This suggests that the addition of Spirulina might have affected the olfactory perception, which is consistent with findings in other studies that note the strong odor of Spirulina can influence sensory appeal (Beheshtipour et al., 2013).

4. **Overall Acceptance:** The overall acceptance score was 6.23, with a standard deviation of 1.840, indicating a favorable perception of the candies as a whole. This score suggests that despite the unique attributes of Spirulina, the product was well-received by the majority of participants.

TABLE 4.2: PAIRED SAMPLES STATISTICS AND CORRELATIONS

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Flavor	5.69	230	1.725	.114
	Color	5.25	230	1.977	.130
Pair 2	Flavor	5.69	230	1.725	.114
	Smell	4.05	230	1.993	.131
Pair 3	Flavor	5.69	230	1.725	.114
	Overall acceptance	6.23	230	1.840	.121
Pair 4	Smell	4.05	230	1.993	.131
	Color	5.25	230	1.977	.130
Pair 5	Smell	4.05	230	1.993	.131
	Overall acceptance	6.23	230	1.840	.121
Pair 6	Color	5.25	230	1.977	.130
	Overall acceptance	6.23	230	1.840	.121

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Flavor & Color	230	.339	.000
Pair 2	Flavor & Smell	230	.321	.000
Pair 3	Flavor & Overall acceptance	230	.459	.000
Pair 4	Smell & Color	230	.130	.049
Pair 5	Smell & Overall acceptance	230	.178	.007
Pair 6	Color & Overall acceptance	230	.316	.000

A paired samples T-test was conducted to analyze the relationships between different sensory attributes of the Spirulina-enriched algal candies. Paired Samples Statistics shown in Table 4.2 indicate statistical significance between different pairs. Pair 1 (color and flavor) has a correlation of 0.339, pair 2 (flavor and smell) has a correlation of 0.321, pair 3 (flavor and overall acceptance) has a correlation of 0.459, pair 4 (smell and color) has a correlation of 0.130, pair 5 (smell and overall acceptance) has a correlation of 0.178, and pair 6 (color and overall acceptance) has a correlation of 0.316. All correlations are statistically significant ($p < 0.05$), indicating that these associations are not due to random chance.

- Pair 1: Falvor and color: The results showed that the mean score for flavor (5.69) was higher than that for color (5.25). The positive correlation between these two attributes suggests that participants who rated the flavor more favorably were also likely to rate the color positively.

- Pair 2: Flavor and smell: The flavor of the candies received a much higher mean score than the smell (4.05). The correlation indicates a moderate relationship between the two, meaning that while they are somewhat connected in participants' perceptions, they are rated differently.
- Pair 3: Flavor and Overall Acceptance:
  The overall acceptance score (6.23) exceeded the flavor score, with a strong positive correlation suggesting that flavor is a key factor influencing the overall appeal of the product.
- Pair 4: Smell and Color:
  The smell scored significantly lower than color, and the weak but significant correlation indicates that while there is some relationship between the two, they do not strongly influence each other.
- Pair 5: Smell and Overall Acceptance:
  The overall acceptance was much higher than the smell score. The weak correlation suggests that although smell has some impact on overall acceptance, it is likely less influential compared to other attributes.
- Pair 6: Color and Overall Acceptance:
  Color scored lower than overall acceptance, with a moderate positive correlation. This suggests that color contributes to overall satisfaction, but it is not the primary factor driving consumer approval.

A paired samples T-test was conducted to compare the mean scores between different sensory attributes of Spirulina-enriched algal candies. The test aimed to determine whether there were statistically significant differences between these attributes. The results are summarized in Table 4.3.

