

A Qualitative Exploration of Indigenous Food Processing Practices among Reang and Debbarma Tribes in Tripura India Using Grounded Theory and ATLAS.ti

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A Qualitative Exploration of Indigenous Food Processing Practices among Reang and Debbarma Tribes in Tripura India Using Grounded Theory and ATLAS.ti

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Abstract

Indigenous food processing practices play a crucial role in preserving cultural heritage and ensuring food security. These practices, often rooted in traditional knowledge, not only enhance the nutritional value of food but also contribute to the resilience of communities against climate change and economic challenges. The purpose of the study was to emphasize the generation of concepts and categories that emerge from participants' lived experiences, rather than testing pre-existing theories by showing the most validated statements having the relevant sentiments. The study was done on selected villages of Ambassa and Old Agartala blocks of the Reang and Debbarma tribes of Tripura using a mixed-method research design. The generated theory is the adaptive preservation of the tribal food heritage system, with 293 identified neutral sentiments. Expert validation revealed high levels of effectiveness, cultural appropriateness, economic feasibility, and environmental sustainability across the documented practices, with validation indices ranging from 87 to 91 percent. The findings highlight the scientific relevance and practical utility of Indigenous food processing knowledge. While Indigenous food processing practices are essential for cultural preservation and food security, they face challenges from modern food systems that often overlook their significance. Balancing traditional methods with contemporary innovations may provide a pathway to sustain these vital practices.

Keywords: Grounded Theory, ATLAS.Ti, Cultural heritage, Food security, Nutritional value, Adaptive preservation, Scientific relevance, Sentiment Analysis

Introduction

Indigenous food processing practices embody a rich repository of traditional knowledge, shaped by generations of interaction between local communities and their environments. Indigenous food

practices are deeply rooted in cultural heritage, reflecting the unique identities of various ethnic groups. These practices often involve traditional techniques like fermentation and sun-drying, which enhance nutritional value¹. Indigenous processed foods are safe, nutritious, and culturally acceptable, thus supporting local diets². These practices support small-scale enterprises, providing income opportunities for rural communities, particularly women^{3,4}. It also promotes sustainable practices that align with local ecological conditions, fostering biodiversity and resilience against climate change⁵. So, Indigenous foods embody cultural identity and traditional knowledge, fostering a connection between communities and their environment^{6,7}. By integrating Indigenous practices with modern technologies, communities can enhance market access and improve livelihoods⁸. The erosion of these practices due to urbanization and globalization poses a threat to food security and cultural identity, highlighting the need for policies that recognize and support Indigenous knowledge systems⁹.

India, especially the northeastern part of India, is inhabited by hundreds of ethnic population groups. Unlike mainland India, where traditional food preservation knowledge is declining in use due to continuous urbanization and commercialization¹⁰, the indigenous communities of northeast India continue to preserve a vast diversity of culinary expertise rooted in the oral transmission of ancestral techniques^{11,12,13}. However, the rapid modernization of lifestyle and a diminishing engagement among the younger generation with wild-harvested ingredients necessitate a systematic approach to capture these ephemeral practices before they are lost¹⁴. Also, the phenomenon of climate change across the world is imposing risks to the availability of traditional ingredients, causing a decline in practices and adaptations in preservation methods¹⁵. With the increasing risk of erosion of traditional knowledge, which is quite evident across the world, several studies have been carried out in India too to document the indigenous knowledge of various fields¹⁶. Most of the studies have utilized survey or other quantitative as well as qualitative methods¹⁷. Although several qualitative methods like ethnographic study, key informant interviews or participant observation were found dominantly used, they often lack rigorous qualitative data analysis^{18,19}. This oversight can limit the depth of understanding regarding indigenous practices and knowledge systems. To address this analytical gap, this study employs a Grounded Theory framework facilitated by ATLAS.ti software to systematically code and categorize the oral traditions of Tripura's indigenous communities in relation to food processing practices²⁰. By employing the grounded theory framework alongside ATLAS.ti, this study seeks to systematically

codify these qualitative insights to map the intricate socio-cultural processes governing the production, preparation, and consumption of indigenous food resources^{21,22}.

Among the seven states of North-Eastern India, Tripura is the most distant state. It showcases a complex demographic landscape characterised by a blend of tribal and mainstream Bengali communities. This mixed population has evolved through historical migrations and socio-economic changes, impacting traditional practices. It distinguishes Tripura from its predominantly tribal neighbours²³. This unique demographic configuration is the cause of the adaptation of traditional practices followed by the indigenous communities of Tripura²⁴. Despite this unique demographic composition, the intricate link between indigenous culinary wisdom and the specific social-ecological conditions of Tripura remains insufficiently explored²⁵. Ethnic groups in Tripura prepare a range of cured foods, including fermented, dried, and smoked products such as bamboo shoots and fish, which are integral to their diets. These foods are believed to have medicinal properties, addressing various health issues and enhancing nutritional intake²⁶. Indigenous practices for producing fermented foods, like Sheedal (salt-free fish) and various vegetable-based products, are prevalent. The fermentation process often involves local herbs and rice, showcasing traditional knowledge passed through generations²⁷. Despite these recognized cultural and nutritional merits, there is an urgent research gap concerning the systematic codification of these techniques. These techniques are currently being compromised by the rapid shift toward processed, market-available food alternatives^{22,28}. The complexities of traditional knowledge, particularly within restrictive tribal groups, necessitate advanced qualitative data collection techniques like grounded theory²⁹. By utilizing qualitative methods, researchers can create a sense of cultural safety, enabling indigenous participants to express their identities and concerns freely³⁰. For that purpose, a qualitative method, the grounded theory approach, has been utilized for documenting Indigenous processing practices, which helps to emphasize the generation of concepts and categories that emerge from participants' lived experiences, rather than testing pre-existing theories. Grounded theory utilizes various methods, including in-depth interviews, observational techniques, and focus groups, allowing for flexible data gathering as theories evolve³¹. This approach can help bridge the gap between traditional practices and contemporary challenges faced by Indigenous communities. The iterative process in Grounded theory allows researchers to refine their theories continuously, ensuring that the resulting framework is deeply rooted in empirical evidence³². The theories generated through Grounded theory can provide insights into the

