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Traditional Preparation Methods And Tribal Variations Of Axone: A Fermented Soybean Product In Nagaland, India

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AXONE: NAGA TRADITIONAL FOOD

Abstract
Axone is a traditional fermented soybean product that is widely consumed by various tribes in Nagaland, India. This study conducted an extensive survey of nineteen tribes resident in Nagaland to investigate the different methods of axone preparation and preservation. The tribes included in the survey were Ao, Angami, Chakhesang, Chang, Chirr, Khiamniungan, Konyak, Lotha, Makuri, Pochury, Phom, Rengma, Rongmei, Sangtam, Sumi, Tikhir, Yimchunger, Zemi, and Kuki. The study found that each tribe has its own vernacular name for axone and slight variations in the preparation methods, such as the use of different types of soybean seeds, soaking duration, cooking time, and wrapping leaves. The traditional method involves soaking the soybean seeds, cooking them until soft, wrapping the cooked beans in leaves like banana, Phrynium pubinerve, or Macaranga indica, and allowing them to ferment near a fireplace for several days. Factors affecting the fermentation process include the duration of keeping the wrapped beans near the fire, the total fermentation time, and additional techniques to delay deterioration. The final product is either consumed fresh, dried, or stored for later use. The survey revealed that axone preparation is an indigenous practice that has been passed down through generations without the use of starter cultures or modern technological inputs. The skills required for preparation are not sophisticated, and production is limited to household scale. This study provides valuable insights into the diverse methods of axone preparation across different Naga tribes and highlights the cultural significance of this traditional fermented food.

Keywords: *Axone, Fermented soybean, Traditional food, Nagaland, - Naga tribes, Fermentation process, Indigenous Practice*

1. Introduction

The practice of fermenting foods is deeply rooted in the culinary traditions of Southeast Asian countries, particularly those nestled around the Himalayan belt, encompassing regions from Jammu and Kashmir to Arunachal Pradesh and the northeastern state of Nagaland in India [1]. This extensive area, stretching approximately 3,500 km, stands out as one of the world's most biodiverse ecosystems. The indigenous communities inhabiting this region possess a wealth of knowledge regarding the nutritional benefits derived from both plant and animal sources, which they skillfully incorporate into their daily diets. Over generations, they have developed intricate and unique methods of food preparation, with fermentation being a prominent technique applied to both plant and animal-derived ingredients. The local populations have a deep understanding of their environment, using indigenous flora and fauna and developing traditional methods to

maximise benefits from available resources [2,3]. Despite the exchange of certain food items across borders, each region maintains distinct food preparation techniques and a unique history of indigenous nomenclature. Traditional fermented foods are associated with specific microorganisms, such as lactic acid bacteria and Bacillus, suggesting their potential to promote human health [4]. Lactic acid bacteria are crucial in Asian fermented foods, preserving edibles through fermentation of raw materials like rice wine, cakes, and fish by producing organic acids that control harmful microorganisms and create desirable flavors [5].

1. Literature Review

In the context of food fermentation, the ingenious use of natural resources is a hallmark of these traditional practices, with communities leveraging the diverse array of flora and fauna to their advantage and integrating innovative methods to optimize the overall benefits derived from their food

The Eastern Himalayan region showcases the close ties in the origin and settlement of ethnic groups, which is reflected in their traditional knowledge. The food culture reflects the knowledge transfer within and between different ethnic groups in the region. Fermented foods in the Eastern Himalayas include a wide variety of vegetables, cereals, and milk products. These foods are usually made through the knowledge of the locals using readily available raw material [6,7]. As communities produce and consume fermented foods worldwide, they have become an important part of daily diets. Fermentation relies on partial oxidation of carbohydrates without external electron acceptors, influenced by sugar type, nutrient and oxygen availability, competitive microorganisms, and time [8]. Fermentation boosts food availability and quality and improves safety and nutritional value.

Traditional fermented foods can be classified into nine groups: fermented cereals, vegetables, legumes, roots or tubers, milk, meat and fish products, miscellaneous fermented products, and alcoholic beverages. Across cultures globally, fermented foods, an integral part of daily diets, are produced and consumed. Fermentation is a metabolic process which involves the partial oxidation of carbohydrates without external electron acceptors. It is impacted by several factors, including the type of sugar present, along with the oxygen, important nutrients, microorganisms, and also the duration of the process. Fermentation enhances both the availability and quality of food products, while also contributing to improvements in safety and nutritional value [9]. Some of the reasons for fermenting foods are for improved preservation and also for the organoleptic quality. But most importantly, it is for the enhanced nutritional properties. Since as early as 8000 BC, fermented foods have been an essential part of the human diet, making up about a third of what people eat worldwide [10,11].

