BUTTER AND GHEE

PRACTICAL ACTION
Technology challenging poverty

technical brief

Introduction

There are four types of butter that can be made from fresh or fermented milk, from cream, or from the whey that remains after cheese making (Table 1). Butters are made by separating the fat in milk. They contain more than 80% fat with a small amount of water dispersed through the fat as tiny droplets, which are so small that the butter looks dry. Butters have a pale yellow/cream colour, and a smooth consistency so that they spread easily and melt in the mouth. They are used as spreads, for cooking, or as bakery ingredients. Heat is used to destroy food poisoning bacteria and most spoilage bacteria. The heat also inactivates some of the enzymes in the cream. Secondary preservation is due to the low moisture content, by keeping the butter cool and packaging it so that it cannot become recontaminated by dirt, insects or micro-organisms. This also slows the development of rancidity.

Ghee is a golden oil or fat (depending on the room temperature), made from cow's or buffalo milk. It has a high demand in some countries as domestic cooking oil and as an ingredient for bakeries. It is made by heating cream to boil off the water and then filtering out the solidified proteins. Ghee is preserved by a combination of heat, which destroys enzymes and contaminating micro-organisms, and by removing water from the oil to prevent micro-organisms growing during storage. It has a long shelf life if it is stored in a cool place, using airtight, lightproof and moisture-proof containers to slow down the development of rancidity. Further details of the principles of preservation are given in Technical Brief: *Dairy Processing - an overview,* which is intended to be read alongside this Technical Brief.

Type of butter	Description
Lactic (or 'cultured') butter	Made from soured milk or cream, may be salted or unsalted. Slightly acid taste
Fresh (or 'sweet') butter	Made from cream, may be salted or unsalted, mild creamy flavour
Ghee	A clear golden brown oil with a characteristic flavour of milk fat, made by heating cream to remove the moisture and filtering out the solids.
Whey butter	Made from whey separated from curd during cheese making. It is strong tasting with a slight cheesy and slightly acidic flavour. It can taste salty if salt is added to the cheese before the whey is drained off. It is less shiny than fresh butter, more oily, and with a deeper yellow colour.

Table 1: Types of butter (Adapted from *Dairy Science and Technology Education*).

Most butters contain about 16% water, and any contaminating micro-organisms are found in the water droplets. When salted butter is made, the salt (1-2%) dissolves in the water droplets, so the effective salt concentration is approximately 10% in the water. It acts as a preservative to improve the shelf life by suppressing the growth of any micro-organisms that are present, and also improves the flavour.

Methods of processing

Fresh milk is first separated into skim milk and cream and the cream is then used to make fresh butter or ghee. These processes are described in more detail below. To make lactic butter, milk is fermented to yoghurt (see Technical Brief: *Soured milk and yoghurt*), and this is then churned as for fresh butter. Whey has a butterfat content of 3.5 - 8.75%, depending on the type of cheese being made (see Technical Brief: *Cheesemaking*). It may also contain residual starter culture from the cheese whey. The process is similar to that used to make fresh butter.

Practical Action, The Schumacher Centre for Technology & Development
Bourton Hall, Bourton-on-Dunsmore, Rugby, Warwickshire CV23 9QZ, UK
Tel: +44 (0)1926 634400 Fax: +44 (0)1926 634401 E-mail: infoserv@practicalaction.org.uk Web: www.practicalaction.org

Fresh butter
The process is described in Figure 1 below.

