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SOURED MILK AND YOGHURT

technical brief

Introduction

Traditionally, soured milk is produced by the uncontrolled fermentation of milk using lactic acid bacteria that occur naturally in the milk. It is a thick clotted product that has a stronger flavour and a more acidic taste than yoghurt. It has a shelf life of 3-8 days and is used as a drink or as an accompaniment to a meal. Cultured buttermilk is the fermented by-product of butter manufacture (see Technical Brief: *Butter and ghee*), but it is also produced as a product from skimmed milk or whole milk using a culture of *Streptococcus lactis* or *Streptococcus cremoris*. There are a large number of other cultured milk products, including kefir, koumiss, labneh, and others that are specific to particular regions, which each have different flavours and textures that depend on the starter micro-organisms that are used.

Yoghurt is produced by the controlled fermentation of milk by two species of lactic acid bacteria (*Lactobacillus* sp. and *Streptococcus* sp.). The acid they produce causes the milk to form a characteristic curd and flavour. It can be kept for up to ten days under refrigerated storage (see Technical Brief: *Dairy processing - an overview* for the principles of preservation, which is intended to be read alongside this Technical Brief). The removal of lactose by lactic acid bacteria also means that soured milks and yoghurt can be eaten by people who suffer from lactose intolerance. Flavoured and fruit yoghurts have a similar shelf life to plain yoghurt, a similar smooth creamy texture and a sweet-sour taste with the characteristic flavour and colour of the essence or fruit that is added. These products are mainly used as desserts.

Methods of processing

Soured and cultured milks

These are produced without specialised equipment. The milk is filled into food-grade plastic, aluminium or stainless steel containers (e.g. 5-litre) that have close-fitting lids, and allowed to sour naturally in a warm ventilated room for 1-2 days. It can then be sold directly from the container or dispensed into pots or jars for sale.

In the production of cultured buttermilk, milk is heated to 95 °C and cooled to 20-25 °C before adding 1-2% starter culture. The fermentation time is 16-20 hours. This product may be used as an ingredient in bakeries as well as being sold at retail outlets.

Yoghurt

There are two types of plain (unflavoured) yoghurt that are produced under more controlled conditions than soured milk. These are 'set' yoghurt that has a firm curd, and 'stirred' yoghurt that has a smooth creamy consistency, similar to a thick cream. The production method is:

1. Heat milk in a stainless steel (or less desirably an aluminium) pan to 80-85 °C and hold at this temperature for 15-20 minutes with constant stirring. This destroys contaminating micro-organisms.
2. Cool to 40-45 °C as quickly as possible and add a starter culture (or 'inoculum') of the mixed lactic acid bacteria (see below).

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3. Depending on the type of yoghurt required, the milk is then either kept in the pan (for stirred yoghurt) or filled into individual retail pots (for set yoghurt).
4. Incubate the milk at 40-45 °C for 4-6 hours to allow the fermentation to take place.
5. For stirred yoghurt, the pan of curd is then stirred using a sterilised spoon or ladle until the curd becomes a smooth cream that has a thick consistency without any lumps. This is then either filled into retail pots that are sealed with lids, or sold into customers' containers. Pots of set yoghurt are sealed without disturbing the solid curd.
6. Both types of yoghurt are stored in a refrigerator at 4-8°C. If pots are to be distributed to retailers, they should ideally be transported in an insulated box to keep them cool.

Flavoured or fruit yoghurt

Flavoured or fruit yoghurt is produced using the same method as plain yoghurt. For flavoured yoghurt, the essence (e.g. vanilla, chocolate or a fruit flavour) with or without added colouring, is added before the milk is fermented.

Yoghurt that contains fruit pulp is made in a similar way to plain yoghurt, and the fruit pulp is added after fermentation. Less acidic fruits such as melon or pawpaw (papaya) are more successful because they do not react with the milk. Acidic fruits (lemon, lime, pineapple etc.) may cause excessive curdling and separation of the yoghurt.

