TRADITIONAL FOODS OF NEPAL

Ganga P. Kharel
Dilip Subba
Pushpa P. Acharya
Basanta K. Rai

PREFACE

Many traditional foods have no recorded manuals. The tradition of verbally handing on the skill is still extant. Such a trend will naturally lead to erosion of skill overtime, which will be to the detriment of person dependent on it. One purpose of this publication is therefore to document such information in an accessible but scientific way.

Many traditional foods are facing problems due to introduction of Western foods and consequent acculturation. In many cases traditional foods may lack good image or have a poorer perceived quality than the newer foods. A few of these foods have no doubt evolved into semi-commercial commodity but most of them are still in a primitive stage. If this trend is to continue, many of our traditional foods will soon be lost for ever.

Traditional foods are receiving renewed interest in the scientific community today. Their preparation is viewed as an opportunity for rural development. The information in this book is therefore intended to enable producers to upgrade traditional processes and to improve the product quality in terms of both safety and acceptability so that the producers may compete effectively.

This book also aims to provide good quality information for new producers when they are starting a food processing business.

In each entry a description of the food is followed by the principles of preservation and processing, including a production flow diagram to describe the processing stages and conditions. Finally, notes are included on quality control factors, suitable packaging.

Any criticism or suggestion regarding errors and omissions in particular and improvement of the book in general will be thankfully received.

Dharan, Feb 2008

Authors

ACKNOWLEDGEMENTS

CONTENTS

LIST OF TABLES AND FIGURES

Figures

Tables

CHAPTER 1
UNFERMENTED CEREAL PRODUCTS

Cereals and legumes are energy-dense and are important sources of nutrients. The global cereal consumption directly provides about 50% of protein and energy necessary for the humans. An additional 25% of protein and energy is obtained via livestock intermediaries. In the developed countries, about 70% of the cereal goes to livestock whereas in developing countries, 68-98% of the cereal crop is used for human consumption. A number of traditional food products utilize cereals in combination with legumes, thus leading to overall increase in the protein quality. A detailed treatment of the common cereal and legume products is given in the following sections.

1.1 CHIURA (BEATEN RICE FLAKES)

Chiura or beaten rice flakes is a very common food item in Nepal. It is pre-cooked, has a crispy texture, and is in a ready-to-serve form. It is eaten as a snack or as full meal with *achar* (pickle), chutney, meat, eggs, vegetables, beans, etc. It is also found in other Southeast Asian countries such as India, Bangladesh, Bhutan and Pakistan. It is popular in all communities especially in Newar, Brahmin, Chettri, Rajbanshi, Choudhari, etc. Special, coarse varieties of rice are suitable for *chiura* production. *Chiura* is considered an essential item in occasions like marriage ceremony, festivals, picnic and party. Researches show that *chiura* making incurs loss of minerals like calcium and iron. To this end, there have been some studies on the fortification of *chiura* with these minerals for compensating the loss.

1.1.1 Processing

The traditional method of *chiura* preparation does not have much variation. The preparation utilizes simple tools like *okhli*[1] and *dhiki*[2]. However, the use of power-

[1] A large-size wooden mortar and pestle
[2] Foot-operated pounding tool

operated mills is gaining popularity, especially for large scale production. As a result, people prefer buying *chiura* from the stores rather than preparing themselves using traditional *okhli* and *dhiki*. But *chiura* from traditional method tastes better than that from mill. The traditional procedure for *chiura* preparation in Nepal is presented in Fig. 1.1.

Recently in the Terai, *chiura* is prepared using power mill in large-scale. Cleaned paddy is packed in jute bags and soaked in water-filled cemented tanks for 1 to 2 days. The paddy is taken out and roasted in *karahi*[3] (Fig. 3.7) using large spoons for uniform stirring. It is then passed via magnetic sieves to remove metal particles that may damage machinery. While still hot the roasted paddy is passed between iron rolls for flattening. The pulverized dust in *chiura* is removed mechanically by an aspirator (fans). *Chiura* is packed in polythene-lined bags and sent to market or store. Generally, *chiura* is consumed within 1 to 2 months of production (depending on temperature, humidity, and packaging factors).

Process	*Notes*
Paddy	° Select a suitable variety and clean
↓	
Clean	° Remove dust and stone particles
↓	
Steep (soak)	° Soak paddy for 12-24 hrs depending upon temperature; hot water soaking is faster
↓	
Cook (steam)	° Continue cooking until few grains burst
↓	
Drain	
↓	
Roast	° Roast paddy in small lots in a *karahi* or earthenware pot until few grains begin to pop
↓	
Flake	° Flatten immediately after roasting in an *okhli* or in a *dhiki* (Fig. 1.2 and 1.3.)
	° Continue beating until the paddy is dehusked and flattened
↓	
Winnow	° Take out and remove pulverized husks and dusts using *nanglo*[4] (Fig. 1.4)
↓	
Chiura	° Ready to eat crispy rice flakes

Fig. 1.1 Preparation of *chiura* by traditional method

[3] Caldron made of cast iron. It is generally used for preparing curry
[4] A circular winnowing tray made from bamboo strips

Fig. 1.2 Beating *chiura* in *okhli*

Fig. 1.3 Beating *chiura* in *dhiki*

1.2 SELROTI

It is a doughnut-shaped, deep-fried rice confection indigenous to Nepal. Normally, it is prepared in festive occasions and rituals like *Tihar*, *Pooja*, *Bratavanda*, and *Kajkriya*. But, these days it is available almost all the time at *hat-bazaars* (local markets) and cities. The main ingredients used for making *selroti* are rice flour, sugar, ghee and refined oil. The process of manufacture and the ingredients used depend on the availability of raw materials and differ from place to place and household to household. In some places people use ripe banana, *dahi* and cream as an improver. Finely ground rice flour, sugar (to taste) and ghee are mixed properly and fried in *ghee* or *vanaspati* (hydrogenated vegetable oil). The quality of *selroti* obtained from this composition is not so good because it is not puffed properly. Often, the dough remains uncooked in the internal portion of

the *selroti*. As a result, *selroti* prepared by traditional method is hard to digest. The shelf life is also very short because of high moisture content: the product goes moldy very soon. But in the city area the process is somewhat different. The improved method of *selroti* preparation is described in Fig. 1.5. Grinding in a machine to make flour is less labor-intensive but this produces inferior quality *selroti* because of excessive damage of the starch granules. The flour should be neither too fine nor too coarse. In the traditional method, the particle size of the flour is manipulated by vibrating *nanglo* in an inclined position.

Process	*Notes*
Rice	° Special types of rice, e.g., *Anandi*, are used
↓ Soaking	° Soaked overnight in adequate amount of water for 12 hrs
↓ Draining	° Drained to remove as much of water as possible
↓ Pounding	° Pounded in *dhiki* or *okhli* into coarse flour
↓ Ageing	° Done for 1-2 days for improving textural, organoleptic, and frying properties of *selroti*. A mild lactic fermentation ensues, thereby imparting a pleasant taste to *selroti*.
↓ Kneading and mixing	° Sugar, ghee or cream, curd, fenugreek, etc., are added ° Kneaded thoroughly to improve textural property
↓ Batter	° Some water is added and the resulting batter worked (whipped) with hand to make a viscous batter ° The batter left for some time to allow mild fermentation. This gives a better puffing (swelling) to *selroti*
↓ Frying	° The batter is poured in a ring shape in very hot oil in a *tai* [5] (Fig 1.4) by hand or scoop. Frying is done until the ring turns yellowish brown. The number of pieces can vary depending on the size of *tai*.
↓ Draining	° *Selroti* is manipulated out of *tai* with the of help of a bamboo skewer (called *jheer*, Fig. 1.4). The fat is drained and *selroti* set aside in a container
↓ *Selroti*	° Better when served hot (Fig 1.5)

Fig. 1.5 Improved method of *selroti* preparation

[5] An iron frying pan

The oversized particles that roll down the *nanglo* are collected and pounded again. The *selroti* prepared as above is characteristically puffed and cooked properly.

The shelf life of *selroti* prepared by this method is longer than that by traditional method and can remain acceptable for about 15 days (without mold growth).

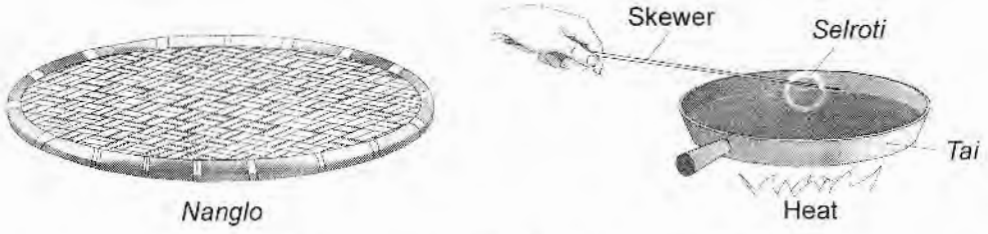


Fig. 1.4 Some tools used for *selroti* preparation

Fig. 1.5 *Selroti* ready for serving or sale

1.3 BHUJA OR MURAI

Bhuja is a puffed rice product. It is mainly consumed as snack in the Terai belt of Nepal. The word *murai* is derived from the term *murra*, which means 'puffed'. The nutritional value is similar to that of rice. It is mainly used by the *Tharu* and *Chaudhari* ethnic groups of Nepal. For them it is a very important food item in marriage ceremony, festivals and other occasions. *Murai* is also used for the preparation of *chatpate*, a peppery snack sold by the vendors in the local markets. The food goes well with all types of dishes. It is generally produced from long variety rice *Oryzae indica*.

1.2.1 Processing

Bhuja preparation requires different tools/equipment, such as metal pot, drying mat, winnowing device, plastic bags, sand, wooden stirrer, plastic bags, stove or fire wood, strainer, etc. A detailed method of *bhuja* production by traditional method is given in Fig. 1.6.

The commercial method of *bhuja* production is different from the traditional method. An outline of the commercial method is given in Fig 1.7.

1.4 BHAKKA

It is a steam-cooked cereal product prepared from coarse rice flour. The product is indigenous to the Tharu community of the Terai but is relished by all. *Bhakka* is eaten mostly from November to February. *Bhakka* has no legend but the term must have come from a pair of native words *bhaff* (= vapor/steam) and *khabe* (= to eat). It is commonly served hot in the form of breakfast. The product can be stored for 1-2 days without spoilage but not without the loss of characteristic sensory properties. The traditional method of *bhakka* preparation is given in Fig. 1.8 and 1.9.

Process	*Notes*
Paddy	
↓	
Cleaning	
↓	
Soaking	° 24 hrs in clay pot
↓	
Boiling	° In metallic pot over firewood or stove
↓	
Straining	° Draining of excess water
↓	
Cooling	° 12 hrs
↓	
Steaming	° Until a few grains begin to split
↓	
Drying	° Uniform drying on mat or floor
↓	
Hulling	° In a huller to remove hulls
↓	
Winnowing	° Separation of hulls in a winnowing device
↓	
Seasoning	° Mix water and salt (~1%). Cook under uniform and mild heating with continuous stirring
↓	
Puffing	° Baking in hot sand placed in sieve
↓	
Separation	° Separation of puffed rice from the sand
↓	
Bhuja/Murai	
↓	
Packing	° In plastic bags and sealed with a sealer

Fig. 1.6 Preparation of *bhuja/murai* by traditional method

Process	*Notes*
Paddy	
↓	
Cleaning	° Separation of foreign materials (impurities, stones, etc.)
↓	
Grading	° Generally not done in traditional method
↓	
Soaking	° Done in soaking vats. Low temperature soaking takes longer time. Longer soaking produces better quality of *murai*. This transfers the color of husk to bran and *murai* becomes more attractive (reddish). Soaking period depends on temperature. The moisture content reaches 35-40%.
↓	
Drying	° Sun drying takes a long time and is labor-intensive. Mechanical drying is faster
↓	
Tempering	° To equilibrate moisture to 12-13%
↓	
Dehusking	° A pair of rubber roller is used
↓	
Stone separation	° Not necessary if destoning of paddy has been done
↓	
Soaking in salt solution	° 1% salt (in the form of saturated brine) ° For every 100kg rice, 4 lit of saturated brine and 8 lit of plain water is used and mixed thoroughly. The moisture reaches ~ 24%. The rice is heaped to temper for 12-16 hrs. During tempering, lumps are formed, which are broken and mixed at least once. The brown rice is heaped again
↓	
Drying	° Generally sun drying. Agitation done to break the cakes. The moisture is reduced to ~ 10%
↓	
Puffing	° Roasting in hot sand (200-300°C). A cylindrical roaster is used
↓	
Screening	° Perforated cylinder is used to separate *murai* from sand
↓	
Grading	° Done by size screening process in a rotary reel grader
↓	
Packaging	° Hygroscopic in nature because of large surface area ° Packed in container with low water vapor permeability

Fig. 1.7 Preparation of *bhuja/murai* by modern method

Process	*Notes*
White rice	° Freshly milled
↓ Soaking	° Soaked ½ -1 hr at normal temperature (Water:Rice = 2:1)
↓ Draining	° Water completely drain
↓ Grinding	° Mortar and pestle is better for small quantities ° For large quantities, burr mill or attrition mill is used ° About 15-25% of unsoaked broken rice and grits can be added during grinding
↓ Sieving	° Coarse flour sieve is used ° Overtailing is returned to the grinder
↓ Mixing	° Water is added to give moisture content of ~ 36% in the mix. The mix must remain as a consolidated mass when held lightly in the fist ° Force the mix through coarse sieve by rubbing. This helps form granules, which facilitates steam transfer and provides characteristic texture to *bhakka*
↓ Molding	° The mix is put in cups, patted a little and leveled off with a knife
↓ Wrapping	° Wrap the molded mix in an oversize, clean muslin cloth
↓ Steaming	° Place the wrapped cup over the steam outlet in an inverted position ° Remove the cup without destroying the shape ° Gently tuck the sides of muslin to cover the molded shape completely ° Cook in steam at normal pressure for 3-5 min for small *bhakka* (~ 5cm dia × 3-4cm height)
↓ *Bhakka*	° Serve hot with pickle

Fig. 1.8 Preparation of *bhakka*

Fig. 1.9: A lady preparing and selling *bhakka* (inset: *bhakka*)

1.5 PAPANDA

Papanda is one of the many types of breads made from finger millet. It is prepared in the hills and is popular among Limbu community. It is generally eaten as such or with some *achar*. It is mildly sweet in taste and has a crumbly texture. *Papanda* is comparatively tougher to bite and is unsuitable for old people with weak teeth.

Finger millet is considered a poor man's cereal. Finger millets of both red and white varieties are available but the red millet is preferred for making *papanda*. All food items derived from red millet becomes black upon cooking. This is considered to be unappealing to many people. Finger millet contains 13% moisture, 3.5% crude fiber, 72% carbohydrate, and 2.7% total ash. Finger millet is known to be rich in iron. Thus, the black color notwithstanding, *papanda* is very nutritious. *Papanda* is prepared as given in Fig. 1.11 (see Fig. 1.10 also).

Fig. 1.10 *Papanda* ready for serving

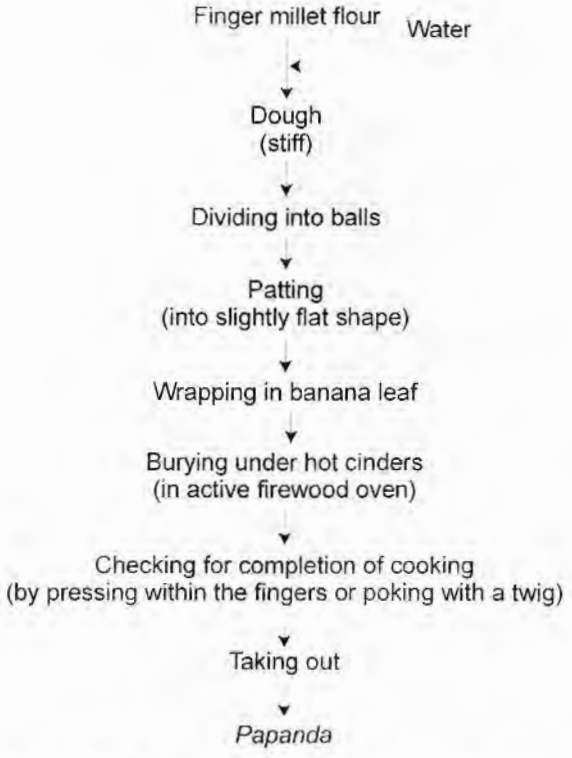


Fig. 1.11 An outline of *papanda* preparation

1.5 LUNGHAKCHA

Lunghakcha is a Limbu name for a solid food made by boiling green maize paste. The food is eaten as breakfast or in the main course but can also be dried for future use. Normally, it has the shape of a rolling pin. The traditional preparation of *lunghakcha* is given in Fig. 1.12 (see also Fig. 1.13 also).

Lunghakcha preparation probably evolved in the period of food crises. People might have resorted to this alternative to feed themselves until optimum harvest maturity of maize. Under normal conditions, people generally do not prepare *lunghakcha*. The food has a unique taste and is palatable. The nutrient content of *lunghakcha* is similar to that of green maize. Green maize grain contains 67% moisture, 4.7% crude protein, 0.9% crude fat, 1.9% crude fiber, 0.8% total ash, and 24.7% carbohydrate. If some improvements can be done, it may find a place in restaurants and hotels. For instance, grinding in *janto* is both tedious and unhygienic. Use of *okhli* can be a better option. The best option would be to use any of the commercial grinding machines, such as hand-operated attrition devices readily available in the market.

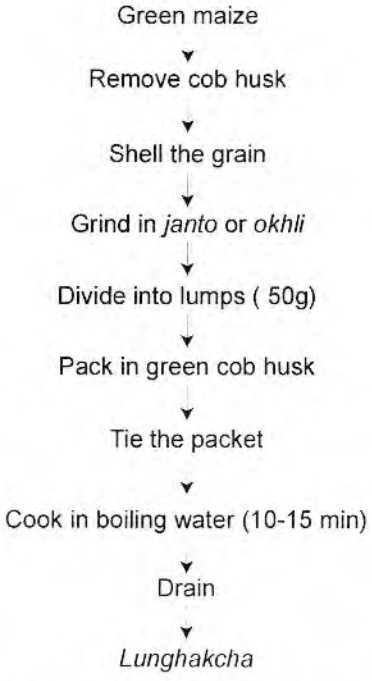
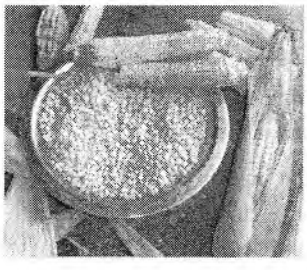
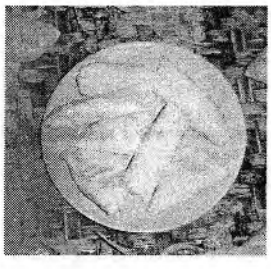


Fig. 1.12 An outline of *lunghakcha* preparation



(a) Shelling tender maize

(a) Packing in cob husk



(a) *Lunghakcha*

Fig. 1.13 Different stages of *lunghakcha* preparation

CHAPTER 2

MEAT AND FISH PRODUCTS

Meat is a nutritious food, containing quantities of essential amino acids in the form of protein. Meat also contains B group vitamins (especially niacin and riboflavin), iron, phosphorus, ash, and calcium. Certain meats, especially liver, contain vitamins A and D.

2.1 SUKUTI (DRIED MEAT)

It is an indigenous dried meat product especially from buffalo lean meat. In the traditional method, lean meat is cut into strips and hung over the fireplace in kitchen, and subjected to heat and smoke of the burning woods till the strips become adequately dry and hard. It can also be prepared by air drying or sun drying but drying and smoking over fireplace imparts more characteristic, pleasant taste and texture than the sun-dried or air-dried counterpart.

Most of the *sukuti* available in the local market are air-dried, sun-dried or smoke-dried, which should be cooked prior to consumption. Steamed-and-dried *sukuti* is also available in the market that need not be cooked before consumption. However, it is not very common in the market. There are several styles of eating *sukuti* but one of the more general styles is by roasting it in burning coal. The *sukuti* chips are then mixed with tomato chutney, ground spices, chilli, sauce, onion, garlic, salt, etc. (according to local taste), and served while *sukuti* is still brittle. It is very delicious and goes well with *jand* (cereal beer), *raksi* (distillate from *jand*) or commercial beer.

In Nepal, buffalo meat is abundantly found in the market. It is also cheaper than any other meats. Most of the portion is lean and is therefore suitable for *sukuti* preparation. *Sukuti* preparation can be considered a traditional, low-cost meat preservation method and is generally carried out in home scale. It is a very popular food item and is within the reach of have-nots also. *Sukuti* is mostly consumed in Eastern regions and Kathmandu valley of Nepal.

Sukuti can be processed and preserved easily at home. The moisture content of the final product is <10% (water activity, a_w < 0.5), where microbial growth is impossible in a package or over fireplace. Dried *sukuti* can be stored for up to 1 year if packed in an appropriate package or else it should be kept over fireplace where it is frequently exposed to heat and smoke. Besides imparting taste, smoking also has a preservative effect.

2.1.1 Processing

Dried meat products have a history of more than 1000 years in China. During the Sung Dynasty (960-1279 A.D.) already 200 types of dried meat products, based on red meat, poultry and fish were known. In Nepal, there is lack of such documented record. The general method of *sukuti* preparation is discussed in the following sections. The proximate composition of *sukuti* is given in Table 2.1.

2.1.1.1 Slaughtering

Local butchers slaughter the buffaloes in open ground by traditional method. In general the buffaloes are stunned by direct blow in the skull using a pole axe, then bleeded with sticking the major arteries of the neck immediately. *Jhatka* (deheading with heavy knife) method is rarely used. The most objectionable thing is that there is lack of slaughter hygiene and no provision of modern slaughtering. So, meat often becomes contaminated with dust, mud, etc., leading to entry of different types of spoilage and pathogenic microorganisms in the meat. The buffaloes themselves may be suffering from various zoonotic diseases, which are very dangerous for human health.

2.1.1.2 Cutting and trimming

In general, hind quarter portion is taken for the preparation of *sukuti*. However, forequarter and sirloin parts can also be used. Bones, fat and other undesirable portions are removed.

2.1.1.3 Strip preparation

There is no any fixed standard dimension for meat strips. In general, they are stripped in the dimensions of approximately (250×20×20 mm).

2.1.1.4 Smoking and drying

Traditionally these meat strips were hung over a fireplace of the kitchen where the strips dried due to the mild heat and smoke produced during cooking the meal.

Sometimes air- and sun drying may be used. A typical sun-dried product requires a drying time of 3-10 days.

2.1.1.5 Packaging and storage

In the rural areas, some people still used *perunga* (a bag prepared by weaving bamboo strips) as a packaging material. *Perungo* (along with the product) is often hung in the andiron for storage. However, *perungo* is less suitable than plastic packaging.

