

Sathu changal hme and the fermented pork dishes of the Hmar people of Northeast India

C. Vanlalawmpuia

awmpuiawrites@gmail.com

Manipur University

Research Article

Keywords: sathu changal hme, Hmar, fermented pork fat, Indigenous food knowledge, alkaline cooking, Northeast India

Posted Date: September 8th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10949394/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Sathu changal hme is a Hmar dish prepared with fermented pork fat, vegetables and an alkaline cooking liquid. This study documents its preparation and variation in relation to Hmar food practices in Northeast India. The descriptive account draws on verbal information from Hmar community members in Pherzawl district, Manipur, together with regional food literature and community recipe sources. The compiled material contains 21 named preparations, distinguished mainly by their principal vegetable or plant part. Across these preparations, sathu provides a shared ingredient, while bamboo shoots, leafy vegetables, stalks, flowers and other locally used ingredients produce different versions of the dish. Three examples are discussed in detail: rawtuoi, made with bamboo shoots; maikung, made with pumpkin stalks; and khanghmuk, made with climbing wattle shoots, sometimes accompanied by brinjal. The account distinguishes the ripening of sathu from the subsequent alkaline cooking of the finished dish. Published research on the related Mizo product sa-um provides a basis for discussing lipid composition, microbial ecology and food safety, but these properties were not measured in the present study. Historical mobility offers a possible context for preservation practices; the evidence does not establish that migration caused the dish to develop. Sathu changal hme is best understood as a shared preparation method that accommodates varied ingredients. Documenting this method preserves culinary knowledge and identifies specific questions for future measurements of fermentation conditions, cooked-food composition and safety.

Introduction

Hmar communities live in Manipur, Mizoram, Assam, Meghalaya and Tripura in Northeast India [1]. Their food practices draw on cultivated crops and locally gathered ingredients. Fermented foods form part of this repertoire, as they do in neighbouring communities across the region [2, 3, 4]. Sathu, a fermented or ripened pork ingredient made predominantly from fat, is used in a family of dishes known as sathu changal hme.

The name identifies the components of the preparation: sathu refers here to the fermented pork ingredient, changal to an ash-derived alkaline liquid, and hme to a dish. Baking soda is used as a substitute for changal in some contemporary recipes. Vegetables, water, salt and chillies complete the basic preparation; dried meat, or sahero, may also be included. The term changal hme is broader than sathu changal hme because alkaline-cooked dishes can contain other fermented ingredients. This paper uses the more specific name wherever sathu is present. Related preparations are described as bai in Mizo food literature [3, 5]. These linguistic connections provide useful comparisons without implying that recipes are identical across communities.

Regional accounts have documented fermented pork products and the use of wild edible vegetables, including preparations recorded among Hmar households in Mizoram [2, 3, 6]. The present account focuses more narrowly on how sathu combines with different vegetables within the named sathu changal hme repertoire in Pherzawl. A catalogue of names alone cannot explain this relationship. The

preparation sequence, the role of changal and the distinction between a fermented ingredient and a cooked dish are also important to understanding the food.

This study therefore documents the preparation of sathu and sathu changal hme, describes selected variations, and considers their cultural and food-science significance. It also examines the proposed connection between food preservation and historical mobility. Hmar migration traditions are relevant cultural accounts, but they do not by themselves establish when or why a particular food-processing practice began.

Review of literature

Regional fermentation and the distinction between ingredient and dish

Research on Northeast Indian fermented foods places sathu within a diverse regional repertoire rather than an isolated culinary invention. Tamang et al. [4] describe more than 250 fermented foods and alcoholic beverages prepared from substrates including vegetables, bamboo shoots, legumes, cereals, milk, meat and fish. Their synthesis emphasises variation in microorganisms and sensory characteristics. Its relevance here is comparative: similarities in the use of fermentation do not establish identical processing conditions, a common date of invention or equivalent nutritional effects. A Hmar preparation therefore requires documentation at the level of its own ingredients, terminology and household practices.