To make fruit pulp:

1. Select fully ripe fruits.
2. Wash in clean water.
3. Remove the peel and seeds.
4. Pulp the fruit.
5. Heat the pulp for 15-20 minutes at 70-80 °C in a stainless steel pan, with constant stirring to prevent it burning onto the pan. This softens the fruit and destroys any contaminating micro-organisms and naturally occurring enzymes that would cause changes to the colour or flavour of the fruit during storage.
6. Cool to room temperature.
7. Either mix the pulp into stirred yoghurt (e.g. 1 part pulp to between 3-5 parts yoghurt) or place a layer of pulp at the bottom of pots before filling stirred yoghurt.
8. Store as for plain yoghurt.

Other product variations

- Fruit or nut pieces can be added to each type of yoghurt, but care is needed to ensure that they are thoroughly cleaned and blanched in boiling water or steam for approximately 5 minutes to prevent them introducing micro-organisms that would contaminate the product.
- A layer of fruit syrup, maple syrup or treacle can be poured onto the top of set yoghurt.
- If thicker stirred yoghurt is required, this can be made by mixing dried skimmed milk (at approximately 50g/litre) into the milk before it is heated.
- Some larger commercial yoghurt manufacturers use other thickeners such as starch or pectin, but these are not necessary at a small scale of operation.
- There is increasing interest in 'probiotic' bacteria that are reported to have health benefits. To make probiotic yoghurt, the lactic acid bacteria *Lactobacillus acidophilus* and *Bifidobacterium* sp. should be used (see 'Yoghurt culture' below).

Quality assurance

The quality of milk and the processing conditions that are used for making yoghurt 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 (Table 1).

HACCP (Hazard Analysis Critical Control Point)

The specific potential hazards in making cultured milks and yoghurt 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.

Hygiene

Technical Brief: *Dairy processing - an overview* gives details of hygiene and sanitation, 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

Unclean equipment, contaminated milk, poor hygiene of production staff or incorrect processing and storage conditions will each cause spoilage of soured milk and yoghurts. All equipment should be thoroughly cleaned after use and checked before production starts again. The temperature and time of heating milk should be monitored and controlled to ensure that it is not over- or under-heated. 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 yoghurt and cultured milk production should be fresh, good quality and free from dirt and excessive contamination by bacteria. Older milk may impart an unpleasant flavour to the final product. The Technical Brief *Dairy processing - an overview* gives details of the methods needed to ensure that good quality milk is used.

Yoghurt culture

In yoghurt making, the correct amount of inoculum and the correct proportions of the two lactic acid bacteria are both important to produce good quality yoghurt. Commercially produced dried mixed cultures of inoculum (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* subspecies *bulgaricus*) can be obtained from many large towns/cities or from suppliers elsewhere, and these suppliers also supply probiotic lactic acid bacteria. The dried culture is grown in pasteurised milk (see Technical Brief: *Pasteurised milk*) and then kept in a refrigerator. A part of this 'master culture' (1-3% of the weight of the batch of milk) is then used each day for a week. The last part is inoculated into pasteurised milk to form a new master culture. This method can be continued for several months, provided that good hygiene is practised, but eventually undesirable bacteria will contaminate the culture and it must be replaced.

It is also possible to use commercial yoghurt - ie. 'live' yoghurt that has not been pasteurised - as a starter culture. New yoghurt should be used each day at between 20 and 50g per litre of milk. Alternatively, part of the yoghurt produced can be held overnight in a refrigerator and added the following day to a new batch of milk at 20-50g per litre of milk. There is a greater risk of contamination using this method and it is not recommended unless the other methods described are not possible.

Process control

A process control schedule should be prepared for each product. Table 1 is an example of a process control schedule for yoghurt production.