TABLE 4.3: PAIRED SAMPLES TEST

Paired Samples Test

	Paired Differences						
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference	t	df	Sig. (2-tailed)

					Lower	Upper			
Pair 1	Flavor - Color	.439	2.138	.141	.161	.717	3.115	229	.002
Pair 2	Flavor - Smell	1.635	2.177	.144	1.352	1.918	11.388	229	.000
Pair 3	Flavor - Overall acceptance	-.548	1.856	.122	-.789	-.307	-4.476	229	.000
Pair 4	Smell - Color	-1.196	2.619	.173	-1.536	-.855	-6.925	229	.000
Pair 5	Smell - Overall acceptance	-2.183	2.460	.162	-2.502	-1.863	-13.453	229	.000
Pair 6	Color - Overall acceptance	-.987	2.234	.147	-1.277	-.697	-6.700	229	.000

T- value for the first pair (Flavour and Color) was 3.115. This indicates that participants rated flavor significantly better than color. T-value for the second pair was 11.388. The large t-value and low p-value suggest a strong and statistically significant preference for flavor over smell. T-value for the third pair (Flavor and Overall Acceptance) was -4.47 and the mean difference of -0.548 indicates that overall acceptance was rated higher than flavor, on average. The T-value implies that while flavor was rated highly, overall acceptance considered additional factors that led to a higher rating. T-value for the fourth pair (Smell and Color) was -6.925. The large negative t-value indicates a strong, statistically significant difference, with smell being rated much less favorably than color. T-value for the fifth pair (Smell and Overall Acceptance) was -13.453. The very low p-value and high t-value emphasize the considerable gap in favor of overall acceptance over smell. T-value for the sixth pair (Color and Overall Acceptance) was -6.700. This suggests that color, while important, was less influential in determining overall acceptance compared to other attributes.

4.2 Conjoint Analysis

The CA aimed to understand consumer preferences for Spirulina-enriched algal candies by evaluating four attributes: texture, brand, health claims, and price. Participants ranked nine different product profiles based on these attributes.

TABLE 4.4: MODEL DESCRIPTION FOR CA

Model Description

N of Levels	Relation to Ranks or Scores

texture	2	Discrete
brand	2	Discrete
health	3	Discrete
price	3	Linear (less)

TABLE 4.4 describes the model used for CA. Texture, brand, and health were chosen as discrete variables. Whereas price was chosen as a linear less variable because of its expected inverse relationship with choice.

4.2.1 Utility Scores:

TABLE 4.5 highlights the utility estimates for different attributes of the candy. These findings highlight the trade-offs consumers are willing to make, with affordability and health benefits being the most significant factors.

TABLE 4.5: UTILITY ESTIMATE FOR CONJOINT ANALYSIS

Utilities

		Utility Estimate	Std. Error
texture	soft	.227	.191
	hard	-.227	.191
brand	yes	1.160	.191
	no	-1.160	.191
health	none	-1.997	.255
	antioxidants	.633	.255
	vitamins	1.364	.255
price	20	-.334	.220
	30	-.668	.441
	40	-1.002	.661
(Constant)		5.206	.485

The utility estimates provide insight into how different levels of each attribute contribute to consumer preferences for spirulina-enriched algal candies. Higher utility values indicate a positive influence on consumer choice, while lower or negative values suggest a less favorable impact.

Texture:

The utility score for a soft texture is **0.227**, indicating that consumers generally prefer a soft texture in their candies. The utility score for a hard texture is **-0.227**, suggesting that a harder texture is less appealing to consumers.

Brand:

The utility score when a known brand is present is **1.160**. This high positive utility indicates that consumers are more likely to choose products associated with a recognized brand. The utility score for products without a brand is **-1.160**, reflecting a lower preference for unbranded products.

Health Claims:

The utility score for products without health claims is **-1.997** which indicates a negative impact on consumer preference. The utility score for products labeled "High in Antioxidants" is **0.633**, suggesting that this claim is highly attractive to consumers. The utility score for products labeled "High in Vitamins" is **1.364**. This is the highest positive utility within the health claims attribute, indicating that consumers have a strong preference for products that are high in vitamins.

Price:

The utility score for the lowest price, RS. 20, is **-0.0334**. This negative value, although small, indicates a slight consumer preference for the lowest price point.The utility score for a price of RS. 30 is **-0.668**. This more negative utility suggests that consumers are moderately less favorable toward this mid-range price. The utility score for the highest price, RS. 40, is **-1.002**. This most negative utility indicates that the highest price is the least preferred by consumers.

