



Ethnic Fermented Foods and Beverages of West Bengal and Odisha

23

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Abstract

West Bengal and Odisha are the two neighbouring states in India. Due to the climatic variations, a large number of crops, vegetables and fishes are produced in this region. Therefore, diverse numbers of fermented foods are prepared which can be categorized into four different groups (cereal- and pulse-based, plant-based, dairy-based and fish-based). In this chapter, we focused on the traditional preparation process, microbiology, nutritional value, optimization and commercialization of the fermented foods prepared in West Bengal and Odisha. The native people usually practise their indigenous knowledge for preparation of the fermented foods. They unknowingly use the microbes for fermented food preparation. Among the microbes, yeast, mould, lactic acid bacteria and *Bacillus* (*B.*) sp. majorly took part in the fermentation process. However, most of the fermented foods did not achieve significant scientific attention. This fact may lead to the disappearance of the traditional knowledge. Therefore, it is essential to explore the nutritional content and health benefits, detect critical control point, optimize preparation process and eventually commercialize the traditional fermented foods.

Keywords

Traditional fermented foods · Yeast · Lactic acid bacteria · Chenna poda · Haria

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23.1 Introduction

Odisha (formerly Orissa) and West Bengal are two neighbouring states in Eastern India. These states were united in the Bengal Presidency of British India. Odisha became a separate province (state) on 1 April 1936, whereas West Bengal separated from East Bengal during India's Independence in 1947. The Bengali people possess some Austro-Asiatic ancestry via gene flow from East and Northeast India (Khan 2017), but Odisha history predates Aryan-Indian history (Choudhury 2013). Due to close proximity and similar geo-climatic environment, West Bengal and Odisha have identical tradition and civilization. Hindu festivals celebrated by the people are very common. Both have enriched cultural foundation. Bengali and Odisha languages are very close in some standards especially the dialects that are neighbouring. Sambalpuri dialect is in some ways sound closer to Calcutta dialect. It is thought that both of the languages are directly descended from Magadhi Prakrit.

Rice is the staple food in both states. The food culture particularly uses mustard oil as a cooking medium; vegetables and spices are very common in both states' cuisine. The diversity of ethnic foods in this region is related to the diversity of ethnicity and abundant bioresources. Rice, pulses, vegetables, milk and fishes are the major food-stuff, and different varieties of non-fermented and fermented foods are prepared. The scarceness information of traditional food culture in these states leads to difficulty to make a portrait of food history in this area. However, this is the inherited food culture of Indian civilization. The culture of preparing food with proper methods was introduced by the two ancient Indian civilizations – the Harappa and the Mohenjo-daro (<https://www.dosamatic.com/history-of-indian-food/>). The first preparation of food included a number of cereals and pulses. Gradually, the diet consisted of vegetables, fruits, grains, meat, honey, dairy products, beverages and special kind of spices as better forms of cooking were innovated and the civilization moved towards perfection. The Vedic food culture was further enriched due to Aryans influences that travelled from Central Asia with a number of new cuisines. Food components went through the massive changes during the rule of Maurya and Gupta Empires, who forced to incorporate vegetarian diet due to some sacred beliefs (<https://www.dosamatic.com/history-of-indian-food/>). The food habits underwent revolutionized with the introduction of the most popular Mughal cuisine during the Mediaeval period (<https://www.dosamatic.com/history-of-indian-food/>). They brought different kinds of meats, fruits and flatbread in the diet of Indians. Sumptuous dishes were prepared during the rule of Shah Jahan and Jahangir. Next, the Nizams and the Portuguese, Chinese, British, and Anglo-Indian influence on Indian food (<https://www.dosamatic.com/history-of-indian-food/>). This continued in modern days as well.

The techniques of ethnic fermented food and beverage preparation by the rural people are somehow untouched or unmodified with the upgradation of the culinary culture of Indian civilization. The native knowledge and skillful technology for preparing varieties of the fermented products using carefully selected raw ingredients and other materials are unparalleled to the other communities of the world. Moreover, they unknowingly used the beneficial microorganisms (natural or starter added) to maintain the standard of fermented foods and beverages. They employed trial and

error methods for improving the quality of the foods. The gathered indigenous knowledge is still maintained and modernized when passed on the generations. However, traditional knowledge is not sufficiently documented scientifically. If it is ignored continuously, the indigenous traditional knowledge will disappear soon without any scientific improvement (Tamang et al. 2016). Hence, there is a need to explore the ethnic foods and beverages scientifically to find out the benefits of those. Finally, modern civilization can achieve health benefits from traditional foods.

The traditional or indigenous fermented foods and beverages are an integral part of the dietary culture in India from ancient times. It was documented that the food fermentation appeared in India in the time between 6000 and 4000 BC (Tamang et al. 2016). The history of the Indian cereal-based fermented foods like *idli*, *dosa* and *dhokla* was reported around 1100 AD (Gode 1943; Nair and Prajapati 2008). *Kinema*, a soybean-based fermented food in Sikkim, India, originated around 600 BC to 100 AD (Tamang et al. 2016). Dairy-based fermented foods, viz., *dahi* and *butter*, are popular in India since the Lord Krishna's time about 3000 BC. However, *dahi* was first mentioned in the Veda and Upanishad during 6000–4000 BC (Yegna Narayan Aiyar 1953).

Most of the traditional fermented foods are scientifically unexplored considering their hidden constituents, technological upgradation and commercial exploitation. Besides, the majority of minor or restricted community-based traditional foods are undocumented. However, these are ancestrally experienced as safe and nutritious, have ameliorative to the certain ailment and have strong ritual values. Considering the exponential uprising of the market of functional foods, there is enough scope to explore the regional traditional foods in India for the sake of native people and to attract the outsiders. Based on this perspective and rationale, the goal of this article is to document the preparation procedure, the composition of nutrients, microbial composition and other health benefits of major and minor traditional fermented foods of West Bengal and Odisha on the basis of available data and our own observation.

23.2 Fermented Foods and Beverages in West Bengal and Odisha

A total of 5,296,953 and 9,590,756 schedule tribes inhabit in West Bengal and Odisha, respectively, as per 2011 census (<http://censusindia.gov.in/2011-Common/CensusData2011.html>). Among the schedule tribes, there are *Santal*, *Oraon*, *Munda*, *Bhumij*, *Kora*, *Lodha*, *Mahali*, *Bhutia*, *Bedia* and *Savar*. These vast numbers of ethnic people use their indigenous knowledge to prepare diverse types of foods and beverages. However, the non-ethnic group also followed the methods developed by their ancestors in preparation of the fermented products. This region has a large diversity of fermented food products made from both animal and plant sources. The high diversity of fermented products is probably dependent upon the food habits of ethnic community and the availability of food ingredient (Tiwari and Mahanta 2007). Moreover, the diversity of the natural microorganism also has an impact on the large variation of the indigenous fermented foods (Tamang 2009). These types

Table 23.1 Nutraceuticals and functional properties of popular fermented products in West Bengal and Odisha

Types of fermented foods	Name of the fermented food	Associated microbes	Nutritional composition	Health benefits	References
Cereal- and pulse-based fermented products	<i>Chakali pitha</i>	Not reported	Phytic acid is degraded and thus increased the availability of minerals (zinc and iron) and vitamins (vitamin B and C)	Not reported	Ray et al. (2016), Sahoo et al. (2017)
	<i>Enduri pitha</i>	<i>Lb. fermentum</i>	Not reported	It boosts the immune system and acts as a protective agent in different seasonal infections	Ray and Swain (2013), Ray et al. (2016), Roy et al. (2007)
	<i>Podopitha</i>	Not reported	Abundant carbohydrates, free Sugars and fibres	Not reported	Ray and Swain (2013)
	Sour rice	<i>Lb. casei</i> , <i>Lb. bulgaricus</i> , <i>Pd. acidilactici</i> , <i>Streptococcus thermophilus</i> and <i>Saccharomyces</i> sp.	pH (4.89), phytic acid (0.313 mg/g), vitamin B complex and K, minerals [iron (73.91 mg/100 g), sodium (303 mg/100 g), potassium (839 mg/100 g), calcium (850 mg/100 g), phosphorus (80.4 mg/100 g), magnesium (532.3 mg/100 g), zinc (32.8 mg/100 g), etc.]	It is an energy-rich food and helps to restore the gastrointestinal flora during intestinal ailments such as irritable bowel syndrome, duodenal ulcers, Crohn's disease, etc. It prevents the constipation	Choi et al. (2014), Goswami et al. (2016), Ray and Swain (2013), Ray et al. (2016)
	<i>Jalebi</i> ^a	<i>Lb. fermentum</i> , <i>Lb. buchneri</i> , <i>Streptococcus lactis</i> , <i>Streptococcus faecalis</i> and <i>S. cerevisiae</i>	pH (4.4–3.3), protein (24.1 mg/g), carbohydrate (13.9 mg/g), reducing sugar (29.9 mg/g), fat (4.31 g/100 g), lactic acid	It provides instant energy	Sekar and Mariappan (2007), Sharma et al. (2013)

