ORIGINAL PAPER

CONSUMER PERCEPTION TOWARDS TRACEABLE DAIRY PRODUCTS: AN EMPIRICAL STUDY

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ABSTRACT. Background: Growing concerns about food safety and quality practices require the dairy industry to sustain accountability and transparency. Knowing consumer perceptions and attitudes regarding traceability is critical for developing efficient market-driven approaches.

Purpose of the Study: This empirical research explores consumer perceptions of product traceability within the dairy industry. It seeks to address the gap between industry practices and consumer demands by investigating their preferences, perceptions, and issues, which leads to enhanced decision-making, transparency, and a sustainable future.

Design Methodology/Approach: A literature review was conducted to identify research gaps. The authors developed a questionnaire about traceability in the context of food safety and quality awareness. Exploratory factor analysis (EFA) was used to analyze the data collected from 439 respondents, and Principal component analysis (PCA) was used to factor categorization and analyze consumer perception of traceability.

Findings: The reliability analysis of the data shows significantly high reliability. Five factors were extracted after performing EFA, and factor loadings and communality were acceptable. The research indicates that consumer demand for transparency in the dairy industry is increasing. Consumers are increasingly interested in learning about the historical background of dairy products, production practices, and ethical aspects. Traceability becomes an influential factor in purchases and devotion to a brand.

Originality/Value: This study contributes to consumer awareness and allows industry stakeholders to improve the quality and safety of food techniques, promoting transparency at all supply chain stages.

Keywords: Traceability, Dairy Supply Chain, Consumer Perception, Food Security, Food Safety, Sustainability

INTRODUCTION

In an era of progressively evolving and globalized food supply chains, maintaining the safety of products, quality and transparency has become crucial. Over the last decade, several safety and contamination incidents have shaken consumer trust in the agri-food industry (Montgomery *et al.*, 2020). These incidents have demonstrated the value of accountability and transparency in the food supply chain. As a result, authorities and regulators adopted strict traceability guidelines to improve food quality and safeguard consumers (Badia-Melis *et al.*,

2015). Due to these challenges, the dairy industry, an essential sector of the global food landscape, is at a turning point. The requirement for reliable traceability systems has emerged as a critical concern through many global supply chains involving many actors (Tan and Ngan, 2020). As a significant player in the global food market, the dairy industry has also seen an increased emphasis on product traceability (Casino *et al.*, 2021). The dairy industry's importance extends beyond its role as a nutritional staple; it represents a vast economic landscape, an essential source of income for millions, and an integral part of culture for numerous cultures (Khanna *et al.*, 2022). Milk

and related products are nutrient-dense foods high in vitamins, minerals, and proteins (Burke *et al.*, 2016). However, the journey from the udder to the consumer's table is fraught with complexities, posing problems with quality control, safety assurance, and ethical considerations (Mor *et al.*, 2021). In this context, traceability becomes an approach to mitigating hazards, developing trust, and offering consumers information sharing (Vp *et al.*, 2022).

Furthermore, shifts in consumer tastes, such as the rise of health-conscious and environmentally-conscious consumers, have increased consumer demand for additional details about the origin and sourcing of dairy products. Consumers are concerned about the nutritional aspects of dairy products and the social and environmental consequences of their purchasing decisions (Naspetti *et al.*, 2021). As a result, they desire to purchase sustainably and ethically acquired dairy products, contributing to a more significant movement regarding accountable and conscious buying (Maitiniyazi and Canavari, 2020). This study investigates consumer perceptions of product traceability in the dairy industry. The study aims to investigate consumers' attitudes towards dairy traceability, including their beliefs about the importance of traceability and its impact on food safety.

The rest of the article is organized as follows: Section 2 includes the literature review, Section 3 presents the methods adopted for the study, Section 4 presents the analysis and results, Section 5 discusses the findings, and Section 6 concludes the research.

LITERATURE REVIEW

Product traceability is critical in the dairy industry, as it ensures the safety and quality of dairy products, while also building consumer trust (Patelli and Mandrioli, 2020). Traceability enables dairy companies to quickly identify contamination sources and implement targeted recalls, lowering the risk of foodborne illness outbreaks (Charlebois and Haratifar, 2015). Traceability also improves supply chain efficiency by streamlining inventory management and reducing waste. Consumers, becoming more informed and discerning,

appreciate such transparent and accountable practices in the dairy industry (Vriezen *et al.*, 2022). Implementing robust product traceability measures can also provide a competitive advantage in the business world (Prashar *et al.*, 2020). Companies that invest in traceability technologies and open communication can distinguish themselves in the market, attracting consumers looking for safer and more ethically produced dairy products. Furthermore, traceability can help develop a brand's reputation and consumer loyalty (Pelegrino *et al.*, 2020).

