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Potential business scope, micro-economy and strategy conservation of traditional fermented food and beverages of North and South Dinajpur districts of West Bengal, India

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Abstract

Fermented food products are an integral part of the indigenous population residing in West Bengal, an eastern state of India. This study documented the most popular and economically important fermented food and beverages of the Northern plains of the state- the North Dinajpur and South Dinajpur districts. *Chullu* and *Haria* are very popular fermented rice based alcoholic recreational beverage consumed widely by the tribal population and some low income non-tribals as well. *Tal Tari* is the spontaneously fermented sap of palm tree, also consumed as alcoholic beverage by tribals and low income non-tribals. *Khajur Tari* is consumed by almost all type of low-middle income people and the jaggery from *Khajur Tari* called *nolen gur*, is a highly demanding product among higher income group of people. Milk based fermented product *Doi* is prepared in various ways and consumed more as a dessert throughout the state. *Jilipi* is a snacks item, achar is an accompaniment with rice or roti staples and *Panta Bhaat* is an economical but heavy breakfast during summer for low-income people. Another delicacy called *Dalbori* is made mainly by the Sher-sha-badia community using pulses. All these products are prepared at house hold level as well as in small to medium scale commercial levels. These fermented products are thus not only a part of the traditions of these ethnic people but also a contributor to their day-to-day earnings. Proper documentation and standardization of these ethnic fermentation technology is of utmost importance for the preservation of this useful traditional knowledge. It will also help in proper commercialization and revenue generation thereby uplifting the rural microeconomy and job opportunities as well as nutritional requirement of this area.

Key Words: Fermentation, Documentation, Food and Beverages, Traditional Knowledge, Microeconomy

Introduction

Food is the most basic need for our survival and with the advancement of social life, ancient civilizations have developed various traditional food preservation techniques. Most common and widely used food preservation processes are sun drying, smoking, salting and fermentation (Chakraborty and Roy 2018). Biochemically, fermentation is utilized by many microorganisms to metabolize complex food materials into more simpler end products like ethanol or lactic acid (FAO 1998). Fermentation is a very versatile and scientific technique to process seasonal raw edibles into sustainable and healthy products with enhanced shelf life. Traditionally, ethnic people across the globe were not aware about the intriguing microbiology or the science behind fermentation but still developed an array of indigenous fermentation techniques to not only preserve food items but also to produce more exotic and palatable items. Worldwide reports on fermented food and beverages shows the diversity in raw materials usage for fermentation where cereals, pulses, fruits and vegetables, meat and fish as well as local seasonal items like bamboo shoots or wild edibles are fermented to produce non-perishable delicacies (Ray et. al., 2016 and Rawat et. al., 2018).

Fermented food and beverages differ largely from their raw counterpart wherein the fermented food products have enhanced and unique flavour, aroma and texture (Behera et. al., 2020) thereby maintaining their popularity and legacy across generations. All the traditional fermented food and beverages are thus savoured by the ethnic communities and are an integral part of their socio-economic culture (Ghosh et. al., 2014). These communities have also been consuming various fermented food products for their therapeutic or ethnomedicinal properties (Ghosh et. al., 2014 and Ray et. al, 2016). In recent times, fermented food and beverages from across the world have been studied with the focus being on their health benefitting properties. Ample data have shown the positive aspects of fermented food such as the presence of various prebiotics, probiotics, increased levels of micronutrients and macronutrients, antimicrobial and anti-inflammatory substances and other promising metabolites (Sanlier et. al., 2017). Also, fermentation reduces or removes the naturally occurring antinutritive substances in many raw food materials and make them easy to digest and absorbed in the body. One such antinutrient is phytic acid, found in cereals and pulses, but absent in their fermented counterparts (Chavan et. al., 2009).

The most widely consumed food in the world is cereal based of which rice is a staple in most of the Asian countries including India. Even though rice is consumed as the major carbohydrate source, it is a nutrient limiting food as it contains very less protein especially

lysine and contains antinutrients like phytic acid. Fermented rice products such as *idli, dosa, selroti* have been shown to have enhanced nutritional profile and improved bioavailability of nutrients (Ray et. al., 2016). Milk is a complete food high in nutritional value and Indians consume milk daily in a variety of ways. Fermentation can enhance the nutritive value of milk to a larger extent by inclusion of probiotics and by increasing the digestibility of milk proteins such as in fermented milk products like curd (Milind and Jyoti 2014). Another staple plant-based protein source consumed widely are pulses which causes digestive discomfort if consumed on a regular basis. A few fermented pulse-based products consumed in India include dosa, dhokla, dal bori etc which are easy to digest and have improved nutritional quality (Ghosh et. al., 2020).