Fermented foods have been in existence since time immemorial, which shows strong connections to culture and traditions and sheds light on indigenous people's ability to prepare microbial products other than food and beverages. In modern times, however, traditional fermented food preparation is considered a household art rather than a necessity [12].

It is learned that fermentation may be considered as one of the oldest food preparation methods in the Indian subcontinent. This theory holds, as several reports have been conducted on food quality enhancement, whereby vitamins and proteins are more soluble in this process of food preparation. The northeastern states of India also prepare fermented foods regularly, and they have vernacular nomenclature [13,14]. For instance, the fermented soybean is called by the vernacular name-Hawaijar by the Meitei in Manipur, the Sumi Naga in Nagaland calls it axone, the people of Meghalaya fondly calls it Tungrymbai, in Arunachal Pradesh the Apatani calls it Peruyyan,the Mizos in Mizoram calls it Bekantha, in Sikkim people call it Kinema[12,15–17] . They are similar to Natto in Japan, Chungkok-jang in Korea, and Thua-nao in Thailand[18] . These fermented foods show the extent of cultural and traditional practices.

Although each fermented soybean bears a resemblance to the others, each region has a unique history of food evolution. For instance, oral traditions have been around, as in the case of the state of Nagaland in India. A certain Naga tribe, known as the Sumi, has been the connoisseurs of fermenting soybean seeds[12,19] The story of the old says that soybean seeds were paid as wages in place of money by a rich landlord to an impoverished female labourer. She cooked soybeans and consumed them daily. This was a monotonous diet.

Therefore, she flung the cooked soybean in exasperation at the far end of the fireplace, where the wood is stacked. One day, the landlord missed his payment of soybean seeds to the labourer for some reason. She became so hungry that she foraged the fireplace for the soybean she had flung on the fireplace earlier. It fermented over the days, and she liked it better. It was better in taste and aroma, which later on came to be known as 'axone' in the Naga Sumi dialect [20,21]. Thereafter, the traditional practice of cooking soybean seeds, wrapping them in banana leave and keeping them near fireplaces for fermentation has become a conventional practice in the Sumi Naga tribe. Subsequently, the rest of the tribes of Nagaland duplicated the method for preparing fermented soybeans. The vernacular names of each tribe were coined accordingly. Various elders of the Sumi Naga tribe have affirmed this brief oral narrative. It is therefore safe to state that the Nagas were originally using fermented soybean as an accidentally discovered food and were not learned or duplicated from anywhere else. It is interesting to note that the fermentation period is very brief, approximately three to four days in the summer months and a week or so in the cold winter months in Nagaland. Tungryumbai in Meghalaya takes roughly six months or so to ferment, and more so in Chungkok-jang, Korea [22,23].

Some points of high interest are the slight variation in the preparation of fermented soybean by each tribe, such as the use of different kinds of leaves for wrapping the cooked soybean before fermentation, and variation in the size of seeds. In addition, the time required to cook using different sources of energy, such as firewood and electricity, is important in preparation. Many indigenous fermented foods, such as those containing non-pathogenic microorganisms, are made using starter cultures. However, in axone, the fermented soybean of Nagaland was not used as a starter [12]. Moreover, they were not even aware of the role of the starter culture in the preparation of axone.

The axone deserves special attention in the Naga diet. However, a lack of documented reports of this special traditional food item in the Nagas compels one to conduct a thorough study and report on this indigenous food. It would create a decent foundation to study this traditional food item and make improvisations in its hygienic handling, as well as find ways to enhance the taste and flavour, for which we have ample room to work on.

3. Methodology

3.1. Study area

In this study, the area covered consists of the local market and households of the Sumi Naga tribe in Zunheboto District, Nagaland, India, for the fermentation of food products. Zunheboto is one of the eleven districts of Nagaland, and it is situated at an altitude of 1250 m above sea level and lies between 25°57′ N latitude and 94°33′ E longitude, with a total geographical area of 1255 sq. km. [24]

3.2 Data Collection

The documentation is based on a field survey from 2024 to 2025 across 50 villages in Nagaland. There are seventeen tribes recognised and approved by the government of Nagaland in the northeast India [35] During the survey, it was found that almost all of the tribes were involved in making and consuming fermented soybeans. Therefore, to conduct an extensive study of Nagaland as a whole, almost all approved tribes and the remaining indigenous tribes were taken into consideration for the survey conducted. The tribes selected for the study are Ao, Angami, Chakhesang, Chang, Chirr (Burma), Khiamniungan, Konyak, Lotha, Makuri (Burma), Pochury, Phom, Rengma, Rongmei, Sangtam, Sumi, Tikhir (Burma), Yimchunger, Zemi (Peren) and Kuki.

