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RESEARCH ARTICLE

Sustainable Design Innovation for Tea Packaging: Assessing Material Selection and Consumer Preference Trends

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ABSTRACT

The packaging industry is increasingly focused on sustainable design improvement in tea packaging due to the necessity to lessen environmental effects and the increasing demand for eco-friendly alternatives. In this packaging innovation, the tea's quality and freshness are preserved while simultaneously meeting customer demands for environmentally friendly products. The study goal is to analyze sustainable design innovation for tea packaging by evaluating customer preference trends and material choices. A survey of 316 participants completed an online survey that included a question that assessed tea beverage characteristics, packaging material type, product claims, price, sustainability, and demographics, involving choice-based conjoint tasks and ranking tasks. The data were analyzed using statistical analysis methods. The study emphasizes that consumer knowledge changes beliefs about the sustainability of materials including paper, cardboard, tin, and biodegradable plastics that are frequently used in tea packaging. Tin packaging was also favored by consumers for its perceived sustainability; it was commonly associated with recyclability and durability. According to the findings, a consumer's choice of material should combine price and sustainability to promote more environmentally friendly buying practices. This study emphasizes that material choice influences consumer perceptions and promotes innovative sustainable tea packaging.

Acronyms	Full form
CAWI	Computer-assisted web interviewing
MOS	Multimetal oxide sensor
Deep LSTM	Deep Long-Short Team Memory
FWTCS	Funding White Tea Culture System
MI	Mutual information
ATTCS	AnxiTieguany in Tea Culture System
ML	Machine Learning
CRn-gCS	Conditional Random n-gram Classifier Sentimental
LDPE	Low-Density Polyethylene
RSM	Response Surface Methodology
IoT	Internet of Things
PDEIEPC	Packaging design evaluation based on image emotion perception computing

TGA	Thermo gravimetric analysis
ECDSA	Elliptic Curve Digital Signature Algorithm
IPFS	Inter Planetary File System
BP	Backpropagation
SCOBY	Symbiotic Culture of Bacteria and Yeast
CBC	Choice-Based Conjoint
MSE	Mean Square Error

INTRODUCTION

Tea, a popular beverage, is the second largest drink consumed worldwide after water. It is separated into six type: yellow,black, oolong, dark,white, and green. The global tea industry is growing, driven by rising customer demand for high-quality products and environmentally conscious option. With sustainability being a key component of modern customer behavior, the tea packaging industry is under increasing pressure to innovate [1]. Tea contains functional components like polyphenols, anine, and caffeine, which sustain various physiological activities like anti-tumor, anti-bacterial, anti-oxidant, anti-viral, cardiovascular disease prevention, and protected regulation. As health concerns develop intowell-known, tea products are becoming popular among all age groups [2]. Packaging is not only a efficient component for preserving tea advantage, but it also serve as a brand and communication standard. However, conventional packaging materials are recurrentlyprepared of non-biodegradable plastics or multi-layer composites, which pose essential environmental risk [3]. The growing awareness of ecological issues has pushed sustainability to the forefront of the intend and packaging industries. Tea packaging, which contributes to a significant portion of global packaging waste, has recently emerged as a focus for modernsolutions intended at reducing environmental impact. Figure 1 represents the process of tea packaging design.