Even with the growing importance of traceability of products in the dairy industry, there is a knowledge gap regarding consumer attitudes towards traceable dairy products (Naspetti *et al.*, 2021). While research studies have looked at the significance of traceability on consumer behavior in various food sectors, few have explicitly examined customer perceptions and intentions regarding dairy product traceability (Qian *et al.*, 2020). Dairy industry stakeholders must understand how consumers perceive product traceability in the dairy supply chain to align their practices with consumer demands and preferences (Jouzdani *et al.*, 2020). Consumers' perceptions and attitudes toward traceability are essential because they impact purchase decisions and brand loyalty, eventually determining the dairy industry's future (Lin and Wu, 2021). Transparency is in increasing demand as today's customers become increasingly demanding and health-conscious (Astill *et al.*, 2019). People are becoming more interested in learning about the origins of what they consume, the circumstances in which it was grown, and the methods that regulate its path from farm to plate (Gholizadeh *et al.*, 2021).

The research objective in this context is to provide insight into the complex relationship between traceability and consumer behavior in dairy products. Considerable research is required to understand what consumers' views on the traceability of products in the dairy supply chain (Mor *et al.*, 2018). The study emphasizes that consumers are not identical entities; their choices, ideas, and trust indicators are distinct throughout demographic data, civilizations, and scenarios. As a result, this research aims to capture all of this variation and present perspectives that can inform regulations,

industry practices, and consumer awareness. The only risk factors connected to food were those associated with sanitation or limited availability, considered low-risk situations (Leong *et al.*, 2019). Increased food safety regulations have been implemented due to several incidents in which food contamination was the primary source of consumer risk (Wang *et al.*, 2020). Throughout several recent decades, understanding of the production and distribution procedures has grown along with the awareness of customers regarding food quality. Still, there also needs to be more performance and stability in the collaboration between consumers and regulatory bodies (Peng *et al.*, 2022).

Concerning product knowledge, consumers are more likely to trust dietitians and environmentalists than food producers and governmental organizations (Liu *et al.*, 2018). For some consumers, the quality and perception of food may not be consistent, and they may differ based on their tastes and preferences (Imami *et al.*, 2014). The reliability of the business or organization that manufactures the product and consumer confidence in the manufacturer must be the foundation for food safety and quality standards (Röhr *et al.*, 2005). The research emphasizes that traceability is not entirely new and has been used in various industries other than food, including pharmaceuticals, electronics, and textiles (Marconi *et al.*, 2017). However, its application to the dairy supply system presents challenges. Various production scales, the participation of smallholders, different processing methods, and the complexity of cold chains distinguish the dairy industry (Casino *et al.*, 2020). Thus, the study understands that for potential traceability mechanisms to be effective, they must align with these realities. The study's scope also takes into account how quickly technology is developing. Blockchain, RFID, barcoding, and other cutting-edge technologies show potential for improving traceability (Paul *et al.*, 2022). These technologies can provide real-time data, secure authentication, and a decentralized information ledger (Khan and Salah, 2018). However, the feasibility, financial implications, and stakeholders' capacity to embrace and adapt to new systems must all be considered carefully before integrating into the dairy supply chain (Cabrera and Fadul-Pacheco, 2021). An in-depth knowledge of consumer attitudes toward traceability of products is essential as the global dairy industry negotiates an intersection of customer requirements, technological advances, and supply chain complexity (Akzar *et al.*, 2022; Naspetti *et al.*, 2021).

The literature findings show that very few consumer-focused studies in the dairy industry related to their perception of product safety and quality.

MATERIALS AND METHODS

The study investigates the consumer attitude towards traceability in the dairy industry. The authors adopted an empirical approach to identify and investigate the factors. Quantitative and qualitative methodologies are used in the empirical study of consumer attitudes. The systematic gathering of data from a representative sample of consumers from across various geographical regions will be made possible by quantitative surveys. These studies will examine the variables that affect purchasing choices, the function of information about traceability, and the perceived importance of transparency. Parallel to this, qualitative interviews will elucidate underlying motivations, trust dynamics, and potential obstacles to embracing traceability, adding depth and nuance to these findings.

