

YOGURT PRODUCTION

INGREDIENTS, MANUFACTURING
AND FAULTS

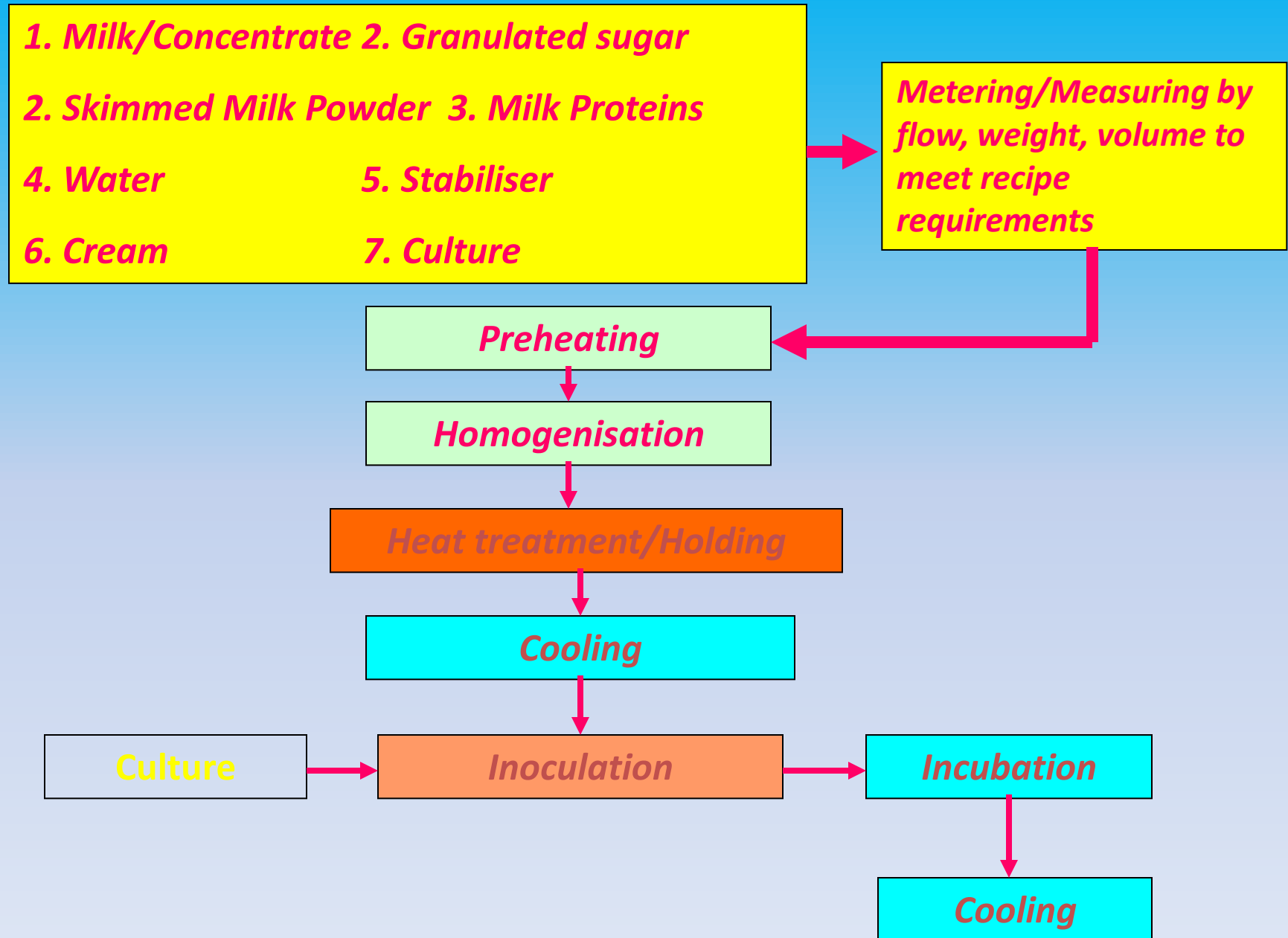
YOGURT PRODUCTION

- RAW MATERIALS
- PRODUCT FORMULATION
- MANUFACTURE
- WHAT GOOD LOOKS LIKE
- FRUIT YOGURT

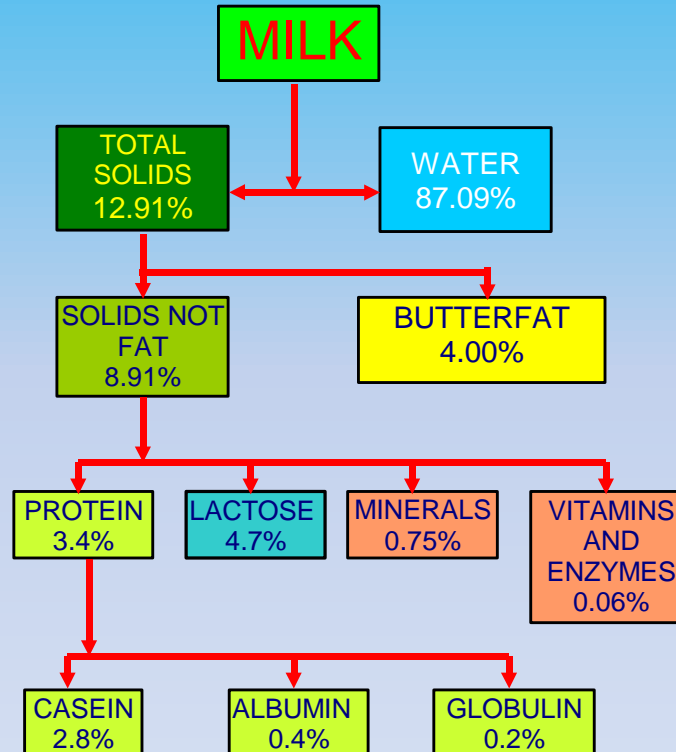
2. DEFINITION

*Yogurt is a **FERMENTED** dairy product made from various milks standardised to a specific composition and coagulated to a smooth curd by the action of **SPECIFIC LACTIC ACID BACTERIA**. Fruits, sugar flavours, colours etc. may be added.*