Table 2.1 Proximate composition of *sukuti*

Parameter	*Value, %*
Moisture	8-10
Protein	75-77
Fat	4-5
Ash	5-6

There are some advantages as well disadvantages related to *sukuti*. Advantages include simplicity of the process and shelf-stable nature of the product. Disadvantages include variable quality, poor hygienic practice, and danger of carcinogens developed during smoking. The variability in meat quality is explicable because buffaloes are seldom raised for meat purpose.

2.2 CHOYLA

It is a buffalo lean meat delicacy prepared by the Newar community of Nepal. These days, *choyla* preparation has taken a semi-commercial shape and is available in many restaurants and bars. Depending on the method of preparation, there are two types of *choyla*, viz., (i) prepared from boiled lean meat, and (ii) prepared from scorched lean meat. The methods for the preparation of both the *choyla* types are given in Fig 2.1 and 2.2.

In particular, *choyla* prepared by 'scorching' deserves special mention because scorching is done in a very unique way. The meat strips are kept within the folds of paddy straw and then the latter is ignited. The fire scorches the meat strips and imparts a very characteristic sooty color and taste to the meat. In Newari dialect, scorched *choyla* is called *haku choyla*, where *haku* means 'black'.

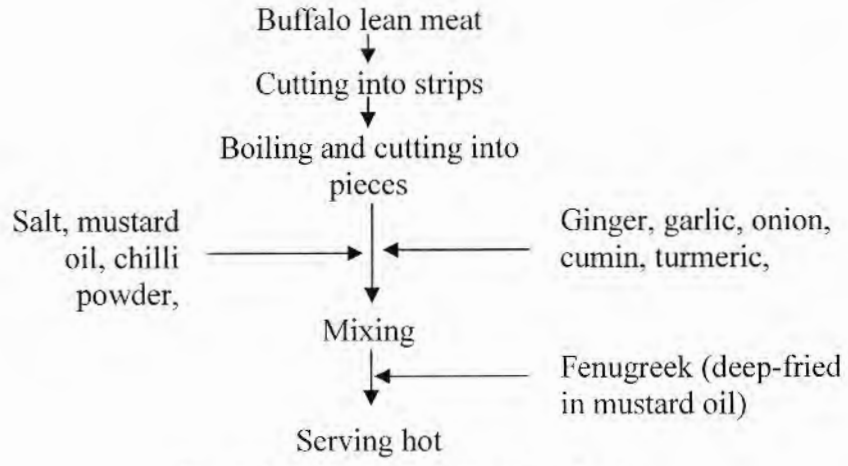


Fig. 2.1 Preparation of boiled *choyla*

Process	*Notes*
Buffalo lean meat	
↓	
Cutting	° Cutting into long strips
↓	
Scorching	° Placed within the folds of paddy straw and igniting the latter ° A black sooty color and flavor is developed
↓	
Slicing	° Strips cut into size suitable for consumption
↓	
Seasoning	° Fresh ginger, garlic, cumin, chilly powder, raw mustard oil, fenugreek, turmeric ° Ginger has a proteolytic effect on meat. Its use in liberal amounts tenderizes meat, thereby resulting in a digestible, chewy product
↓	
Mixing	° Mixed uniformly
↓	
Serving	

Fig. 2.2 Preparation of scorched *choyla*

2.3 KACHILA

Kachila is a special lean meat dish prepared in special occasion in the Newari community. The lean meat is obtained from different sources, such as buffalo, chicken, and goat. The term *kachila* is derived from *kacho* or *kach* which implies

'raw'. An unusual feature of *kachila* preparation is that the final product is raw (neither boiled nor roasted done, Fig. 2.3). This practice of consuming raw meat immediately invites doubts regarding safety of *kachila* because the slaughtering practice as well as animal health is often far from satisfactory. However, there is no recorded incidence that substantiates this fear. The liberal amounts of different spices used in the recipe may have a role in the safety of *kachila*.

Process	*Notes*
Buffalo lean meat ↓ Cutting	° Chopped with a blunt knife by keeping over *achano*[6] (Fig. 2.4)
↓ Collection of chopped meat	° The fibers get stuck in the *achano* and hence only the lean meat is available
↓ Seasoning	° Raw mustard oil ° Prepared spices (ginger, garlic, chilly powder, cumin, turmeric, onion, asafetida, etc.) ° Fenugreek (deep fried in mustard oil)
↓ Mixing	° Mixed uniformly
↓ Serving	

Fig. 2.3 Preparation of *kachila*

Fig. 2.4 *Achano*

2.4 SEKUWA

Sekuwa in a strict sense is not a traditional product of Nepal. Normally, lean meat from goat, chicken or buffalo is used. Lean meat is cut into sizes suitable for skewering. It is then mixed with seasonings (garlic paste, ginger paste, chilli powder, mustard oil, and salt) and left for curing for 2-3 hrs (curing for 8-10 hrs is

[6] A wooden block used for chopping meat

better). The meat pieces are then skewered and roasted over burning coal. *Sekuwa* goes well with alcoholic drinks and is best when served hot.

2.5 DRIED FISH

Fish can become an important part of diet of malnourished children whose small stomach prevents them from consuming the bulk they need to get enough nutrients. Fish is an excellent source of protein, essential amino acids, polyunsaturated fatty acids, minerals and vitamins. Preservation of fish in developing countries is generally done by salting and drying or by salting, smoking and drying. In Nepal, fish is preserved in a small scale by smoking and or drying.

2.5.1 Drying

Drying can be carried out singly or in combination with smoking or salting. The main aim in all is to remove moisture to a safe level. Drying is usually done in the sun. Fish is more difficult to dry than fruits and vegetables. However, with the proper technique and some practice, fish can be dried with little effort and at low cost. Dried fish usually fetch a good price in the market.

Fish can be divided into two categories:

1. Small fish: white baits, silver bellies, small sardines, prawns, soles, etc.
2. Medium and large fish: mackerels, Jew fish, croaker fish, pomfrets, seer, catfish, tuna, shark, etc.

The process for drying small fish is different from drying medium- and large-size fish. However, all sizes of fish must be fresh and odor-free. Sun drying takes two to three days for an average 8 to 10 hrs a day, with a maximum temperature of 38°C. Properly dried fish should contain 12 to 15% moisture.

Small fish

1. Wash in clean water to remove dirt and sand
2. Allow excess water to drain out for 30 min
3. Spread washed fish on mats, split bamboo, or gunny bags, hang them from a line to dry
4. Allow the fish to dry in the sun (Fig 2.5)
5. Occasionally, turn the fish so that both sides dry
6. Pack the dried fish in polythene bags
7. Put the bags in plastic or wooden containers
8. Store dried fish in a cool, dry place.

Medium and large fish

1. Cut off the head
2. Slit open the belly and remove the guts
3. Wash the fish in water and remove the blood
4. Make a mixture of common salt using 1/3 fine salt and 2/3 coarse salt
5. Salt the fish-one part salt to four parts fish (1:4)
6. Leave the fish to absorb the salt for about an hour
7. Sandwich the fish between slabs of cement or wooden boards piled with weights
8. After one day, turn the fish
9. Wash the salted fish in 3.5% salt solution
10. Dry the fish by spreading them on mats
11. Pack the dried fish in polythene bags and store them in a cool, dry place

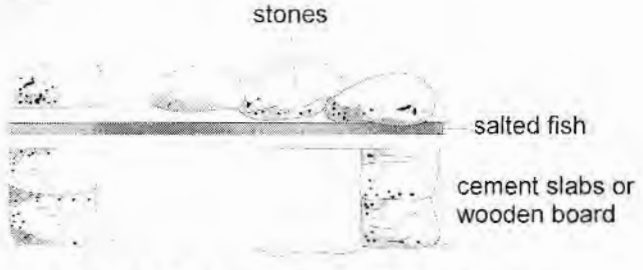


Fig. 2.5 Drying of small fish in the sun

2.5.2 Smoking

Fish may be hot-smoked or cold-smoked. If the pH is high and salt is scarce, hot smoking, where the fish is cooked, is the only method of preserving fish. Wood or other locally available combustible materials may be used for the generation of smoke.

Depending on local customs, the fish may be prepared simply by washing followed by smoking (e.g. herring, bonga). Alternatively, scaling, gutting, splitting and filleting may be carried out prior to smoking. In general, it is the smaller fish which are used whole. This has become a traditional method because of the difficulty in gutting large numbers of small fish. Medium-sized fish, such as tilapia and catfish, are normally split and gutted.

Salting can be done (dry salting or saturated brine) to bring the salt level to 8-10%. Whatever the method, fish must be pre-dried prior to smoking, preferably in the shade. Pre-drying tends to enhance the surface gloss on the product, and helps prevent case hardening which tends to develop during the smoking process. Drying is best carried out on the frames or hooks on which the fish will eventually

be smoked. If frames are used, the fish should be spread out in one single layer and spaced out to allow passage of heat and smoke. However, it is advantageous to hang the fish on hooks since this avoids leaving frame contact marks on the flesh where the smoke is not able to penetrate. Frames also allow a more efficient flow of smoke and hot air especially to the products furthest away from the heat/smoke source.

2.5.2.1 Cold smoking

Fish which are to be cold smoked are hung after preparation (which usually includes splitting) at a set distance from the smoke source. They should be maintained at a temperature below 29°C which may be raised to 35°C for the last half hour of smoking for some fish products. Temperature constraints tend to limit cold smoking, in its strictest sense, to cool climates. The storage life of cold smoked fish depends on the length of time the fish are smoked, the loss of moisture and whether salt has been used. Fish smoked for just a few hours will not keep much longer than fresh fish. Cold smoking tends to involve more risks than hot smoking and spoilage can occur during processing. Cold smoking requires rigorous quality control, strict hygienic practices, and the product must be kept in chilled or frozen storage. As a means of preservation, it cannot be generally recommended for use in developing countries which lack the required storage and distribution facilities.

2.5.2.2 Hot smoking

The temperature used for hot smoking can vary from 65°C to temperatures as high as 120°C. The fish are partially or wholly cooked within a short time (2-4 hours). In the initial stages of hot smoking, it is important that the fish are not subjected to excessively high temperatures as this will result in the flesh being cooked and breaking up prior to the formation of a surface skin which will hold it together. If hot smoking is continued over an extended period, drying will take place, thus resulting in smoke dried products with an extended storage life. Smoke drying temperatures should be between those used for cold and hot smoking. A range between 45 and 70°C can be suggested although temperatures well above this are often used. Hot smoking requires kilns which may be traditionally built of oil drums, stones, etc.

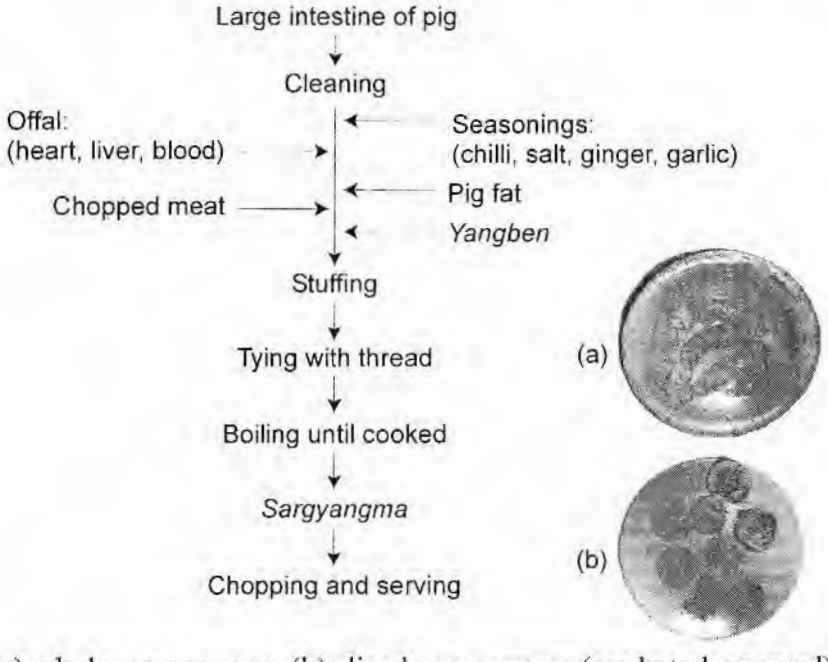
2.6 SARGYANGMA

This is a type of unsmoked sausage prepared by Limbus in freshly prepared pork intestine casing. It is normal practice to prepare *sargyangma* in the household whenever a pig is slaughtered. *Sargyangma* is a good example of by-product utilization. People of all ages relish it.

The nutritional value of *sargyangma* depends on the amount of each ingredient used. The main ingredients influencing the proximate composition are quantities of *yangben* (60-70%), blood (10-20%), heart, liver, fat and meat used in the reciple. On an average, a typical *sargyangma* contains 12% crude protein, 41% moisture, 16% crude fat, 30% carbohydrate (from *yangben*) and 1% minerals. The dish is rich in iron because of the inclusion of blood.

Sausages prepared by Limbus are very unique and tradional. But it has yet to take a commercial form. Adopting basic technological inputs such as selection of raw materials, hygiene, 'adequate' heat treatment, and suitable packaging can significantly improve the quality. The general method of *sargyangma* preparation is given in Fig. 2.6.

The fundamental difference between a regular sausage and *sargyangma* is the use of *yangben* as the principal ingredient in the latter. Fresh *sargyangma* has a very short shelf life (1-2 days). Occasionally, people preserve the surplus *sargyangma* by immersing it in dry-rendered lard (from pig). This product remains stable for at least 6 months at temperatures below 25°C.



(a) whole *sargyangma*, (b) sliced *sargyangma* (ready to be served)

Fig. 2.6 Basic steps in the preparation of *sargyangma*

2.6 WOMYUK

Womyuk is as special Limbu dish prepared from charred down-feathers, wings and offal (legs, intestine, gizzard, heart, head and liver) of local chicken. *Womyuk* is bitter in taste, goes well with local alcoholic beverages, and also works as an

appetizer. In the household, it is prepared everytime a local breed chicken is dressed. The nutritional value depends on the amounts of individual ingredients used in the recipe. The dish is rich in minerals, particularly calcium and phosphorus due to the inclusion of fine bones. A typical *womyuk* recipe contains 50% moisture, 15% crude fat, 28% crude protein, traces of carbohydrates and 7% ash. Some people associate bitterness of *womyuk* to medicinal properties.

Womyuk is prepared as shown in Fig. 2.7.

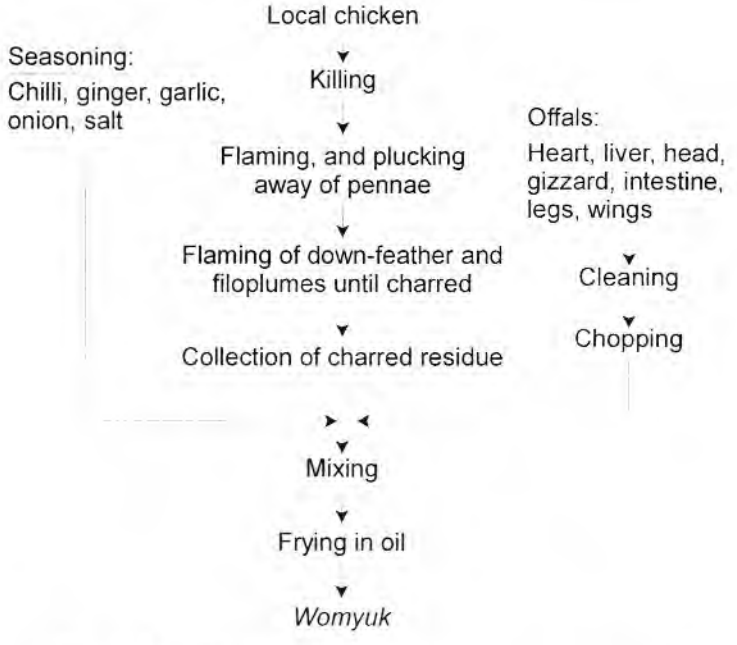


Fig. 2.7 Basic steps in the preparation of *womyuk*

Womyuk is not produced in large amounts, nor is it sold in the market. However, it can find a place in restaurants and hotels as a special dish.

Pyrolysis of organic matter (during charring) has been shown to form carcinogenic compounds, which implies that excessive consumption of *womyuk* may not be good for health.

CHAPTER 3
MILK PRODUCTS

Milk is a highly nutritious, versatile food. People enjoy drinking milk in its natural form and also use it to make a wide range of food products, including cream, butter, yogurt, cheese, and ice cream. For neonates, this is the sole source of nutrients.

3.1 DAHI

Dahi or curd is the traditional fermented milk product obtained from pasteurized or boiled milk by souring with natural microflora or by the harmless lactic acid or other bacterial culture. *Dahi* is popular throughout the Indian subcontinent. It is consumed either in the main course or as a refreshing beverage. It is assumed that over 50% of total milk produced in Nepalese households is converted into *dahi*: only a small amount of the milk produced is sold. The conversion of milk into *dahi* is an important intermediary step in the manufacture of *nauni* (indigenous dairy product resembling butter) and *ghee* (butter-oil).

For the most part, two types of *dahi* are produced. They are: (i) Sweet/mildly sour variety with the pleasant flavor, and (ii) Sour variety with a distinct acid flavor.

Sweet *dahi* is prepared using (singly or in combination) *Streptococcus lactis*, *S. diacetylactis*, and *S. cremoris* as the lactic culture. In sour *dahi* preparation, additional cultures (singly or in combination), viz., *Lactobacillus bulgaricus* and *Streptococcus thermophilus* are used. The requirements for both the types of *dahi* are given in Table 3.1. The chemical composition of whole milk *dahi* is given in Table 3.2.

Dahi can also been classified into two groups and additional subgroups on the basis of intended use, for instance:

I. For churning to produce *nauni* and *deshi* butter
II. For direct consumption
    a. Whole milk *dahi* and Skim milk *dahi*
    b. Sweet (mild) *dahi*, Sour *dahi*, and Sweetened *dahi*

Table 3.1 Requirements for *dahi*

Characteristics	*Requirements*	
	Sweet dahi	*Sour dahi*
Acidity as lactic acid (%wt, max.)	0.7	1.0
Yeast and mold count (per g, max.)	100.0	100.0
Coliform count (per g, max.)	10.0	10.0
Phosphatase test	Negative	Negative

Table 3.2 Chemical composition of whole milk *dahi*

Constituents	*Amount, %*
Water	85-88
Fat	5-8
Protein	3.2-3.4
Lactose	4.6-5.2
Ash	0.7-0.72
Lactic acid	0.5-1.1

In our country only the whole milk *dahi* is prepared, both for production of *nauni* and direct consumption. In the rural areas the milk may be boiled for longer periods of time. The volume may be reduced to one-third of its original volume and spontaneously fermented in *theki*[7] (Fig. 3.4). Fermentation is carried out overnight at room temperature.

3.1.2 Methods of *dahi* preparation

3.1.2.1 Traditional method

The traditional method of *dahi* production is limited to small scale and is produced either in consumer's household or sweet-maker's shop (in urban areas). In the cold weather, the *dahi* setting vessel (*theki*) is kept over or near the fireplace to maintain the warmth needed for fermentation. It is also usual to wrap *theki* with woolen cloth for the same. In the shops, the method is more or less same except that milk is concentrated somewhat before inoculation and *dahi* is usually set in a circular earthenware pot.

[7] A close-necked wooden vessel carved out of *Boehmeria rugulosa* Wedd tree

Process	*Notes*
Milk	° Good quality milk
↓	
Boiling	° Boiled for ½ hr to increase solid-not-fat (SNF)
↓	
Cooling	° Spontaneous cooling to body temperature
↓	
Inoculation	° Addition of previous day's *dahi* or cultured buttermilk or fermented whey
↓	
Incubation	° Standing overnight, preferably near the fireplace to maintain the warmth needed for the fermentation. A firm coagulum forms when kept overnight
↓	
Dahi	° Consumed or sold in the nearby markets

Fig. 3.1 *Dahi* preparation by traditional method (mesophilic culture)

3.1.2.2 Improved/Commercial method

Dahi preparation in the household depends on non-specific mesophilic starters that work around 25°C and takes a longer time to form curd. On a commercial scale, *dahi* can be prepared using specific mesophilic cultures as well as thermophilic cultures. Process notes for traditional- and commercial methods for *dahi* production using mesophilic cultures are given in Fig. 3.1, 3.2 and 3.3. The product thus prepared is now ready for sale. The temperature is maintained at or below 5°C until consumed. The product remains acceptable for 1-2 days under refrigerated condition.

3.1.3 Food and nutritive value

The fermented milk products including *dahi* are superior to the original milk in terms of nutritional quality. Besides, it is more palatable and easier to digest. It is also known to be beneficial during intestinal disorders.

3.2 JUJU DHAU

Juju dhau is a set type of yogurt produced only in Bhaktapur district by Newar community. *Juju dhau* (*juju* means 'king' and *dhau* means 'dahi' in Newari dialect) has a peculiar taste and appearance. Due to its unique sensory property, *juju dhau* is widely consumed as a side dish, in religious ceremonies, festivals, and carnivals. Production of *juju dhau* has remained confined to domestic- or cottage scale operations from a long time (for over 400 years) in Bhaktapur

municipality areas (Sukul Dhoka, Bansagopal, Mahakali, Chyamasingh, Jagate, Suryabinayak and Thimi in particular).

Process	*Notes*
Milk	° Receiving good quality of milk (cow, buffalo)
↓	
Preheating	° Heated to 35-40°C
↓	
Filtration/Clarification	° To remove suspended particles, cells, etc
↓	
Standardization	° 2.5-3% fat, 10% SNF to improve body and texture
↓	
Homogenization	° Single-stage homogenizer ° Done to prevent creaming ° Improves color
↓	
Pasteurization	° 80-90°C for 15-30 min ° Kills germs and hydrates milk proteins
↓	
Cooling	° 22-25°C
↓	
Inoculation	° 1-3% specific lactic starter culture
↓	
Packaging	° Suitable container such as plastic cups, clay pots, etc., of required capacity
↓	
Incubation	° 22-25°C for 16-18 hrs until firm curd is formed
↓	
Dahi	
↓	
Cooling and storage	° < 12°C in about 1 hour by circulating chilled water or air around the containers ° Marketed at less than 5°C

Fig. 3.2 *Dahi* preparation by improved method (mesophilic culture)

Process	*Notes*
Milk	° Fresh, good quality
↓	
Preheating	° 35-40°C to facilitate filtration/clarification
↓	
Filtration/Clarification	° Through closely woven cloth or centrifuge to remove particulate foreign materials like visible dirt, frass (insect refuge), hair, etc
↓	
Standardization	° 3% fat, 8% SNF
↓	
Homogenization	° Single-stage homogenizer
↓	
Pasteurization	° 80-90°C for 15-30 min
↓	
Cooling	° 40-42°C
↓	
Inoculation	° 1-3% pure lactic acid culture (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*)
↓	
Filling	° In plastic cups, clay pots, or other containers
↓	
Incubation	° 40-42°C for 2-3 hrs
↓	
Cooling	° 4°C within 1 hr by circulating chilled water or air
↓	
Storage	° 5°C until sold

Fig. 3.3 *Dahi* preparation by commercial method (thermophilic culture)

Juju dhau is prepared preferably from buffalo milk. Because it is concentrated for a fairly long time in *karahi*, the product is rich in fat content and MSNF. Basically, there are two types of *juju dhau*, viz., (i) plain, and (ii) sweet. The plain type is made without addition of sugar while the sweet type is prepared by addition of 5% sugar on fresh milk basis. The traditional method of *juju dhau* (sweet type) production is given in Fig. 3.4 and Fig. 3.5.

