Technical and Technological Issues

for

Donors, Programme Administrators and Processors

For Kenya Dairy Board
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About SNV

SNV Netherlands Development Organisation is an international development organization founded in the Netherlands in 1965. It operates in 38 of countries worldwide and supports local communities, organisations and businesses in designing and implementing sustainable solutions in agriculture, livestock, renewable energy and WASH. In agriculture SNV works in various commodity chains, including dairy. In Africa, SNV implements dairy projects in Ethiopia, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe and Kenya.

In Kenya SNV/Kenya implements the Kenya Market-led Dairy Programme (KMDP). This program is funded by the Netherlands Embassy in Nairobi and runs from July 2012 till December 2016. KMDP looks at the entire dairy value chain. In dairy production it supports smallholders, medium & large scale dairy farmers, and commercial fodder producers, with knowledge and skills transfer for enhanced farm management, productivity and profitability. Higher up in the dairy value chain KMDP supports farmer owned dairy cooperatives/ companies and processors. In addition KMDP partners with input suppliers, service providers and dairy training centers. KMDP's approach is private sector driven and market-led. Focus is on systemic issues like feed & fodder, farm productivity, milk quality, practical training & skills transfer. Introduction and adoption of best practices and innovations are key.

KMDP facilitates linkages between Kenyan dairy value chain actors and technology/ knowledge providers, input suppliers, investors and other private and public parties. This includes Dutch players who wish to profile themselves in the Kenya market. Preferably this is done on a business-to-business basis, sometimes with seed capital provided by SNV/KMDP to kick-start introduction of new technologies and business concepts through demos. See: www.snvworld.org/en/sectors/agriculture/our-work/agriculture/dairy

About this Paper

SNV Kenya was requested by the Kenya Dairy Board to identify an international expert who has worked extensively in dairy, and was involved in the design and implementation of school milk programs in an international context.

SNV approached for this purpose Mr Irwin Foreman – a dairy technologist/processing engineer – who has worked across the world in private sector and donor funded dairy projects and programs, including school milk programs. Irwin was responsible for the technical parts of these programs.

There is a lot of information on school milk programs, which have been documented well through various reports. Reference is made below to a WFP report of 2013 titled "State of School Feeding Worldwide'. This information on school milk programs is accessible through the internet and in the public domain. The reports pay much attention to financing models and management & administration of these projects.

Mr Foreman's Paper focuses more on technical matters and gives recommendations and information as regards to food safety and possible fortification of milk and milk products. It should be noted that his Paper is written in his personal capacity and does not necessarily reflect SNV's views and opinions.

IRWIN FOREMAN MSC

Dairy Technologist/Processing Engineer

Mr. Foreman has wide international experience in dairy processing plant management and dairy product processing.

Long term assignments were in the Middle East, China, Uganda and 8 years as Land O'Lakes Regional Africa Dairy Processing Advisor in Kenya, providing technical support for Land O'Lakes dairy projects internationally.

His experience gained from participation in several school milk programmes in a range of culturally diverse countries are provided here in an overview of the technical and technological issues which should be addressed by school milk projects.

The essential issues which must be foremost in the attention of the administrators and managers of school milk programmes are nutritional efficacy, product integrity and food safety.

School Milk

An Overview of Technical and Technological Issues for Donors, Programme Administrators and Processors

Irwin Foreman MSc (Agric.), Dairy Industry Consultant (UK)

"There is no finer investment for any community than putting milk into babies" – Winston Churchill, 1940.

1. Background

The health benefits of providing milk to school children are well documented. A mid-morning serving of milk, usually 200mls, is a powerful boost to meeting children's nutrient needs. A carton of school milk will provide more than half a five year old child's calcium, phosphorus and vitamin B2 requirements and a third of their protein needs.

The European Union provides subsidies to schools so that they can provide the children with selected milk and milk products, the purpose of the scheme being to encourage consumption of milk to promote a healthy balanced diet by making milk available to the pupils at a reduced cost.

Historically in the UK, the provision of free school milk was introduced by Government in 1946 with the specific purpose of boosting children's nutritional levels in an era of food scarcities and shortages in the aftermath of the war. From 1946 until 1968 all schoolchildren received one third of a pint (189ml) of milk daily. In 1968, because of financing constraints, later governments removed free school milk for secondary school children, and then in 1971 free school milk was removed entirely from the government agenda. Currently, only children under five years old continue to receive free milk, provided they are within a childcare framework.

