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Soaking and Thermal Processing of Glutinous Rice-Based Traditional Foods: Chemical, Nutritional and Sensory Changes with Special Reference to Jakkep

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Abstract

Glutinous rice-based traditional foods are common ingredient used in indigenous food systems of Northeast India, particularly among communities in Meghalaya. Their chemical composition and sensory characteristics are influenced by the ingredients used along with it and the method of processing the food such as soaking, grinding, steaming, and roasting. This review study the chemical and nutritional changes associated with the processing of glutinous rice-based traditional foods with reference to *Jakkep*.*Jakkep*, a culturally significant Garo traditional food prepared from glutinous rice, black sesame, and sugar or jaggery, despite its cultural importance, information on its starch characteristics, thermal behavior, phytochemical composition, and processing-induced chemical changes remains limited. Each ingredient used in the traditional food such as sesame plays a role in relation to its lipids, lignans, tocopherols, and roasting-induced changes.This review highlights the need for systematic chemical investigation and scientific documentation of *Jakkep* and related traditional foods.

Keywords: Glutinous rice, Jakkep, Traditional foods, Processing-Induced Changes, chemical composition

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Introduction

Traditional food serves as a pathway for knowledge that is passed down from one generation to the next, reflecting the roots of a community. These foods serve as a symbol of the community's identity, representing its way of life, knowledge, and beliefs. In Northeast India, rice occupies a foundational position in the traditional food systems of indigenous communities across the region's seven states. Rice cakes, in particular, hold special cultural and emotional significance and are commonly prepared for festivals, rituals, and seasonal celebrations. Traditionally made with minimal oil and sugar, these preparations are economically accessible and perceived as healthier alternatives to many modern processed foods. Globally, rice-based foods are increasingly gaining attention for their palatability, energy content, and distinctive sensory attributes. [1].

In Meghalaya, rice based foods plays a key role in their food systems, with rice serving as the staple crop and primary source of carbohydrates for major tribal communities such as the Garos, Khasis, and Jaintias. Within this regional context, the Garo community consumed rice multiple times a day in various forms, including white rice (*migra*), red rice (*mi gitchak*), black rice (*mi gisim*), and glutinous or sticky rice (*minil*)[2-4].

Glutinous rice (minil) is particularly significant among the rice varieties cultivated by the Garo community due to its distinctive texture, aroma, and culinary versatility. This rice is scientifically classified as *Oryza sativa var. glutinosa*. Its low amylose content results in the characteristic stickiness observed when cooked [2,5]. Glutinous rice forms the base of several traditional snacks and ceremonial foods prepared using locally available ingredients such as black sesame seeds, jaggery, and sugar. These foods are prepared using conventional techniques such as soaking, pounding, roasting, and steaming [6,7].

Traditional rice-based foods of Northeast India have been documented in several ethnographic and food culture studies, with emphasis on their cultural relevance and diversity. However, existing literature largely remains descriptive in nature and focuses on broad categories of rice-based products rather than on individual foods. Studies addressing

glutinous rice preparations of the Garo community are particularly limited and fragmented, with only cursory references to specific products such as *Jakkep*. This review summarizes the available literature on the processing chemistry of traditional rice-based foods of Northeast India. It focuses on the effects of soaking and thermal processing on starch structure, nutrient composition, bioactive compounds, and sensory properties. It also highlights the limited chemical characterization of less-studied traditional foods, such as *Jakkep*, and identifies areas that require further research.