Modernization and urbanization are the leading cause of health issues in the younger generations as they are more dependent on store brought less nutritious and quite unhealthy food and beverages. None the less, a growing popularity in fermented food and beverages is being observed among the health aware individuals (Raghuvanshi et. al., 2019). Nutritionally rich and flavourful fermented food products are a better and healthier alternative provided they are commercialized and made easily accessible. Thus, fermented food products can be a one stop solution for tasty and healthy food in this ultra busy malnourished and nutrient deficient world. Documentation of fermented food and beverages from all over the world followed by standardization of preparation protocols and commercialization will not only solve the global food insecurity and health issues but also uplift the socio-economic condition of various ethnic communities. An additional benefit will be the preservation of these immense traditional knowledge of fermentation technology which otherwise is getting lost as the younger generation of the ethnic communities are rapidly losing interest in learning this craft.

The technique of fermentation is more popular and prevalent in the Asian countries and Indian fermented foods are quite well reported and studied. West Bengal is an eastern Indian state with a rich cultural heritage, diverse geography and ethnic communities and its share of fermented foods and beverages (Alam et. al., 2024). In West Bengal, most of the fermented food and beverages have been reported either from the hilly regions or from the coastal plains (Tamang et. al., 2012 and Ghosh et. al., 2014). The fermented food and beverages from the plains of Northern West Bengal are largely unexplored, hence underreported. We aim to record and document the traditional fermentation technology employed by the indigenous ethnic population of the above-mentioned area to produce the most popular fermented food

products namely *Achar, Chullu, Dalbori, Doi/Dahi, Jilipi, Khajur Tari, Panta Bhaat and Tal Tari*. We have also looked into the day-to-day dependency of the ethnic communities on these food items, especially the food habit and the socio-economic aspects. This work is confined to the northern plains of the state comprising the districts of South Dinajpur and North Dinajpur.

Methodology

The survey was conducted from August 2022 to July 2023, covering two major districts of Gour Banga, namely North Dinajpur (Latitude 25º11´ N to 26º49´ N, Longitude 87º49´ E to 90º00´ E, total area 3142 sq. kilometers) and South Dinajpur (Latitudes 25º10´55´´ N to 26º35´15´´ N, Longitude 87º48´30´´E to 89º 0´30´´ E, Total area 2162 sq. kilometers) (Fig. 1). This study focused on the following major ethnic communities residing in this area of West Bengal: Ghosh (Gowala), Santal, Orao, Sher-Sha-Badia and low-income group of people from other communities.

Figure 1: Map of West Bengal showing the study area with different colour for two different districts

The focus of the study was to gather indigenous knowledge about the preparation process, mode of consumption, marketing strategies, self-consumption, and the socio-economic aspects of fermented products like *Achar, chullu, Dalbori, Doi, Haria, Jilipi, Khajur Tari, Panta Bhaat and Tal Tari* from makers and sellers. The documentation was based on answers collected using a standard questionnaire format from the local people of the respective area for the respective products associated with specific communities. For instance, information about *Doi* was sought from Ghosh (Gowala), *Chullu* from Santal, Orao etc. and *Dalbori* from Sher-Sha-Badia (Badia) communities.

Result

After the analysis of survey data, we could document about nine different varieties of food and beverages from our study area (Table 1, Fig. 2). The key difference lies in the raw material type and processing as well as the duration of fermentation. Some of these products uses traditional starter cultures for fermentation while others depend on the natural flora (i.e; microorganisms present naturally in the raw materials or from environment) which carry out spontaneous fermentation. These are economical as well as health beneficial fermented products produced by the ethnic group of North and South Dinajpur districts as they claimed.