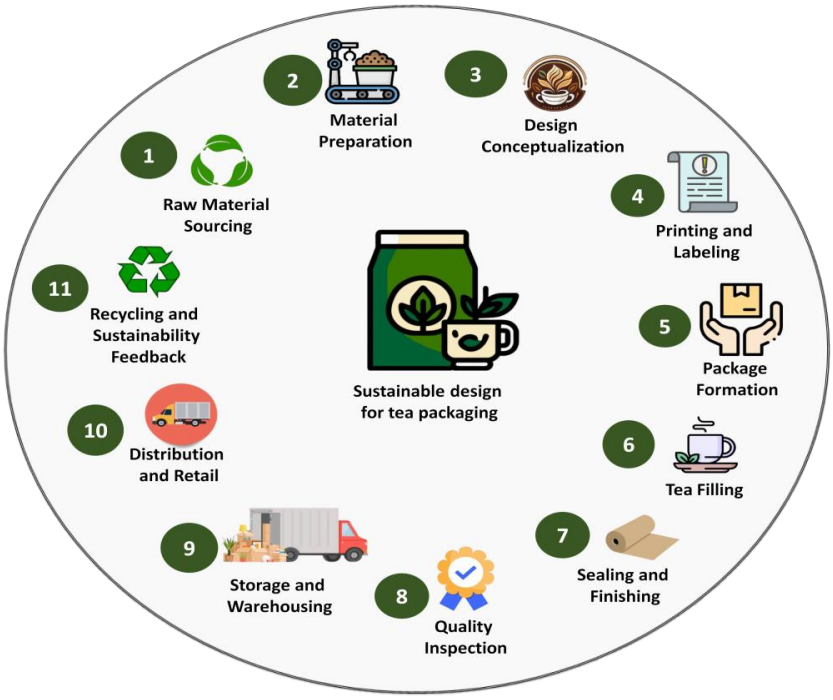

Figure 1: Process of tea packaging design

As consumers demand eco-friendly alternatives, the tea industry faces the dual challenge of maintainingmanufactured goods quality while reducing environmental impact [4]. Sustainable intent for tea packaging entails striking a balance between functionality, aesthetics, and

biologicalsociability. It has encouraged the advance of alternative materials such as ecological polymers, recycled paper, and plant-based films [5]. Comprehending consumer preference and willingness to adopt eco-friendly packaging solutions is also significant, as these can differ depending on cultural, economic, and demographic factors [6].

Tea, a popular financial crop with ideal health benefits, is gaining global attention due to its high dietary value and increasing demand. However, today's tea manufacturing and distribution chain is based on established management, which has significant hazards and inadequate effectiveness[7]. It leads to resource consumption and common losses. To decrease the hazard and advance the quality of tea products, manufacturers are creating IoT-based farming information systems to increase invention and conserve human resources [8]. This advance establishes to reduce the need for qualified manpower and human oversight in the tea industry.

Objective of the study:

This research determines the consumer preferences and substance choices in sustainable tea packaging, focusing on eco-friendly options like paper, cardboard, tin, and biodegradable plastics. It seeks to understand how these resources, product claims, and pricing influence consumer decisions and promote environmentally conscious tea packaging innovations.

Contribution of the study:

The study considers consumer preferences for tea packaging materials and their impact on environmental dependability, contributing to sustainable packaging design knowledge and guiding manufacturers in designing eco-friendly packaging options like tin, cardboard, and biodegradable plastics.

It highlights the role of customer knowledge in shifting perceptions about material sustainability, and examines the requirement for cultural efforts to foster more sustainable consumer choice.

There search also demonstrates the consequence of subsequent price and sustainability in material assortment, indicating that cost-effectiveness remains a considerable factor in environmentally conscious purchasing decisions.

Finally, it signified how consumer-driven innovation promotes more sustainable packaging solutions in tea manufacturing, and current a arrangement for companies to enlarge their sustainability practice while convention consumer demands for eco-friendly goods.

The organization of the study is given as follows: Section 2 describes the related works of the study. Section 3 explains the materials and methods and Section 4 illustrates the results and discussion of the research. The conclusion is determined in Section 5.

RELATED WORK

The literature review discusses advancements in sustainable packaging, bio plastics, and food safety, focusing on consumer preferences, eco-friendly materials, and intelligent technologies.

Study [9] utilized CAWI to analyze Polish tea consumption habits, brewing methods, and preferences among 1700 adult tea consumers. Six groups were formed based on preferences. The findings revealed that they are not tea connoisseurs, preferring black tea that lacks additives, steamed in containers for as lengthy as three minutes, and consumed at home several times per week. Lipton was the most popular brand among respondents. However, consumers have a vague understanding of tea's health benefits.

The yogurt market is growing, and packaging design has become a crucial instrument for advertising. However, design conflicts with consumer demand have impacted advertising techniques. Study [10] investigated the relationship between yogurt packaging design and customer preferences and

discovered that consumers preferred yogurt packaging shapes (39.017%) and concrete graphics (31.330%). Consumers preferred the combination of these attributes, which resulted in positive purchasing attitudes. The study enabled the development of a yogurt packaging design that reflects consumer preferences, improving understanding of the consumption market and promoting positive purchase attitudes. The increasing demand for eco-friendly food packaging materials is being promoted by the detrimental environmental impact of single-use plastics, as seen in [11]. The need for sustainability drives the development of bioplastics, which are renewable materials that can be biodegradable or compostable in particular situations. The investigation discussed the majority and significant bioplastics on the market, their prospective applications in food packaging, customer observation of bioplastics, rigid issues, and potential issues. Initiatives from the scientific area, manufacturing, and governments were required to accelerate the adoption of these materials.

