Stirred Yoghurt:

Agricultural processing brochure

South African farmers facing current economic realities are searching for new options to maintain or expand their businesses. One of the many opportunities to grow markets, turnover and profits is by adding value to farm produce. Options need to be selected carefully based on sound information and knowledge of the opportunities presenting themselves, taking into account the strengths and weaknesses of individual farms.

Introduction:

Product group: Dairy products

Dairy milk is one of the most versatile products available to the processor. Processing options include fermenting, concentrating, drying, freezing and many more methods of preservation. Processed dairy products are divided into five groups:

- Concentrated dairy products
- Cultured dairy products
- Frozen dairy products
- Liquid dairy products
- Powdered dairy products

Yoghurt is categorised as a *cultured dairy product*.

Product description:

Stirred yoghurt

Yoghurt is categorised as a cultured dairy product which is obtained from pasteurised milk or reconstituted milk that has been inoculated with yoghurt culture, and allowed to ferment under controlled conditions to develop a characteristic flavour and texture.

Stirred yoghurt has a thick smooth consistency and is viscous enough to hold fruit in suspension and is classified according to its fat content. It can be high fat (> 4.5%), full fat (3.5 – 4.5%), low fat (1,5 - 2,5%) or fat-free (< 0,5%).

Yield: Between 0.82 – 0.92 kg of whole raw milk will yield approximately 1 kg of stirred yoghurt (depending on the fat content of the yoghurt).

Storage of raw milk for processing

Milk is a highly perishable product that may turn sour if left at room temperature. Milk is cooled to improve its quality and stability. Milk leaves the cow at ± 37°C and must be cooled within 3 hours to 4°C. During cold storage, the milk must be stirred gently to prevent a cream layer from forming on top (cream separation by gravity).

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Raw milk is thus kept in large vertical tanks at the factory or processing plant, which is fitted with one or more propeller agitator(s) until further processing proceeds.

Milk preparation for the manufacturing of stirred yoghurt

Clarification of milk

Clarification is the removal of solid impurities (dirt particles, white blood cells and cells of udder tissue) from the milk, prior to further processing. Clarification is achieved through filtration. Milk may be filtered through a perforated strainer, fine-wire mesh or woven cloth ("melkdoek") in small dairies. Medium and large dairies use replaceable in-line filters situated before the heat exchanger.

Pre-heating of milk for separation

Prior to separation the milk is heated to 45 - 60°C to ensure effective separation of the skim milk and cream phase. Heating also inactivates the enzyme lipase that is responsible for the development of rancidity in fats. Pre-heating guarantees the highest possible cream quality, i.e. the lowest amount of free fat in skim milk. Heating takes place in a batch vessel or in a plate heat exchanger.

Fast facts:

Fresh milk should be cooled to: **4 °C**

Prior to separation the milk is heated to: **45 - 60 °C**

Separation and standardisation of milk for yoghurt

Separation: The cream fraction of raw milk is separated from the skim milk by passing pre-heated raw milk (45 – 60°C) through a conventional or hermetic centrifugal separator.

Standardisation follows directly after separation and involves the adjustment of the fat content of milk to obtain a product with a defined, guaranteed fat content. Yoghurt products are classified according to their fat content. The fat content of milk must therefore be adjusted and standardised accordingly since the fat content of raw milk varies. Standardisation is preceded by separation of the milk and cream and then re-mixing the two fractions in the desired proportions.

Take note: Fat-free drinking yoghurt is made from skim milk and does not require re- mixing - only separation.

Fortification and stabilisation of milk for yoghurt

Fortification is the process by which manufacturers add micronutrients such as vitamins and proteins to milk. The yoghurt-milk is generally fortified with skimmed milk powder, stabilisers and sugars.

- The solid-non-fat (SNF) content of the milk must be raised by 1.5 - 3%. The milk is therefore fortified by adding skimmed milk powder.
- Water-binding stabilisers (hydrocolloids) are used to increase the viscosity and reduce whey separation of the final product. The stabilisers used must be in accordance with legal requirements.
- Sugar or another forms of sweetener is an optional ingredient that may be added at this stage.