4.2.2 Importance Values

TABLE 4.6 shows the importance values for each variable in the model. Importance values reveal the significance of each attribute in influencing consumer decisions. Higher values suggest that the attribute is more critical in the decision-making process

TABLE 4.6: IMPORTANCE VALUES FOR ALL ATTRIBUTES

	Importance Values
texture	16.191
brand	26.833
health	42.758
price	14.219

Texture: The importance value for texture is **16.191**, indicating that texture is a notable factor in consumer decisions, though less critical than some other attributes.

Brand Presence: The importance value for brand presence is **26.833**, showing that having a known brand is a significant factor in consumer preference.

Health Claims: The importance value for health claims is **42.758**, making it the most influential attribute. This reflects the importance consumers place on health-related benefits when choosing a product.

Price: The importance value for price is **14.219**, indicating that the cost is a crucial consideration, with consumers being sensitive to price differences. Participants preferred lower-priced options, which aligns with market trends where cost is a major factor in consumer choices (Kotler & Armstrong, 2018).

4.2.3 Correlation Measures

TABLE 4.7 indicates the correlation measures, which assess how well the conjoint model predicts consumer preferences.

TABLE 4.7: CORRELATION MEASURES

Correlations[a]

	Value	Sig.
Pearson's R	.986	.000
Kendall's tau	.944	.000

The Pearson's R value is **0.998**, which suggests a very strong correlation between the predicted and actual consumer preferences, indicating that the model is highly accurate. The overall Kendall's Tau value is **0.944**, reflecting a strong agreement between predicted and actual rankings, which supports the robustness of the model.

4.2.4 Reversals

Factor	price	76
	health	0
	brand	0
	texture	0

Reversals indicate instances where the predicted order of preferences does not align with the actual order provided by respondents. The number of reversals helps to assess the consistency and accuracy of the model. For the price attribute, there were 76 reversals. This suggests that the predicted preference order for price levels did not always align with the actual

preferences, indicating some inconsistencies in how consumers ranked price compared to other attributes or reflecting varying consumer sensitivity to price.

5 DISCUSSION

The findings from both the sensory and conjoint analyses provide insight into consumer preferences for Spirulina-enriched algal candies. The sensory analysis revealed that flavor is a critical component of consumer acceptance. Despite Spirulina's distinct taste, the candy's flavor was generally well-received, suggesting that the formulation effectively balanced the algal taste with other flavors. This aligns with prior research indicating that taste is a key driver of acceptance in functional foods. The color and smell received slightly lower scores, indicating potential areas for improvement, especially in masking Spirulina's natural odor (Beheshtipour et al., 2013).

The sensory analysis provided important insights into consumer preferences regarding Spirulina-enriched algal candies. While the overall acceptance of the product was positive, with an average score of 6.23, there were notable differences in how specific attributes were received.

Color: The moderate mean score for color suggests that while the appearance was generally acceptable, it did not significantly enhance the product's appeal. The diversity of responses indicates that improvements in color could be beneficial in increasing consumer satisfaction.

Flavor: Flavor emerged as one of the stronger attributes, with a mean score suggesting general acceptability. However, the variability in responses indicates that the flavor might not appeal equally to all consumers, suggesting a potential area for refinement to cater to a broader audience.

Smell: The lower score for smell is concerning, as it is a critical component of the overall sensory experience. The lower average score and the wide range of responses suggest that the smell may be a detracting factor for some consumers, and addressing this issue could significantly improve the product's overall appeal.

Overall Acceptance: The relatively high overall acceptance score indicates that, despite some concerns about specific attributes like smell and color, the product is generally well-received. This suggests that the product has a solid foundation, but targeted improvements, particularly in smell, could enhance its market potential.

Correlation Coefficients are used to assess the strength and direction of a relationship between two variables. They indicate whether changes in one attribute correspond with changes in another but do not reveal if the average scores between these attributes differ significantly. Essentially, a correlation coefficient tells us whether higher or lower scores in one attribute are typically associated with higher or lower scores in another attribute.

Correlation Coefficient measures the degree to which two attributes (like flavor and color) are related. Significance (p-value) shows if the correlation is statistically significant, meaning the relationship is unlikely due to chance. So, correlation helps identify if two attributes are linked but does not indicate if one attribute is rated higher or lower than another.