Sampling and Data Collection

The targeted respondents for the study are consumers from the state of Haryana. The study adopted a quantitative approach, including data collection through an online survey. For this objective, a survey instrument in the form of a questionnaire was developed based on an exhaustive literature review to identify the factors responsible for traceability implementation in the dairy industry in the consumer attitude context. The questionnaire was validated by subject experts from the dairy industry and digital technology aspects. The questionnaire used as a research instrument contained thirty-seven statements about consumer attitudes toward traceability in the dairy industry. The statements were measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). A total of 452

responses were collected. Thirteen responses were removed due to no variation in respondent response or the same response for every statement. Finally, 439 responses were considered for the analysis. The respondent's demographic details are given in the next section.

Respondent's Demographic Profile

A sample of 439 consumers was considered for this study. The responses were collected from all age groups and professionals. Table 1 describes the respondent's profile, which is given below.

Table 1: Demographic information of respondents

Demographic Categories		No. of Respondents
Gender	Male	310
	Female	129
Age	Under 18	2
	18-24	257
	25-34	104
	35-44	55
	45-54	18
	55-64	2
	65 or Older	1
Occupation	Student	287
	Full-time Employee	122
	Part-time Employee	7
	Self-Employed	16
	Retired	1
	Other	6
Highest Level of Education	High School or Equivalent	122
	Bachelor's degree	125
	Master's degree	141
	Doctoral Degree	48
	Others	3
Total		439

Statistical Tool and Analysis

The authors used the factor analysis technique to identify the factors related to consumer perception/attitude towards traceability in the dairy industry. Exploratory factor analysis is suitable when research has no defined hypothesis related to factors, and the objective is to find internal reliability.

Initially, the authors identified and made 37 statements using literature review analysis. Then, EFA was performed using IBM SPSS 23 software.

- After data collection, responses were checked for outliers, invalid responses, and response variations. The following steps were performed:

- The authors coded the raw data from the questionnaire as "Strongly Disagree=5; Disagree=4; Neutral=3; Agree=2; Strongly Agree=1".
- Outliers were removed.
- The standard deviation was checked for each respondent's response to the statement to check the variation in responses. All responses with 0 (SD) rank were removed because of no variation.
- A final table with coding was prepared to perform EFA.

RESULTS

Reliability Analysis

The reliability of the data collected was calculated using the Cronbach alpha coefficient, which helps to check the internal consistency of data. The researchers can use reliability analysis to verify that the measurement instruments are reliable, consistent, and can generate reliable data. The authors calculated the value using IBM SPSS v23 software, which was 0.973 for the statements. A measure of the reliability of 0.973 indicates that the measurement error influences a small percentage of the variation in the responses. The calculated value demonstrates the significantly high reliability of constructs and individual statements (Cronbach, 1951).

Factor Analysis (FA)

The authors performed EFA systematically, considering all 37 statements. As Hair *et al.* (2006) recommended, the authors initially employed the Bartlett test of sphericity to confirm that factor analysis was appropriate. The confirmation was made by examining the correlation matrix of data. Kaiser-Meyer-Olkin (KMO) statistics were calculated simultaneously to determine the suitability of data. The results for the Bartlett test of sphericity and the KMO value were calculated using SPSS v23, shown in Table 2.

Table 2: KMO and Bartlett's Values

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.968
Bartlett's Test of Sphericity	Approx. Chi-Square	14889.601
	df	666
	Sig.	0.000

Factor analysis identified and grouped the factors related to consumer perception/attitude towards traceability in the dairy industry. The KMO values >0.6 specify the suitability of factor analysis. For the data, factor analysis gives KMO value >0.968, which falls in the greater good category for the factors related to consumer perception/attitude. The results were significant; thus, the factor analysis was considered valid (Mor *et al.*, 2020). Bartletts test of sphericity was highly significant (P<.000), confirming the correlation between the population attributes. From the EFA, authors extracted five factors named F1: Perception of Trust, Brand Perception, and Industry Responsibility; F2: Awareness of Adulteration and Contamination Practices; F3: Influence of Traceability on Consumer Decisions; F4: Awareness and Knowledge of Traceability; F5: Access to Traceability Information and Communication/ Perception of Quality and Consumer Engagement.

The analysis gives the commonalities values of each statement. It should be greater than 0.5. If any statement has an extraction value less than 0.5, the statement should be removed, and factor analysis needs to be done again. The factor loadings for all 37 statements were found to be ≥0.5, hence acceptable (Mor *et al.*, 2020).

Table 3 shows the values greater than 0.5 for all 37 statements, indicating that all statements are fit for analysis and the total variance explained by all 37 factors. Five factors have been identified as accounting for 71.767% of the variance. The eigenvalues of all five extracted factors are greater than one.

