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Ethnogastronomic Insights into Indigenous Deep-fried Snack Foods of Northeast India: A Review of Traditional Knowledge Systems and Processing Practices

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Authors' contributions

This work was carried out in collaboration among all authors. Author Apeksha conceptualized the study, performed the methodology, did data visualization, investigation, wrote and prepared the original draft of the manuscript. Author DDB searched for resources, wrote, reviewed and edited the manuscript. Author SJ conceptualized the study, helped in project administration, supervised the work, wrote, reviewed and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Background: Traditional foods are integral to cultural identity and heritage, offering insights into regional diversity and culinary practices. In North East India, the rich tapestry of indigenous snacks reflects the region's unique geographical and climatic conditions. These snacks, primarily cereal-

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based and often deep-fried, include items like Sel roti, Zhero (Sikkim), Pukhein (Meghalaya), Khapse (Arunachal Pradesh), and Kakching Bora (Manipur). Steamed varieties such as pithas and pusyep are also prevalent. Despite their cultural significance, traditional production methods for these snacks are time-consuming, labor-intensive, and result in product non-uniformity.

Objective: This study aims to explore and document indigenous knowledge related to the traditional processes of snack production in North East India. It seeks to identify gaps in standardization and propose modern technological interventions to enhance production efficiency, product consistency, and shelf life.

Methods: A comprehensive review of existing literature was conducted to understand traditional snack preparation methods. Field visits were undertaken to engage with local producers and gather firsthand insights into raw material selection, processing techniques, and packaging practices. Additionally, consultations with food technologists were held to assess the feasibility of integrating contemporary technologies into traditional practices.

Results: The study identified several challenges in traditional snack production, including variability in taste and texture, inconsistent product sizes, and limited shelf life. However, it also highlighted the potential for improvement through the adoption of modern technologies such as standardized cooking equipment, automated frying processes, and advanced packaging materials.

Conclusions: Integrating contemporary food processing technologies with traditional methods can significantly enhance the quality, consistency, and shelf life of indigenous snacks from North East India. This fusion not only preserves cultural heritage but also opens avenues for commercial viability and broader market reach. Further research and development are recommended to tailor technological solutions that align with local practices and resources.

Keywords: Local snacks; north east; ethnic foods; traditional; deep-fried.

1. INTRODUCTION

India is a country embracing various cultures, languages, climates, religions and communities. India's diverse climate, ethnicity, and religion impact food production and consumption across the country. By virtue of such diversity, India is blessed with many cuisines employing a variety of ingredients and preparation methods. The eating patterns of people living in various parts of the country are very diverse, especially in the hilly regions where people have established indigenous methods of preparing fermented foods and beverages based on conveniently available local raw materials (Pohsnem et al., 2023). Every state has its own special food which is consumed in a particular season and occasion. North-East India, also called the “Land of Seven Sisters”, represents both a geographic and political administrative division of the country. The North-Eastern region (NER) comprises of eight States viz. Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. In comparison to other parts of the nation, NER is a region rich in biodiversity, home to a variety of indigenous species. NER makes up 5000 of the nation's 17,000 flowering plant species (Dikshit & Dikshit, 2013). North-East India is home to 3.8% of the national population and occupies about 8% of India’s total geographical area. Indigenous food has always been a diverse component of North Eastern culture. These eating habits are influenced by socio-economic level, religious significance, and cultural customs. It is widely accepted that these foods and drinks belong to hill communities since they feature essential components such as an exquisite texture, ethnic flavour, and nutritional content.

In every nation or community, Local traditional foods (LTFs) are those that have a long history of preparation and consumption and are consumed by the locals as part of their purpose-oriented (occasional, ritual, medicinal, or refreshment) diet (Batu, 2018; Bhuiyan et al., 2022). McWilliams (2022) defined traditional food as “a coherent tradition of food preparation that rises from the daily lives and kitchens of a people over an extended period in a specific region of a country, or a specific country, and which, when localized, has notable distinctions from the cuisine of the country as a whole. The methods of preparing traditional cuisines are part of a country's culture and folklore. Traditional foods have been disappearing in recent years as a result of changing lifestyles and consumption patterns (Basak *et. al.*, 2023). The market for industrially processed foods is growing at an exponential rate, endangering the availability of traditional foods that are chosen by certain demographics. Food product development is always being

driven by consumer preferences both in local and foreign market (Byakika et al., 2019; Lücke and Zangerl, 2014; Panagou et al., 2013) In light of this, documentation and the generational flow of information are essential to the sustainable use and preservation of traditional foods.

North-East Indian cuisine is a unique blend of foods with regional distinctions and international influences. With its cultural and traditional variants, the NER of India is renowned for its diverse culinary offerings, which include both vegetarian and non-vegetarian options. North-East India's several states each have their distinct cuisine culture. Some of these ethnic dishes include *Pitha*s of Assam, *Apong*: a refreshing drink of Arunachal Pradesh, *Kabok* and *Iromba* of Manipur, *Jadoh* and *Pukhlein* of Meghalaya, *sel roti*, *Zhero* and *Chang* of Sikkim etc. (Kala, 2021). The processing and preparation of various ethnic foods not only demonstrate the creativity and treasure of food heritage of localized people but also their incremental learning to sustain the life and ecosystem as a whole (Singh et al*.,* 2007). The Indian food industry is trying to manufacture many traditional snack foods while solving issues in machinery design, process development, raw material selection, end product packaging, and preservation for shelf-life extension. Batch production often results in a non-uniform quality of the product. Keeping in mind the significance, the work will be able to help and provide all the basic information in the proper assessment for further research on scientific basis acquires from local people. In the past two-decade people across the world are attracted towards snacks. Snacking can be described as the problem-free consumption of easy-to-handle, miniature-portioned, hot or cold products in solid or liquid form which need little or no preparation and are intended to satisfy the occasional pangs of hunger. Thus, snacks should be in convenient manageable portions satisfying short term hunger. Indian traditional snack has both nutritional and commercial values. For producing this kind of traditional snack at mass level, there is a need of implementation of current technology and research (Kumar et al., 2017). By producing such traditional snack at higher level will help in the growth of Indian economy. There is a huge scope for innovation in the development of machine which can produces these items in managing hunger and nutrition. (Anadani et al*.,* 2020**)**. In view of the above importance, the present study attempts to record all the information collected from the culture and knowledge of the several ethnic people and create a scientific systematic document on existing production process, quality and overall knowledge of snacks connected to ethnic/religious beliefs of North-Eastern India as there is a threat to this knowledge with the change of life style of the community and the emergence of various fast foods.