White Base Flow Diagram



RAW MATERIALS



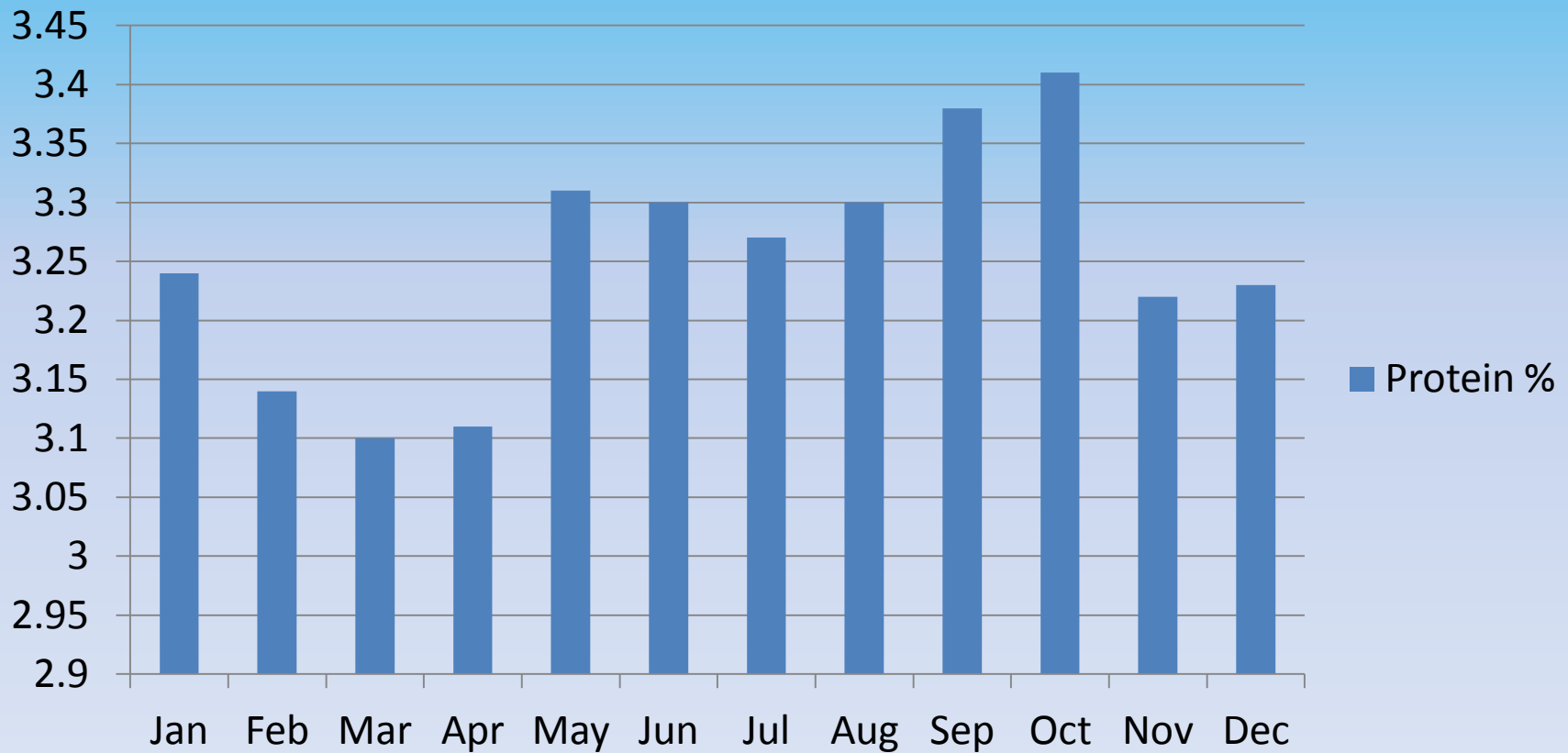
Milk Composition

- Milk is the secretion of the mammary gland – staple food for all young mammals (usually not consumed post weaning).
- High nutritive value – but varies between species

Constituent (g/100g)	Cow	Goat	Sheep	Human
Water (g)	87.9	88.9	83	88.2
Energy (kcal)	66	60	95	69
(kJ)	276	253	396	289
Protein (g)	3.2	3.1	5.4	1.3
Fat (g)	3.9	3.5	6	4.1
Lactose (g)	4.6	4.4	5.1	7.2
Calcium (mg)	115	100	170	34

MILK SEASONAL PROTEIN VARIATION

Protein %



MILK STORAGE

- EX FARM MILK CAN BE STORED UP TO 72 HOURS BEFORE USE
- IT SHOULD BE STORED AT LESS THAN 7°C
- IT CAN DETERIORATE DURING STORAGE
- DETERIORATION CAN INCLUDE:
- PROTEIN BREAKDOWN
- RANCIDITY
- GROWTH OF MICROFLORA CAUSING FLAVOUR TAINTS AND ACIDITY DEVELOPMENT
- FAT WILL SEPARATE IF THE MILK IS NOT AGITATED

SKIMMED MILK CONCENTRATE

- Normally produced by evaporation.
- Normally concentrated to 35% total solids.
- The protein content will vary on an annual basis as it does for milk.

SKIMMED MILK CONCENTRATE

- Can be produced by reverse osmosis.



SKIMMED MILK CONCENTRATE STORAGE

- SKIMMED MILK CONCENTRATE CAN BE STORED FOR UP TO 72 HOURS.
- IT SHOULD BE STORED AT LESS THAN 7°C
- IF IT IS NOT AGITATED LACTOSE CAN CRYSTALLISE AND SETTLE OUT
- IT IS SUBJECT TO THE SAME RISKS OF DETERIORATION AS MILK

CREAM

- IS SUBJECT TO THE SAME RISKS OF DETERIORATION AS EX FARM MILK AND SKIMMED MILK CONCENTRATE.