The ISAPP consensus statement defines fermented foods in terms of desired microbial growth and enzymatic transformation of food components [7]. This provides a more precise analytical starting point than treating fermentation as a synonym for food becoming spoiled. In the present case, the ingredient sathu is ripened before being incorporated into a vegetable preparation. The later addition of changal belongs to cooking, not automatically to fermentation. Whether particular household sathu processes produce reproducible microbial changes remains an empirical question. Likewise, describing a food as fermented does not itself demonstrate that it contains a clinically validated probiotic or that beneficial organisms remain viable after cooking.

Hmar food documentation and the ecology of ingredient choice

A particularly close precedent is Lalmuanpuii et al. [6], who documented food preparation in 35 households, including 21 Hmar and 14 Paihte households, in two villages of Aizawl district during 2018. Their study recorded 24 recipes and described combinations of wild vegetables, fermented pork fat and ash filtrate. It consequently supplies direct evidence that Hmar cooking has already entered the published ethnobotanical literature. However, its unit of analysis is a broader repertoire of wild-vegetable recipes in Mizoram, rather than a catalogue specifically organised around sathu changal hme in

Pherzawl. The present account should be positioned as a focused extension of that work, not as the first documentation of Hmar vegetable cooking.

Konsam et al. [8] broaden this ecological context through surveys of 20 markets and interviews with 154 plant collectors and sellers in Manipur. They documented 68 wild leafy vegetables and recorded differences in edible parts, availability, preparation and local preference. Their deposited herbarium specimens also provide a stronger model for botanical identification than photographs alone. This research suggests that ingredient substitution should be examined alongside seasonality, access and taste, rather than explained solely by historical travel. For sathu changal hme, distinctions among leaves, shoots, stalks and dried ingredients may reflect practical ecological knowledge; the present catalogue cannot determine which of these factors explains any particular entry.

Preservation, acquired taste and cultural continuity

Ethnographic approaches complicate the assumption that fermented foods persist merely because fresh food is unavailable. Kikon [9] examines fermented bamboo shoots in Northeast India as foods through which taste, social relations and identities are organised. Her analysis directs attention to the cultural work of fermentation and to the relationship between foods and the communities that prepare and consume them. Although bamboo-shoot fermentation is not equivalent to pork-fat ripening, this approach supports asking how Hmar cooks learn to recognise and value sathu, rather than treating its pungency as an accidental characteristic requiring a scarcity-based explanation.

Ralte [10] offers a closer comparison in her study of Mizo foodways. She describes meat smoking as formerly serving preservation while continuing because consumers appreciate its smell and taste. This is a useful example of a processing practice acquiring or retaining sensory value beyond its initial practical purpose. Her discussion also relates food preparation to memory and customary knowledge. Nevertheless, evidence about smoked meat cannot establish that Hmar sathu originated through accidental spoilage, or that preference for it arose during migration. It supports the narrower proposition that preservation, learned taste and cultural continuity can reinforce one another.

Flachs and Orkin [11] connect these social questions with microbial investigation. Their research combined interviews and participation in a fermentation workshop with sampling of fermented foods and participants' gut microbiomes. It illustrates how culturally informed production practices can be studied alongside biological variation. The setting was a contemporary workshop in Tennessee, so its findings are not evidence about Hmar food origins or the health effects of sathu. Its methodological contribution is the integration of accounts of learning and authenticity with direct measurements, an approach that could inform future community-led research on pork-fat ripening and household definitions of acceptable flavour.

Historical mobility: a hypothesis requiring specific evidence

Comparative work makes deliberate consumption of strongly ripened animal foods historically plausible without making it uniquely nomadic. Speth [12] reviews ethnographic and ethnohistorical accounts of fermented or deliberately decomposed meat, fish and fat among northern foragers. These foods were sometimes valued rather than consumed only as a last resort. His extension of this evidence to Palaeolithic diets is explicitly interpretive. Such comparisons challenge the assumption that strong-smelling animal foods necessarily indicate desperation, but differences in environment, substrate and processing prevent their use as proof of either a Hmar origin sequence or the safety of sathu.

Tamang's study of Himalayan fermented-food antiquity [13] provides a more regionally relevant model. It draws on oral histories, legends and preparation accounts while acknowledging uncertainty about the origins and dispersal of particular foods. This distinction matters because accounts of migration can explain how culinary knowledge travels without identifying when a technique was first invented. Historical migration, periodic village relocation and nomadic subsistence are not interchangeable categories. Accordingly, "historical mobility" is preferable here unless evidence establishes a specific pattern of nomadism and its connection to food preparation.