persistence of indigenous food processing practices, highlighting the interplay between tradition and contemporary challenges³³. Sentiment analysis, also known as opinion mining, is a vital area within natural language that focuses on identifying and classifying emotions expressed in textual data. It classifies sentiments expressed in text as positive, negative, or neutral, making it essential for understanding public opinion³⁴. It also faces challenges such as ambiguity in language and the need for context, which can complicate accurate sentiment classification. While indigenous practices are invaluable, there is a need for modern validation and integration with contemporary methods to address hygiene and efficiency challenges, ensuring these traditions continue to thrive in a changing world. Thus, the present study was designed to analyze traditional food processing practices among tribals of Tripura state following the logic of grounded theory. By employing ATLAS.ti as a systematic analytical tool, this research systematically organizes qualitative transcripts into conceptual codes, thereby transforming raw empirical observations into a robust theoretical framework³⁵, followed by scientific validation of these practices.

Methodology

Participants

The study was conducted using an ex post facto research design where Dhalai and West Tripura districts (Fig.1) were selected purposively, depending on the tribal population distribution among the eight districts of Tripura. This study was conducted between January 2025 and May 2026. Using the random sampling method, blocks and villages were selected. The selected villages are Ghantacherra, Kekmacherra, and Kulai from Ambassa block and Paschim Naobadi, Radha Kishore Nagar, and Uttar Champamura from Old Agartala block. 9 Focus group discussions (Fig.1) have been conducted to collect data from the respondents, as it has reached theoretical saturation. It serves as a methodological benchmark, ensuring that qualitative research is grounded in sufficient data richness and depth³⁶. 74 respondents were selected in 9 groups. Those respondents were selected based on their age (more than 45 years), and women of the Reang and Debbarma tribes were selected in particular, as they are the custodians of the Indigenous knowledge. Older women, particularly centenarians, have refined their Indigenous knowledge over time, providing insights into sustainable practices that have been passed down through generations³⁷. Data saturation was obtained when no new data emerged. It is essential for ensuring the completeness and credibility

of research findings, as it indicates that the research has sufficiently explored the phenomenon under study³⁸.



Fig. 1: Study area and the focus group discussion for collecting Indigenous food processing techniques

Data Collection

The data were collected through observation and focus group discussions using a semi-structured interview schedule. It consisted of open-ended questions, which lasted for 60-90 minutes. Before interviews, participants were informed about the study's purpose, procedures, and their rights, including anonymity and non-disclosure of personal information. Eight Indigenous food processing practices were collected from the respondents. Audio recordings serve as the primary source for creating transcripts, allowing for precise capture of the interview content. Transcription involves converting spoken language into written text, which is essential for analysis and reporting. In total, 9 transcripts were prepared based on collected responses using audio recording, note-taking, and observation.

Data Analysis

A grounded theory qualitative approach was applied to develop a theory based on Indigenous processing practices in the selected area. Open coding has been done by line-by-line coding from the transcript. Axial coding has been done to make categories from the generated codes. The categories are very subjective in nature. Based on these categories, a core concept was developed, which is known as selective coding. Based on the concept, a theory was generated.