<i>Barfi</i> ^a	<p>No such data is available for <i>bari</i> prepared in this region. Considering the similar products in India, the following bacteria might be involved. <i>B. subtilis</i>, <i>Candida famata</i>, <i>Candida curvata</i>, <i>Candida parapsilosis</i>, <i>Candida krusei</i>, <i>Candida vartiovaarai</i>, <i>Cryptococcus humicola</i>, <i>Debaryomyces tamarii</i>, <i>Debaryomyces hansenii</i>, <i>Hansenula anomala</i>, <i>Geotrichum candidum</i>, <i>S. cerevisiae</i>, <i>Kluveromyces marxianus</i>, <i>Enterococcus faecalis</i>, <i>Trichosporon beigeli</i> and <i>Wingea robertsii</i></p>	<p>Protein (16–23.8 mg/g), carbohydrate (9.4–13.9 mg/g), reducing sugar (28–34.1 mg/g)</p>	<p>It reduces flatulence-causing Oligosaccharides It exerts significant level of antioxidant and antimicrobial activities against the pathogenic bacteria</p>	<p>Kulkarni et al. (1997), Rahi and Soni (2007), Sharma et al. (2013), Tewary and Muller (1992)</p>
<i>Papad</i> ^b	<p><i>Candida krusei</i> and <i>S. cerevisiae</i></p>	<p>Carbohydrates (60 g/100 g), proteins (26 g/100 g), fat, minerals, calcium, iron, carotene and crude fibre</p>	<p>It is good appetiser and digestive food. It is claimed that it absorbs the fatty material from the mouth</p>	<p>Aidoo et al. (2006), Renu and Waghray (2016)</p>

(continued)

Table 23.1 (continued)

Types of fermented foods	Name of the fermented food	Associated microbes	Nutritional composition	Health benefits	References
	<i>Haria</i>	Mould, yeast, lactic acid bacteria (<i>Lb. fermentum</i>) and <i>Bifidobacterium</i> sp.	pH (3.5), reducing sugar (mg/mL) (6.5), total sugar (mg/mL) (51), protein content (mg/mL) (0.63 maltooligosaccharides), pyranose sugar derivatives, vitamins, minerals and phenol-rich beverage	It is believed that it protects from gastrointestinal ailments like dysentery, diarrhoea, amebiasis, acidity and vomiting. It exerted significant level of antioxidant activity. It is effective against inflammation of body parts, diarrhoea and urinary problems, expelling worms and as a treatment of cholera	Ghosh et al. (2014, 2015a, b), Ray et al. (2016)
Plant-based fermented products	<i>Pickle</i>	Lactic acid bacteria	Carbohydrate, dietary fibres, minerals, vitamins, free reducing sugar (450.15 µg/g) and protein content (8.573 ± 1.01 µg/g) (unpublished data)	It exerts the health benefits associated with the lactic acid bacteria. It showed antimicrobial and antioxidant activities	Unpublished data
	<i>Toddy</i>	Yeast (<i>S. cerevisiae</i>), acetic acid bacteria, lactic acid bacteria, specifically <i>Leuc. sp.</i> , <i>Lb. sp.</i> and <i>Zymomonas sp.</i>	pH (5.5), sucrose (12–15%), protein (0.23%), fat (0.02%), mineral, ascorbic acid 5.7 mg/100 ml) and alcohol (5–6%). There is very little reducing sugar, although glucose, fructose, maltose and raffinose are present	<i>Toddy</i> is believed to be good for the health particularly for eyesight and also serves as a sedative. It is also a mild laxative relieving constipation. It is prescribed as a tonic for those recovering from chickenpox	Karthikeyan et al. (2014), Sekar and Mariappan (2007), Steinkraus (1996)

<i>Mahua</i>	Yeast (<i>S. cerevisiae</i>)	pH (3.8), alcohol (10–15%)	<i>Mahua</i> is used as an alcoholic drink. There is no such report about the health benefits of <i>Mahua</i> . However, the substrate <i>Mahua</i> flower exerts antihelmintic, antibacterial, analgesic and hepatoprotective effects	Chandra (2001), Katiyar et al. (2011), Umadevi et al. (2011), Verma et al. (2010)
<i>Karadi</i>	Unknown	Unknown	It is used in the treatment of digestive problems, especially in constipation	Satish Kumar et al. (2013)
Dairy-based fermented products	<i>Lb. alimentarius</i> , <i>Lb. bifementans</i> , <i>Lb. paracasei</i> , <i>Lb. delbrueckii</i> subsp. <i>indicus</i> , <i>Lb. acidophilus</i> , <i>Lb. bulgaricus</i> , <i>Lb. cremoris</i> , <i>Lb. helveticus</i> , <i>Lb. fermentum</i> , <i>Lc. lactis</i> , <i>Streptococcus lactis</i> , <i>Streptococcus cremoris</i> , <i>Streptococcus thermophilus</i> , <i>Pd. acidilactici</i> , <i>Pd. pentosaceus</i> , <i>Weissella cibaria</i> , <i>Saccharomycopsis</i> sp. and <i>Candida</i> sp.	pH (4.2–4.3), free reducing sugar (3.2%), hydrosoluble protein (2.75%), free amino acids (1.10%), vitamins (thiamine, riboflavin, folic acid, niacin), proteins, essential amino acids, lactic acid (1.6% titratable acidity)	<i>Dahi</i> exerts antimicrobial effects against the pathogenic bacteria due to the high content of lactic acid and production of antimicrobial agents such as bacteriocin, antimicrobial peptides by the participating lactic acid bacteria. It is also effective in reducing cardiovascular diseases and tumours and increases the immunity	Adak et al. (2013), Bamba et al. (1973), Laxminarayana and Shankar (1980), Dave et al. (1992), Singh and Deodhar (1993), Sinha and Sinha (2000)

(continued)

Table 23.1 (continued)

Types of fermented foods	Name of the fermented food	Associated microbes	Nutritional composition	Health benefits	References
	<i>Mishti dahi</i>	<i>Lb. acidophilus</i> , <i>Lc. lactis</i> subsp. <i>lactis</i> , <i>Lb. delbrueckii</i> subsp. <i>bulgarius</i> , <i>Streptococcus salivarius</i> subsp. <i>thermophilus</i> and <i>S. cerevisiae</i>	pH (5.1), free reducing sugar (3.78%), hydrosoluble protein (1.25%), free amino acids (0.54%), lactic acid (0.96% titratable acidity)	It protects the individual from different gastrointestinal ailments. It exerts significant antimicrobial activities against pathogenic bacteria (<i>Clostridium perfringens</i> , <i>Escherichia coli</i> , <i>Shigella dysenteriae</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> and <i>Salmonella typhi</i>). It also exhibits significant antioxidant activities	Adak et al. (2013), Ghosh and Rajorhia (1990), Gupta et al. (2000)
	<i>Bandel cheese</i>	<i>Lactic acid bacteria</i>	Not reported	Not reported	–
	<i>Lassi</i> ^a	<i>Lactic acid bacteria</i> and <i>dahi</i> -associated microbes	No such data is available for <i>lassi</i> prepared in West Bengal and Odisha. However, considering similar preparation process of <i>lassi</i> in other Indian states, the following might be the nutritional components. pH (3.83–4.34), lactic acid (0.67–1.0% titratable acidity), fat (2.10–4.24%), protein (2.78–3.6%), total sugar (12.31–14.30%), amino acids, peptides, vitamins, minerals	It helps in digestion. It is effective in gastrointestinal ailments such as diarrhoea, dysentery, etc.	Munde (2015), Paedghan et al. (2015), Tamang et al. (2016)

	<i>Chhena pona</i>	<i>Not reported</i>	Protein, fat, vitamins, calcium	It is believed that the food strengthens the bones and good for digestion	-
Fish-based fermented products	Dry salted <i>Khainga</i>	Lactic acid bacteria and <i>Bacillus</i> sp.	Drying process increase the protein, lipids, vitamins and minerals	Not reported	Chukwu (2009), Thapa et al. (2007)
	<i>Sukuti</i> or <i>shutki</i> ^a	<i>Lb. lactis</i> subsp. <i>cremoris</i> , <i>Lb. lactis</i> subsp. <i>lactis</i> , <i>Lb. plantarum</i> , <i>Lb. mesenteroides</i> , <i>Enterococcus faecium</i> , <i>Enterococcus faecalis</i> , <i>Pd. pentosaceus</i> , <i>Candida chiropterorum</i> , <i>C. bombicola</i> and <i>Saccharomycopsis</i> spp.	Not reported	Not reported	Rapsang et al. (2011), Thapa (2016)

^aNo such data are available for these foods and beverages. However, considering the similar products in other states of India, it can be assumed that these products might contain similar microflora and nutrients and exhibit identical health benefits

of traditional fermented products can be categorized into (1) cereal- and pulse-based fermented products, (2) plant-based fermented products, (3) dairy-based fermented products, and (4) fish-based fermented products (Table 23.1).

23.3 Cereal- and Pulse-Based Fermented Products

Cereals are considered one of the staple foods in West Bengal and Odisha. Among the cereals, rice is the major producing cereal in West Bengal and Odisha. The people in this region take rice as a staple food because of its high calorific value (1460–1560 kJ) (FAO 1993) and availability. Rice provides a moderate amount of protein (6.3–7.1%) but devoid of lysine (FAO 1993). Another important ingredient in food fermentation is *pulse*. It is estimated that 442 thousand tonnes of *pulses* are produced in 2012 in West Bengal and Odisha (Inbasekar 2014). *Pulse* contains a high amount of protein, carbohydrate, dietary fibre, fat, and vitamins (Ofuya and Akhidue 2005). Hence, it is considered good nutritive food. Recent research showed that *pulses* are effective in cardiovascular diseases, cancer, hypertension and gastrointestinal disorders (Hu 2003; Ray et al. 2015). Commonly used *pulses* in this region are *black gram*, *soybean*, *Bengal gram*, *red gram* and *green gram*. *Pulses* are locally known as ‘*dal*’.

In West Bengal and Odisha, the traditional fermented foods are generally prepared from most common types of available cereals such as rice and pulses mainly *black gram*. The popular fermented foods made up by cereals and *pulses* in this region are fermented rice cake (*pitha*), sour rice (*panta bhat*), fermented legume (*bari and papad*) and rice-based fermented beverage (*haria or handia*).