3.3 Explanatory research

The method of explanatory research was used to inquire about the preparation and usage of fermented soybeans among the different tribes of Nagaland. Both rural and urban populations are involved in the preparation and usage of fermented soybeans. Women comprise the majority of workers in the process of

making fermented soybeans in Nagaland, which is mainly due to the dominant role of women in the kitchen. Each tribe has a vernacular name for the fermented soybean.

3.4 Different types of soybean seeds used

Soybean also known as Glycine max (L.) Merrill, belongs to the family Leguminosae, sub-family Papilionaceae was probably introduced into India from China through the Himalayas several centuries ago, and some believe that soybeans were also brought to Myanmar by traders from Indonesia [25].Two indigenous varieties of soybeans, "yellow cultivar" and "dark brown cultivar", are grown between May and June and harvested in November [26]. Locally grown soybeans are harvested, and the dry seeds of soybeans are naturally fermented into axone. The different tribes of Nagaland have used both these yellow cultivars and the brown cultivar, which have certain variations in their shades, although the colour is primarily of two shades. In very rare cases, green and ivory shades of the seeds have also been reported. The varieties of soybean used are mostly local cultivars, and the seed colours vary.

3.5 Different tribes use different soybean seed colours.

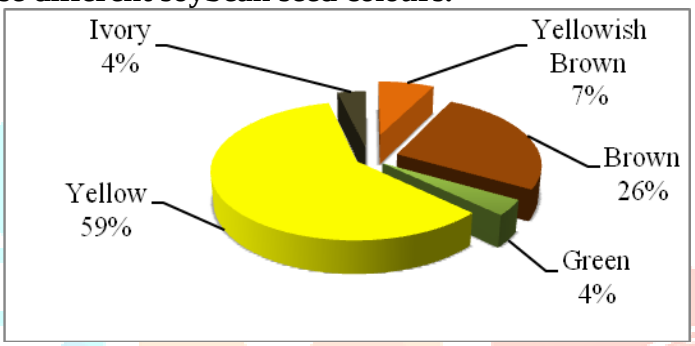

Fig 1. Color of raw soybean seeds used by different tribes in Nagaland.

Table 1- Preparation of fermented soybeans by different tribes in Nagaland.

Tribes	Seed color	Vernacular name	Duration of soaking before cooking (hours)	Utensil used for cooking	Cooking time (hours)
Ao	Brown or yellow	azüngkenshi	12	Aluminium pot Pressure cooker	4 1
Angami	Yellowish or yellowish brown	dzachie	24	Pressure cooker	1
Chakhesang	Brown or yellowish	toche or süjoche or broche	24	Pressure cooker Aluminium pot	1 4
Chang	Brown or light Yellow	mabong	12	Pressure cooker aluminium pot	0.5 4
Chirr (Burma)	No data	-	-	-	-
Khiamniungan	Yellow	chiuteh	3	Pressure cooker Aluminium pot	0.5 6 to 7
Konyak	Dark yellow Or ivory	yongpheang	4	Aluminium pot Clay pot	4 to 5 12

Lotha	Yellowish or brown	linkhyim or lintüm	24 -	Pressure cooker Aluminium pot	0.5 5 to 6
Makuri(Burma)	No data	-	-	-	-
Pochury	No data	ashepre	5	-	
Phom	Yellow or bright Yellow	ashe	Not soaked	Aluminium pot	1 to 2
Rengma	Light yellow	ahaiyen	12	Pressure cooker	0.5
Rongmei	No data	-	-	-	-
Sangtam	Yellowish	xongyangsü or hongyangshü	12	Pressure cooker Aluminium pot	0.5 1.5
Sumi	Brown or yellow	axone	6	Steel or any kind of pot	2-3
Tikhir(Burma)	Brownish yellow	bongshaw	4	Pressure cooker	2
Yimchunger	Yellow	mongshüshü	5	Pressure cooker	2
Zemi(Peren)	Green	ntsang	24	Pressure cooker Aluminium pot	0.5 2 to 3
Kuki	Brown	bethu	Not soaked	Aluminium pot	0.5

3.5 Types of Leaves Used

It is interesting to note that after the soybean is cooked, some plant leaves such as banana, Phrynium pubinerve Blume (Marantaceae), or Macaranga indica Wight (Euphorbiaceae) leaves are used to wrap the cooked soybean and remain above the fireplace for a week.