Stage in process	Optional	Notes
Cooled and filtered raw milk		Milk with a high fat content (Table 2) gives a higher butter yield. Technical Brief: *Dairy processing - an overview* gives details of raw milk quality.
Separate		Pre-heat milk to 36-40°C. Separate into skim milk and cream using an electric or manual cream separator (Fig. 2).
Pasteurise		Heat the cream to at least 63°C for 30 minutes (or 72°C for 15 seconds) in a stainless steel pan. For improved keeping quality of the butter, it is advisable to exceed this minimum heat treatment (e.g. 75°C for one minute). Start timing when the cream reaches the correct temperature and continually stir to ensure even heating and prevent over-heating at the bottom of the pan that would change the flavour of the cream. At a larger scale of production a jacketed pan may be used, which reduces the risk of overheating (see Technical Brief: *Pasteurised Milk* for details).
Chill		To below 4°C for several hours (or overnight) to 'age' the cream. This allows the fat to partly crystallise, which helps the churning process and improves the butter yield.
Churn		In a butter churn. Small butter churns (Fig. 3) have a paddle that is rotated either manually or using an electric motor. At a larger scale, a drum churn (Fig. 4) is rotated to churn the cream. Fill the churn to 40-50% of capacity to allow space for the cream to foam. Churn at 25-35 rpm for 5 minutes. Stop the churn and release the gases that are produced. Churn again at 25-35 rpm for 20-45 minutes. The cream gets thicker and it then 'breaks' to form 'grains' of butter and buttermilk. Churn until butter grains stick together into large lumps. Keep the temperature as low as possible during churning. If the temperature is too high, there are greater losses of fat into the buttermilk. Churning at low temperatures makes the fat droplets in cream join together.
Separate		Drain off the buttermilk. It is either used as a drink or fed to animals.
Wash		Add the same amount of chilled or cold water as the amount of buttermilk removed (water should be drinking quality). Churn at 10-15 rpm for 5 minutes. Drain the water and rotate the churn at 10-15 rpm for 10-20 minutes. Remove the butter.
	Salt	For salted butter, add salt (1-2% of butter weight) with continued slow churning to achieve even salt distribution.
Work/ Mould		Work the butter to the required consistency with butter pats (Fig. 5). Mould it into solid blocks with the butter pats or press it into butter moulds that can have different shapes (Fig. 6), especially for use in hotels or restaurants.
Pack/Store		Into greaseproof paper, aluminium foil, or plastic bags or tubs (usually 200 - 500 g) for retail sale. Small plastic single-serve portion pots (10–15 g) of butter are another type of product that is supplied to airlines and hotels in some countries. Store below 4°C in a refrigerator.

Figure 1: Processing fresh and salted butter (From *Opportunities in Dairy Processing*)

technical brief

Figure 2: A Cream separator. Photo: Courtesy of Lehman's.

Animal	Fat (%)
Buffalo	7.4
Camel	5.4
Cow	3.7
Goat	4.2
Horse	1.6
Llama	3.2
Sheep	7.9
Yak	8.0

Table 2: Fat content of milk from different types of animals. From: Opportunities in Dairy Processing.

Figure 3a: Small butter churn. Photo: Peter Fellows.

Figure 3b: Small butter churn. Photo: Courtesy of Selam Technical & Vocational College.

Figure 4: Large butter churn. Photo: Courtesy of Jaya Industries.

Figure 5: Butter pats. Photo: Peter Fellows.

Lactic butter

Fresh whole milk is pasteurised (see Technical Brief: *Pasteurisation of milk*) and cooled before adding a starter culture and fermenting it to make yoghurt (see Technical Brief: *Soured milk and yoghurt*). The yoghurt is chilled for several hours and then churned as for fresh butter. Lactic butter is salted and packaged in the same way as fresh butter. Traditional lactic butters are more acidic than products from commercial dairy plants, but may be preferred by people in some countries because of their pronounced flavour. They can be made more easily than fresh butter at a micro- or small-scale because they do not require the use of a cream separator. In some areas, the fermentation is done in containers that are coated inside with wood smoke to disinfect them. The wood smoke imparts a characteristic flavour to the butter and the buttermilk.

Figure 6: Silicone butter mould. Photo: Courtesy of La Prima shops.

Ghee

The processing method is:

1. Pre-heat fresh, filtered cow's or buffalo milk in a stainless steel pan (or less desirably an aluminium pan) to 36-40 °C (to optimise the efficiency of the cream separator).
2. Separate preheated milk into cream and skim milk using a cream separator. (Traditionally cream is not separated and whole milk is boiled and cooled several times and the fatty scum is skimmed off).
3. Boil the cream in the pan and stir continuously until the milk proteins start to coagulate and the cream changes from white to golden brown. The end point of the boiling stage is shown by the correct colour of the ghee. There is no simple test for this and it is judged by experience.
4. Leave the product to cool and allow particles to settle at the bottom of the pan.
5. Filter the oil carefully using cheesecloth so that it is clear without any particles. Filter cloths should be boiled each day and thoroughly cleaned of particles to avoid contaminating the ghee.
6. Pack the oil. Metal (tinplated steel) cans are normally used. Iron or copper (brass) containers should not be used because they accelerate the development of rancidity. Alternatives include ceramic pots sealed with cork/plastic stoppers, or airtight coloured plastic or glass bottles or jars. All containers should be thoroughly cleaned, especially if they are reused.
7. Store at room temperature away from heat and sunlight. The shelf life can exceed 12 months with correct packaging and storage conditions