Table: 1: List of fermented products and their starters, main ingredients, physical states

SL No.	Name of fermented product	Starter culture	Main Ingredients	Physical State
1.	*Achar*	Natural flora	Mango/Indian Plum	Semi-solid
2.	*Chullu*	Bakhar	Rice	Liquid
3.	*Dalbori*	Natural flora	Pulses	Solid
4.	*Doi*	Old stock of Doi	Milk	Semi-solid
5.	*Haria*	Bakhar	Rice	Liquid
6.	*Jilipi (Jalebi)*	Natural Flora/Doi	Maida, Besan	Solid
7.	*Khajur Tari*	Natural flora	Sap of date palm	Liquid
8.	*Panta Bhaat (Sour Rice)*	Natural flora	Rice	Solid
9.	*Tal Tari*	Natural flora	Sap of palm tree	Liquid

Achar (pickle): The Bengali *Achar* is prepared from a wide variety of fruits but the most common ones are the *aam-er achar* and *kul-er achar* prepared from mango during summer and Indian plum during winter respectively. North and South Dinajpur districts are one of the largest producers of mango in India, so, they preserve it in various forms by using different types of techniques: fermented and non-fermented. The most acceptable fermented relishes

form to preserve mango is aam-er *achar*. Indian plum, a type of tropical berry, also grows widely in the studied area and hence easily available at low cost which people preserve in the form of *kul-er achar* and savour all throughout the year. *Achar* is prepared at homes by most of the communities for self-consumption and some of the low-middle income residents of these two districts also sell the homemade *achars* for livelihood.

Chullu: *Chullu* is famous with its many names such as *desi daru, cholai mod* etc. It is an alcoholic distillate beverage produced and consumed mainly by the tribal community as well as low-income group of people from other community. *Chullu* has three different variety based on the main ingredients: rice *chullu*, main ingredient is rice; jaggery *chullu*, main ingredient is jaggery and *mahua chullu*, main ingredient is *mahua* flower (*Madhuca indica*). The starter tablet bakhar or modguli is made by mixing rice flour and locally available medicinal plants along with older bakhar. All three types of *chullu* are prepared by the mixing starter tablet bakhar with the raw material and kept for fermentation in dark place for 3-4 days during summer and 5-7 days during winters. Jaggery *chullu* preparation process is less time consuming as compared to rice chullu. Orange/Banana/other ripened fruits or their peels are added 6/7 hours prior to boiling and distillation to enhance the flavour. Sometimes flavouring substances are added along with the starter tablets.

Dalbori: Traditionally, *dalbori* is dried pulse-based delicacy prepared by Sher-sha-badia community. It uses only two ingredients- *maskalai* (urad dal/Black gram) and *chal kumro* (Ashgourd/winter melon). In West Bengal ash gourd season is during October to December, hence *bori* are also prepared during the winters and consumed all throughout the year. Now-a-days, commercial producers are also adding rice flour to reduce the cost of production and masoor dal, moong dal or motor dal as an alternative of urad dal for variation. Commercial *bori* do not contain any type of vegetables to make them economically reasonable.

Doi: For *Doi*, four different techniques have been observed to be employed by the Ghosh (Gowala) community and other commercial sellers of the area under study. The raw material for *Doi* preparation is milk in various forms like whole full fat milk, skimmed milk, condensed milk or milk powder mixed with full fat milk. Commercially, *Doi* makers also use some additives to get better texture and flavour as well as taste and health benefits. ***Tok doi*** (Curd) is a widely consumed milk based fermented product produced commercially as well as at household levels in all over West Bengal. ***Misti doi*** (sweet curd) is a West Bengal specific sweet curd dessert relished by all. This variety of curd preparation is similar to ***Tok***

Figure 2: Images showing different fermented food and beverages, raw materials, traditional appliances and Selling at market

doi, the only difference being the use of caramelized sugar which gives this ***Misti Doi*** its unique earthy aroma and flavour. The most popular and exotic indigenous *doi* of the studied area is ***Kheer doi*** (curd pudding) which basically is an amalgam of *Misti Doi* (sweet curd) and payesh (rice pudding). The preparation of *kheer doi* is done by mixing milk powder and a small amount of rice flour followed by cooking and fermentation. This dessert is a celebrated delicacy of the Gangarampur area of South Dinajpur and is prepared commercially in family-owned sweetshops as the preparation process is still a well-preserved family trade secret.