2. GEOGRAPHICAL AND CLIMATIC PERSPECTIVE

Northeastern area of India is incredibly distinctive in its geographic location, biodiversity, abundance of natural resources, multi-cultural tribal and non-tribal groups, and customs around the world. NER is connected to other Indian states by Siliguri (North Bengal), often known as the “Chicken neck”, and shares 90% of its border with India's international borders with Bhutan, China, Bangladesh, and Myanmar. Therefore, people's eating habits and culture are influenced by the nations that surround them (Haokip, 2024; Das et al., 2016; Basumatary et al., 2023). Due to a lack of information about food safety and cleanliness in the communities, the majority of these meals may become contaminated during preparation. The safety of traditional foods, which are local specialties and are therefore in continual demand in various Northeast Indian regions, must therefore be established. These meals are made at home and sometimes sold in small amounts at local markets because they are not commercially available. As a result, collecting and assessing these foods is difficult (Keisam et al., 2019). With its cultural and traditional variants, the Northeastern region of India is renowned for its diverse culinary offerings, which include both vegetarian and non-vegetarian options. The tribal groups have preserved the art of food preparation, which has been practiced by individual families and sustained from generation to generation. Northeastern traditional food products are primarily limited to local regions and the surrounding areas, despite being regarded as delicious and healthful. The rest of India knows very little, if anything, about Northeastern cuisine. North East India offers over a hundred traditional cuisines, but just a few of the most promising and well-liked ones are emphasized. In order to promote the items and raise awareness of these well-liked traditional dishes, documentation is needed (Kadirvel et al., 2021). With an elevation of over 1200 meters, 28.3% of the entire NER geographical area is at a high height; 17.9% of

the region is between 300 and 600 meters. 10.8% of them are situated between 300 and 600 meters above sea level. The ethnic diversity of North-East India is diverse, ranging from the Mongoloids, which included Indo-Aryans, Austric or Australoids, and the Dravidians, including a small population of immigrants. Besides, they have a tribal and non-tribal group that mainly lives in the hills of Arunachal Pradesh, Nagaland, Mizoram, and Manipur, as well as along Myanmar's borders, including Meghalaya. The non-tribal community is usually found in Assam, Tripura, and Manipur. It has been observed that people from North-East India mostly rely on cereal, particularly rice, and that a wide range of cereal-based snacks are made for occasions like weddings and festivals (Deka & Sit, 2022).

3. CLASSIFICATION OF SNACK FOODS

Snack foods can be categorized based on their components, the technology or processing they go through, their kind of consumption (e.g., RTE or RTP), or even their origin (or the region of popularity). In addition, there are several traditional dishes in various regions of the world (Bhattacharya, 2022). According to Bawa & Sidhu (2003), snack products can be classified into various categories viz., warm snacks, cold snacks, milk and dairy products, bakery bars, savoury snacks, confections, extruded goods, and snacks made with nuts, meat, and legumes. A variety of snacks are available throughout India. Indigenous snacks of India are mostly steamed (*momo*, *pittha*) or deep fried (*Gaja*, *Khaja*, *murukku* etc.). Indigenous deep-fried snacks are integral to the culinary heritage of Northeast India, often prepared during festivals and community gatherings. These snacks are typically made from locally sourced grains and are deep-fried, contributing to their extended shelf life. However, despite their cultural significance, there is a notable lack of standardized production processes and scientific documentation regarding these traditional foods. Additionally, the growing consumer preference for ethnic flavours presents an opportunity to commercialize these traditional snacks. Standardizing production processes and ensuring food safety can enhance the quality and marketability of these indigenous foods. Therefore, this study aims to address the gaps in standardization and documentation of indigenous deep-fried snacks in Northeast India, ensuring their preservation, safety, and potential for wider recognition.

4. METHODOLOGY

The study was conducted in College of Agricultural Engineering and Post Harvest Technology (CAEPHT), Ranipool, Sikkim where students from universities (ages 18 to 23) who come from all around the north-eastern states were selected. Also, the local people, including farmers, street vendors, college employees, and store owners were included as they are more cognizant of the regional cuisine culture and history. This investigation consisted of open-ended questions through an internet survey and an in-person interview. Data from several databases and search engines, such as ScienceDirect, Web of Science, Wiley Online Library, Springer, and Google Scholar, were thoroughly evaluated and synthesized for this review.

5. DEEP FRIED ETHNIC SNACKS OF NORTH-EAST INDIA

Deep-fried snacks have gained a lot of popularity and are widely enjoyed. Deep-frying technique has been used for generations and are widely consumed in home kitchens, restaurants, and the catering business. The flavour, affordability, and ease of preparation of deep-fried dishes are the main factors contributing to their popularity (Chang et al., 2020). Due to their unique sensory qualities, it is favoured by a range of age groups. In the culinary services and food processing industries, frying is a particularly popular technique worldwide (Devi et al., 2021). Deep fried food is produced by immersing it in hot, high-temperature oil or fat and doesn't utilize any water. The thickness and type of food being cooked determine the ideal frying temperature, which normally ranges between 160-190 °C (Shabbir et al., 2015; Wang et al., 2019). Fried foods/snacks can be sweet or savoury in taste and of different shapes. Food moisture is removed as steam during the frying process as a result of heat from the oil or other energy sources being absorbed. As a result, the food's weight, volume, and moisture content all noticeably drop (Zhang et al., 2020). Protein denaturation, the Maillard reaction, hydrolysis, sugar dehydration, polymerization, lipid oxidation, and starch gelatinization are just a few of the many chemical events that take place during deep-fat frying. The development of aroma, distinct texture, and deepening of food colour are all influenced by these responses. The Maillard reaction and lipid oxidation are two of these processes that are very important in determining the final flavour

profile (Kalogeropoulos et al., 2007). A series of physical and chemical changes occur throughout the frying process, including the development of a crispy crust on the fried surface, protein denaturation, water evaporation, and starch gelatinization. Furthermore, frying can efficiently eliminate bacteria, deactivate enzymes, and reduce food products' water activity (Hosseini et al., 2016). The safety and preservation of fried meals are enhanced by these effects (Karimi et al., 2017). Deep-frying is a quick cooking technique that improves certain foods' flavour and texture. The method gives the food a desired texture and a delightful crispiness, which makes it a popular option for cooking several foods (Shabbir et al., 2015). Some of the examples of North-east deep-fried snacks are discussed below (Table 1).

