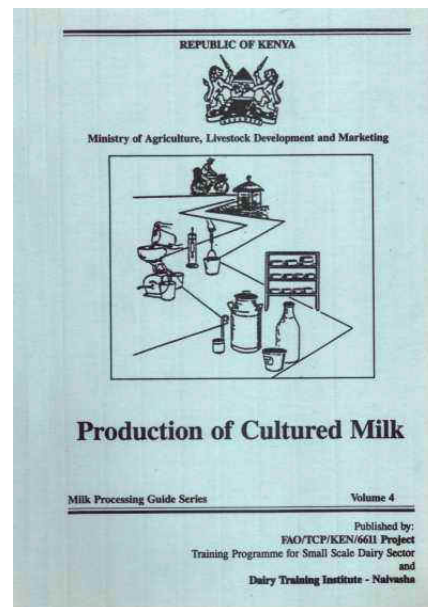


Production of Cultured Milk



Milk Processing Guide Series

Volume 4

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**Training Programme for Small Scale Dairy Sector and Dairy Training
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1. INTRODUCTION

Under unrefrigerated storage, milk becomes sour in a matter of hours after milking. This is due to the action of natural lactic acid bacteria on the milk sugar, turning it to lactic acid which causes the milk protein to coagulate. Traditionally, most communities in Africa and Kenya in particular have used this natural fermentation to produce a variety of fermented milks for home consumption.

Under modern dairy processing industry, selected lactic starter cultures are used to ferment milk during preparation of a variety of cultured dairy products. Since the liberalisation of the dairy industry in Kenya in 1992, a number of small to medium scale dairy processing plants have emerged. Apart from processing liquid milk, most of these plants are also producing a variety of cultured milk products. The quality of these products vary from being of average or below average quality to high quality products. In order to assist the small to medium scale processors improve the quality of their products, the Training Programme for the Small Scale Dairy Sector under project GOK/FAO/TCP/KEN/6611, has prepared this guide on Production of Cultured Milk to be used for training and by the private small scale dairy processors. The emphasis is on hygienic

milk production methods and a good understanding of starter culture technology and handling method which is essential for successful production of good quality cultured dairy product.

2. PRODUCTION OF CULTURED MILK

2.1 WHAT IS CULTURED MILK?

Cultured milks are products made by use of special lactic acid bacteria cultures. They fall into two broad categories. Those made by use of lactic acid bacteria which grow well at ambient temperature (25-30°C). Such lactic acid bacteria are known as Mesophilic starter cultures. Maziwa lala or Mala as it is popularly known in Kenya, is made by use of such cultures. The other type of cultured dairy product is the one made by use of lactic acid bacteria which grow well under warm conditions (38 - 45°C) The lactic acid bacteria used are technically known as Thermophilic starter cultures. Yoghurt or yoghurt like products belong to this group.

2.2 TYPES OF CULTURED MILK AND STARTER CULTURES.

As mentioned above, cultured dairy products fall in two broad categories; those made by use of mesophilic starter cultures and those made by use of thermophilic starter cultures. Depending on the type of culture used, the flavour, texture and consistency can vary widely and may be grouped as follows:

i) Products made by use of mesophilic lactic starter cultures may

use one of the following starter culture types:

O-type: These are starter cultures in which the main lactic acid bacteria are *Lactococcus lactis subsp. lactis* and *Lactococcus lactis subsp. cremoris*. These produce mainly lactic acid. They are thus, homofermentative.

D-type: These are starter cultures containing, in addition to the O-type bacteria also a flavour producing lactic bacteria known as *Streptococcus lactis subsp. lactis var. diacetylactis*. This, as the name implies, produces a flavour compound known as diacetyl which gives a flavour characteristic of cultured cream butter or its buttermilk by-product. In addition to production of diacetyl, it also produces carbon dioxide which contributes to the blend of a delicate flavour.