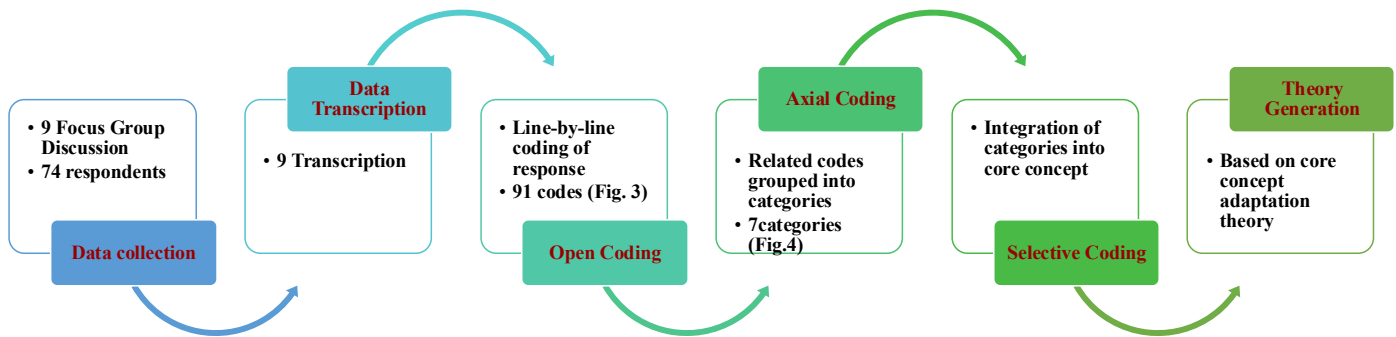


Fig. 2: Steps used for generating theory using the grounded theory approach

Sentiment analysis has also been done based on the approach of positive, negative, and neutral aspects of the responses using ATLAS.ti. This sentiment analysis has been shown using a radar chart to determine the intensity of the approach of the processing practices among the community. Validating Indigenous food processing practices through expert opinion is a critical process that ensures the scientific credibility and practical applicability of traditional practices.

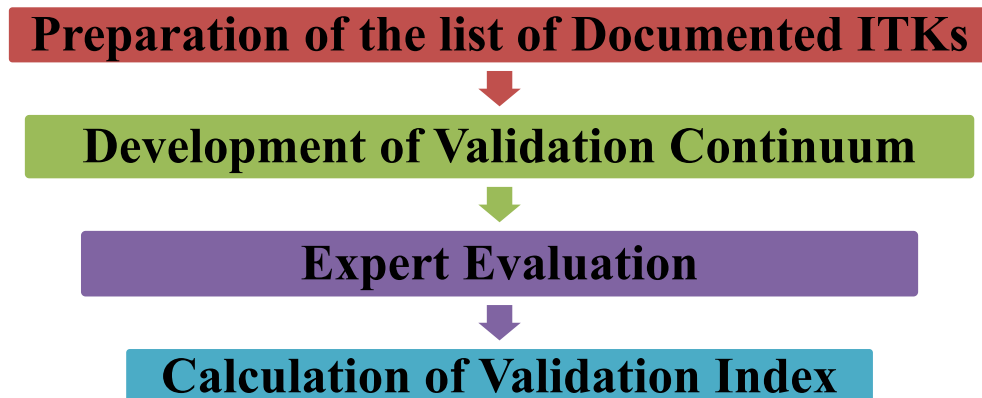


Fig. 3: Steps used for validation of documented processing practices

Table 1: Criteria decided for validation

Efficacy	It denotes the desired effectiveness of the documented indigenous practices.
Cost-effectiveness	It denotes the economic efficiency of documented indigenous practices
Availability	It denotes the resource accessibility of documented indigenous practices
Complexity	It denotes the difficulty level of indigenous practices
Cultural appropriateness	It denotes the cultural compatibility of the indigenous practices
Environmental soundness	It denotes the sustainability of the indigenous practices

The predetermined criteria selected for validation are mentioned in Table 1. Each of these aspects plays a crucial role in ensuring that Indigenous food processing practices remain relevant and beneficial. These practices are typically low-cost, making them accessible to communities with limited resources³⁹. Even though Indigenous food processing practices were widely available within local communities, often passed down through generations³⁹. The complexity of these practices is rooted in deep cultural understanding, making them adaptable to local environmental conditions⁴⁰. Indigenous food processing practices are inherently tied to the cultural identity of communities, ensuring that practices are not only accepted but also respected⁴¹. This cultural relevance enhances community engagement and the likelihood of successful implementation⁴⁰. Many Indigenous food processing practices promote sustainable agricultural methods, reducing reliance on harmful chemicals and fostering biodiversity^{41,42}. The integration of Indigenous food processing practices with scientific approaches can lead to environmentally sound solutions that respect traditional wisdom⁴⁰. Thus, a scientific validation was carried out by expert opinion. Those experts belong to the agriculture, horticulture, and food industries.

$$\text{Validation Index (\%)} = (\text{Mean Score} \div 5) \times 100$$

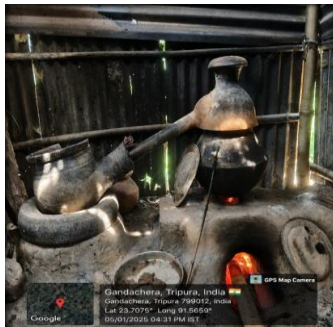
For the collection of data for validation purposes, a Google Form was designed with a 5-point Likert-style response continuum ranging from Strongly Agree-5, Agree-4, Neutral-3, Disagree-2, and Strongly Disagree-1.

Results and Discussion

This section presents the qualitative analysis of the documented Indigenous food processing practices to develop the theory from the generated codes in the transcripts.

Grounded Theory Generation

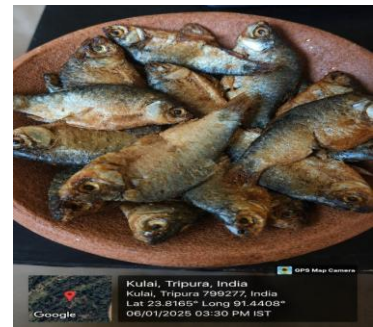
The eight Indigenous food processing practices were local wine, rice beer, fermented fish making, bamboo tube cooking, smoking food over firewood, sun drying of bamboo shoots, boiling of meat, and leaf-based wrapping and processing (Fig. 4) were documented during collection of data. The generated codes from each Indigenous practice are in Fig. 5, and formulated categories are developed based on generated codes (Fig. 6).