DISCUSSION

The study aims to identify the key factors related to consumer perception/attitude towards traceability in the dairy industry. The factor analysis categorized 37 statements into five major factors in Table 3.

F1: Perception of Trust, Brand Perception, and Industry Responsibility

The first factor, "Perception of Trust, Brand Perception, and Industry Responsibility", explains 24.9% of the total variance. Eleven statements define the factor having factor loadings ranging from 0.563 to 0.815, given in Table 3. The reliability analysis for factor 1 was done using the Cronbach alpha method and

calculated as 0.966, indicating a significantly high reliability of factor 1 and its statements.

The findings highlight that "F1: Perception of Trust, Brand Perception, and Industry Responsibility" is a major factor consumers relate to traceability implementation in the dairy industry. A correctly implemented traceability system can assure consumers as to the quality and safety of dairy products, boosting their trust (Maitiniyazi and Canavari, 2020).

The factor "F1: Consumer Perception about Perception of Trust, Brand, and Industry Responsibility" surfaced as an influential indicator of how consumers consider traceability within the dairy sector. This aspect consists of observations indicating the complicated connection between customer opinion, brand confidence, and the dairy industry's responsibility for ethical behavior. These opinions demonstrate a variety of opinions, ranging from highlighting the importance of traceability as an established practice to its influence on consumer choices and confidence in dairy products (Naspetti *et al.*, 2021). The statements in this context emphasize traceability's critical role in developing and sustaining consumer trust in dairy products. The idea that "Traceability is crucial for building trust between consumers and dairy brands" emphasizes the fundamental relationship between supply chain transparency and customer trust. This corresponds to current trends and consumers' need to provide product-related information such as origin, quality aspects, etc., and transparency in the dairy industry.

The findings also show consumers recognize traceability to identify reliable dairy companies. The statement "I consider traceability to be an indicator that distinguishes reliable dairy brands" indicates how consumers perceive traceability strategies as an indicator of a brand's dedication to quality and transparency. Consumers value and regularly seek out dairy companies that are open about their origins, procedures, and manufacturing practices. The perception that dairy producers must implement traceability is a significant outcome (Lin and Wu, 2021). As participants stated, "The dairy industry needs to address consumer concerns about traceability" and "The

dairy industry should invest more in implementing traceability." The statements imply that customers anticipate the dairy industry implementing preventative measures to ensure that certain product quality originates from and is produced ethically.

Additionally, findings show that consumers consider transparency within the supply chain and request the presence of traceability details on packaging for products. The statement "Transparency in the supply chain affects my trust in dairy products" emphasizes the positive connection between the accessibility of information and consumer confidence. The factor analysis highlights the important roles consumer perception, trust in brands, and the dairy industry's ethical responsibility play in influencing perspectives on traceability (Liu *et al.*, 2018). The mentioned factor demonstrates the perception that traceability is not just a technical process but also a foundational element of differentiation among brands, industry transparency, and building confidence. These results indicate that dairy businesses can leverage traceability as a potent tool to increase consumer confidence and brand devotion and guarantee the quality of their products (Malik *et al.*, 2023).

F2: Awareness of Adulteration and Contamination Practices

The second factor, "Awareness of Adulteration and Contamination Practices", explains 15.3% of the total variance. Seven statements define the factor as having factor loadings ranging from 0.705 to 0.759, as given in Table 3. The reliability analysis for factor 2 was calculated as 0.933, indicating a significantly high reliability of factor 2 and its statements.

Table 3: EFA Findings with Factors and Factors Loadings

Factors & Statements	Commonality	Factors					Measurement on 5-point Likert scale		Overall score of factor	
		F1	F2	F3	F4	F5	Mean	Standard Deviation	Mean	Standard Deviation
(F1): Perception of Trust, Brand Perception, and Industry Responsibility/										
Traceability should be a standard practice in the dairy industry.	0.761	0.745					3.86	1.190	3.922	1.113
Traceability is crucial for building trust between consumers and dairy brands.	0.795	0.801					3.98	1.071		
Traceability enhances my confidence in the safety and quality of dairy products.	0.754	0.780					3.88	1.134		
Assurance of safe and hygienic production practices impacts my perception of dairy products/purchasing decisions.	0.726	0.709					3.97	1.113		
Transparency in the supply chain affects my trust in dairy products.	0.716	0.755					3.85	1.131		
I consider traceability as a factor that differentiates trustworthy dairy brands.	0.769	0.738					3.86	1.086		
The dairy industry should invest more to implement traceability.	0.814	0.815					3.94	1.091		
The dairy industry should have stricter quality control measures in place.	0.776	0.783					4.04	1.105		
The dairy industry needs to address consumer concerns about traceability.	0.808	0.787					3.98	1.062		
I trust dairy brands that actively promote their traceability initiatives.	0.761	0.740					3.83	1.135		
Traceability information should be displayed on dairy product packaging.	0.687	0.563					3.95	1.121		
(F2): Awareness of Adulteration and Contamination Practices										
I am aware of possible adulteration and contamination practices in dairy products.	0.679		0.728				3.79	1.017	3.971	1.110
I am aware of the potential risks associated with adulterated dairy products.	0.712		0.730				3.79	1.054		
Consumers should be concerned about the risks associated with dairy (milk) products.	0.779		0.742				4.08	1.136		