Stage in process	Activity	Process control points
Heat	Heat milk to destroy micro-organisms and enzymes.	Check temperature and time (80-85 °C for 15-20 minutes).
Cool	By immersing vessel in cold water and stirring milk	To 44 °C +/- 2 °C within 20 minutes
Ferment	Add yoghurt starter culture and ferment for 4-6 hours.	Check that starter culture is active and check weight of culture added. Maintain temperature at 44 °C +/- 2 °C. Check texture of yoghurt to determine end of fermentation time (5 hours +/- 1 hour)
Fill pots (stirred yoghurt)	Stir the yoghurt to break the gel and then pour liquid yoghurt into pots	Check the weight of yoghurt in each pot (e.g. 200g +/- 2g net weight)

Seal	Seal pots with a foil lid or clip-on plastic lid	Check that the seal is properly formed
Label	Attach label to pots	Check that correct label is used, that they are correctly positioned, and show the correct use-by date and batch number.
Refrigerate	Hold at 4-8 °C	Check refrigerator temperature

Table 1. Process control points in yoghurt production

The temperature and time of heating and cooling the milk should be controlled. Over-heating and/or slow cooling causes changes to the flavour, colour and nutritional value of the milk, whereas under-heating may lead to survival of undesirable micro-organisms, causing spoilage of the product. The correct yoghurt incubation temperature is required to allow rapid production of lactic acid by lactic acid bacteria. If the temperature is too high the bacteria will be killed; if it is too low there may be insufficient acid production to form the yoghurt.
The main controls for processing the fruit pulp for fruit-flavoured yoghurt are:

- Fruit should be ripe or slightly over-ripe, free from insect damage or mould/yeast growth, and free from bruises, cuts or splits. Correct sorting, cleaning and peeling procedures are needed to remove unwanted parts of the fruit and any contaminated or spoiled fruit.
- Correct pulping to produce a uniform fine pulp without large pieces that would be inadequately heated during pasteurisation.
- Adequate time and temperature of pasteurisation to destroy contaminating micro-organisms (especially yeasts and moulds that are able to grow in the yoghurt).
- Mixing of pulp and yoghurt in the correct proportions to retain the thick creamy consistency while giving the required flavour and colour in the final product.

Maintenance of correct incubation temperature

A commercially produced domestic scale yoghurt maker may be purchased, but they are relatively expensive. A local engineering company may be able to fabricate a shallow water bath with a small electric heating element and thermostat to keep the water at the correct temperature. The fermentation pan is placed in the water. Alternatively, at a micro-scale of production the inoculated milk at 40-45 °C is filled into large thermos flasks, which retain the heat for the required time. Similar insulation can be achieved using a block of 10 cm thick polystyrene, which has indentations to fit small containers. The warm inoculated milk is filled into the containers in the block of polystyrene, and a polystyrene lid is placed on top. A similar incubator consists of a hollow polystyrene box approximately 0.75 m^3 fitted with a 40 W electric light bulb. The heat from the lightbulb maintains the temperature within the required range. Typically these incubators can accommodate up to 250 pots per batch. Practical Action South Asia with the Cathy Rich Memorial Food Processing Centre have designed improved low cost incubators for yoghurt that have a greater capacity, with either manual and semi-automatic operation. The incubators have aluminium frames with 'rigid foam' insulation. There are two chambers with 6 removable shelves in each chamber. 40W light bulbs are fitted at the base of the incubator to supply the required heat. The incubator has a glass panel to view the yoghurt without opening the incubator. The manual model requires the incubator temperature to be monitored and the light bulbs to be turned on and off as required, whereas the semi-automatic version uses a thermostat to control the temperature. There is an optional internal fan to produce more uniform temperatures throughout the incubator.

The materials required for construction are:

Number	Type
3	Aluminium bar 1.25 x 1.25 cm, 3.65 m lengths (½" x ½", 12 ft lengths).
10	Aluminium bar 1.9 x 1.9 cm, 3.65 m lengths (¾" x ¾", 12 ft lengths).
6	Aluminium 'T' Sections 2.54 x 2.54 cm, 3.65 m lengths (1" x 1", 12 ft lengths).
1	Aluminium 'U' Section 3.65 m lengths (12 ft lengths).
1.5	Aluminium sheets 20-gauge 20 cm x 10 cm (8" x 4").
4 m^2	Welded Mesh 75 mm.
0.8 m^2	Plain Glass.
10	Light bulbs 40W.
1	Dial thermometer 0 - 100 °C.
1	Thermostat, adjustable.
1	Electric fan, low profile vertical operation box fan.
(as required)	Rigid foam insulation, wires, teflon sleeving, connectors, self tapping screws as required. 240V electricity supply, floor area 60 cm x 122.5 cm.