SKIMMED MILK POWDER

- NORMALLY PRODUCED BY SPRAY DRYING.
- IS SUPPLIED AS LOW, MEDIUM AND HIGH HEAT

FUNCTIONAL MILK PROTEINS

- CAN BE DERIVED FROM CASEIN OR WHEY PROTEINS
- CAN BE A MIXTURE OF THE ABOVE IN ANY COMBINATION
- NORMALLY SUPPLIED AS A POWDER
- THEY CAN BE MICROPARTICULATED AND USED AS A FAT MEMETIC
- CAN BE SUPPLIED AS A LIQUID

STABILISERS

- THE MOST COMMON ARE STARCH, PECTIN AND GELATIN
- ARE NORMALLY SUPPLIED AS POWDERS
- ARE OFTEN SUPPLIED AS PROPRIETRY BLENDS

SUGAR

- CAN BE SUPPLIED IN GRANULAR OR LIQUID FORMS
- ALL POWDERED / GRANULAR INGREDIENTS SHOULD BE STORED IN COOL AND DRY CONDITIONS

CULTURES

- CAN BE EITHER BULK OR DVI (DIRECT VAT INOCULATION)
- DVI CULTURES ARE NORMALLY STORED FROZEN AT -44°C .
- SOME CAN BE STORED AT -18°C
- IF THE USE BY DATE IS EXCEEDED OR THE STORAGE TEMPERATURE RISES CULTURE ACTIVITY DETERIORATES

YOGURT FORMULATION

- YOGURT MANUFACTURE IS SUBJECT TO A CODE OF PRACTICE OF WHICH DAIRY UK ARE THE CURRENT CUSTODIANS
- PROTEIN MUST BE AT LEAST 2.9%
- LOW FAT MEANS LESS THAN 2.0% FAT
- VIRTUALLY FAT FREE MEANS LESS THAN 0.3% FAT
- NATURAL MEANS PLAIN AND UNSWEETENED

YOGURT FORMULATION

- SHOULD BE BASED ON A SPECIFICATION OF THE DESIRED ATTRIBUTES OF THE FINISHED PRODUCT
- THE ATTRIBUTES SHOULD INCLUDE:
 - VISCOSITY
 - TEXTURE
 - FLAVOUR
 - SWEETNESS

YOGURT FORMULATION

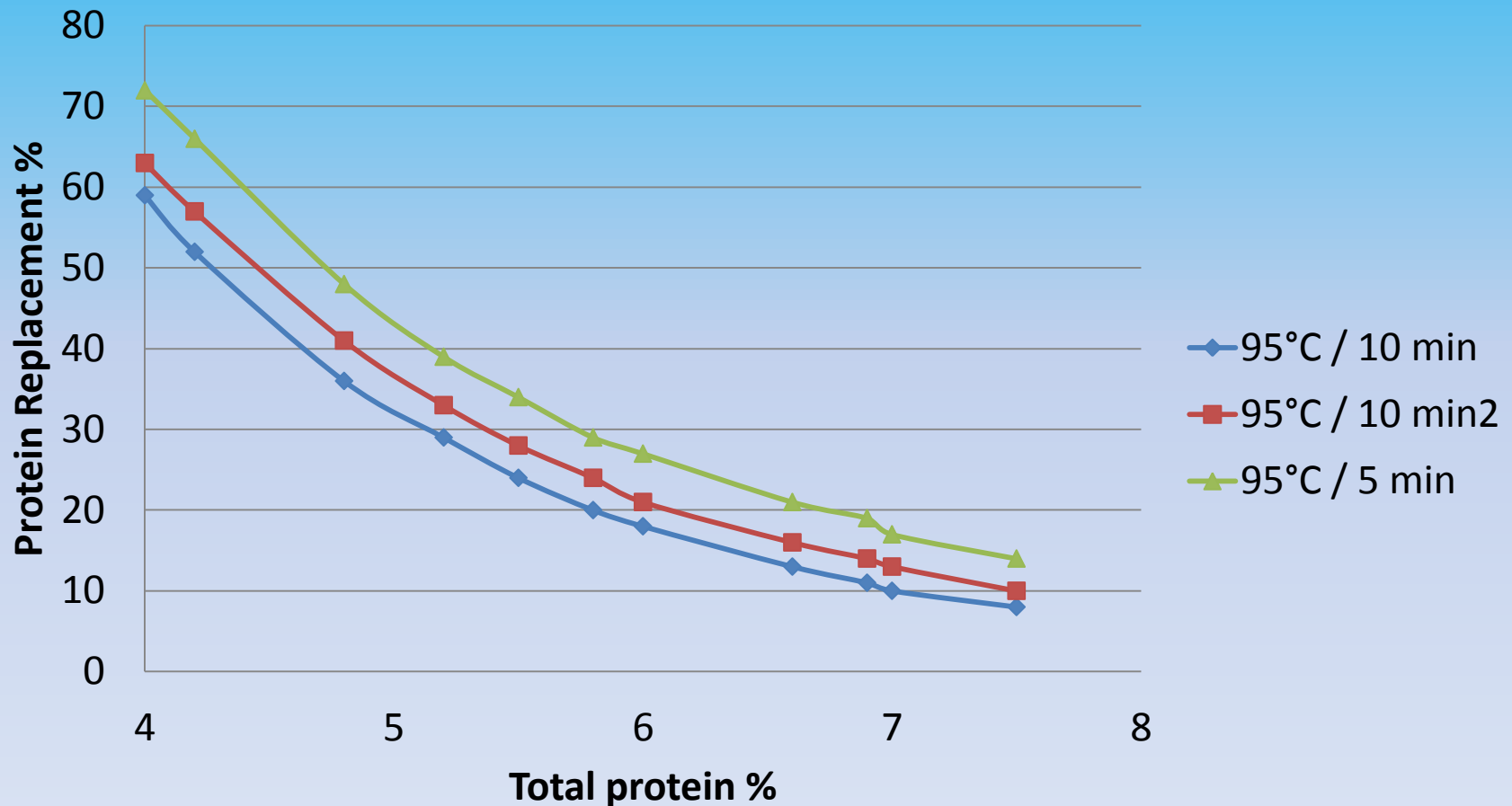
- THE FOLLOWING FACTORS AFFECT VISCOSITY:
- TOTAL SOLIDS %
- PROTEIN %
- STABILISER SYSTEM
- CULTURE CHOICE

