ORIGINAL ARTICLE

Harnessing the indigenous technological knowledge base regarding post-harvest management of agricultural products

K. Pradhan[1], Zigme Yolmo[1], Avishek Saha[1], Sabita Mondal[1], Ganesh Das[2]

[1]Department of Agricultural Extension, Uttar Banga Krishi Viswavidyalaya, Coochbehar, West Bengal, India, [2]Coochbehar KVK, Uttar Banga Krishi Viswavidyalaya, Coochbehar, West Bengal, India

Abstract

Background: In the present agriculture scenario, the indigenous technological knowledges (ITKs) related to post-harvest management contributes to the sustainable livelihood of the rural people through improvement of shelf life of the perishable produces, development of value added product, and preservation of agricultural commodities**. objective:** The study was conducted to document and validate various ITK related to post-harvest management of agricultural produces depicted from the local people's knowledge and experience in Darjeeling district of West Bengal. **Materials and Methods:** The information related to the same was collected from the selected key informants of the local area where the study was conducted. The simple random sampling procedure was followed to select the 100 number of key informants in case of identifying and documenting the traditional knowledge base related to post-harvest management. All these ITKs were documented with the help of some key features of the knowledge and validated by collecting the information from 25 key informants who were locally available and has the expertise on that knowledge. **Results:** The study has identified 10 ITKs related to the post-harvest management and value addition to the agricultural produces. Out of those 10 ITKs, 8 ITKs were found to be scientifically valid and economically feasible and environmentally safe. These ITKs are timely tested and may be further extrapolated in the similar type of ecosystem. **Conclusion:** The findings will help in developing the contents of ITK which will be disseminated to the entire community for its future implication in other areas.

Key words: Indigenous technological knowledge, livelihood, perishable produces, post-harvest management, shelf life, sustainable, value addition

INTRODUCTION

Our country has witnessed the Green Revolution in agriculture in the late 60s of the last century and now we are self-sufficient in almost all the food grains production. However, in recent times, there is another call throughout the country for the second Green Revolution which raises the question regarding the success of the previous Green Revolution. The answer can be traced to the fact that though the Green Revolution has helped in many ways to enhance the production and productivity in agriculture, due to its input-intensive nature like higher use of fertilizers, irrigation, plant protection chemicals, and high-yielding varieties, it could not do significantly in the sustainability concern. Rather, in the long run, the then Green Revolution has posed serious threats to the quality of the soil, water, air, and other components of the environment. The aftermath impact of the Green Revolution is not at all conducive to the crop ecology, and it failed to sustain the increased productivity achieved during the 1960s because the indiscriminate use of the inputs during Green Revolution era has led to the environmental degradation, loss of soil fertility, emergence of new strains of insect-pests, extinction of several indigenous crop varieties, and many more unwanted constraints. Therefore, to overcome this crisis, nowadays, a new concept of second Green Revolution is gaining momentum which emphasizes on the sustainability in agriculture through controlled use of inputs and blending of the scientific knowledge with the local indigenous

Address for correspondence:
Avishek Saha, Department of Agricultural Extension, Uttar Banga Krishi Viswavidyalaya, Coochbehar, West Bengal, India.
E-mail: avishek.extension.2014@gmail.com

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technological knowledge (ITK) in agriculture. Here, lies the importance of ITK in agriculture. ITK is the actual knowledge of a given population that reflects the experiences based on tradition and includes more recent experiences with modern technologies.[1] Anonymous[2] conceptualized the ITK as the basis for local–level decision-making in agriculture, health care, food preparation, education natural resource management, and a host of other activities in rural communities.