Haria: *Haria* is a rice based fermented recreational and therapeutic alcoholic beverages produced and consumed mostly by tribals like Santal and Oraon and low-income non-tribals. In lateritic area of West Bengal, the final product *Haria* is the paste or mixture of fermented watery rice (Ghosh et. al. 2014) but in the area of Gour Banga (our study area), the final product *haria* is produced by separating fermented water from the rice by sieving**.** This fermented water is consumed as *haria*.

Jilipi: It is a sweet item consumed as snacks or dessert. The main ingredients of *jilipi* are Maida (all-purpose flour), Besan (Chana dal Flour), sugar and small amount of *tok doi* (curd) as a starter culture. *Jilipi* makers prepare a batter of maida and besan (optional) and leave it for 8-10 hours for fermentation. After that, the batter is poured on heated oil through a funnel making a spiral shape and deep fried. *Jilipi* fried in ghee are costlier, healthier and tastier. Deep fried *jilipi* are then dipped in a sugar syrup for 5 minutes to make the final sweet mouthwatering delicacy.

Khajur Tari: This is basically the spontaneously fermented sap of silver date palm tree and is mostly consumed by rural Bengalis. During winter, ethnic rural people collect the sap in earthen pots from sunset to sunshine and it is mildly alcoholic. At times, sap is collected during day time or late morning for more alcohol concentration as the higher temperature helps incubating the microbes to produce more metabolites. The shelf-life of *khajur tari* is very less approximately 6-8 hours, so, unsold or unconsumed *khajur tari* is converted into a more demanding and costlier *nolen gur* (dates palm Jaggey) by concentrating the sap with the help of continuous heating.

Panta Bhaat: The main ingredient of *panta bhaat* is left-over rice which is naturally fermented. Post dinner, the left-over rice is soaked in excess drinking water at 1:2 ratio and kept for overnight fermentation. Next morning, people consumed it along with fish fry, onion and roasted red chilli or green chilli or some other spicy curry. *Panta bhaat* is a nutritious and cooling food which is very economical and easy to prepare.

Tal Tari: This is an exotic naturally fermented colourless mild alcoholic beverage made up from the sap of palmyra tree (*Borassus flabellifer*). The sap is collected from both male and female young inflorescence by a process called tapping. The shelf-life of *Tal tari* is very less approximately 8-10 hours post collection after which it develops sour and off taste.

Traditional serving and consumption process

Achar is commonly eaten along with staple meals and it can be either sweet or savoury. It is popular among all the communities in West Bengal. *Achar* is also served in "*Thali meals*" in hotels and food junctions to make the meals more traditional and appealing. ***Chullu/Desi Daru*** and ***Haria*** are both fermented alcoholic beverage prepared and consumed mostly by the indigenous tribes (Santal, Oraon, Munda) of South Dinajpur and North Dinajpur districts. Usually, tribal males consume more in comparison to the tribal females and these are also popular recreational drink among the low-income non-tribal males. Apart from the regular *chullu* and *haria* consumers, these are also served in all tribal social ceremonies- from birth and marriages to funerals. Mostly *chullu* and *haria* are sold in weekly local haats (open markets) and people consume it in groups there itself during socializing. Other than the regular haats, *chullu* and *haria* consumers also drink it in shops or in the homes of the makers. Commonly, jaggery *chullu* and *haria* are consumed by regular consumers due to their being economical while the costlier rice *chullu* is served during festivals and social ceremonies. Mahua *chullu* is more exotic and expensive seasonal variety made during the availability of mahua fruit. All variant of *chullu* and *haria* are usually bottled in recycled 750ml beer bottles for commercial selling.

Dalbori is consumed in various vegetable curries and fish curries. *Bori* is usually fried in a little oil and added to the curries either by crushing or as a whole. Usually around 2-3 *bori* are served per head. These high protein *bori* are quite affordable and thus can be enjoyed by almost all income groups. ***Tok Doi*** seasoned with salt is consumed along with meals during lunch time and is also used in many cooking recipes in Bengali households. It is also used to prepare "ghol" (buttermilk) and sweet or salted lassi. *Tok doi* is an everyday staple whereas *misti doi* is more of a dessert for social ceremonies and festivity consumption. *Kheer doi* is consumed mostly in sweet shops itself or as takeaways. The serving size is of all these *doi* varities are around 150-250g per adult. ***Jilipi*** is a one of the occasional snacks or dessert item for the people of West Bengal. All type of bengali community crave for it and people purchase it from sweet shops and weekly Haat/Baazar or occasional Mela (Fair). A healthy adult Bengali people can eat 4-6 pieces of *jilipi* at a time.