At 5°C, *juju dhau* remains mildly acidic for 3 days. After 7 days, *juju dhau* becomes acidic and undesirable for consumption.

Although there is no organized market for *juju dhau*, a conservative estimate of it consumption is 3000 liters per day.

Process	*Notes*
Milk	° Fresh buffalo milk (4.5-6% fat) is strained with muslin cloth or wire net of any suitable strainers
↓ Heating	° Milk is heated (~ 95°C) in *karahi* over an open fire until it concentrates to about four-fifth of the original volume
↓ Sugar addition	° Sugar is added at the rate of 5% on fresh milk basis about 10-20 min before the concentration process ends
↓ Filling	° The concentrated milk is cooled (spontaneous) and filled in clean earthen troughs (called *vigut*, size ranging from 200 ml to 20 liter) ° Before the filling begins, *viguts* are buried to about three-fourth portion in a rice husk bedding. Depending on the requirement, the husk bedding can accommodate several dozens of *viguts* ° A peculiarity in *juju dhau* preparation is that filling is carried out by repeatedly pouring milk(2-6 times at intervals of 10-20 min) in the *vigut* from a height of about 1 m
↓ Culture addition	° The temperature of the milk is optimally kept at about 50°C ° Previous day's *juju dhau* is diluted in water and added to *vigut* at the rate of 1% by volume
↓ Incubation	° The *viguts* are covered by inverting empty *viguts* on top ° Gunny bags or similar insulating materials are placed over the covered *viguts* and left for fermentation for 4-6 hrs ° The temperature should remain around 32-34°C
↓ Cooling	° *Viguts* are taken out and cooled (spontaneous cooling for 2 hrs in winter) ° Nowadays, electric fans are commonplace and these can be used for cooling in summer ° For commercial production, refrigerators are also used
↓ *Juju dhau*	

Fig. 3.4 Preparation of sweet *juju dhau*

Juju dhau typically contains about 5% fat, 5% protein, and 25% total solids. The pH and the corresponding Titrable acidity are 4.45 and 1% respectively. Lamsal (2007) has reported considerable degree of variation in syneresis, which indicates further scope for study whereby this problem can be technologically addressed. The same author has reported presence of coliforms in 4 out of 5 samples

(3.28×10^2 to 1.03×10^3 cfu/ml). Since the survival of coliforms during the heat treatment is out of question, the critical control points here appear to be packaging material (*viguts*), culture, incubation facility, and post production operations.

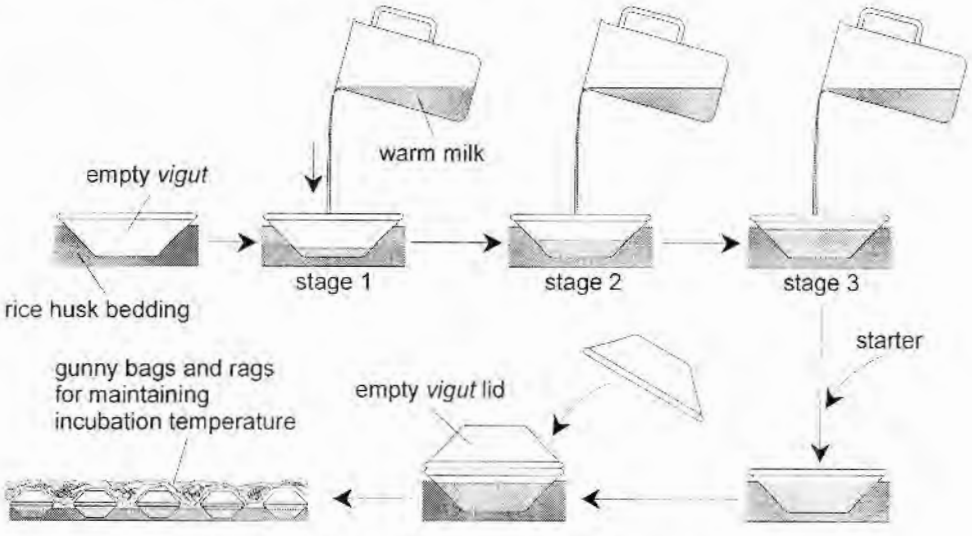


Fig. 3.5 Major steps in *juju dhau* preparation

3.3 PUSTAKARI

Pustakari is a brown-colored, tough, milk based confection indigenous to Newar community. In Newari language, *pusta* means 'healthy'. Some people believe that *pustakari* originated even before the advent of chocolate in Europe. *Pustakari* is widely used in the Kathmandu valley as a refreshment food and *naivet* (food offered to God). It is also used in festivals and marriage ceremonies by the Newar community. In other parts of the country *pustakari* is considered a souvenir from Kathmandu.

Basically, *pustakari* is a made by cooking *khoa*, sugar, *maida* (wheat flour) and coconut. The traditional method of *pustakari* preparation is given in Fig. 3.6. Instead of sugar, molasses is also sometimes used and this type of product is called *chaku pustakari*.

Although very popular, *pustakari* production is still confined to municipalities of Kathmandu valley. The sale of *pustakari* is about 1000 kg/day (price NRS 150 /kg as of 2007). *Pustakari* contains 12% protein, 9% moisture, 14% fat, 62.5% carbohydrate, 0.5% crude fiber (from flour, coconut, etc.) and 2% total ash. It has a pH of 5.88, a TSS (total soluble solids) of 93 °brix, and provides about 420 kcal/100 g.

The recipe as well as the manufacturing process of *pustakari* is subject to slight variations from place to place. Typically, *pustakari* production requires sugar, *khoa*, *maida*, and coconut powder in the ratio (by weight) 100:100:40:3, although

a ratio of 45:45:10:? has been reported by Achhami (2007) to give *pustakari* of very high sensory quality. If packed in low density polyethylene (LDPE, 75μ) and stored for about 4 weeks at room temperature (18-22°C) without significant deterioration is sensory quality.

Process	*Notes*
Melting of sugar	° Table sugar is melted in *karahi* in an open flame ° Temperature reaches around 175°C
↓	
Khoa addition	° *Khoa* is added slowly (with continuous stirring) and cooked for 5 min at ~ 95±3°C
↓	
Other ingredient addition	° Coconut dust is added (with continuous stirring) and cooked for 3 min at 90±3°C ° Maida is similarly added and mixed
↓	
Cooking	° Cooking (and concentration) is carried out with continuous stirring until a thick, non-sticky mass is obtained
↓	
Cooling	° The mass is transferred to a greased tray for cooling to about 60°C ° The mass, while still warm (~ 55°C), is divided into lumps of about 10 g and then rolled into balls ° The balls are hardened by cooling to room temperature (20-22°C)
↓	
Pustakari	° The balls are packed (to give about 100 g weight) in suitable plastic packages and then stored or sent for sale

Fig. 3.6 Major steps in *pustakari* preparation

3.4 GUNDPAK

Gundpak is a *khoa*-based Nepalese indigenous dairy sweetmeat originally invented and coined by Pannalal Maske in 1993 (Sharma, 2007). The product contains *khoa*, *ghee*, edible gums, different types of dried fruits, nuts, and herbs, which makes the product very nutritious. Although popular among all age groups, lactating women are encouraged to eat it in the Kathmandu valley. *Gudpak* especially formulated for lactating mothers is called *sutkeri gundpak*. Outside Kathmandu, *gundpak* is prized as a souvenir from Kathmandu.

The production of *gundpak* is confined to Kathmandu valley (Kathmadu, Lalitpur and Bhaktapur), especially within few Maske and Haluwai family, in cottage scale. At the moment, a few dairy industries are starting the production of

gundpak. However, there is great variation in the quality and storage stability of these commercially produced *gundpak*. When vacuum-packed in LDPE (75μ), the shelf life of *gundpak* (18-22°C) is up to 2 weeks. Under refrigeration, the product is acceptable for 4 weeks. The production of *gundpak* in the Kathmandu valley is estimated to be 1000 kg/day and the price range is NRs 150-200 (as of 2006).

There is a great deal of variation in the amounts and types of ingredients taken for *gundpak* preparation, as also the method of preparation. However, *khoa* and sugar are quantitatively the most important ingredients. The ratio of *khoa* to sugar may vary from 1.0-8.0. For optimum sweetness, flavor and color development, the *khoa* to sugar ratio of 1.5 can be considered optimum.

According to Shakya (2006) and Shrestha (2006), following recipe can be used for producing *gundpak*: *khoa* 1 kg *khoa*, 1.0 kg sugar, 0.1 kg edible gum (gum Arabic), 0.15 kg *ghee*, 0.2 kg rice flake powder, 0.25 kg raisin, 0.01 kg small cardamom powder, 0.3 liter water. Other spicy and aromatic materials include (for the same recipe) 0.05 kg coconut pieces, 0.05 kg date, 0.25 kg *kaju*, 0.25 kg *desi badam*, 0.025 kg *dacha*, 0.025 kg pistachio, 0.25 kg cucumber seeds, 0.025 kg ash-gourd seeds.

It is also very common to use *battisa*, a herbal preparation consisting of 32 medicinal herbs (*sanai patti*, 0.5 kg; *thulo okhati*, 1.0 kg; *pakhan ved*, 1.0 kg; bark of *kaphal*, 0.5 kg, bark of *koiralo*, 0.5 kg; ginger powder, 0.2 kg; pipla, 0.1 kg; *shankha puspa*, 0.5kg; *amla*, 1.0 kg; *jethimadu*, 0.5 kg, *harro*, 1.0 kg; *nag kesar*, 0.2 kg; *cinnamon*, 0.2 kg; *barro*, 1.0 kg; *rupakesar*, 0.2 kg; *bayu widhang*, 0.1 kg; *jwano*, 0.5 kg; *jeera*, 0.2 kg; *kurilo*, 0.5 kg, *widhara*, 0.5 kg, *simalko phul*, 0.5 kg; *ajun*, 1.0 kg; *ashwagandha*, 0.5 kg; *kachur*, 0.2 kg; *kauchho*, 0.5 kg; *gurjo*, 1.0 kg; *gokhur*, 0.5 kg; *ghanera*, 0.5 kg; *nagarmotha*, 0.2 kg; *bel*, 1.0 kg; *majetho*, 0.5kg; *punarba*, 0.5 kg).

Because of the variation in the recipe of *gundpak*, it is difficult to generalize its proximate composition. Nevertheless, a typical *gundpak* may contain 20% fat, 14% protein, 2.4% total ash, 13.5% moisture, 0.1% crude fiber, and 50% carbohydrates. The energy value is 425 to 450 kcal/100 g.

The method of *gundpak* (plain) preparation is given in Fig. 3.7. In general, the principle involved in *gundpak* preparation is quite straightforward. Sugar is melted at and further heated (175-200°C) with continuous stirring until it turns into brown yellow (honey-like consistency). Thereafter, ground *khoa* is mixed and cooked along with fried edible gum and dried fruit grits and nuts. The attractive texture and color of *gundpak* is mainly due to the caramelization of sugar that occurs when sugar is heated at high temperature. Because of the presence of proteins and amino acids, maillard reaction also occurs to a significant extent.

Because of the rigor of heat treatment, survival of microbial contaminant is out question. However, post-production contamination must be avoided. Rancidity (development of off flavor) is the main reason of spoilage.

Process	*Notes*
Figuring the mix	° 600 g *khoa*, 400 g sugar, 50 g edible gum, 60 g *ghee*, 30 g date (edible part), 30 g coconut powder, 15 dried grapes, 15 g cashew nuts, 15 g almond, 15 g pistachio, 6 g small cardamom, 6 g *battisa* powder, 60 g rice flake flour, 25 g ash gourd seeds/cucumber seeds, 100 ml potable water/whole milk
↓	
Melting *ghee*	° *Ghee* is melted (108-110°C) in frying pan under gentle and constant flame
↓	
Frying of seeds, dried fruits, edible gum	° Seeds and dried fruits – half-fried ° Edible gum – deep-fried
↓	
Cooking sugar	° Sugar is brought to honey-like characteristics by heating (160-200°C) in *karahi* under gentle flame ° Stirring is done continuously
↓	
Mixing of ingredients	° Add and mix well the ground *khoa* ° Pour *ghee* (that remained after frying seeds, fruits, etc.) ° Add and mix fried ingredients (gum, fruit, seeds), rice flake powder, and *battisa* powder ° Stir continuously under low flame during addition ° Add the requisite amount of water or milk
↓	
Cooking	° Cook at 93-95°C under gentle and constant flame ° Stir continuously until *ghee* begins to ooze out and the contents no longer sticks to the *karahi* ° A characteristic caramel flavor and color develops
↓	
Molding/setting	° The preparation is poured on a shallow, greased aluminum or steel tray
↓	
Top dressing	° While still warm, top dress with previously fried raisins and seeds
↓	
Pressing	° Gently press the mass with a clean ladle to anchor raisins and seeds ° Cool the mass to 60-65°C
↓	
Packing	° Cut *gundpak* into desired size of pieces with a clean knife and pack in LDPE bags in amounts of 250 g-1.0 kg ° Vacuum packaging is more effective in terms of shelf life of the product

Fig. 3.7 Major steps in *gundpak* preparation

3.2 NAUNI GHEE

It is a cultured, butter-like dairy product obtained by traditional churning of *dahi* or fermented cream. It contains 77-78 % fat, which is lesser than in the commercial butter (which contains 80-82 % fat). It is also more intense in flavor than commercial butter. *Nauni* production incurs appreciable loss of fat, which can of course be reclaimed in *mohi* (cultured buttermilk). *Nauni* is sold as such in the local markets or can be used for the preparation of ghee (butter oil). In the villages, it is customary to consume *nauni* with rice, the staple food of most Nepalese.

The traditional preparation of *nauni* involves churning of *dahi* in the *theki* itself with the help of wooden paddle called *madani* (Fig. 3.8*)*. *Madani* is rotated back and forth with the help of a super-coiled rope called *neti*. *Dahi* is churned in *theki* after adding adequate amount of water (normally represents one-half to two-third by volume). After some time has elapsed (about half an hour, but depends on the amount of *dahi*, size of *theki*, temperature and vigor of churning) small grains of fat begin to separate out of the serum portion. These grains become progressively larger to form granular agglomerate. This lump of fat that accumulates in the neck of *theki* is brought out by adding more water and then scooped out with hand into a container.

The temperature of water for churning *dahi* and working *nauni* is very critical. During summer, the villagers add some cold water for better recovery of *nauni*. For the same reason, they add warm water in the winter. This is a skill that has been handed on through the generation. The producers do not have any idea about the relationship of fat agglomeration with temperature.

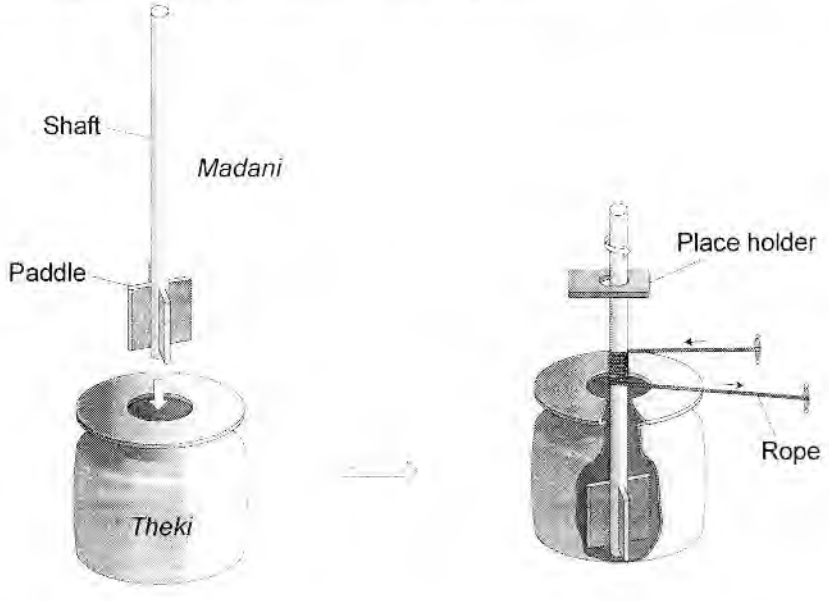


Fig. 3.8 Separation of *nauni* from *dahi*

In the rangelands where cattle are reared, a more portable form of churner is often preferred. This churner consists of a cylinder with an open end. *Dahi* and some water are poured in and the mixture gently agitated by driving up and down a loose-fitting wooden piston (Fig. 3.9). After maneuvering for some time, the fat grains will rise up, which is subsequently recovered.

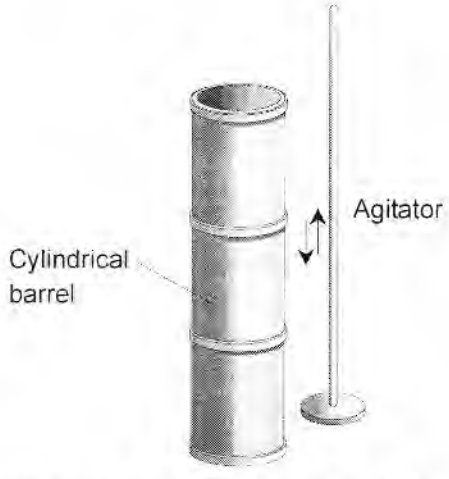


Fig. 3.9 *Dahi* preparation by commercial method (thermophilic culture)

3.3 MOHI

Mohi is basically cultured buttermilk obtained as a by-product during the preparation of *nauni* by traditional churning of *dahi*. Technically, the serum portion that remains after *nauni* has been taken out is called *mohi* (Fig. 3.10). *Mohi* contains almost all proteins, lactose, minerals and vitamins found in milk. It also contain appreciable amount of fat (residual). Thus, *mohi* is a nutritious dairy by-product popular in the rural areas. *Mohi* can be drunk as such as a refreshing drink or in the main course.

Milk is fermented not with the primary objective of preparing *mohi*. Therefore it is explicable that special processes do not exist in the traditional method of *mohi* preparation. In the rangelands where cattle are reared, *mohi* is in fact given to the cattle themselves in the form of feed. These days, however, dairies are putting emphasis on value-addition of milk by-products. One of the value-added products that have evolved as a result of this effort is *jeera mohi*, produced commercially by Dairy Development Corporation (DDC), Nepal. A brief discussion on *jeera mohi* is given in the following section.

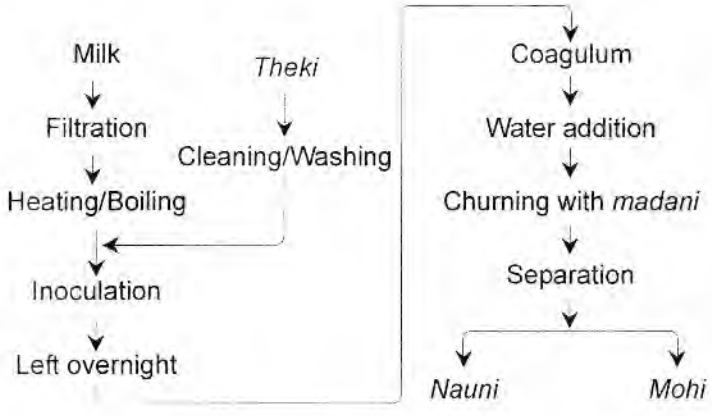


Fig. 3.10 Traditional preparation of *mohi* and *nauni*

3.4 JEERA MOHI

This is a value-added buttermilk product gaining popularity in Nepal. The basic material is the buttermilk, which may be obtained as a by-product of ripened or unripened butter production. Buttermilk is tested for acidity, fat, and SNF. The acidity should not be too high. Fat is adjusted to 1% by adding cream and SNF is adjusted to 5.5% by adding skim milk. The mixture is heated to 85°C and then cooled to 30-32°C. Ripened buttermilk can be processed as such but for unripened buttermilk, *dahi* culture is added and left for 12 hrs. Roasted *jeera* (cumin seeds) and salt is added at the rate of 0.5% each. The mixture is passed through the homogenizer without applying pressure. The product can now be packed in pouches and stored cold until consumed.

3.5 SOLLAR

Sollar is a spiced soup prepared by frying sour *mohi*. It has a tart, highly appetizing flavor and hence adds variety to our food. An outline of *sollar* preparation is as follows: Small amounts of fenugreek, chopped onions, cumin seed, turmeric powder, etc., are fried in a small amount of oil in *karahi* (Fig. 3.11). After the spices have become golden brown *mohi* is poured in, thereby producing a characteristic sizzle. Salt is added to taste. The soup is brought to first boil and served hot.

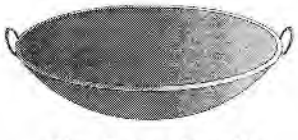


Fig. 3.11 *Karahi*

Sollar preparation is a good option for utilizing *mohi* that has incidentally gone sour. Although *sollar* is relished by all, people suffering from cold, fever and sore throat are found to benefit greatly.

3.6 *GHEE*

It is a clarified fat obtained by cooking/heating *nauni* or butter. The *ghee* produced from *nauni* contains somewhat lesser fat than the *ghee* obtained from butter. Since *nauni* has more intense cultured flavor than butter, *ghee* prepared from *nauni* is naturally more flavorful than that from butter. A general flow sheet for the preparation of *ghee* is given in Fig. 3.12. Because of the low moisture content, *ghee* is relatively more stable than *nauni*.

Fig. 3.12 Outline of *ghee* preparation by traditional method

3.7 *CHURPI*

Churpi is a chhanna-based milk product indigenous to Nepal, Sikkim and Bhutan. It is often hard, but sometimes the soft form is also used. Hard *churpi* is used as a nutritious masticatory milk item. In Bhutan, *churpi* production is mainly carried out by Drukpas (the main nationality of Bhutan).

Hard *churpi* is light yellowish to dark brown, cubical or cylindrical, faintly sweet, but distinctly smoky with a hard and compact body. Because of variations in the production method and other factors, the quality of *churpi* is highly variable. On an average, it keeps well for about six months.

3.7.1 Varieties

A number of methods are used for *churpi* making, resulting in a number of varieties. The use of raw materials and types of coagulants vary with place and tribes. The quality of milk obtained from different herds is different. Even a single breed will produce milk of different composition according to the feed and climatic condition. The coagulant type and quality, curd formation, treatment of curd and drying process are other major contributory factors for the final characteristics of *churpi*. *Churpi* can be divided into 3 basic types (i) Soft *churpi*, (ii) *Dudh churpi*, and (iii) Hard *churpi*. A brief treatment of these *churpi* types is given in the following sections.