Quality assurance

The quality of milk and the processing conditions that are used to make butter or ghee should be standardised so that consistent quality products are made each time. This involves control of factors in the process that affect the quality or safety of the product. These are known as 'control points' and are the points at which checks and measurements should be made.

HACCP[1]

The specific potential hazards in making butter or ghee are food poisoning bacteria from the raw milk, poor hygiene and sanitation during processing, and incorrect processing conditions. Other hazards that are common to all types of food processing (including contamination of foods by insects, glass etc.) are prevented by correct quality assurance, including the design and operation of the processing facilities, staff training in hygiene and production methods, and correct cleaning and maintenance procedures.

[1] Hazard Analysis Critical Control Point

Hygiene
Technical Brief: *Dairy processing - an overview* gives details of hygiene and sanitation, the methods needed to ensure that good quality milk is used, the design of a dairy and the use of correct cleaning procedures. Hygiene requirements are also described in Technical Brief: *Hygiene and safety rules in food processing.*

Avoiding spoilage
The main cause of spoilage of butter and ghee is rancidity, and this is prevented by packaging and storage control (below). Unclean equipment, contaminated milk, poor hygiene by production staff, and incorrect processing and storage conditions will each also cause spoilage. All equipment should be thoroughly cleaned after use and checked before production starts again. The temperature and time of heating the cream should be monitored and controlled to ensure that it is not over- or under-heated. For lactic butter, the temperature and time of incubation should be monitored and controlled to ensure that the fermentation takes place correctly.

Raw material control
The milk used for butter and ghee production should be fresh, good quality and free from dirt and excessive contamination by bacteria, so that it will not clot or curdle during processing. Older milk can impart an unpleasant flavour to the final product. The fat content of cream can be tested using the 'Gerber' method with a 'cream buytrometer'. However, the cost of analytical equipment and the expertise required to do the test are likely to be greater than small-scale butter makers can afford. If a producer wishes to know the fat content of cream, the test can be done at a Bureau of Standards or a university Food Science Department.

Process control
A process control schedule should be prepared for each product. Table 3 is an example of a process control schedule for fresh butter production. If a refrigerator or chilled water is not available, it is possible to make butter but there may be the following problems:

- If the cream is not allowed to age at a low temperature, the milk fat does not develop the crystalline structure needed for good separation into butter and buttermilk.
- A higher temperature during churning reduces the butter yield, because some of the butterfat liquefies, and is lost with the buttermilk.
- The water used for washing butter should be cold to prevent it melting the butter. It must also be of drinking quality or else it will contaminate the butter and reduce its shelf life. Any food poisoning bacteria in the water will be transferred to the butter (although they are killed if salt is added to the butter).
- The shelf life of butter is reduced if it is stored without refrigeration. At refrigeration temperatures, butter will keep for many months, but at ambient tropical temperatures rancid odours may develop after a few days. However, in many countries, a slightly rancid flavour in butter is acceptable. In some countries an anti-oxidant such as BHA or BHT[2] may be permitted by law to prevent rancidity. However, butter is not usually stored for long periods and these chemicals may not be readily available, may be expensive, and are not needed.