For example, if the correlation between flavor and color is 0.339 with a p-value less than 0.001, this indicates a moderate positive relationship, meaning that as flavor scores increase, color scores also tend to increase. However, this doesn't reveal whether participants rated flavor higher or lower than color.

Therefore, Paired Samples T-Test is used to determine whether the mean scores of two related attributes are statistically different. It helps to understand if the average difference between two attributes is significant. The T-test analysis provided a deeper understanding of how different sensory attributes influence the overall perception of spirulina-enriched algal candies. Mean Difference is the average difference in scores between two attributes. T-Value indicates the magnitude of the difference relative to the data's variability. P-Value shows whether the difference in means is statistically significant. Hence, a T-test reveals if participants generally rated one attribute higher or lower than another.

For example, a T-test comparing flavor and color might show a mean difference of 0.439 with a t-value of 3.115 and a p-value of 0.002, suggesting that flavor was rated significantly higher than color.

The paired samples T-test provided insights into how different sensory attributes of the Spirulina-enriched algal candies interact and affect consumer perceptions.

- **Flavor and Color**: The analysis revealed that flavor and color are moderately related. While the flavor score was slightly higher, the correlation indicates that participants who liked the flavor also tended to appreciate the color. This suggests that these two attributes work together to enhance the overall appeal of the product.

- **Flavor and Smell**: The significant difference in mean scores between flavor and smell suggests that these two attributes are perceived differently. Although there is a moderate correlation, the lower smell score highlights a potential area of concern, as it may detract from the overall experience.
- **Flavor and Overall Acceptance**: Flavor emerged as a strong predictor of overall acceptance. The close relationship between these two attributes indicates that improving the flavor could have a significant positive impact on how the product is perceived as a whole.
- **Smell and Color**: The weak correlation between smell and color suggests that these attributes do not have a strong influence on each other. The significant difference in their scores further indicates that participants may be more forgiving of one attribute if the other is more appealing.
- **Smell and Overall Acceptance**: The analysis showed that while smell affects overall acceptance, its impact is less pronounced compared to flavor and color. The low score for smell suggests that this is an area that needs improvement to boost the overall attractiveness of the product.
- **Color and Overall Acceptance**: Although color is positively correlated with overall acceptance, it is not the dominant factor. This indicates that while enhancing the visual appeal of the product is important, other sensory attributes like flavor should be prioritized to achieve higher consumer satisfaction.

The T-test analysis provided a deeper understanding of how different sensory attributes influence the overall perception of spirulina-enriched algal candies.

- **Flavor vs. Color**: The significant difference between flavor and color, with flavor being rated higher, suggests that consumers place more value on taste than on appearance. This finding indicates that while the visual appeal of the candies is important, the taste is a more crucial factor in consumer satisfaction.
- **Flavor vs. Smell**: The pronounced difference between flavor and smell points to a potential issue with the product's aroma. Despite the favorable flavor, the lower smell ratings suggest that the aroma may detract from the overall sensory experience. Improving the smell could enhance the overall appeal of the product.

- **Flavor vs. Overall Acceptance**: Although flavor was rated highly, overall acceptance was even higher, suggesting that participants considered more than just taste when forming their overall opinion of the product. This implies that other factors, such as texture, appearance, or even packaging, might also play a role in enhancing overall acceptance.
- **Smell vs. Color**: The lower ratings for smell compared to color indicate that while the appearance of the candies was generally acceptable, the aroma was less so. This suggests that improving the smell could be a more effective way to increase overall consumer satisfaction than focusing solely on color.
- **Smell vs. Overall Acceptance**: The significant gap between smell and overall acceptance underscores the importance of aroma in shaping the overall consumer experience. The poor smell rating likely dragged down the overall sensory experience, indicating that enhancing this attribute could lead to better overall acceptance.
- **Color vs. Overall Acceptance**: Although color contributed to the product's appeal, the lower rating compared to overall acceptance suggests that it is not the most critical factor. Consumers may prioritize other sensory attributes, such as flavor or smell, when determining their overall satisfaction with the product.

The CA provides crucial insights into the factors that influence consumer preferences for spirulina-enriched algal candies. The results highlight the relative importance of various attributes, such as texture, brand presence, health claims, and price, and how each of these attributes impacts consumer choices.