L-type: This type of starter culture contain, in addition to the O-type bacteria, also *Leuconostoc mesenteroides subsp. mesenteroides* as the main flavour compound producing bacteria. It produces diacetyl, acetic acid, acetaldehyde and other flavour compounds but less carbon dioxide than the D-type.

LD-type: These contain a combination of *Str. lactis subsp. lactis var diacetylactis* and *Leuconostoc mesenteroides subsp. mesenteroides* to give a fine blend of dedicated flavour and aroma.

Most "Maziwa lala" products can be made by use of any of these

types of lactic starter cultures. They will all give products differing in flavour and texture. Which ever one chooses to use, care should be taken not to use those that lack the desired flavour or those which halve excessive gas production (good for some cheese, but not entirely welcome in good cultured dairy products!). Excessive production of acetaldehyde can also lead to a defect known as "green flavour" more akin to yoghurt than to "Maziwa lala" group of cultured products.

ii) Products made by use of thermophilic starter cultures.

The main product in this group is yoghurt. The typical lactic acid bacteria in yoghurt starter culture are Streptococcus salivaricus subsp. thermophilus and Lactobacillus delbrueckii subsp. bulgaricus. The former is responsible for fermenting lactose to lactic acid whereas Lb. delbrueckii subsp. bulgaricus is responsible for flavour production, mainly in the form of acetaldehyde. Due to its proven health food qualities, other thermophilic lactic acid bacteria may be included in yoghurt starter cultures to enhance its dietetic and health food status. Lactobacillus acidophilus, which produces a natural antibiotic, acidophilin and Bifidobacterium spp., which are part of the natural bacterial flora of the human gut, are often included in special yoghurt starter cultures. Products such as Bioghurt are made by use of such specially blended cultures and are marketed under the banner of "Health foods" useful for the restoration of normal bacterial flora hollowing a course of oral antibiotic therapy in patients.

2.3 WHY MAKE CULTURED MILK?

Apart from fresh milk, fermented milk is the most common milk food in Africa and Kenya in particular: There is thus, a big demand for cultured milk which is perhaps not yet well exploited. In general, the production of cultured milk by dairy processors in Kenya should be advocated further on the following grounds:

- Cultured milk is a milk product with a shelf life (at ambient temperature) of about 4 days compared to 24 hours for fresh pasteurised milk.***
- Cultured milk is highly digestible making it to have, on a volume to volume basis, better nutritional quality than liquid milk.***
- Certain individuals who do not consume milk regularly experience stomach upsets if they try to consume a glass or two of fresh milk. This is because they are unable to digest the milk sugar (lactose) which is then fermented in the lower gut thereby causing gas production and flatulence. Experience has shown that such, so called "lactose intolerant" people can consume cultured milk without problems because a large part of the milk sugar has already been digested for them by the lactic acid bacteria!***
- The regular consumption of cultured milk has been shown to have therapeutic properties due partly to the presence of natural antibiotics such as nisin and acidophilin which is produced by***

specific lactic acid bacteria. This has gives certain cultured products such as Acidophilus milk, yoghurt (Bioghurts) special "Health food) status and may be recommended by medics for restoration of normal gut flora following oral therapy.

2.4 CHOOSING TYPE OF CULTURED PRODUCT

Most dairy processors in Kenya are making either "Maziwa lala" type of yoghurt type of cultured milk. Whichever product one chooses to manufacture, it is important to consider appropriateness and desirability.

"Maziwa lala" type products.

These have the advantage in that their flavour is close to that of naturally fermented milk to which most of the Kenyan cultured milk consuming public is familiar with. Furthermore fermentation takes place at ambient temperatures obviating the need for incubators. Even without cooling of the coagulum, the fermentation process stops at 0.85-1.0% Lactic acid (pH 4.3 - 4.2) resulting in mild sour products with a shelf life of up to 4 days without refrigeration.

Yoghurt and yoghurt like products.