Milk adulteration is a growing issue in the dairy industry.	0.741	0.759		3.99	1.118		
I feel concerned about the health implications of consuming adulterated milk.	0.747	0.756		3.98	1.112		
There is a need for stricter regulations to combat milk adulteration.	0.700	0.724		4.05	1.155		
Consumers should know the source and authenticity of the ingredients used in dairy products.	0.749	0.705		4.12	1.177		
(F3): Influence of Traceability on Consumer Decisions							
I believe that product traceability is an important factor in ensuring the safety and quality of dairy products.	0.713	0.635		3.86	1.117	3.864	1.056
I believe that traceability measures can help prevent adulteration in the dairy industry.	0.663	0.589		3.87	1.058		
Traceable dairy products influence my purchasing decision.	0.613	0.505		3.54	1.062		
Traceability ensures transparency and accountability of the dairy industry.	0.747	0.609		3.94	1.009		
Traceability is essential for ensuring the safety and quality of dairy products.	0.781	0.639		3.99	1.081		
Traceability information helps to make more informed choices about the dairy products I purchase.	0.707	0.624		3.96	.965		
I prefer dairy products with traceability measures more than those without.	0.676	0.613		3.76	1.035		
Consumers should have clear and accessible information about the origin, processing, packaging, etc. of dairy products.	0.755	0.554		3.99	1.118		
(F4): Awareness and Knowledge of Traceability							
I am aware of the concept of traceability in the dairy industry.	0.661		0.717	3.35	1.061	3.158	1.105
I am aware of how traceability works in tracking the journey of dairy products.	0.751		0.828	3.21	1.059		
I am aware of the information that can be obtained through traceability measures.	0.759		0.810	3.21	1.121		
I know how to access traceability information for the dairy products you purchase.	0.697		0.830	3.03	1.112		
I actively seek out traceability information when buying dairy products.	0.646		0.724	2.99	1.172		

(F5): Access to Traceability Information and Communication/ Perception of Quality and Consumer Engagement						
I find it easy to access information about the origin, processing, packaging, etc. of dairy products.	0.550		0.650	3.18	1.157	3.663	1.097
I prefer dairy brands that provide clear and understandable traceability information.	0.634		0.538	3.74	1.051	
Knowledge about the product production process influences my perception of its quality.	0.712		0.552	3.72	1.116	
Consumers should support dairy brands that have environmentally friendly practices.	0.701		0.518	3.97	1.066	
Traceable products are of premium quality.	0.664		0.707	3.58	1.102	
Consumers should be actively involved in shaping traceability practices in the dairy industry.	0.650		0.564	3.79	1.089	

Note: Extraction Method: Principal Component Analysis.
     Rotation Method: Varimax with Kaiser Normalization.
     F1-F5 represents individual factors.

The second factor, "F2: Awareness of Adulteration and Contamination Practices," emphasized the consumer perception towards knowledge and understanding of potential adulteration and contamination practices within the dairy industry. This factor includes statements that indicate how effectively consumers understand possible adulteration and contamination practices in dairy products. These statements draw attention to consumer awareness and concern about food quality, safety, hygiene, and authenticity. This component significantly impacts the possible health threats related to the contamination of dairy products (Malik *et al.*, 2023). Indeed, individuals expressed concern regarding the "health consequences of consuming counterfeit dairy products" and demanded "stricter guidelines for preventing milk adulteration." Analysis highlights the risks of counterfeiting and contaminants to the well-being of consumers. These results additionally indicate that consumers want to be aware of the authenticity and source of specific dairy ingredients. The statement that "consumers should know about the origin and authenticity of the components used in dairy products" emphasizes the need for supply chain transparency and an interest in making informed consumption choices. This factor also indicates that consumers believe being cautious about the potential dangers of contaminated milk and milk products is critical. The statement "Consumers should be concerned about the risks associated with dairy (milk) products" indicates that consumers prefer to decide on the quality and safety of their products. The study emphasizes the importance of consumer concerns and understanding in influencing thoughts about the dairy industry's potential adulteration and contamination practices. The factor identified emphasizes the significance of consumer transparency, regulation, and health awareness. The results imply that consumer awareness and industry initiatives to prevent adulteration and contamination are critical to maintaining food safety and increasing consumer trust in dairy products (Khanna *et al.*, 2022).