YOGURT FORMULATION

- VISCOSITY INCREASES AS THE PERCENTAGE OF TOTAL SOLIDS INCREASES
- THE INCREASE IS DEPENDENT ON WHICH TYPE OF SOLID CONTENT IS BEING INCREASED
- PROTEIN HAS A SIGNIFICANT EFFECT ON VISCOSITY.
- THIS EFFECT CAN VARY DEPENDENT ON THE TYPE OF PROTEIN

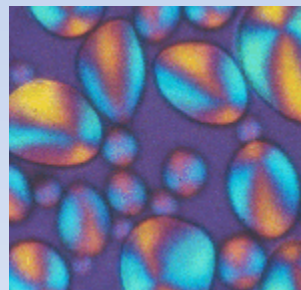
YOGURT FORMULATION

Protein replacement by whey protein



YOGURT FORMULATION

- THE ADDITION OF STARCH INCREASES VISCOSITY
- STARCH IS RELATIVELY CHEAP
- IT IS USUALLY ADDED AT AROUND 2%



YOGURT FORMULATION

- THE ADDITION OF GELATIN INCREASES VISCOSITY
- 240 BLOOM GELATIN IS USUALLY ADDED AT AROUND 0.5%

YOGURT FORMULATION

- THE ADDITION OF PECTIN INCREASES VISCOSITY
- IT IS USUALLY ADDED AT AROUND 0.5%
- INCREASING PROTEIN CONTENT AFFECTS TEXTURE BY ADDING MORE BODY.
- INCREASING STARCH AFFECTS TEXTURE BY ADDING MORE BODY.
- STARCH CAN IMPART A SLIGHTLY GRAINY AND DULL CHARACTERISTIC

YOGURT FORMULATION

- INCREASING GELATIN AFFECTS THE TEXTURE BY ADDING MORE BODY
- GELATIN IMPARTS A SLIGHTLY GELLED CHARACTERISTIC WITH SHORT TEXTURE
- INCREASING PECTIN AFFECTS THE TEXTURE BY ADDING MORE BODY
- PECTIN IMPARTS A SLIGHTLY GELLED CHARACTERISTIC THAT IS MORE “PUDDINGY” THAN GELATIN

YOGURT FORMULATION

- CULTURE CHOICE HAS A LARGE IMPACT ON TEXTURE
- CULTURE COMPANIES GRADE THEIR CULTURES BASED ON HOW MUCH VISCOSITY THEY PRODUCE
- CULTURES GENERATE VISCOSITY BY PRODUCING MUCOPOLYSACCHARIDES
- MUCOPOLYSACCHARIDES IMPART A LONG TEXTURE IN ADDITION TO ADDING BODY

YOGURT FORMULATION

- SOME WHEY PROTEINS CAN AFFECT FLAVOUR BY IMPARTING A “CARDBOARDY” FLAVOUR
- STARCHES CAN IMPART DIFFERENT FLAVOURS ACCORDING TO THEIR SOURCE eg RICE, POTATO, MAIZE ETC
- GELATIN IS FLAVOUR NEUTRAL
- PECTIN CAN IMPART A CITRUS FLAVOUR

YOGURT FORMULATION

- CULTURES HAVE A MAJOR IMPACT ON FLAVOUR
- THEY PRODUCE LACTIC ACID
- THEY PRODUCE OTHER FLAVOUR COMPOUNDS
- THESE OTHER FLAVOUR COMPOUNDS VARY BY SPECIES, STRAIN AND GROWTH CONDITIONS

YOGURT FORMULATION

- SWEETNESS IS ACHIEVED BY ADDING SUGAR OR ARTIFICIAL SWEETENERS
- GRANULATED SUGAR (SUCROSE) IS NORMALLY SPLIT BETWEEN THE YOGURT BASE AND FRUIT PREPARATION
- ARTIFICIAL SWEETENERS ARE NORMALLY ADDED TO THE FRUIT PREPARATION

YOGURT MANUFACTURE

- INGREDIENTS HAVE TO BE MIXED BEFORE PROCESSING
- THIS CAN BE A CONTINUOUS BUT IS NORMALLY A BATCH PROCESS
- LIQUID INGREDIENTS ARE MEASURED BY FLOW METER OR LOAD CELL
- METERING SYSTEMS MUST TAKE INTO ACCOUNT THE DENSITY OF LIQUID INGREDIENTS
- POWDER INGREDIENTS ARE ADDED VIA A RECIRCULATION LOOP WITH A POWDER HOPPER
- POWDERS ARE LEFT TO HYDRATE BEFORE PROCESSING

YOGURT MANUFACTURE

- THE YOGURT MIX IS NORMALLY HEATED TO APPROX 50°C PRIOR TO HOMOGENISATION
- HOMOGENISATION PRESSURE IS TYPICALLY 2000 psi FIRST STAGE 500 psi SECOND STAGE
- HOMOGENISATION PREVENTS FAT SEPARATION DURING INCUBATION
- SOME HAVE REPORTED IMPROVED TEXTURE DUE TO EFFECT ON PROTEINS

YOGURT MANUFACTURE

- HEAT TREATMENT FOLLOWS HOMOGENISATION
- A PLATE HEAT EXCHANGER IS NORMALLY USED
- 95°C FOR 10 MINUTES IS TYPICAL
- THIS REDUCES CONTAMINATION BY MICROORGANISMS TO AN ACCEPTABLE LEVEL
- THE PROTEIN STARTS TO DENATURE
- THIS IS DELIBERATE AS IT IMPROVES TEXTURE
- IF STARCH IS PRESENT IT IS COOKED OUT