Since the prehistoric times, people are growing food on these earth using their own knowledge, skill and technologies. Hence, they have developed their own technology from their life-long experiences for cultivating crops which is very much localized. However, with the development of modern science and technology in agriculture, these traditional people with their traditional agricultural technology are often being neglected in the process of technology generation, assessment and refinement. As a result, the technology developed at the research station are rejected by the farmers because the farmers find it not suitable for their situation and on the other hand, the scientists fail to consider farmers' practical situation and their knowledge level which makes the technology merely a futile exercise. Without doubt, there is a conviction in many quarters of the need to tap into the stock of indigenous knowledge if appropriate planning and land management strategies are to be developed in a sustainable way.[3,4] A number of different ITK can be observed in several aspects of agricultural practices starting from land preparation to the marketing of the produce. These traditional practices also vary from place to place because of its much-localised nature. Therefore, the present study has been restricted to one important aspect of the agricultural production system, and that is, the ITK in the postharvest management of the agricultural products.

Nowadays, the post-harvest management has gained great importance in the light of reducing the huge post-harvest losses of agricultural and horticultural products. Some estimates suggest that about 30-40% of fruit and vegetables are lost or abandoned after leaving the farm gate. India is not an exception in this fact. Although India is a major producer of horticultural crops, many Indians are still unable to obtain their daily requirement of fruits and vegetables and hence, the Human Development Index is very low. Considerable quantities of fruits and vegetables produced in India go to waste owing to improper postharvest operations and the lack of processing. This results in a considerable gap between gross food production and its net availability. Hence, proper identification and validation of ITK for post-harvest management can be helpful in this regard if properly blended with modern and scientific postharvest technologies and practices. In fact, many studies have proved it very effective. For example, Anonymous[5] concluded from their study that scientists favored the continuation of 9 out of the 11 indigenous post-harvest practices followed by a sample of 200 farmers.[5] Anonymous[6] observed that scientists rated more than 80% of the indigenous post-harvest practices as rational. Under such a resilient research climate, the present study was conceptualized and carried out to identify, collect and finally to document some of the valuable ITK regarding postharvest management of agricultural products.

METHODOLOGY

The ITK in the study area were collected from the selected informants and documented in a systematic manner on the basis of the following attributes.

- Title
- General description of the ITK
- Area of specialization
- Application of ITK
- Cultural compatibility and environmental feasibility
- Sustainability
- Scientific rationale
- Revelation
- Photograph.

This type of documentation may help in developing the contents of ITK which will be disseminated to the community for its future implication in other areas through Information Communication Technology (ICT).

The ITK was documented through interaction and discussion with the farmers of the study area without knowing its scientific validity. Scientific validity refers to the degree to which the information on ITK is realistic with a scientific backstopping. The validation of documented ITK was done with a group of scientists for identifying the scientific relevance of these ITK practices. The documented ITK which is of farmer's interest was sent for scrutiny.

These were circulated to 25 scientists for their responses on three-point validity continuum, and the responses scored 5, 3 and 1 for valid, not considered and not valid, respectively. Thus, one ITK could get a maximum score of 125 and a minimum of 25.[7] The higher scores on scientific validity of ITK would establish the validity of the particular ITK in a scientific manner.

RESULT AND DISCUSSION

Identified ITKs Regarding Post Harvest Management of Agricultural Products

Gundruk: A fermented leafy vegetable

- General description of the ITK: It is a common dried fermented leafy vegetable of the Nepalese communities of the Darjeeling hills. To prepare it, the leaves of radish (*Raphanus sativus*) are wilted for about 2-3 days in the sun before it is shredded and then crushed mildly with