3.6 Tribes under the survey

Ao, Angami, Chakhesang, Chang, Chirr (Burma), Khiamniungan, Konyak, Lotha, Makuri (Burma), Pochury, Phom, Rengma, Rongmei, Sangtam, Sumi, Tikhir(Burma), Yimchunger, Zemi (Peren) and Kuki are the nineteen tribes surveyed for the explanatory research.

Depending on the method of preparation and the type of soybean seed used, different tribes use different names for fermented soybean, which is given in Table 1

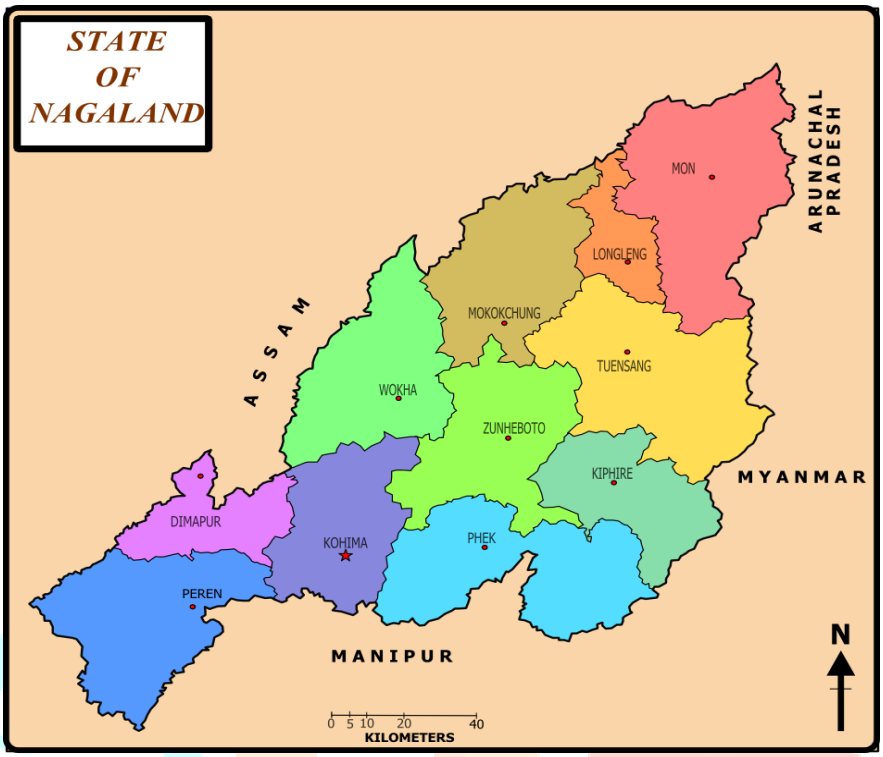

Figure 2. Administrative district map of Nagaland, India, showing district boundaries and neighbouring states. Adapted from MapsofIndia.com (accessed on 11 July 2025).

Table 2- Different districts of Nagaland showing the concentration of the tribes in different areas.

District	Tribes located
Dimapur	Sema, Ao, Lotha, Angami
Kiphire	Sangtam
Kohima	Angami, Rengma
Longleng	Sangtam, Phom
Mokokchung	Ao
Mon	Konyak
Peren	Zeliang
Phek	Chakhesang, Pochury, Rengma
Tuensang	Sangtam, Chang, Khiamniungan, Yimchunger
Wokha	Lotha
Zunhebhoto	Sema

Table 3: Factors affecting the traditional method of preparing fermented soybean or axone.

