

## Fermented milk products of Ladakh

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Ladakh, situated in the western Trans Himalaya, is a high altitude cold arid region of India. It is one of the remotest and least accessible regions in the world. The area remains cut off from rest of the country for about five months in a year. Meagre precipitation and extremely low temperature during winter months results in a very short growing season. Limited availability of vegetables and fruits is a major concern for the general health of the local inhabitants. Thus, milk and fermented milk products are very crucial for nutritional security of the local people. Being pastoralist by tradition, *Ladakhis* have developed various methods of fermenting and preparing ethnic milk products. Milk of female yak and yak-cattle crossbreds (*zho*) is the main substrate used for preparing fermented milk products. *Jho, tara, labo, chhurphe, maar* and *thuth* are the such important ethnic products relished by the local people. These products not only supplement their nutritional intake but also augment their income.

**Keywords:** Ladakh, Trans Himalaya, Fermented milk products, Yak, Nutrition

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Ladakh is a high altitude Trans Himalayan region of Jammu and Kashmir, the northern-most state of India. The region is sandwiched between the Greater Himalayas in its South and the Karakoram ranges in the North. Rugged terrain, lofty mountains and numerous high altitude passes constitute the general landscape of this region. The region remains cut off from rest of the world for around 5 months in winters due to closure of approach roads at the two entry points: Zojila pass in the West on Srinagar-Leh highway, and Rohtang and Baralacha passes in the East on Manali-Leh highway.

Crop farming is generally restricted to the period May-September during which wheat and barley is grown besides peas and mustard. Double cropping is practiced only in the pockets lying below 3000 m altitude. Wheat is grown up to 3600 m asl and barley up to 4400 m. Barley is the major crop grown on about 54% of total acreage of 22,443 ha<sup>1</sup>. Typical meals are preparations based on barley, wheat, peas, potato, turnip and green leafy vegetables in addition to milk and meat. Availability and affordability of vegetables and fruits decrease in winters resulting in

pronounced seasonality of dietary patterns<sup>2</sup>. There is increased consumption of cereals, meat and milk products, and reduced intake of fruits and vegetables during winters.

Milk contains major nutrients needed by the body for good health, including fats, carbohydrates, proteins, minerals, vitamins and growth factors. Most important protein in milk is casein- a complete protein that contains all essential amino acids. It contains minerals, most abundantly calcium and phosphorus. In fact, it is the best dietary source of calcium. All nutritive values apart, fresh milk suffers from two major disadvantages-lactose intolerance and high perishability. Fermentation results in extended shelf life as well as bio-improvement in lactose metabolism<sup>3</sup>.

Limited food resources and seasonal accessibility to vegetables and fruits renders the population liable to nutritional deficiencies. However, like other isolated communities, *Ladakhis* have developed some indigenous practices of food processing. Being pastoralist, they include milk and milk products to supplement staples. Fermented milk products are essential ingredients of their diet, which improves nutritional spectrum of their food especially during

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winters. The method of fermentation and its utilization is quite unique to them. *Ladakhi* community consists of different ethnic groups such as *Bot, Balti, Brokpa, Beda, Gara, Mon, Purik, Shina*<sup>4</sup> and many more inhabiting geographically distinct locations. Variety of preparations, procedural nuances and multiplicity of appellation manifests their ethnic diversity. This paper is an attempt to document this quaintness of fermented milk products of Ladakh.

### Methodology

The study sites are situated approximately between 32°N to 36°N and 75°E to 80°E (Fig. 1). Administratively the region is divided into Leh and Kargil district including Changthang and Zanskar- the two wide stretched vast expanses of highland grazing ecosystems. The region covers an area of 59,146 sq km<sup>5</sup>. The topography is characterised by undulating terrain interspersed with rocky hills, and the elevation ranges from 2,900–5,800 m above sea level.

For this study, 4 villages two each in Leh and Kargil districts (Hanley, Stakna, Kurbathang and Padum) were selected. Information on substrate, fermentation processes, products and their consumption was gathered by interviewing seven elderly people mainly women in the selected villages during 2011 and 2012. Information was also collected on ethnic nomenclature, regional variation and ethnic perception of its nutritional importance. Data were collected largely through a combination of semi-structured interviews of people, questionnaire and on-spot direct observation.

### Results

Pastoralism is the mainstay of the people of Ladakh who lives in the elevated regions of Changthang and Zanskar. They process milk in a number of ways and many products are unique to Ladakh. Milch animals reared in the region include sheep, goat, cow, *dzomo* and *dimo*. *Dzomo* is the female crossbred of cow and yak while *dimo* is a female yak. The following are the fermented milk products prepared and consumed in Ladakh.