23.3.1 Fermented Rice Cake (*Pitha*)

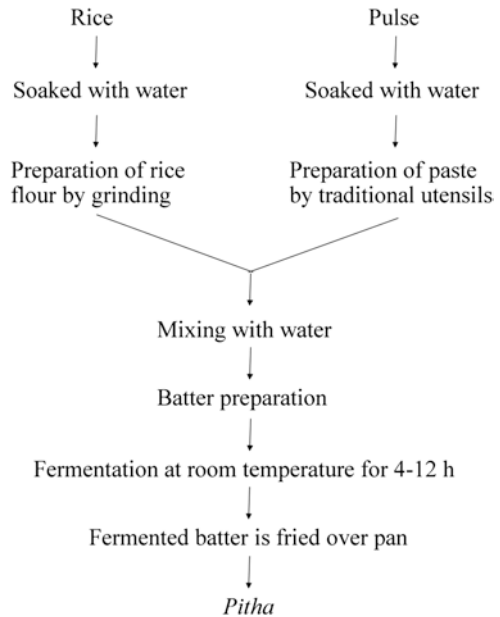
Fermented rice cake is popularly known as *pitha* in West Bengal and Odisha. *Pitha* is made up from either fermented rice or rice-legume batter.

Flow sheet of traditional method of *Pitha* preparation in West Bengal and Odisha is presented in Fig. 23.1.

Culinary and mode of consumption For its preparation, the rice is first soaked in water for 8–12 h and air-dried (Fig. 23.1). Then the soaked rice is ground to make the fine flour by using a traditional grinder. The soaked legumes are pasted by traditional utensils. The rice flour and the pasted legume are then mixed with water to prepare the batter which is allowed to ferment for 4–5 h in summer and 10–12 h in winter. The fermented batter is fried over a pan. The food is taken at breakfast and lunch.

Socio-economy and ethnical or religious values During the Paush Sankranti (last day of ninth Bengali month called Paush, middle of December, winter season) or Raja Sankranti (summer), preparing and sharing of *pitha* are traditional culture.

Fig. 23.1 Traditional method of *Pitha* preparation in West Bengal and Odisha



Microbiology Although these types of *pitha* are very popular in this region, surprisingly no such research efforts have been made to find out its nutritional and microbiological composition.

There are different kinds of *Pitha*: *Chakuli pitha*, *Enduri pitha*, *Munha pitha*, *Chhuchipatra pitha* and *Podo pitha* (Ray et al. 2016; Ray and Swain 2013).

23.3.2 *Chakuli Pitha*

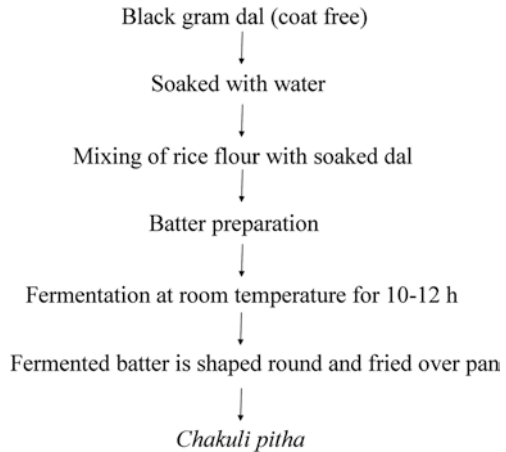
Chakuli pitha, a round-shaped flattened pancake is similar to a popular South Indian food called *dosa*. The food is popular in West Bengal and Odisha.

Flow sheet of traditional method of *Chakuli pitha* preparation in West Bengal and Odisha is presented in Fig. 23.2.

Culinary and mode of consumption The principal ingredients are rice (*Oryza sativa*) and *black gram dal* (*Phaseolus mungo*). The batter is prepared by the coat-free *black gram dal* and rice and left for fermentation about 10–12 h (Ray et al. 2016). After fermentation, the batter is fried over a pan with a structure of round shape.

Socio-economy and ethnical or religious values The food is generally prepared during the Paush Sankranti or Raja Sankranti by the women in houses. After preparation, the food is usually offered to the God at first and then consumed by the other members.

Fig. 23.2 Traditional method of *Chakuli pitha* preparation in West Bengal and Odisha



Microbiology Its microbiological composition is unknown so far. Considering its preparation process which is similar to the *dosa*, it is likely that lactic acid bacteria and yeast might play the major role in this fermentation.

Nutritional value Looking into its nutrient enrichment, it was suggested that the amount of vitamin B, vitamin C, zinc and iron are increased during fermentation. Moreover, fermentation helps to increase the bioavailability of the minerals by degrading the phytate, which is an antinutrient in cereals (Sahoo et al. 2017).

Optimization and commercialization This product is usually prepared in the household. Best of our knowledge, the food is not sold in the market.

23.3.3 *Enduri Pitha*

Enduri pitha is the flavoured cake prepared in West Bengal and Odisha.

Flow sheet of traditional method of *Enduri pitha* preparation in West Bengal and Odisha is presented in Fig. 23.3.

Culinary and mode of consumption It is prepared by rice and *black gram dal*. In its preparation, the fermented batter is kept and folded in turmeric (*Curcuma longa* L.) leaf followed by cooking over steam.

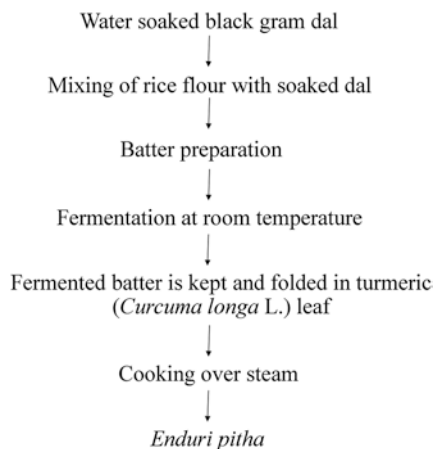
Socio-economy and ethnical or religious values Same as *Chakuli pitha*.

Microbiology *Lactobacillus (Lb.) fermentum* is one of the fermenting bacteria in this fermentation (Ray and Swain 2013).

Nutritional value It was reported that it helps in boosting the immune system (Roy et al. 2007) and acts as a protective agent in different seasonal infections (Ray et al. 2016). The health benefits probably come from the turmeric leaf and the participating lactic acid bacteria.

Optimization and commercialization Unknown.

Fig. 23.3 Traditional method of *Enduri pitha* preparation in West Bengal and Odisha



23.3.4 *Munha Pitha*

Munha pitha is a spongy fermented cake which is very famous in West Bengal and Odisha.

Flow sheet of traditional method of *Munha pitha* preparation in West Bengal and Odisha is presented in Fig. 23.4.

Culinary and mode of consumption The principal ingredients are rice and *black gram dal* which are used for batter preparation (Ray and Swain 2013). Usually, a short fermentation time is required. After fermentation, the fermented batter is kept in cloth which is then placed in the mouth of an earthen pot containing half-filled water. Then it is boiled until the batter becomes spongy. Usually, this food is served with sugar and vegetable curry.

Socio-economy and ethnical or religious values Same as *Chakuli pitha*.

Microbiology The microbiology and nutritional values of this product are unexplored so far. Clearly, a detailed analysis is needed.

Nutritional value Unknown.

Optimization and commercialization Unknown.

23.3.5 *Chhuchipatra Pitha*

Chhuchipatra pitha is a square-shaped *pitha*. The food is nutritious, palatable and delicious (Ray and Swain 2013).

Flow sheet of traditional method of *Chhuchipatra pitha* preparation in West Bengal and Odisha is presented in Fig. 23.5.

Culinary and mode of consumption The batter is similar to the *Chakuli* batter. However, sometimes the curd (fermented milk) is added for better fermentation (Ray et al. 2016). Then the fermented batter is spread as a thin smear over the pan.

Fig. 23.4 Traditional method of *Munha pitha* preparation in West Bengal and Odisha

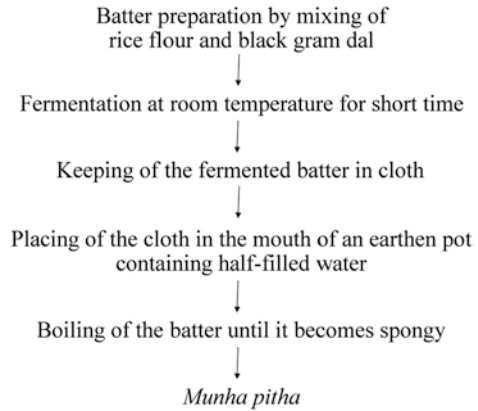
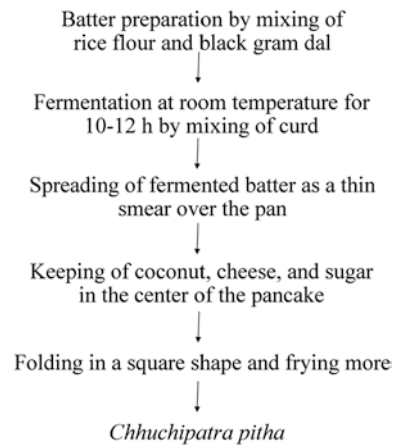


Fig. 23.5 Traditional method of *Chhuchipatra pitha* preparation in West Bengal and Odisha



Then coconut, cheese and sugar are kept in the centre of the pancake followed by folding in a square shape and then allow frying more.

Socio-economy and ethnical or religious values It is generally prepared during Raja Sankranti (summer) festival in rural Odisha.

Microbiology As the curd (locally known as *dahi*) is added for fermentation, it is likely that the food might contain lactic acid bacteria. Again, no such studies have been conducted to explore its microbial contents.

Nutritional value Unknown.

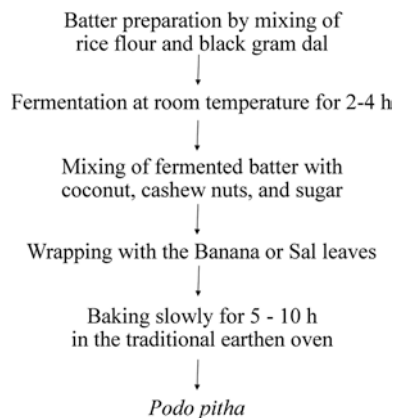
Optimization and commercialization Unknown.