Due to the environmental impact of traditional plastics, the food packaging industry is increasingly looking for sustainable alternatives. Bioplastics, which could be bio-based, biodegradable, or both, were produced as a new generation of plastic materials investigated in the research [12]. It investigated the fundamental role of food packaging, various types of packaging, the necessary qualities, processing processes, and bioplastic degradation pathways. The main intention is to enhance the performance of natural biodegradable polymers, synthesize potential sustainable polymer compounds, improve the manufacture of bio-based standard polymers, and investigate new renewable sources. The purpose was to address worldwide demand for eco-friendly and sustainable packaging materials. Matcha, a powdered green tea derived from the *Camellia sinensisL*. plant, contains antioxidants due to its high bioactive content. Research [13] assessed the physical qualities of water, such as its activity, absorption index, and water holding capacity, which are critical factors for consideration, pH, ◦ Brix, and osmolality of 10 Matcha green teas. Matcha M-4 has been utilized to create two functional model beverages that were regenerative, high in protein, and included bioactive components. The drink was advised for a wide range of users, including athletes and the elderly, as well as for preventing and treating bone and joint tissue deterioration. The market for green agricultural products was expanding rapidly due to rising environmental challenges and food safety concerns, as outlined in [14]. Tea, one of the most prevalent three beverages consumed worldwide, was rapidly gaining popularity. A study focused on assessing the association between green food buyers' awareness of the product, perceived product quality, trust, purchase intention, and purchasing habits. Data was gathered from 700 questions administered through the Credemo questionnaire platform and processed using SmartPLS software. The investigation demonstrated that product understanding, which includes qualities and green information, had a favorable impact on perceived product quality, trust, purchase intention, and behavior.The method [15] employed emotional perception techniques and a deep LSTM framework to effectively assess package designs based on their psychological consequences. The suggested method outperformed other methods in packaging design quality, performance success, and MSE rates using the Image-Emotion-Social-Net dataset from Flickr.A MOS detection method for distinguishing various tea leaf grades has been examined in [16]. Sensor array optimization algorithms were used to mitigate duplicated information interference and increase detection capabilities. The central idea was to choose sensors based on an evaluation index that ranks their importance. The weighted modified MI optimization algorithm was designed to incorporate consideration of relevancy, redundancy, and complementarity. The experimental results revealed that the strategy produced the highest system performance with the fewest number of sensors.

An ML-based sentiment analysis technique called CRn-gCS for modelling packaging design style prediction has been evaluated in the [17]. The model employed dominant algorithms to evaluate consumer sentiments and patterns in historical data, forecasting and recommending packaging designs that employ positively with intention audience. The CRn-gCS enhanced response analysis by considering conditional correlations between n-grams, resulting in a more proficient considerate of

customer preferences. The technique enabled designers and marketers to render informed judgments, ensuring that packaging reflects visual trends and stimulates favorable emotional responses from consumers. Traditional packaging protected food from harm and storage while also displaying branding and nutritional information, as explained in [18]. Plastic film advancements have increased shelf life through active and intellectualcovering design. Consumer observationinfluenced the package resources and designs, with an increasing preference for environmentally friendly packaging. Sustainable packaging has emerged as a result of customer choices and environmental concerns. The study discussed the significance of food packaging, the advancement of smart, dynamic, and intelligent packaging arrangements, and the features of oxygen barriers. It also covered consumer attitudes toward environmentally friendly packaging in the food business.