1. **Sri** (colostrum): This is milk secreted by cow, *zhomo* or *dimo* for a few days after parturition. After boiling, *sri* is allowed to stand. In the process it curdles. It is consumed with sugar or salt. *Sri* is distributed among family members and friends as special dish for celebrating arrival of a new member, a propitious sign, in the family.



Fig. 1—Study area

The most active ingredient in the bovine colostrums is proline rich polypeptides. It acts systemically modulating the complex immune system and stimulates an underactive immune system or down-regulating an overactive immune system.

Bovine colostrum is a combination of vitamins, minerals and amino acids that are naturally occurring in a perfect combination<sup>6</sup>. Vitamin A, B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, B<sub>12</sub> and E are found in small amounts while trace of all other vitamins as well as mineral like calcium, sodium, magnesium and zinc are also present in colostrums. Essential and non essential amino acids and essential fatty acid are also present. Some growth factors such as Growth Factor-1 and -2, Epithelial Growth Factor, Fibroblast Growth Factor and Platelet Derived Growth Factors are present in colostrums. These growth factors are peptides that function as intracellular signaling molecules to turn on and off the production of specific proteins in the target cells. It also contain immunoglobulin mainly IgG and lactoferrin, an iron-binding protein that releases iron into blood enhancing oxygenation of tissue<sup>6</sup>.

2. **Jho** (curd) and **Tara** (buttermilk): Milk (*oma*) is boiled and allowed to cool. It is then inoculated with the previous batch of buttermilk and incubated overnight at a warm place to form curd (known as *jho* in Leh). In Changthang, curd is shaken vigorously in a bag made of goat skin to separate butter and

buttermilk. In other parts of Ladakh, buttermilk is made by churning curd in a special wooden vessel (*zem*) made of Juniper wood (Fig. 2). Sometimes instead of boiling, milk is heated just enough (45-50°C) to support growth of inoculums, back slopped and then incubated to curdle. In Kargil, nomenclature for these fermented milk products is quite different: they call milk *orjen*, curd *oma* and buttermilk *derba*.

Though, the nutrient composition of curd varies according to the milk source, extent of dilution during churning, and efficiency of fat removal, content of different components range as: water 85-88%, fat 5-8%, protein 3.2- 3.4%, lactose 4.6 - 5.2%, ash 0.70 - 0.75%, lactic acid 0.5 - 1.10%, calcium 0.12 - 0.14% and phosphorus 0.09 - 0.11%<sup>7</sup>. In general the composition of buttermilk is found to be: water 96.2%, fat 0.8%, protein 1.29%, lactose 1.2%, lactic acid 0.44%, ash 0.4%, calcium 0.6% and phosphorus 0.04%<sup>8</sup>.

The positive probiotic impacts of traditionally prepared curd and buttermilk on health other than high nutritive value are well known. They are used against dyspepsia, dysentery and other intestinal disorders. During preparation of curd microbial fermentation produces antibacterial compounds, lowers intestinal pH thus preventing growth of undesirable organisms and helps to improve digestibility<sup>9</sup>. Inhibition of pathogens in the fermented milk is also due to acid production. The effect of acidity is relatively small compared to specific substances of antibiotic nature formed by the fermenting microorganisms. It is also believed to improve appetite and vitality.

3. **Maar** (butter): Butter is known as *maar* in Ladakh. After churning curd, butter is separated from buttermilk by filtering through a cotton cloth. The solid portion is dipped into cold water for further separating liquid portion from butter. Butter thus prepared is considered very pure and preferred for all religious purposes. Butter in Zanskar region of Ladakh is packed tightly in a bag stitched of goat skin and exported throughout Ladakh (Fig. 3). The molten butter is known as *maarkhu* and used to light up lamps in monasteries, used as cooking oil and for making *kholak*, one of the most famous dishes of Ladakh which is made of powdered roasted barley. Besides being concentrated energy source (Ca. 700 kcal per 100 gm) butter also contains protein, vitamin A, vitamin D, vitamin E and cholesterol. It is rich in

the most easily absorbable form of Vitamin A necessary for thyroid and adrenal health. Vitamin D found in butter is essential for absorption of calcium. It also protects against calcification of the joints.