23.3.6 *Podo Pitha*

Podo pitha is a slow-cooked *pitha*.

Flow sheet of traditional method of *Podo pitha* preparation in West Bengal and Odisha is presented in Fig. 23.6.

Fig. 23.6 Traditional method of *Podo pitha* preparation in West Bengal and Odisha



Culinary and mode of consumption Like the other *pitha*, rice and *black gram dal* are used for the batter preparation. The fermentation time is only 2–4 h. The fermented batter is mixed with coconut, cashew nuts and sugar (Ray and Swain 2013). The mixture is wrapped with the banana (*Musa paradisiaca* L) or sal (*Shorea robusta* C.F. Gaertn) leaves and baked slowly for 5–10 h in the traditional earthen oven which is covered by hot charcoal (Ray and Swain 2013). The outside of the product is usually slightly burnt, whereas the white spongy soft inside.

Microbiology Not reported so far.

Nutritional value It was reported that the food is energy rich because of the high carbohydrate content, sugar and fibres (Ray and Swain 2013).

Optimization and commercialization Unknown.

23.3.7 Sour Rice

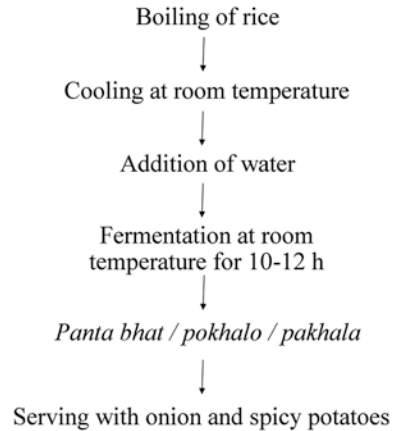
Sour rice is popularly known as *panta bhat* in West Bengal and *pokhalo/pakhala* in Odisha. It is a naturally fermented rice product which is consumed during lunch and breakfast.

Flow sheet of traditional method of *panta bhat/pokhalo/pakhala* preparation in West Bengal and Odisha is presented in Fig. 23.7.

Culinary and mode of consumption In its preparation, the boiled rice is cooled down at room temperature followed by the addition of adequate water. Then it is kept in the room temperature for 10–12 h for fermentation. This is a natural fermentation; no starter is required. However, sometimes curd, salt and some vegetables are added for better fermentation and taste enhancement (Ray and Swain 2013). The sour rice is consumed with onion and cooked spicy vegetables.

Microbiology Lactic acid bacteria [especially *Lb. casei*, *Lb. bulgaricus*, *Pediococcus* (*Pd.*) *acidilactici*, *Streptococcus thermophilus*] and yeast [*Saccharomyces* (*S.*) sp.] actively participated in this fermentation (Ray et al. 2016).

Fig. 23.7 Traditional method of *panta bhat/pokhalo/pakhala* preparation in West Bengal and Odisha



Nutritional value After fermentation sour rice is enriched with vitamins (B complex and K) and minerals (iron, sodium, potassium, calcium, etc.) (Ray et al. 2016). It is an energy-rich food and helps to restore the gastrointestinal flora during intestinal ailments such as irritable bowel syndrome, duodenal ulcers, Crohn's disease, etc. (Choi et al. 2014; Ray and Swain 2013). Moreover, the food was also reported to prevent constipation (Ray et al. 2016).

Optimization and commercialization Unknown.

23.3.8 Jalebi

Jalebi is a popular Indian sweetened fermented product. It is usually sold in *mela* (social gathering) and sweet shops.

Flow sheet of traditional method of *Jalebi* preparation in West Bengal and Odisha is presented in Fig. 23.8.

Culinary and mode of consumption It is made from maida (wheat flour), *dahi* (curd) and water (Steinkraus 1996). The batter is fermented for 4–6 h in room temperature. For its preparation, the batter is squeezed through an embroidered hole (about 4 mm in diameter) in a thick and durable cotton cloth and dispensed in the hot oil (Tamang et al. 2016) in a manner as it gets a unique shape (round shaped with a network like arrangement; Fig. 23.9). The fried one is immersed in sugar syrup for 2–5 min.

Microbiology *Lb. fermentum*, *Lb. buchneri*, *Streptococcus lactis*, *Streptococcus faecalis* and *S. cerevisiae* were found in the fermented batter (Sekar and Mariappan 2007).

Nutritional value The pH in the fermented batter is around 3–4. Moreover, the content of amino nitrogen and free sugar were also decreased during fermentation (Steinkraus 1996).

Optimization and commercialization Many small cottage industries (sweet shops) now prepare this food. The usual price of the product is Rs. 150 per kg.

Fig. 23.8 Traditional method of *Jalebi* preparation in West Bengal and Odisha

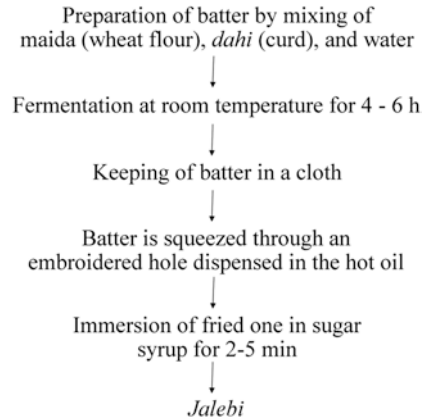


Fig. 23.9 *Jalebi*



23.3.9 Bari

Bari is a pulse-based traditional fermented food. Different types of pulses (*Urad dal*, *Chana dal*, *Matar dal*) are used in its preparation (Sha et al. 2013).

Flow sheet of traditional method of *Bari* preparation in West Bengal and Odisha is presented in Fig. 23.10.

Culinary and mode of consumption In its preparation, the pulses are soaked with water for 10–12 h followed by grinding to make the paste. Then some spices (chilli, coriander, cumin seeds, etc.) and salts are added to that paste. The dough is pressed to make an oval or round shape and kept in a cloth followed by sun drying for 5–10 days. Due to this drying process, moisture content is very low in *bari*. Hence, *bari* can be preserved in a container for 6 months to 1 year. *Bari* (Fig. 23.11) is consumed after cooking with vegetable curry or directly after frying.

Socio-economy and ethnical or religious values *Bari* is very popular in West Bengal and Odisha. Consumption of *bari* during occasion is a traditional culture (Sha et al. 2013).

Fig. 23.10 Traditional method of *Bari* preparation in West Bengal and Odisha

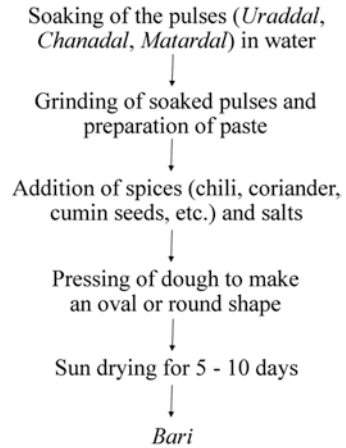


Fig. 23.11 *Bari* prepared from *Matar dal*



Microbiology *B. subtilis*, *Candida famata*, *Candida curvata*, *Candida parapsilosis*, *Candida krusei*, *Candida vartiovaarai*, *Cryptococcus humicolus*, *Debaryomyces tamaraii*, *Debaryomyces hansenii*, *Hansenula anomala*, *Geotrichum candidum*, *S. cerevisiae*, *Kluyveromyces marxianus*, *Enterococcus faecalis*, *Trichosporon beigelii*, and *Wingea robertsii* were isolated from *bari* prepared in another region (Rahi and Soni 2007).

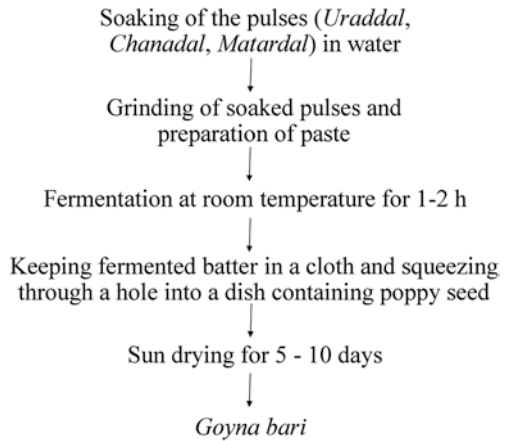
Nutritional value It is a protein-rich food. It reduces flatulence-causing oligosaccharides (Kulkarni et al. 1997; Tewary and Muller 1992).

Optimization and Commercialization *Bari* is usually prepared in the household and small cottage industries. The product is available in the market. Due to an easily available substrate and short preparation time make the product inexpensive (approximate cost is Rs. 150 per kg).

23.3.10 Goyna Bari

Goyna bari is a decorated *bari*. It is designed like the traditional ornaments.

Fig. 23.12 Traditional method of *Goyna bari* preparation in West Bengal and Odisha



Flow sheet of traditional method of *Goyna bari* preparation in West Bengal and Odisha is presented in Fig. 23.12.

Culinary and mode of consumption The preparation process of *Goyna bari* is illustrated in Fig. 23.12. The fermented batter is kept in a cloth and squeezed through a hole into a dish containing poppy seeds. The poppy seeds help to maintain the texture of the *Goyna bari* and to easily separate the *Goyna bari* from its base. Then the *Goyna bari* (Fig. 23.13) is dried under sunlight and kept in the airtight container. Surprisingly there are no such reports on its microbial and nutritional compositions.

Socio-economy and ethnical or religious values In West Bengal particularly in East Midnapore district, the shape of the *bari* is decorated like ornaments. This is an ancient food art of this region. Particularly the women are experts in making of this *Goyna* (ornaments) *bari*.