The incubator frame is rectangular with the glass sheet at the front. The thermostat is attached to the external frame. Bulbs are placed at the base of the incubator. The incubator has 2 chambers with 6 trays each. Each tray holds 42 pots (500 pots per batch). Technical drawings are available from Practical Action South Asia.

Product control

The main quality factors for soured milk and yoghurt are the colour, taste and texture. The colour should remain unchanged during processing. The taste and texture both depend on the amount of lactic acid produced during the fermentation and this in turn depends on the amount of inoculum added to the milk, and the temperature and time of incubation. In flavoured or fruit yoghurt, the colour and flavour depend on the type and amount of added essence, colouring or fruit.

Packaging and storage control

The products require protection against dust and insects during distribution and retail display. Traditionally, covered clay pots, gourds and wooden or ceramic bowls have each been used and these are suitable provided proper hygiene and cleaning are observed, particularly if they are to be reused. Plastic pots are more hygienic, more attractive to consumers, more convenient to use and easily sealed with a foil cover or clip-on plastic lid. Other alternatives are returnable glass jars or waxed paperboard cups. Products should be stored in a cool place away from sunlight and preferably in a refrigerator at 4-8 °C.

Summary

Soured milk and yoghurt are low- to medium-risk products that can easily be made at a small scale. They often have a high demand and different flavours can be produced to give a range of products.

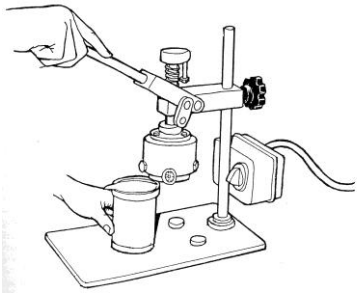

Fig. 1. Yoghurt pot sealer.
(Practical Action)

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Equipment required

- Milk churns or similar containers.
- Pasteurising pan (e.g. 10 litres) preferably made from stainless steel, but aluminium is acceptable.
- Source of heat.
- Thermometer (0-100 ºC) for checking product and refrigerator temperatures (preferably an electronic thermometer).
- Incubator.
- Refrigerator.

Optional

- Pot sealer. Pot sealers can be made locally by fixing a domestic electric iron to a drill stand. Commercially available pot sealers have a thermostatically controlled sealing head, which can be adjusted for sealing foil or plastic lids.
- Fruit pulper. Manual or electric pulpers are available (see Technical Brief: *Fruit juice processing*)
- Scales. 0-1 kg +/- 1 g for weighing ingredients, 0-25 kg +/- 100 g for milk or fruit.

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, laboratory supplies, books and contacts for small dairy processing.

Dairy processing equipment

- Fullwood Ltd., Grange Road, Ellesmere, Shropshire, SY12 9DF, UK. Tel: +44 (0) 1691 622391. Fax: +44 (0) 1691 622355. www.fullwood.com

Batch Pasteuriser.

- C Van t Riet Dairy Technology, Dorpsstraat 25, 2445 AJ Aarlanderveen, The Netherlands, Tel: +31 172 571304, Fax: +31 172 573406, E-mail: info@rietdairy.nl, Website: http://www.rietdairy.nl/
- Dairy Udyog, C-230, Ghatkopar Industrial Estate, L.B.S. Marg, Ghatkopar (West), Mumbai - 400 086, India. Tel: +91 (0)22 2517 1636 / 2517 1960. Fax: +91 (0) 22 2517 0878. Email: jipun@vsnl.com

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

Yoghurt incubators

- 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
- Ashoka Industries, Kirama, Walgammulla, Sri Lanka, Tel: + 94 71 7654725
- Industrial Development Board, Galle Road, Katubedda, Moratuwa, Sri Lanka

Ingredients

Lactic acid bacteria cultures

- Dalton Biotechnologie, Via Italia 87, 65010 Spoltore (PE), Italy, Tel: +39 085 415 6634, Fax: +39 085 4146636, E-mail: info@dalton.it, Website: http://www.dalton.it/

Essences and food colourings

These ingredients are used for bakery products and are suitable for use in yoghurts. They are available in large cities from supermarkets or bakery suppliers.