4. **Labo** (cottage cheese): *Tara* (buttermilk) is boiled and allowed to cool for 10-20 minutes. This results in separation of solid from liquid which is filtrated out. Liquid (whey) is known as *chhurkhu* and solid (cottage cheese) as *labo* (Fig. 4). *Labo* is eaten fresh with bread or *kholak*, usually after adding sugar to it. *Chashrul* is a kind of semi-solid preparation

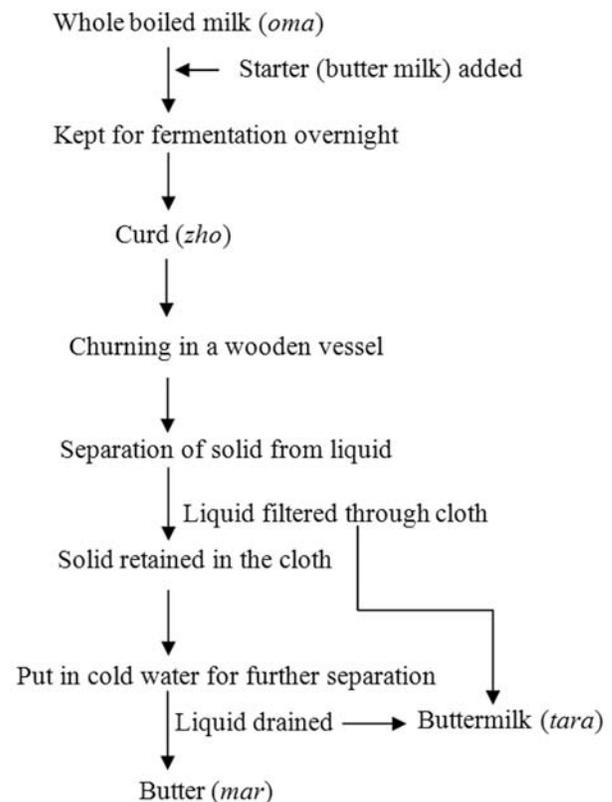


Fig. 2—traditional method of butter (*mar*) preparation



Fig. 3—Butter packed in goat skin brought from Zanskar for sale in Leh market

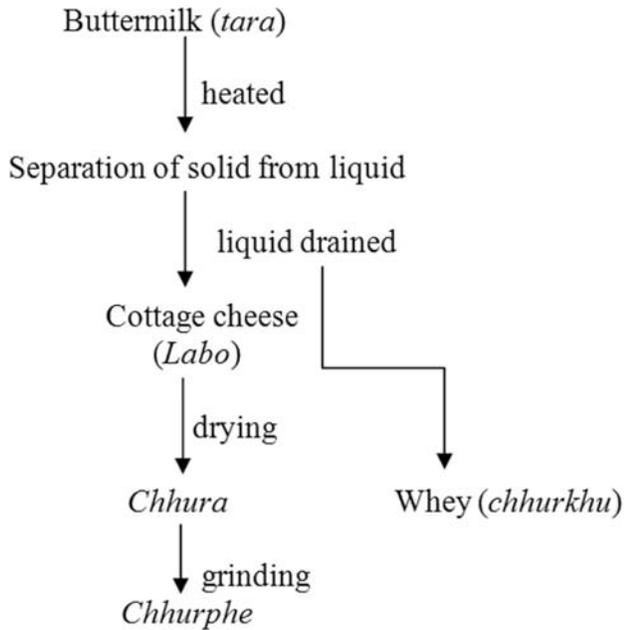


Fig. 4—Traditional method of preparing cottage cheese and its derivatives

made by mixing *labo*, *phey* and salt tea which is served hot. *Chhurkhu* is considered to provide instant energy and consumed by farmers after they finish their work in field. In Changthang, *chhurkhu* is mixed with *nyasphey* to make cake which is consumed during travel. The nutrient value of *labo* has been found to be: moisture 73.8%, pH 4.2, acidity 0.61%, ash 6.6% of dry matter, fat 11.8% of dry matter, protein 65.3% of dry matter, carbohydrate 16.3% of dry matter, Calcium 44.1 mg/100gm, Iron 1.2 mg/100gm, Magnesium 16.7 mg/100gm, Manganese 0.6 mg/100gm and Zinc 25.1 mg/100gm<sup>10</sup>.

5. **Chhura** (dried cottage cheese): As *labo* is perishable and cannot be stored, it is dried to increase its storability. The dried product is known as *chhura* and its powdered form is known as *chhurphe* (Fig. 5). *Chhura* is one of the ingredients of *thukpa*, a thick soup or sometimes stew-like preparation of roasted barley flour. On cooking, it becomes soft which is then easily chewed. Hard *chhura* is eaten as chewing gum and masticator, which gives an extra energy to the body by continuous movement of jaws and gum in high mountains. Nutrient composition is same as in *labo*, excepting that the moisture content is reduced to as low as 4-5% and have similar health benefits. This increases its storability to a great extent. These low-fat and high-protein product has great potential to be exploited as commercial health food.