3.7.1.1 Soft churpi

It is prepared in both hilly and the Terai regions. Also called *kachha churpi* (by the Nepalese) or *chuiw* (by the Lepchas), soft *churpi* is prepared from cow milk. The milk (boiled or without boiling) is kept in a wooden vat at room temperature for 24 hrs. Often, the cream is allowed to separate and the milk is curdled by boiling. The casein mass is wrapped tightly in a piece of muslin cloth and allowed to drain for 3-4 hrs. *Churpi* is consumed as a condiment by mixing with sliced radish or cucumber; it can also be mixed with meat, vegetables and spices to prepare curry.

3.7.1.2 Dudh churpi

Partially defatted milk (yak, dzno and cow) is coagulated by the combined action of acid (citric acid) and heat. The preparation process is almost similar to that of *churpi* except that a small amount of sugar is added in the coagulum to improve palatability. The product is moderately sweet and faintly smoky in taste with creamy to chalky white surface. It has moderately hard and compact body texture.

3.7.1.3 Hard churpi

Hard *churpi* shows an altitudinal bias (1300-4000m) and is found in Darjeeling district and north-east India. Hard *churpi* (*chura* to the Sikkimese; *khamum* to the Lepchas, an ethnic group) is prepared from cow or yak milk. Hard *churpi* is also called *durkha* (also spelt *durukha*). A self explanatory outline of generic process for hard *churpi* preparation is given in Fig. 3.14 (see Fig. 3.13 also). This type of *churpi* becomes very hard because of low moisture. For the same reason, it can be stored for a number of years. See Fig. 3.15 for process notes on *churpi* production from yak milk.

3.7.2 Nutritive value of *churpi*

Churpi is basically a concentrated mass of milk protein and hence does not contain all the nutritive constituents of milk. Most of the lactose, lactalbumin and soluble mineral salts remain in the whey. The contents of these water-soluble vitamins and other constituents vary with the amount of whey retained by the cheese and the extent to which the curd is handled. A small amount of fat-soluble vitamins may be retained in the fat present in *churpi*. *Churpi* is a masticatory item and hence contributes to mouth and teeth exercise.

Fig. 3.13 *Churpi* ready for sale

3.7.3 Additional notes on traditional *churpi* making

The basic science behind *churpi* making is the coagulation of milk to obtain a caseinous mass which is subsequently pressed and dried to obtain a shelf-stable masticatory item. Depending on the availability, *chauri* (yak) or cow milk can be used. The chemical composition can also be manipulated to bring about differences in organoleptic properties. *Dudh churpi* and fat *churpi* are some examples of manipulation in chemical composition. Fat *churpi* is prepared from partially defatted milk of cow or *chauri*.

Sherkhum is a similar intermediate product obtained during the production of *churpi* from buttermilk. *Sherkhum* production follows after the extraction of *nauni* from *dahi*. When buttermilk is boiled, milk protein will be precipitated out to give *sherkhum*. This is then cut into small pieces and dried in the sun to a moisture content of 12-14%. Once again, we get *churpi* or *durukha* as the final product.

In some places, traditionally, milk is coagulated with previous batch of whey and the green curd is cooked in an open pan. The cooked coagulum is heavily pressed overnight and dried for 40-60 days by hanging the pieces over the fireplace.

However, in Darjeeling the green curd is not cooked but wrapped in a Hessian cloth, stitched and dried in kitchen.

The yield of *churpi* generally depends upon the type of milk used, heat treatment, coagulant and other aspects which are known to vary to a great extent. The smoking process further reduces the weight of the *churpi*. It is estimated that 100 liter of milk produces about 4 kg of *churpi*.

Process	*Notes*
Milk	° Fresh milk (6.5% fat, 9% SNF) is strained with muslin cloth or wire net of any suitable strainers
↓	
Cream separation	° Cream is used for *nauni* or *ghee* making
↓	
Skim milk	° Consists of ~ 1% fat
↓	
Coagulation	° Heated to 60-65°C for 30 min ° Addition of *dahi* or whey (sour) as required ° Boiling for 30-60 min
↓	
Coagulum	° Excess (30-40%) whey is drained away ° The coagulum is further heated until it forms long strings when pulled ° The color of coagulum becomes creamy
↓	
Pressing	° Excess whey is strained through muslin cloth
↓	
Cutting	° Curd is pressed in mold for 24 hrs ° The pressed mass is cut into long rectangular pieces
↓	
Air-drying	° The strips of curd are dried in the air by placing them on a sieve or a mesh prepared from bamboo strips for 12-15 days
↓	
Final drying	° Dried over fireplace to develop smoky flavor. Smoke also has a preserving effect. *Churpi* prepared by this method is stable for 6-8 months
↓	
Hard *churpi*	

Fig. 3.14 Traditional method hard *churpi* preparation

Traditionally, *mohi*, lemon juice, *chook* (a tart, dark concentrate of citrus juice) or alum is used as the coagulant. Alum is a double salt (potassium sulfate-aluminum sulfate) and has been shown to cause health hazard. Its use is therefore discouraged. In many countries, use of alum in foods has been already banned. As

of now, the aforementioned coagulants are being replaced by citric acid because it is cheaper and easily available.

Process	*Notes*
Yak milk	° Yak milk contains more solids
↓	
Dahi	° Prepared as described elsewhere
↓	
Churmini	° Long, cylindrical barrel (*dhungro*, Fig. 3.5) used ° Loose piston driven up and down to separate *nauni*
↓	
Mohi	
↓	
Coagulation	° Traditionally, alum is used
↓	
Hanging	° The coagulated mass is wrapped in cloth, tied, and hung for 2-3 days. Water drains out and the mass solidifies into a lump. The mass may be pressed to flatten it
↓	
Cutting	° Cut into pieces (3cm×3cm×10cm). Pieces are strung by piercing with a threaded needle
↓	
Drying	° Dried in shade or over fireplace. Smoke and heat dry the pieces into hard mass
↓	
Churpi/Durkha	

Fig. 3.15 Process notes on *churpi* production from yak milk

CHAPTER 4
FRUIT, VEGETABLE, AND LEGUME PRODUCTS

Most vegetables are valuable sources of vitamins, minerals, and fiber and are low in fat and calories. With cereals and legumes, they are important to a healthy diet. Many fruits taste sweet and delicious, and have the advantage of being relatively low in calories and high in nutrients. Fruits contain many important vitamins and minerals as well as the complex carbohydrates needed for a balanced diet. A list of important fruits and vegetables are given in the Appendix.

4.1 PICKLES

The process of fermenting fruits and vegetables in the presence of common salt is called pickling. Salt is generally used to selectively control microorganisms and for taste. Pickles are made from different vegetables and fruits. A lot of variation exists in the traditional method of pickle preparation. Unlike commercial preparations, traditional methods do not rely on chemical preservatives (e.g., benzoates) for preservation.

4.1.1 *Nimki*

Nimki is a salt-cured, highly appetizing partially fermented citrus product. It is used as a side dish. The preparation of *nimki* is given in Fig. 4.1.

4.1.2 *Khalpi*

Khalpi is a pickle especially prepared from ripe cucumber. It is mostly prepared from local varieties of cucumber which are jumbo large in size (50 cm × 20 cm, length × dia.). Salt and mustard powder selectively control undesirable microorganisms but allow the growth of lactic acid bacteria (LAB). The prepared *khalpi* is sour in taste with a typical, pleasant flavor and consumed with great relish. It is a good appetizer, adds palatability and complements the Nepali meal

(*dal-bhat-tarkari*[8]). Variations exist from locality to locality but a typical process of *khalpi* preparation is given in Fig. 4.2.

4.2 GUNDRUK

Gundruk is a non-salted fermented food product prepared by spontaneous lactic acid fermentation of leaves or seedlings of Brassica family, such as radish, cauliflower, rape, mustard, etc. *Gundruk* is one of the most prized typical indigenous vegetable products and believed to have existed in the Nepalese culture since time immemorial. It occupies an eminent place in the Nepalese diet and is eaten with great relish. *Gundruk* preparation is generally confined to household level and purpose. A crude estimate reveals that only about 2% of *gundruk* is produced in commercial amounts. Now, *gundruk* has begun to appear in shelves of departmental stores and even in supermarkets. This is an indication that the popularity of *gundruk* is slowly increasing. *Gundruk* made from the mustard leaves are believed to be the best and also supposed to have medicinal value by many people.

Gundruk is the major source of minerals and vitamins during off-season when green vegetables are scarce. *Gundruk* is valued for its uniquely appetizing flavor and served in a number of ways. It is lightly washed, soaked, mixed with onion pieces, oil and salt, and eaten in solid form; or boiled with salt, oil, tomatoes and the soup taken with rice.

4.2.1 Raw materials

The most common raw materials used for preparing *gundruk* are the leaves of *Brassica* species such as mustard (*Brassica campestris L.*), rayo (*B. juncea L.* – broad leaf mustard), cauliflower (*B. compestris L. var botrytis L.)*, cabbage (*B. oleracea*, L). Radish (*Raphanus sativus L.*) leaves can also be used.

4.2.3 Process of preparation

Gundruk preparation is widespread in Nepal. However, the best *gundruk* is reported to be made in the hills. Methods of *gundruk* preparation differ slightly, according to the area and tribal communities, but in general the following procedure is followed (see Fig. 4.3 for flow sheet).

The process of *gundruk* making is quite simple. However, the preparation of *gundruk* of superior quality merits an experienced hand. After selection of leaves, the green, matured leaves are manually cleaned and mud and other foreign matters are removed. The leaves are than withered in the sun for a day or two. Sun drying makes the leaves tender, which in turn facilitates filling in the container. It is then

[8] A set containing split pulse soup + rice + vegetable curry

crushed and shredded into small pieces. The crushing releases the juice on which fermentation occurs. It is then tamped in earthen pots, *dhungro* (barrel made from whole bamboo stem), glass bottles, plastic container, etc., and capped tightly. *Gundruk* prepared with improper packing results in a poor-quality product. The packed containers are kept in warm places, in the sun during day and near the fireplace during night, for 10-15 days. The first sign of fermentation is the froth that seeps from the vessel, and this is usually followed by oozing out of a brown-colored liquid. The leaves inside the vessel also give off a pleasant odor. The completion of fermentation is judged by a typical sour and pleasant smell that comes off the containers. The fermented *gundruk* is then removed from the containers. A part of it is consumed as fresh and a part is dried in the sun.

In practice, larger amounts of *gundruk* are prepared by tamping crushed vegetables in a pit. Pit fermentation in bulk produces better *gundruk*. A suitable pit is dug according to the amount of *gundruk* to be prepared. The pit is warmed and disinfected by burning hay or straw. About two inches of rice straw is laid on the bottom and lined round the inner wall of the pit. This is followed by lining with banana leaves. The withered and shredded vegetable leaves are pressed little by little with clean feet until the pit is full. Warm water may be sprinkled while pressing. At the end, leaves and rice straw are folded over it and covered with soil. Heavy stones are kept over the pit for pressing. The completion of fermentation is judged by the smell as in the previous case. The *gundruk* is removed off the pit with great care and dried on a straw or bamboo mat or a piece of cloth. The quality of *gundruk* has been primarily judged on the basis of acidic taste and typical *gundruk* flavor. These two characteristics have been embodied as key indicator of quality. *Gundruk* is now stored in a dry place until needed.

Process	*Notes*
Lime/Lemon	° Fully ripe lime or lemon
↓	
Washing	
↓	
Rubbing	° Remove all flavedo part of albedo
↓	
Cutting	° Cut into 4 slits without separation
↓	
Packing	° Pack into earthenware or glass container ° Layer with salt (~ 10%) and stopper
↓	
Curing	° Keep in the sun for 7 days
↓	
Nimki	° Product is shelf-stable indefinitely

Fig 4.1 Preparation of *nimki*

Process	*Notes*
Cucumber	° Take fully ripe cucumber. Nepali local cucumber grown in hill are jumbo large size
↓ Washing	° Wash thoroughly with clean water
↓ Cutting	° Cut into halves and remove inner soft portion that contains seeds with a knife ° Cut into 3-4cm squares and section each pieces from inner side towards peel to facilitate smearing of spices powder
↓ Wilting	° Wilt in the sun for 5-6 hrs. Moisture should be reduced to 50-60%, otherwise excess liquid that exudes later will result in loss of spices during fermentation
↓ Seasoning	° Mix with a spice mixture containing mustard or mustard powder (raw or roasted), salt, turmeric, chilli, etc
↓ Tamping	° Pack tightly in clean earthenware or glass or wooden containers and secure the lid
↓ Fermentation	° Keep in the sun during day and near the fireplace at night ° Remove excess water, press, and cover with mustard oil (1 cm) after 1or 2 days ° Continue fermentation until a brown color develops (5-7 days). Natural fermentation occurs due to the presence of lactic acid bacteria. ° Typical sour taste and flavor are indications of its readiness
↓ *Khalpi*	
↓ Storage	° *Khalpi* is shelf stable product and easily stores for 7-8 months

Fig 4.2 Preparation of *khalpi*

Most villagers prefer to draw off the fermented juice that leaches out of the container. Fermentation is usually completed within 10-25 days, depending on the surrounding temperature. Completion of fermentation is usually ascertained by smelling the typical flavor. The fermented *gundruk* is then dried in the sun until it becomes brittle.

Process	*Notes*
Leaves	° Pluck tender leaves of *rayo*, mustard, cauliflower, cabbage or radish
↓ Washing	° Clean in running water
↓ Withering	° Wither in the sun or shade
↓ Crushing/Shredding	° Crush or rupture the leaves and make small shreds
↓ Tamping	° Stuff the ruptured leaves in pit lined with straw followed by banana leaves ° Cover again with the leaves followed by straw and soil ° Keep a heavy stone or load on top of it
↓ Fermentation	° Keep for 10-25 days depending on ambient temperature ° Judge the end of fermentation by a typical sour smell on pit premises
↓ Taking out	° Take out fresh *gundruk* from the pit with care to avoid contamination ° Remove the spoiled parts on top and sides (if any).
↓ Sun drying	° Cut and spread on *mandro*[9] (Fig. 5.3) or dry in the sun until it becomes brittle (moisture < 10%)
↓ Packaging	° Package in an earthenware such as *ghainto* (*ghyampo*, Fig. 5.3) and plug with old cloth
↓ Storage	° Store over the fireplace

Fig 4.3 Preparation of *gundruk*

4.2.4 Microorganisms and their actions

Gundruk is produced by spontaneous lactic fermentation of leafy vegetables. In vegetables, one or more species of lactic acid bacteria plays an important role. The lactic acid bacteria are a group of Gram-positive, non-spore forming bacteria. Most of them work best in the temperature range of 18 to 22°C. They are unable to act on starch due to the lack of amylases.

The final quality of *gundruk* ultimately depends on the indigenous flora present in the vegetables. Fresh vegetables contain numerous and varied epiphytic micro

[9] A bamboo mat used for drying grains

flora, including many potential spoilage microorganisms and a mall population of lactic acid bacteria. The natural or spontaneous fermentation of vegetables is therefore the result of concerted action of these microorganisms.

A number of lactic acid bacteria (LAB) are involved in *gundruk* fermentation. They are mainly *Leuconostoc* sp., *Streptococcus* sp. *Pediococcus* sp. and *Lactobacillus* sp. Fermentation is primarily initiated by heterolactic *Lactobacillus cellobiosus* and homofermentative *Pediococus pentosaceus* and subsequently completed by the more acid-producing homolactic *Lactobacillus plantarum*.

In *gundruk* fermentation, sugar present in leaves is converted into lactic, acetic and other minor acids and small amounts of alcohols. On the basis of the end products formed, *gundruk* fermentation may be a homo- or hetero-fermentation. The LAB involved, by analogy, are designated as homolactic (homofermentative) and heterolactic (heterofermentative). The homolactics produce mainly lactic acid via Embden-Meyerhoff scheme of glycolysis and mainly involve *Streptococcus, Pediococcus* and various *Lactobacillus* species. The heterolactics consist of *Lactobacillus* and *Leuconostoc* species. They produce acetic acid, ethanol, carbon dioxide, etc., in addition to lactic acid. For lactic acid fermentation, heterolactics are preferred since the end products (acetaldehyde and diacetyl) are responsible for the flavor of the product. However, both homolactic and heterolactic fermentations have important practical implications.

During the course of fermentation, acidity increases by many folds. The final product contains about 0.5% acidity as lactic. The quality of *gundruk* mainly depends on the balanced production of lactic acid (about 50%) and acetic acid (about 35%). Organic acids not only contribute to the desired taste and flavor of the final product but also make the substrate unfavorable for proliferation of spoilage and other undesirable microorganisms. At the same time the acid makes the substrate more suitable for the growth of microorganisms that improve the properties of the food. The combined effect of these acids along with various other metabolites, CO_2 and ethyl alcohol contributes to the characteristics flavor and texture of *gundruk*.

4.2.5 Changes in amino acids, lipids and flavors

Various changes in amino acids occur during *gundruk* fermentation. The extent of changes in all the 20 amino acids varies with the type of vegetable used for fermentation. Glutamate, alanine, and leucine increase more whereas threonine, glycine, cystein, methionine, isoleucine, phenylalanine and lysine increase less during fermentation. Asparagine, glutamine, proline, tyrosine, histidine and arginine decrease but aspartate, valine and tryptophan remain almost constant during fermentation.

The most pertinent alteration of lipid during *gundruk* fermentation is the substantial increase in free fatty acid fraction. Triglycerides and some unknown

fractions are also hydrolyzed during *gundruk* fermentation, liberating free fatty acid fraction that may eventually be beneficial for the generation of desirable ester-like flavor in *gundruk*. The main flavor components of mustard vegetable *gundruk* consists of cyanides (15.7%), isothiocynates (5%), followed by alcohol (12.5 %) and esters (4.1%).

4.2.6 Improvement of *gundruk* preparation

Hygienic and nutritional quality of *gundruk* can be improved by using selected strains of mixed cultures of LAB consisting of *L. cellobiosus*, *P. pentosaceus*, and *L. plantarum* rather than using pure culture. These organisms impart balanced acidity and typical flavor to *gundruk*.

Gundruk quality and consistency can be maintained by pit fermentation, followed by solar drying. Solar drying improves hygienic condition and reduces drying time. Some of the researchers suggest that the acidity level of *gundruk* can be increased by adding cabbage leaves. Selection of uniform tender leaves or seedlings, use of a mixture of pure LAB, pit fermentation in bulk at lower temperature (15-20°C), and solar drying result in better and consistent quality *gundruk*. At about 20°C, a week-long fermentation in pit is sufficient for good quality *gundruk*. Since fresh *gundruk* does not keep for more than 3-4 days at ambient temperature, it should be dried and packed in high density polyethylene packages.

4.2.7 Preservation of *gundruk*

Properly prepared and packed *gundruk* is self-stable for 1 year. The following hurdles prevent *gundruk* from being spoiled and decomposed by microorganisms:

- Depletion of sugar – At the end of fermentation, the sugar (which is the source of carbon and energy for the microorganisms) is almost exhausted due to its conversion into acids and alcohol. As a result, various spoilage microorganisms, including yeasts and molds, will not grow.
- High acidity – *Gundruk* is highly acidic (~ 0.5 % acidity as lactic acid; pH < 4), which is enough to prevent the growth of *C. botulinum* (a pathogen) and other spoilage microorganisms.
- Low water activity (a_w) – Dried *gundruk* has $a_w < 0.6$, which does not permit the growth of even the most xerophilic fungi. Besides, packaging also helps retain low a_w during storage.

4.2.8 Consumption and nutritive value of *gundruk*

Gundruk is served in different ways. It may be served with or without cooking. Generally, it is soaked in water for 1-2 hr, drained, and mixed with chopped onion, salt, mustard oil and green chilli and served as a pickle. *Gundruk* may also

be cooked as a curry: for this, it is soaked and mixed with potato, tomato, soybeans, onion or other vegetables and boiled with some chilli and salt. *Gundruk* is primarily valued for its uniquely appetizing flavor and is mostly used in the preparation of curry, soup, chutney and other local delicacies.

Gundruk is an important source of minerals particularly calcium (2.5g/100g), iron (27mg/100g), and vitamin A (1500 IU). The taste, flavor and acidity of *gundruk* are due to the synergistic action of three lactic strains, viz., *L. cellobiosus, P. pentosaceus* and *L. plantarum*. The general composition of *gundruk* is presented in Table 4.1.

Table 4.1 Composition of mustard *gundruk*

Parameter	*Value per 100 g dry edible portion*
Calories (Cal)	19-30
Protein (%)	3.5
Fat (%)	0.1
Carbohydrate (%)	1-2
Carotene (μg)	1,000-3,000
Riboflavin (mg)	0.2
Thiamine (mg)	0.07
Niacin (mg)	0.5
Ascorbic acid (mg)	55.0

Source: Saono *et al.* (1986)

4.3 SINKI

Sinki is a non-salted fermented vegetable product prepared from radish. It is more popular among fermented foods in Nepal. *Sinki*, a unique traditional Nepalese fermented food, has been eaten from the very beginning. Yet it is very difficult to trace its exact origin due to the lack of authoritative accounts. The process of preparation and the pattern of *sinki* fermentation are similar to that of *gundruk* but it is solely prepared from radish. It can also be prepared together with *gundruk* in the same fermentation pit.

The popularity of *sinki* stems from two reasons: (i) ease of cultivation of radish (in the Terai as well as the hills), and (ii) good shelf life (pH < 4 and low moisture content)

Quality of *sinki* has been primarily judged on the basis of acid taste and typical *sinki* flavor. However, quality of *sinki* mainly depends upon the balanced proportion of lactic acid and acetic acid, which is highly desirable to maintain stability in the product. Because of its taste and typical flavor, *sinki* is equally liked by the people of village and urban areas. *Sinki* is the cheapest supplementary food item for minerals, fibers and vitamins.

4.3.1 Method of *sinki* preparation

Radish is dug from the field and leaves are removed. For a good quality *sinki*, only the succulent type of radish should be selected, preferably the white variety found in the hills. Often, *sinki* is produced by the villagers to value-add and/or manage the surplus radish. A typical process for preparing *sinki* is given in Fig. 4.4.

In the villager's view, *sinki* prepared in pit and bamboo tube (*dhungro*) is more palatable. Any type of container, such as glass, wooden, plastic, earthenware, etc., can be used for stuffing. According to some researchers *sinki* produced in glass container is better in quality.

Radish is packed gently and tightly in a clean container. Tight packing removes most of the air and thus provides a facultative environment needed for the production of good quality *sinki*. Loose packing results in spoilage. Hot water can be sprinkled over *sinki* (to provide warmth) during stuffing in cold weather. If *sinki* is packed in a container, it should be kept near fireplace. The juice that exudes during first phase of fermentation is drawn off from the container. In the pit fermentation, excess liquid is absorbed by the soil.