The proposed sequence—food altered during movement, its flavour became appreciated, and the practice was deliberately reproduced—can therefore be retained only as a hypothesis to investigate. None of the sources reviewed establishes that sequence for sathu changal hme. An alternative is that pork-fat ripening developed in settled households and subsequently travelled with people; another is that neighbouring communities exchanged an existing practice. Moreover, the stored ingredient and the freshly cooked vegetable dish may have different histories. Future interviews would need to distinguish remembered practices from retrospective explanations and document who transmitted each account, where, and across which generations. Dated descriptions of containers, storage and journeys would strengthen historical interpretation.

Food-science evidence and the remaining research gap

The closest laboratory comparison is De Mandal et al. [14], who analysed Mizo sa-um using chemical measurements and 16S rRNA sequencing. Six samples from different locations were mixed before analysis, limiting assessment of between-household variation. This design offers a useful initial characterisation, but not a time-series demonstration of fermentation or a direct evaluation of Hmar batches. Separately, Liu et al. [15] experimentally linked sodium-bicarbonate cooking of lotus rhizome to pectin changes and reduced hardness. That finding supplies a mechanism worth testing for changal-based cooking, not a measured explanation of texture changes in the vegetables documented here.

Taken together, the literature supports a study connecting culinary variation, ecological knowledge and the cultural valuation of processed foods. It leaves unresolved the historical sequence of sathu production, the reasons for household preference, and the relationship between ripening conditions and the cooked dish. The present contribution is therefore a focused organisation of 21 named preparations around a shared method. Its value does not depend on proving a single nomadic invention. A

preservation-and-mobility interpretation can guide further enquiry while remaining separate from the descriptive evidence and from claims requiring botanical, sensory or laboratory verification.

Methods

Study setting and sources

The study is a descriptive account centred on Hmar food practices in Pherzawl district, Manipur. Information on ingredients and preparation was obtained verbally from local Hmar community members. The account was supplemented by published work on Hmar history and regional foods, the Hmar Hme recipe website, and a preparation account attributed to Joyful Thiek in the Hmar Hme Facebook community [1, 2, 3, 5, 6, 16, 17, 18]. Community recipe sources were used to document culinary practice; they were not treated as evidence of nutritional benefit or microbiological safety.

Organisation of the culinary material

The preparation information is presented in two stages: production of sathu and cooking of the finished vegetable dish. The compiled catalogue contains 21 named preparations. Entries are organised by local dish name, principal ingredient and any additional ingredient specified in the source material. The catalogue records named preparations rather than independently sampled households, cooking trials or botanical species. It should not be interpreted as an estimate of how commonly each dish is eaten.

Three preparations are discussed in detail to make the comparison manageable: bamboo shoots, pumpkin stalks and climbing wattle shoots. They illustrate differences in plant material within the shared cooking method; no consumption-frequency data are available to rank them as the most popular dishes. The remaining 18 photographs and the complete catalogue are provided in Additional file 1. Photographs illustrate the named dishes and were not used to confirm botanical identifications or ingredient quantities.

Scope of analysis

The study did not include laboratory testing, a controlled sensory panel or quantitative dietary assessment. Descriptions of smell, appearance and texture are culinary descriptions. Nutritional, microbial and epidemiological findings discussed below come from published studies, principally on the related product sa-um, and are distinguished from the preparation information documented here. Plant names are retained at the level supported by the available material; uncertain species identifications are not treated as confirmed records.

Results

Core ingredients and preparation of sathu

Sathu supplies the pork component shared by the 21 preparations. The source accounts describe a fatty, pungent ingredient that can be scooped into a cooking pot. Chungal supplies the alkaline cooking liquid, while chillies contribute heat and sahro is an optional dried-meat ingredient (Table 1). Water and salt complete the basic preparation.

Table 1

Core and optional ingredients in sathu chungal hme. Descriptions summarise culinary source accounts [3, 16]; they are not laboratory or sensory-panel measurements.