Yoghurt is a well liked dairy product in Europe and North America, where sales have increased substantially during the last two decades partly because of its health food aspect and its ability to blend so well with a variety of exotic tropical fruits/flavours. It

requires incubator at 42°C during manufacture and has to be cooled to stop further acidification to less than pH 4.0 - 3.8. It thus costs more to process than its "Maziwa lala" counterpart.

In view of this, the production and marketing of yoghurt in Kenya is normally targeted at the upper niche of the market segment in metropolitan cities of Nairobi and Mombasa. Demand is likely to increase with increase in peoples' incomes. With so much bananas, pineapples, papayas, mangoes, oranges, passion fruits, straw berries around us in Kenya, the opportunity to produce yoghurt fruit blends is not yet fully exploited!

SUMMARY OF STARTER CULTURES AND CULTURED MILK

Starter culture type	Description	Effect on cultured milk product	Products for which used
O	Pure, mesophilic, homofermentative	Lactic acid production	Mala, Sour cream, cultured buttermilk and cheddar cheese
L;D;LD	Mixed, mesophilic, heterofermentative	Lactic acid production, antibiotic (acidophilin)	Acidophilus milk; "Bioghurt"

		production	
Acidophilus	Pure; thermophilic, homofermentative	Lactic acid production, antibiotic (acidophilin) production	Acidophilus milk; "Bioghurt"
Yoghurt	Mixed, thermophilic	Lactic acid production, flavour and aroma production	Yoghurt

2.5 SOURCING FOR STARTER CULTURES

There are a few specialised starter culture suppliers. Commercial starter culture suppliers such as Chr. Hansen¹ supply three types of starter cultures:

Dri-vac: This type contains inactive microorganisms in freeze dried form. They must be activated by propagation at least through 3 passages before they can be used in the production of cultured milk product.

Redi-set: This type has active lactic acid bacteria and is used directly in the production of cultured milk products. It has the advantage of avoiding possible contamination associated with serial transfers of starter cultures during propagation. It also enables the

production of products of uniform quality throughout the production year. Its main disadvantage is that it is considerably more expensive than the Dri-vac type.

DVS: This is similar to Redi-set but stronger (more concentrated) and has the same advantages and disadvantages.

Note: Other starter culture manufacturers² will provide similar products under different proprietary names.

1 Chris Hansen's Laboratorium, AS; Borge All'e 10-12, 2970 Horsholm, Denmark.

2 See Directory of scale Dairy Equipment Suppliers, DTI, P.O. Box 449, Nairobi.

Whichever starter culture you choose to use you should maintain the highest degree of hygiene and use the same starter culture from the same supplier for any given product. This is important because a starter culture has a strong influence on the flavour and textural characteristics, of your product which is important for retaining consumers of your products. Erratic changes may result in production of different product altogether causing you loss of dedicated customers!

2.6 STARTER CULTURE PROPAGATION

Preparation of starter culture and maintenance of its quality is an

important aspect of production of cultured milk. Once you obtain a new supply of freeze dried starter culture proceed as follows:

(adapted from TECHNOSERVE, 1994)1

1. First Passage

a) Obtain plastic bottles that hold 880 - 1,200 ml of liquid and have screw type covers.

b) Select good quality raw milk.

c) Skim the raw milk using a milk separator (skim milk has best results, however one can use whole milk).

d) Sterilize skimmed milk by heating to 100 °C for 10 - 20 minutes, or 90 - 95 °C for 30 minutes constantly stirring to ensure even heating.

e) Wash and sterilise the plastic bottles and lids, either by boiling for 30 minutes or by disinfecting in 68 -70% (vol) ethyl alcohol then place them upside down on a sterile towel to dry. Sterilize the towel by moistening it with alcohol.

f) Cool the milk to room temperature, 20 - 25 °C or 30 - 37 °C in the case of

yoghurt starter culture.

g) After the milk has cooled, add 1 to 2 grains of freeze - dried culture per litre of sterilized skimmed milk and stir for one minute.

h) Using only sterile equipment, fill the plastic bottles about two - thirds full and immediately screw on covers.

i) Allow the inoculated milk to incubate at room temperature for 16- 24hours or 42 °C for aft hours in the case of yoghurt starter.