Population expansion, climate change, and pandemics have compound the global food security challenge. 3D printing was an achievable approach to solve these concerns and improve food sustainability [19]. It generated highly personalized food in a variety of ways, including form, texture, flavor, structure, and nutritional content. However, the sustainability of the printed meals, as well as 3D printing in general, was an important concern. The paper offered a framework of 3D-printed meals, including current technologies and applications in tailored nutrition, packaging, value addition, and monetization. It attempted to combine sustainability considerations with the promise of 3D food printing.The evaluation [20] performed a thorough sustainable packaging study, showing four primary research domains: sustainable packaging materials and qualities, management techniques, consumer behavior toward sustainable packaging, and packaging waste management. The research suggested four potential study directions: increasing sustainable packaging commercialization, addressing social research challenges, improving stakeholder integration, and investigating contingency variables affecting waste management efficacy. These directions aimed to provide practical insights for developing sustainable packaging strategies and sustainable development skills. Research [21] investigated the application of DL models in low-carbon package design for smart cities. It utilized floral and fruit tea packaging as an illustration to investigate green packaging design and performance. The BP neural network model was used to assess customers' emotional responses to green packaging. In the 78th epoch, the model displayed high prediction performance by establishing correlations between color attributes and emotional assessment levels. The findings have significance for developing low-carbon green packaging and lowering environmental pollution.

To assess their lifestyles and food security, the researchers apply statistical analysis and a multinomial logistic regression model, as represented in [22]. The research revealed that natural farming households have lower welfare levels in the ATTCS, but people enrolled in the FWTCS have better well-being. Farmers' livelihood choices were influenced by factors such as the size of their tea plantations and the number of laborers. Tea products' high economic value, as well as compound growing in tea gardens, contributes to food security. These findings were critical for developing policies promoting sustainable agriculture.The increasing volume of plastic packaging trash generates serious environmental concerns. The design stage for recycling can assist in preventing plastic packaging from transforming into solid waste by prolonging its life cycle and enhancing recycling values [23]. The investigation addressed the concepts, procedures, techniques, and design solutions for recycling plastic packaging, such as automated sorting, mechanical recycling, and chemical treatment of polymer and thermodynamic materials. Combining front-end recycling designs and back-end recycling technology has the potential to rapidly accelerate the plastic cover manufacturing transition from an indefensible to a profitable cycle approach, presenting economic, ecological, and social advantages.

Research [24] offered a biopolymer-based film consisting ofglycerol chitosan, and gelatin,as a viable replacement to petrochemical-based polymers such as LDPE, which are highly polluting. The mechanical characteristics of the film were improved using RSM. The material outperformed films

made of LDPE in terms of thermal, optical, and biodegradable. TGA showed that the film was thermally secure at temperatures below 300°C, which is important for the food business. The biopolymer-based film's decreased fluid solubility and superior biodegradability qualities indicate that it has prospective uses in the foodstuff sector as a new packaging substance and provided a foundation for proactive packaging innovations.Blockchain technology, particularly in the context of Industry 4.0, has the potential to transform supply chain networks by enabling decentralization, dependability, accountability, and visibility. Research [25] anticipated incorporating blockchain 3.0 into the tea supply chain, with an emphasis on data transparency and the prevention of counterfeiting techniques. The ECDSA method certified the identification of individuals in the hyper ledger Fabric control, while IPFS equipment safeguards traceability data. The system evaluated interactions with varying connection periods and produced satisfactory findings. The research employed distributed theory and service-oriented thinking to establish regulatory anti-counterfeit traceability throughout the tea supply chain.The investigation [26] described a publicly accessible bioreactor that improves and optimizes the SCOBY manufacturing procedure. The bioreactor was a component of a wider, design-driven project designed for processing both edible and non-edible materials. The paper offeredand evaluated techniques for constructing and improving the bioreactor, as well as information for replication with devices and materials licensed under creative commons.

Food safety is important to human wellness, however, management and screening were complex and expensive, and it has been examined in [27]. To mitigate these dangers, DL, the IoT, portable devices, rapid reaction codes, and smart packaging are being deployed.Brilliant structures utilize digital technologies and biosensors show significant promise for transforming food safety processes. Food safety 4.0 incorporated intelligent biosensors, enabling immediate surveillance, forecasting, increased reliability, and empowering consumers, hence enhancing hazardmanagement and maintaining high safety requirements.

Research Gap

The study explores general consumer preferences for tea packaging but doesn't consider regional or demographic variations. Understanding these factors' influence on packaging material choices and sustainability concerns could offer more insights into eco-friendly packaging market segmentation.