Ingredient	Material	Reported characteristic or use
Sathu	Predominantly pork fat; lean meat may be included	Pungent, fatty ingredient added to the dish
Chungal	Ash-derived alkaline filtrate	Alkaline cooking liquid; baking soda is a reported substitute
Sahro	Dried meat, usually pork or beef	Optional dried-meat ingredient
Tlang hmarca	Locally used hill chilli, fresh or dried	Contributes pungency and heat

The documented preparation of sathu begins with fatty pork cut into small pieces; some accounts allow the addition of lean meat. The pork is boiled and transferred to a container for a reported ripening period of approximately 3–5 days. A dried hollow gourd is traditionally used, while jars and metal containers are also described. The container may be kept in sunlight or near a cooking fire [16]. These are reported household practices, not experimentally established processing specifications. The account does not establish a validated combination of temperature, moisture, acidity and storage time that would make the product safe or shelf-stable.

Cooking the finished dish

The recipe accounts describe a common sequence with some variation in the order of addition [16, 17]. Water is heated in a pot, with dried meat and chillies sometimes added early. Ingredients requiring longer cooking may be precooked. The principal vegetables are added and cooked until softened. Chungal, or baking soda as a substitute, is then added; the accounts describe reducing the heat when foaming occurs. Sathu and salt are incorporated and the mixture is boiled further. Some cooks add sathu before the alkaline ingredient.

The defining distinction is between ripening the pork ingredient and cooking it with vegetables. Adding alkali to the pot is a cooking step, not evidence that the complete dish undergoes fermentation. Ingredient quantities, final pH and cooking times were not standardised in this study, so the sequence describes a culinary practice rather than a reproducible laboratory formulation.

Rawtuoi sathu chungal hme

Rawtuoi sathu changal hme uses bamboo shoots as its principal vegetable (Fig. 1). It demonstrates a preparation in which one named plant ingredient is combined with the shared sathu and alkaline-cooking base. The catalogue also distinguishes tuoiterek, described as baby bamboo shoots; rawtuoi hro, dried bamboo shoots; and a mixed preparation combining rawtuoi with khanghmuk. These distinctions show that the local names capture ingredient combinations and preparation states as well as broad vegetable categories.

The fresh-shoot example provides a useful reference for comparing these related preparations. However, the record does not specify the bamboo species or a complete pretreatment procedure. Cooking requirements should therefore not be assumed to be interchangeable across all the bamboo-shoot entries.

Maikung sathu changal hme

Maikung sathu changal hme uses pumpkin stalks (Fig. 2). It illustrates the use of a plant part that differs from the leaves and tender stalks described together in maihna preparations. The compiled entry for maikung specifically identifies stalks.

The stalk-based preparation makes the role of cooking texture particularly relevant. The documented general method involves softening the vegetable before or during the addition of alkali and sathu. The material contains no instrumental texture measurements, preparation weights or comparison of cooking times, so any explanation of alkaline softening remains a literature-informed interpretation rather than a measured result for this dish.

Khanghmuk sathu changal hme

Khanghmuk sathu changal hme contains climbing wattle shoots, with brinjal listed as an accompanying ingredient (Fig. 3). Climbing wattle is identified in regional literature as *Senegalia pennata* [6]. The local ingredient identification in this account was not supported by a voucher specimen and should be understood at that level of certainty.

This preparation illustrates how a named principal ingredient can be accompanied by another vegetable while retaining the shared sathu-based method. The separate rawtuoi le khanghmuk entry combines climbing wattle with bamboo shoots. Together, these entries support a description of the dish as a family of flexible preparations, rather than one fixed combination of vegetables.

Breadth of the documented variations

The complete catalogue includes preparations based on leaves, shoots, stalks, flowers or buds, fruits and mushrooms (Additional file 1, Table S1). It also includes dried taro leaves, dried taro stems and dried bamboo shoots. Thus, variation concerns both the ingredient selected and its condition before cooking. These entries document the breadth of the compiled repertoire; they do not establish the frequency,

geographical distribution or historical origin of individual recipes. Uncertain local-to-botanical name matches remain explicitly unresolved in the supplementary catalogue.