5.1 Khapse

Khapse is a sweet fried biscuit from Arunachal Pradesh and Sikkim that is commonly prepared during the Losar and Losoong/Namsoong festival by the Moonpa tribe (Arunachal Pradesh) and Lepcha/ Bhutia tribes of Sikkim. The process flow chart for making *Khapse* is shown in Fig. 1. The ingredients include maida, sugar, oil, and a pinch of salt. All the ingredients are mixed well to form a batter and allowed to rest for a while. Dough is shaped into little balls and rolled to a diameter of approximately 14 inches. The dough is sliced into 1-inch-wide strips either manually or using noodle making machine. These strips are then twisted manually by hand into a variety of sizes and shapes that is deep-fried in refined oil over medium heat until it turns golden brown. The size of *khapse* varies between 6-8 cm in length and 4-6 cm in width. It is served usually at tea time. One packet of *khapse* (500 g) costs about Rs.130-150.

5.2 Ghila Pitha

Ghila pitha is sweetened rice fritters prepared during Bihu as well as consumed as evening munchies. Rice flour (ideally *bora chawl*), Semolina (sooji), jaggery (gur), refined oil for deep frying, and water are necessary for its preparation. The rice is first soaked for 2-3 hours before being drained and dried. It is then ground and sieved to obtain fine rice flour. The jaggery is then well blended with hot water in a big pan. The rice flour is slowly incorporated into the jaggery and water combination, and then semolina and additional water are added to prepare dough. The dough is kept for 15 minutes. The dough is then shaped into small balls and then flattened followed by deep frying till it turns into golden brown colour (Deka & Sit, 2022). The process flow chart for making *Ghila pitha* is shown in Fig. 2.

5.3 Tel pitha

A fried rice pitha is known as *tel pitha*. It is sometimes referred to as "*Bor pitha*" or "*Dhupa pitha*". Rice flour, refined flour, or all-purpose flour, baking powder, salt, water, and fennel seeds (optional) are needed to make *tel pitha*. Initially, the same process as previously explained in section 5.2 is used to make the rice flour. After that, water is added to the jaggery in a pan, and is heated to ensure good mixing. Then, in a separate pan, rice flour, refined flour for optimal binding, and fennel seeds for taste are carefully incorporated. The jaggery mixture is gradually added to the blend of fennel seeds, rice flour, and refined flour. They are mixed together and more water may be added if necessary to create a viscous mixture. Oil is placed in a pan and heated by placing it on a flame. One tablespoon of batter is added to the hot oil once it has heated up. The *pitha* is then fried till golden brown with intermittent switching of sides (Deka & Sit, 2022). The process flow chart for making *tel pitha* is shown in Fig. 3.

5.4 Sitao

A rice cake specialty of the Assamese Bodo ethnicity is *Sitao* (Fig. 4). Bora saul flour, sesame seeds (10–15%), sugar (6–10%), and salt (1-2%) are the primary ingredients used to make *sitao*. The sticky rice flour is combined with the freshly ground sesame seeds, sugar, and salt. After that, 60–65% water is added and kneaded until a dough forms. After shaping the dough into a smaller, flat circular cake, it is deep-fried at 60-65 ℃ for 5 minutes on each side, or until it turns brown (Basaiawmoit et al., 2023; Bora, 2020).

5.5 Kakching Bora

The Kakching area of Manipur is home to the traditional *Kakching Bora*, which is made with rice flour as the main ingredient. Rice is soaked in clean water for 1-2 hour prior to beginning the preparation process. The excess water is appropriately drained out and the soaked rice is ground using a conventional hand pounder/grinder until the required level of fineness is reached in the rice flour. After combining rice flour, soda powder, salt,

Table 1. Ethnic deep-fried snacks of North east India

Food product	Region	Major ingredient	Nature and use	Major consumers
Khapse	Arunachal Pradesh, Sikkim	Maida, sugar	Sweet**,** deep-fried, snack	*Monpa, Bhutia, Lepcha, Tamang*
Ghila pitha	Assam	Rice flour, Semolina, jaggery	Sweet, deep-fried, snack	*Assamese*
Tel pitha	Assam	Rice flour, jaggery	Sweet, deep-fried, snack	*Assamese*
Sitao	Assam	Sticky rice, sesame seeds	Sweet, deep-fried, snack	*Bodo*
Kakching bora	Manipur	Rice, chickpeas	Savoury**,** deep-fried, snack	*Meitei*
Haokhamui	Manipur	Sticky rice flour, frying oil, water, sugar	Sweet, deep-fried, snack	*Tangkhul*
Sachao	Manipur	Sticky rice flour, oil, sugar, sesame seeds	Sweet, deep-fried, snack	*Tangkhul*
Pukhlein	Meghalaya	Rice flour, refined oil, jaggery	Sweet, deep-fried, snack	*Khasi* and *Jaintia*
Pita	Meghalaya	Sticky Rice flour, plain rice flour, sugar/ jaggery, oil	Sweet, deep-fried, snack	*Garo*
Pu khadu	Meghalaya	Rice flour	Savoury**,** deep-fried, snack	*Khasi* and *Jaintia*
Punei	Meghalaya	Rice paste	Shallow fried, snack	*Jaintia*
Chhangkan	Mizoram	Rice flour, sugar	Sweet, deep-fried, snack	*Lushai*
Kithou Raokhao	Nagaland	Rice flour, sugar, mustard oil	Sweet, deep-fried, snack	*Poumai Naga*
Sel-roti	Sikkim	Rice flour, ghee and sugar	Sweet, deep-fried, snack	*Nepalese*
Zhero	Sikkim	Rice flour	Sweet, deep-fried, snack	*Bhutia, Lepcha*
Awang bleb	Tripura	Sticky rice flour, Bengal Joha rice flour, jaggery/sugar, salt, sesame seeds	Deep fried snack	*Tripuri*

Source: Modified from Dutta & Dutta (2005), Deka & Sit, (2022)