F3: Influence of Traceability on Consumer Decisions

The third factor, "Influence of Traceability on Consumer Decisions", explains 11.7% of the total variance. Eight statements define the factor having factor loadings ranging from 0.505 to 0.639, as given in Table 3. The reliability analysis for factor 3 was calculated as 0.934, indicating a significantly high reliability of factor 3 and its statements.

The third factor, "F3: Influence of Traceability on Consumer Decisions", highlighted traceability's critical role in influencing customer opinions and choices. These statements represent how consumers consider traceability crucial for ensuring the security of products, quality, transparency, and accountability. The statements in this factor encourage the fundamental idea that traceability contributes considerably to the safety and quality of dairy products. The opinion that "I believe that product traceability is an important factor in ensuring the safety and quality of dairy products" strengthens the perception that traceability is an essential component in protecting consumers from potential risks and compromises in dairy products (Zhang *et al.*, 2012).

Based on the findings, consumers perceive traceability as a preventative measure against counterfeiting and fraudulent activity in the dairy industry. The observation that "I believe that traceability measures can help prevent adulteration in the dairy industry" demonstrates how traceability is regarded as safeguarding dairy product quality by preventing unethical behavior. Recognizing that traceable milk and its derivatives, consumer purchasing decisions are critical to this factor. According to the findings, consumers regard traceability as an essential quality influencing their purchasing decisions (Pelegrino *et al.*, 2020). The results highlight the significance of traceability for encouraging transparency and accountability and the broad implications of traceability outside specific purchasing choices in the dairy industry. The aspect also emphasizes that consumers can locate "clear and accessible information about the origin, processing, packaging, etc. of dairy products".

This highlights even more how important it is for consumers to have complete supply chain transparency. The study discovered that traceability is critical in shaping consumer choices in the dairy industry. The factor emphasizes the significance of traceability in ensuring product safety, preventing adulteration, increasing transparency, and encouraging informed decision-making (Lin and Wu, 2021). These findings highlight the necessity for dairy industry stakeholders to communicate effective traceability measures to consumers transparently and put them into practice. Traceability has an impact that extends beyond specific purchasing choices and contributes to the more general objectives of industry accountability and consumer trust (Liu *et al.*, 2018).

F4: Awareness and Knowledge of Traceability

The fourth factor, "Awareness and Knowledge of Traceability", explains 10.7% of the total variance. Five statements define the factor having factor loadings ranging from 0.717 to 0.830, given in Table 3. The reliability analysis for factor 4 was calculated as 0.883, indicating the considerably high reliability of factor 4 and its statements.

The fourth factor, "F4: Awareness and Knowledge of Traceability", focuses on how knowledgeable consumers are about the idea, how it works, and the practical significance of traceability. This factor includes perceptions that point out consumer awareness of traceability methods and their grasp of how traceability affects the journey of dairy products from production to consumption. This component points out consumers' basic understanding of dairy traceability. Individuals indicated their knowledge by declaring, "I am aware of the concept of traceability in the dairy industry".

Findings show that most participants know how traceability works in dairy industry operations. The statement, "I am aware of how traceability works in tracking the journey of dairy products", implies that consumers know how traceability works within the dairy supply chain. The factor also emphasizes consumers' ability to obtain traceability information and their decisive strategy. The findings suggest that consumers value traceability information highly when making purchasing decisions. It raises awareness of traceability as a method for making well-informed choices. According to the results, consumer awareness and comprehension of dairy industry traceability practices are essential (Charlebois and Haratifar, 2015).

Individuals also showed an awareness of how traceability functions when monitoring the flow of dairy products. The factor identified demonstrates that consumers are not only aware of traceability but also have a basic understanding of how it works. This awareness enables consumers to seek out traceability information when purchasing proactively. The findings highlight the importance of dairy industry stakeholders not only implementing traceability measures but also effectively communicating the benefits and implications of traceability to consumers. A well-informed consumer base can help to build trust and support traceability initiatives in the dairy industry (Imami *et al.*, 2014).