Fermentation is usually complete within 20-40 days depending on the surrounding temperature. Temperature of fermentation has a determinant role on the microbial profile at different stages of fermentation (and therefore the quality of *sinki*). A lower fermentation temperature (15-22°C) yields a better quality *sinki* (smooth flavor). The end of fermentation is judged by the villagers by typical smell/flavor of *sinki*. The fermented *sinki* is taken out from container or pit and is cut into suitable size and finally dried in the sun until brittle, which is easily judged by experience.

In large scale preparations, pit fermentation is used. A pit is dug to suit the amount of radish to be used. Usually the pit has 3-4 ft depth and 2-3 ft diameter. Floor and wall of the pit are plastered with mud. A fire is ignited inside the pit using rice straws or other dried grasses in order to destroy and kill insects and germs and also to warm up wall and floor of the pit. Rice straw is spread uniformly against the wall and on the floor. Next, banana leaves are placed uniformly over the straw at the base. Wilted radish leaves are then placed and upon which clean, prepared radishes are piled and stuffed layer by layer until the pit becomes full. Finally, it is again covered with wilted radish leaves, then banana leaves, and lastly, with hay. Prepared radish pieces are stuffed tightly by feet or other suitable means. Traditionally, young women are discouraged to do this. Hot water may be sprinkled during stuffing for better pressing. Pit is filled with radish until it comes up 3-4 inches above the surface of the land. The pit should be dug in a dry and elevated place. At the top it should be covered with wilted radish leaves and on top of it straw is folded. It is then covered with soil and a big stone or log is kept on top of it to exert pressure to the packed mass. It requires 20-40 days for the fermentation to complete. The pit method is used only

during the winter. This method has been handed on from generation to generation. Although it is a time-consuming method, people are still in favor of this method for the production of high quality of *sinki*.

Process	*Notes*
Radish	° Take sound radish and remove leaves
↓ Cleaning	° Clean thoroughly in running water
↓ Withering	° Wither in sun or shade until tender
↓ Crushing	° Fragment or rupture the wilted radish on *dhiki* or beat with a wooden hammer
↓ Tamping	° Stuff in pit as in *gundruk* preparation (described earlier). Use hot water during stuffing in cold weather
↓ Fermentation	° Keep for 20-40 days depending on ambient temperature ° Judge completion of the fermentation by a typical smell in the premises
↓ Taking out	° Remove spoiled parts on top and sides, if any ° Taste fresh *sinki* with salt, onion and tomato or make a soup
↓ Sun drying	° Cut and tear into smaller pieces ° Spread on *mandro* for sun drying until it becomes brittle (moisture < 10%)
↓ Packaging	° Package in a *ghaito* (*ghyampo*), plug with cloth, and seal with mud. Bamboo tubes, tin or plastic container may be used
↓ Storage	° Store over a wood burning place in a house

Fig 4.4 Preparation of *sinki*

Sinki can be prepared in a short period in smaller amounts in small containers such as glass jar and earthenware. Prepared radish pieces are stuffed little by little in the containers using warm water and fermented for 10-15 days, by keeping in the sun during day time and near fireplace at night until sour flavor develops.

4.3.2 Microorganisms and their actions

The pattern of *sinki* fermentation is similar to that of *gundruk* and LAB are involved in the fermentation. At the beginning, *Leuconostoc mesenteroides* and *Lactobacillus brevis* dominate and at the termination *Lactobacillus plantarum* becomes dominant at a lower pH. It is in turn subsequently inhibited due to lower pH. Physical, chemical, biological and nutritional changes are very complex and not fully understood.

4.3.2 Nutritional aspect of *sinki*

Nutritional quality of *sinki* mainly depends on radish plus some of the nutrients that are synthesized during fermentation. Chemical composition of radish analyzed several days after harvest is presented in Table 4.2.

Table 4.2 Proximate, minerals and vitamins compositions of radish per 100g

Proximate composition		*Mineral and vitamin composition*	
Water, g	94.6	Potassium, mg	290
Protein, g	0.9	Phosphorus, mg	28
Fat, g	0.1	Vitamin A, IU	12
Carbohydrate, g	3.2	Thiamine, mg	0.03
Energy (cal)	15	Riboflavin, mg	0.03
Calcium, mg	27	Niacin, mg	0.3
Iron, mg	0.9	Ascorbic acid, mg	23
Sodium, mg	16		

4.3.3 Preservation of *sinki*

The principle involved in the preservation of *sinki* is similar to that of *gundruk*, viz., low moisture content (~ 10%; $a_w < 0.6$), high acidity (~ 2%, pH < 4) and packaging. In the traditional method, *sinki* is filled in an earthenware and plugged with old cloth and kept over fireplace. Whenever needed, the required amount of *sinki* is taken out and dish prepared. In this way it can be well stored for more than a year. *Sinki* in its fresh, crisp form can be stored for a month or two by pasteurizing at 85°C for 15 min.

4.4 MESU (FERMENTED FIRST SHOOT)

Bamboos (*Dendrocalamus* spp.) abound in number and type in Nepal. Sweet *tama* (tender bamboo shoot, non-astringent variety) is used for the preparation of curry, chutney and for canning in brine (2%) whereas both sweet and bitter (mildly astringent variety) are fermented for preservation. *Mesu* is a non-salted naturally fermented traditional food product prepared from bamboo first shoot. The name is derived from a Limbu vernacular term, (*mé* = first bamboo shoot; *su* = sour). *Mesu* is used as pickle and can be consumed for a longer period. *Mesu* is generally prepared in the months of July to September when bamboo shoots sprout from the ground.

4.4.1 Traditional method of *mesu* preparation

Mesu is prepared by a traditional method from the different local varieties of bamboo. These varieties differ from place to place. However, the most widely used bamboo varieties are: (i) *Choya bansa* (*Dendrocalamus hamiltonii*), (ii) *Karati bansa* (*Bambusa tulda* Roxb.), (iii) *Bhalu bansa* (*Dendrocalamus sikkimensis*), (iv) *Dhungre bansa* (*Dendrocalamus gigantea*), (v) *Mal bansa* (*Bambusa nutans*), and (vi) *Mitho bansa.*

A detailed procedure for *mesu* preparation is presented in Fig. 4.5. Raw material selection should be done cautiously.

Process	*Notes*
Tender shoot	° Harvest 20-30 cm high young shoot
↓ Cleaning	° Remove outer cover with knife
↓ Washing	° Soak overnight in cold water or 5-6 hrs in hot water
↓ Cutting into rings	° Trim harder portions of the shoot
↓ Boiling	° Boil in excess water for at least 30 min to remove toxic principles ° Add some firewood ash for removal of bitterness (in bitter varieties of bamboo)
↓ Slicing	
↓ Pitching	° Mix with previous *mesu* (5%) or extract
↓ Stuffing	° Stuff tightly in a clean earthenware or plastic/glass container, or a bamboo tube with an open end (*dhungro*) and secure the lid
↓ Fermentation	° Keep in a warm (25-30°C) place, often near fireplace for 10-15 days
↓ Fresh *mesu*	° Judge for the completion of fermentation by a typical flavor

Fig 4.5 Preparation of *mesu*

Generally bamboo shoots that cannot be used as such in curry preparation due to their astringent and bitter taste are used for *mesu* fermentation. Sweet varieties of bamboo are not required boiling before fermentation. Boiling and fermentation reduce toxic cyanogenic glucosides to a significant level in mildly bitter and astringent varieties. Traditionally, firewood ash is added in the boiling water for more bitter varieties of bamboo for easy and efficient removal of the glucosides. Though fermentation causes partial detoxification of cyanogenic glucosides and

significantly reduces the cyanide content, even a small residue may cause headache, palpitation and muscle weakness. In general, natural microorganisms present in the shoot quickly establish and begin fermentation, and culture from the previous batch is not required. However, if the shoots have been boiled, an inoculum from previous batch of *mesu* is needed. Fully fermented *mesu* may not be an ideal starter (in terms of flavor) because of the dominance of homolactics at the end of the fermentation. Fresh *mesu* can be pasteurized to extend its shelf life for about one week.

4.5 *MASEURA / MASYAURA*

Maseura[10] is a protein-rich dried product prepared from paste consisting of black gram as an essential raw material plus other pulses and vegetables in different proportions. It is a good source of protein (from pulses) and fair source of minerals (from vegetables and roots). It is a popular indigenous food of Nepal. The vegetables most often used for the preparation of *maseura* are radish, taro or colocasia (*Colocasia esculanta*), ashgourd, bottleguard, pumpkin and squash.

The word *maseura* is believed to have derived from the word *mashauto*, which means 'lumps of ground soaked pulse'. The combination of ingredients in the hills and the Terai may vary according to the availability of the raw materials, e.g., black gram and colocasia tubers in the hills, and black gram or green gram and ash guard in the Terai. Traditionally, it is prepared during the winter when raw materials are abundant and the days are sunny. It is prepared in several ways in different parts of Nepal and the ingredients used vary from region to region.

Maseura is liked by all classes of people (urban as well as rural) and is used as a side dish (curry). For the same reason, *maseura* is produced at home as well as in semi-commercial scale. For dish preparation, *maseura* alone or in some combination with other items may be used. As a dried product, it can be stored safely for a long period of time without any deterioration in quality.

4.5.1 Preparation of *maseura*

Different formulations can be used for *maseura* preparation but black gram is an essential ingredient. Black gram (*Phaseolus mungo*) protein contains high albumin content, which entrap air easily and has good foaming or whipping property. Black gram paste and colocasia or ashgourd produces the best quality of *maseura*. Since black gram is relatively more expensive, other pulses such as green gram (*Phaseolus aureus*), soybean (*Glycine max* L.) can be mixed with black gram paste along with easily available vegetable grits or pieces. Whatever the formula, black gram proportion should be more than one-third (see Table 4.3).

[10]dried nugget of pulses, esp. black gram plus vegetables grits.

A detailed method of *maseura* preparation is presented in self explanatory flow-chart (Fig. 4.6)

The mixed mass is fermented spontaneously by the natural bacterial flora. It is necessary to thoroughly knead the mash to entrap air and make it easy for regular shaping. Improper kneading results in a hard mass of low bulk density, which is undesirable. The kneaded, viscous paste is dropped in the form of lumps (~ 2 cm dia) by hand on *mandro* (Fig. 5.3) and then sun dried. Later on, the dried *maseura* is scrapped off the mat. The final product is brittle in texture. It is stored in earthenware or other containers and kept over fireplace.

4.5.2 Composition of *maseura*

Composition of *maseura* depends on the raw material used in the preparation. Proximate compositions of three different formulations are given in Table 4.3.

Table 4.3 Proximate composition of *maseura* with three different formulations

	Value (g/100 g)		
Parameter	*Formulation I*	*Formulation II*	*Formulation III*
Moisture	8.5	8.2	7.5
Protein	23.3	22.0	20.8
Fat	3.5	2.4	2.0
Ash	4.3	4.8	4.4
Crude fiber	4.2	5.1	4.2
Carbohydrate	60.3	64.5	68.9

Formulation I: Blackgram, 85% + soybean and colocasia (2:1), 15%.
Formulation: Blackgram + green gram + vegetables (1 : 1 : 1).
Formulation: Black gram + Colocasia (2 : 1).

4.5.3 Characteristics of *maseura*

Maseura is a low-moisture dried product. Low bulk density, porous texture, white color, and regular and uniform shape are some of the important desirable characteristics of a good quality *maseura*. It should have no cracks, should be free from brokens and have good rehydration property.

4.5.4 Preservation and consumption

Maeura is shelf-stable due to lower water activity and packaging. Traditionally, it is packed in earthenware and plugged tightly with cloth rags and stored over fireplace. It remains dry and in good condition for about one year. It can also be packed in polyethylene bags.

It is generally consumed as curry. Being a porous product, it requires less cooking time. It is cooked with tomato, onion, salt, chilli, etc.

Process		*Notes*
Colocasia corm	Black gram	° Take good quality pulses
↓	↓	
Cleaning/washing	Cleaning	° Remove stones, pebbles, mud, etc
↓	↓	
Peeling	Splitting	° Split into halves in *janto*[11] (Fig. 5.3)
↓	↓	
Washing	Soaking	° Soak overnight
↓	↓	
Shredding (1 part)	Rubbing and dehulling	° Rub the soaked mass and remove the floating husk
	↓	
	Draining	
	↓	
→	Grinding (2parts)	° Grind into paste in *janto* or grinder
	↓	
	Mixing	
	↓	
	Holding	° Hold for 4-6 hrs for fermentation at room temperature
	↓	
	Kneading	° Beat or knead thoroughly to entrap air
	↓	
	Shaping	° Make small balls or lumps on *mandro* (Fig. 5.3) or tray
	↓	
	Drying	° Dry in a cabinet dryers at 60°C for 12-15 hr or dry sun dry for 2-3 days
	↓	
	Packing	° Pack in earthernware with tight plug
	↓	
	Storage	° Store over fireplace
		° Stable for a year

Fig. 4.6 Preparation of *maseura*

[11] A hand-operated attrition device carved out of stone slab

4.6 KINEMA

Kinema is a soybean-based, non-salted, fermented traditional food with slimy appearance and slightly alkaline taste. Soybean protein better complements cereals in amino acids composition. It is rich in lysine but deficient in sulfur-containing amino acids (particularly methionine). It is a high-protein food popular among Kirant and Limbu ethnic groups in eastern hills of Nepal, mainly as a seasoning agent. It is also consumed in north-eastern hills of India bordering Nepal and Bhutan. Its origin is not known. It has a revolting odor reminiscent of a putrefied food, particularly to those who are not used to it. For a habitual consumer, however, the same flavor is highly appetizing. It is either eaten fresh or dried for preservation. It is consumed in a variety of ways, such as thick curry, fried snack, soup, and pickle (mixed with onion, chilli, salt, etc). It can also be mixed with other vegetables, *gundruk*, or *sinki*.

The main organism responsible for *kinema* fermentation is *Bacillus subtilis*. It is a non-pathogenic, aerobic, Gram-positive, endospore forming rod having proteolytic and lipolytic abilities. In the traditional method of *kinema* preparation, along with *Bacillus subtilis*, a number of other microorganisms are also involved. *Kinema* resembles other oriental fermented foods like *natto* of Japan, *thua-nao* of Thailand, *tempeh* of Indonesia and *hawaijar* of Manipur (India). *Kinema* has also been prepared in laboratory using pure culture of *B. subtilis* KK2:B10 strain, which is reported to have better sensory qualities than that of traditional one. Researches show that *kinema* has superior nutritional value than the raw or roasted bean counterpart. *Kinema* can be an ideal protein source for the poor in hills who cannot afford the prohibitively expensive animal proteins.

4.6.1 Preparation

Kinema preparation has remained a traditional art and practiced in the homes in crude form. The method of preparation of *kinema* differs from home to home, depending upon the localities, family convenience and materials available. Traditional method of *kinema* preparation is shown in Fig. 4.7.

Kinema preparation involves soaking of soybean, cooking with excess water until the beans split, draining, mixing with firewood ash, and fermentation in bamboo basket lined with leaves of fern (*Athyrium* sp.), banana, or sal (*Sorea robusta*). Fermentation is carried out in a warm place (near fireplace). Ash may not be added in some cases but it is desirable to halt the growth of undesirable microorganisms and to intensify taste. The ash increases pH of soybean, which inhibits the growth of undesirable organisms like fungus while facilitating the growth of *Bacillus*. It will also increase the level of mineral content in the final product. The final product has a sticky/slimy texture, typical musty flavor, and a detectable ammoniacal odor. *Kinema* is considered to be of good quality if long, stringy slimes are formed when beans are pulled apart. After fermentation, fresh

kinema is sun dried and stored for months. Alternatively, the fresh *kinema* can be served as curry or sent for sale.

The traditional method of *kinema* preparation involves a large number of microorganisms besides *Bacillus subtilis*, e.g., *Enterococcus faecium, Candida parapsilosis, Geotrichum candidum*, etc., and many yeasts and molds. Raw material quality, unhygienic method of preparation, minerals used, fermentation condition and poor storage condition increase the possibility of contamination of the product. Due to a large number of variations, traditional method of *kinema* preparation results in rather inconsistent quality.

Process	*Notes*
Soybean	° Choose sound soybeans ° Yellow variety considered better
↓	
Cleaning	° Clean in running water
↓	
Soaking	° Soak overnight in cold water, or 5-6 hrs in hot water
↓	
Dehulling	° Dehul using *okhli* or *dhiki*
↓	
Cooking	° Cook in a pressure cooker for 30 min
↓	
Draining	° Drain excess water
↓	
Cooling	° Cool to ~35°C
↓	
Ash addition	° Add 0.5-1% white firewood ash and mix well
↓	
Wrapping	° Wrap the mass with fern, banana, or sal leaves
↓	
Fermentation	° Keep near the fireplace for 2-3 days
↓	
Fresh *kinema*	
↓	
Sun drying	° Spread on mat until the grains become free-flowing
↓	
Packaging and storage	° Pack in earthenware and place over the fireplace

Fig. 4.7 Traditional method of *kinema* preparation

A better quality *kinema* can be prepared using pure culture technique (Fig. 4.8). Pure culture of *B. subtilis* KK2:B10 strain is used for this purpose. Similar strains of *B. subtilis* can be isolated from fresh *kinema* on nutrient agar (NA) plate and stored in NA slant until used.

4.6.2 Changes during *kinema* fermentation

During *kinema* fermentation, *B. subtilis* produces strong proteolytic enzymes which hydrolyze the protein into peptides, amino acids, ammonia and other flavoring compounds. Proteolysis increases the solubility of protein and improves other functional properties as well. The release of ammonia increases pH from neutral to 8.0. The combined effect of higher pH, ammonia and other metabolites inhibit the growth of other organisms in *kinema*. The fermenting organisms produce sticky mucilaginous gum on the surface of the soybean. These gummy substances are exopolypeptides of D-isomeric glutamic acid. The extent of production mucilaginous gum depends upon the strain of fermenting organism.

Process		*Notes*
B. subtilis (NA slant)	Dehulled soybean	° Clean, sort, heat (80°C/2 hrs), cool, dehull in hammer mill, and remove hull
↓ Transfer to nutrient broth	↓ Soaking and draining	° Soak overnight in cold water, or 5-6 hrs in hot water
↓ Incubate (37°/24hrs)	↓ Cooking	° Cook under pressure at 15 psig for 30 min
↓ Seed culture	↓ Cooling	° Cool to 40°C
→	↓ Inoculation and mixing	° Inoculate pure culture of *B. subtilis* KK2:B110 at the rate of 1-3%
	↓ Packing	° Pack in clean polythene bags containing small holes
	↓ Fermentation	° Keep at 37-40°C, 85% RH for 48 hrs
	↓ Fresh *kinema*	° Can be stored and consumed for a week
	↓ Drying	° Dry in a cabinet dryer at 70°C for 10 hrs or sun dry until 10% moisture content
	↓ Packaging and storage	° Pack in polythene bags and store in a dry and cool place

Fig. 4.8 Improved method of *kinema* preparation by using pure culture

Total sugar and crude fiber reduce while reducing sugar and fatty acids increase. There is significant increase in the level of thiamine, riboflavin, and vitamin B_{12}

during fermentation. Proximate composition, mineral, and amino acid changes during fermentation are summarized in Table 4.4.

4.6.3 Nutritional benefits

Fermentation of soybean is an important processing method for converting less digestible soybean into easily digestible and more nutritious form. During soaking, heat treatment and fermentation, many nutritionally desirable changes occur.

Table 4.4 Proximate, minerals and essential amino acids composition of raw soybean and *kinema* (dry weight basis).

Parameters	Soybean	Kinema
Proximate (g/100 g)		
Moisture	11.9	15.2 ± 1.6
Ash	5.5	6.02 ± 0.31
Lipid	17.0	22.7 ± 2.3
Protein	44.2	47.63 ± 1.94
Carbohydrate [+]	34.0	N.A.
Mineral (mg/100g)		
Potassium	1936	1768 ± 130
Magnesium	240	252 ± 19
Copper	1.31	1.71 ± 0.18
Iron	8.7	17.7 ± 3.7
Manganese	2.7	5.41 ± 1.87
Zinc	3.76	4.52 ± 0.71
Sodium	1.7	27.7 ± 3.71
Phosphorus	721	729 ± 84
Calcium	186	432 ± 98
Amino acids (mg/100g)		
Threonine	1742	1761 ± 110
Valine	2054	2166 ± 192
Methionine	282	393 ± 90
Isoleucine	2099	2157 ± 171
Leucine	3564	3697 ± 222
Phenylalanine	2455	2670 ± 121
Lysine	2751	2951 ± 151
Tryptophan	N.A	N.A.
Histidine*	1012	1016 ± 41

*Essential in infants; N.A = data not available [+]Source: Kawamura (1997)

Soybean is fermented in different ways in different countries, resulting in a variety of food products. Though soybean is rich in protein, its nutritional value is relatively low because of its higher molecular weight and formation of complexes with carbohydrates, phytin, and polyphenols. Carbohydrates in raw soybean are also not easily available due to the presence of oligosaccharides such as raffinose, stachyose and verbiscose. Processing and heat treatment reduces the oligosaccharide and phytin contents to a large extent. In fermentation, proteins and carbohydrates are partially hydrolyzed into smaller units and hence become easily available. As a result of fats hydrolysis, polyunsaturated fatty acids, particularly essential fatty acids, also increase during fermentation. Antinutritional factors such as enzyme inhibitors (inhibitors of trypsin, chymotrypsin and α-amylase), hemagglutinins, goitrogens, cyanogenic glycosides, flatus factors and alkaloids present in raw soybean are greatly reduced during *kinema* preparation. Furthermore, fermentation reduces the bitter taste, accumulates B-complex vitamins (especially vitamin B_{12} and riboflavin), releases bound minerals, reduces cooking time, and adds variety to foods with diverse tastes.

4.7 *YANGBEN*

Yangben is a Limbu term that refers to certain species of lichens (*jhyau* in Nepali) consumed as food by Limbus of eastern hills of Nepal. Some of the common *yangben* used as food are species of *Parmelia*, *Ramalina*, *Cladonia*, and *Usnea*.

Nepal exports about 250 MT of lichens to India annually, 70% of which consists of *Parmelia* species, the rest being *Usnea* species.

The cell wall of lichen contains complex polysaccharides like lichenin, glucan, and isolichenin. Lichens also contain polyols, depsides and depsidones. Depsidone derivatives are responsible for the characteristic bitterness of lichens.

Although lichens are flat-tasting or have an acidic taste, they have plentiful starch-carbohydrate which makes lichen useful for human food. The proximate composition of raw (unprocessed) *yangben* reported by Subba Yashok (2003) is shown in Table 4.5. As can be seen from Table 4.5, the protein and carbohydrate contents are quantitatively similar to those of conventional cereals, viz., rice, maize and wheat. *Yangben* has very high crude fiber content. Crude fiber has no nutritional implications but is an indispensable factor for maintaining healthy bowel function.