Fig. 1. Process flow chat for preparation of *Khapse*

Fig. 2. Process flow chat for preparation of *Ghila pitha*

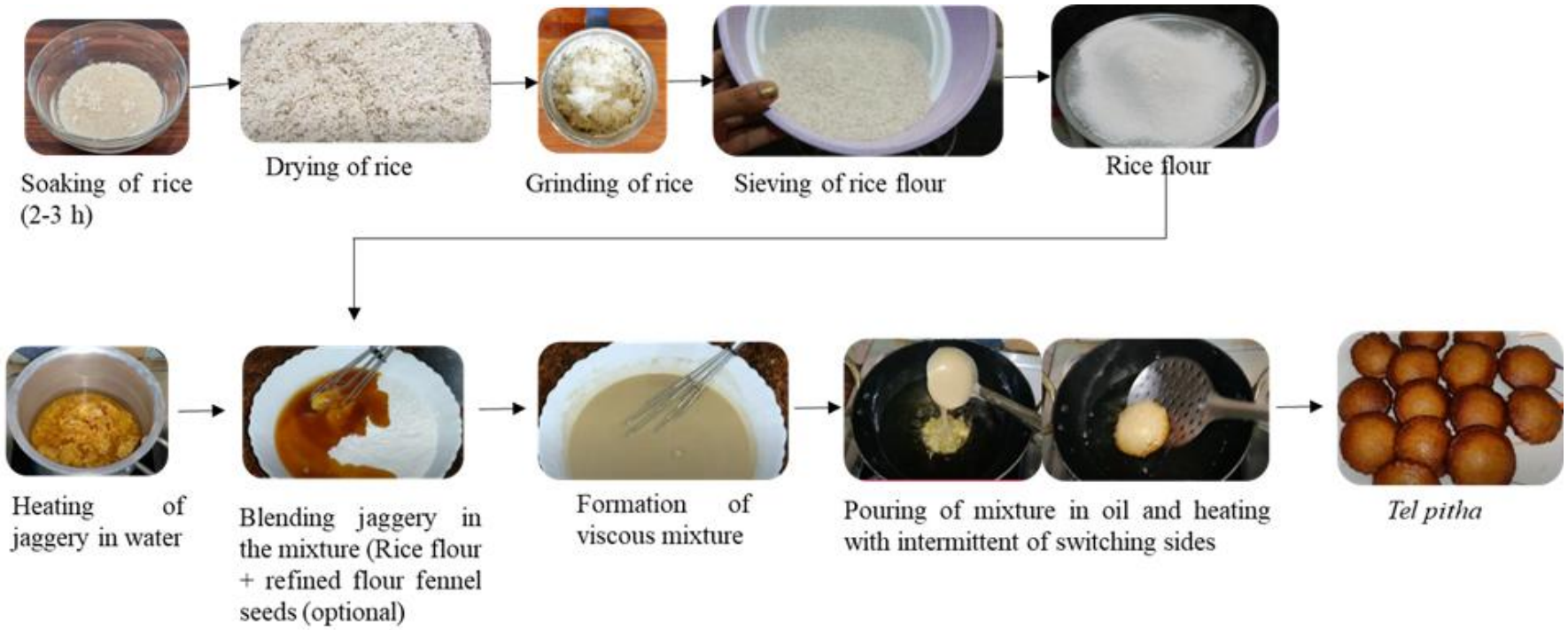

Fig. 3. Process flow chat for preparation of *tel pitha*

and water to make a dough, it is allowed to rest for an hour. Once the dough has rested, the soaked peas are combined with it. Next, it is formed into little balls and filled with one or two soaked peas. After that, the little balls are spread out in bamboo winnowing trays and let to dry in the sun. Then, it is deep-fried in hot cooking oil in a pan until it is golden brown. It can be kept for a long time in storage after being packaged in a plastic container (Raleng et al., 2021). The process flow chart for *kakching bora* is depicted in (Fig. 5). One packet contains around 60-70 pieces which is sold at Rs.100.

5.6 Hao Khamui

Hao khamui, a traditional snack is a rice cake prepared by Tangkhul tribe of Manipur. Locally, sticky rice known as "*Manui*" is used in its preparation, along with water (60%) frying oil (3–4%), and sugar (5–6%). A mixer grinder/conventional hand pounder is used to crush the rice into a fine flour after it has been soaked for 6 hour. Water is added to the rice flour as needed, and the mixture is kneaded to create dough/batter. The flavour is enhanced with sugar. A flat roti (15–20 cm in diameter) is created from the dough/batter after it has been divided into little pieces. This roti is cooked for 0.5 to 1 hour in a small amount of oil at a low temperature (40-50 °C). It is customary to serve this rice cake during Christmas and New Year's festivities (Basaiawmoit et al., 2023). The process flow chart for preparation of *Hao khamui* is depicted in (Fig. 6).

5.7 Sachao/Chakhao

The Tangkhul tribe of Manipur is mostly known for preparing *Sachao/Chakhao* (Fig. 7). Sticky rice flour, oil (10–15%), sugar (3–4%), and crushed black sesame seeds (15%) are the ingredients. The process of making *Sachao* is similar to that of making *Hao khamui* rice cake. The sticky rice is combined with powdered sesame seeds and sugar after being soaked for 6 hours, pounded into a fine flour, and formed into a dough with 60% water. After shaping the dough into a tiny rectangle, it is deep-fried for 10-15 min. *Sachao* is mostly made around the holidays and after the harvest (Basaiawmoit et al., 2023).

5.8 Pukhlein

Pukhlein is a sweet, brown and round fried rice snack native to Meghalaya, typically made from rice flour and jaggery. It has a diameter of 6-7 cm with 3-4 cm thickness. It is known as "*pukhlei*" and "*Tpuphniang"* in Khasi and Jaintia respectively. It is made by combining melted jaggery and non-sticky rice flour (2:1), cold water, and a bit of baking soda to form a batter. In a small pan, water (about 1/2 cup) is heated and then the jaggery is added. It is stirred until it melts completely and forms a syrup and then left aside to cool. The rice is soaked for approximately 6 hours (or overnight) and then ground it into a fine flour. In a large mixing bowl, rice flour and a pinch of baking soda and salt is added to balance the sweetness of jaggery. Gradually the cooled jaggery syrup is poured into the rice flour and mixed to form a batter of flowy consistency. Oil is heated in a frying pan over medium heat. Once hot, the batter is gently poured into the oil using a round serving ladle/spoon. It is fried until it turns golden brown on both sides. It is to be made sure the heat is medium so they cook through without burning.

Fig. 4. Sitao
(Source: Basaiawmoit et al., 2023)