Discussion

Culinary knowledge and historical mobility

The common use of sathu and alkaline cooking across different plant ingredients is the clearest pattern in the compiled material. It suggests that culinary knowledge resides partly in knowing how to adapt a preparation method to available ingredients. This interpretation is consistent with regional documentation of varied fermented foods and edible plants [4, 6]. It does not require all 21 preparations to have a single origin or an identical recipe.

Hmar historical writing and accounts of the post-harvest Sikpui Ruoi festival place food within wider narratives of livelihood and community identity [1, 18]. Migration traditions, including accounts of Sinlung, provide a context in which the transmission of preservation knowledge can be investigated [19]. A plausible interpretation is that a stored pork ingredient, combined with locally available vegetables, could have supported culinary continuity across changing environments. This is an inference about possible usefulness, not evidence of invention during migration. The literature review also identifies learned taste and seasonal food management as alternatives to an exclusively mobility-based explanation. Neither the historical invention of sathu nor an origin through accidental spoilage is established by this study.

To evaluate the mobility hypothesis, future research should ask whether sathu was actually carried during journeys, how long it was kept, which containers were used, and whether elders distinguish travel provisions from everyday household use. Accounts should be compared across settlements and generations, including accounts that do not associate the food with migration. The origin of pork-fat ripening must also be distinguished from the later adoption of alkaline vegetable cooking. Until such evidence is available, “a food tradition potentially adapted to historical mobility” is a more defensible interpretation than a demonstrated “nomadic dish”.

Fermentation and the limits of microbial inference

The regional term fermented pork fat encompasses household ripening practices whose conditions may vary [3, 5]. For the related Mizo product sa-um, De Mandal et al. [14] reported approximately 91% fat on a dry-weight basis. Their analysis combined 16S rRNA gene sequencing with predictions of microbial functions. The reported bacterial profile included assignments to *Clostridium* and other genera of potential safety interest. Such sequence assignments do not establish viable pathogen counts, toxin production or illness caused by the food.

These findings identify reasons for direct testing of Hmar sathu, but they cannot establish its composition or safety. Nor does that study demonstrate a probiotic effect of the cooked dish. Reviews

of fermented foods emphasise that health effects depend on the particular food, microorganisms and evidence available [20, 21, 22]. Fermentation alone is insufficient grounds for describing sathu changal hme as probiotic or health-promoting.

Alkaline cooking and vegetable texture

Changal and baking soda warrant attention as processing ingredients rather than simply as seasonings. Their alkalinity provides a plausible explanation for changes in vegetable texture. In an experimental study of lotus rhizome, Liu et al. [15] linked sodium-bicarbonate cooking to pectin degradation and tissue softening. This offers a mechanism to investigate in Hmar dishes, but the result cannot be transferred quantitatively to bamboo shoots, pumpkin stalks or climbing wattle without testing.

Ash filtrate and sodium bicarbonate should also not be assumed to be chemically equivalent. Comparing them would require measurements of their composition, concentration and effect on the pH of the cooking liquid. A useful experiment would compare water-only cooking, a measured amount of changal and a measured amount of sodium bicarbonate, using defined vegetable portions and recording texture over time. No such comparison was undertaken here.

Nutrition and health evidence

The composition of a fatty fermented ingredient cannot be used as the composition of the complete dish. The amount of sathu, the water content, the vegetables, any dried meat and the serving size all affect the food consumed. These quantities were not measured. It is therefore not possible to calculate energy density, nutrient intake or a nutritional advantage for the finished preparations from this study.

Published epidemiology raises questions that should be acknowledged without attributing causation to this dish. A hospital-based case-control study in Mizoram associated frequent sa-um consumption with higher odds of stomach cancer (odds ratio 3.4) and also reported an association with an alkaline food additive [23]. Another study, involving 500 people with type 2 diabetes and 500 controls, reported an association between sa-um consumption and diabetes [24]. These studies concern reported dietary exposures in other study populations. They do not isolate the effect of Hmar sathu changal hme, establish an individual consumer's risk, or justify adding together the reported associations for different ingredients. Recall, selection and confounding require consideration when interpreting such observational findings.

The practical scientific question is how the preparation and consumption of this particular food relate to its composition and safety. That requires direct sampling and dietary information, rather than assuming either benefit or harm from its traditional status.