YOGURT MANUFACTURE

- THE HEAT TREATED MIX IS COOLED TO INCUBATION TEMPERATURE
- THE COOLED MIX IS INOCULATED WITH THE STARTER CULTURE
- THE BACTERIA IN THE STARTER CULTURE CONVERT THE LACTOSE IN THE MILK TO LACTIC ACID
- THIS CAUSES A DROP IN pH

YOGURT MANUFACTURE

- THE DROP IN pH CAUSES THE PROTEIN TO SET INTO A GEL
- THE HIGHER THE PROTEIN CONTENT THE STRONGER THE GEL
- THERE IS A THEORY THAT INCREASING THE RATIO OF WHEY PROTEIN TO CASEIN INCREASES GEL STRENGTH
- THIS COULD BE DUE TO WHEY PROTEIN COMBINING WITH CASEIN DURING HEAT TREATMENT

YOGURT MANUFACTURE

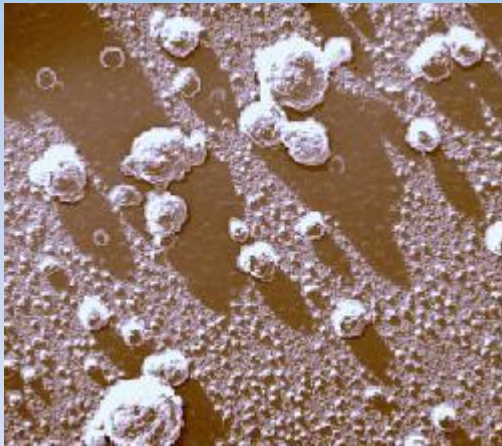
- BECAUSE PROTEIN GENERATES VISCOSITY BY FORMING A GEL ITS LEVEL SHOULD BE CONTROLLED FOR CONSISTENCY
- RECIPES MUST THEREFORE BE ADJUSTED TO TAKE ACCOUNT OF THE SEASONAL VARIATION IN PROTEIN CONTENT

YOGURT MANUFACTURE

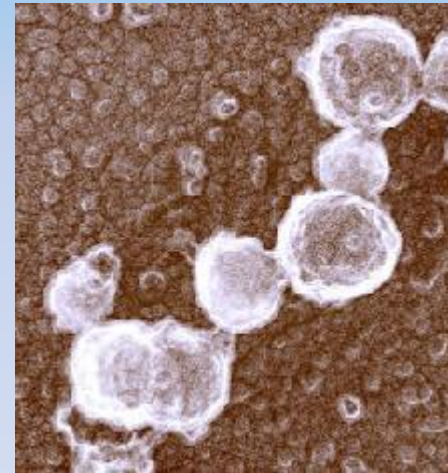
- PROTEIN IN ITS NATIVE STATE HAS A NET NEGATIVE ELECTRICAL CHARGE
- PROTEIN MICELLES STAY IN SUSPENSION BECAUSE THEY REPEL EACH OTHER
- A GEL FORMS BECAUSE THE ACIDIC CONDITIONS NETRALISE THE ELECTRICAL CHARGE AND THE MICELLES CAN COME TOGETHER
- THE pH AT WHICH THIS OCCURS IS CALLED THE ISOELECTRIC POINT

YOGURT MANUFACTURE

CASEIN MICELLES IN MILK



CASEIN MICELLES IN YOGURT



YOGURT MANUFACTURE

- THE ISOELECTRIC POINT OF CASEIN IS pH 4.6
- THE END POINT OF INCUBATION IS NORMALLY DETERMINED BY pH MEASUREMENT AND IS TYPICALLY 4.5
- TITRATEABLE ACIDITY CAN ALSO BE USED

YOGURT MANUFACTURE

- AT THE END OF INCUBATION THE SET IS BROKEN BY STIRRING
- THIS IS NORMALLY DONE VIA A GATE AGITATOR
- A FIXED BAFFLE PLATE IS HIGHLY DESIRABLE BECAUSE IT PREVENTS THE MASS FROM SPINNING WITH THE AGITATOR
- THE COAGULUM SHOULD BE BROKEN DOWN TO AN HOMOGENOUS FLOWING CONSISTENCY

YOGURT MANUFACTURE

- AFTER BREAKING THE SET THE YOGURT IS COOLED TO ARREST CULTURE ACTIVITY
- NORMALLY DONE BY PUMPING THROUGH A PLATE COOLER
- SOME FORM OF TEXTURISING DEVICE IS USUALLY PLACED BETWEEN THE PUMP AND COOLER
- THE PURPOSE OF THIS IS TO MAKE THE YOGURT COMPLETELY SMOOTH

YOGURT MANUFACTURE

- TEXTURISING IS BEST DONE AT INCUBATION TEMPERATURE
- YOGURT HAS THE PROPERTY OF THIXOTROPY
- THIS MEANS IT GETS THINNER WITH MECHANICAL HANDLING
- YOGURT IS LESS VISCOUS AT HIGHER TEMPERATURES

YOGURT MANUFACTURE

- LESS VISCOSITY MEANS THE YOGURT IS SUBJECTED TO LESS SEVERE MECHANICAL HANDLING BECAUSE LESS SYSTEM PRESSURE IS GENERATED
- THE BEST PRACTICE IS TO IMPART THE MINIMUM MECHANICAL INTERVENTION TO YIELD A SMOOTH YOGURT
- THIS YIELDS THE HIGHEST VISCOSITY AND THEREFORE THE BEST VALUE FROM THE INGREDIENTS

YOGURT MANUFACTURE

- THERE ARE MANY TYPES OF TEXTURISING DEVICE INCLUDING:
- FILTERS
- ORIFICE PLATES
- PRESSURE CONTROL VALVES
- MECHANICAL TEXTURISERS

YOGURT MANUFACTURE

- FILTERS NEED TO BE A MAXIMUM OF 250 microns
- THEY HAVE A LARGE SURFACE AREA TO KEEP PRESSURE BUILD UP TO A MINIMUM
- 1 mm MESH FILTERS (TYPICALLY USED TO REMOVE FOREIGN BODIES) WILL NOT WORK
- FILTERS HAVE TO BE REMOVED BEFORE CIP