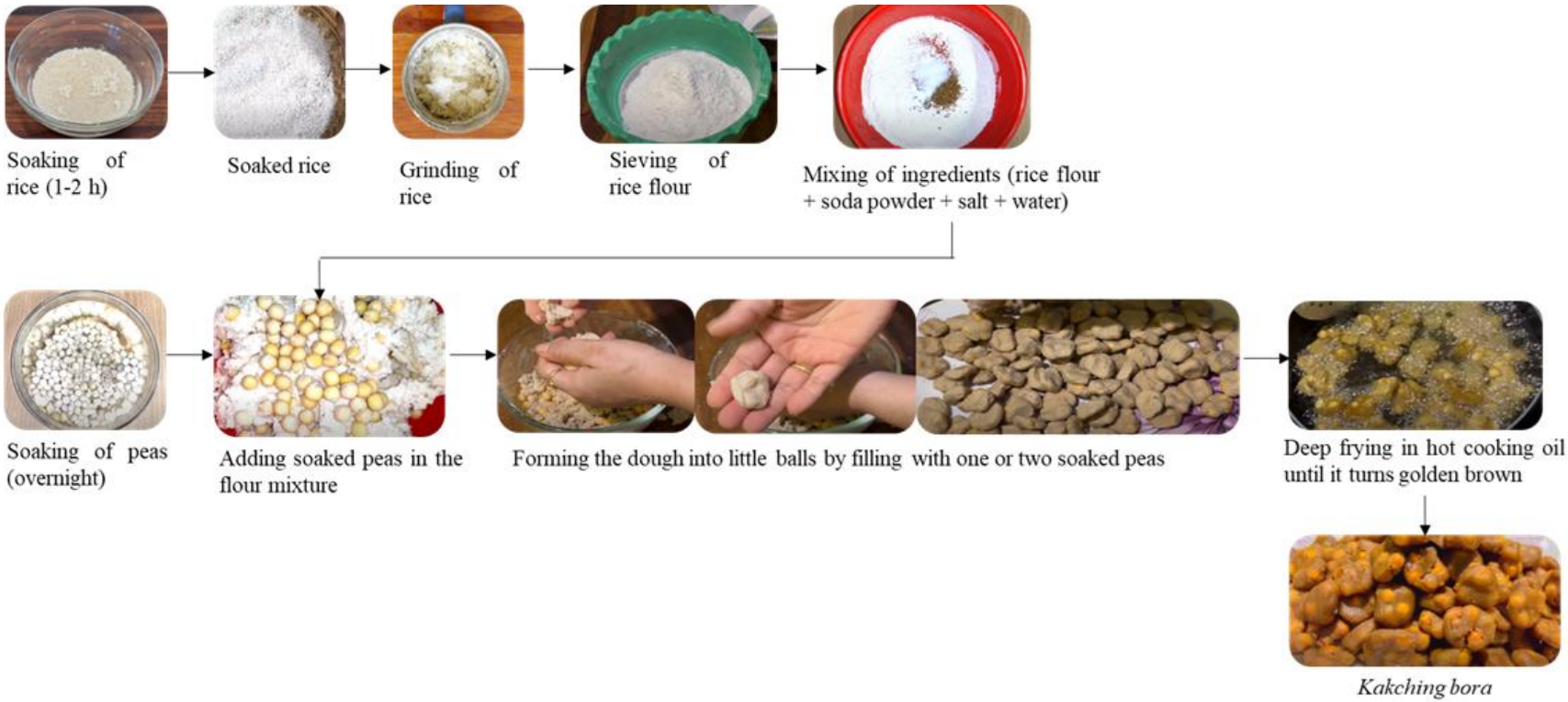

Fig. 5. Process flow chat for preparation of *Kakching bora*

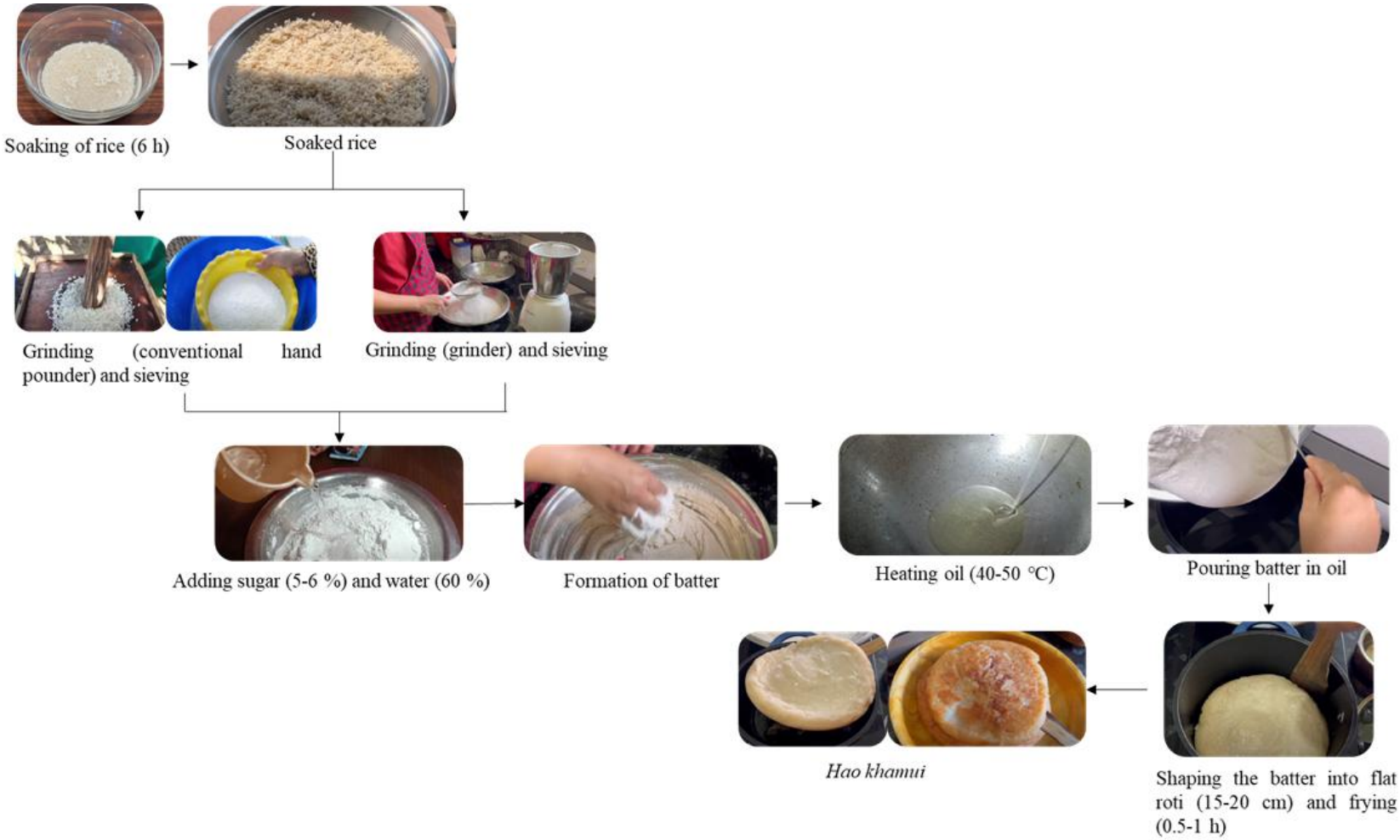

Fig. 6. Process flow chat for preparation of *Hao khamui*

Popular in all Khasi and Jaintia Hills marketplaces, this native fried food is always enjoyed with tea. Most often, it is made for festivals, weddings, and other events (Umdor et al., 2016). It is sold at Rs. 10 for four pieces in low-density polyethylene (LDPE) packets in local markets. The process flow chart for preparation of *Hao khamui* is depicted in (Fig. 8).