Tribes	Duration for for cooked soybean	Duration for complete fermentation.	Any other newer steps/ Techniques	Storage methods to delay	Time taken to deteriorate the fermented

	kept near intense fire daily(hrs)	(days)	added to the existing ones	deterioration	soybean
Ao	4	Summer 3-4 d Winter 6-7 d	-	Kept near fire	6 months
Angam	5	Summer 4 d. Winter 5d	-	Kept in an air-tight containers or wrapped in a banana leaf and kept near the fire for a few days.	5-6 months
Chakhesang	4	7 d	-	Packed in banana leaves and kept in the sun/ near fire.	4 months
Chang	7	7 d	-	Packed in banana leaves and kept in the sun or near a fire.	2-3 months
Khiamniungan	6	4-5 d	-	Covered with leaf and left to dry or kept near fire. Avoid keeping near meat or burning plastic.	When heated too long in fire.
Konyak	6-7	7 d	-	Cooked and cooled Soybean is covered.	1 month
Lotha	6-7	Summer 4 d. Winter 7d	-	Mixed with salt, mashed, packed in teak leaves. Dried.	-
Makuri	no data	-	-	-	-
Pochury	7	7 d	-	Covered with leaf and keep near fire.	2 months
Phom	4-5	7 d	-	Wrapped in banana Leaf and kept near fire.	3 months
Rengma	6-8	5-6	-	Bottled	2 months
Rongmei	-	-	-	-	-

Sangtam	8	5 d in summer 7 d in winter. Further kept for 3 d more.	-	-	-
Sumi	-	4-5 d in warm places. 14- 21 d in colder places.	Fermented soybean is dried and crushed.	Covered with banana leaf, or bottled.	1 month
Tikhir (Burma)	10	14 d roughly	- cold place.	Kept in 4-5months	
Yimchunger	9	2-3 d	-	Bottled and kept near moderate fire	1 month
Zemi (Peren)	10	9 d	-	Covered banana leaf	2-3 weeks
Kuki	10	7 d	-	Kept near fire.	2 weeks

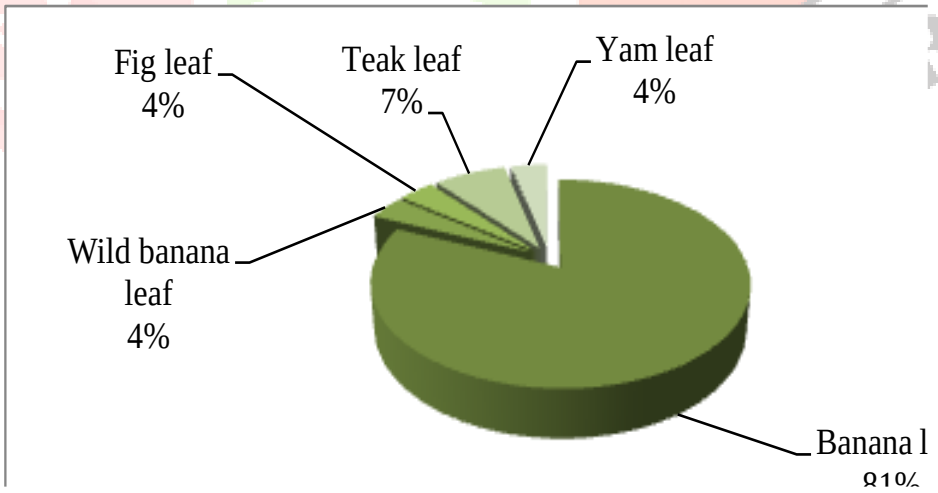

Fig 3. Types of leaves used by the different tribes of Nagaland to wrap freshly cooked soybeans for fermentation.

3.7 The Process of Making axone

Fermented soybean is made from Glycine max (L.) Merril [27], which is popularly known as the axone in the Sumi-Naga dialect of Nagaland. Axones are typically prepared from locally available soybean seeds. Axone was prepared primarily by cleaning and soaking for a period, which softens the soybean seeds. Then, it was cooked in aluminium pots for a pressure cooker for an hour or so till the soybean seeds were fully cooked. The cooked beans were ground using a wooden mortar and pestle. However, it is a matter of choice to wrap the leaves directly without grinding. Banana, Phrynium pubinerve Blume (Marantaceae), or Macaranga indica Wight (Euphorbiaceae) leaves were used to wrap the cooked soybean in approximately 100 g portions and kept at a height of one to two metres above the fireplace to ferment for a week. The final axone product has an umami flavour, which is slightly alkaline in taste with an ammoniacal smell. Fresh axone is considered ready after fermentation when converted into sticky and stringy lemon-colored products. To obtain axone-matured packets, unopened packets are allowed to stay in a smoke-rich kitchen area for several weeks. A dried axone is made from mature axone when it is dried in situ after one or two months of storage, ground, and kept in airtight glass jars for use as curry powder. Except for boiled and dehulled soybean paste, nothing is added to it, while in a similar product of Sikkim called as Kinema, approximately 1% wood ash is added before putting it for fermentation [28]

The quality of axone varies depending on the variety of soybean used, variation in environmental temperature, kitchen conditions, and the tribal liking for flavour. Lotha and Ao tribes like it mildly matured Angami mostly like strongly fermented fresh axones, while Sumi and Chakhesang tribes prefer to consume brown, fully matured axone[23] . Axone resembles fermented soybean products used in other parts of the Northeastern Himalayas, including hawaijar of Manipur, tungrymbai of Meghalaya, and bekang of Mizoram [29–31].