Fig. 5—Chhura (dried cottage cheese) kept in a bowl

6. **Thuth**: It is prepared by mixing *chhurphe*, *maar* and sugar. Generally it is given form of cake which can be of different shapes and size. It can be stored during winters and served especially during *losar* (Ladakhi New Year). In Changthang *thuth* is almost always used with *paq* (a kind of *kholak*) plus one slice of frozen liver and two slices of frozen meat. It is also common in Zanskar.

Besides these fermented milk products, the famous beverage of Ladakh, salted butter tea (*gurgur cha*), is also prepared which uses *maar* (butter) as one of the principal ingredients.

7. **Gurgur cha**: This is the onomatopoeic name for a concoction in which tea, salt, milk and butter are blended using a cylindrical wooden *churn* (*dongmo*). Name of the product is derived from the sound churning produces. Tea leaves are boiled, skimmed and poured into the *dongmo* (also called *gurgur*), along with yak's butter, milk and salt and churned with a plunger. The plant whose leaves are used is botanically different from the common tea plant and the end product also looks like anything but tea. It is a purplish liquid that is about the thickness of stew and tastes more like soup. The finished product is transferred to copper pots that sit on a brazier or in a thermos to keep it hot (Fig. 6).

The general practice is to boil tea leaves for several hours to get a concentrated tea extract. The filtered concentrate is called as *cha-thang* and for better decoction a small amount of *pul* (local yeast) is also added while boiling the tea leaves. This *cha-thang* can be stored for few days. Whenever tea has to be prepared, the *cha-thang* is mixed with water to the desired dilution. It is then mixed with butter, milk and salt, and churned in the *gurgur*.

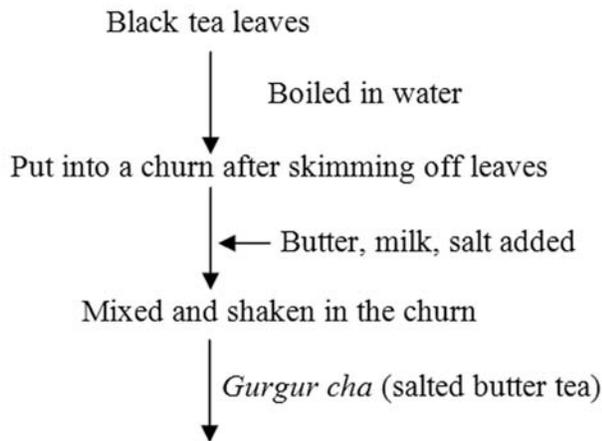


Fig. 6—Traditional method of preparing gurgur tea

Local people are accustomed to drink several bowlfuls of this beverage at a stretch. Nomads are said to often drink up to 40 cups a day. It is rather a substitute of water. *Gurgur cha* is always served to guests. It is drunk in separate sips, and after each sip the host refills the bowl to the brim. Thus, the guest is never able to empty his bowl. If the guest does not like to have more the best thing to do is to leave the bowl untouched until the time comes to leave and then gulp the drink in a single go. In addition to providing energy it also contains some nutrient like sodium and antioxidants of tea. Butter tea is of high calorie and is supposed to have refreshing effect to the mind.

### Discussion

Fermentation conserves all the critical nutrients of milk and modifies others, enhancing its nutritive and healthy benefits. Development of LAB types to high cell densities during fermentation modifies milk constituents (protein and fats) through their proteolytic and lipolytic complex systems<sup>11</sup>. This contributes to the final rheological and sensorial characteristics of fermented products. Starters are also responsible for the production of a series of volatile compounds, such as acetaldehyde, ethanol, acetoin, and diacetyl, and key flavour components in many dairy products<sup>11</sup>.

Varieties of fermented milk products are produced and consumed throughout the world, however, majority of them uses cattle milk as substrate. In Ladakh, on the other hand, milk of *dimo* and yak-cattle crossbred is the main substrate while that of cattle and goats contribute less. Use of milk of buffaloes, yaks, goats, camels, donkeys, and horses for fermentation in minor ethnic groups has been

reported earlier also<sup>3</sup>. Another peculiarity is that here instead of using standard starter culture, back slopping techniques of freshly boiled milk is used for fermentation of milk.