YOGURT MANUFACTURE

- ORIFICE PLATES ARE NORMALLY BUTTERFLY VALVES WITH HOLES IN
- THE HOLES RESTRICT THE CROSS SECTIONAL AREA WHICH GENERATES HIGH PRESSURE
- THE HIGH PRESSURE MAKES THE YOGURT SMOOTH
- THE VALVES CAN SIMPLY BE OPENED TO CIP
- A CRACKED OPEN BUTTERFLY VALVE HAS THE SAME EFFECT

YOGURT MANUFACTURE

- PRESSURE CONTROL VALVES MAKE THE YOGURT SMOOTH BY GENERATING PRESSURE
- MECHANICAL TEXTURISERS CONSIST OF ROTATING INTERMESHING PEGS THROUGH WHICH THE YOGURT FLOWS.
- THE HIGH LEVEL OF MECHANICAL INPUT MAKES THE YOGURT SMOOTH
- EVERY OPERATION FOLLOWING TEXTURISING SHOULD IMPART THE MINIMUM POSSIBLE MECHANICAL INTERVENTION

YOGURT MANUFACTURE

- EVERY OPERATION FOLLOWING TEXTURISING SHOULD IMPART THE MINIMUM POSSIBLE MECHANICAL INTERVENTION
- THIS MAINTAINS THE PRODUCT VISCOSITY

YOGURT MANUFACTURE

- THIS IS NORMALLY DONE USING A PLATE HEAT EXCHANGER.
- THE GAPS BETWEEN THE PLATES SHOULD BE WIDE TO MINIMISE PRESSURE
- BEST PRACTICE IS TO COOL TO THE HIGHEST POSSIBLE TEMPERATURE AS THIS YIELDS THE HIGHEST VISCOSITY
- YOGURT IS NORMALLY COOLED TO 15 – 25°C PRIOR TO STORAGE
- THIS SLOWS CULTURE ACTIVITY TO AN ACCEPTABLE LEVEL

YOGURT MANUFACTURE

- AFTER COOLING YOGURT IS NORMALLY STORED PRIOR TO PACKING
- IF BULK STORAGE TANKS ARE USED THEY SHOULD BE GENTLY STIRRED BY GATE AGITATORS
- AGITATION PREVENTS WHEY SEPARATION
- THERE MUST BE A MEANS OF TRANSFERRING THE YOGURT FROM STORAGE TO A FILLER
- THIS IS NORMALLY DONE VIA A POSITIVE PUMP
- IT CAN ALSO BE DONE BY OVERPRESSURE

YOGURT MANUFACTURE

- PACKING IS NORMALLY DONE BY VOLUMETRIC METERING
- PACKING AT THE HIGHEST POSSIBLE TEMPERATURE FOLLOWED BY IN POT COOLING YIELDS THE HIGHEST VISCOSITY
- WARNING! RETAILERS REJECT CHILLED PRODUCTS AT DELIVERY TEMPERATURES ABOVE 5°C

WHAT GOOD QUALITY LOOKS LIKE

- TEXTURE SHOULD BE SMOOTH
- THIS IS EASILY TESTED BY SMEARING ONTO A BLACK SURFACE
- VISCOSITY SHOULD COMPLY WITH SPECIFICATION
- THERE ARE MANY METHODS OF TESTING VISCOSITY INCLUDING:

WHAT GOOD QUALITY LOOKS LIKE

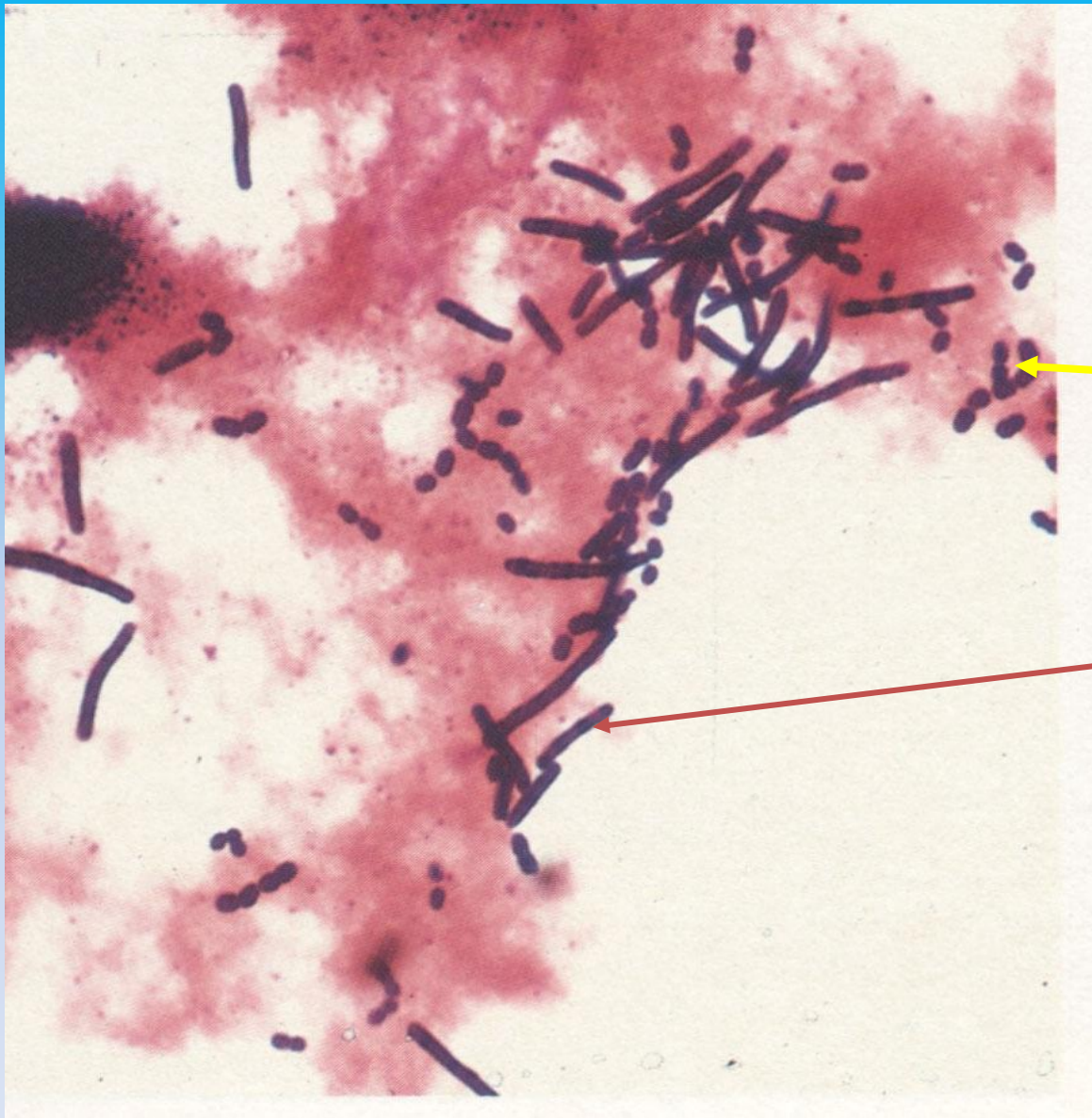
- VISCOSITY SHOULD COMPLY WITH SPECIFICATION
- THERE ARE MANY METHODS OF TESTING VISCOSITY INCLUDING:
 - BOSTWICK CONSISTOMETER
 - TORSION WIRE VISCOMETER
 - BROOKFIELD VISCOMETER
 - PENETROMETER