Panta Bhaat is eaten largely by the rural low-income populations during hot summers as it is very economical and easy on the stomach. Some urban population also consume it for health benefits. Fish fry/spicy curry with onion and chilli are the most preferred add-on items while eating *panta bhaat*. Both *Khajur Tari* and *Tal Tari* are mild alcoholic beverages with *tal tari*

being a little more alcoholic. *Khajur tari* is consumed by low and medium-income group of people at early morning before breakfast or as breakfast with puffed rice. Highly demanding *khajur gur/nolen gur* (date palm jaggery) is used to make several sweets and desserts like rosgolla, sandesh and payesh. *Tal tari* is more of a recreational drink consumed more during the summers to cool down and relax. *Tal-er Patali gur* (jaggery) and *tal misri* are also prepared from the palm sap.

Socio-Economy: All these ethnic fermentation technologies used to prepare various fermented food and beverages are community specific ancestral knowledge passed on across generations. These communities thus use this knowledge and skill to not only maintain their traditions but also to generate income (Table 2). *Chullu* and *Haria* are prepared and sold by both males and females of the tribal communities. Survey result showed the involvement of mostly women workforce in production and selling process of *chullu* and *haria* while men, both tribal and non-tribal, are prime consumers. As mentioned earlier, *tok doi* is the simplest *doi* variety and is prepared commercially as well as at homes but *misti doi* and the more sophisticated *kheer doi* is produced commercially mainly by the Ghosh community who owns most of the sweet shops in the studied area. *Maskolai chaalkumro dal bori* is prepared mainly by the females of the Sher-sha-badia community and the technique is mostly passed on from mothers to daughters.

With the passing time, all these fermented food and beverages started gaining popularity outside of these communities thus opening up a huge market for commercialization. So, at present people from other communities have also started preparing and selling these products at small scale to generate income. *Chullu, haria* and *dal bori* contribute a lot to rural microeconomy and the consumer base is quite localized. Commercially *dal bori* is prepared by the females and senior citizens of other communities but they use rice flour to reduce the production cost. *Doi,* in all its varied form has a huge consumer base across all communities and age groups thus having footprints in both urban and rural economy all across West Bengal with the exception being the exotic *kheer doi.* The production of *kheer doi* is confined only to some specific families of the Gangarampur area of South Dinajpur district thereby making it more of a family trade secret.

Table 2: Raw ingredients, production cost, market price and net profit of the fermented products

Raw ingredients and total cost	**Production and market value**	**Net Profit**
Achar		
1.Unriped mango or matured Indian plum 2. Spices Total cost per kg □ 65	From 5 kg of mango around 4kg of *achar* is produced. From 5kg of Indian plum 4 to 4.5 kg of *achar* is produced. Selling price is around □280 to □300 per kg.	Not commonly sold in market but some ethnic restaurant or hotels serve this delicacy. Processing for 5kg raw material, on an average need one or two labour which cost □400. Net Profit= (1120-725) = □**395**
Rice Chullu		
1. Low grade Rice □18 per kg for 16 kg @ □288 2. Low grade Jaggary □20 per kg for 4 kg @ □80 3. Fire Wood 20 kg @ □80 4. 2 labour @ □500 5. Bakhar @ □10 **Total cost-□458** (excluding labour charges) **Total cost-□958** (including labour charges)	From 16 kg of rice and 4 kg of jaggery, we will get 16 bottles (750 ml) high concentrated *chullu*. After adding water @ 2:1 ratio, they make it 24 bottles. One bottle *chullu* sell at □60. **Gross income-□1,440**	**Net profit = (1,440-958) = □482** Producer is doing all the works themselves (From raw material purchase to *Chullu* selling). *Chullu* has a high demand in market and local employment is scare so this serves as a self-employment source for generous income. Thus, they do not include the labour charges and feel that **Total income is (1,440-458) =□982**
Jaggery/Molasses Chullu		