Milk of *dimo* and its fermented products are popular dairy items in the Himalayan regions of India, Nepal, Bhutan, and China<sup>12</sup>. Ethnic fermented milk products are high calorie content foods of which butter made of yak milk has a high calorie value of 876.3 kcal/100gm<sup>13</sup>. *Dimo* made *chhurpi* give extra energy and are a nutritious source of protein and fat<sup>14</sup> to the people living in snow bound areas.

*Dimo's* milk drives a selection for particular microbial types and, consequently, products made from *dimo's* milk may harbor a distinctive microbiota<sup>15</sup>. The probiotic properties of indigenous microorganisms isolated from the cheese like product *chhurpi* have been reported<sup>16</sup>. Probiotic milk products can have several health promoting benefits such as modulation of the immune system, maintenance of gut flora, regulation of bowel habits, alleviation of constipation, and curing of gastrointestinal infections<sup>17</sup>.

*Chhura* or *chhurphe*, the dried cottage cheese is very common and popular product in Ladakh. It is dried, hard and looks like finger chips (Fig. 5). It has a long shelf life and is mildly acidic. Similar product has also been reported from Tibet, Nepal and Bhutan<sup>3</sup>. *Zanskari* butter (*maar*) is another famous fermented milk product of Ladakh. It is in great demand among the Buddhist population in Leh and even outside Ladakh (e.g. Dehradun) due to its unique flavour and taste.

### Traditional significance to the society/farmers/researchers

The dearth of foods of vegetable origin especially during long winter months makes the local inhabitants vulnerable to nutrient imbalance. Fermented milk products available in abundance in the region compensate the vitamin and mineral deficiencies that would have resulted due to less consumption of vegetable and fruit. Nutraceutical importance of these products for the locals is further accentuated by the fact that the modern medical advancements and their benefits are far from visible at these hard-to-reach places.

The high altitude pasture region like Zanskar and Changthang where Pastoralism is the mainstay of the local community, the surplus of these products provides an opportunity to augment their income.

There is a great demand for the fermented milk products especially for *Ladakhi* butter and dried cottage cheese (*chhura/chhurphe*). *Ladakhi* butter fetches better price (Rs 350/- to 400/- per kg) than all other commercially available butter in the market due to its peculiar flavor, consistency and religious connotation. However, these prospective economic benefits mostly remain untapped due to a few bottle necks and need attention of researchers and policy makers.

While lack of proper packaging is the main issue in marketability of butter, absence of drying techniques is the major reason of concern for *chhurphe*. Traditionally, the butter is packed in a batch of 10-15 kg either inside the cleaned stomach extracted out of the killed sheep or goat, or their skin casing and stitched tightly. Though it remains well-preserved up to a year or so, if kept as such, it spoils quickly if cut open for sale in smaller quantity (1-2 kg) to small consumers. It diminishes the bargaining power of the producer who wants to retail their produce in the market. Storing the butter in the organ extracted out of killed animal also preempt its acceptability among Muslims due to their religious considerations. So, a proper packaging technique needs to be devised for *Ladakhi* butter.

Similarly, absence of scientific drying techniques for *chhurphe* results in poor marketability of this produce. To make *chhurphe*, conventionally the fresh cottage cheese is dried in open. It attracts dirt and other undesirable particles that stick to its wet surface. The product thus obtained is poor in hygiene and unattractive in appearance and hence inferior in quality that fetches lower price. Farmers need technical input and logistic support. Technical support for better hygiene of the product through improved drying technology and better packaging materials along with the know-how is needed. They also need logistic support in terms of marketing infrastructure and publicity to strengthen their customer base.

### Conclusion

In Ladakh, due to poor accessibility, especially during winter months, seasonal availability of vegetables is more pronounced. So, the foods of animal origin become much important; milk being the most important among them. *Ladakhis* have traditionally developed the methods of milk processing that is unique to the region. This uniqueness originates in two aspects: the substrate and the product. The main substrate used for fermentation

is the milk of *dimo* or *Zhomo*, which is relatively rich in fat and thus, more energy-packed than the products made of other milk sources. Again the end products made up of fermented milk are distinctively different from those of the other regions. Among these, the *Ladakhi* butter and *chhurpey* (dried cottage cheese) are much sought after products and are produced on comparatively large scale. In addition to its nutritional and religious significance, *Ladakhi* butter is also valued for the economic benefits it accrues to the tribals of Changthang and Zanskar regions. This butter is exported within and outside Ladakh wherever a substantial population of Buddhists resides. *Chhurpey* is another such product which is in great demand in Ladakh.

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