Consumers showed a clear preference for a soft texture over a hard one. This suggests that the tactile quality of the candy is an important factor in consumer satisfaction. A softer texture likely aligns better with what consumers expect and enjoy in a candy, contributing positively to their overall experience. Therefore, product developers should prioritize achieving a soft texture to meet consumer expectations and enhance the appeal of the product.

The analysis revealed that brand presence significantly influences consumer decisions. Consumers showed a strong preference for products associated with a known brand, likely due to the trust and familiarity that branded products provide. In contrast, the absence of a brand made products less appealing. This finding underscores the importance of brand recognition in consumer purchasing behavior. Building a strong brand or partnering with

established brands could therefore be key strategies for increasing product appeal and market share.

Health claims were the most influential attribute in the analysis, particularly those related to vitamins and antioxidants. The preference for these health-related claims suggests that consumers are increasingly health-conscious and seek products that offer added nutritional benefits. The strong aversion to products without health claims further emphasizes the importance of promoting the health benefits of the product. Highlighting these claims in marketing efforts could significantly enhance the product's attractiveness to consumers.

While price was the least important attribute in the analysis, it still played a role in consumer decisions. The negative utility values for all price points, especially the highest one, indicate that consumers are price-sensitive, but they balance this sensitivity with their preferences for other attributes like health benefits and brand recognition. This suggests that while keeping the product affordable is important, consumers may be willing to pay more for products that offer clear health benefits and come from trusted brand.

The high values for Pearson's R and Kendall's Tau indicate that the conjoint model was effective in predicting consumer preferences. The strong alignment between predicted and actual preferences, with minimal inconsistencies, demonstrates that the model accurately captures the factors that drive consumer choices. This reliability adds confidence to the findings and supports their use in guiding product development and marketing strategies.

6 CONCLUSION

This study has provided a detailed exploration of consumer perceptions and preferences regarding Spirulina-enriched algal candies, using both sensory analysis and CA to gather insights. The results offer important guidance for product development and marketing strategies.

6.1 Key Findings

From the sensory analysis, it was evident that consumers generally preferred a softer texture and had a favorable overall acceptance of the product. However, certain attributes like smell and color received mixed responses, suggesting that while the product is well-received, improvements could be made, particularly in enhancing its aroma and visual appeal to better align with consumer expectations.

The CA further clarified which product attributes most influence consumer decisions. Health claims, especially those emphasizing vitamin and antioxidant content, were found to be the most significant factors driving consumer preference. The presence of a recognized brand also played a crucial role, underlining the importance of brand trust in consumer choices. While texture was valued, it was less critical than the health benefits and brand presence. Price, although an important consideration, was the least influential attribute in consumer decision-making.

These findings suggest that to improve consumer acceptance and achieve market success, the focus should be on enhancing the perceived health benefits of the product and leveraging brand strength. Additionally, ensuring that the texture meets consumer expectations will be important, although consumers may be willing to pay a higher price for products that offer clear health advantages and are associated with trusted brands.

6.2 Implications for Product Development:

This study suggests some of the implications for product development:

- **Flavor Optimization**: Formulations should focus on improving taste to enhance acceptance.

- **Competitive Pricing**: Cost-effective production strategies are essential to maintain affordability.
- **Health Benefit Communication**: Marketing should emphasize the nutritional advantages of Spirulina.

6.3 Future Research:

Future studies could investigate the development of new flavors and the inclusion of other functional ingredients to boost consumer appeal for spirulina-enriched algal candies. By testing various flavor combinations and beneficial additives, researchers may discover options that resonate with a wider range of consumers. Additionally, it would be valuable to carry out long-term studies to observe how consumer preferences shift over time, particularly as more people become aware of the health advantages of Spirulina. Such research could reveal whether greater awareness leads to increased acceptance and liking of these products.

By understanding consumer preferences, this study contributes to the development and marketing of Spirulina-enriched algal candies, providing a foundation for further research in functional food innovation.

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ANALYZING CONSUMER PERCEPTION FOR ALGAL CANDIES THROUGH CONJOINT ANALYSIS

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