Yangben is probably never eaten alone. It is normally served as mixed curry with offal of animals including blood as the complement. *Yangben* curry goes well with alcoholic beverages like *tongba* and *raksi*. It can also be eaten with the main dish.

Table 4.5 Proximate composition (g/100g dry basis) of unprocessed two varieties of *yangben*

Parameter	*Ramalina farinacea*	*Ramalina conduplicans*
Moisture	13.7	11.3
Carbohydrate	70.4	71
Crude protein	9.04	9.4
Crude fat	5.8	5.1
Crude fiber	10.0	11.6
Ash	3.95	2.5

Raw *yangben* is bitter in taste. Traditionally, the bitter principles are removed by boiling *yangben* in 10% wood ash solution in a closed vessel for 20-30 min. The dark gruel that gets extracted is drained away. The alkaline nature of ash probably helps neutralize the bitter principles present in raw *yangben*. Boiling under alkaline condition also helps lighten the color. Later on it is washed, sun-dried, packed and stored. It can be rehydrated before making curry mixture.

Due to use of liberal amounts of firewood ash and consequent inadequate washing, the ash content of *yangben* becomes appreciably higher. In relation to the amount of *yangben* consumed normally, the increased ash levels may not be harmful. However, the sensory and nutritional quality may be affected because of the variation in mineral composition and alkalinity of ash.

Although *yangben* is customarily taken as a delicacy it can also be a good source of income. A small amount of processed *yangben* is occasionally found in market places for sale. The commodity is highly prized by the Limbus. Collection and home processing of *yangben* does not entail full-time involvement. People going to forests for the collection of fodder and firewood, as also cowherds roaming the forest area (or in the vicinity) with their cattle, can readily collect a sizeable amount of *yangben*. *Yangben* collection can therefore be an important side job.

A few studies on *yangben* are available. Those of Dhungana (1985), Subba (1997) and Subba Yashok (2003) have relevance to the food use of *yangben*. Subba Yashok (2003) carried out a comparative study of the efficiency of ash, sodium bicarbonate and calcium carbonate for removing the bitter principles. His finding indicated that sodium bicarbonate can also be used for processing *yangben*. Since the quality of *yangben* can be materially affected by ash (because of variable mineral composition and alkalinity), supplanting it with cheap and readily available sodium bicarbonate can be an attractive proposition.

CHAPTER 5

FERMENTED CEREAL PRODUCTS

Cereals have been used for the production of fermented products from eons past. Most traditional fermented cereals consist of acid- and alcohol type beverages.

5.1 JAND AND RAKSI

Jand is a traditional undistilled alcoholic beverage prepared from starchy raw materials, usually millet (*Eleusine coracana* L), by using locally made starter culture known as *murcha* (Rai, 1991). It is called *jand* by Limbu and Rai, *chhang* by Sherpa and Bhote, and *tongba* by Tibetan. Literally, *tongba* is the name of a container (wooden or aluminum, Fig 5.3) in which the fermented mass is kept and served with the help of bamboo straw. The technology of *jand* and *raksi*, (distilled *jand* that likens whiskey) has existed in Nepal since time immemorial. Although alcoholic beverages are believed to have originated in Egypt and Mesopotamia around 6,000 years ago, no reported data have been found as to when the preparation and consumption of *jand* and *raksi* began. It is usual to use a modifier with the term *jand* to distinguish the source material of *jand*, as is the case with wine. For instance, the terms *kodoko jand* and *bhatte jand*, mean *jand* from finger-millet and rice, respectively.

Raksi is a distilled liquor from *jand*. It is obtained by using a traditional, single column pot distillation. The first two or three fractions of distillate are separated based on alcohol contents and priced accordingly. The spent mass is generally used for pig feeding. *Raksi* from millet is known as pure *raksi*, and in other cases it is designated by the raw materials as in *jand*.

The traditional method of brewing *jand* and distilling *raksi* has been known since antiquity and is indigenous to Nepal. This traditional art is limited to home-brewing scale throughout the country and prepared by almost all ethnic groups. They are also prepared in Bhutan and some parts of India by the resident Nepalese.

5.1.1 Raw materials

All starchy type materials such as millets, wheat, maize, rice or broken rice, barley, potato, sweet potato, etc., and saccharine type materials such as molasses, jaggery and fruits are used in *raksi* preparations. For *jand*, finger millet and broken rice are commonly used. However, finger millet is generally believed to yield *jand* and *raksi* of unmatched quality. However, due to cost constraint, broken rice and jaggery are increasingly becoming the raw materials of choice for *raksi* preparation. Spent millet after *tongba* serving is seldom re-fermented but *raksi* can still be prepared from it. However, village distillers do not feel comfortable with this fact because this practice is not considered clean.

In Nepal the total production of millet was estimated to be 95 metric tonnes in 2000 (Economic Survey, 2002). Millet is mainly used for *jand* and *raksi* preparation because it happens to be one of the lesser preferred foods. However, it bears excellent properties for *jand* making. In particular, millet has better handling characteristics. Besides, it has less protein, which is responsible for cleaner flavor and aroma. It is drought resistant, easily cultivated in less fertile land and pest resistant. Besides cereals, molasses jaggery, some fruits (orange, pear) and flowers of wild plants, mahuwa (*Madhuca indica*) have also been used for *jand* and *raksi* preparation.

5.1.2 Traditional method of *jand* brewing

Although various ethnic groups of Nepal prepare *jand* according to their own method, the basic method of *jand* making has remained more or less unchanged. A very slight variation in *jand* preparation may occur from place to place and people to people depending on raw materials, types of *murcha* chosen and the prevailing climatic conditions. However, the common way of preparation usually adopted by Rai, Limbu, Gurung, Magar, Thakali, Bhotiyas, Tharu and almost all other ethnic groups are related to Mongols. Flow diagram of the traditional method of *jand* brewing from millet is presented in Fig. 5.1.

For *raksi* preparation, the starchy or saccharin type raw materials are fermented following almost the same procedure for *jand*. Broaken rice and jaggery or molasses and their combination are often chosen as raw materials due to their cheaper prices. Besides, jaggery has a very high percentage of readily fermentable sugar. Higher amounts of *murcha* may be used in fermentation for *raksi* preparation. Cereals are cooked, cooled, and mixed with *murcha* and left for 4-5 days. The rice starch is saccharified into simple sugars by molds (present in *murcha*), and the simple sugars in turn is fermented into ethanol by yeasts (also present in *murcha*). The turbid extract (extracted with water) is strained and served as *jand* or distilled to produce *raksi*.

Process	*Notes*
Millet	° Select mature and old (aged) millet
↓ Cleaning	° Remove soil, stone etc.
↓ Pounding	° Outer husk is removed in *dhiki* or *okhali*.
Winnowing	° Loosened husk is removed by winnowing using *nanglo* (Fig 5.3)
↓ Washing with Squeezing	° Put dehusked and cleaned millet into *thunse*[12] or *dalo*[13] (Fig 5.3) and wash in free running water (*dharo*) in villages
↓ Cooking or Steaming	° Cook with just enough water. Alternatively, place millet in an earthen pot with holes at the bottom and steam from another copper vessel placed under it. Bursting a few grains indicate the completion of cooking
↓ Spreading	° Spread on clean *mandro* (Fig 5.3)
↓ Inoculation	° Inoculate with powdered *murcha* while it is tepid warm. Mix the whole mass thoroughly. Little lemon juice may be mixed in the mass.
↓ Primary fermentation	° Fill in banana leaves lined *thunse* and fold and cover the top with the leaves. ° Keep in warm place and allow to remain for 3-6 days. ° Forths start coming out of the chinks of *thunse* ° Liquid oozes out from the *thunse*. ° Pleasant smell develops
↓ Secondary fermentation	° Transfer into cleaned and sun dried earthen jar (*ghyampo*, Fig. 5.3). ° Lid is tightened to make it air-tight
↓ *Jand*	° For soft or sweet *jand*, it required 10-15 days in winter and 8-10 days in summer. ° For strong or bitter *jand*, it can be kept as long as 6 months. ° It is diluted (1 part solid *jand* + 3 parts hot/cold water), strained in a *chhapani* and liquid portion served as *jand*. ° Or, solid *jand* is filled in a cylindrical vessels (generally wooden, or aluminum), hot water poured over it and the extract drawn with the help of straw; called *tongba* serving.

Fig. 5.1 Preparation of *jand* from finger-millet

[12] A conical container made from densely woven bamboo strips (capacity: 30-40kg of cereals).

[13] Basket made out of woven bamboo strips

The traditional method of *raksi* distillation is shown in Fig. 5.2. About 2/3 of the *phonsi* is filled with fermented mash and water is added to cover the mash. *Paini*, *nani* and *bata* are set up as shown in Fig. 5.2. Some time after the fire has been lit, alcohol vapor goes up and gets condensed upon the contact with cooler surface of *bata*. The alcohol condensate then drops inside the *nani*. The alcohol is allowed to condense until the water warms up to ~ 55°C. A change of cold water is necessary at this point. The first change of water is called *ekpanè* and the resulting *raksi*, *ekpanè raksi*. Heating is continued until again another change of water is becomes necessary. This second change is called *duipanè* and the resulting *raksi*, *duipanè raksi*. The water is similarly changed up to the ninth fraction. Alcohol concentration decreases from the first fraction to the next, and the mash is almost exhausted in the ninth fraction. However, these fractions are not collected separately.

Generally, the first-two to first-three fractions are taken out together and referred to as strong, the fourth to sixth as medium, and the seventh and onward as weak in alcohol content. The price of alcohol (*raksi*) is fixed according to the alcohol contents (which ranges from 15 to 55% by volume).

Fig. 5.2 Traditional method of *raksi* preparation

5.1.3 Consumption pattern

Jand is a common drink for Sherpa, Bhote, Rai, Limbu, Magar, Thakali, Newar, Jyapu, Damai, Kami, etc, (collectively called *matwali*, meaning "with tradition of drinking alcoholic beverages"). Now it is getting popular among Brahmin and Chetri also (they are actually forbidden to drink alcoholic beverages by religion). The natives prepare *jand* for themselves. Women, especially in rural areas prepare and sell *jand* in *haat* or *bazzar* (local market). It is an important source of income for them.

The fermented mash, *jand*, is consumed in two different methods. It is squeezed with added water, strained in a traditional bamboo-made *chhapani*[14] (Fig. 5.3) or aluminum strainer, and the whitish cloudy extract thus obtained is served in deep bowls, tumblers or other containers. Alternatively, the fermented mash is put into a wooden or aluminum cylindrical vessels, hot water added over it and the extract sucked with a help of bamboo- or aluminum-made straw. The other end of the straw is perforated just to allow the extract pass through while sucking. The straw is pressed through the *jand* in the vessel up to the bottom to reach extractives. Hot water addition and sucking is continued many times until the extract becomes exhausted. This procedure is properly known as *tongba* serving (Fig. 5.3).

Fig. 5.3 Tools/equipment used in traditional food preparation

[14] Strainer made of bamboo strips

5.1.4 Cultural significance

Jand and *raksi* are consumed by more than 60 ethnic groups of Nepal. Although Brahmin and Chettri are prohibited to drink alcohol by Hindu religion, it is now becoming popular among all male adults. Children are forbidden to drink alcohol; nevertheless, the poor of hills do not mind drinking, even by schoolchildren and pregnant women. For *matwali* (people with the tradition of drinking alcohol), such as Limbu, Rai, Sherpa, Newar, Bhote etc.), the tradition of consuming *jand* and *raksi* pervades their life, right from the birth to death. *Jand* in rural hills is used for refreshing people paying visit to their hosts, for paying homage to their ancestors, and for appeasing deities. *Jand* and *raksi* are indispensable items in feasts, festivals, marriage ceremony, dispute settlement, and ritual performances of all ethnic groups. For settling marriages in various ethnic groups, the prospective groom approaches the would-be bride's party with filled-up *tongba* and *raksi*. Accepting the *tongba* and *raksi* is a blue sign for marriage settlement. Drinking *jand* and *raksi* is intimately related to the unique and rich culture of tribal people in all parts of Nepal.

5.1.5 Nutritional significance

Nutritional value of *jand* is not reported so far. It is an instant energy giving and stimulating drink. Millet can best be utilized by brewing *jand* because no other easily acceptable food products can be prepared from it. Since *jand* is unrefined, besides ethanol it also contains simple protein or amino acids, sugar, soluble crude fiber, vitamins, and minerals. Millet vitamins (thiamin, niacin, riboflavin) and minerals (iron, calcium) are extracted in *jand* and some vitamins are also synthesized as in other fermentation. It is, therefore, in cold hills, a moderate drinking of *jand* along with other foods has a positive effect on their health. On the other hand, *raksi* is considered an empty stimulator. Excess drinking of *raksi* not only leads to poor health but may also be the cause of social misdemeanor. Often, people succumb to premature death due to excess consumption *raksi* and inadequate intake of nutritious foods. Poverty, ignorance, poor sanitation, and lack of clean drinking water and health care services further aggravate the problem.

5.1.6 Quality of *jand* and *raksi*, and legal aspects

The traditional method of *jand* and *raksi* preparation is similar throughout the country. The code of practice for the preparation of *jand* and distilling *raksi* is so followed that no casualty due to faulty fermentation are recorded until now. However, the traditional method of distillation fails to rectify ethanol. In traditional method no attempt is made to discard or separate lower and higher alcohols that cause more negative health impact than ethanol does. Generally in *raksi* distillation, two or occasionally three fractions are separated for pricing purposes. No attempt is rendered to improve the traditional method of brewing *jand* and distilling *raksi* in Nepal. Nepal has banned to prepare *jand* and *raksi* for

commercial purposes. If it is to be prepared in large quantities for marriage or any ritual gatherings, permission is required.

5.2 MURCHA (STARTER CULTURE)

Murcha, yeast cake, is a locally made special fermenting agent extensively used in Nepal, Bhutan and some parts of India (especially in Darjeeling district). In its traditional preparation, a number of wild plants serve as the source of valuable microflora. It is a source of mixed culture consisting of saccharifying molds, fermenting yeasts, and bacteria. *Saccharomyces cerevisiaae*, *Rhizopus* sp., *Endomycopsis fibuligera*, *Pediococcus pentosaceus* and *Lactobacillus plantarum* are the microflora identified in *murcha*. Besides, yeast belonging to genera *Saccharomycopsis*, *Pichia* and molds of genera *Rhizopus* and *Mucor* are also reported. Rice, wheat or millet have been used for the preparation of *murcha*. Traditional method of *murcha* making is shown in Fig. 5.4.

Fig. 5.4 Preparation of amylolytic of starter cultures

Manapu preparation in Luvu VDC of Lalitpur district is very famous and is kept secret in the family. It is interesting that the father teaches the art of *manapu* preparation only to son and daughter-in-law but not to daughter. In this way they keep this secret and hand it on from generation to generation. *Mana* from wheat is not as common as *manapu*. In hills and mountains it is called *murcha*. The basic principle of *murcha* preparation is almost similar to *manapu* except that a number of different plants and their mixture are used in the former, and generally dried on fern leaves. The preparations of *mana* and *manapu* are given in Fig. 5.4. *Murcha* makers in village do not want to disclose the exact recipe or formulation because they want to keep it a trade-secret.

A number of wild plants that serve as the source of valuable microflora have been used for the preparation of *murcha*. Hilly people are aware of those plants which can produce good *murcha*. The choice of these plants depends on their availability. *Murcha* plants and non-*murcha* plants may be classified by hit and trial method and the practice has been handed on from one generation to the next until now. A complete list of wild plants used by different ethnic or tribal groups at different altitudes of Nepal is not currently available. However, K.C. *et al.*, (2001) reported a list of wild plants used in *murcha* making in the Eastern Nepal. They identified 38 plants (out of 42) and reported their uses by 16 ethnic groups. *Vernonia cinerea* (local name, *Phulunge*), *Clematis grewiaeflora* (*Mahagagro*), *Piper chaba* (*Chabo*), *P. longum* (*Pipla*), and *Plumbago zeylanica* (*Chitu*) are some of the wild plants extensively used for *murcha* preparation.

CHAPTER 6

MISCELLANEOUS PRODUCTS

Nepal has a rich traditional food heritage. Over the years, several traditional food practices have evolved and been exchanged across the country and also across the borders. This gradual exchange overtime has sometimes led to confusion regarding the origin of these foods. There are many food types which have not received attention in the scientific community despite their popularity. As a result, the contributions (socio-economic, religious, nutritional, and cultural) of these foods have largely gone unnoticed.

In this chapter, brief descriptions of some of such foods will be made.

6.1 MOMO

Momo, which is basically a meat-filled steamed dumpling, is thought to have originated in Tibet. These days, it very popular in Nepal, especially in the urban areas. There are two basic types of *momo*, viz., ball type (commonly referred to as *momocha*), and crescent type (referred to as *momo*). Preparation of *momo* requires some maneuvering, especially in the packaging part. First of all meat (pork, chicken, chicken, or buffalo meat) is comminuted to prepare what is called *keema*. *Keema* is then seasoned with finely chopped garlic, onion, ginger, salt, and other optional ingredients to taste. A very elastic wheat flour dough is prepared separately. The dough is divided into small balls and rolled out with a pinion into thin circular discs. Requisite amounts of seasoned *keema* are placed in the center of the discs and the edges are folded over to affect sealing. The sealing is achieved by pinching the edges skillfully with fingers. A multichambered steaming pan called *moktu*, Fig. 6.1) is required for cooking *momo*. The pan consists of a large bottom section for generating steam (contains water or dilute soup), several shallow false floors (with several smalls holes at the bottom) in between (to receive *momo* for steaming), and a snugly fitting lid. The false floors are greased with edible oil before raw *momo* is neatly laid on it. The greasing is necessary to prevent *momo* from sticking on the floor during steaming. Several false floors (usually 2-4) are filled with *momo* and stacked. The assembly is finally placed

over the steam vessel. The lid is put on and steaming carried out for 15-20 min or until the *momo* is cooked.

The delicacy can be served with soup, pickle, or sauce.

These days, vegetarians have evolved a new variant of *momo* called "vegetable *momo*". The meat part of the *keema* is replaced here by shredded cabbage or cauliflower. A small amount of oil is also used to imitate meat fat.

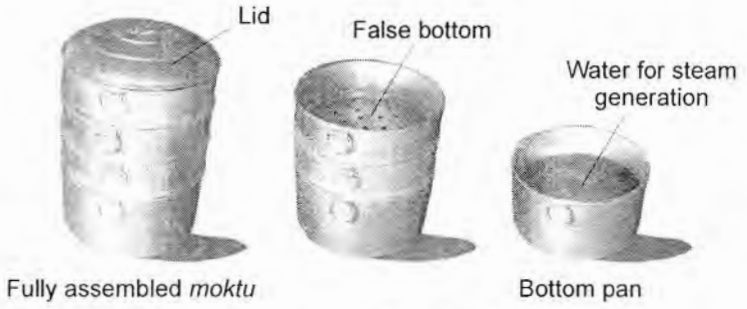


Fig. 6.1 *Moktu* for cooking *momo*

6.2 TARUWA

Taruwa is a maithili word, meaning frying. *Taruwa* is prepared by deep-frying thin slices of vegetable after heavily coating them with rice flour paste. The commonly used vegetables for *taruwa* preparation are potato, brinjal (eggplant), cauliflower, etc. A flow diagram of the basic steps of *taruwa* preparation is given in Fig. 6.2.

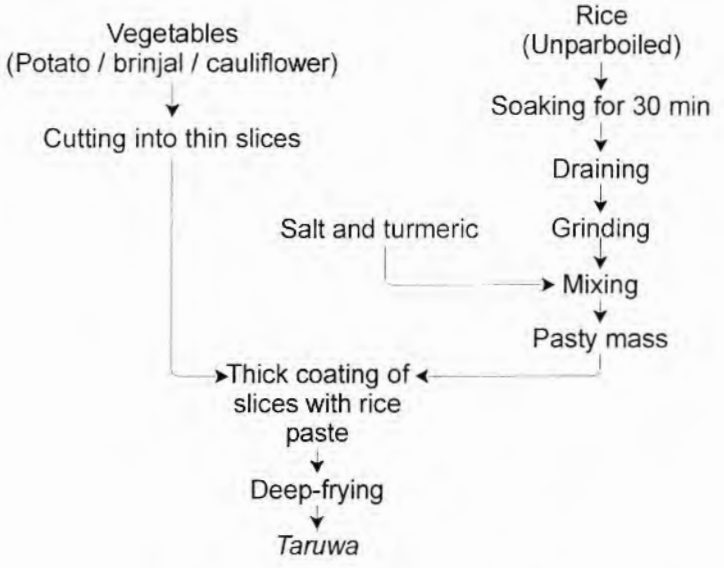


Fig. 6.2 Preparation of *taruwa*

6.3 BARI

It is an indigenous Maithili food very popular in the Terai regions. *Bari* is prepared on the auspicious occasion of *Baisakh* 1st (New Year in Nepal). *Bari* is prepared from different materials (which is also the basis for classification) but *chana bari* (*bari* made from chickpea). An outline of the method of *bari* preparation is given in Fig. 6.3.

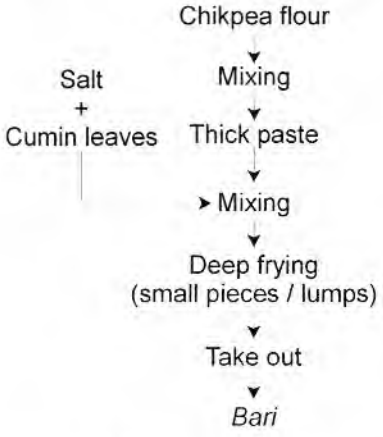


Fig. 6.3 Preparation of *bari*

6.4 SATTU

Sattu is the name given to ready-to-eat flour obtained from roasted chickpea (*chana*). It is popular all over Nepal but in the Maithili community is has a special meaning. *Sattu* is consumed on the occasion of *Baisakh* 1st in Maithili community. The general method of *sattu* production is given in Fig. 6.4.

Fig. 6.4 Preparation of *sattu*

In the summer season, a slurry (in water) of *sattu* is drunk to cool off. It is also consumed by people suffering from acidity. Drinking of *sattu* with lemon and salt in regularly in the morning is believed to reduce body fat. Because of the proven medicinal value, *sattu* is commercially marketed nowadays. Often, the product comes blended with cumin powder (which is beneficial in acidity and peptic ulcer). *Sattu* is also a very good source of protein (about 22%). Because chickpea is relatively more expensive, some people tend to adulterate *sattu* with flour obtained from cheaper grams, e.g., *khesari* (grass pea).

6.5 AMAT

The word 'amat' is derived from "aam", which means mango. *Amat* is prepared from mango pulp. It is also known as "mango leather" in common English. Different varieties of mango can be used for amat preparation but the best amat can be prepared from *Maldah* and *Bombay* variety of mangoes. *Amat* is produced and sold in commercial quantities in the Terai belts of Nepal, border regions in particular.