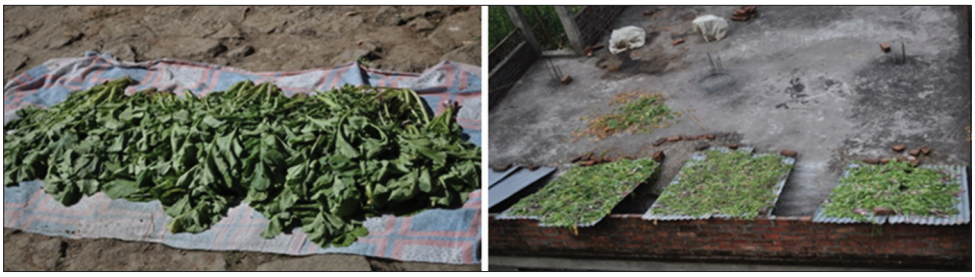

Figure 1: Sun drying of radish leaves

Figure 2: Crushing of leaves and fermenting process

a special wooden piece commonly known as mungo [Figures 1-3]. It is then wrapped in a polythene bag and kept in a jar or container which is then pressed with a wooden block known as achano. The product is then kept for fermentation for about 7-10 days. The freshly fermented gundruk is then removed from the jar and is spread over a polythene sheet and sun dried for about 5-6 days. Finally, completely dried Gundruk can be consumed and stored for more than 2 years.

- Area of specialization: Postharvest management of the agricultural product.
- Application of ITK:
  a. Gundruk is mostly taken as a substitute of pulses during the winters and rainy seasons. It is mostly consumed in the form of soup and pickles
  b. Gundruk also helps in digestion of food
  c. Gundruk has fetched high market price. Therefore, it serves as a source of income for farmers.
- Cultural compatibility and environmental feasibility: Gundruk is culturally compatible and does no harm to the environment. It is an organic product in nature.
- Sustainability: Gundruk is mostly consumed during the cold winters and rainy seasons in the form of soup with rice and when the availability of vegetables is less in the market. Due to its availability during the stress condition and its economic feasibility and cultural acceptability by the tribal people, this ITK is sustainable and can be extrapolated in the other areas of the similar ecosystem.
- Scientific rationale: Gundruk can be stored for a longer period and can be consumed as soup just by boiling it in water, thus saves time. Moreover, it is produced through scientific fermentation and can be stored and consumed afterward even without a hint of any artificial preservative.
- Revelation: This ITK can be helpful in the ushering of a new era of value-added perishable agricultural products when the fresh agricultural produces are not available.

Kinema: A fermented soyabean food product

- General description of the ITK: Kinema is a sticky fermented soybean food product of the Nepalese community produced by natural fermentation [Figure 4]. During production, local varieties of soybean are soaked overnight, boiled and drained off and then the cooked soybeans are broken to split the cotyledons. About 1% of fire ash is added to the cooked soybeans to maintain the alkaline level. First, the leaves of *Leucosceptrum canum* locally known as ghurpis, are spread over the base of the basket and then the soybean grits are kept on it. It is then covered and left to ferment naturally for 4-5 days. Shelf life of kinema may be prolonged by drying in sun for 3-4 days.
- Area of specialization: Post-harvest management of the agricultural product.
- Application of the ITK: Kinema is consumed in the form of curry, pickle, and soup. It is also sold in the nearby areas as per demand.
- Cultural compatibility and environmental feasibility: It is culturally compatible and environment-friendly.
- Sustainability: It is considered as a special traditional dish of the tribal people and is consumed at least twice a month. The taste and flavor of kinema make it one of the most preferable value added product, hence it is sustainable.
- Scientific rationale: Kinema is preferred because of its special taste and flavor. It can be stored and consumed for long without any preservative. Usually, it takes very less time to cook kinema thus can also be used at the time of emergencies.
- Revelation: This ITK can be further launched to produce such a fermented value-added agricultural product that can be an alternative in lean Season.

Kodo ko Jaanr or Chhyang and BhaatiJaanr or Chhyang: Traditional alcoholic beverages

General description of the ITK: Kodo ko Jaanr or Chhyang, as it is locally called, is an indispensable alcoholic beverage prepared by the tribal people of Darjeeling and a must in all social functions [Figure 5]. It is prepared from finger millets and rice and has a sweet, sour and acidic taste. Seeds of finger millets (*Eleusine coracana*) are boiled for 30 min after thorough segregation and cleaning and