MATERIALS AND METHODS

The research evaluates sustainable design innovation for tea packaging by analyzing customer preferences and material choices. An online survey assessed tea beverage characteristics, packaging material type, product claims, price, sustainability, and demographics, and statistical analysisusing choice-based conjoint tasks and ranking tasks.

Data Collection

The study on sustainable design innovation for tea packaging utilizes data from 316 participants gathered through a survey conducted online. The data estimatethe demographic characteristics and customer preferences, including material preferences, price sensitivity, and sustainability awareness.Table 1 categorizes participants into five age groups: gender, education level, employment, packaging preference, and sustainability concern.

Table 1: Characteristics of demographic category

Demographic Category	Category	Frequency (n=316)	Percentage (%)
Age	18-24 years	45	14.2%
	25-34 years	82	25.9%
	35-44 years	75	23.7%
	45-54 years	61	19.3%
	55+ years	53	16.8%

Gender	Male	142	44.9%
	Female	174	55.1%
Education	High School	28	8.9%
	Undergraduate Degree	134	42.4%
	Graduate Degree	154	48.7%
Employment	Employed	221	69.9%
	Unemployed	48	15.2%
	Student	47	14.9%
Income Level	Less than 20,000	55	17.4%
	20,000 - 40,000	92	29.1%
	40,000 - 60,000	95	30.1%
	60,000+	74	23.4%
Packaging Preference	Paper	102	32.3%
	Cardboard	89	28.2%
	Tin	96	30.4%
	Biodegradable Plastic	29	9.2%
Sustainability Concern	High	178	56.3%
	Moderate	96	30.4%
	Low	42	13.3%

It incorporate both male and female participants, with a slightly higher number of females. The majority have completed undergraduate or graduate degrees. The research also calculate the relationship between economic status and consumer behavior. Participants' packaging preference include paper, cardboard, tin, and biodegradable plastic. The stage of concern about sustainability could influence their preference for eco-friendly packaging options.

Study Design

To evaluate consumer preferences and material choices in sustainable tea packaging, this study focus on environmental impact and produce sustainability. A total of 316 participants were surveyed to consider their preferences for tea packaging materials, such as paper, cardboard, tin, and ecological plastics. The survey also included questions about tea beverage characteristics, packaging substance type, product claims, price sensitivity, and sustainability awareness. Demographic data is analyzed to assessment the consumer preferences, material choice, price, and environmental impact in the tea packaging manufacturing, and identify development and contributing to sustainable purchasing performance.

Statistical Analysis

The study uses the SPSS 24.0 software to analyze consumer preferences for sustainable tea packaging. To estimatecustomer preferences for tea packaging, the research evaluated the regression analysis, rank analysis, and CBC analysis. The research utilized regression analysis to examine the relationship between price, sustainability, and material type in tea packaging. The rank analysis assessed participant preference, while the choice-based conjoint analysis evaluated how specific packaging features influence consumer decisions.

RESULT AND DISCUSSION

The significant differences in packaging materials, claims, and sustainability levels, with p-values indicate robust findings. Rank analysis revealed that tin was the most preferred packaging material, followed by cardboard and biodegradable plastic, it determined that the plastic being the least favored. Regression analysis enlarge the important influence of packaging material type and sustainability claim on customer choices, with higher coefficients for tin and eco-friendly claims. The

CBC analysis revealed that packaging material, price, and sustainability are the most influential factors in consumer decision-making, with tin packaging and high sustainability and the highest effectiveness score. The findings provided important information about customer priority and preference for tea packaging resources and features.

Performance of Regression Analysis Results

The regression analysis examines the impact of tea packaging attributes on consumer preferences, including packaging material type, product claims, price, and sustainability stage. Table 2 determined the information on the coefficients, standard errors, t-statistics, and p-values for each attribute, highlighting their influence on consumer decision-making.