1 Technoserve, 1994. Male Milk Manual; A guide for establishing and operating small scale Enterprises for production of Cultured Milk: (Technoserve- P. O. Box 14821 Nairobi: or P.O. Box 2117. Arusha, Tanzania).

2. Second Passage.

a) Repeat First Passage Steps a) to e) using a litre of milk.

b) Pour the hot skimmed milk into the bottle to two-thirds its capacity cover tightly. Let the milk cool as in f) above.

c) After the bottled sterilised skim milk has cooled to room temperature, add the First passage inoculum into each bottle in a 2 - 3% mixture by volume and stir.

Close each bottle tightly and leave it to incubate fur 16 - 24 hours (or 3 - 4 hours at 42 °C in the case of yoghurt) to produce inoculum for the next passage.

d) Discard any remaining First Passage inoculum.

3. Third passage.

a) Follow second passage procedures to produce the third passage culture inoculum. This active mother culture may be used for the production of bulk starter to be used in the production of cultured milk ("Maziwa lala" or Yoghurt). Keep mother culture in a refrigerator for not more than 5 days, then re-activate by repeating 2nd passage procedure.

2.7 PRESERVATION OF MOTHER CULTURE BY DEEP-FREEZING

In order to cut down the cost of obtaining fresh freeze dried starter cultures each time one wants to prepare a fresh stock of mother culture, it is possible to preserve some of the mother culture obtained after the 3rd Passage above.

Do as follows:

a) Prepare 20 - 30 plastic bottles of 100 - 250 ml capacity.

b) Prepare good quality skim milk and fill the plastic bottles to 2/3 of their capacity.

c) Sterilise as described in section (d) under First Passage above.

d) Cool to ambient temperature.

e) Inoculate with mother culture at the rate of 2 - 3%, close the bottles and immediately place in a deep freezer.(After inoculation the acidity of the sterilised milk should not be less than pH 6.4). Such culture will remain viable for up to 1- 2 year if not allowed to thaw (defrost).

2.8 PREPARATION OF STARTER CULTURE FRONT FROZEN FLUID CULTURE

- i. Remove from the deep-freezer one of the frozen liquid starter cultures prepared under Section 2.8 above, when required.***
- ii. Thaw at room temperature and leave to coagulate in 16 - 24 hour) (for yoghurt incubate at 30 °C for 16 - 20 hours).***
- iii. Select good quality raw whole milk.***
- iv. Heat the milk to 90 - 92 °C for 10 - 20 minutes, stirring constantly to avoid cream separation and ensure even heating.***
- v. Sterilize plastic bottles (100 - 1,500 capacity), with screw type lids and place them upside down on a sterile towel to dry.***
- vi. Fill the bottles two-thirds full with the hot milk and cover them tightly. Let them cool at room temperature for 20 - 30 minute.***
- vii. Place the bottles in water bath to cool to 20 - 25 °C (or 42 °C in the case of yoghurt starter).***
- viii. Inoculate die sterilised whole milk in bottles with 2 - 3 % of***

- the coagulum produced under (ii) above.*
- ix. Make two more transfers to activate the starter culture in the same way as has been described under section 2.7 for 2nd and 3rd passages.*
 - x. Use coagulated inoculum as mother culture for the production of bulk starter to be used in the production of your cultured milk. Each time your bulk mother culture becomes exhausted or weak, go for another deep-frozen liquid culture and repeat the above procedure. This procedure will enable you to extend the use of one original pouch of freeze dried culture for up to 2 - 3 years!*

2.9 PREPARATION OF BULK STARTER FROM MOTHER CULTURE

a) Follow steps (iii) to (vii) as if preparing mother culture from frozen liquid culture.

b) After cooling to the appropriate incubation temperature, inoculate with 2-3% of fluid mother culture and incubate until coagulation has occurred.