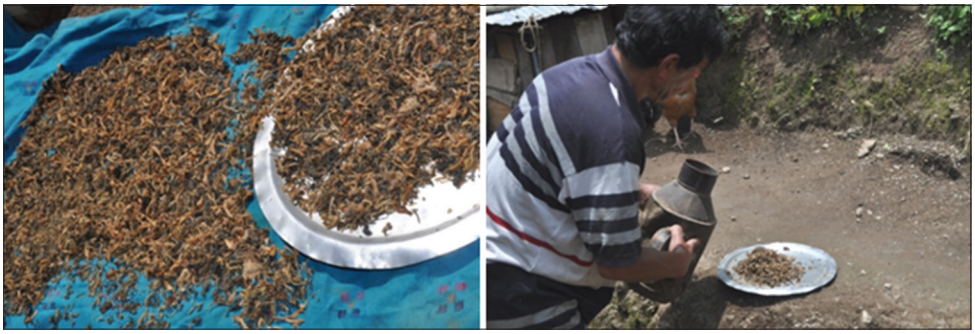

Figure 3: Processed and dried gundruk ready for consumption and storage

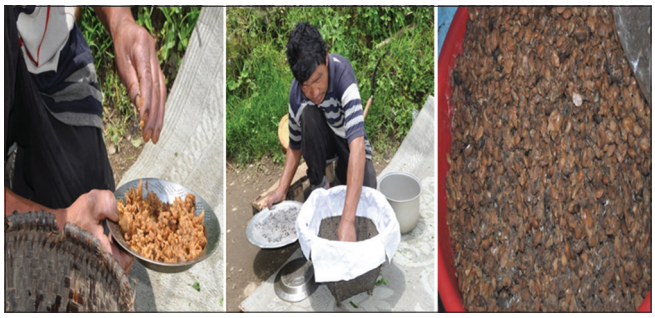

Figure 4: Postharvest processing of kinema

Figure 5: Kodo ko Chhyang, popularly called Tongba

Figure 6: Bhaati ko Chhyang or jaanr, ready to consume

then drained off, and the cooked millets are spread over a polythene sheet for cooling. Then, after adding about 1-2% of powdered marcha (starter), these seeds are packed in an air tight container which is kept for minimum 3-4 days. To consume it, 200-300 g of fermented millet grits is poured in a bamboo vessel to which luke warm water is added which, after 10-15 min, produces a milky white liquid product being ready to consume with a pipsing (a narrow straw made of bamboo).

The rice-based alcoholic beverage is called Bhaati ko Jaanr or Chhyang [Figur 6]. Cooked rice is added with 2% powdered marcha (starter) and stored in an airtight container or bucket for 3-4 days. It is then made into a thick paste by stirring the fermented mass by a hand driven wooden or bamboo stirrer known as firkay and is served in mugs.

- Area of specialization: Postharvest management of the agricultural product.
- Application of ITK:
  a. Due to its high-calorie content it is being consumed by ailing people to regain the strength
  b. Low alcohol content of chhyang compared to other available beverages makes it more popular among people
  c. It is also being offered to God by some tribal during their festivals and ceremonies.
- Cultural compatibility and environmental feasibility: It is culturally compatible, and its production causes no harm to the environment.
- Sustainability: It is mostly prepared and consumed during religious ceremonies and festivals. It is also consumed regularly by some people to overcome tiredness after a long day work.
- Scientific rationale: Chhyang is purely organic. Consuming it in the evening increases the appetite as well as gives them a sound sleep. Its fermentation is scientific and can be stored without adding preservatives.
- Revelation: Chhyang is an organic alcoholic beverage, and when consumed moderately according to one's requirement, it can be beneficial for health. It can be further consumed as a traditional alcoholic drink having with low alcohol content.