Table 2: Findings of Regression Analysis

Variable	Regression Coefficient (β)	Standard Error	t-Statistic	p-value
Packaging Material Type				
Tin	0.42	0.07	6.00	< 0.001
Cardboard	0.24	0.06	4.00	< 0.001
Biodegradable Plastic	0.18	0.05	3.60	< 0.001
Plastic	-0.15	0.06	-2.50	0.012
Product Claims				
Eco-friendly	0.28	0.05	5.60	< 0.001
Organic	0.15	0.04	3.75	< 0.001
Fair Trade	-0.10	0.04	-2.50	0.014
Price				
Low Price	0.35	0.08	4.38	< 0.001
High Price	-0.25	0.07	-3.57	< 0.001
Sustainability				
High Sustainability	0.48	0.06	8.00	< 0.001
Moderate Sustainability	0.26	0.05	5.20	< 0.001
Low Sustainability	-0.12	0.04	-3.00	0.003

The regression analysis reveals the significant factors influencing consumer preferences for tea packaging. Tin packaging ($\beta = 0.42, p < 0.001$) is the most favored due to its sustainability, followed by cardboard($\beta = 0.24, p < 0.001$) and biodegradable plastic($\beta = 0.18, p < 0.001$), while plastic($\beta = -0.15, p = 0.012$) is the least preferred due to environmental concerns. The eco-friendly product claim ($\beta = 0.28, p < 0.001$) has the strongest positive impact on preferences, followed by the organicclaim($\beta = 0.15, p < 0.001$), while the fair trade claim ($\beta = -0.10, p = 0.014$) negatively influences consumer choice. Low price($\beta = 0.35, p < 0.001$) is preferred, whereas high price($\beta = -0.25, p < 0.001$) reduces preference. In terms of sustainability, high sustainability($\beta = 0.48, p < 0.001$) has the greatest influence, with moderate sustainability($\beta = 0.26, p < 0.001$) also positively valued, and low sustainability($\beta = -0.12, p = 0.003$) negatively impacting choices. Overall, customers prioritize sustainability and affordability, with packaging resources that align with these standards being preferred. These negative coefficients reflect areas where the attributes detract from consumer appeal, guiding businesses to focus on more preferred options like recyclable materials and affordable, sustainable products.

Assessment of Rank Analysis Results

The rank analysis results indicate the relative preference order for each attribute based on consumer rankings.Table 3 provides insights into the relative preferences of consumers for various tea packaging attributes based on their rankings.

Table 3: Outcome of rank analysis

Attributes	Rank Order	Average Rank
Packaging Material Type		
Tin	1st	1.85
Cardboard	2nd	2.25
Biodegradable Plastic	3rd	3.40
Plastic	4th	4.50
Product Claims		
Eco-friendly	1st	1.62
Organic	2nd	2.15
Fair Trade	3rd	3.15
Price		
Low price	1st	1.80
High Price	2nd	2.20
Sustainability		
High Sustainability	1st	1.58
Moderate Sustainability	2nd	2.32
Low Sustainability	3rd	3.10

Packaging material type shows that tin (average rank 1.85) is the most preferred material, followed by cardboard (2.25), biodegradable plastic (3.40), and plastic (4.50), indicating a strong preference for sustainable materials. In case of product claims, eco-friendly (1.62) ranks highest, demonstrating its importance to consumers, with organic (2.15) and fair trade (3.15) following in preference order. In terms of price, low price (1.80) is the most preferred, emphasizing price sensitivity, while high price (2.20) is less favored. Finally, sustainability reveals that high sustainability (1.58) is the top choice, with moderate sustainability (2.32) and low sustainability (3.10) ranked lower, underscoring the importance of sustainable packaging in consumer decision-making. The rank analysis confirms that consumers prioritize eco-friendly, affordable, and highly sustainable options when choosing tea packaging.

Evaluation of CBC Analysis Results

The CBC analysis regulates with assessing customers' preferences and levels of importance while making tea packaging decisions. It examined real-world purchase decisions, determining the relative value of each trait and its utility to consumers. This approach provides an improved comprehension of the aspects that influence obtained behavior. Table 4 depicts the overall findings of the CBC analysis.

Table 4: Numerical findings of CBC analysis

Attributes	Average Utility	Relative Importance (RI) (%)
Packaging Material Type		
Tin	42.11	34.5%
Cardboard	24.34	25.8%
Biodegradable Plastic	11.76	21.2%
Plastic	-15.44	18.5%
Product Claims		
Eco-friendly	8.13	12.7%
Organic	4.77	9.1%
Fair Trade	-2.35	6.2%
Price (per tea box)		
Low price	19.92	25.5%

High price	11.56	20.3%
Sustainability		
High Sustainability	24.68	20.8%
Moderate Sustainability	10.11	22.5%
Low Sustainability	-5.23	9.2%