Wine preparation technique



Rice beer



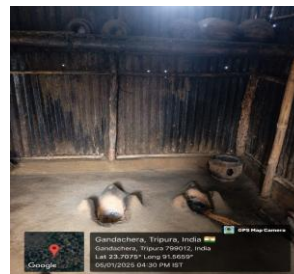
Fermented fish



Fermented fish



Bamboo tube cooking



Smoking over firewood



Leaf based wrapping

Fig.4: Different processing techniques and products

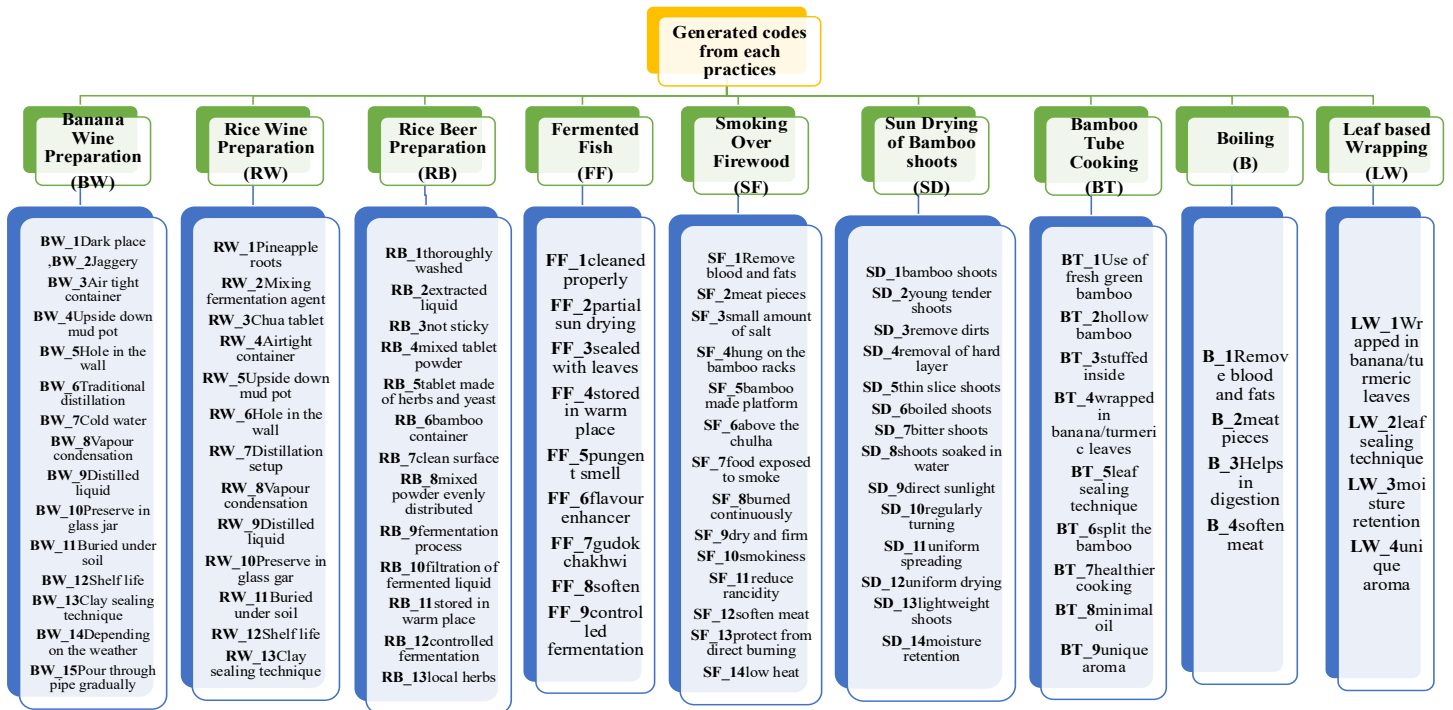


Fig.5: Generated codes from Indigenous processing practices

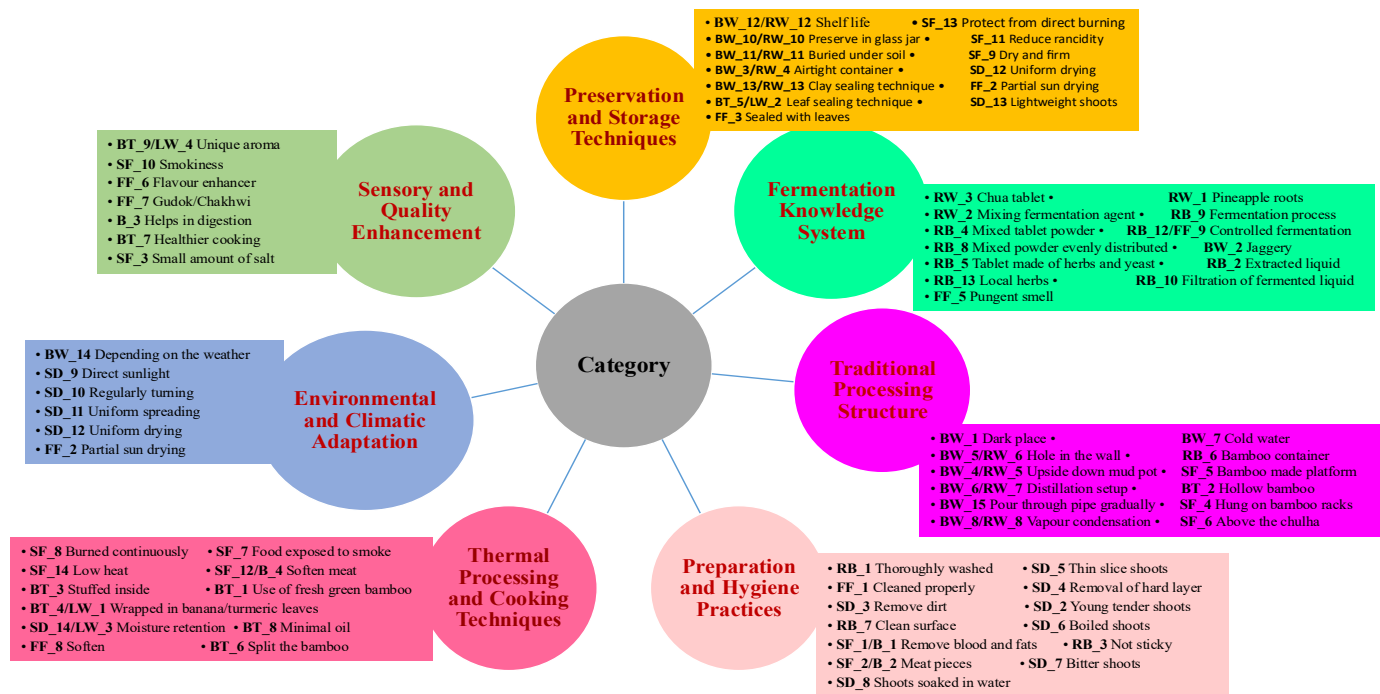


Fig:6 Categories developed from generated codes (BW: Banana Wine; RW: Rice Wine; RB: Rice Beer; FF: Fermented Fish; SF: Smoking over Firewood; SD: Sun Drying; BT: Bamboo Tube cooking; B: Boiling; LW: Leaf based Wrapping)

Seven categories were developed based on generated codes, which is essential for creating a coherent theoretical framework that emerges directly from empirical data. This process allows researchers to identify patterns and relationships within the data, facilitating a deeper understanding of the phenomena under study⁴³. These categories are subjective in nature. Indigenous foods are often rich in flavour and nutrition, with traditional methods like fermentation enhancing their sensory qualities and health benefits^{7,44}. So, the Sensory and Quality Enhancement category is suitable for developing theory. Even Traditional storage methods, including the use of bamboo vessels and clay pots, are integral to maintaining food quality without modern refrigeration^{44,45}. and encourage the category of Storage Techniques. Fermentation is a critical aspect of Indigenous food systems, providing not only processing practices but also health benefits, such as improved gut health⁴⁴, and is also linked to cultural identity and community rituals, reinforcing social bonds⁴⁴, leading to the Fermentation Knowledge System and Processing Structure category. Indigenous communities have developed unique hygiene practices that align

with their ecological knowledge, ensuring food safety and contaminant management⁴⁵. However, challenges remain in maintaining these practices amidst modern influences and urbanization⁸. This also leads to the category of Preparation and Hygiene Practices. Traditional cooking methods, such as slow cooking and steaming, are designed to maximize flavour and nutritional retention¹ and are often adapted to local ingredients and seasonal availability, showcasing environmental adaptability⁷. Indigenous food processing practices are increasingly recognized for their resilience to climate change, utilizing local crops that are well-suited to specific environments⁸. This leads to Thermal Processing, Cooking Techniques, and the Environmental and Climate Adaptation category.

Based on these categories, a core concept has been developed: “Indigenous food processing and preservation system for enhancing shelf life, safety, and sensory quality”. Indigenous methods, such as drying and fermentation, have been used for generations to preserve food and enhance its nutritional value. These techniques are often cost-effective and culturally significant, providing a sustainable means of food preservation⁴⁶. Implementing these integrated approaches can empower local communities, particularly women and smallholder farmers, by enhancing their livelihoods and food security⁸.