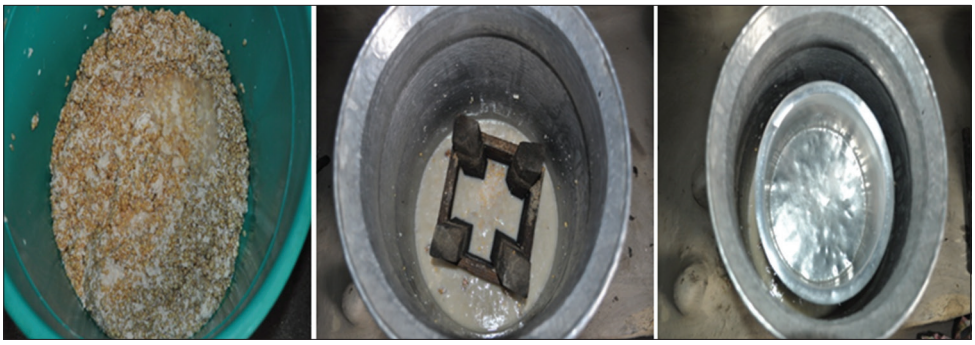

Figure 7: Materials being set for the preparation of rakshi

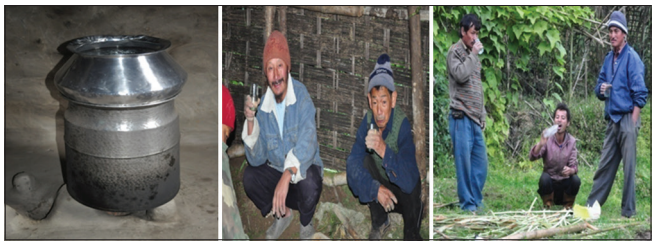

Figure 8: Processed rakshi consumed as a refreshing drink after a long day work

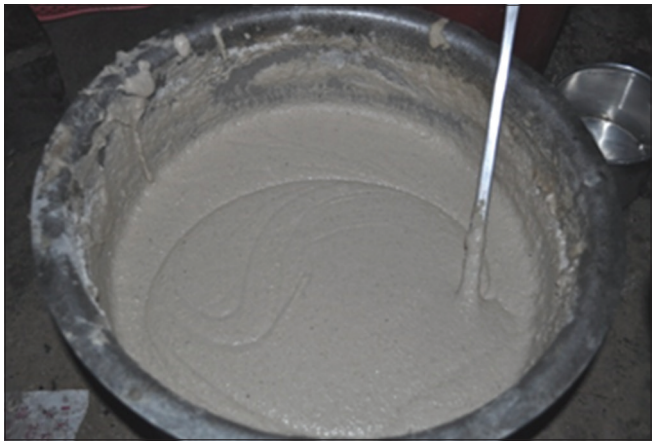

Figure 9: Ingredients mixed together

Figure 10: Selroti being prepared in a pan

Rakshi: A traditional alcoholic beverage

- General description of the ITK: Rakshi is a transparent alcoholic beverage made from wheat [Figure 7]. Firstly, the wheat is segregated, washed and boiled for about 30 min and then drained off. After that, the cooked wheat is spread over a polythene sheet known as mandro for cooling. Cooked seeds are then kept in an airtight container for 3-4 days after adding 1-2% of powdered marcha (starter). After 3-4 days, some water and sugar is added to the fermented mass (1 kg sugar/5 kg wheat) and again kept in packed condition for 3-4 days. It is then put into an aluminum vessel known as phosi, a small triangular wooden stand called odaan is kept inside the vessel and a metal bucket containing one-fourth level of water is rested above the odaan. Finally, the phosi is covered on the top with a round vessel filled with water to check leakage of gases. It is then heated from base for about 2 h. The vessel inside the phosi gets filled with rakshi having low alcohol percentage [Figure 8].
- Area of specialization: Postharvest management of agricultural product.
- Application of the ITK:
  a. Usually consumed by the people to combat their tiredness, after a long and hard day of work
  b. It is also a good substitute of the expensive alcoholic beverages that are available in the markets
  c. It is also used in festivals and religious ceremonies for offering to Gods by some of the tribes.
- Cultural compatibility and environmental feasibility: It is culturally compatible, and its production causes no harm to the environment.
- Sustainability: It is mostly prepared during religious ceremonies and festivals as it is very much popular in such occasions. It is also consumed on regular basis by some people to overcome tiredness which ensures its sustainability.
- Scientific rationale: Rakshi is an organic alcoholic beverage. Its consumption in the evening improves the appetite and assures good sleep. It is also being offered to God on certain occasions, and its fermentation is scientific and without nay preservative.