3.8 Why Starters Are Not Used for Fermentation

The axone is prepared at the household level without using a starter culture under Nagaland's different tribal practices. This is mainly because crude practices using only native ingredients, such as local soybean seeds, have never been discussed or challenged. As a result, axone has been consumed for a long period without any change in the traditional preparation practices without a starter culture.

Several studies have reported the microbiological quality of axone-like products throughout Northeast Asian countries, but little is known about axone. Natto and Kinema have been well studied, and microflora have been characterised to standardise production at a commercial scale.Studies on a limited number of axone samples from Sema and Chakesang tribes provided only a bird's eye view of one of the most widely used products [20,30]. Although most of the products in this class are made from boiled soybeans through aerobic fermentation, products from different regions contain different types of bacteria. In natto, it is Bacillus natto, a variant of B. subtilis, in kinema, it is mostly B. subtilis, in the axone of the Chakesang tribe, though B. subtilis was detected, but major bacteria are B. coagulans, while in chungkukjang, the most active bacteria identified are nontoxigenic B. cereus, along with B. amyloliquefaciens and B. subtilis [30,32–34]. All tribes were unanimous in not using any extra or special ingredients to enhance the taste of the cooked soybean, which was meant to enhance fermentation. In some cases, salt use has been reported.

4. General method of preparation of fermented soybean by the traditional method

In the traditional method of preparing fermented soybean or axone, raw soybean seeds are first taken from stock and soaked for a certain period until they become soft. It is then cooked in an aluminium pot, using firewood as the main source of energy. It is cooked for an hour until the seeds are dehulled and soft. After the soybean seeds were fully cooked, they were drained and cooled. Finally, the cooked soybean seeds were wrapped in banana leaves, such as banana, Phrynium pubinerve Blume, Marantaceae, or Macaranga indica Wight, Euphorbiaceae. The wrapped seeds were kept near fire for a period of three–four days in summer and six–seven days in winter for complete fermentation to take place. When the fermented soybean is removed from the leaf wrapping, it is either crushed and stored for further use in containers or dried completely in the sun.

Pictures of traditional preparation and diversity of axone: fermented soybean in Nagaland, India

Fig.4 Raw soybean seeds

Fig.5-Soaked seeds

Fig.6 Soybean seeds being cooked

Fig.10 Dried fermented soybean(30 days old)

Fig.8 Fermented soybean seeds

Fig.9 Fermented seeds wrapped in Phrynium pubinerve

Fig.7 Cooked and drained and crushed soybean soybean(7 days old)

4.1. Fermented soybean of the Ao tribe

Azungkenshi is prepared from brown or yellow soybean seed, which is soaked for 12 hours Before cooking, and then cooked in an aluminium pot for 12 hours without using any preservatives. It is then drained, allowed to cool, and covered with a banana leaf. It is then left near a strong fire for approximately 3 hours a day for 3-4 days in summer and 6-7 days in winter, after which complete fermentation occurs and the preparation becomes ready for consumption. Azungkenshi is kept near the fire to reduce spoilage over time. It is believed that taste is enhanced by keeping the item near the fire during storage.

4.2. Fermented soybean of the Angami tribe

Dzachie was prepared from yellowish-brown soybeans soaked for 1 day before cooking and then cooked in a pressure cooker for 2-3 hours without using any preservatives. It is then drained and cooled by washing with cold water, and then covered with a banana leaf. It is then left near a strong fire for approximately 5-6 hours a day for 4 days in summer and 5 days in winter, after which complete fermentation takes place and the preparation becomes ready for consumption. Dzachie is kept in airtight containers or wrapped in banana leaves or newspapers and kept near the fire to reduce spoilage over time. However, if the fermented soybean becomes sour, ash from firewood is mixed with water and put in the

soybean and kept near the fire for some days and reused for consumption. Dzachie is kept in airtight containers or wrapped in banana leaves and kept near the fire to reduce spoilage over time.