Limitations and priorities for further research

This account combines verbal preparation information with published and community recipe sources. It does not provide a representative household survey, a documented prevalence estimate or laboratory

validation. The available record lacks a reproducible account of participant recruitment, fieldwork dates, interview procedures and recording or translation methods. These limitations restrict the strength of claims about the wider Hmar population and the independent field provenance of individual catalogue entries.

Photographs and common names are insufficient to verify plant species. In particular, uncertain names should be checked with knowledgeable community members and a botanist, with voucher specimens where appropriate. Research on microbial succession would require separately collected batches, recorded time and temperature, pH and water-activity measurements, and suitable microbiological assays. Analyses of the cooked dish should measure actual ingredient amounts and serving sizes. Combining these measurements with community-led documentation would preserve the specificity of Hmar food knowledge while providing a stronger basis for food-science interpretation.

Conclusion

Sathu changal hme is a family of Hmar fermented-pork dishes organised around a common ingredient and alkaline-cooking method. The compiled record identifies 21 named preparations, and the bamboo-shoot, pumpkin-stalk and climbing-wattle examples show how different plant materials fit within that method. The study's contribution is descriptive documentation of culinary knowledge. It does not demonstrate a nomadic origin, probiotic activity, nutritional benefit or a disease effect. Direct studies of processing conditions, botanical identity, cooked-food composition and safety are needed to resolve those questions.

Abbreviations

rRNA
ribosomal ribonucleic acid

Declarations

Funding

No specific funding was reported for this study.

Availability of data and materials

The compiled dish catalogue is provided in Additional file 1. Published sources are listed in the references.

Competing interests

The author declares no competing interests.

References

1. Dena L. In search of identity: Hmars of North East India. Delhi: Akansha Publishing House; 2008.
2. Wahengbam R, Thangjam AS, Keisam S, Asem ID, Ningthoujam DS, Jeyaram K. Ethnic fermented foods and alcoholic beverages of Manipur. In: Tamang JP, editor. Ethnic fermented foods and beverages of India: science history and culture. Singapore: Springer; 2020. https://doi.org/10.1007/978-981-15-1486-9_14.
3. Thanzami K, Lalhlenmawia H. Ethnic fermented foods and beverages of Mizoram. In: Tamang JP, editor. Ethnic fermented foods and beverages of India: science history and culture. Singapore: Springer; 2020. p. 435–457. https://doi.org/10.1007/978-981-15-1486-9_16.
4. Tamang JP, Tamang N, Thapa S, Dewan S, Tamang B, Yonzan H, Rai AK, Chettri R, Chakrabarty J, Kharel N. Microorganisms and nutritional value of ethnic fermented foods and alcoholic beverages of North East India. *Indian Journal of Traditional Knowledge*. 2012;11(1):7–25.
5. Lalthanpuui PB, Lalruatfela B, Zoramdinthara, Lalthanzara H. Traditional food processing techniques of the Mizo people of Northeast India. *Science Vision*. 2015;15(1):39–45.
6. Lalmuanpuui R, Zodinpuui B, Lalbiaknunga J, Zothanpuia. Traditional food preparation of wild edible vegetables among the ethnic groups of Mizoram, North East India. *Journal of Ethnic Foods*. 2021;8:26. <https://doi.org/10.1186/s42779-021-00104-5>.
7. Marco ML, Sanders ME, Gänzle M, Arrieta MC, Cotter PD, De Vuyst L, et al. The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on fermented foods. *Nat Rev Gastroenterol Hepatol*. 2021;18(3):196–208. <https://doi.org/10.1038/s41575-020-00390-5>.
8. Kongsam S, Thongam B, Handique AK. Assessment of wild leafy vegetables traditionally consumed by the ethnic communities of Manipur, northeast India. *J Ethnobiol Ethnomed*. 2016;12:9. <https://doi.org/10.1186/s13002-016-0080-4>.
9. Kikon D. Bamboo shoot in our blood: fermenting flavors and identities in Northeast India. *Curr Anthropol*. 2021;62(S24):S376–87. <https://doi.org/10.1086/715830>.
10. Ralte L. Food, memory and identity: tracing Mizo foodways. *Litfinite J*. 2022;4(1):13–20. <https://doi.org/10.47365/litfinite.4.1.2022.13-20>.
11. Flachs A, Orkin JD. On pickles: biological and sociocultural links between fermented foods and the human gut microbiome. *J Ethnobiol Ethnomed*. 2021;17:39. <https://doi.org/10.1186/s13002-021-00458-9>.
12. Speth JD. Putrid meat and fish in the Eurasian Middle and Upper Paleolithic: are we missing a key part of Neanderthal and modern human diet? *PaleoAnthropology*. 2017;2017:44–72. <https://doi.org/10.4207/PA.2017.ART105>.
13. Tamang JP. Dietary culture and antiquity of the Himalayan fermented foods and alcoholic fermented beverages. *J Ethn Foods*. 2022;9:30. <https://doi.org/10.1186/s42779-022-00146-3>.