Figure 11: Selroti ready for consumption and storage

Figure 12: Plant used for preparing Marcha

Figure 13: Picture of *Ficus racemosa*

- Revelation: Rakshi is an organic traditional alcoholic beverage of the hills produced from locally available resources. This energy booster beverage rakshi can paves way for entrepreneurship development, especially during winter seasons.

Selroti: Traditional rice bread

- General description of the ITK: Selroti is a Nepali word and a popular fermented rice-based, ring-shaped, spongy, deep-fried pretzel like food item commonly consumed in Darjeeling [Figure 9-11]. It is prepared during religious festivals and special occasions. Selroti is a Nepali word for ring-shaped rice bread. During selroti preparation, local variety of rice is cleaned, washed and soaked in cold water overnight at ambient temperature (sometimes milled rice is also used for preparation of selroti). Water is then decanted from the drained off rice and is spread over a woven tray made up of bamboo locally called naanglo and dried in the sun for about an hour. Soaked rice is grinded into coarse powder in a wooden mortar and pestle known as okhli and musli, respectively. When the powdered rice is ready, it is mixed with sugar (as per taste), 10% fresh butter or cream, 2.5% spices/condiments such as large cardamom, clove, etc., and then, milk or water is added to finally make a batter with easy flow. Batter is left to ferment at ambient temperature (20-28°C) for 2-4 h during summer and at 10-18°C for 6-8 h during winter. The oil is heated in a cast iron frying pan locally called tawa. The fermented batter is squeezed using hand or a metallic mug with a hole at the base and poured as continuous ring onto the hot edible oil to be fried until golden brown and then, drained out from the oil using a poker locally made of bamboo called jheer or suiro. Deep fried selroti is served as a confectionery. It can be stored at room temperature for about 2 weeks.
- Area of specialization: Postharvest management of the agricultural product.
- Application of ITK:
  a. Selroti has an ethnic importance among the Nepalese communities. It is the most important food item served during marriages and festivals.
  b. It is also sold in the local food stalls and canteens.
- Cultural compatibility and environmental feasibility**:** It is culturally acceptable and has no harmful effects on the environment.
- Sustainability: Selroti is the most important food item of the Nepalese and is commonly served during marriages and festivals. Hence, it is sustainable.
- Scientific rationale: The appearance and taste of selroti make it a popular item to be prepared and served during occasions. Selroti is deep fried in edible oil due to which it has a longer shelf-life.
- Revelation: This ITK can be utilized as a value-added agricultural product in different occasions. It can also help in developing an entrepreneurship area.