Note: Preparation of bulk starter culture need to be one every day from the same mother culture.

A change of the mother culture from which the bulk starter culture is prepared daily will only become necessary if and when:

- Coagulation of milk takes longer than usual in inhibitor free*

milk.

- ***The final product develops off-flavours or defects such as excessive gas yeasty taste and flavour etc.***
- ***A mishandling or contamination of the mother culture has occurred.***

Always ensure that enough bulk starter culture is available for the next day's production i.e 10 - 20 litres for every 500 litres of cultured milk.

SUMMARY OF STARTER CULTURE PROPAGATION

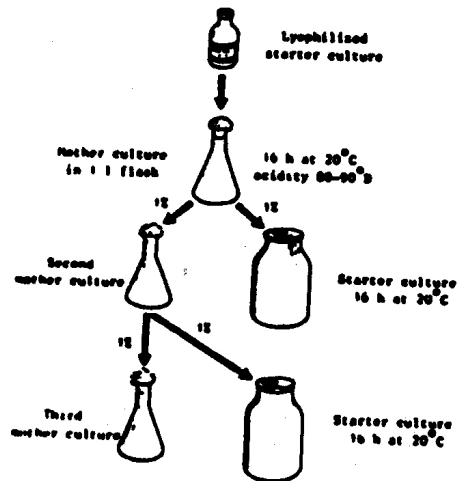


Fig 1. Steps in starter culture propagation

2.10 PRODUCTION OF CULTURED "Maziwa lala"

Cultured milk way be produced in quantities ranging from as little

as 50 litre per day to 500 litres per day for small scale dairy plants to several thousand litres per day in medium scale dairy plants. Whatever the size of your operation, the basic steps are the same. The difference will be in the type and size of equipment used. We shall only discuss processes involved. For further information of suitable equipment for the size of operation envisaged contact the Dairy Training Institute at Naivasha or the Department of Food and Dairy Technology at Egerton University and Department of Food Technology and Nutrition University of Nairobi at Kabete

- 1. For production of good quality "Maziwa lala" you require good quality milk (see section 2.6.)***
- 2. Ensure you have good starter culture (see section 2.7).***
- 3. Filter the milk to remove physical dirt.***
- 4. Pasteurise the milk at 80 - 85(C for 30 minutes in a batch pasteuriser which can be a 50 litre can heated in hot water or improved wood fueled jiko.***

This is done to:

- Destroy spoilage and pathogenic bacteria.***
- Produce a smooth and viscous product.***
- Prevent wheying off in the sour curd.***
- Enable starter cultures to grow well in the milk.***

If you are using continuous flow pasteurisers you may heat the milk to 90 - 95 °C for 2 - 5 minutes.

- 5. After pasteurisation the milk should be cooled to 20 - 25 °C. Cooling may be done rapidly in a cold water basin or trough.***

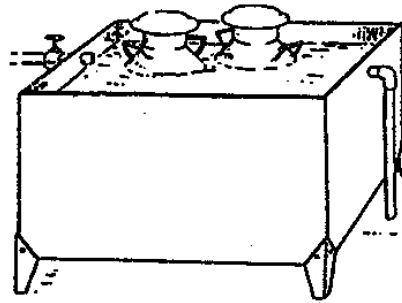


Fig. 2: Cooling in water ensures faster cooling than cooling in air.

- 6. After inoculate the milk with 2 - 3 % active starter culture. Stir well for 3-5 minutes to ensure uniform distribution of starter culture.***
- 7. Incubate at ambient temperature overnight (for 16 -18 hours).***
- 8. Check the coagulum. It should be compact without cracks and whey on top. You may cool the coagulum before stirring or breaking the curd if you have the facilities. This will improve the viscosity and the consistency of the product but it is not essential.***
- 9. Break the coagulum and stir well to homogenise the curd to a smooth consistency. You may add sugar and flavourings at this stage. To minimise contamination sugar may be added towards***

the end of the pasteurisation process i.e when the milk is still hot.