Packaging material type plays a dominant role, with tin (42.11 utility, 34.5% RI) being the most preferred, followed by cardboard (24.34 utility, 25.8% RI) and biodegradable plastic (11.76 utility, 21.2% RI), while plastic (-15.44 utility, 18.5% RI) ranks the least favorable. Product claims show that eco-friendly (8.13 utility, 12.7% RI) is the most valued, with organic (4.77 utility, 9.1% RI) also being important, while fair trade (-2.35 utility, 6.2% RI) is less preferred. In terms of price, consumers show a clear preference for low price (19.92 utility, 25.5% RI) over high price (11.56 utility, 20.3% RI). Sustainability also plays a significant role, with high sustainability (24.68 utility, 20.8% RI) being the most important, followed by moderate sustainability (10.11 utility, 22.5% RI), while low sustainability (-5.23 utility, 9.2% RI) is the least attractive. The ranking analysis reinforces the importance of sustainability and affordability, with material choices and sustainability claims strongly influencing consumer preferences.

Comparative analysis of attributes

Figure 2 compares the weighted importance of four factors: Price, Product Claims, Durability, and Sustainability Attributes. Among these, sustainability attributes are the most important, reflecting a growing concern for environmentally friendly practices.

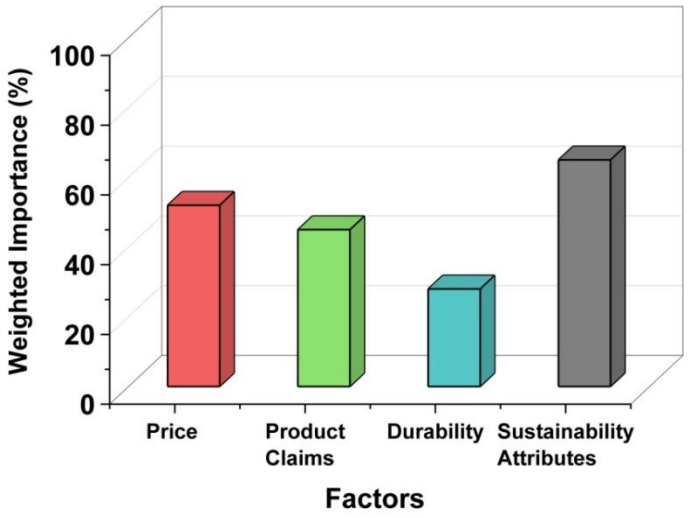

Figure 2: Graphical outcome of weighted importance

Price is the second most significant factor, indicating its influence on decision-making. Product claims, which represent the perceived value or promises of the product, show moderate importance. Durability, though relevant, holds the least weight among these factors, suggesting that longevity is less prioritized.

Analysis of Sustainability Concern

Figure 3 depicts the association between sustainability concerns and the relevant values. Individuals with high sustainability concerns have the highest values, highlighting the importance of environmentally sensitive actions.

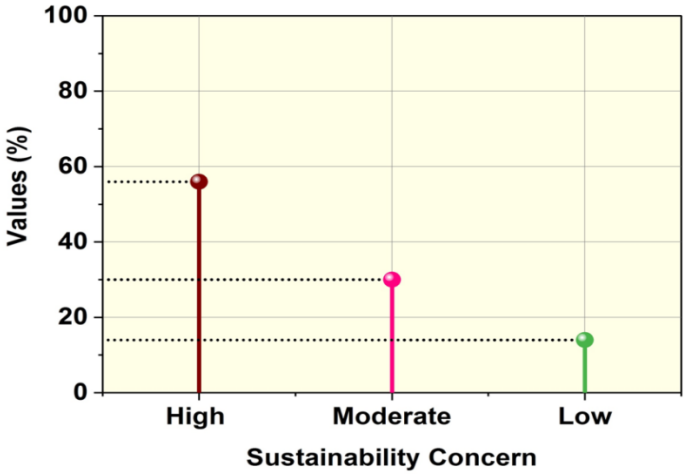

Figure 3: Evaluation of sustainability concerns

Those with moderate concern possess lower values, indicating a balance between sustainability and other issues. Furthermore, people with low concern indicate limited values, indicating that they neglect sustainability in their decision-making.