Microbiology Our group is now engaged to explore this *Goyna bari* scientifically. Initial results showed that yeast and lactic acid bacteria are the predominant microbes in this food (Unpublished data, Manuscript in preparation).

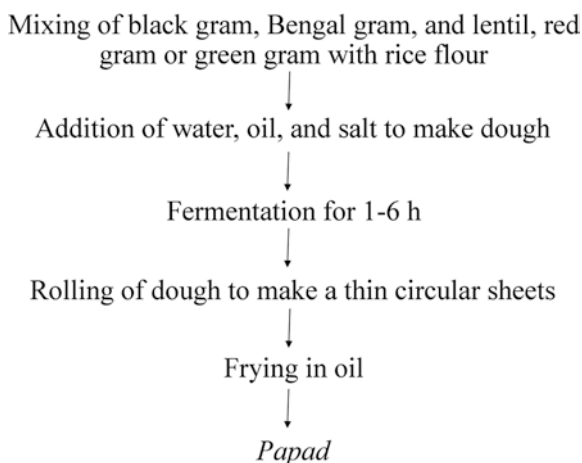
Nutritional value Moreover, *Goyna bari* is a nutrient-rich product and exerts a significant level of antioxidant and antimicrobial activities against the pathogenic bacteria (Unpublished data, Manuscript in preparation).

Optimization and commercialization The people in the West Midnapore district prepare it in the house and sell in the nearby states. The approximate price of the product is Rs. 300 per kg.

23.3.11 Papad

Papad is a pulse-based food. A circular sheet-like material is fried in oil and consumed as snacks.

Flow sheet of traditional method of *papad* preparation in West Bengal and Odisha is presented in Fig. 23.14.

Fig. 23.13 *Goyna bari***Fig. 23.14** Traditional method of *papad* preparation in West Bengal and Odisha

Culinary and mode of consumption The raw ingredients are *black gram*, *Bengal gram* and lentil (*Lens culinaris*), *red gram* or *green gram*, a small quantity of peanut oil and common salt. In its preparation, flour of the above-mentioned pulses is mixed with rice flour and water and knead into dough with oil and salt (Shurpalekar 1986). Sometimes the spices are also added to enhance the taste and flavour. The dough is then allowed to ferment for 1–6 h. Then the dough is rolled into thin circular sheets and left for drying in room temperature (Fig. 23.15a). The dried sheet can be preserved for 4–6 months. The sheet is fried in oil and served as snacks (Fig. 23.15b). Usually, it is taken after a heavy meal and also as snacks.

Socio-economy and ethnical or religious values *Papad* consumption after a heavy meal is an ancient culture in West Bengal and Odisha. During any occasion, it is usually served during lunch or dinner. Sometimes it is also consumed as snacks.

Microbiology *Candida krusei* and *S. cerevisiae* were the principal microbes in this dough fermentation (Aidoo et al. 2006).

Nutritional value *Papad* contained a significant amount of carbohydrates, proteins, fat, minerals, calcium, iron, carotene and crude fibre (Renu and Waghray

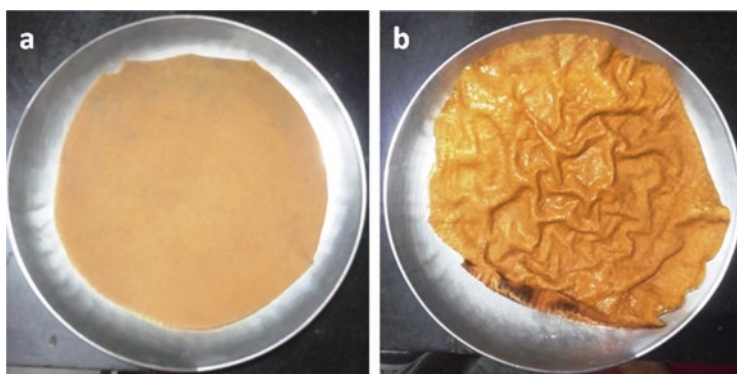


Fig. 23.15 Dried *papad* (a) and fried *papad* (b)

2016). It is a good appetiser and digestive food as it contains dietary fibre. It is suggested that it absorbs the fatty material from the mouth. Renu and Waghray (2016) claimed that the health benefits of the *papad* come from the used raw ingredients.

Optimization and commercialization As it is one of the regularly consumed foods in these states, the commercialization and the market value are increasing day by day. It is usually sold in a packet, and the cost is approximately Rs. 100–200 per kg.

23.4 Fermented Beverage

23.4.1 *Haria* or *Handia*

A popular ethnic rice-based alcoholic fermented beverage in this area is known as *Haria* (in West Bengal) or *handia* (in Odisha). This drink is very popular among the tribal people. The principal ingredient of this beverage is low-graded boiled rice which is mixed with the traditional starter called *Bakhar* (Ghosh et al. 2014). Six different types of plant (*Cissampelos pareira*, *Diospyros melanoxylon*, *Lygodium flexuosum*, *Orthosiphon rubicundus*, *Ruellia tuberosa* and *Terminalia alata*) parts and the rice dust are used in the preparation of *Bakhar* (Dhal et al. 2010; Ghosh et al. 2014). This starter is very unique as no old inoculum is added during its preparation. The endophytic microbes present in the plant materials are solely responsible for the rice fermentation.

Flow sheet of traditional method of *Haria* preparation in West Bengal and Odisha is presented in Fig. 23.16.

Culinary and mode of consumption In its preparation, the charred boiled rice is mixed with the *Bakhar* (Fig. 23.17a; about 2–3 g of starter was added to 200 g of boiled rice) and allowed to ferment within an earthen pot for 4–5 days (Ghosh et al. 2014). The fermented material (Fig. 23.17b) is diluted with drinking water and sieved by the cloth. The glutinous material is then consumed with spicy vegetables.

Fig. 23.16 Traditional method of *Haria* preparation in West Bengal and Odisha

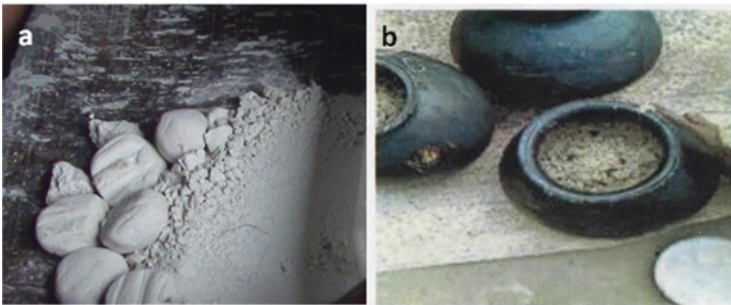
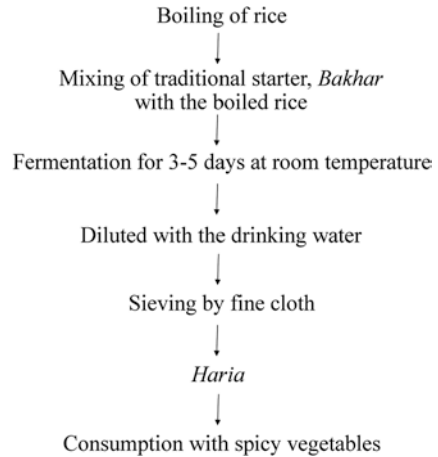


Fig. 23.17 Plant-based starter, *Bakhar* tablet and dust (a); rice-based fermented beverage, *Haria* (b)

Socio-economy and ethnical or religious values *Haria* is very popular among the tribal groups of West Bengal and Odisha. They regularly consume it as a staple food. During any occasion, sharing and consumption of *Haria* are traditional culture.

Microbiology Mould, yeast, lactic acid bacteria and *Bifidobacterium* sp. were the predominant microbes in *Haria* (Ghosh et al. 2015a). In the initial days of fermentation, mould and yeast grew well due to the aerobic environment and produced different amylolytic enzymes. The enzymes degraded the complex starch and produced the simple sugars which are then used by other bacteria such as lactic acid bacteria, *Bifidobacterium* sp., etc. for their growth (Ghosh et al. 2015a). The partial anaerobic condition inside the pot (due to consumption of oxygen by mould and yeast) also helped to grow lactic acid bacteria, *Bifidobacterium* sp.

Nutritional value *Haria* contained probiotic bacteria (*Lb. fermentum*), prebiotic component (maltooligosaccharides which stimulate the growth of probiotic bacteria, inhibit the growth of intestinal pathogens, and are nutritive for infant and aged persons), different pyranose derivatives

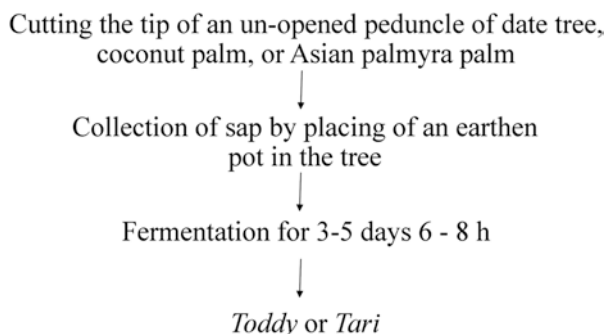


Fig. 23.18 Traditional method of *Toddy or Tari* preparation in West Bengal and Odisha

(2,3,4,5-tetra-O-acetyl-1-deoxy- β -D-glucopyranose, β -D-mannopyranose pentaacetate, β -D-galactopyranose pentaacetate and 1,2,3,6-tetra-O-acetyl-4-O-formyl-D-glucopyranose which have significant antioxidant, immunostimulatory and antimutagenic activities), phenolics and flavonoids (showed antioxidant activities) (Ghosh et al. 2015a, b). Ray et al. (2016) suggested that *Haria* could protect from different gastrointestinal ailments like diarrhoea, dysentery, amebiasis and vomiting.