1.Low grade jaggery or Molasses@ □470 per tin (1tin contains 22 kg of jaggery) 2. Fire Wood 20 kg @ □80 3. 2 labour @ □500 4. Bakhar @ □10 **Total cost-□560** (excluding labour charges) **Total cost-□1,060** (including labour charges)	It can produce 13 bottles (750ml) of highly concentrated *chullu* to which water is added in a ratio of 1:2. Finally, 13+26=39 bottles of *chullu* is produced. Price of 1 bottle jaggery *chullu* is □45. **Gross income-□ 1,755**	**Net Profit-(1755-1060) = □695** Producer is doing all the works by himself/herself (From raw material purchase to *Chullu* selling). Due to scarcity of local employment, they feel that they are self-employed and consumers are also available in the local area. So, they are not included the labour charges and feel that **Total income is - (1,755-560) = □1,195**

Mahua Chullu

1. Dried Mahua flower □ 45 per kg (Sometimes it is free of cost as they will collect from wild). For 15 kg @ □ 675 2. 5 kg Jaggery @ □ 100 3. Fire Wood 20 kg @ □80 4. 2 labour @ □500 5. Bakhar @ □10 **Total cost- □865 (excluding labour charges)** **Total cost-□1,365 (including labour charges)**	It can produce 16 bottles (750ml) of *chullu* before adding water for dilution. Water is added in equal volume and finally produces 16+16=32 bottles of *chullu*. Selling price of one bottle *chullu* is □ **75.** **Gross income-□2,400**	**Net Profit-(2400-1365) = □1035** *Chullu* maker is doing all the works by himself/herself (From raw material purchase to *Chullu* selling). Due to scarcity of local employment, they feel that they are self-employed and consumers are also available in the local area. So, they are not included the labour charges and feel that **Total income is - (2,400-865) = □1,535** N.B. This is prepared occasionally and seasonally when flower is available.

***Dalbori* for own consumption (Home-made)**

1. Maskolai Dal (whole Urad Dal/ Black gram) 10kg @ □1000 2. Ash Gourd (Whole)13-16 kg @ □150 3. Two labour @□500 **Total cost □1,650**	This is a high demand product but it is not available in market. Sometimes, they may sell it in household level at □300 per kg. Approximately, 9-10 kg of *dalbori* will produce from this much of raw materials. **So, gross income is □2,700**	**Net profit- (2700-1650) = □1050** *Maskolai dalbori* has a high demand in market and generally produce it for own consumption by sher-shah-badia community. If they sell it in market, **final income will be □1,050.**

***Dalbori* for selling**

1. Maskolai Dal (whole Urad Dal/ Black gram) 10kg @ □1000 2. Rice flour 5kg @ □350 3. Nigella seeds @ □5 4. Two labour @□500 **Total cost □1,855**	Form 10 kg *maskolai dal* and 5 kg rice flour produce 12-13 kg *dalbori.* Market price is in between □200-□250 per kg. it depends on the percentage of rice flour added on it. If average selling price is □225, **So, gross income will be □2,700**	**Net profit- (2700-1855) = □845** *Maskolai dalbori* has a high market demand and generally produced by tribals and other low-income people. Now a days sellers produce it by using masoor dal (lentils), moong dal (green gram) as alternative of urad dal. Small scale producer not included labour charges, so they feel that the **final income is (□845+□500) = □1,345**

***Tok Doi* (Plain Curd)**

1. Cow milk/ Buffalow Milk (for household consumption, people prefer cow/buffalo milk but sellers always mix powdered milk to maintain shortfall and price along with texture) 20 litre @ □800 2. Fire Wood 10kg @ □40 3. Old Stock 400 gm @ □60 4. 1 labour @ □250 **Total cost- □900** (excluding labour charges) **Total cost-□1,150** (including labour charges)	From 20 litres of milk, approximately 14 to 15 kg of *Tok Doi* is prepared. 1 kg of *Tok Doi* can be sold at □140. **Gross income is □1,960**	**Net profit- (1960-1150) = □810** Small scale producer is doing all the works by himself (From raw material purchase to *doi* selling). *Tok doi* has a high demand in market and local employment is scare so this serves as a self-employment source for income generation. Thus, they do not exclude the labour charges and feel that **Total income is Rs. (1960-900) = □1,060.**