Overall performance of tea packaging

Figure 4 illustrates the distribution of preferences for different types of sustainable packaging materials among respondents. The segments include tin packaging, biodegradable plastics, papers and cardboard, and others.

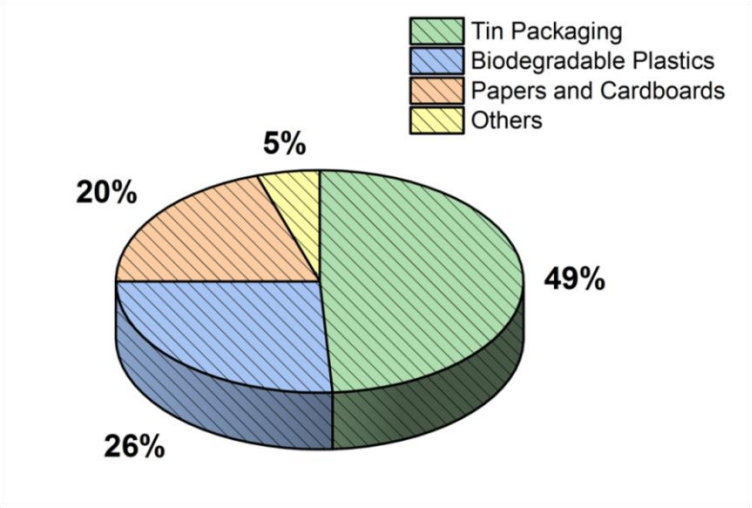

Figure 4: Pie chart represents the usage of tea

Tin packaging represents 49% of respondents, making it the most popular choice. Biodegradable plastics contain26%, ranking second in preference. Papers and cardboard achieve 20% of preferences, showing a moderate appeal. Others represent only 5%, indicating minimal preference for alternatives.

Discussion

The study highlights key findings regarding consumer preferences for sustainable tea packaging, emphasizing the significant role of material type, price, product claims, and sustainability in decision-making. Regression analysis revealed that tin packaging was determined to be the most superior due

to its perceptible sustainability, followed by cardboard and biodegradable plastic, while plastic was the least preferred due to environmental concern. The rank analysis confirmed this preference, with tin, eco-friendly claims, and low-price option ranking highest among consumers, highlighting a strong tendency toward sustainability and affordability. The CBC investigation reinforced these results, showing that packaging material type had the highest comparative importance, with tin promising as the dominant choice, followed by cardboard and biodegradable plastics. Eco-friendly claims and low prices were also prioritized, while sustainability levels cooperate a essential role in shaping preference, with high sustainability valued mainly. The comparative investigation demonstrate that sustainability attribute were the most considerable factor, followed by product claims, price, and durability, while sustainability concerns varied among participants, with superior sustainability concerns driving stronger preferences for eco-friendly covering. Overall, the study highlights the growing consumer require for sustainable, affordable, and environmentally conscious packaging, with tin packaging leading the preference ranking, reflecting a shift towards more sustainable packaging solutions in the tea industry.

CONCLUSION

This research emphasized the critical role of sustainable design innovation in tea packaging by analyzing consumer preferences and material collection trends. The findings revealed that sustainability and affordability are the two most significant characteristic that influence consumer decision. Tin packaging determined the ideal due to its durability, recyclability, and eco-friendly values, followed by cardboard and biodegradable plastics. Environmental concerns and price sensitivity influence consumer preference. Additionally, high sustainability was consistently prioritized over rational or low sustainability in both rank and regression analysis outcomes. The CBC analysis promoted and emphasized the foremost role of packaging material and sustainability in driving consumer choices, with tin packaging and superior sustainability attribute having the highest utility and relative significance. The findings emphasized the need for greater consumer responsiveness about the environmental benefits of sustainable materials to advance eco-conscious purchasing behavior. The investigation examined that businesses should incorporate sustainability with aggressive pricing and efficient product claims to gather customer demands and encourage environmentally responsive practices in tea packaging.

LIMITATIONS AND FUTURE SCOPE OF THE STUDY

The analysis primarily assesses commonly used materials like tin, cardboard, and biodegradable plastics, neglectingmodern eco-friendly alternative. Future research should investigate bio-composites, algae-based plastics, and compostable packaging to assess their feasibility, cost-effectiveness, and consumer reception in sustainable packaging solutions.

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