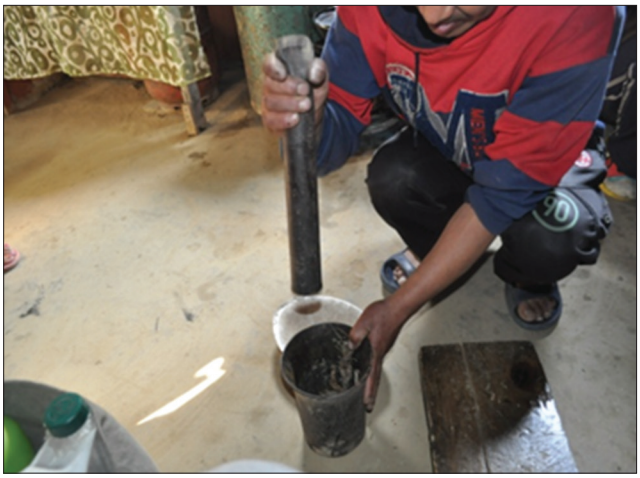

Figure 14: Dried roots being powdered

Figure 15: Marcha being covered with wild ferns

Figure 16: Freshly prepared Marcha

Marcha: A starter cake used for fermentation of alcoholic drinks

- General description of the ITK: Marcha is a fermented starter cake needed for the preparation of alcoholic beverages [Figures 12-17].. Roots of a rarely found plant *Ficus racemosa* locally known as damru, is collected and dried initially, it is then pounded inside an iron/wooden mortar locally known as okhli, with an iron/wooden pestle known as musli, till it attains a greenish powdered form. It is then mixed with rice flour or finger millet flour at 100 g root powder per 1 kg flour. The required amount of water is added to the mixture, and it is then worked into dough manually. With this dough, small circular cakes (approximately 4-6 cm diameter and about 1 cm thickness) are made by pressing it between the palms of hands. Sometimes, the size of the starter cakes can also be bigger like the size of a chapatti. The starter cakes are covered with a typical fern from one side and are left for drying in smoke, for about 6-7 days till it becomes harder.
- Area of specialization: Postharvest management of agricultural product.
- Application of ITK:
  a. It is used for fermentation in the preparation of traditional alcoholic beverages such as chhyang and rakshi.
  b. It is also sold in the local markets.
- Cultural compatibility and environmental feasibility: It is culturally compatible and environment-friendly.
- Sustainability: It is widely used for the fermentation of alcoholic beverages by the tribal people. Hence, it is sustainable.
- Scientific rationale: The product can ferment food grains and turn them into alcohol. The presence of certain alkaloids in the plant roots added in marcha helps in the fermentation process of alcoholic drinks.
- Revelation: Marcha acts as an important agent in the fermentation process of indigenous alcoholic beverages. Today it is being used by few people, therefore, this ITK should be promoted to conserve them as an indigenous fermenting agent.

Gheu/Butter and Mohi/Whey

- General description of the ITK: Gheu (local name) or butter and mohi (local name) or whey are common milk products prepared by the farmers [Figures 18 and 19]. First, the milk is stored for some days to prepare curd locally known as dahi. It is then poured inside a self-made wooden or bamboo vessel (locally known as the theka) and is pumped up and down with the help of a long wooden stick having a circular base with holes. This process continues till the butter is produced. The raw butter floats on the top, and the creamy liquid that remains at the bottom of the vessel is the mohi (Whey).
- Area of specialization: Postharvest management of the dairy product.
- Application of the ITK:
  a. It is mainly prepared for self-consumption, and during excess production, it is sold in the nearby areas. Its demand is high in the market.
  b. It is also needed for the festivals and religious ceremonies held in and around the village.

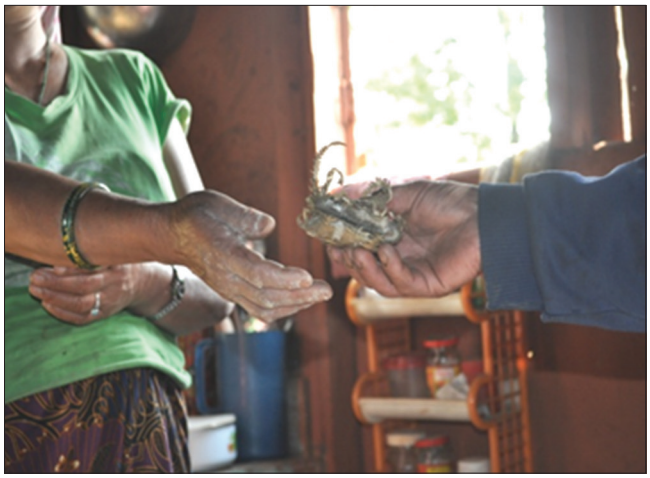

Figure 17: Marcha being exchanged

Figure 19: Leaving mohi at the bottom

Figure 18: Gheu being extracted from the theka

Figure 20: Chyadung, brick tea, raw butter and bhyochya being prepared

- Cultural compatibility and environmental feasibility: It is culturally compatible and environment-friendly.
- Sustainability: It is mostly prepared for self-consumption and is also needed for religious ceremonies and festivals. Therefore, its use in the hills is generally high and thus, it is sustainable.
- Scientific rationale: The temperature in the hills normally remains low; due to this reason gheu is consumed almost every day as a fat supplement in their daily diet. It also supplies energy during the cold season.
- Revelation: Since the demand and price of gheu is high in the market, its preparation can become a good source of income generation for the dairy farmers. This value-added product may be utilized as an energy supplier in cold regions.