***Misti Doi* (Sweet Curd)**

1. Mixture of Cow / Buffalow Milk and Milk powder @ □800 for 20 litres 2. Sugar 2kg @ □80 3. Fire Wood 10kg @ □40 4. *Tok doi* as sajh (starter culture) 400 gm @ □60 5. 1 labour @ □250 6. Mud pot @ □1.5 per pcs For 60pcs □90 **Total cost-□1320**	Approx. 14.5 to 15.5 kg of *misti doi* is produced. Market price of *misti doi* is □160 per kg. **So, the gross income is □2,320.**	**Net profit- (2320-1320) = □1000** *Misti Doi* has a high demand in market and generally produced by sweet shopkeepers. After calculating all type of expenditure (excluding establishment cost), final **income is □1,000.**

Kheer Doi

. 1. Mixture of Cow / Buffalow Milk and Milk powder @	Approx. 10kg of *kheer doi* is produce from 20 litre of	**Net profit- (2200-1400) = □680**

□800 for 20 litres . 2. Sugar 2kg @ □80 3. cardamom 15-20gm @ □70 3. Fire Wood 15kg @ □60 4. *Tok doi* as sajh (starter culture) 400 gm @ □60 5. 1 labour @ □250 6. Mud pot @ □80 (Producers using rice flour at 10% rate) **Total cost-□1,400**	milk pure milk. Per kg price is □220**.** **So, the gross income is □2,200.**	*Kheer Doi* has a high demand in market and generally produced by the sweet shopkeepers. After calculating all type of expenditure (excluding establishment cost), final **income is □680.**
Haria		
1. Low grade Rice □18 per kg for 16 kg @ □288 2. Fire Wood 10 kg @ □40 4. 1 labour @ □250 5. Bakhar @ □ 10 **Total cost-□338** (excluding labour charges) **Total cost-□588** (including labour charges)	From 16 kg of rice, 12 bottles (750 ml) high concentrated *haria* is produced. After adding water @ 1:1 ratio, they make it 24 bottles. One bottle *haria* sell at □40. **Gross income-□960**	**Net profit = (960-588) = □372** But producer is doing all the works by himself/herself (From raw material purchase to *Haria* selling). *haria* has a high demand in market and local employment is scare so this serves as a self-employment source for generous income. Thus, they do not include the labour charges and feel that **Total income is (960-338) =□622**
Jilipi		
1.Maida □ 35 per kg 2.Besan □ 65 per kg (Optional) 3.Sugar □ 40 per kg	From 10 kg of maida, we can get 14 kg of *jilipi*. Market price of 1 kg oil	On an average, cost to prepare one kg of *jilipi* is □55-60. Net profit per kg is **□40-45.**

4.Oil for deep frying	fried *jilipi* is □100.	
5.Curd/doi □10		
6.Labour		
Khajur Tari		
1. Date palm tree 2. Mud pot 3. Knives and ropes All are one time investment	**Selling price is** □20 per litre. people harvest 12-15 litre per day per tree. One person can harvest and sell *tari* from around 5-6 trees. **So, gross income is □1,440**	Tree owners have to pay 1/3rd of the total income. So, Net profit including labour charge is **960/day.** N.B. Initial one week there is no income because people need to work for preparation.
Panta Bhaat		
Left-over rice	Not Applicable	Not Applicable
Tal Tari		
1. Palm tree (Tal Tree) 2. Mud pot 3. Knives and ropes All are one time investment	**Selling price is** □20 per litre. people harvest 8-10 litre per day per tree. One people can harvest and sell tari from around 5-6 trees. **So, gross income is □1,200**	Tree owners have to pay 1/3rd of the total income. So, Net profit including labour charge is **800/day**. N.B. Initial one week there is no income because people need to do preparatory work.

Fermented *achar* is not much available in market and is mostly prepared at homes only. *Panta Bhaat* is also a homemade food and not sold in markets. *Jilipi* has huge market in the studied area. The seasonal beverages *Khajur Tari* and *Tal Tari* also have market potential but are getting quite limited due to reduction in these tropical plants.