References

- *Dairy Processing* Practical Action Technical Brief
- *Basic Rules of Hygiene, Sanitation and Safety in Food Processing* Practical Action Technical Brief
- *Pasteurised Milk* Practical Action Technical Brief
- *Butter and Ghee*, Practical Action Technical Brief.
- *Cheese making*, Practical Action Technical Brief.

Further reading

- *Appropriate Food Packaging: Materials and methods for small businesses* Fellows, P., Axtell, B., Practical Action Publishing, 1993.
- *Traditional Foods: Processing for profit* Fellows, P.J., (Ed.), Practical Action Publishing, 1997.
- *Dairy Processing* UNIFEM Practical Action Publishing, 1996.
- *Dairy Processing Handbook*, Alfa Laval/Tetra Pak Processing Systems, S-221 86, Lund, Sweden, 1995.
- *Dairy Science and Technology Education,* Goff, D., University of Guelph, Canada,
- *Dairy Science and Technology: Principles and Applications*, La Fondation de Technologie Laitiere et Department de Science et Technologie des Aliments Universite Laval. Les Presses de l'Universite Laval, Quebec. 1985.
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- FAO Information also at www.fao.org/docrep/007/y3548e/y3548e09.htm or www.fao.org and search 'dairy processing book' for a list of publications that can be downloaded.
- *How to Clean*. Dillon, M and Griffith, C., M.D. Associates, Cleethorpes Enterprise Centre, Unit 43, Jackson Place, Humberston, Grimsby, South Humberside DN 36 4AS UK. 1999.
- *Preparation of Dairy Products, Agrodok 36*, Agromisa Foundation, P.O. Box 41, 6700 AA Wageningen, The Netherlands 1991.
- *Rural Dairy Technology,* O'Connor, C.B., ILRI Training Manual 1. International Livestock Research Institute (ILRI), Nairobi, Kenya. 1995.
- *Small Scale Food Processing – a directory of equipment and methods,* 2nd Edition, Azam-Ali, S., Judge, E., Fellows, P., and Battcock, M., Practical Action Publishing, UK. 2003.
- *Strategies for market orientation of small scale milk producers and their organizations*, Proceedings of a FAO Workshop, L.R. Kurwijila, J. Henriksen, A.O.O. Aboud and G.C. Kifaro (Eds.), Sokoine University of Agriculture, FAO Rome. 1995.
- *The Food Hygiene Handbook*, Sprenger, R.A., Highfield Publications. Doncaster DN5 7LY, UK, 2002.
- *Tools for Agriculture: A Guide to Appropriate Equipment for Smallholder Farmers,* Practical Action Publishing, CTA & GRET, 1992
- *Village Milk Processing*, Animal Production and Health, Lambert, J.C., Paper no. 69, FAO, Rome. 1988.
- *The technology of traditional milk products in developing countries*, Technical Bulletin #85, Food and Agriculture Organization of the United Nations, Rome, 1990

Support organisations

- Agromisa, Agromisa Foundation, P.O. Box 41, 6700 AA Wageningen, The Netherlands 1991. www.agromisa.org
- Cathy Rich Memorial Food Processing Centre, Yodagama, Embilipitiya, Sri Lanka. Tel: +94 47 30248, Fax: +94 77 324162, E-mail: crmfpc@foodhints.com. The training centre was a subsidiary of Practical Action South Asia until 1997. It is now an independent NGO that works closely with Practical Action South Asia.
- 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/
- Practical Action South Asia, 5 Lionel Edirisinghe Mawatha, Kirulapone, Colombo 5, Sri Lanka, Tel: +94 1 2829412, Fax: +94 1 2856188, E-mail general@itdg.slk.lk.
- 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

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