Traditional rice-based foods of Northeast India

Northeast India holds a unique position in the center of the glutinous rice cultural region, as the only region in South Asia to which the Southeast Asia-centered glutinous rice cultural zone has expanded. This geographical and cultural location is reflected in the extensive production and diversified utilisation of glutinous rice in the region, especially in the manufacture of traditional rice-based foods [9]. In Assam, *Bora* (glutinous) and *Chokuwa* (Semi-glutinous), a waxy type rice are popular, especially *Chokuwa* which can be prepared instantly after soaking, which is known as *Komal Chaul*, making it a practical food for breakfast, travel, feasts, and festivals [10]. Apart from these simple preparation methods, glutinous rice is also used for making different types of rice cakes and snacks which are consumed in different occasion like *Putharo,Pumaloi, Pusyep,Pukhlein, Menilpita, Menilrita, SakinGata, Chubitchi,* and *Jakkep* in Meghalaya [8,11] and *Pitha* snacks in Assam, in which each household have their own way of preparation method depending on local available raw material [12]. These foods are not only culturally significant, *Chahou*, an aromatic glutinous rice shows high nutritional values including strong phytochemical and mineral and high demand in market, which supports interest in preserving and commercializing these traditional foods[13,14].Deep fried rice snacks such as *Khapse* are among the traditional products associate with Arunachal Pradesh. *Kakching Bora* is another deep-fried rice snacks among the Manipur region which were famous [15]. Rice is integrated into several traditional meals, snacks, cakes, and fermented preparations throughout the Northeast region, including Mizoram, Nagaland, Tripura, and Sikkim, however accessible literature remains inconsistent between states [12]. Within this diverse regional food system, Meghalaya's glutinous rice-based, locally known as *minil,* are used in many traditional foods, and these have remain largely underexplored in terms of their nutritional and physiochemical and processing characteristics. These serve as an important foundation for studying the relationship between rice composition, traditional processing, and the chemical and sensory properties of indigenous foods.

Chemical changes of glutinous/sticky rice

Glutinous rice (Oryza sativa var. glutinosa) is defined by a genetic change in the waxy (wy) gene that inhibit granule bound starch synthase, resulting in starch composed almost entirely of amylopectin with small amount of amylase [16]. Amylose present in the waxy rice ranges from 0-2% [17]. These compositions add to the chewy, and sticky texture in many of the traditional foods [18]. The ratio of short to medium amylopectin branches leads to gelatinization properties, where short A chains (DP 6-12) lowers the effect of gelatinization, whereas medium B2 chains (DP 12-24) increases its effect [19]. Most of the traditional food like *Jakkep* that required soaking of the rice before further processing it [26], the water hydrates the starch granule present in the rice and change their crystalline state before any processing begins. Limited water absorption limits uniform processing, which can affect the acceptability of the traditional rice based snacks.[20]. The moisture content of the rice grain when grinding affect the moisture content of the batter and the extent of the starch swelling during further heating [21]. Also, the traditional pounding may produce softer and lighter texture in the traditional snacks due to different particle size and starch compared to mechanical grinding [22]. Protein present in the glutinous rice flour can increase hardness and reduce the overall acceptability of the product such as dumplings and rice cake. Although about 1% of lipid present in it, its content can affect the pasting properties and retrogradation [23]. In glutinous rice, higher starch molecular weight, crystallinity and particle size are associated with higher thermal properties and faster starch retrogradation [24]. But compared to non-waxy rice, Glutinous rice shows slower retrogradation due to the branched amylopectin structure resisting reassociation [25] which can affect the shelf life of a traditional foods.

Chemical Changes in Sesame Seeds

Sesame seeds are included in traditional foods in the form of sesame paste, and sesame oil, with each product retaining different levels of bioactive compounds [27]. It contain high amount of unsaturated fat that provide richness and mouthfeel in foods such as *Halwa, Laddu* [28]. It is resistant to oxidative deterioration despite its high unsaturation [29], this contribute to present of lignans and tocopherols in the oil [30]. Roasting also affect the sesame by producing additional antioxidant- active compound and change its flavor [31]. The heat can convert sesamolin to sesamol and

related compound, which helps explain the characteristic changes of roasted sesame seed and its products [33]. Hence, traditional sesame foods require a balance between good sensory quality and phytochemical retention [33].

Chemical Changes Involve During Processing

Processing the rice based foods affect the chemical changes spanning starch structure rearrangement, protein denaturation, lipid oxidation, and phytochemical degradation [34,35. This change regulates the texture, flavor, and the nutritional quality of traditional products.