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Homogenisation of milk for yoghurt (optional)

Homogenisation, an optional process which is most effective when the milk is slightly heated (55 - 60°C), is the process where the fat globules in cream (or milk) are disintegrated or finely and homogeneously distributed to reduce creaming or prevent fat separation. It can be considered as a special method of emulsification.

The diameter of the fat globules is reduced and their ability to separate is lowered, making the homogenised product very stable. The homogenisation head consists of a high-pressure positive pump that forces the cream through a narrow gap in a specially designed valve. The high pressure (15 – 25 MPa) on the inlet side causes the fat globules in the cream to break up. Homogenisation takes place at the first homogenising head. The second head, which operates at a lower pressure and is used to break up any clusters of fat globules, is also recommended.

Advantages and disadvantages of homogenisation for yoghurt are

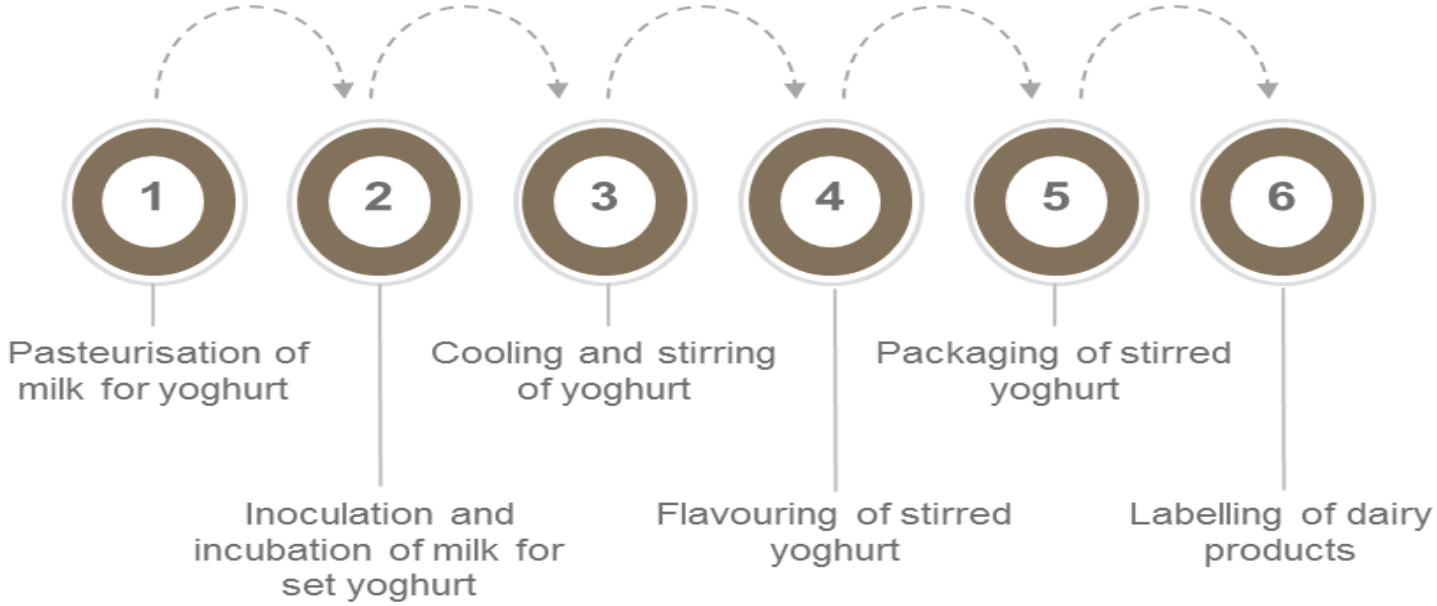
Advantages

- the uniform distribution of the fat globules provides for a creamier taste,
- reduced sensitivity to oxidation and
- it changes the structure of the protein-casein micelle, which improves the water binding capacity of the yoghurt.

Disadvantages

- increased sensitivity to sunlight which leads to the development of a metallic taste,
- increased sensitivity to lipase (enzyme) and
- reduced protein stability during temperature variations.