4.3. Fermented soybean of the Chakhesang tribe

Toche, Sujoche, and Broche were prepared from brown soybeans soaked for 1 hour before cooking and then cooked in a pressure cooker for 30 minutes without using any preservatives. It is then drained and covered with an uncooled yam leaf without any cooling. It is then left near a strong fire for approximately 4 hours a day for 7 days, after which complete fermentation takes place, and the preparation becomes ready for consumption. Toche is covered with yam leaves and is regularly exposed to sunlight to prevent decomposition. When a fire is not accessible, the item is kept in the hot sun. To enhance taste and reduce spoilage over time, it is believed that water should be drained completely after cooking. A small quantity of mustard oil also enhances the taste. In order to improve the odour, high-quality firewood should be used, and bamboo leaves for wrapping should be fresh. It is better to avoid burning plastic and frying oil near the fermented soybean. To improve shelf life, airtight containers are better than leaf covering. If leaf covering is used, keeping it near the fire makes it last longer.

4.4. Fermented soybean of the Chang tribe

Mabong is prepared from brown soybean, which is not soaked before cooking and is cooked in a pressure cooker for 3-4 hours without using any preservatives. It was then drained and covered with banana leaves without any cooling. It is then left near a strong fire for around 4-5 hours a day for 1-2 weeks, after which complete fermentation takes place and the preparation becomes ready for consumption. To improve shelf life, mabong is covered with banana leaves and kept near fire or in the sun, upon which it stays without spoiling for 2-3 months. It is dried and kept in airtight bottles or covered with a leaf, upon which it stays without spoiling for about 1 month.

4.5. Fermented soybean of the Khiamniungan tribe

Chiuteh/ Chiude is prepared from yellow soybean, which is soaked for 2-3 hours before cooking and then cooked in an aluminium pot for about 6-7 hours or in a pressure cooker for about 30 minutes without using any preservatives. It was then drained and covered with banana leaves after cooling for approximately 15 minutes. It is then left near a strong fire for approximately 4-5 days, after which complete fermentation takes place, and the preparation becomes ready for consumption. To improve the shelf life, chiuteh is covered with leaves and left to dry. To enhance the taste and reduce spoilage over time, it is kept near fire and keeping near meat/ burning plastics is avoided.

4.6. Fermented soybean of the Konyak tribe

Yongpheang is prepared from dark yellow soybeans by soaking the beans for 3-4 hours before cooking and then cooking in an aluminium pot for approximately 4-5 hours without using any preservatives. It was then drained, cooled, and covered with a wild banana leaf. It is then left near a strong fire for approximately 6-7 hours a day for 1 week, after which complete fermentation takes place and the preparation becomes ready for consumption. To enhance taste and reduce spoilage over time, cooked and cooled soybeans are covered with perforated banana leaves. The fermented soybean is pounded, packed with banana leaves, and stored in bamboo containers, and here it remains edible for about 1 month. To enhance taste and reduce spoilage over time, it is kept near the fire.

4.7. Fermented soybean of the Lotha tribe

Linkhyim is prepared from yellowish soybeans that are not soaked before cooking and are cooked in an aluminium pot for approximately 5-6 hours without using any preservatives. It is then drained, but not cooled, and covered with a teak leaf. It is then left near a strong fire for approximately 6-7 hours a day for about 4 days in summer and 1 week in winter, after which complete fermentation takes place. After removal from the fire, it is mixed with salt, smashed, packed in teak leaves, and dried. During fermentation, animal fats are burned in a fire to improve their taste. Animal skin and plastic should not be burned during the fermentation process. It is mixed with salt and chilli powder and dried for longer periods of preservation. The samples are then stored in airtight containers.

4.8. Fermented soybean of the Phom tribe

Ashe is prepared from bright yellow soybeans that are not soaked before cooking and cooked in an aluminium pot for approximately 1-2 hours without using any preservatives. It is then drained, cooled for approximately 30 minutes and covered with banana leaves. It is then left near a strong fire for around 4-5 hours a day for 2 weeks, after which complete fermentation takes place and the preparation becomes ready for consumption. To reduce spoilage over time, fermented soybeans are wrapped in banana leaves and kept near the fire and can be preserved for approximately three months.

4.9. Fermented soybean of the Rengma tribe

Ahaiyen is prepared from light-yellow soybeans soaked overnight before cooking and is cooked in a pressure cooker for approximately 30 minutes without using any preservatives. It was then drained and covered with banana leaves without allowing the soybean to cool. It is then left near a strong fire for approximately 6-8 hours a day for 5-6 days, after which complete fermentation takes place, and the preparation becomes ready for consumption. To reduce spoilage over time, fermented soybeans are salted slightly and then bottled, which lasts from 2 months to even one year.