Optimization and commercialization Considering its popularity among the tribal groups, some small cottage industries now prepare and sell *Haria*. Due to the low cost of rice and *Bakhar*, the product price is only Rs. 10 per 250 mL.

23.4.2 *Toddy or Tari*

Toddy or Tari is an alcoholic drink mainly prepared in West Bengal and Odisha.

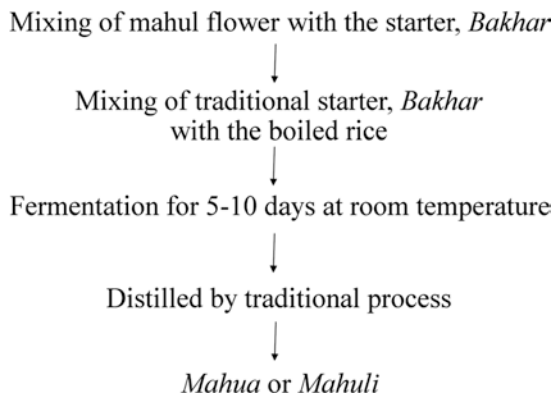
Flow sheet of traditional method of *Toddy or Tari* preparation in West Bengal and Odisha is presented in Fig. 23.18.

Culinary and mode of consumption The principal ingredients are the sap from date tree (*Phoenix sylvestris* L.), coconut palm (*Cocos nucifera* L.) or Asian palmyra palm (*Borassus flabellifer*) (Karthikeyan et al. 2014). The sap is collected from these trees by cutting the tip of an unopened peduncle. An earthen pot (containing little amount of old *Toddy or Tari*) is placed in the tree to collect the sap. It takes only 6–8 h to complete the fermentation. The fresh sap contains sucrose (12–15% by weight) and other monosaccharides which favour the growth of fermenting microflora. The shelf life of this drink is only 12–24 h. After fermentation, a white colour sweet material is consumed with some spicy vegetables.

Socio-economy and ethnical or religious values The product is consumed as a refreshing drink in this region.

Microbiology Acetic acid bacteria and lactic acid bacteria, specifically *Leuconostoc* (*Leuc.*) sp., *Lactobacillus* sp. and *Zymomonas* sp., were involved in the

Fig. 23.19 Traditional method of *Mahua* preparation in West Bengal and Odisha



early fermentation (Steinkraus 1996). Later *S. cerevisiae* produced the alcohol (Sekar and Mariappan 2007).

Nutritional value The alcohol percentage is only 4–6%. *Toddy* is believed to be good for the health particularly for eyesight and also used as a sedative (Sekar and Mariappan 2007). Moreover, it is a mild laxative relieving constipation (Sekar and Mariappan 2007). It is prescribed as a tonic for those recovering from diseases such as chickenpox (Steinkraus 1996).

Commercialization The shelf life of *Toddy* or *Tari* is very short (6–12 h). Hence, it is sold immediately after processing. The price of 250 mL of *Toddy* or *Tari* is Rs. 15–25.

23.4.3 *Mahua* or *Mahuli*

Mahua (West Bengal) or *Mahuli* (Odisha) is a distilled fermented beverage made from mahul flowers (Ray and Swain 2013).

Flow sheet of traditional method of *Mahua* preparation in West Bengal and Odisha is presented in Fig. 23.19.

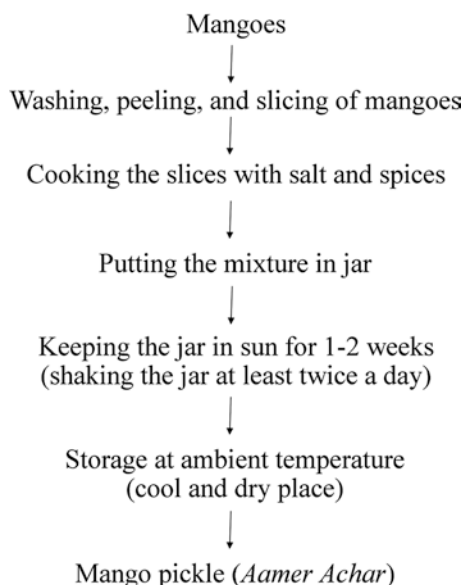
Culinary and mode of consumption In its preparation, the mahul flower is washed and mixed with the starter *Bakhar* (plant-based starter) (Dhal et al. 2010) and an adequate amount of water. Generally, 10 kg of *Mahua* flowers is mixed with 300 g of *Bakhar* and 32 litres of water (Behera et al. 2016). In another method, 4 kg of *Mahua* flowers are mixed with 6 kg molasses, 300 g of *Bakhar* and 32 litres of water (Behera et al. 2016). After fermentation, the product is distilled by the traditional distillation process (Ray and Swain 2013).

Socio-economy and ethnical or religious values This product is popular among the tribal people of this region. During any types of occasions, consumption of *Mahua* (West Bengal) or *Mahuli* is traditional culture. It is consumed as a refreshing drink.

Microbiology Unknown.

Nutritional value The distilled product is diluted with water, and the alcohol percentage is 10–15% (Ray and Swain 2013).

Fig. 23.20 Traditional method of *Aamer achar* preparation in West Bengal and Odisha



Optimization and commercialization The product is usually bottled in glass or plastic. Since it is popular among the tribal community, it is sold only in the tribal population-rich location.

23.5 Plant-Based Fermented Products

23.5.1 *Achar/Chadnee*

Pickle (*achar*) is one of the oldest methods of food preservation. Pickle is usually made from chopped fruits (cucumber, olive, tomato, mango, lemon) and vegetables (cabbage, cauliflower, mustard vegetable). The name of the pickle is given based to their substrate such as mango pickle (*Aamer achar* in Bengali), lemon pickle (*lebur achar*), tomato pickle (*tomato chadnee*), etc. The most common pickles in this region are mango or lemon pickle.

Flow sheet of traditional method of *Aamer achar* preparation in West Bengal and Odisha is presented in Fig. 23.20.

Culinary and mode of consumption The preparation process of mango pickle is shown in Fig. 23.20. At first, the chopped fruits and vegetables are lightly fried in oil. Then salt, chilli, turmeric and some other spices are added there. After that, the mixture is kept in a container and allowed to ferment for 1–2 weeks. Pickle is mainly two types: sour (Fig. 23.21a) and sweet (Fig. 23.21b). In a sweet pickle, a high amount of sugar is added.

Socio-economy and ethnical or religious values Pickle is popular among all age group people. At the end of a heavy meal, the consumption of pickle or chadnee is an ancient culture.

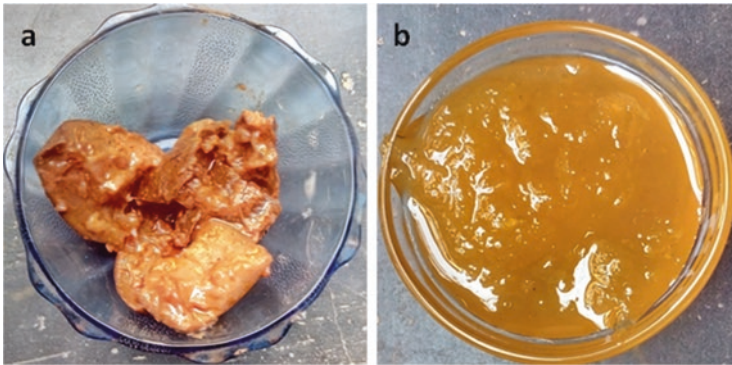


Fig. 23.21 Sour mango pickle (a) and sweet pickle (b)

Microbiology The naturally occurring lactic acid bacteria actively participate in this fermentation.

Nutritional value The bacteria produce lactic acid and as a result, the *pickle* becomes acidic (sour). *Pickle* is enriched with dietary fibres, minerals and vitamins. It exerts the health benefits associated with lactic acid bacteria.

Optimization and commercialization: Due to the low pH, high salt concentration and low moisture content, the *pickle* can be stored 6 months to 1 year. Nowadays, several small-scale industries have started producing and marketing *pickle* considering its popularity.

23.5.2 Karadi

Karadi is an ethnic fermented bamboo shoot (*Bambusa arundinacea* L.) product of Odisha (Ray and Swain 2013).

Flow sheet of traditional method of *Karadi* preparation in Odisha is presented in Fig. 23.22.

Culinary and mode of consumption The tip of the youngling bamboo is sliced into small pieces and dipped into water for 1 day for fermentation (Ray and Swain 2013). After fermentation, the product is cooked with the other vegetables. Sometimes the powdered fermented product is sun-dried and stored for 1 year (Panda and Padhy 2007).

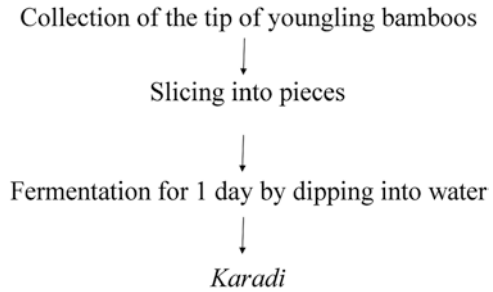
Socio-economy and ethnical or religious values The product is used in the treatment of digestive problems, especially in constipation (Satish Kumar et al. 2013).

Microbiology Unknown.

Nutritional value Unknown.

Optimization and Commercialization Unknown.

Fig. 23.22 Traditional method of *Karadi* preparation in Odisha



23.6 Dairy-Based Fermented Products

Dairy-based fermented foods in West Bengal and Odisha are usually naturally fermented. The ethnic people use the black-slopping method where the previously fermented product is used as an inoculum to ferment the new batch (Josephsen and Jespersen 2004). The examples of some dairy-based products in this region are *dahi* (curd), *paneer*, *lassi* and *chhena poda*. These dairy-based foods and beverage are rich in proteins, carbohydrates, vitamins and minerals and exert different therapeutic activities (Sarkar 2008).