Process overview



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Stirred yoghurt process

1. Pasteurisation of milk for yoghurt

Pasteurisation is generally defined as a mild heat treatment that destroys all vegetative pathogens and heat sensitive enzymes. Pasteurisation of milk for yoghurt is done at relatively high temperatures in order to denature the whey proteins and to form complexes between milk proteins, and therefore increase the water binding properties and increase the viscosity of the product.

Various pasteurisation methods available, depending on the size of the processing plant:

Batch pasteurisation: This method is suitable for small operations with less than 2500 litres of milk per day. The milk is pumped into an open vat or jacketed vat fitted with an agitator where it is heated. The milk is held at least 30 minutes at 85.5°C followed by cooling within 30 minutes to 43 - 45°C.

Continuous pasteurisation: Large processing plants make use of a continuous High Temperature Short Time (HTST) method. Milk is heated quickly to 90 - 95°C for 15 - 40 seconds in a plate heat exchanger. This is a compact, simple, easily cleaned and economic heating device since it uses the hot pasteurised milk to pre-heat the incoming cold milk (and vice versa), i.e. makes use of energy regeneration. The pasteuriser consists of series of stainless steel plates mounted vertically, supported by cylindrical bars, and are tightly packed and sealed together. The plates have waffle-like indentations that provide a large heat transfer area and a turbulent flow of the liquids.

Fast facts: Small operations: **Batch** pasteurisation | Large operations: **Continuous** pasteurisation

A rubber-seal between the plates keep them about 5 - 8 mm apart. The liquids leave the plates through holes in the corners of the plates. Open and blind holes route the liquids to the correct plate processing area. Five stages of heat exchange can be identified:

- **Regenerative heating**: The incoming milk is pumped to the regeneration section of the heat exchanger where it is heated to 55 - 65°C by heat transfer from freshly pasteurised milk. Up to 92% of required heat can be recovered in this way. Milk may leave the pasteuriser at this stage to be homogenised and return to the next section.
- **Heating:** Milk is further heated indirectly with hot water, vacuum steam or saturated steam at atmospheric pressures to the required temperature (90 - 95°C).
- **Holding:** The hot milk is held at the required temperature in a chamber or a holding pipe for the required period of time (15 - 40 seconds). The dimensions of the holding pipe must be sufficient to ensure the required residence time and flow rate of the milk. The stainless steel holding pipe slopes upwards and excludes trapped air. The temperature at the end of the pipe is continuously monitored to ensure sufficient pasteurisation. If the required temperature is not maintained for long enough, the milk is returned to the heating and/or holding sections via the flow diversion valve.
- **Regenerative cooling:** The hot milk from the holding section goes to the regeneration section where it is cooled to 50 - 60°C by heat transfer to the incoming milk.

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- **Cooling:** Milk is further cooled to 43 - 45°C, first with cold water and finally with chilled water or refrigerant (brine or polyalcohol solutions). The higher the fat content of the milk, the higher the final temperature of the cooled milk will be. This prevents the milk from thickening, resulting in clogging of pipelines and filling problems. The mechanical action involved in pumping and filling thick, cold milk could also cause damage to the fat globules.

  Take note: It is required by law in South Africa that processors keep thermographic recordings of the temperature of pasteurisation for at least four weeks; and that apparatus used must be calibrated monthly to ensure the correctness of the pasteurisation process.

4. Inoculation and incubation of milk for yoghurt

Inoculation is the addition of starter cultures to a food substance to initiate fermentation reactions. The warm milk (42°C) is pumped into the fermentation tank and inoculated with a starter culture mixture containing Streptococcus thermophilus and Lactobacillus delbrueckii subspecies bulgaricus. The milk and starter culture are mixed thoroughly to ensure even dispersion of the culture in the milk.