WHAT GOOD QUALITY LOOKS LIKE

- THERE SHOULD BE NO OFF FLAVOURS OR TAINTS
- NORMALLY A MILD ACIDITY WITH BACKGROUND BUTTERY NOTES IS DESIRED
- THIS IS ACHIEVED BY USING BIO CULTURES
- BIO CULTURES ARE USUALLY BLENDED WITH *Streptococcus thermophilus*

BIOCULTURES

- *L. delbruekii sub sp. casei*
- *L. acidophilus*
- *L. acidophilus NCFM strain*
- *Bifidobacterium sp.*
- *L. acidophilus LC1 strain*
- *Causido cultures*
- *Survives low pH and bile. Adheres to gut wall.*
- *Suvives longer in gut. Milder taste*
- *Produces bacteriocins*
- *Longer survival in gut. Milder taste*
- *Stimulates immune system*
- *Claimed to reduce cholestrol*

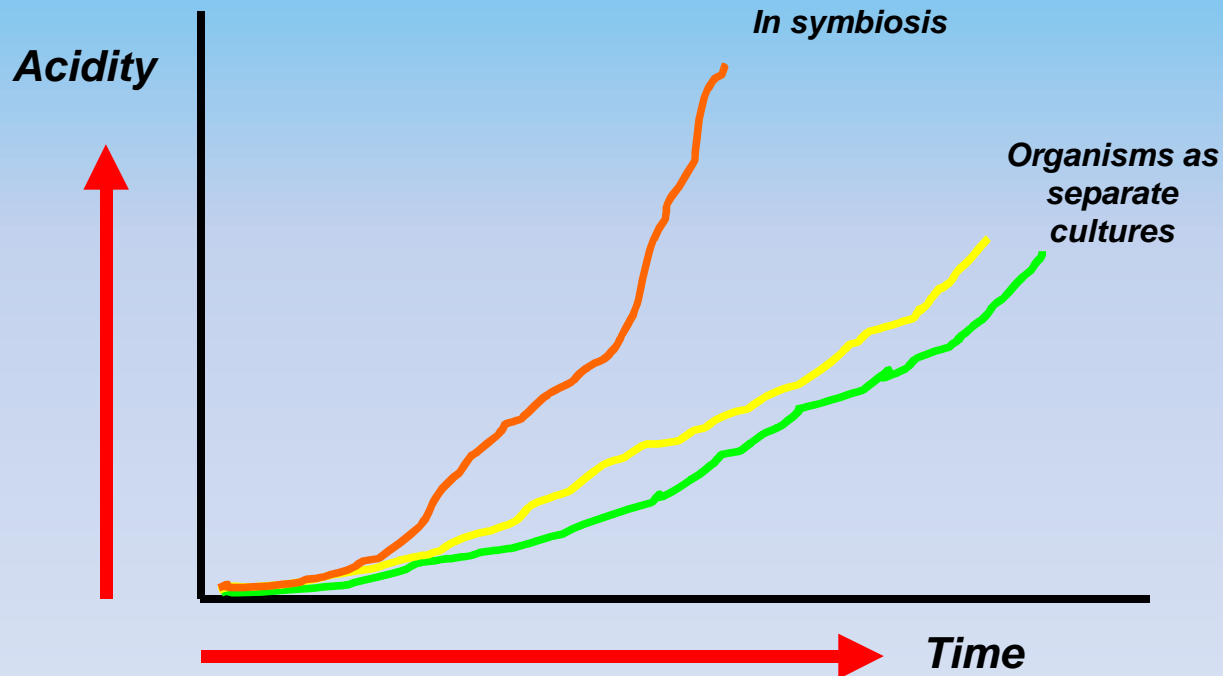


Streptococcus salivarius
sub species
thermophilus

Lactobacillus delbruekii
sub species *bulgaricus*

Culture information

Acid production/Symbiotic growth



WHAT GOOD QUALITY LOOKS LIKE

- *Lactobacillus bulgaricus* CONTINUES TO PRODUCE ACID OVER SHELF LIFE
- MOST YOGURTS USED TO BE MANUFACTURED WITH A BLEND OF *Streptococcus thermophilus* and *Lactobacillus bulgaricus*.

WHAT CAN GO WRONG?