5.9 Pita

The Garo tribe of Meghalaya is known for preparing a local rice cake called *pita* (Fig. 9). This process uses 50% sticky rice flour and 50% plain rice flour. In the Garo language, plain rice is called "*Miari merong*", and sticky rice is called "*Minil merong*". Water (65%), sugar or jaggery (6%), and mixed rice flour are added and thoroughly mixed. Once the rice flour and sugar or jaggery have melted, the mixture is baked for around 5 minutes. After the mixture has cooled, it is manually moulded into little *pitas* and then fried for 6 minutes, or until golden brown. This rice cake is frequently offered during festivals as a tea snack (Basaiawmoit et al., 2023).

5.10 Pu khadu

Pu khadu (Fig. 10), a traditional fried rice snack of bangle-shaped is commonly prepared by the *Jaintia* tribes of Meghalaya. The method of preparation is similar to "*pukhlein*" but the rice flour used should not be too smooth as in *pukhlein* dough. For preparation, the paste/dough is rolled into bangle-shape with hand and shallow fried in refined oil. It is prepared in most festivals and occasions of the *Jaintia* (Umdor et al., 2016).

5.11 Punei

This native fried rice snack, which is highly well-liked by the Khasi and Jaintia tribes of Meghalaya, is made by blending salt and ground sesame/perilla seeds, known as "*neilieh*" (*Anisomeles indica* (L) O *Kuntze, Syn. A*. *ovata R. Br*. (Lamiaceae)) with powdered rice paste (Ahmed & Borthakur, 2005). In this preparation, non-sticky rice locally called "*khawmynri*" and sticky rice locally called "*khawpnah*" are soaked separately in water (6 hours). The water is drained and the rice is hand pounded separately with the help of wooden pestle and mortar locally called "*Synrei*" and "*thlong*" followed by sieving. The sesame/perilla seeds are roasted in a hot pan and ground into fine powder. The roasted and ground sesame/perilla seeds are added to the rice flour along with salt/sugar (as per the taste) and mixed well. Hot boiling water (40%, 80-90 ℃) is added to the flour mixture and mixed thoroughly with cold water (20%) to form a batter of thick flowy consistency. One can also add turmeric powder to the mixture if necessary. Ratio of the rice paste to *neilieh* is 8:1. The pan is heated and to it little oil is added. Once the oil is heated, the batter is poured into the pan using a serving spoon or ladle into a circular shape and covered with a lid and is let to cook in low flame. *Punei* has a diameter of 8-9 cm and 2-3 mm thickness. *Punei* (Fig. 11) is typically prepared for festivals and special occasions and eaten as a snack with tea (Bareh, 2007).

Fig. 7. Sachao (Basaiawmoit et al., 2023)

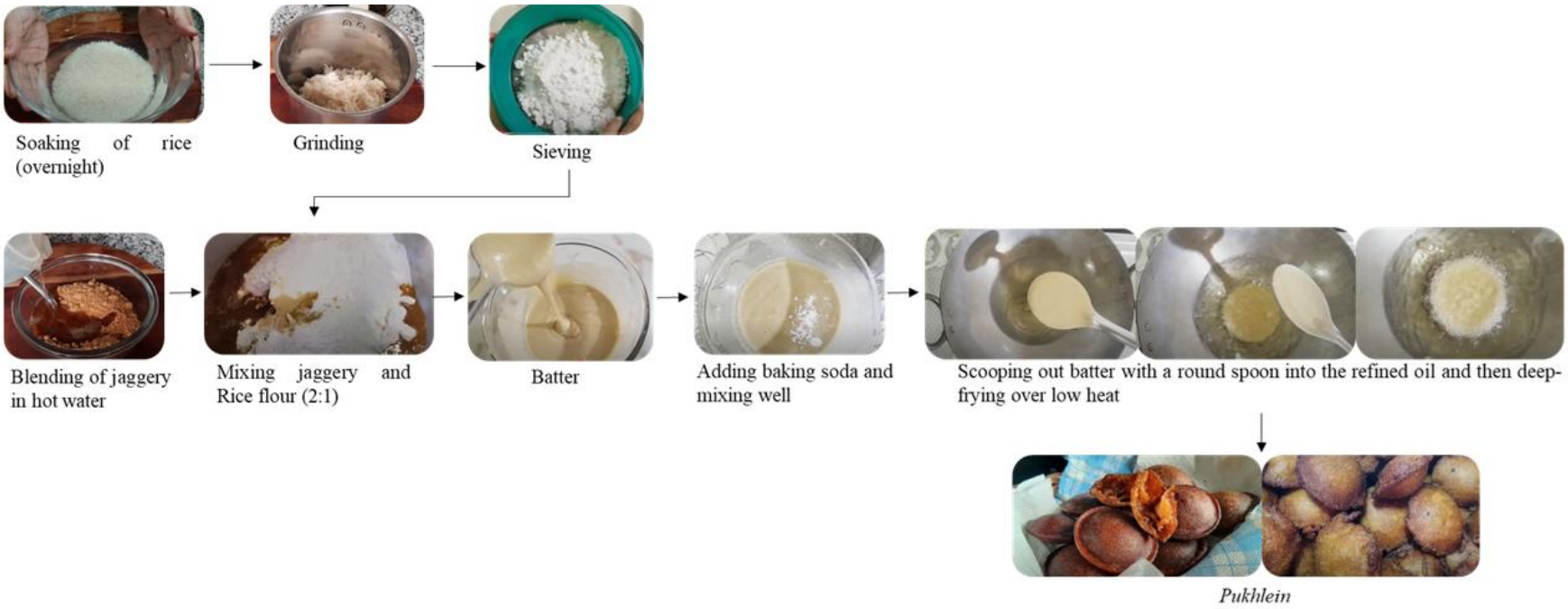

Fig. 8. Process flow chart for preparation of *Pukhlein*

Fig. 9. Pita
(Source: https://www.youtube.com/watch?v=7fNZNJqvs4o)

Fig. 10. Pu khadu
(Source: Umdor et al., 2016)

Fig. 11. Punei

5.12 Chhangkan

The Lushai people of Mizoram is known for preparing *Chhangkan,* a regional fried rice cake. After cleaning, the local rice is let to soak in water for an hour. Then, it is sun-dried for 6 hours and ground into a fine powder using a wooden mortar and pestle/grinder. The rice flour is well kneaded after being mixed with 60% water and 5% sugar. The dough is formed into a tiny, flat, round shape and cooked by shallow-frying in oil for 5 minutes on each side. It is offered with tea as a snack (Basaiawmoit et al., 2023). The process flow chart for preparation of *Chhangkan* is depicted in (Fig. 12).