- 10. Pack the finished product in tall containers for marketing. You may use plastic sachets (1/2litre to 1 litre or plastic cups 150 ml to 200 ml) Avoid contaminating the product during packaging (swollen packages in the market is often due to contamination at this stage). Ensure the packages are well labelled and attractive.***

2.11 PRODUCTION OF Yoghurt

The manufacturing process for yoghurt is similar to "Maziwa lala" " with the exception that a yoghurt starter culture is used instead and the milk is incubated under warm conditions. To produce good quality yoghurt proceed as follows:

- 1. For Production of good quality yoghurt, you require good quality milk (see section 2.6).***
- 2. Ensure you have good starter culture (see section 2.7).***
- 3. Filter the milk to remove physical dirt.***
- 4. Pasteurise the milk at 80 - 85°C for 30 minutes in a batch pasteuriser which can be a 50 litre can heated in hot water or improved wood fuelled jiko (see Fig. 2.).***
- 5. After pasteurisation the milk should be cooled to 40 - 45°C. Cooling may be done rapidly in a cold water basin or trough (see Fig. 3).***
- 6. After cooling, inoculate the milk with 2 - 3% active starter***

culture. Stir well for 3-5 minutes to ensure uniform distribution of starter culture.

- 7. Incubate at 40-45 °C for a period of 2 - 3 hours.***
- 8. Check the coagulum. It should be compact without cracks and whey on top.***
- 9. Check the acidity. It should be 0.8 - 0.9% lactic acid or pH 4.3 - 4.2.***
- 10. Cool the coagulum by placing cans in chilled water or store in a refrigerator for 12hrs. This is essential in preventing over souring of yoghurt. It also improves consistency and viscosity as well as full yoghurt flavour development.***
- 11. Break the coagulum and stir well to homogenise the curd to a smooth consistency. You may add sugar and flavourings at this stage. To minimise contamination sugar may be added towards the end of the pasteurisation process i.e when the milk is still hot.***
- 12. Pack the finished product in retail containers for marketing. You may use plastic sachets (1/2 litre to 1 litre or plastic cups 150 mls to 200 mls). Avoid contaminating the product during packaging- swollen packages in the market is often due to contamination at this stage. Ensure the packages are well labelled and attractive!***

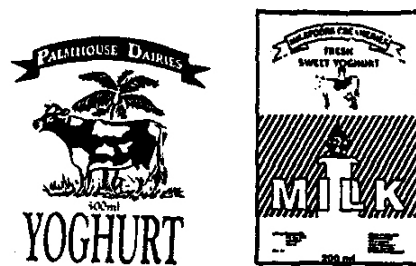


Fig. 3: Attractive and hygienic packaging is good for sales promotion of yoghurt

Note: An alternative method for production of yoghurt is to incubate at 30(C for overnight. This type of yoghurt has less risk of wheying off after coagulation due to the slow acid development it will have richer flavour and high viscosity. In addition, it has a mild taste and will require less sugar than conventional yoghurt.

2.12 Basic Practical Requirements for Production of Good Quality Cultured Milk

- a. Use high quality milk.**
- b. Use colostrum and mastitis free milk.**
- c. Use milk free of starter culture inhibition (chemical and drug residues). Conduct the inhibitor test regularly on milk destined for production of cultured milk (see processing guide series Vol. 2).**
- d. Use clean equipment.**
- e. Pasteurise the milk to recommended temperatures.**
- f. Use fresh starter cultures.**

- g. Cool yoghurt promptly and maintain cold chain during marketing to avoid over-souring; keep "Maziwa lala" cool although this is not as critical as it is for yoghurt.***
- h. Package the products in attractive, well-labelled containers.***