Discussion

Indigenous knowledge about the technique of food preservation by using fermentation technology has mostly been sought from the senior citizens, mainly women. In this study we have documented nine different types of food and beverages based on mainly their popularity and economic importance. *Dalbori, Jilipi* and *Panta Bhaat* are fully solid and non-alcoholic items consumed by most of the communities in West Bengal. *Chullu, Haria, Khajur Tari* and *Tal Tari* are all liquid alcoholic beverages with chullu being highest in alcohol content and *Khajur tari* being the lowest. All these recreational beverages are produced and sold at a small scale by low-income people. *Achar* and *Doi* are semi solid non-alcoholic foods and are popular among the people of all income groups. *Achar* is always served with starters of the main course while *doi* being a dessert indicates the ending of meals.

Doi, the go-to dessert for all the communities residing in the Northern plains of West Bengal also needs quality control assessment. For all the *doi* varieties, the quality of milk determines the taste and aroma while the thickness or condensation of milk and its fat content determines the texture and creaminess. Commercial *doi* producers mix milk and milk powder to achieve desired milk consistency to produce *doi.* Hence quality of these raw materials should be monitored so as to maintain the health benefitting properties of *doi*. Apart from the three *doi* varieties mentioned in this paper, there is another type of *doi* called "*Chandranchur Doi*" which is quite famous and popular in this area. Traditionally *bori* is prepared at Sher-sha-badia households for family consumption and uses *mashkolai* with ash gourd. Other muslim communities use *mashkolai* along with colocasia to prepare *bori*. Commercial *bori* makers avoid the use of these vegetables and use a mixture of rice flour along with pulses to reduce the preparation time and price. Usually, the price of *bori* in market depends on the proportion of rice flour used with the costlier ones containing minimum rice flour additive. Taste and flavour of the traditional *bori* is extremely superior and the quality reduces with the increasing use of rice flour. In case of *jilipi*, makers add besan (gram flour) along with maida for making the batter and fry more for crispy and tasty *jilipi*. The reuse of oil for frying *jilipi* makes it quite unhealthy and hence the costlier high-quality ones are fried in ghee which can resist high temperature.

Survey result indicates that all type of fermented food and beverages are mostly prepared in dry season as the area under study has high humidity during monsoon. Hence, people avoid making these fermented food and beverages as the rate of microbial contamination (specifically fungal) becomes high. Use of contaminated starters like dampen bakhar/modguli

and old *doi* stock during humid seasons may develop bad odour in final products and in worst cases can even lead to poison formation. Thus, hot humid weather conditions do pose a high risk during the production of fermented products. As per sources, in earlier days, producers of fermented products were not adding spices or flavouring agents but now-a-days people always add them to develop diversified taste and enhanced products. Currently use of medicinal plant leaves or other parts have gained popularity in *achar* making to improve taste and health. All the fermented food and beverages studied here are mostly prepared in small scale for commercial selling and no standard protocols or safety procedures are taken to maintain hygiene or avoid any health hazards. Hygiene is of utmost importance to prevent contamination during fermented product preparation but traditional *chullu* and *haria* is mostly prepared in unhygienic manner with cheap raw materials and poor handling techniques. Producers also uses water from nearby river or unsafe source rather than potable drinking water for preparation or for dilution of fermented products before consumption may lead to pathogenic bacterial infections from coliform like *E.coli, Enterobacter, Staphlococcus etc*. (Alam and Pandey 2014) for which awareness is needed. Also, standard equipment for fermentation and distillation is a must to maintain the quality of *chullu* and *haria*. There is no standard hygiene practice for *khajur tari* and *tal tari* selling and consumption. Proper handling knowledge along with the use of standard equipments (such as fermenters and distillation unit for *chullu*, incubator and refrigerator for *doi*, grinder and dryer for *bori* etc) along with scientific preservation process and packaging can help these commercial producers to maintain the quality as well as production scale all throughout the year thereby maintaining their income source as well as market demands.

Conclusion

All the fermented products documented in this study have traditional significance and commercial impact as well as nutritional benefits. Proper documentation, standardization and commercialization of these ethnic fermented food and beverages will be beneficial for generating income source and opening up job opportunities. These fermented products are an easily affordable and healthy food source for the people of this area and it may play an important role to achieve food and nutrition security of our nation, mainly for the economically weaker sections. This also calls for the implementation of proper Government regulations to make the fermented products as per industrial hygiene standards as well as their proper packaging, storage and marketing so as to avoid any health hazards or fatality. To organize awareness programme and increase popularity regarding fermented food and

beverages, initiatives can be taken by Government organisations, NGOs and other relevant stake holders.

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