Soaking starts the first stage of chemical changes by leaching the surface compound and activate the endogenous enzyme. Water removes about 60-70% of the total surface lipids, which them reduce the undesirable flavor development. Presoaking increases the release of glucose, fructose oleic acid, and linoleic acid, which serve as precursor for flavor formation during thermal processing [36]. Increase in the temperature during soaking can increase the starch granule viscoelasticity and changing of physical state and pasting properties [34].

Hydrothermal cooking is an important stage in the flavor formation of rice, the volatile profile changes from hydrocarbons to aldehydes, furans, and alcohols. The starch undergoes gelatinization; the heat and water affect the granule's crystalline structure to form an amorphous, digestible structure [37]. Steaming which is another heating process which is done in most of the traditional foods promotes the protein aggregation present in the rice which then increases the particle size and reducing the solubility by oxidizing sulfhydryl groups into disulfide bonds [38]. Heat-moisture treatment changes the starch-lipid complexes that restrict enzymatic digestion and change the pasting viscosity [39]. Roasting which is another treatment for traditional foods like *Jakkep* leads to millard reaction and lipid oxidation that form characteristic aromas while changing the bioactive stability. Roasting removes undesirable volatile organic compounds formed during germination and maintains microbial stability [26,40].

Jakkep: a chemically underexplored Garo traditional food

Jakkep is one of the most widely consumed and culturally significant glutinous rice-based foods of the Garo community [26]. *Gipok Minil* is the type of rice used for making *Jakkep*. Comparable to a traditional crepe or pancake, it is a two-layered roasted product prepared from soaked glutinous rice, black sesame seeds, and sugar or jaggery. The preparation of *Jakkep* relies on indigenous knowledge transmitted orally across generations and involves the use of traditional tools such as wooden mortars and pestles, bamboo sieves, and flat griddles [8]. It is traditionally regarded as an energy-rich food valued for its taste, satiety, and perceived health benefits.

Minil is used in most of the traditional food product, including *Jakkep*, *Pita*, *Sakkin* and the fermented rice beverage *Chubitchi* [8].This highlight the relationship between traditional rice diversity and food processing practices. Garo sticky-rice landraces have received some nutritional attention. A study of 32 rice landraces from the Garo Hills, including eight glutinous varieties, reported verities in nutrient composition and identified the composition of glutinous rice as a distinctive feature of these traditional cultivars [6]. Another study has also stated that *Minil-Michudari*, a traditional sticky rice variety, had approximately 14-21 mg calcium/100 g, compared with about 7.49 mg/100 g reported for raw milled rice in the Indian Food Composition Tables[41]. These finding shows the *minil* has scientific relevance although no comprehensive information is available on the starch characteristics, pasting properties, thermal characteristics, phenolic profile or processing-induced chemical changes during possessing of *Jakkep*.

Table 1. Comparison of Jakkep with Other Traditional Rice Based Foods

Food	Region/community/ state	Rice type	Major ingredients	Processing	Major chemical characteristics	Reported bioactives	References
Jakkep	Garo, Meghalaya	Sticky/glutinous rice	Sesame, sugar/jaggery	Soaking, grinding, mixing, shaping, cooking/roasting	Food-specific chemical composition limited	Limited data available	Pandey *et al*. (2022); Basaiawmoit*et al*. (2023)
Sakin Gata	Garo, Meghalaya	Sticky + plain rice	sugar, sesame powder	Soaking, grinding, mixing, cooking	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)