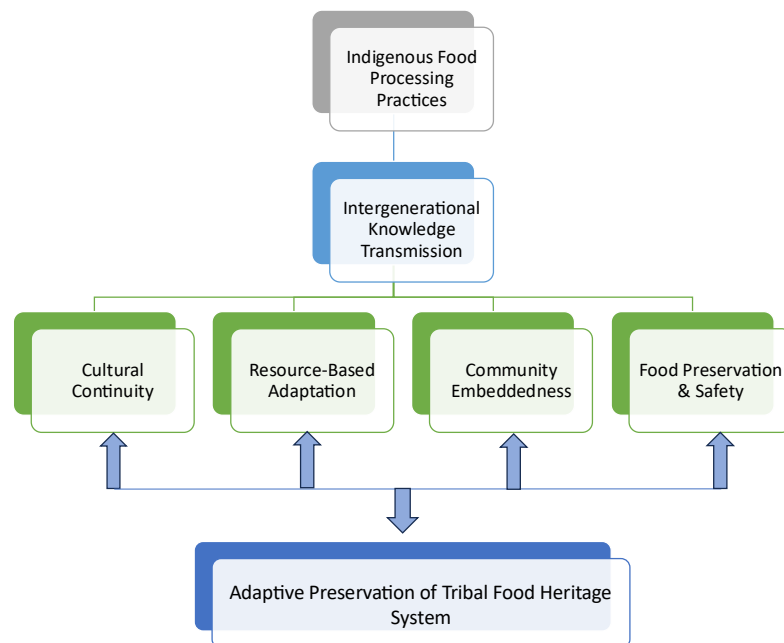


Fig.7 Conceptual Model of Emergent Theory

The generated theory from all these open coding, axial coding, and selective coding is “**Indigenous Knowledge-Based Adaptive Food Processing and Preservation Theory.**” As it explains, time-tested and time-trusted food processing methods/techniques are enriched by means of sensory indicators combined alongside nutritional security, remain compatible with digestive ability, and warrant prolonged shelf life of food. These processing methods utilize salt and beneficial microorganisms to inhibit spoilage and enhance flavour. Drying and Smoking techniques reduce moisture content, preventing microbial growth while preserving taste and texture. Canning and Pickling methods involve sealing food in jars and using acidic solutions to extend shelf life and maintain nutritional value⁴⁷. For maintaining Nutritional Integrity, these methods focus on preserving vitamins and minerals, ensuring that food remains nutritious over time⁴⁸. For Sensory Quality enhancing, these techniques are designed to retain flavour, texture, and aroma, which are crucial for consumer acceptance⁴⁹. While traditional methods have proven effective, the integration of modern technologies presents challenges, such as cost and scalability. However, these advancements are essential for meeting the growing demand for safe, nutritious, and high-quality food sustainably⁴⁸. Grounded theory employs the constant comparative method, which involves continuously comparing data segments to identify patterns and themes⁵⁰. Conceptual modeling (Fig.7) serves as a toolbox for grounded theorists, aiding in the specification of concepts and their relationships⁵¹. The conceptual model (Fig. 7) of Indigenous food processing practices emphasizes the importance of intergenerational knowledge transmission, which is crucial for preserving and adapting traditional techniques. The emergence of an Adaptive Preservation of Tribal Food Heritage System is crucial for Indigenous communities as it intertwines cultural continuity, resource efficiency, community participation, and food safety. This system enables these communities to sustain their food traditions while adapting to environmental and social changes.

Sentiment Analysis

The sentiment analysis results of focus group discussion transcripts have been shown in the radar chart (Fig.8). The analysis classified statements into three sentiment categories: Positive, Neutral, and Negative.

Table 2: Overall Sentiment Distribution

Sentiment Category	Frequency (Gr)	Percentage
Negative	98	19.03%
Neutral	293	56.89%
Positive	124	24.08%
Total	515	100

This Table 2 indicates that respondents primarily provided descriptive and factual information regarding Indigenous food processing practices, resulting in a predominance of neutral sentiments. Positive sentiments were more frequent than negative sentiments, suggesting a generally favorable perception of these traditional practices. From the transcripts, *“After fermentation, it develops a rotten smell and is then mixed properly”* consider as Negative sentiment, as developing a rotten smell consider as unpleasant situation. For Neutral sentiment, some respondents quoted *“All ingredients are mixed and stored in a dark airtight container for 4 to 5 days”*; it is considered Neutral, as the statement shows factual data only without showing any type of emotion. Another quoted, *“The bamboo gives a smoky aroma, and the food is served by splitting the tube. It requires minimal oil and is considered healthy,”* is considered Positive sentiment, which shows the healthy methods of processing techniques, adding the favorable emotion towards it.