F5: Perception of Quality, Consumer Engagement, and Information Accessibility

The fifth factor, "Perception of Quality, Consumer Engagement, and Information Accessibility", explains 8.9% of the total variance. Six statements define the factor having factor loadings ranging from 0.518 to 0.707, given in Table 3. The reliability analysis for factor 5 was calculated as 0.876, indicating a significantly high reliability of factor 5 and its statements.

The fifth factor, "F5: Perception of Quality, Consumer Engagement, and Information Accessibility", investigates the consumer's perception of traceability data affecting their opinions and decisions. This factor highlights the complex interactions among traceability, customer preferences, perception of quality, and participation in developing industry practices. The findings reveal the importance of information accessibility in shaping consumer comprehension and decisions (Maitiniyazi and Canavari, 2020). The requirement for clear and understandable traceability information is

reflected in the responses. Moreover, the outcomes emphasize respondents' support for sustainable dairy industry practices and represent a consumer-driven push for ethical considerations in purchasing decisions directly related to attitudes toward product quality. According to the findings, consumers relate traceability to quality. The results indicate that traceable products are perceived to be superior in reliability and quality. The findings highlight consumers' desire for participation and involvement in industry practices. This reflects a broader trend of empowering customers and the role they perceive themselves playing in establishing industry norms (Maitiniyazi and Canavari, 2021).

The study highlights the complex interactions between traceability information accessibility, product quality perspectives, customer involvement, and their preferences for sustainable production practices in the dairy industry. The findings indicate that traceability goes beyond mere transparency; it encourages well-informed decisions, influences product perspectives, establishes customer preferences, and encourages consumer engagement (Charlebois and Haratifar, 2015). These findings suggest that stakeholders in the dairy industry can improve their approach by coordinating with customer preferences and facilitating their active participation in shaping industry practices.

Implications

The study has many significant implications for academia and the dairy industry stakeholders. The study presents insightful details about how consumers consider traceability in the dairy industry. These findings allow dairy industry stakeholders to better understand consumer preferences, concerns, and priorities. Dairy companies can use these findings to customize their traceability projects, marketing approaches, and merchandise offerings to satisfy customer demands. The industry can gain an edge over competitors by improving traceability strategies and effectively interacting with consumers. The study points to the significance of informing consumers about traceability practices and their consequences. The results indicate that consumers are unaware of or uneducated about traceability. It highlights

the importance of educational and open communication campaigns to bridge these disparities. An educated audience is more likely to value and support traceability initiatives across the industry enhancements in the quality and safety of food. The study reveals that consumers prefer traceable dairy products and are willing to use brands that offer clear traceability information. This gives dairy brands a unique marketing possibility to distinguish themselves by demonstrating their dedication to accountability and transparency. Brands that persuasively convey their traceability approaches can establish a unique brand identity that appeals to concerned customers looking for dependable, excellent-quality dairy products.

The study's implications highlight traceability's critical role in establishing consumer trust. Trust is essential in relationships between customers and brands, and traceability can help to foster it significantly. Brands prioritizing reliable systems for traceability can position themselves as trustworthy and dependable options among consumers. This can result in improved customer trust, frequent purchases, and favorable customer referrals. The study identifies the preferences of customers for sustainable practices as well as their willingness to support dairy companies that prioritize sustainability. This highlights a chance for the dairy industry to link traceability to broader sustainability efforts. Brands incorporating environmental considerations into traceability initiatives can connect with eco-conscious consumers, addressing traceability and sustainability concerns.

From the research perspective, this study adds to the literature on consumer perceptions of traceability in the dairy industry.

Theoretical Implications

The empirical study on "Consumer Perception Towards Traceability in the Dairy Industry" yields several theoretical implications that contribute to a broader understanding of consumer behavior, traceability, and industry-consumer dynamics:

- Consumer Decision-Making: The study illuminates how traceability influences consumer decision-making. This extends theories of consumer behavior by highlighting traceability's role as a critical factor in shaping perceptions, preferences, and purchasing choices in the dairy sector.
- Trust and Brand Loyalty: The research reinforces trust and brand loyalty theories, emphasizing traceability's pivotal role in fostering consumer trust and influencing brand loyalty. This underscores the significance of transparency and accountability in consumer-brand relationships.
- Sustainability and Ethics: The study highlights integrating sustainability and ethics into consumer preferences. This aligns with theories of ethical consumerism, showcasing how traceability resonates with environmentally conscious consumers and contributes to the larger discourse on ethical consumption.