Typically, mango leather preparation begins with the selection of overripe mangoes. These are peeled, pulped, and spread on a bamboo mat or aluminum tray. Alternatively, a clean piece of cotton cloth can also be used. The whole is allowed to concentrate spontaneously by sun drying. The whole process may take 8-10 days, and, depending on the drying condition, pulp can be added on to the drying leather 2-3 times. After about 10 days, the leather with be ready to be taken out from the cotton cloth (or tray). The leather, which is still pliable, is cut into desired sizes. The pieces are then swabbed with mustard oil and then stored in dry condition.

Some researches are available regarding the improvement in quality of amat. Some workers suggest adjustment of sugar content by external addition of table sugar; some suggest addition of citric acid, while some suggest use of preservatives for increasing the shelf life, which is normally about 1 year.

6.6 KHAJURI

Khajuri is a Maithili sweetmeat. It is prepared on the auspicious occasion of *Ganesh Chaturthi* or *Chaudchan* (a religious festival) in the month of *Bhadra* (July). But *khajuri* is also eaten on other days. This is in fact one of the most widely sold sweetmeats in the market. The product is energy dense because of fat, sugar and *maida* (wheat flour).

The preparation of *khajuri* is relatively simple and an outline of the same is given in Fig.6.5.

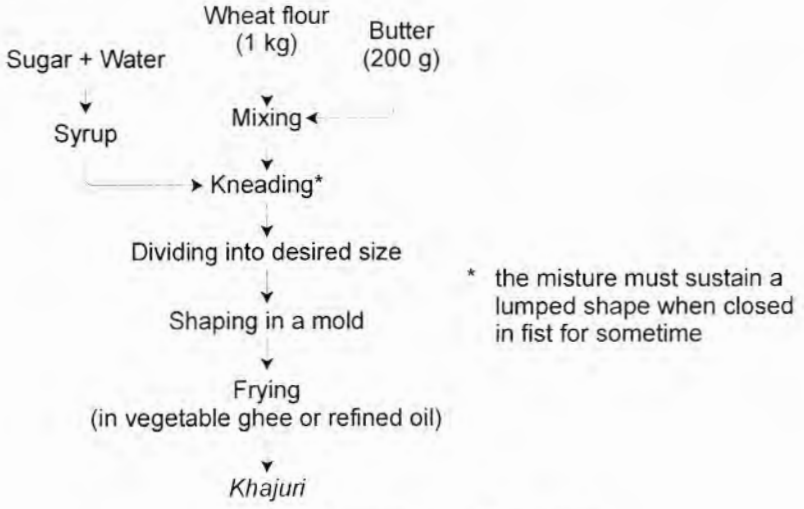


Fig. 6.5 Preparation of *khajuri*

6.7 THEKUWA

Thekuwa is a religious food prepared on the occasion of Chhath (a religious puja) in the month of *Kartik* (October-November). *Chhath* is mainly celebrated in the Hindu religion in the worship of the God sun. It is believed that sun is the main source of energy. It is also believed that all types of skin diseases can be prevented by appeasing the sun with offerings and prayers. The general method of *thekuwa* preparation is given in Fig. 6.6. *Thekuwa* sweet in taste and has a biscuit-like appearance. However, it does not have the 'short' characteristics of a biscuit.

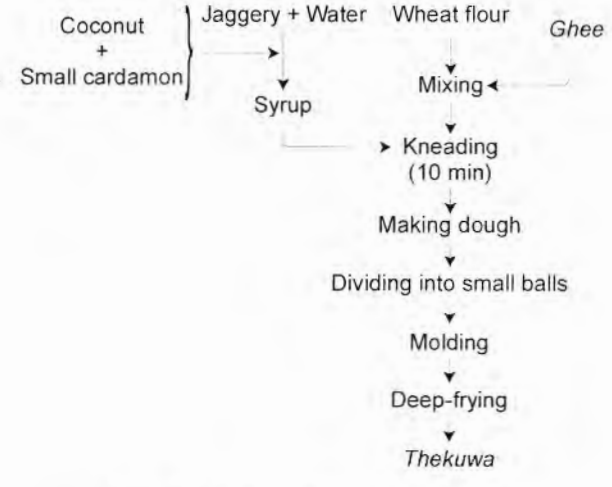


Fig. 6.6 Preparation of *thekuwa*

6.8 KUMBHARAURI

It is prepared from *kumbhar* (ash gourd) and hence is known as *kumbharauri*. It is a vegetable product which can be eaten in rainy season when all the vegetables have high price. The method of preparation is given in Fig. 6.7.

Fig. 6.7 Preparation of *kumbharauri*

BIBLIOGRAPHY

Aidoo, K. E. (1992). Lesser-known Fermented Plant Foods. In: Application of Biotechnology to Traditional Fermented Foods. Report of an Ad Hoc Panel of the Board on Science and Technology for International Development (BOSTID), (e-book), National Academy Press, Washington, D.C.

Aidoo, K. E., Nout, M. J. R. and Sarkar, P. K. (2005). Occurrence and Function of Yeast in Asian Indigenous Fermented Foods: A Mini-review. FEMS Yeast Res. **6(2006)**: 30-39

Bhandari, S. (1997). Comparative Study on Raksi Production from Different Raw Materials Using *Murcha* and Pure Culture. B. Tech. (Food) Dissertation. Tribhuvan Univ., Nepal, p 36

Dahal, N. R., Karki, T.B, Swamilingappa, Li, Q., and Gu, G. (2005). Traditional Foods and Beverages of Nepal – A Review. Food Reviews International **21**: 12-16

Dhungana, K. P. (1985). Study on the Food Values of Lichens (*Jhyau*) of Species *Cladonia* and *Usnea* found in Dhankuta District of Dandabazar Village Panchayat. B. Tech. (Food) Dissertation. Tribhuvan Univ., Nepal, pp. 12-35

Gajurel, C. and Baidya, K. (1979m). Yeast: *Mana* and *Manapu* Technology. In: Traditional Technology of Nepal (in Nepalese). Tribhuvan Univ., Nepal, pp 191-95

Gautam, G. (1987). Efficiency of Ethanol Production by *Murcha* Yeast. B. Tech. (Food) Dissertation. Tribhuvan Univ., Nepal, p 44

Haard, N. F. (1999). Cereals: Rationale for Fermentation. In: Fermented Cereals, a Global Perspective. FAO Agriculture Services Bulletin No. 138 (e-book)

Hesseltine, C. W. (1979). Some Important Fermented Foods of Mid-Asia, the Middle East and Africa. J. American Oil Chem. Soc. **56**:367-74.

Karki, T. B. (1986). *Murcha*. In: A Concise Handbook of Indigenous Fermented Foods in the ASCA Countries. Saono S., Hull R., Dhamcharee, D. (eds). The Govt. of Australia, Canberra, p 136

KC, J. B., Subba, D. K. and Rai, B. K. (2001). Plants used in *Murcha* Preparation in Eastern Nepal. J Hill Res Sikkim Sci Soc. **14(2)**: 107-109

Lee, C. H. (1999). Cereal Fermentations in Countries of the Asia-Pacific Region. In: Fermented Cereals, a Global Perspective. FAO Agriculture Services Bulletin No. 138 (e-book)

Rai, B. K. (1991). Preparation and Quality Evaluation of *Jand* from Malted and Non-malted Millet (*kodo*) by using *A. oryzae* and *S. sake*. B. Tech. (Food) Dissertation. Tribhuvan Univ., Nepal, p 11

Rai, B. K. and Subba D. K. (2003). Screening of Fermentative Yeasts from *Murcha* Plants and Assessment of their Brewing Value. J. Food Sci. Technol. **40(4)**: 382-385

Rai, B. K., Subba, D. K., Limbu, K. P. and Maden, K. (2006). Some Indigenous Limbu Foods of Dhankuta (district), Terhathum (district) and Dharan (municipality, Sunsari district). J. Food. Sci. Technol. Nepal (JFSTN). **2**: 1-8

Rajbhandari, D. (2005). Process Time Determination for Strained *jand*. B. Tech. (Food) Dissertation. Tribhuvan Univ., Nepal, p 22

Shrestha, B. (1985). Studies on *Rukhsi* [sic] Production from Rice by Traditional Method. B. Tech. (Food) Dissertation. Tribhuvan Univ., Nepal, p 44

Shrestha, H., Nand, K. and Rati, E.R. (2002). Microbiological Profile of *Murcha* Starters and Physico-chemical Characteristics of Poko, a Rice based Traditional Fermented Food Product of Nepal. Food Biotech. **16(1)**: 1

Steinkraus, K. H. (1996). Handbook of Indigenous Fermented Foods. 2nd edn., Marcel Dekker, New York.

Steinkraus, K. H. (1997). Classification of Fermented Foods: Worldwide Review of Household Fermentation Techniques. Food Control. **8(5/6)**: 311-17

Subba, C. (1985). *Raksi* Production from Finger-millet (kodo) by Traditional Method. B. Tech. (Food) Dissertation. Tribhuvan Univ., Nepal, p 28

Subba Yashok, G. (2003). Evaluation of Nutritive Value and Processing Effect on Nutrients of *Yangben* (Edible Lichen). B. Tech. (Food) Dissertation. Tribhuvan Univ., Nepal, pp. 22-30

Subba, R. (1997). Evaluation of Nutritive Value of (Edible Lichen) and Effects of Processing on its Nutrients. B. Tech. (Food) Dissertation. Tribhuvan Univ., Nepal, pp. 22-26

Tamang, J .P. and Sarkar, P. K. (1988). Traditional Fermented Foods and Beverages of Darjeeling and Sikkim – A Review. *J. Sci. Food Agric.* **44**: 375-85

Tamang, J. P. and Sarkar P. K. (1995). Microflora of *Murcha*: An amylolytic Fermentation Starter. Microbios. **81(327)**: 115-22

Yadav, B. K. (1993). Study on some Physicochemical Indices of Locally Produced *Rakshi* Quality. B. Tech. (Food) Dissertation. Tribhuvan Univ., Nepal

APPENDIX-1 LIST OF COMMON VEGETABLES AND FRUITS

I. VEGETABLES

1. Root vegetables

Common name	*Latin name*	*Nepali name*
Beet	*Beta vulgaris*	Chukandar
Carrot	*Daucus carota*	Ganjar
Chayote root	*Sechium edule*	Iskush
Parsley	*Petroselium crispum*	Jwanu
Radish	*Raphanus sativa*	Mula
Swede turnip	*Brassica napus* var. *nepobrassica*	---
Turnip	*B. campestris* var. *rapifera*	Salgam
Viper's grass	*Scorzonera hispanica*	---

2. Tuberous vegetables

Arrowroot	*Tacca leontopetaloides*	---
Cassava (manioc, tapioca)	*Manihot esculenta*	Simal tarul
Celery tuber	*Apium graveolens*	---
Kohlrabi	*Brassica caulorapa*	---
Potato	*Solanum tuberosum*	Alu
Sweet potato	*Ipomoea batatas*	Suthuni
Taro (elephant ear tuber)	*Colocasia esculenta*	Pidalu
Yam	*Dioscorea batatas*	Tarul

3. Bulbous- root vegetables

Garlic	*Allium sativum*	Lasun
Leek	*Allium ampeloprasum*	---
Onion	*Allium cepa*	Pyaj
Vegetable fennel	*Foeniculum vulgare*	---

4. Stem (shoot) vegetables

Asparagus	*Asparagus officinalis*	Kurilo
Bamboo shoot	*Bambusa vulgaris*	Tama
Chayote (choko) shoots	*Sechium edule*	Iskushko munta
Pumpkin shoots	*Cucurbita moschata*	Pharsiko munta

5. Leafy (stalk) vegetables

Amaranth	*Amaranthus dubius*	Latte saag
Celery	*Apium graveolens*	---
Rhubarb	*Rheum rhaponti*	---

6. Leafy vegetables

Black mustard leaves	*Brassica juncea*	Toriko saag
Brussels sprouts	*B. oleracea*	Bunda gobi
Chinese cabbage	*B. pekinensis*	Chiniya saag
Chinese cabbage (petchay)	*B. chinensis*	---
Chinese chive	*Allium tuberosum*	Dunduko saag
Cress	*Lepidium sativum*	Chamsur saag
Endive (chicory)	*Cichorium intybus* var. *foliosum*	---
Garden cress	*Lipidium sativum*	---
Globe artichoke	*Cynara scolymus*	---
Goosefoot	*Chenopodium album*	Bethuko saag
Jerusalem artichoke	*Helianthus tuberosum*	---
Kale (borecole)	*Brassica oleracea* var *sabellica*	
Knol knoll	*B. oleracea (*var *gongylodes)*	Gyanth gobhi
Lamb's salad (lettuce)	*Valerianella locusta*	---
Lettuce	*Lactuca sativa*	Jiriko saag
Parsnip	*Pastinaca sativa*	Gujur
Pigweed	*Amaranthus viridis*	Latte saag
Red cabbage	*Brassica oleracea* var. *f. rubra*	---
Savory cabbage	*B. oleracea var. sabauda*	---
Spinach	*Spinacia oleracea*	Palak
Sting nettle	*Urtica dioica*	Sisnu
Watercress	*Nasturtium officinale*	Simsaag
White (common) cabbage	*B. oleracea* var. *capitata*	---
Winter endive	*Cichoricum endivia*	---

7. Flowerhead (calyx) vegetables

Artichoke	*Cynara scolymus*	
Bauhinia (white)	*Bauhinia variegate*	Koiralo
Broccoli	*Brassica oleracea*	Kauli
Cauliflower	*Brassica oleracea* var. *botrytis*	Kobi

8. Seed and fruity vegetables

Bitter gourd	*Momordica charantia*	Karela
Bottle gourd	*Lagenaria leucanth*	Lauka
Chestnut	*Castanea sativa*	---
Chilli	*Capsicum annuum*	Khorsani
Corn (maize), sweet	*Zea mays*	Makai
Cucumber	*Cucumis sativus*	Kankra
Drum stick	*Moringa oleifera*	Sajiun
Egg plant (brinjal)	*Solanum melongena*	Baigun
Garden bell pepper	*Capsicum annuum*	---

Garden squash	*Cucurbita pepo*	---
Green beans	*Phaseolus vulgaris*	---
Ivy gourd	*Coccinia grandis*	Gol kankri
Jackfruit	*Artocarpus heterophyllus*	Rukh katahar
Okra	*Hibiscus esculentus*	Bhindi
Pointed gourd	*Trochosanthes dioica*	Parwal
Snake gourd	*Trichosanthes anguina*	Chichindo
Sponge gourd	*Luffa cylindrica*	Ghiraula
Squash	*Curcurbita maxima*	---
Tamarillo (tree tomato)	*Cyphomandra betacea*	---
Tomato	*Lycopersicon lycopersicum*	Tamatar
Tree tomato	*Cyphomumdra betacea*	Tymtor
White flower gourd	*Lagenaria siceraria*	Lauka
Zucchini	*Cucurbita pepo*	----

9. Mushroom

Cep	*Xerocomus badius*	---
Chanterelle	*Cantharellus cibarius*	---
Edible boletus	*Boletus edulis*	---
Field champignon	*Agaricus compester*	Chyau
Field mushroom	*Agaricus bisporus*	Gobre chyau
Garden champignon	*A. horttensis*	---
Morel	*Morchella esculenta*	---
Ringed boletus	*Suillus luteus*	Chyau
Saffron milk cap	*Lactarius deliciosus*	---
Truffle	*Tuber melanosporum*	---

10. Algae (seaweed)

---	*Geumelatum belochan*	---
Porphyra	*Porphyra* sp	Nori (Japan)
Sea lettuce	*Ulva lactuca*	---
Sweet tangle	*Laminaria sp.*	Combu (Japan)
Undaria	*Undaria pinnatifida*	Wakami (Japan)

II FRUITS

1. Pomme fruits

Apple	*Malus sylvestris*	Syau
Pear	*Pyrus communis*	Naspati
Quince	*Cydonia oblonga*	---

2. Stone fruits

Apricot	*Prunus armeniaca*	Khurpaani
Peach	*Prunus persica*	Dhusure aaru
Plum/prune	*Prunus domestica*	Aaru bakhada

Pomegranate	*Punica granatum*	Anaar
Sour cherry	*Prunus cerasus*	Cheri
Sweet cherry	*Prunus avium*	Gilaas

3. Berry fruits

Bilberry	*Vaccinium myrtillus*	---
Black currant	*Ribes nigrum*	---
Blackberry	*Rubus fruticosus*	---
Cranberry	*Vaccinium vitis-idaea*	---
Fig (Eve's apron)	*Ficus auriculata*	Nebhaaro
Gooseberry	*Ribes uva-crispa*	---
Grapes	*Vitis vinifera*	Angur
Raspberry	*Rubus ellepticus*	Ainselu
Red currant	*Ribes rubrum*	---
Strawberry	*Fragaria vesca*	---

4. Citrus fruits

Citron	*Citrus medica*	Bimiro
Grapefruits	*Citrus paradesi*	Sankatro
Kumquat	*Fortunella margarita*	---
Kumquat	*Fortunella japonica*	Muntola
Lemon	*Citrus limon*	Nibua
Lime	*Citrus aurantifolia*	Kaagati
Mandarin	*Citrus reticulata*	---
Orange	*Citrus sinensis*	---
Papaya	*Carica papaya*	Mewa
Pear-shaped pomelo	*Citrus grandis*	Bhogate
Pomelo	*Citrus maxima*	---
Rough lemon	*Citrus jambhiri*	Naite jyamir
Seville orange	*Citrus aurantium*	Kali jyamir
Sweet lime	*Citrus limettioides*	Chaaksi
Sweet orange	*Citrus sinensis*	Junaar
Sweet orange (Mozambique orange)	*Citrus sinensis*	Mausambi

5. Other fruits

Acerola	*Malpighia emarginata*	---
Avocado	*Persea americana*	Ramphal
Banana	*Musa* sp	Kera
Cantaloupes	*Cucumis melo*	---
Cherimoya	*Annona cherimola*	---
Date	*Phoenix dactylifera*	Khajur
Golden shower	*Cassia fistula*	---
Guava	*Psidium guajava*	Amba
Indian fig	*Opuntia ficus-indica*	---

Jackfruit	*Artocarpus heterophyllus*	Rukh takahar
Kiwi fruit	*Actinidia chinensis*	Kiwi
Litchi	*Litchi chinensis*	Lychee
Loquat	*Eriobotrya japonica*	---
Mango	*Magnifera indica*	Aanp
Mangosteen	*Garcinia mangostana*	---
Nectarine	*Prunus persica*	---
Papaya	*Carica papaya*	Mewa
Passion fruits	*Passiflora edulis*	---
Persimmon	*Diospyros kaki*	Haluwabed
Pineapple	*Ananas comosus*	Anarus
Pomegranate	*Punica granatum*	Anaar
Rambutan	*Nephelium lappaceum*	---
Watermelon	*Cirtrullus lanatus*	Kharbuja

6. Wild fruits

Apricot	*Prunus armeniaca*	Khurpani
Bael fruit	*Aegle marmelos*	Bel
Banyan fruit	*Ficus benghalensis*	Bar
Black mulberry	*Morus nigra*	Kalo kimbu
Carambola	*Averrhoa carambola*	---
Elderberry	*Sambucus nigra*	---
Emblic/Indian gooseberry	*Phyllanthus emblica*	Amla
Indian blackberry	*Syzygium cumini*	Jamun
Indian gooseberry	*Phyllanthus fraternus*	Bhui amala
Indian plum	*Zizyphus mauritiana*	Bayar
Jack fruit	*Artocarpus heterophyllus*	Rukh katahar
Local mulberry	*Morus bombycis*	Kimbu
Nepal fodder fig	*Ficus semicordata*	Khanyu
Nepalese hog plum	*Choerospondias axillaries*	Lapsi
Oriental cashewnut	*Semecarpus anacardium*	Bhalayo
Rambutan	*Nephelium lappaceum*	---
Rose hips	*Rosa* sp.	---
Seabuck thorn	*Hippophae rhamnoides*	Daali chook
Sumac	*Rhus javanica*	Bhakimlo
Tamarind	*Tamarindus indica*	Titiri
Wild date palm	*Phoenix sylvestris*	Khajur
Wild Korean mulberry	*Morus serrata*	Kali kaphal

7. Legumes

Black gram	*Phaseolus mungo*	Maas
Broad beans	*Vicia faba*	Bakula
Chick peas/gram	*Cicer arietinum*	Chana
Cow pea	*Vigna unguiculata*	Bodi

Green gram	*Phaseolus aureus*	Mung
Horse gram	*Dolichos uniflorus*	Gahat
Kidney bean	*Phaseolus vulgaris*	Dale simi
Lablab bean	*Dolichos lablab*	Sibi
Lentils	*Lens culinaris*	Musur
Lima beans	*Phaseolus lunatus*	---
Peas	*Pisum sativum*	Kerau
Pigeon pea	*Cajanus cajan*	Rahar
Rice bean	*Phaseolus calcaratus*	Masyang
Runner beans	*Phaseolus cocineus*	---
Soya beans	*Glycine max*	Bhatmas

8. Oilseed

---	*Craniotome furcata*	Batule silam
Leaf rape	*Brassica rapa*	Kalo sarsyu
Niger seed	*Guizotia oleifera*	Philinge
Wild perilla	*Perilla frutescens*	Silaam

9. Shell (nut) fruits

Almond	*Prunus amygdalus*	Badam
Butter fruit	*Bassia butyracea*	Chiuri
Cashew nut	*Anacardium occidentale*	Kaju
Nepal chestnut	*Castanopsis indica*	Dale katus
Peanut/groundnut	*Arachis hypogaea*	Badam
Walnut	*Juglans regia*	Hade okhar

10. Spices and drink, color

---	*Zanthoxylum aromatum*	Timur
---	---	Jimbu
Aniseed	*Foeniculum vulgare*	Saunf
Asafetida	*Ferula asafoetida*	Hing
Betel	*Piper betle*	Supari
Bird pepper	*Capsicum microcarpum*	Jire khursani
Catechu	*Acacia catechu*	Kattha
Cinnamon bark	*Cinnam,omun zeylanicum*	Dalchini
Clove	*syzypgium aromaticum*	Lwang
Coriander	*Coriandrum sativum*	Dhaniya
Cumin	*Cuminum cyminum*	Jira
Fennel	*Foeniculum vulgare*	Madesi sounf
Fenugreek seeds	*Trigonella foenum-graecum*	Methi
Garden cress	*Lepidium sativum*	Chamsur
Ginger	*Zingiber officinale*	Aduwa
Japanese pepper	*Zanthoxylum oxyphyllum*	Boke timur
Large cardamom	*Amomum subulatum*	Alainchi
Liquorice	*Glycyrrhiza glabra*	Jethimadhu

Love-in-a-mist	*Nigella sativa*	Kaljira
Neal aromatic leaf garlic	*Allium hyposistum*	Jimbu
Nutmeg	*Myristica fragrans*	Jaiphal
Parsley	*Petroselinum crispum*	Jwano
Safflower	*Carthamus tinctorius*	Kusum
Small cardamom	*Elettaria cardamomum*	Sukumel
Tea	*Camellia sinensis*	Chiya
Turmeric	*Curcuma domestica*	Hardi

APPENDIX-2 FOOD COMPOSITION TABLE

NUTRIENT CONTENT OF NEPALESE FOODS, HMG-N (2043)
CEREAL AND CEREAL PRODUCTS

Common name	*Edible part, %*	*Moisture, g*	*Protein, g*	*Fat, g*	*Ash, g*	*Fiber, g*	*Carb, g*	*Energy, kcal*	*Ca, mg*	*P, mg*	*Fe, mg*
Bajra	84	12.4	11.6	5	2.3	1.2	67.5	361	42	296	5
Barley	100	12.5	11.5	1.3	1.2	3.9	69.6	336	26	215	3
Buck wheat	74	11.3	10.3	2.4	2.3	8.6	65.1	323	64	355	15.5
Foxtail millet	79	11.2	12.3	4.3	3.3	8	60.9	331	31	290	12.9
Jowar	100	11.9	10.4	1.9	1.6	1.6	72.6	349	25	222	5.8
Maize, dry	100	14.9	9.1	3.6	1.5	2.7	66.2	342	10	348	2
Maize flour, white	100	12	9.2	3.9	1.2	1.6	73.7	355	20	255	2.4
Maize flour, yellow	100	12	9.2	3.9	1.2	1.6	73.7	355	20	256	2.4
Maize, granular	100	12	9	3.4	1.1	1	74.5	362	17	223	1.8
Maize, tender	37	67.1	4.7	0.9	0.8	1.9	24.6	125	9	121	1.1
Oatmeal	100	10.7	13.6	7.6	1.8	3.5	62.8	374	50	380	3.8
French millet	59	11.9	12.5	1.1	1.9	2.2	70.4	341	14	206	5
Ragi (finger millet)	100	13.1	7.3	1.3	2.7	3.6	72	328	344	283	6.4
Rice, parboiled, pounded	100	12.6	8.5	0.6	0.9	--	77.4	349	10	280	2.8
Rice, parboiled, parboiled	100	13.3	6.4	0.4	0.7	0.2	79	346	9	143	4
Rice, hand-pounded	100	13.3	7.5	1	0.9	0.6	76.7	346	10	190	3.2
Rice, raw, milled	100	13.7	6.8	0.5	0.6	0.2	78.2	345	10	160	3.1
Rice, flakes	100	12.2	6.6	1.2	2	0.7	77.3	346	20	238	20
Rice, puffed	100	14.7	7.5	0.1	3.8	0.3	73.6	325	23	150	6.6
Rice bran	--	11	13.5	16.2	6.6	4.3	48.4	393	67	1410	3.5

Continued...