4.10 Fermented soybean of the Sangtam tribe

Xongyangsu is prepared from yellowish soybean, which is soaked for about 12 hours before cooking and is cooked in an aluminium pot for about one hour and 30 minutes without using any preservatives. It was then drained, cooled to room temperature, and covered with a banana or teak leaf. It is then left near a strong fire for approximately 9-10 hours a day for 5-6 days in summer & 7-8 days in winter, after which the preparation becomes ready for consumption. If wrapped with teak/banana leaves and kept near the fire, it remains without spoiled for 3-4 weeks. To enhance the taste of burning plastics near the fire, wood that gives a bad odour when burnt is avoided, and citrus fruit is not kept near fermenting soybean. It is stored in air-tight bottles and kept away from the fire, upon which it remains stable for approximately one month.

4.11 Fermented soybean of the Sumi tribe

The axone is prepared from brown soybean, which is cooked in a steel or iron pot until the soybean turns soft without using any preservatives. It was then drained, cooled for 15–20 minutes and covered with banana leaves. It was then left for 4-5 days in a warm place, to for 2-3 weeks in cold places, after which preparation was ready for consumption. It was ensured that the cooked soybean was completely drained, dried, and then wrapped with banana leaves. The dry fermented soybean is crushed and stored air-tight, upon which it remains stable for approximately 1 month.

4.12. Fermented soybean of the Tikhir (Burma) tribe

Bongshaw was prepared from brownish yellow soybeans soaked for 3-4 hours before cooking and cooked in a pressure cooker for approximately 2 hours without using any preservatives. It is then drained, cooled, and covered with a banana or any other leaf. It is then left near a strong fire for approximately 8-10 hours a day for about two weeks, after which the preparation becomes ready for consumption. If kept in a cool place, it remains stable for about 4-5 months.

4.13. Fermented soybean of the Yimchunger tribe

Mongshuhshu is prepared from yellow soybeans soaked for 4-5 hours before cooking and cooked in a pressure cooker for approximately two hours without using any preservatives. It was then drained, cooled for approximately 30 minutes and covered with banana leaves. It is then left near a strong fire for approximately 11 hours a day for approximately 9 days, after which the preparation becomes ready for consumption. The cooked soybeans were transferred to clean plastic bags and kept near the fire. When fermented soybeans were kept in a container and kept in a cool place, they remained stable for approximately 5 months.

When the fermented soybean is bottled and kept near a moderate fire, it remains stable for approximately one month.

4.14. Fermented soybean of the Zemi (Peren) tribe

Ntsang is prepared from green soybeans soaked for 24 h before cooking and cooked in an aluminium pot or pressure cooker for approximately 2-3 hours without using any preservatives. It was then drained and cooled for approximately 10 minutes and covered with a banana leaf. It is then left near a strong fire for

approximately 9-10 hours a day for approximately 9 days, after which the preparation becomes ready for consumption. When fermented soybeans are wrapped in banana leaves, they remain stable for–2-3 weeks.

4.15 Fermented soybean of the Kuki tribe

Bethu is prepared from brown soybeans that are not soaked before cooking and cooked in an aluminium pot for about 30-40 minutes without using any preservatives. It is then drained, cooled for approximately 20 minutes and covered with banana leaves. It is then left near a strong fire for about one week, after which the preparation is ready for consumption. When fermented soybeans are kept near the fire, they remain stable for approximately two weeks. It is believed that taste and odour are dependent on the leaves and quality of the soybean used.

5. Results and discussion

A total of 19 tribes belonging to the state of Nagaland in Northeast India were studied, of which 16 tribes produced all the data required for the explanatory research. In all of these surveys, it was found that fermented soybean or axone is an original indigenous food item that has been designed from local soybean seeds by indigenous tribal people living in Nagaland. Each tribe has its vernacular name, and the raw material used is harvested from its land. The method of preparation lacked any modern technological inputs, such as energy-efficient techniques in the preparation and preservation methods.

The skills required for preparation were not sophisticated. The scale of the prepared products was just to meet household demands and not on an industrial scale, which was found to be due to a lack of knowledge of the usage of starter cultures and preservatives. However, the ethnic food was prepared in a similar way of fermentation when compared to the fermented soybean products of other neighbouring states of Nagaland and countries that made such food items. Temperature control and time duration were similar, and the method of preparation all pointed towards aerobic fermentation, which is the major chemical change that brings about the fermentation of the soybean.

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