Practical Implications

The empirical findings hold practical implications for the dairy industry, offering actionable insights to enhance business strategies, communication practices, and consumer engagement:

- Enhanced Traceability Communication: Dairy brands should prioritize clear and accessible traceability information. This can be achieved through product packaging, websites, and mobile apps, ensuring consumers can easily access information about the product's origin, processing, and packaging.
- Transparency and Trust-Building: The industry can leverage traceability to build and reinforce consumer trust. By actively promoting traceability initiatives, brands can establish themselves as transparent and accountable, appealing to safety-conscious consumers.
- Sustainable Practices: Brands should consider integrating eco-friendly practices into their traceability initiatives. Highlighting environmentally conscious

measures, such as sustainable sourcing or reduced carbon footprint, can resonate with environmentally aware consumers and differentiate brands in the marketplace.

- Consumer Engagement: Engaging consumers in shaping traceability practices can create a sense of ownership and commitment. Brands can initiate dialogues, surveys, or interactive campaigns to involve consumers in co-creating traceability solutions, fostering a deeper connection between consumers and the industry.

Suggestions

The findings suggest the key factors influencing consumers' perception of traceable dairy products. Based on the analysis, the authors proposed suggestions to help the industry establish a reliable relationship with consumers. The following suggestions are:

1. Comprehensive Traceability Systems: The dairy industry should invest in robust traceability systems to trace the products from origin source to distribution, giving consumers access to precise and reliable information about the dairy products they purchase.
2. Sustainable Practices: The industry should emphasize integrating sustainable development into traceability actions. To attract eco-conscious customers, emphasize environmentally friendly practices such as responsibly purchasing, minimizing waste, and using energy.
3. Engage Consumers: Encourage customer participation through collaborative initiatives, questionnaires, or communication on social platforms. Develop an environment of shared responsibility by involving consumers in developing traceability practices and addressing their concerns.
4. Educational Outreach: The introduction of promotional initiatives to raise consumer knowledge and awareness about the importance of traceability. Assist consumers in making informed decisions by explaining how

traceability ensures product safety and quality.

5. Collaborate for Industry Standards: The collaboration with regulatory agencies, industry organizations, researchers, and technology providers to develop standardized traceability practices. This promotes uniformity, credibility, and trust throughout the dairy industry.

By integrating these recommendations, the dairy industry can successfully utilize traceability as an opportunity for transparency, customer satisfaction, and long-term growth while coordinating industry practices with changing consumer expectations.

CONCLUSION

This study investigates the consumer's perception of traceability implementations in the dairy industry. The major factors were explored through a literature survey, and 37 statements were considered for factor analysis. The EFA reduced 37 statements to five major factors. The findings highlighted five factors: Perception of Trust, Brand and Industry Responsibility, Awareness of Adulteration and Contamination Practices, Influence of Traceability on Consumer Decisions, Awareness and Knowledge of Traceability, and Perception of Quality, Consumer Engagement, and Information Accessibility. The reliability of each factor was calculated by Cronbach alpha, which was 0.966, 0.933, 0.934, 0.883, and 0.876, respectively, demonstrating the significantly high reliability of the factors. This study is significant because it can improve customer awareness regarding product traceability and its importance for the dairy industry. The findings will aid all dairy industry stakeholders, such as producers, processing units, and vendors, in establishing focused advertising approaches and outreach initiatives through understanding customer needs and preferences regarding traceability. Furthermore, this research can empower consumers by allowing them to make well-informed choices when buying dairy products.

This study is an essential guide for policymakers as well as industry administrators seeking to align their practices with consumer preferences as consumer demands for transparency and sustainability continue to rise. It can also illuminate potential gaps in traceability practices and inspire additional research and development in the dairy supply chain. This study addresses the communication gap among consumers and the dairy industry by understanding consumer perceptions of product traceability. The study aims to create the foundation for a more open and consumer-focused dairy supply chain that will benefit consumers and industry stakeholders by understanding consumer preferences and attitudes. The study aims to offer significant new insights into the practices and marketing strategies used in the dairy industry by examining the factors affecting consumer attitudes, trust, and preferences related to traceability information. The study will also provide insightful recommendations for fostering consumer loyalty and trust through successful traceability initiatives.

Limitation and Future Scope

The study has limitations such as sampling errors and cultural variation. The implications suggest future research directions, such as examining the relationship between the need for traceability and consumer behavior, assessing the impact of traceability on brand loyalty over time, and examining the efficiency of different approaches to communication in providing traceability knowledge to consumers. Areas such as factors influencing traceability adoption from an industry point of view, sustainable traceability approaches, and their adoption barriers can also be potential future research directions.

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