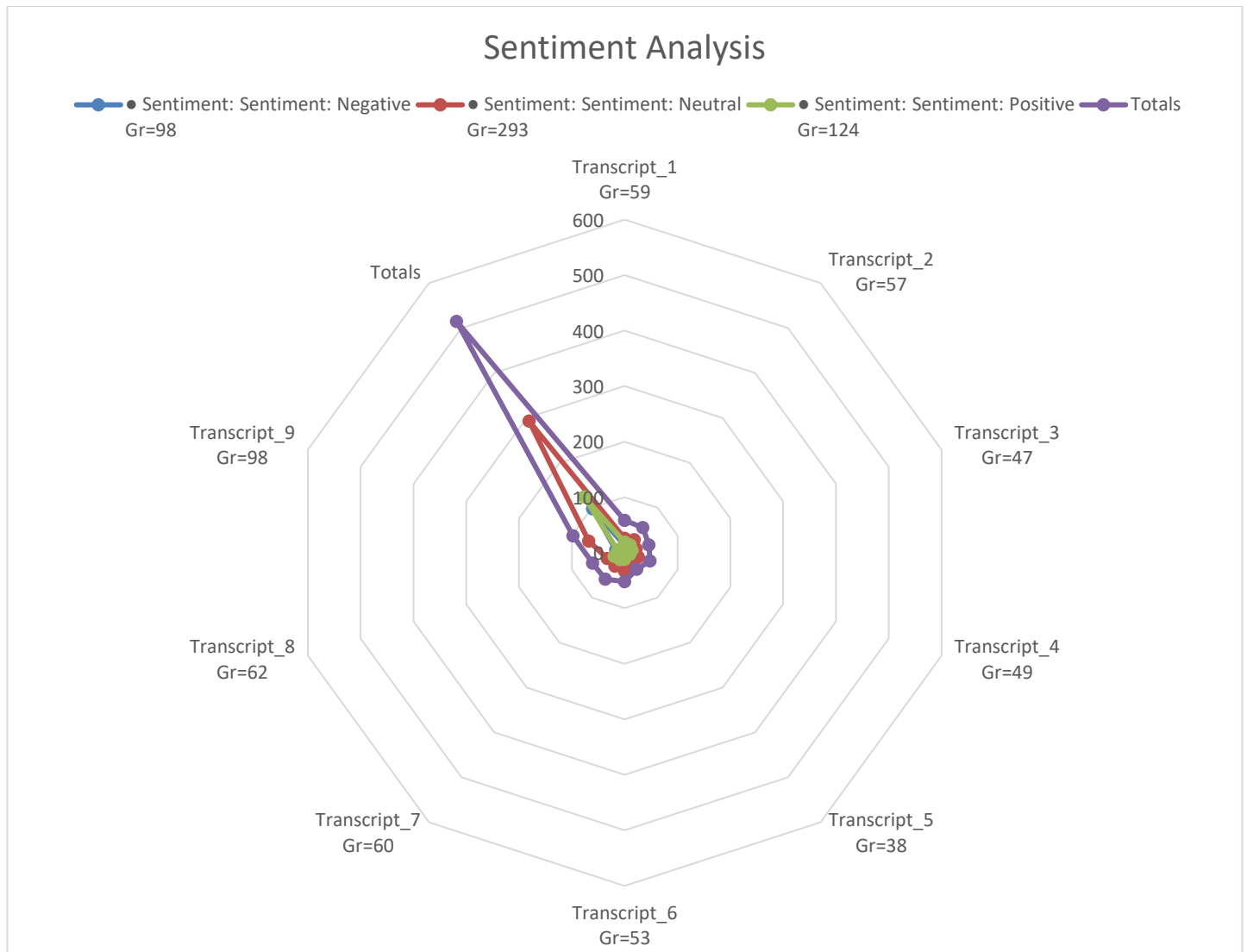


Fig.8: Radar Chart representing sentiment analysis

From Fig.8, it is clearly evident that in Transcript 1, the Groundedness (Gr) is 59, indicating that the sentiments generated by the codes are 59. These transcripts reflected a description of processing practices with a predominantly neutral sentiment. Transcript 2 shows a Gr of 57, where most are neutral with a few positive sentiments, which represent the usefulness and effectiveness of the processing techniques. Similarly, Transcripts 3 and 4, having a Gr of 47 and 49, emphasize the information regarding taste, health benefits, and cultural importance. Transcript 5, having the lowest Gr of 38, also has a moderate proportion of neutral sentiments. Transcript 6, with 53Gr, highlighted the traditional processing practices and their practical application, with positive sentiments reflecting appreciation for the sustainability of the practices. Transcript 7 and 8, which

show Gr of 60 and 62, emphasize the significance of these practices in daily life and festivals. Positive sentiments increased due to their pride in maintaining their cultures. Transcript 9, having the highest number of coded segments of 98, shows that extensive sharing of factual data regarding their experience and knowledge regarding food processing practices is implemented, which reflects the strong cultural connections to tradition. The study on the Xerente people illustrates how emotions such as solidarity and respect are integral to community cohesion and cultural identity. These emotions are strategically used in rituals and intergenerational practices, reinforcing social bonds and cultural sustainability⁵². Even in Brazil, sentiment analysis of Indigenous letters reveals coherent patterns between themes and emotions, suggesting the potential for culturally sensitive narrative verification solutions⁵³. It employed computational methods to detect emotional polarity and key themes, revealing coherent patterns between topics and sentiments. The results indicated that Indigenous communities express strong emotional ties to their Indigenous food processing practices, viewing it as essential for cultural identity and livelihood. The sentiment analysis of comments on the Canadian Indigenous water crisis highlights negative stereotypes and blame directed at Indigenous communities, reflecting broader socio-political biases⁵⁴.

Validation of the Techniques

To validate documented Indigenous food processing practices followed by tribal communities based on expert perception using selected criteria, 26 experts have been taken as respondents. The 5-point Likert scale was used for the validation purpose.