Stage in process	Activity	Process control points
Pre-heating/ milk separation	Warm milk before passing through a cream separator	Check the temperature is at 36-40°C during pre-heating to optimize the efficiency of the separator. If the milk is too hot, the milk fat will be difficult to separate and the yield of cream will be reduced.
Pasteurise cream	Heat cream to destroy micro-organisms and enzymes.	Check the temperature and time (e.g. 75°C +/- 2°C for 1 minute)

[2] Butylated Hydroxy Anisole and Butylated Hydroxy Toluene

Chill	To age the cream	Temperature control at 6°C +/- 2°C. If the milk is too hot the milk fat will be difficult to separate and the yield of butter will be reduced.
Churn	To produce butter	Check speed of churn, time of churning (see text for details)
Wash	To remove buttermilk	Number of washings, check the temperature of water and ensure it is drinking quality (have it tested at a laboratory)
Salting, working	Adding salt for salted butter and working the butter	Check the amount of salt added. Check the time of working to ensure that salt is evenly distributed through the butter and it has uniform consistency
Pack	In greaseproof paper, foil or plastic wrapper, plastic pots with clip-on or foil lids.	Check the weight (e.g. 200g +/- 2 g net weight)
Label	Attach label or print on the wrapper	Check that correct labels are used, that they are correctly positioned, and show the correct 'best before' date (e.g. 9 months from date of production) and production batch number.
Store	Hold at 4-8°C in a refrigerator	Check refrigerator temperature is 6°C +/- 2°C

Table 3: Process control points in fresh butter production.

Product control
The main quality factors for butters are colour, texture, flavour and odour. For ghee they are colour, clarity, flavour and odour. In butters, correct colour is due to control over heating, texture is controlled by the extent to which cream is cooled, by the temperature when working the butter, and temperature of storage. At higher temperatures the fat softens and results in a soft, greasy butter, whereas butter from cooled milk fat is hard and stiff. The flavour/odour are controlled by preventing rancidity. In ghee, the clarity is mainly due to proper filtering. The taste, colour and odour of ghee depend on both the time of heating and preventing rancidity. Overheating produces a burnt taste and odour and a darker colour. Incorrect packaging and storage conditions accelerate the development of rancidity

Packaging and storage control
Rancidity during storage is reduced by using clean, dry containers and by keeping the stored product away from light and heat. Iron and copper should not be used in any vessels, utensils or packaging as these metals promote rancidity in the product.

Summary

Butter and ghee are low-risk dairy products that can have a high demand. They can be made relatively easily at a small scale.

Equipment required

For fresh butter:
- Butter churn.
- Butter moulds (optional).
- Butter pats.
- Cream separator (manual or electric)
- Pasteurising pan (e.g. 10 litres) preferably made from stainless steel, but aluminium is acceptable. Or jacketed pan.
- Refrigerator.

- Scales (optional): 0-1 kg +/- 1 g for weighing ingredients, 0-25 kg +/- 100 g for milk
- Thermometer (0-100 °C) for checking product and refrigerator temperatures (preferably an electronic thermometer).
- Timer.

Additionally for lactic butter:
- Incubator.

Additionally for ghee:
- Cheesecloth
- Bottle filler (optional)
- Lid/cap sealer for bottles (optional)

Equipment suppliers

Note: This is a selective list of suppliers and does not imply endorsement by Practical Action. The website www.smalldairy.com/dairy%20resources.html also lists equipment suppliers, books and contacts for small dairy processing.

Butter making equipment including butter churns, moulds, vats.
- Goma Engineering PVT Ltd Majiwada, Behind Universal Petrol Pump, Thane - 400 601, Mumbai, India, Tel: +91 22 534 6436/534 0875, Fax: +91 22 533 3634/3632, E-mail: goma@bom3.vsnl.net.in
- Jaya Industries, 235 Jessore Road, Kolkata - 700 028, West Bengal, India. Tel: +91 33 25799337, Fax: +91 33 25513568, Email**:** jaya.group.ind@gmail.c. Website: www.jaya-industries.com.
- SELAM Technical & Vocational College, P.O. Box 8075, Addis Ababa, Ethiopia. Tel: +251 (0)11 646 29 42, Fax: +251 (0)11 646 34 79, E-Mail: selamtvc@ethionet.et, Website: www.selamethiopia.org/vocational.htm

Butter & yoghurt making ingredients & equipment
- Finest Kind, P.O. Box 1, Plettenberg Bay 6600, South Africa, Tel: +27 (0) 44 533 1623, E mail**:** info@finestkind.co.za, Website: www.finestkind.co.za/equipment.html