14. De Mandal S, Singh SS, Muthukumaran RB, Thanzami K, Kumar V, Kumar NS. Metagenomic analysis and the functional profiles of traditional fermented pork fat 'sa-um' of Northeast India. *AMB Express*. 2018;8:163. <https://doi.org/10.1186/s13568-018-0695-z>.
15. Liu Y, Liu J, Liu G, Duan R, Sun Y, Li J, Yan S, Li B. Sodium bicarbonate reduces the cooked hardness of lotus rhizome via side chain rearrangement and pectin degradation. *Food Chemistry*. 2022;370:130962. <https://doi.org/10.1016/j.foodchem.2021.130962>.
16. Hmar Hme. Sathu—fermented pork. 2019. <https://hmarhme.com/2019/02/sathu-fermented-pork/>. Accessed 1 June 2024.
17. Thiek J. Sathu changal hme suongdan (cooking with fermented pork and soda—a Hmar dish). Hmar Hme Facebook group; 2020.
18. Baral SD, Lalthlamuani KC. Profile of the Hmar people. *MZU Journal of Literature and Cultural Studies*. 2014;1.
19. Tiwari S, Vanlalawmpuia C. Conceptualizing 'Sinlung' as the 'Imagined homeland' of the Hmar tribe: myth or history? *Asian Ethnicity*. 2026. <https://doi.org/10.1080/14631369.2026.2645646>.
20. Leeuwendaal NK, Stanton C, O'Toole PW, Beresford TP. Fermented foods, health and the gut microbiome. *Nutrients*. 2022;14(7):1527. <https://doi.org/10.3390/nu14071527>.
21. Dimidi E, Cox SR, Rossi M, Whelan K. Fermented foods: definitions and characteristics, impact on the gut microbiota and effects on gastrointestinal health and disease. *Nutrients*. 2019;11(8):1806. <https://doi.org/10.3390/nu11081806>.
22. Diez-Ozaeta I, Astiazaran OJ. Fermented foods: an update on evidence-based health benefits and future perspectives. *Food Research International*. 2022;156:111133. <https://doi.org/10.1016/j.foodres.2022.111133>.
23. Phukan RK, Narain K, Zomawia E, Hazarika NC, Mahanta J. Dietary habits and stomach cancer in Mizoram, India. *Journal of Gastroenterology*. 2006;41(5):418–424. <https://doi.org/10.1007/s00535-006-1761-x>.
24. Lalrohlui F, Ghatak S, Zohmingthanga J, Hruaii V, Senthil Kumar N. Fermented pork fat (Sa-um) and lifestyle risk factors as potential indicators for type 2 diabetes among the Mizo population, Northeast India. *Journal of Health, Population and Nutrition*. 2021;40:32. <https://doi.org/10.1186/s41043-021-00257-8>.

Figures



Figure 1

Rawtuoi sathu changal hme. Bamboo shoots are the principal vegetable. Related entries distinguish young shoots, dried shoots and mixed bamboo-shoot preparations. Photograph from the source collection acknowledged below.



Figure 2

Maikung sathu changal hme. This preparation uses pumpkin stalks; the catalogue distinguishes this ingredient from the pumpkin leaves discussed elsewhere in the source material. Photograph from the source collection is acknowledged below



Figure 3

Khanghmuk sathu changal hme. Climbing wattle shoots are the principal ingredient, with brinjal listed as an accompanying vegetable. Photograph from the source collection acknowledged below.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryAnonymous.docx](#)