23.6.1 *Dahi*

Dahi is naturally fermented milk (lactic acid fermentation) consumed as a refreshing food (Tamang et al. 2016). The word *Dahi* comes from Sanskrit word “dadhi” (Yegna Narayan Aiyar 1953).

Flow sheet of traditional method of *Dahi* preparation in West Bengal and Odisha is presented in Fig. 23.23.

Culinary and mode of consumption In its traditional preparation, milk (from cow or buffalo) is boiled and cooled at room temperature. A small amount of old *dahi* (served as inoculum) is added on that and allowed to ferment for 6–12 h.

Socio-economy and ethnical or religious values *Dahi* (Fig. 23.24) is consumed on a regular basis by the people of this region. The people usually offer *Dahi* to god during worship. It is believed that *Dahi* is a holy product.

Microbiology A number of lactic acid bacteria (*Lb. alimentarius*, *Lb. bifermmentans*, *Lb. paracasei*, *Lb. delbrueckii* subsp. *indicus*, *Lb. acidophilus*, *Lb. bulgaricus*, *Lb. cremoris*, *Lb. helveticus*, *Lb. fermentum*, *Lactococcus* (*Lc.*) *lactis*, *Streptococcus lactis*, *Streptococcus cremoris*, *Streptococcus thermophilus*, *Pd. acidilactici*, *Pd. pentosaceus*, *Weissella cibaria*) and yeast (*Saccharomycopsis* sp. and *Candida* sp.) were isolated from *Dahi* (Dewan and Tamang 2007; Patil et al. 2010; Ramakrishnan 1980).

Nutritional value *Dahi* is nutritious and easy to digest. The number of vitamins (thiamine, riboflavin, folic acid, niacin) (Atreja and Deodhar 1987; Bambha et al. 1973; Laxminarayana and Shankar 1980; Singh and Deodhar 1993), proteins, essential amino acids and lactic acid was significantly increased in *dahi* (Boghra 1988; Sarkar 2008). *Dahi* exerted the antimicrobial effects against the pathogenic

Fig. 23.23 Traditional method of *Dahi* preparation in West Bengal and Odisha

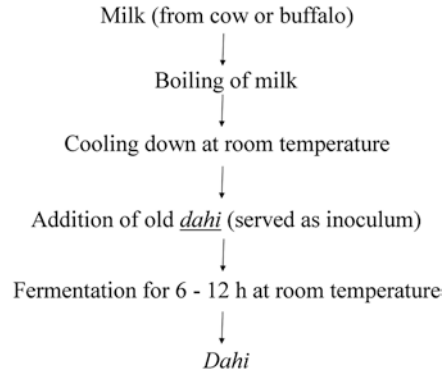


Fig. 23.24 *Dahi*



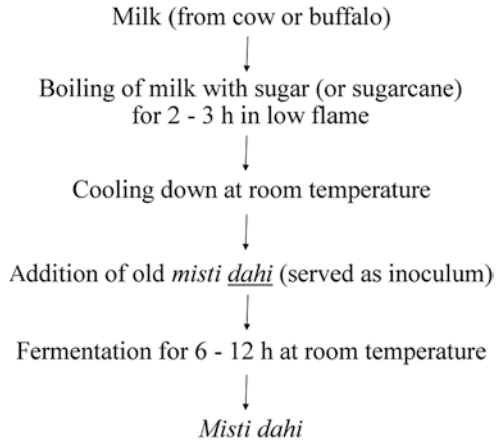
bacteria due to the high content of lactic acid and production of antimicrobial agents such as bacteriocin, antimicrobial peptides by the participating lactic acid bacteria (Dave et al. 1992; Srinivasan et al. 1995). It is also effective in reducing cardiovascular diseases and tumours and increasing immunity (Sinha and Sinha 2000).

Optimization and commercialization Due to its huge consumption, *Dahi* is produced in the home and sweet shops regularly. The sweet shop keeper uses earthen pot for preparation of this product. Each shop keeper has its own starter culture for *Dahi* production. Hence, the sensory properties are different from one shop to another. The cost of *Dahi* is Rs. 15–25 per 100 g.

23.6.2 *Misti Dahi*

Misti dahi is a sweetened fermented milk product prepared mainly in West Bengal. It is an indigenous product of West Bengal. It is mildly acidic, a sweetened product which appears in a light brown (like caramel) colour.

Fig. 23.25 Traditional method of *misti dahi* preparation in West Bengal



Flow sheet of traditional method of *misti dahi* preparation in West Bengal is presented in Fig. 23.25.

Culinary and mode of consumption Traditionally, the milk is boiled with sugar (sometimes sugarcane) for 2–3 h in low flame. The boiling helps to develop the unique red-brown colour and makes it slightly viscous. As like the *dahi* preparation, after cooling the milk, previously prepared old *misti dahi* is added and allow fermenting for 6–12 h in the earthen pot at room temperature.

Socio-economy and ethnical or religious values As like *dahi*, *misti dahi* (Fig. 23.26) is also offered to god. In many occasions in West Bengal, *misti dahi* is served after the lunch.

Microbiology *Lb. acidophilus*, *Lc. lactis* subsp. *lactis*, *Lb. delbrueckii* subsp. *bulgaricus*, *Streptococcus salivarius* subsp. *thermophilus* and *S. cerevisiae* were isolated from *misti dahi* (Ghosh and Rajorhia 1990; Gupta et al. 2000).

Nutritional value It is believed that the *misti dahi* is highly energy-rich food (due to the high sugar content), and it protects the individual from different gastrointestinal ailments.

Optimization and commercialization Usually *misti dahi* is prepared in the sweet shops. Nowadays, several companies started producing *misti dahi* commercially. The approximate cost of the product is Rs. 20–30 per 100 gram.

23.6.3 Bandel Cheese

Bandel cheese is an indigenous unripe, salted soft variety of *cheese*. The name is derived from the place Bandel located near Kolkata, West Bengal. The *Bandel cheese* is unique due to its dry, crumbly, smoky and aromatic flavour.

Flow sheet of traditional method of *Bandel cheese* preparation in West Bengal and Odisha is presented in Fig. 23.27.

Culinary and mode of consumption There are two varieties of *Bandel cheese* – plain and smoked. The raw ingredient is cow milk. After preparing the curds, the

Fig. 23.26 *Misti dahi* which appears in a light brown (like caramel) colour



they are separated by the addition of lemon juice. Then it is moulded and drained in small containers. It is further smoked in the fire as required for smoked *cheese* preparation. The finished *Bandel cheese* is flat round shaped. The *cheese* is salted for long preservation. Just before the consumption, it is soaked in water overnight to remove the excess salt.

Socio-economy and ethnical or religious values This product is not the indigenous product of West Bengal and Odisha. This unique art of cheesemaking was probably introduced by the Portuguese during their colonization in the late sixteenth century.

Microbiology Although it is a popular cheese product in the Kolkata region, there are no scientific evidence about its microbial and nutritional compositions. As *dahi* is one of the important ingredients in *Bandel cheese*, it is likely that the lactic acid bacteria participate in the *dahi* fermentation may engage in the *Bandel cheese* fermentation. Clearly, a detailed study is needed to explore this traditional *cheese* product.

Optimization and Commercialization The product is mainly popular in the Bandel region of West Bengal. There are some shops in Bandel preparing and selling this unique kind of *cheese*.

23.6.4 *Lassi*

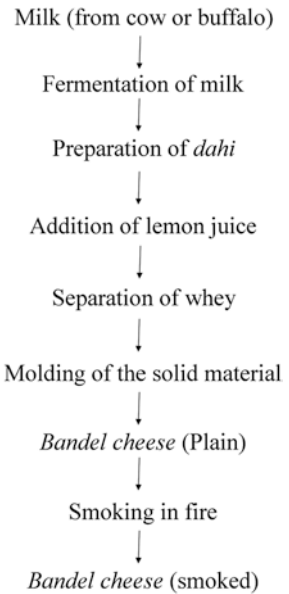
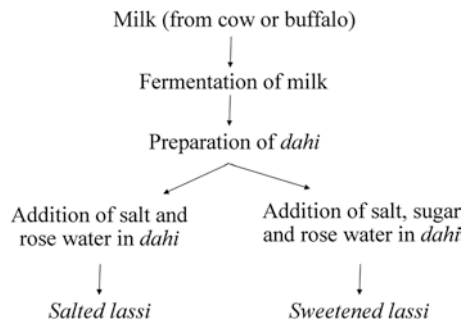
Lassi is a dairy-based low-fat beverage which is consumed in the summer as a refreshing drink.

Flow sheet of traditional method of *lassi* preparation in West Bengal and Odisha is presented in Fig. 23.28.

Culinary and mode of consumption It is prepared by mixing *dahi* with water, salt, sugar and rose water (Padghan et al. 2015). There are two main variants of *lassi*: *sweetened lassi* and *salted lassi*. *Sweetened lassi* (Fig. 23.29) is prepared by mixing *dahi* with sugar syrup and flavour (Shuwu et al. 2011). For *salted lassi*, an adequate amount of salt is added instead of sugar.

Fig. 23.27 Traditional method of *Bandel cheese*

preparation in West Bengal and Odisha

**Fig. 23.28** Traditional method of *lassi* preparation in West Bengal and Odisha

Socio-economy and ethnical or religious values There is an ancient culture of preparing of *lassi* in this region. The people usually drink it after doing heavy work. There is a ritual to offer *lassi* to the guests who visit the host's home in the summer time.

Microbiology Lactic acid bacteria.

Nutritional value The health benefits of *lassi* mainly come from the bioactive components present in *dahi* (due to the action of lactic acid bacteria) and spices. It is a nutritive (amino acids, peptides, vitamins, minerals, etc.) and digestive drink (Padghan et al. 2015). It is effective in gastrointestinal ailments such as diarrhoea, dysentery, etc. (Padghan et al. 2015; Tamang et al. 2016). Nowadays, it is designated as a probiotic drink as the participating bacteria have been established as the probiotic bacteria (Patidar and Prajapati 1998).