5.13 Kithou Raokhao

Mainly, the Poumai Naga tribe of Nagaland prepares *Kithou Raokhao* (Fig. 13). While "*Kithou*" denotes sticky rice or glutinous rice, the local term "*Kithou raokhao*" refers to sticky rice bread or pancake. For its preparation, sticky rice is soaked in water for 2-3 hours. Then, the soaked rice is ground into rice flour using grinder. It is then blended with water (70%) and sugar (5–6%) to form a batter. The batter is then transferred to a circular skillet and cooked for 10 to 15 minutes in mustard oil or until brown colour attains on both sides over low heat (45-50 °C). The major occasions for making this rice cake are during festivals and marriage ceremonies (Basaiawmoit et al., 2023).

5.14 Sel roti

Sel roti, a ring-shaped, spongy product made of rice flour, is one of the fermented foods prepared by the people of Sikkim. Most often, this product is made for festivals and other special events. The inhabitants of Sikkim and the Darjeeling hills of India, Bhutan, and Nepal are the main consumers of them. For its preparation, locally grown rice is soaked overnight in cold water or for 4–8 h. After that, the soaked rice is spread over the *chalni* and is dried for an hour. A conventional pounder (*khal and mussal)* or a grinder is used to pound it. Using a bamboo tray/sieve, the finer and larger particles are separated. Rice flour, refined wheat, sugar, butter, and a spice blend of cardamom, cloves, coconut, nutmeg, cinnamon, and tiny cardamom are among the ingredients. Rice flour is combined with 2.5% spices, 10% butter, and 25% refined wheat flour. Occasionally, baking soda, honey, or unripe bananas can also be used. The dough is then made smoother by adding water or milk. The batter is then left to ferment for 2-3 hours in the summer at room temperature (20-28 °C) and for 6-8 hours in the winter (10-18 °C). The fermented batter is then poured into the hot edible oil using a metallic serving spoon known as a "*daaru*" or hand by forming ring shaped structures in a *Tai* (Deka & Sit, 2022) and then cooked till the reddish brownish colour is obtained on the lower side of *Sel-roti*. It is then turned upside down with the help of *Jhir* (local pointed iron stick) and further cooked till whole of the *Sel roti* turns reddish brown in colour (Dahal & Katwal, 2013). There are minor differences in the preparation procedures in Sikkim, Nepal, East Sikkim, and Darjeeling (Deka & Sit, 2022). The texture of *sel roti* is influenced by the size of rice flour particles and the quality is significantly impacted by batter ageing. The majority of local markets sell it in low-density polyethylene (LDPE) packaging, which costs between Rs. 100-Rs. 140 for 10 pieces. The production process flowchart for *sel rot*i is displayed in Fig. 14.

5.15 Zhero

Zhero is an indigenous cereal based staple food of Sikkim. It is a type of rice-based snack widely popular in *Bhutia* and *Tamang* tribes of Sikkim (Tamang & Thapa, 2014). It is mainly consumed as snacks at tea time, breakfast, festivals, marriage, rituals and special occasions. It is round shaped (15-20 cm in diameter), deep fried, crispy snack made from rice flour. It has bland taste but sometimes it may be little sweet. During processing method of preparation of *Zhero*, rice is sorted, soaked for about 4 hours at 18℃ and ground for 1 minute (20875 rpm) in grinder. During traditional method of processing *khal* and *mussal* is used for grinding soaked rice. It is further sifted with the help of sieves with the mess number 150 µm-300 µm range to obtain fine rice flour. The obtained rice flour is mixed with water for making batter with the flour to water ratio of 1.5:1. The batter is poured in hot oil (190℃) and deep fried for 2-3 minutes with the help of special type of ladle (*kuja)* for making specific pattern of *Zhero*. Some locals mix sugar, small cardamom, milk and maida for making batter followed by deep frying. The deep fried *zhero* is packed in LDPE packages and sold in local markets at the rate of 150-200 rupees @ 10-12 pieces per packet. Fig. 15 shows the pictorial process flowchart for *zhero* production.

Fig. 12. Process flow chart for preparation of *Chhangkan*

Fig. 13. Kithou Raokhao
(Source: Basaiawmoit et al., 2023)