The inoculated milk is incubated for 5 - 7 hours to allow fermentation to take place until the pH is reduced to 4.5. Fermentation is defined as the conversion of the milk sugar (lactose) into simpler substances such as acids through the action of the starter culture and enzymes. The fermentation tanks are insulated to ensure that an even temperature is maintained throughout the incubation period

Fast facts:	Inoculated milk is incubated for:	Hours: 5 - 7	Coagulated milk cooled to: 15 - 22 °C

3. Cooling and stirring of yoghurt

When the coagulated milk has reached the required pH, it must be cooled to 15 – 22°C. This prevents further culture activity, stabilises the pH and ensures a stable texture. Cooling takes place in the fermentation vat by replacing the heating medium (hot water) with cold water.

At the same time, the hot coagulated product is gently stirred (“striked”) for minimum shear to the product. Striking breaks the curd and re-incorporates the whey. It also retards culture activity and slows the souring rate to reduce the risk of over-fermentation.

Cooling renders the proteins less sensitive to agitation and makes it favourable to mix fruit, flavourings and additional ingredients.

2. Flavouring of stirred yoghurt

Pasteurised fruit can be added and gently incorporated into the yoghurt. This is done in batches in bulk tanks or continuously (on large-scale) while the yoghurt is pumped to the packaging machines. Continuous (in-line) flavouring is performed by metering pumps that feed the desired ingredients into the yoghurt.

5. Packaging of stirred yoghurt

Ideally packaging of stirred yoghurt should take place at 20 - 25°C. The yoghurt is filled into pre-formed plastic tubs and sealed with a foil film or snap-on plastic lids. Low viscosity yoghurts should be filled without force (gravity filled) by piston fillers with a large dispensing opening.

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The packaged product is immediately placed in cold storage rooms to reduce its temperature to 12°C and thus extend the keeping quality.

6. Labelling of dairy products

The containers are labelled/printed with the necessary information. The label information and presentation must be in accordance with the requirements set out in the Regulations

Labelling in South Africa is controlled by legislation. Anyone who wants to use the information provided in this document must familiarise him/herself with all the applicable laws that apply to the producing, processing, manufacturing and storage of the products referred to in this document.

Other processing options – Cultured dairy products

Listed below are other processing options not covered in this report, but available from Eskom.

- **Cultured buttermilk** is the product obtained from milk that has been inoculated with a starter culture to produce a viscous liquid with a mild lactic flavour. It is consumed as a refreshing drink or used as an ingredient in various baked products.
- **Gouda** is a close textured, mild cheese. It is classified as semi-hard.
- **Kefir** is a smooth, viscous, fermented dairy drink with a fresh acidic taste and contains lactic acid, alcohol (± 1%) and gas (carbon dioxide).
- **Maas (cultured milk) is** manufactured by inoculating pasteurised milk with a specific bacterial culture. The end product has a firm texture, no gas bubbles and no separation of whey from the coagulum. It has pleasant sour taste with a slight bite/prickliness on the tongue.
- **Processed cheese** is made from a variety of natural cheeses that are ground and blended together with emulsifying agents. Various other additives may also be added. The mixture is heated and packaging in laminated films.
- **Ricotta** is a cheese prepared from whey. Ricotta is a low fat, soft cheese with a maximum fat in dry matter content of 10% and a minimum dry matter of 20%.
- **Cultured (sour) cream** is the product obtained from cream that has been inoculated with a starter culture to allow for the development of lactic acid and flavour compounds under controlled conditions.
- **Cheese spread** is a blend of hard cheese with added emulsifying salts. The mixture undergoes a heat treatment that increases the shelf life. Cheese spread has relatively high moisture content (± 55 %) and a pH of 5.7 – 6.3.
- **Cheddar cheese** is defined as the product obtained from coagulated milk from which the whey has been removed. The coagulum or curd has undergone ripening to a greater or lesser extent. Cheddar is classified as a high fat, hard cheese.
- **Drinking yoghurt** is essentially stirred yoghurt with a lower solids content and broken coagulum. It may be pasteurised and/or aseptically packaged to extend the keeping quality.
- **Feta** is a pickled cheese with a clean, acidic salty taste. It is packaged in a brine solution to prevent drying out and to preserve the cheese.
- **Cottage cheese** is the product obtained from coagulating milk. It is a soft, not matured cheese and contains about 80% moisture.

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