- SOMETIMES THERE IS NO / SLOW ACID DEVELOPMENT DUE TO INSUFFICIENT CULTURE ACTIVITY
- THERE ARE SEVERAL REASONS WHY THIS MAY OCCUR
- IF THE YOGURT MIX IS CONTAMINATED WITH COMPETING BACTERIA, THEY MAY GROW AT THE EXPENSE OF THE CULTURE

WHAT CAN GO WRONG?

- IF THIS OCCURS IT IS NORMAL TO SEE AN INITIAL SMALL AMOUNT OF ACID DEVELOPMENT THAT THEN STOPS
- THE YOGURT MIX WILL HAVE A BITTER TAIN
- OR THE CULTURE COULD HAVE THAWED AND BEEN RE-FROZEN

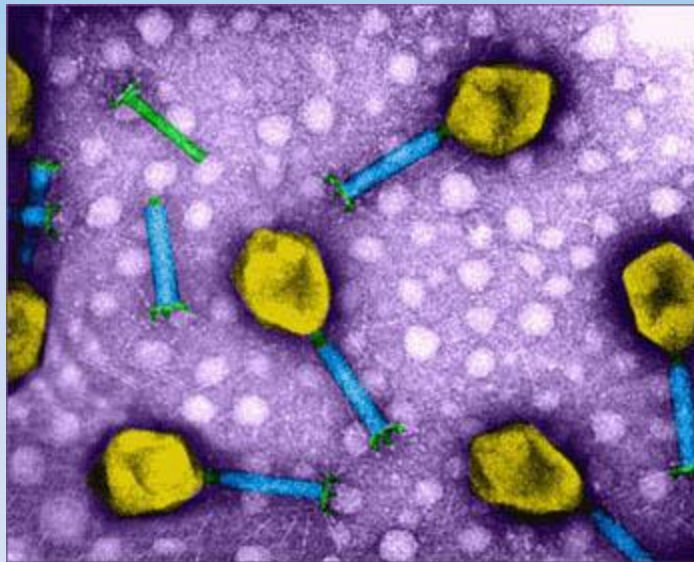
WHAT CAN GO WRONG?

- PHAGE ATTACK CAN OCCUR BUT IS VERY, VERY RARE

Resistance to bacteriophage

*The risk of phage attack is low
due to :*

- 1. Rapid acid development*
- 2. Enclosed nature of production*



WHAT CAN GO WRONG?

- ANTIBIOTICS IN THE MILK CAN ARREST STARTER GROWTH
- THIS IS ALSO VERY RARE

WHAT CAN GO WRONG?

- WEAK SETS AND POWDERY TEXTURE USUALLY OCCUR TOGETHER
- A WEAK SET IS WHERE ACIDITY DEVELOPS DURING INCUBATION BUT THE GEL IS NOT FIRM / ABSENT
- CAN BE CAUSED BY PROTEIN DETERIORATION PRIOR TO HEAT TREATMENT
- THE MAIN CAUSE OF THIS IS ACIDITY DEVELOPMENT IN THE MILK DURING STORAGE

WHAT CAN GO WRONG

- HEATING ACIDIC MILK CAUSES THE PROTEIN TO PRECIPITATE
- THIS CAN BE SEEN AND TASTED FOLLOWING HEAT TREATMENT
- A THIN FILM ON A CLEAR SURFACE LOOKS GRAINY
- IT TASTES POWDERY
- ACIDITY WILL STILL DEVELOP BUT THE PROTEIN IS TOO DAMAGED TO FORM A GEL

WHAT CAN GO WRONG

- THE SAME FAULT CAN OCCUR IF TOO MUCH WHEY PROTEIN IS INCLUDED IN THE FORMULATION
- THERE IS A MAXIMUM HEAT TREATMENT FOR ANY PROTEIN % AND TYPE
- IF THIS IS EXCEEDED THE PROTEIN WILL PRECIPITATE DURING HEAT TREATMENT
- IF NO FUNCTIONAL PROTEINS ARE ADDED THIS MAXIMUM IS HIGHER THAN THAT NORMALLY USED FOR YOGURT MANUFACTURE

WHAT CAN GO WRONG

- WHEY CAN SEPARATE DURING STORAGE
- IT CAN HAPPEN WITHIN 15 MINUTES OF TANK FILLING
- THIS IS MORE OF A PROBLEM WITH MILD YOGURTS
- THE STORAGE pH OF MILD YOGURTS IS CLOSE TO THE ISOELECTRIC POINT
- DURING STORAGE THE PROTEIN GEL STARTS TO FORM AGAIN
- THIS CAUSES SHRINKAGE AND EXPULSION OF WHEY
- THE EFFECT INCREASES AT HIGHER PROTEIN PERCENTAGES
- THE EFFECT INCREASES AT HIGHER TEMPERATURES

WHAT CAN GO WRONG?

- WHEY SEPARATION CAUSES INCONSISTENCY
- IT CAN BE REINCORPORATED BY AGITATION
- THE MINIMUM AGITATION REQUIRED TO MAINTAIN CONSISTENCY SHOULD BE USED
- INTERMITTENT AGITATION IS NORMALLY SUFFICIENT

WHAT CAN GO WRONG?

- GRANULATION ALSO OCCURS BECAUSE OF THE PROTEIN TRYING TO REFORM INTO A GEL
- GRAINS CAN START TO APPEAR 1 HOUR AFTER TANK FILLING
- THE GRAINS CAN BE BROKEN UP BY PUMPING THROUGH A FILTER
- THE FILTER SHOULD BE BETWEEN 100 AND 250 MICRON
- GRANULATION INCREASES AS PROTEIN INCREASES
- IT APPEARS TO INCREASE WITH THE VOLUME BEING STORED

SUMMARY

- RAW MATERIALS MUST BE TO SPECIFICATION
- RAW MATERIALS MUST BE PROPERLY STORED
- FORMULATIONS MUST BE ROBUST
- STORAGE TANKS MUST BE AGITATED
- EX STORAGE TANK FILTERS ARE EXTREMELY USEFUL
- PROCESSING MUST BE CONSISTENT