Bhyochya (local name) or traditional tea

- General description of the ITK: It is a traditional tea, rich in fat, prepared by the tribal people of Darjeeling. First, the tea leaves (brick tea is used for the purpose) are boiled in water [Figure 20]. When it gets ready, it is poured into a bamboo vessel locally known as chyadung, and is mixed together with raw butter, salt, and milk. It is then pumped in an up and down motion with the help of a long thin bamboo stick having a circular base with cuts on the edges. The process is repeated till it becomes creamy to form bhyochya.
- Area of specialization: Value added horticultural product.
- Application of the ITK:
  a. It is mostly consumed during the winters to keep the body warm and strong.
  b. It is also used during festivals, religious ceremonies and important occasions of the Buddhist communities.
- Cultural compatibility and environmental feasibility: It is culturally compatible, and its production causes no harm to the environment.
- Sustainability: Preparation of bhyochya is a tradition in the Buddhist community; it is mostly prepared during the winters and also in festivals to keep the body warm and healthy.
- Scientific rationale: Bhyochya is a health drink, rich in fat and is consumed during cold days to keep the body warm. The richness of fat in bhyochya helps to fight against the cold and keeps the body warm and healthy.
- Revelation: The ITK can be used as a value-added energy drink to be consumed during the cold winter season and pave the way of income generation.

Table 1: Validity scores of collected ITKs assigned by the scientists (*n*=25)

ITK	Scientifically valid (5)	Not considered (3)	Not valid (1)	Validity score
Gundruk: A fermented leafy vegetable	10	9	6	83
Kinema: A fermented soyabean food product	11	9	5	87
Kodo ko Jaanr or chhyang: Traditional alcoholic beverage	10	9	6	83
Bhaati ko Jaanr or chhyang: Traditional alcoholic beverage	9	10	6	81
Rakshi: A traditional alcoholic beverage	4	14	7	69
Selroti: Traditional rice bread	9	11	5	83
Marcha: A starter cake used for fermentation of alcoholic drinks	8	10	7	77
Gheu/butter	11	10	4	89
Mohi/whey	9	11	5	83
Bhyochya or traditional tea	11	8	6	85

ITK: Indigenous technological knowledges

Table 1 presents the validity scores of collected ITK assigned by the scientists. Figure shows that even the scientists have a varied level of perception on different ITK practices. Totally 10 ITKs have been asked for the validity scores out of which 80% of the ITKs (8 out of 10) were scored above 80 which indicate their wider use and compatibility in different agro-climatic zones. Moreover, the higher scores have been obtained in these ITKs as a result of higher points scored under "scientifically valid" column. We may, therefore, conclude that those ITKs are established and practiced with their scientifically valid construct, whereas the ITKs with less score cannot be neglected because still, in the hills, they are very much in practice. Hence, these ITKs can further be tested to prove their importance.

CONCLUSION

The advantages and sustainability of this ITK make it imperative to combine them with high-tech modern knowledge or technology. The ITKs which have a high level of validity scores should be given due importance by the planners and policy makers as it will reduce the expenditure as well as acknowledge the traditional knowledge and pay respect to the ITK users. Efforts should be made to preserve and patent various plants which are of high economic value in terms of preventive and curative properties. In many cases, lack of knowledge regarding processing of herbs, time constraint to document and validate ITKs, lack of awareness about suitable doses and wider use of ITKs for field application are the major constraints of wider ITK applicability. This type of documentation will help in developing the contents of ITK which will be disseminated to the entire community for its future implication in other areas through ICT.

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