Common name	Edible part, %	Moisture, g	Protein, g	Fat, g	Ash, g	Fiber, g	Carb, g	Energy, kcal	Ca, mg	P, mg	Fe, mg
Semolina	100	--	10.4	0.8	--	0.2	74.8	348	16	102	1.6
Sorghum milled	--	14.3	7.6	2.4	1	0.6	74.7	357	17	196	3.6
Uwa, white	100	10.9	12.61	1.6	2.1	2.3	70.5	346	25	--	4.12
Uwa, black	100	12.1	10.39	1.75	2.33	2.51	70.9	340	20.3	--	7.48
Vermicelli	100	11.7	8.7	0.4	0.7	0.2	78.3	352	22	92	2
Wheat flour, whole	100	12.2	12.1	1.7	2.7	1.9	69.4	341	48	355	11.5
Wheat flour, refined	100	13.3	11	0.9	0.6	0.3	73.9	348	23	121	2.5
Wheat germ	100	5.2	29.2	7.4	3.5	1.4	53.3	397	40	846	6
Wheat bran	--	11.9	14.6	3	4.5	6.8	66	207	132	975	13.8
Biscuits, salty	100	4.5	6.6	32.4	1.9	--	54.6	534	--	--	--
Biscuit, sweet	100	5.4	6.4	15.2	1.1	--	71.9	450	--	--	--
Bread, brown	100	39	8.8	1.4	--	1.2	49	244	18	--	2.2
Bread, white	100	39	7.8	0.7	--	0.2	51.9	245	11	--	1.1
Papad	100	20.3	18.8	0.3	8.2	--	52.4	288	80	300	17.2

Values are per 100g edible portion

NUTRIENT CONTENT OF NEPALESE FOODS, HMG-N (2043)
VEGETABLES (NATIVE)

Common name	Edible part, %	Moisture, g	Protein, g	Fat, g	Ash, g	Fiber, g	Carb, g	Energy, kcal	Ca, mg
Armale	--	93	2	traces	1.5	1.4	2.1	16.4	20.5
Asparagus	--	92.9	2.1	0.3	0.7	0.9	3.8	27	22.5
Bander bheti	51.48	56.2	2.4	0.2	0.7	3.1	27.3	320	45.1
Bandari sag	--	90	3.5	0.3	1.3	0.8	4.3	33	89
Bantarul	--	76.2	1.7	0	3.1	1.3	17.7	77	43
Betha sag	--	78	7.1	traces	3.6	2	8.8	64	400
Bhringraj	--	84.9	3.1	0.8	2.7	1.7	6.7	46	224
Chamsur jhar	--	86.6	3.6	0.6	2.3	1.2	5.7	43	382
Chinia	--	81.5	6.1	traces	2.2	1.5	8.7	59	--

Continued...

Common name	Edible part, %	Moisture, g	Protein, g	Fat, g	Ash, g	Fiber, g	Carb, g	Energy, kcal	Ca, mg
Chitlang sag	--	87.5	2.4	0.2	2	1.1	6.7	38	105
Chutro	--	72	2.5	6.9	1	1.4	16.2	87	--
Damaiphal	--	85	0.5	0.3	0.8	1.7	11.5	51	60
Frase tarul	--	75	1.6	traces	0.7	1.5	21	91	--
Gande	--	82	2.1	0.3	2	2.5	11	55	--
Ghod tapre	--	79	3	0.2	1.5	2.6	13.6	68	20505
Ginare, dried	--	7.2	22	traces	21.1	12	37.7	238	2032.4
Githa	74	1.5	0.1	0.8	1.3	22	96	--	--
Guyenlo	--	68	4.6	0.7	1	7.8	17.9	96	70.2
Halhale sag	--	90	3.1	0.3	1.3	1.3	3.8	31	76.6
Jamun	--	87	4	traces	1.6	1.4	6	40	--
Kali kath	--	65.4	1.5	0.7	1.1	5.7	25.4	114	95.1
Kali mayal	--	69	0.7	traces	0.7	8.3	21.3	89	--
Kamal phal	100	81.7	1.8	0.3	1	4.7	10.3	51	21.1
Kane sag	--	91	2.3	0.1	1.6	1.7	3.2	23	86
Kavro	--	69	2.8	traces	0.8	1.6	25.8	114	--
Khaneo	100	85.1	1.4	0.3	1.3	6.1	5.6	31	180.7
Koiralo	--	84.3	1	3.4	2	0.8	8.1	54	75.9
Kukur diano	--	93	1.6	traces	0.6	0.8	2.8	17	20.1
Latte sag, green stem	--	78	6.4	traces	3	1.2	11.4	71	--
Latte sag, red stem	--	81	4.4	traces	2.9	2.4	9.3	48	--
Lude sag	--	83.9	4.7	0.2	2.8	1.1	7.1	49	406.1
Malsahare	--	80	3.3	0.05	0.9	1.6	14.1	70	--
Mayal	--	79.8	0.4	0.2	0.4	2.9	16.2	68	--
Neuro (niguro)	--	88	4.4	0.2	1.3	1.8	4.2	36	30
Phaphar sag	--	90	3.9	0.1	1.9	1	3.8	12	--
Pidale	--	93	2.2	0.1	1.5	0.8	2.4	19	--
Pudina	--	87	4.5	0.1	1.9	1.8	4.6	38	--
Rato tarul	--	74	1.9	traces	0.7	0.2	2.3	100	--
Sati bayer	--	52.5	2.8	0.1	2	10	32.2	142	170.5
Sisnu	--	81.7	6.9	0.5	4.2	1.4	5	53	981.3

Continued...

Common name	Edible part, %	Moisture, g	Protein, g	Fat, g	Ash, g	Fiber, g	Carb, g	Energy, kcal	Ca, mg
Siplicane	--	84	6.3	0.2	1.9	1.8	5.8	50	196
Tarul githa	--	76	2.2	traces	0.9	1.8	19	85	--
Tarul munta	--	89	2.8	0.05	1.1	1.6	5	33	--
Theki phal	--	88.3	0.5	0.1	0.9	2.4	7.5	33	35.1
Thutne	--	91	1.5	traces	0.8	0.9	5.8	29	21.8
Timila, pakche	--	88	1.1	0.3	0.7	2.7	7.2	37	--
Timila, wakche	--	88	1	0.4	0.8	1.6	7.4	37	--
Vyakur	--	77	1.6	traces	0.6	--	--	--	--
Vyakur githa	--	80.7	2	0.05	0.9	1.8	14	66	--
Vyakur jhutre	--	78	1.5	traces	0.8	1.7	18	78	--

Values are per 100g edible portion

NUTRIENT CONTENT OF NEPALESE FOODS, HMG-N (2043)
MEAT, FISH AND EGG

Common name	Edible part, %	Moisture, g	Protein, g	Fat, g	Ash, g	Fiber, g	Carb, g	Energy, kcal	Ca, mg	P, mg	Fe, mg
Buffalo meat	--	78.7	19.4	0.9	1	--	--	86	3	189	--
Duck meat	--	72.3	21.6	4.8	1.2	--	0.1	130	4	235	--
Egg, duck	--	71	13.5	13.5	1	--	0.8	181	70	260	3
Egg, hen	--	73.7	13.3	13.3	1	--	--	173	60	220	2.1
Field rat's meat	--	73.9	23.6	1	1.4	--	0.1	104	30	242	--
Finch	--	68.8	26.6	3	1.7	--	--	133	90	347	--
Goat meat	--	74.2	21.4	3.6	1.1	--	--	118	12	193	--
Goat liver	--	76.3	20	3	1.3	--	--	107	17	279	--
Mutton, muscle	--	71.5	18.5	13.3	1.3	--	--	194	150	150	2.5
Pigeon	--	70.4	23.3	4.9	1.4	--	--	137	12	290	--
Pork, muscle	--	77.4	18.7	4.4	1	--	--	114	30	200	2.2
Snail, small	--	78.9	12.6	1	3.8	--	3.7	74	1321	147	--
Snail, big	--	74.1	10.5	0.6	2.4	--	12.4	97	870	116	--

Continued...

Common name	*Edible part, %*	*Moisture, g*	*Protein, g*	*Fat, g*	*Ash, g*	*Fiber, g*	*Carb, g*	*Energy, kcal*	*Ca, mg*	*P, mg*	*Fe, mg*
Turtle	--	79.4	16.5	1.5	1.1	--	1.5	86	7	162	--
Venison	--	75.3	21	0.6	1.2	--	1.9	97	3	233	--
Chicken	--	66	20.2	12.6	1	--	--	195	--	--	--
Bam fish	--	74.8	16.1	0.9	1.3	--	6.9	100	330	240	0.8
Crab, small	--	65.3	11.2	9.8	4.6	--	9.1	169	1606	253	--
Hilsa fish	--	53.7	21.8	19.4	2.2	--	2.9	273	180	280	2.1
Katla fish	--	73.7	19.5	2.4	1.5	--	2.9	111	530	235	0.9
Koi fish	--	70	14.8	8.8	2	--	4.4	156	410	390	1.4
Mungri fish	--	78.5	15	1	1.3	--	4.2	86	210	290	0.7
Prawn	45	77.4	19.1	1	1.7	--	0.8	89	323	278	5.3
Rahu fish	78	76.7	16.7	1.4	0.9	--	4.4	97	650	175	1
Singhi fish	--	68	22.8	0.6	1.7	--	6.9	124	670	650	2.3
Tengra fish, fresh	--	70	19.2	6.4	2.1	--	2.3	144	270	170	2

SUGAR AND SUGAR PRODUCTS

Product	*Edible part, %*	*Moisture, g*	*Protein, g*	*Fat, g*	*Ash, g*	*Fiber, g*	*Carb, g*	*Energy, kcal*	*Ca, mg*	*P, mg*	*Fe, mg*
Cane sugar	100	0.4	0.1	0	0.1	0	99.4	398	12	1	--
Honey	--	20.6	0.3	0	0.2	--	79.5	319	5	16	0.9
Sugarcane juice	--	90.2	0.1	0.2	0.4	--	9.1	39	10	10	1.1
Jaggery (cane)	--	3.9	0.4	0.1	0.6	--	95	383	80	40	11.4

SOME INDIGENOUS FOODS

Food	*Edible part, %*	*Moist, g*	*Prot, g*	*Fat, g*	*Ash, g*	*Fiber, g*	*Carb, g*	*Energy, kcal*	*Ca, mg*	*P, mg*	*Fe, mg*
Areca nut	--	31.3	4.9	4.4	1	11.2	47.2	249	50	130	1.5
Betel leaves	--	85.4	3.1	0.8	2.3	2.3	6.1	44	230	40	7
Coconut, tender	--	90.8	0.9	1.4	0.6	--	6.3	41	10	30	0.9
Coconut water	100	93.8	1.4	0.1	0.3	0	4.4	24	24	10	0.1

Continued...

Food	*Edible part, %*	*Moist, g*	*Prot, g*	*Fat, g*	*Ash, g*	*Fiber, g*	*Carb, g*	*Energy, kcal*	*Ca, mg*	*P, mg*	*Fe, mg*
Groundnut cake	--	7.2	10.9	7.4	2.5	3.2	38.8	386	213	548	--
Gundruk, mustard leaves	--	11.8	--	--	--	--	--	--	2458	--	94.3
Pumpkin seeds	70	8	24.3	47.2	4.7	0.2	15.6	584	50	830	5.5
Masyaura	--	9.1	21.2	4.1	--	--	--	--	478.1	--	44.9
Mushroom	88	88.5	4.6	0.8	1.4	0.4	4.3	43	6	110	1.5

Values are per 100g edible portion

NUTRIENT CONTENT OF NEPALESE FOODS, HMG-N (2043)
OTHER VEGETABLES, ROOTS AND TUBERS

Common name	*Edible part, %*	*Moist, g*	*Prot, g*	*Fat, g*	*Ash, g*	*Fiber, g*	*Carb, g*	*Energy, kcal*	*Ca, mg*	*P, mg*	*Fe, mg*
Agathi flower	--	92.9	1	0.5	0.4	0.8	4.4	26	9	5	--
Ashgourd	67	96.5	0.4	0.1	0.3	0.8	1.9	10	30	20	0.8
Bittergourd	97	92.5	1.6	0.2	0.8	0.8	4.2	25	20	70	1.8
Bottle gourd	86	96.1	0.2	0.1	0.5	0.6	2.5	12	20	10	0.7
Brinjal	91	92.7	1.4	0.3	0.3	1.3	4	24	18	47	0.9
Broad beans	88	85.4	4.5	0.1	0.8	2	7.2	48	50	64	1.4
Cauliflower	70	90.8	2.6	0.4	1	1.2	4	30	33	57	1.5
Celery stalks	--	93.5	0.8	0.1	0.9	1.2	3.5	18	30	38	4.8
Cho-cho marrow	--	92.5	0.7	0.1	0.4	0.6	5.7	27	140	30	0.6
Cluster beans	--	81	3.2	0.4	1.4	3.2	10.8	60	130	57	4.5
Colocasia stems	86	94	0.3	0.3	1.2	0.6	3.6	18	60	20	0.5
Cowpea pods	--	85.3	3.5	0.2	0.9	2	8.1	43	72	59	2.5
Cucumber	83	96.3	0.4	0.1	0.3	0.4	2.5	13	10	25	1.5
Double beans	--	73.8	8.3	0.3	1	4.3	12.3	85	40	140	2.3
Drumstick	83	86.9	2.5	0.1	2	4.8	3.7	26	30	110	5.3

Continued...

Common name	*Edible part, %*	*Moist, g*	*Prot, g*	*Fat, g*	*Ash, g*	*Fiber, g*	*Carb, g*	*Energy, kcal*	*Ca, mg*	*P, mg*	*Fe, mg*
Drumstick flowers	--	85.9	3.6	0.8	1.3	1.3	7.1	50	51	90	--
Field beans, tender	93	86.1	3.8	0.7	0.9	1.8	6.7	48	210	68	1.7
French beans	94	91.3	1.7	0.1	0.5	1.8	4.5	26	50	28	1.7
Giant chillies (capsicum)	94	91.3	1.7	0.1	0.5	1.8	4.5	26	50	28	1.7
Jack, tender	--	84	2.6	0.3	0.9	2.8	9.4	51	30	40	1.7
Karonda, fresh (natal palm)	98	91	1.1	2.9	0.6	1.5	2.9	42	21	28	--
Ol-k	74	92.7	1.1	0.2	0.7	1.5	3.8	21	20	35	0.4
Ladies finger	84	89.6	1.9	0.2	0.7	1.2	6.4	35	66	56	1.5
Lakooch, raw	--	89.4	1.6	1.2	1.1	2.8	13.9	73	67	25	--
Leeks	--	78.9	1.8	0.1	0.7	1.3	17.2	77	50	70	2.3
Lotus stem, dry	100	9.5	4.1	1.3	8.7	2.5	51.4	234	405	128	60.6
Mango, green	72	87.5	0.7	0.1	0.4	1.2	10.1	44	10	19	5.4
Onion stalks	100	87.6	0.9	0.2	0.8	1.6	8.9	41	50	50	7.4
Papaya, green	--	92	0.7	0.2	0.5	0.9	5.7	27	28	40	0.9
Parwar	95	92	2	0.3	0.5	3	2.2	20	30	40	1.7
Peas	53	72.1	7.2	0.1	0.8	4	15.9	93	20	139	1.5
Pink beans	94	86.8	3.1	0.4	0.6	2.1	7	44	54	70	1.5
Plantain flower	43	89.9	1.7	0.7	1.3	1.3	5.1	34	32	42	1.6
Plantain stem	--	88.3	0.5	0.1	0.6	0.8	9.7	4.2	10	10	1.1
Pumpkin	79	92.6	1.4	0.1	0.6	0.7	4.6	25	10	30	0.7
Pumpkin flowers	--	89.1	2.2	0.8	1.4	0.7	5.8	39	120	60	--
Rape plant, stem	--	91.4	3.1	0.1	1.4	--	4	29	100	100	1.2
Red gram, tender	72	65.1	9.8	1	1	6.2	16.9	116	57	164	1.1
Ridge gourd	82	95.2	0.5	0.1	0.3	0.5	3.4	17	18	26	0.5
Sannhemp flowers	--	78.9	4.8	0.6	1.4	3.9	10.4	66	200	100	--

Continued...

Common name	*Edible part, %*	*Moist, g*	*Prot, g*	*Fat, g*	*Ash, g*	*Fiber, g*	*Carb, g*	*Energy, kcal*	*Ca, mg*	*P, mg*	*Fe, mg*
Silk cotton flowers	--	86.4	1.5	0.3	0.7	1.6	9.5	47	22	45	--
Snake gourd	98	94.6	0.5	0.3	0.5	0.8	3.3	18	26	20	0.3
Spinach stalks	--	93.4	0.9	0.1	1.8	--	3.8	20	90	20	1.6
Sword beans	98	87.2	2.7	0.2	0.6	1.5	7.8	44	60	40	2
Tinda, tender	99	93.5	1.4	0.2	0.5	1	3.4	21	25	24	0.9
Tomato, green	98	93.1	1.9	0.1	0.6	0.7	3.6	23	20	36	1.8
Vegetable marrow	94	94.8	0.5	0.1	0.3	0.8	3.5	17	10	30	0.6
Water chestnut, dry	38	70	4.7	0.3	1.1	0.6	23.3	115	20	150	0.8
Water lily flower	--	90.8	1.6	0.6	0.7	0.9	5.4	33	29	18	--
Banana rhizome	35	85.1	0.4	0.2	1.4	1.1	11.8	51	25	10	1.1
Beet root	85	87.7	1.7	0.1	0.8	0.9	8.8	43	18	55	1
Carrot	95	86	0.9	0.2	1.1	1.2	10.6	48	80	530	2.2
Colocasia	--	73.1	3	0.1	1.7	1	21.1	97	40	140	1.7
Garlic, dry	85	62	6	0.1	1	0.8	29.8	145	30	310	1.3
Ghartarul	100	58.61	4.07	0.07	2.06	2.56	32.6	147	69.8	--	24.03
Githa	66	68.31	3.72	0.94	0.93	0.91	25.19	124	12.41	--	0.95
Lotus root	--	85.9	1.7	0.1	0.2	0.8	11.3	53	21	74	0.4
Mango ginger	87	85	1.1	0.7	1.4	1.3	10.5	53	25	90	2.6
Onion big	95	86.6	1.2	0.1	0.4	0.6	11.1	50	47	50	0.7
Onion small	--	84.3	1.8	0.1	0.6	0.6	12.6	59	40	60	1.2
Potato	85	74.4	1.6	0.1	0.6	0.4	22.6	97	10	40	0.7
Potato, boiled, without skin	--	81	1.9	0.1	0.7	0.3	16.3	72	7	44	0.8
Potato chips, fried	--	4.2	3.6	4.38	2.5	0.9	45.9	562	18	74	1.6
Radish, pink	98	90.8	0.6	0.3	0.9	0.6	6.8	32	50	20	0.5
Radish rat-tailed	--	92.3	1.3	0.3	0.7	1.1	4.3	25	78	24	--

Continued...

Common name	*Edible part, %*	*Moist, g*	*Prot, g*	*Fat, g*	*Ash, g*	*Fiber, g*	*Carb, g*	*Energy, kcal*	*Ca, mg*	*P, mg*	*Fe, mg*
Radish, white	99	94.4	0.7	0.1	0.6	0.8	3.4	17	35	22	0.4
Rani bhyakur	78	72.72	2.29	0.16	1.41	0.7	22.71	101	24.71	--	8.38
Sweet potato	97	68.5	1.2	0.3	1	0.8	28.2	120	46	50	0.8
Sweet potato, boiled	--	70.7	1	0.1	0.8	0.6	27.4	114	36	56	0.9
Turnip	65	91.6	0.5	0.2	0.6	0.9	6.2	29	30	40	0.4
Yam elephant	--	75.7	1.2	0.01	0.8	0.8	18.4	79	50	34	0.16
Yam, wild	89	70.4	2.5	0.3	1.4	1	24.4	110	20	74	1

Values are per 100g edible portion

INDEX