Butter moulds
- La Prima shops, www.laprimashops.com/SiliconeZone-Shell-Tray-Butter-Mold--Bright-Blue-_p_20-838.html

Centrifugal cream separator (manual or electric), butter churns and other dairy equipment
- Smallholding Supplies, Pikes Farmhouse, East Pennard, Shepton Mallet, Somerset, BA4 6RR, UK., Tel/Fax: +44 (0)1749 860688.
- Dairy Udyog C-230, Ghatkopar Industrial Estate, L.B.S. Marg, Ghatkopar (West), Mumbai - 400 086, India, Tel: +91 22 517 1636 / 517 1960, Fax: +91 22 517 0878, E-mail: jipun@vsnl.com.
- Lehman's, P.O. Box 41, Kidron, Ohio 44636, USA. Tel: +1 877 438 5346, +1 888 438 5346, E-mail: info@lehmans.com, Website: http://www.lehmans.com

Cream butyrometer
- Hindusthan Thermostatics, 5- Industrial Estate, Ambala Cantt-133 006 Haryana, India, Tel + 0171 2699116/2663783, Fax: +91 171 2699391, E-mail: ht@htindia.com,

Jacketed pans
- Winkworth Machinery Ltd., Tel: +44 (0)118 988 3551, Fax: +44 (0)118 984 0270, E-mail:enquiries@mixer.co.uk, Website: http://www.mixer.co.uk/

Larger mechanised butter churns
- Van den Heuvel, www.dairyandfoodequipment.com/en/products/27

References and further reading

References

- *Dairy Science and Technology Education*, Goff, D., University of Guelph, Canada, www.foodsci.uoguelph.ca/dairyedu/home.html)
- *Opportunities in Dairy Processing*, Fellows, P.J. and Axtell, B.L.A., (Eds.), CTA, 2008.

Further reading

- *Dairy Processing - an overview,* Practical Action Technical Brief
- *Making Butter,* Feely, J., Econo-Clad Books, Div. of American Cos., Inc., 1999.
- *Making Cheese, Butter and Yoghurt*, Hobson, P., Storey Country Wisdom Bulletin, Storey Books, 1984.
- *Making Cheese, Butter and Yogurt*, Carroll, R., Workman Publishing Co. 2003.
- *Pasteurised milk,* Practical Action Technical Brief
- *Soured milk and yoghurt,* Practical Action Technical Brief
- *Small Scale Food Processing – a directory of equipment and methods*, 2nd Edition (Fellows, P., Azam-Ali, S., Judge, E., and Battcock, M.), IT Publications, London, UK. 2003.

Support organisations

- Agromisa Foundation, P.O. Box 41, 6700 AA Wageningen, The Netherlands, www.agromisa.org
- Centre for Dairy Research, Madison, WI. www.cdr.wisc.edu
- Dairy & Meat Officer (Institutional Support & Training), Animal Production & Health Division, Food and Agricultural Organization (FAO), Rome, Italy, Website: http://www.fao.org/
- International Livestock Research Institute ILRI-Kenya, P.O. Box 30709, Nairobi, Kenya, Tel: 254-2 630743. Fax: 254-2 631499.E-mail: ILRI-Kenya@cgiar.org. Website: www.cgiar.org/ilri/
- International Livestock Research Institute (ILRI) Ethiopia, P.O. Box 5689, Addis Ababa, Ethiopia. Tel: (251-1) 613215. Fax: (251-1) 611-892. E-mail: ILRI-Ethiopia@cgiar.org. Website: www.cgiar.org/ilri/
- SKAT, Vadianstrasse 42, CH-9000 St. Gallen, Switzerland. Tel: +41 71 228 54 54. Fax: +41 71 228 54 55, E-mail: info@skat.ch, Website: www.skat.ch.
- Strengthening African Food Processing www.safpp.net

Practical Action
The Schumacher Centre for Technology and Development
Bourton-on-Dunsmore
Rugby, Warwickshire, CV23 9QZ
United Kingdom
Tel: +44 (0)1926 634400
Fax: +44 (0)1926 634401
E-mail: inforserv@practicalaction.org.uk
Website: http://www.practicalaction.org/

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