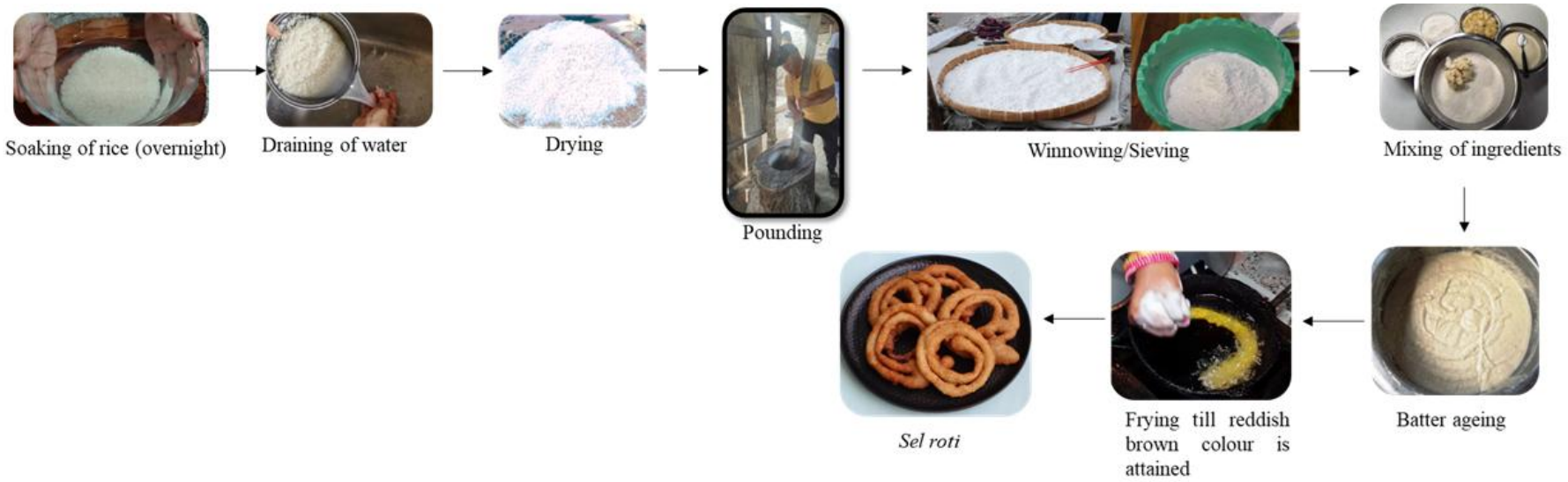

Fig. 14. Process flowchart for prepartion of *Sel roti*

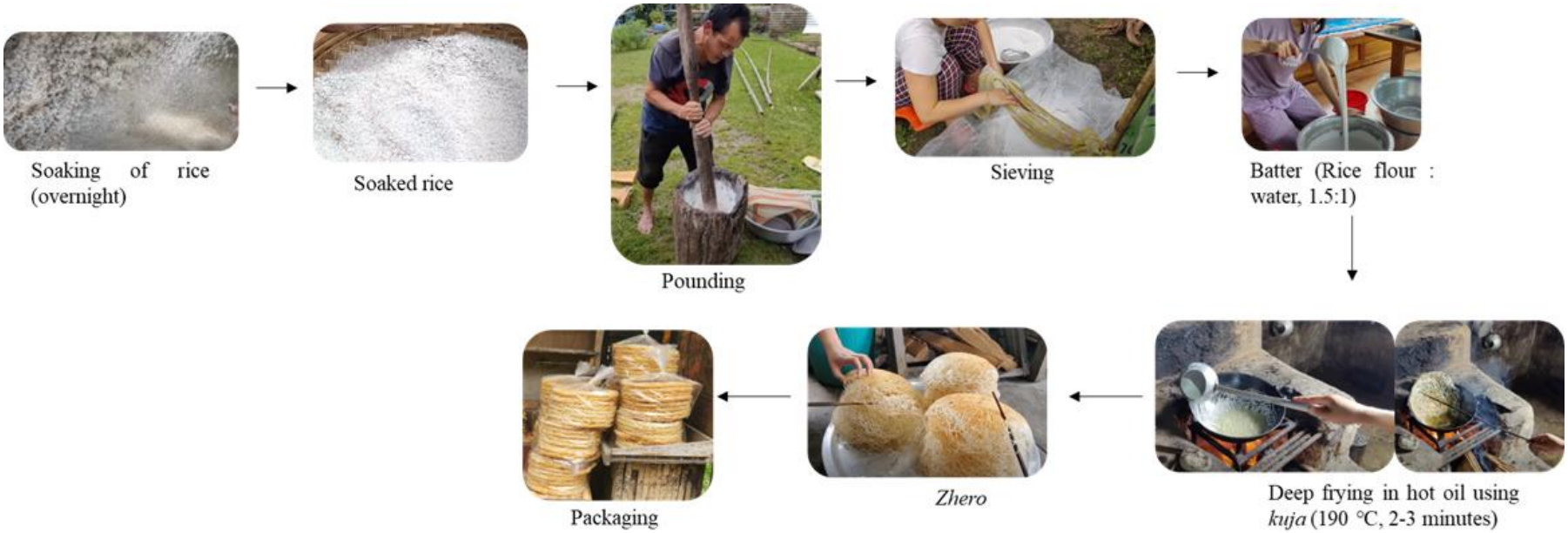

Fig. 15. Process flowchart for preparation of *zhero*

5.16 Awang bleb

The state of Tripura is home to the rice cake variant known as *Awang bleb/Awang belep* (Fig. 16). It is among the most common varieties of rice cake enjoyed at gatherings and at several celebrations. *Awaan/Awang* is a type of sticky rice. Sesame seeds (2 g), jaggery/sugar (10 g), salt (2 g), *Auwan/Gurian Maira* (375 g), and Bengal Joha (125 g) are the components of the recipe. After mixing the two types of rice, sesame seeds, sugar, salt, and melted jaggery are added. To attain a golden-brown colour, the dough is formed into different shapes as preferred and deep-fried at 80-90 ℃ for 5 minutes on each side (Basaiawmoit et al., 2023). Its ability to be made as sweet or salty as desired is what makes this *Awang* unique. It can also be made with regular rice, but using sticky rice gives it a distinct flavour, texture, and aroma.

Fig. 16. Awang bleb/ belep

6. CONCLUSION

North eastern states are rich in natural resources, varied cultures, and customs. Cereals are regarded as a staple diet by the majority of people in the northeastern Indian states and it forms the major component of almost all ethnic snacks consumed. The current study presents a compilation of various deep fried ethnic snacks of North-Eastern region of India, highlighting the ingredients, traditional process, and tools used for their preparation. Food consumption around the world is closely linked to cultures and customs since culture is recognized as a crucial determinant of life. Therefore, learning about and studying ethnic foods is a crucial area of convergence and a pressing necessity. Understanding ethnic cuisines' origins and related cultural contexts is crucial to deepening our awareness of them and promoting their acceptance on a worldwide scale. To make it more feasible and palatable, the developed knowledge must also be incorporated with scientific ideals. These snacks are produced using indigenous techniques mastered from their forebearers. These items serve as a source of income in addition to giving them nutrients and a portion of their meals and snacks. Both the labour input and the processing cost are not particularly high. However, standardization of the processing methods of these snacks is essential for improving its quality, shelf life, which in turn will lead to commercialization thereby elevating the social and economic status of the ethnic community.

7. FUTURE SCOPE/CHALLENGES

Traditional snacks can continue to be enticing and competitive in today's market with the help of innovations in healthier formulations and environmentally friendly packaging. In depth investigation on the nutritional quality of traditional snack foods might give insight into the health effects of these snacks. Low incomes are caused by the unsanitary state of the snacks and the way they are prepared. The indigenous knowledge must therefore be updated and preserved in order to commercialize these products. These traditional foods don’t have a standard packaging material due to which these snacks get spoiled easily. So, identification and selection of proper smart packaging material and techniques for these indigenous snack foods might help in setting up small or medium-sized businesses. In addition to adequate packaging, sophisticated technologies like vacuum frying can be employed for fried snacks, which might increase the value of local goods and make them more palatable to consumers around the world. Developing quality indices for different ethnic snack foods would aid in their certification and broaden their marketing reach. To sum up, maintaining consistent quality, guaranteeing ingredient availability, maintaining sanitation, preserving shelf life, managing labour-intensive procedures, scaling up production, and satisfying contemporary customer demands are some of the inherent issues associated with producing traditional snacks. Standardizing recipes, implementing excellent production procedures, employing suitable preservation and packaging techniques, introducing small-scale mechanization, and progressively scaling with equipment that replicates traditional methods are some ways to handle these issues.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

AVAILABILITY OF DATA OR MATERIALS

The authors declare that there are no associated data or materials with this paper.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

All authors gave their consent before starting the study.

CONSENT FOR PUBLICATION

All authors agree for this publication.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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