Table 3: Validation Index of the processing practices

Criteria/ Techniques	Desi Wine		Rice Beer		Fermented Fish		Bamboo tube Cooking		Smoking Over Firewood		Sun Drying		Boiling		Leaf-based Wrapping	
	CR	VI (%)	CR	VI (%)	CR	VI (%)	CR	VI (%)	CR	VI (%)	CR	VI (%)	CR	VI (%)	CR	VI (%)
Efficacy	4.42	88.46	4.31	86.15	4.31	86.15	4.54	90.77	4.27	85.38	4.54	90.77	4.35	86.92	4.49	89.74
Cost Effectiveness	4.44	88.85	4.44	88.85	4.29	85.77	4.77	95.38	4.31	86.15	4.12	82.31	4.42	88.46	4.31	86.15
Availability	4.62	92.31	4.5	90	4.46	89.23	4.56	91.15	4.5	90	4.52	90.38	4.46	89.23	4.56	91.15
Complexity	4.25	85	4.42	88.46	4.31	86.15	4.4	88.08	4.33	86.67	4.37	87.31	4.37	87.31	4.27	85.38
Cultural Appropriateness	4.52	90.38	4.63	92.69	4.51	90.19	4.54	90.77	4.58	91.54	4.51	90.15	4.44	88.77	4.39	87.85
Environmental Soundness	4.56	91.28	4.62	92.31	4.56	91.28	4.58	91.54	4.4	88.08	4.48	89.62	4.23	84.62	4.52	90.38

*CR= Criteria Mean, VI= Validation Index (%)

The consistently high mean scores (above 4.30) and Validation Index values (above 87 per cent) across all practices indicate that the Indigenous food processing techniques documented among the selected tribes of Tripura are scientifically credible, culturally appropriate, economically feasible, and environmentally sustainable. These findings support the preservation, promotion, and wider recognition of Indigenous food processing knowledge as a valuable community resource and a potential contributor to sustainable food systems and cultural heritage conservation. Indigenous food processing methods, such as the preparation of fermented and dried bamboo shoots, have been validated for their nutritional and medicinal benefits²⁶. Research supports the efficacy of these techniques, showcasing their role in addressing health issues and enhancing food security⁴¹. The Indigenous food processing practices are deeply rooted in the socio-cultural fabric of the tribes, reflecting their ecological knowledge and spiritual beliefs²⁶. Traditional foods serve as a means of cultural expression and community identity, reinforcing social bonds among the tribes⁶. Indigenous foods like Blume, derived from *Amorphophallus bulbifer* (locally known as batema), have high market potential, suggesting that traditional practices can be economically viable¹⁷. The local demand for these products indicates a sustainable livelihood opportunity for the communities involved¹⁷. The use of traditional techniques minimizes reliance on synthetic inputs, promoting environmentally friendly practices that align with sustainable agriculture⁴¹. These methods foster biodiversity and ecological balance, essential for long-term food security⁴¹. While the findings highlight the benefits of Indigenous food processing, it is essential to consider the challenges of commercialization and the potential loss of traditional knowledge in the face of modernization. Balancing processing with innovation will be crucial for the future of these practices. The widespread perception of Indigenous food processing practices among the community is moderately effective, with some practices outperforming in specific contexts⁵⁵. These practices are typically simple and easily accessible, making them suitable for communities with limited resources³⁹. The complexity of indigenous food processing practices is low, allowing users to implement these practices without extensive training,⁴¹ as these Indigenous food processing practices are also deeply rooted in local culture, enhancing their acceptance among communities⁵⁵. Thus, the validated Indigenous food processing practices of Tripura's tribes utilize unique methods of food preservation and are backed by scientifically sound and food safety, with inclusive growth and resilience against climate change

Conclusion

The preservation of Indigenous food processing practices is crucial for maintaining cultural identity and food sovereignty. Grounded theory analysis reveals that these practices are not only about sustenance but also embody traditions, rituals, and community cohesion. The integration of traditional and modern processing methods can enhance the nutritional quality and accessibility of Indigenous foods, ensuring their survival in contemporary food systems. The eight documented practices demonstrate the diverse applications of local resources and knowledge. The concept emphasizes the significance of traditional methods like drying and fermentation in enhancing food safety, shelf life, and sensory quality. The data are mostly factual, with neutral sentiments prominent largely due to having a high validated index showing wider recognition of the Indigenous practices. While the integration of modern technologies presents opportunities for enhancing Indigenous food systems, it is essential to balance these with the preservation of traditional practices to maintain cultural integrity and community health.

Funding

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Declarations

Ethics approval and consent to participate

This study was conducted with prior approval from the Ethical Approval Committee of the Department of Agricultural Extension & Communication, Institute of Agricultural Sciences, Banaras Hindu University (Approval Reference Number Ref. Ext.Edu./2025-26/57, dt. 17.06.26). All research activities conducted for this study were in strict adherence to the relevant guidelines and regulations applicable to research involving human participants. Specifically, the research followed the principles outlined in the Declaration of Helsinki, ensuring the welfare, rights, and dignity of all human participants involved in the study.

Informed consent was obtained from all participants involved in the study before they participated in the questionnaire-based survey. Participants were informed about the purpose and nature of the study, and their participation was voluntary.

Consent for publication

Informed consent to publish identifiable images was obtained from all participants involved in the study. None of the participants were under 18 years old or a child. The participants were informed about the purpose of the images and their intended use in the manuscript, and they voluntarily provided consent for their identifiable images to be published.

Author contributions

Conceptualization, methodology, final analysis, writing, and editing were conducted by the authors.

Competing interests' policy

The authors declare no competing interests.

Data availability

The datasets used during the current study are uploaded as related files and can also be available from the corresponding author on reasonable request.

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