Fig. 23.29 *Lassi*

Optimization and commercialization Many small shops prepare this drink during summer. Nowadays, some companies also started packaging *lassi* in a bottle and sell in the market. The cost of 500 mL of lassi is Rs. 30–50.

23.6.5 *Chhena Poda*

Chhena (cheese) poda (baked) is a quintessential burnt cottage cheese dessert of Odisha. It is originated in Nayagarh (a town in Odisha) in the first half of the twentieth century.

Flow sheet of traditional method of *Chhena poda* preparation in West Bengal and Odisha is presented in Fig. 23.30.

Culinary and mode of consumption In its preparation, the homemade fresh cheese is mixed with sugar, cashew nut and raisins and is wrapped by the leaves of the *sal* tree (<http://www.uppercrustindia.com/oldsite/12crust/twelve/season8.htm>). Then it is baked in a charcoal oven until it becomes brown in colour (Fig. 23.31). It has a shelf life of 5 days. The food is very popular due to its unique flavour which probably comes during baking.

Socio-economy and ethnical or religious values Unknown.

Microbiology Unknown.

Nutritional value The food contains a significant amount of protein, fat, calcium and vitamins. It is believed that the food strengthens the bones and good for digestion. However, the best of our knowledge, this food has been scientifically unexplored till date.

Optimization and commercialization Some sweet shops in West Bengal and Odisha produce and sell this product. The cost is Rs. 500 per kg.

Fig. 23.30 Traditional method of *Chhena poda* preparation in West Bengal and Odisha

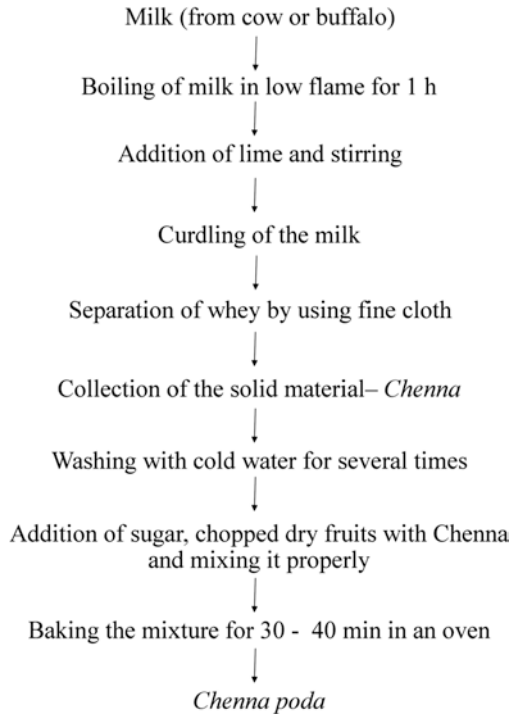


Fig. 23.31 *Chhena poda*



23.7 Fish-Based Fermented Products

Fish is an important component of the human diet in West Bengal and Odisha. More than 90% of the population in this region consume fish. As fish is a perishable food, drying of fish can preserve it for a long time. In its preparation, salt is applied to the fishes (3–4 kg/100 kg of raw fish) to remove the water (Payra et al. 2016). It takes 7–10 days for complete drying. When the salt is added into fish, a certain degree of fermentation occurs (Panda et al. 2017) and that eventually increases the nutritive value and the sensory properties.

23.7.1 Dry Salted *Hilsa*

During the rainy season, a large amount of *hilsa* (*Tenualosa ilisha*) fish is caught. To preserve the excess *hilsa*, it is salted and dried.

Flow sheet of traditional method of dry salted *hilsa* preparation in West Bengal and Odisha is presented in Fig. 23.32.

Culinary and mode of consumption Salt is added to *hilsa* fish followed by fermentation in a brine solution for a period of 4–6 months (Ray and Swain 2013). Then the fishes are dried for 10–15 days. The dried fishes can be preserved for 1–2 years (Ray and Swain 2013). Dried *hilsa* appears in pink glossy colour.

Socio-economy and ethnical or religious values This product is very popular in this region and India due to its unique flavour, aroma and texture (Ray and Swain 2013).

Microbiology The microbial and nutritional quality of this food has been unexplored till now.

Nutritional value Unknown.

Optimization and commercialization Due to its long shelf life, the product is exported in other countries and sold in another part of India.

23.7.2 Dry Salted *Khainga*

Dry salted *Khainga* is a popular fish product in Odisha.

Flow sheet of traditional method of dry salted *Khainga* preparation in West Bengal and Odisha is presented in Fig. 23.33.

Culinary and mode of consumption The preparation procedure of dry salted *Khainga* (*Mugil cephalus*) fish is similar to dry salted *hilsa* (Ray and Swain 2013). The fermentation takes place after removing the water from the fish. Like dried *hilsa*, the fermentation time is 4–6 months and drying time is 10–15 days (Ray and Swain 2013). This fermented fish is popular in Odisha due to its unique flavour and taste.

Fig. 23.32 Traditional method of dry salted *hilsa* preparation in West Bengal and Odisha

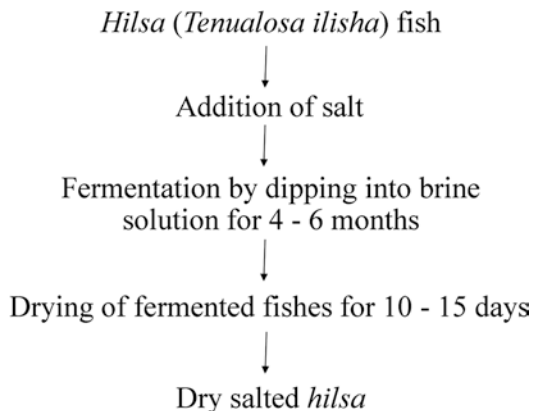
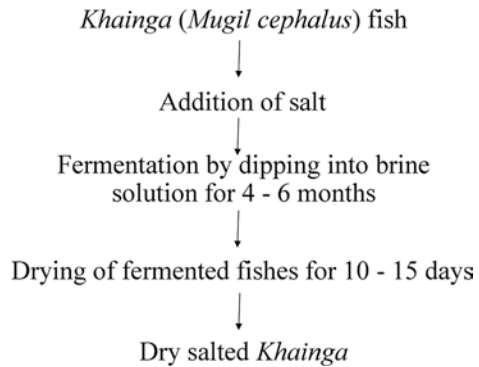


Fig. 23.33 Traditional method of dry salted *Khainga* preparation in West Bengal and Odisha



Socio-economy and ethnical or religious values Unknown.

Microbiology Considering the microorganisms involved in similar products (*karati*, *bordia* and *lashim*) in Assam (Thapa et al. 2007), it can be hypothesized that the lactic acid bacteria and *Bacillus* sp. might have significant impacts in this fermentation.

Nutritional value It was also reported that the drying process can increase the protein, lipids, vitamins and minerals (Chukwu 2009).

Optimization and commercialization Like dry salted *hilsa*, dry salted *Khainga* is also exported to other countries. The approximate cost of 1 kg of this product is Rs. 200.

23.7.3 *Sukuti* or *Shutki*

Sukuti or *Shutki* is a very popular sun-dried fish product in West Bengal.

Flow sheet of traditional method of *Shutki* preparation in West Bengal is presented in Fig. 23.34.

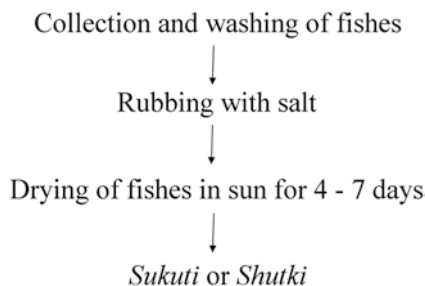
Culinary and mode of consumption Fishes are collected, washed, rubbed with salt and dried in the sun for 4–7 days (Thapa 2016). The product can be stored for 3–4 months (Thapa 2016). *Sukuti* is consumed as soup and curry.

Microbiology Bacteria (*Lb. lactis* subsp. *cremoris*, *Lb. lactis* subsp. *lactis*, *Lb. plantarum*, *Lb. mesenteroides*, *Enterococcus faecium*, *Enterococcus faecalis*, *Pd. pentosaceus*) and yeasts (*Candida chiropterorum*, *C. bombicola* and *Saccharomycopsis* spp.) were isolated from *Sukuti* prepared in other parts of India (Rapsang et al. 2011; Thapa 2016). Considering this, it can be assumed that similar bacteria might be involved in the *Shutki* fermentation in West Bengal and Odisha.

Nutritional value Not reported.

Optimization and commercialization *Sukuti* is exported to other countries. The approximate cost is Rs. 200–300 per kg.

Fig. 23.34 Traditional method of *Shutki* preparation in West Bengal



23.8 Conclusion

The large variety of traditional fermented foods in West Bengal and Odisha is due to the climatic variation and cultural diversity. These factors eventually influence in crop and microbes variety. Most of these fermented products are prepared by using the indigenous knowledge which people acquired from their ancestors. In most of the cases, they are completely unaware of the participating microbes and their effects in fermentation. During preparation of this manuscript, we were surprised to know that some of the fermented foods and beverages produced in this region have been scientifically unexplored or partially characterized. Moreover, due to urbanization and modernization, traditional knowledge is ignored. Hence, it is likely that very soon the indigenous traditional knowledge will be disappeared; modern civilization will be unaware of the hidden health benefits of these foods. Considering this, it is necessary to explore these foods scientifically (biochemical, microbiological and nutritive aspects) and protect them by legal tools like IPR (intellectual property rights). Since the people unknowingly use microbes and follow the old age methods, there is a demand for standardization of these foods by modern science and that may be helpful to increase the functionality of the ethnic foods.

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