Food	Region/community/ state	Rice type	Major ingredients	Processing	Major chemical characteristics	Reported bioactives	References
Pukhlein	Khasi and Jaintia, Meghalaya	Rice	Jaggery, refined oil	Mixing, shaping, frying	Food-specific chemical composition limited	Limited data available	Umdor*et al*. (2016); Basaiawmoit*et al*. (2023)
Til Pitha	Assam	Bora/glutinous rice	Sesame, jaggery/sugar	Soaking, grinding, filling, steaming/roasting	Protein, fat, carbohydrate, fibre, moisture, ash, energy, calcium and iron	Sesame-derived lignans (sesamin and sesamolin)	Paraswal *et al*. (2026); Wei *et al*. (2022)
Entaap	Bodo, Assam	Sticky/glutinous rice	Sesame	Soaking, grinding, mixing, cooking	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)
Bhapot Diya Pitha / TekeliMukhot Diya Pitha	Bodo & Assamese, Assam	Sticky/glutinous rice	Sesame, sugar	Soaking, grinding, mixing, steaming	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)
Sitao	Bodo, Assam	Sticky/glutinous rice	Sesame	Soaking, grinding, mixing, cooking	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)
Winsii	Tangsa, Arunachal Pradesh	Rice	Rice flour	Grinding, mixing, steaming/boiling	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)
Haokhamui	Tangkhul, Manipur	Sticky/glutinous rice	Rice flour, sugar, frying oil, water	Soaking, grinding, shaping, frying	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)
Sachao	Tangkhul, Manipur	Sticky/glutinous rice	Oil, sugar, sesame	Soaking, grinding, shaping, frying	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)
Chhangban	Lushai, Mizoram	Sticky/glutinous rice	Sticky rice flour	Soaking, pounding, sieving, kneading, wrapping, boiling	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)
Chhangkan	Lushai, Mizoram	Rice	Rice flour, sugar	Soaking, pounding, kneading, frying	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)

Food	Region/community/ state	Rice type	Major ingredients	Processing	Major chemical characteristics	Reported bioactives	References
KithouRaokhao	Poumai Naga, Nagaland	Rice	Sugar, mustard oil	Soaking, grinding, shaping, frying	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)
Awang Bangui	Tripuri, Tripura	Sticky + Bengal Joha rice	Jaggery/sugar, salt, sesame	Soaking, pounding, mixing, wrapping in leaves, boiling	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)
Awang Bleb	Tripuri, Tripura	Sticky + Bengal Joha rice	Jaggery/sugar, salt, sesame	Soaking, pounding, mixing, shaping, deep frying	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)
Selroti	Gorkha, Sikkim	Rice	Sugar/jaggery, spices, dry fruits	Grinding/mixing, fermentation, deep frying	Fermentation-related changes in starch and organic acids; frying causes moisture loss and browning	Fermentation-derived metabolites; food-specific bioactive profile not established	Yonzan& Tamang (2009); Basaiawmoit*et al*. (2023)
Yomari	Gorkha, Sikkim	Rice	Jaggery	Rice flour dough, filling, shaping, steaming	Food-specific chemical composition limited	Limited data available	Basaiawmoit*et al*. (2023)
Feeng / Glass noodles	Gorkha, Sikkim	Rice + mung bean starch	Rice starch, mung bean starch	Starch extraction, processing/extrusion, cooking, drying	Starch composition and physicochemical characteristics	Limited data available	Basaiawmoit*et al*. (2023)

Conclusion

Glutinous rice-based traditional foods of Northeast India represent an important connection of food chemistry, indigenous knowledge, nutritional value, and cultural heritage. Various processing methods such as soaking, heating, steaming, and roasting can influence the starch structure, texture, flavour, lipid stability, protein characteristics, and the retention or the change of bioactive compounds. Each ingredient added to the foods changes the sensory attribute of the traditional foods. Within this context, *Jakkep* represents a culturally important but chemically underexplored Garo traditional food. Many traditional foods of the northeast, India also shows similar ingredients in preparing the traditional food, but their physiochemical properties differ due to different processing methods. Although available evidence indicates the nutritional relevance of Garo glutinous rice varieties and the importance of traditional processing, comprehensive information on *Jakkep*'s starch characteristics, thermal properties, phytochemical profile, and processing-induced chemical transformations is limited.

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