Internationally, school milk programmes invariably have one of three possible financing models:

a) Fully financed by government or donors.
b) Partially subsidised by national government and/or local authorities, or the World Food Programme, or by commercial interests, for example packaging suppliers.
c) Parents who pay the full price for the milk (Parent Teacher Associations).

International donors frequently finance school milk programmes, which aim to boost the nutritional status of children in countries or regions where the nutritional status of children is low. Such programmes are highly valuable, but usually run until funding finishes, so that the nutritional boost is not usually sustained in the long term.

In 2013 the World Food Programme published a comprehensive report, which is available online, titled 'State of School Feeding Worldwide': http://www.wfp.org/content/state-school-feeding-worldwide-2013 . The report reviews the prevalence of school feeding, the economics and costs and the importance and the role of development partners in supporting feeding programmes. The report also discusses the experiences gained from school feeding programmes implemented in a number of countries.

According to the report, school feeding exists in almost all countries, but is not always efficient. The coverage and quality of the programmes was found to vary with national income. An analysis of costs indicated that improved efficiency could be achieved, and that the benefits of school feeding programmes extend beyond the health benefits to the children, to include economic and health benefits. The report calls for improved coordination between development partners.

According to the company website, Tetra Pak also supports partners in the implementation of school milk programmes. Tetra Pak cites its wide international experience in school milk programmes: http://www.tetrapak.com/sustainability/food-availability/school-feeding-programmes

There is no question that the provision of milk to children during their growth and development years is of major importance to their health, development and wellbeing. The issue of how to finance a sustainable programme remains a subject of debate.

2. Products for School Milk Programmes

Though natural pasteurised or UHT processed milk is the most common product selected for school programmes, nutritionally enhanced and fortified milk has also been provided. Similarly, fortified yoghurt or cultured milk is sometimes selected, as are flavoured milks, milk-juice products, and also fortified biscuits. The decision on product selection is usually primarily based on an assessment of the nutritional needs of the children and the quality of the milk supply available in the region. Cultural and budget issues are often factored into the decision process. A factor which should receive more attention in the product selection decision process is the technical status and competence of the processing plant which has been identified to be the supplier of the product. Program administrators lacking the skills to assess and evaluate a processing plant, sometimes enter into supply contracts with plants that are inadequately equipped to be able to provide uncompromising food safety.

Requests for fortification by boosting the calcium content of the milk are quite common, and it is sometimes accompanied by nutritional fibre, minerals and vitamins in the same product. This level of nutritional enhancement is usually designated for school populations of low nutritional status where supply of a ‘super’ boost is judged to be beneficial. Products of this type are necessarily complex and require significant development work by nutritionists and processors.

Programme implementers need to take into account that the planning and workup to product development will almost certainly require access to a pilot plant where small batches of 30-50 litres can be processed in trials. Hiring access to product development pilot plants is expensive and can be a significant budget line expense. As the costs are usually charged at a rate per day, the product developer must do the preliminary workup and preparation so that the time in the pilot plant is focussed on running the trial batches.

Product development is expensive and time consuming. Use of a third party pilot plant may cost up to $10,000/day, depending on the equipment to be used and the proposed programme plan. A useful way round this issue is to develop the product in cooperation with a food additive company by committing to purchase the company’s products to be used in the product supplied to the school feeding programme. Provided the volumes of potential sales of company products are substantially high, then access to the pilot plant may be given at no cost. The other advantage of this method of working is that the developer is supported by a company technologist who is familiar with the characteristics of the company's products. It makes the product development easier.

3. Administration and Implementation Issues

School milk is a highly sensitive topic with potential for disaster scenarios if the monitoring and control systems put into place do not prevent food safety failure. In all to do with school milk programmes, donors, programme administrators and processors need to be extra cautious and put into place all possible safeguards to ensure product safety, nutritional efficacy and quality assurance. Whatever the level of vigilance currently applied in the processing plant which has been selected for processing the product, the processing and supply of product to children calls for intensification of efforts and control systems at all stages and all levels by all the participants. There can be no compromises. No programme administrator would want to be faced by sick children and irate parents.

4. Funding Donors

Evidence of a successfully implemented programme is essential to the continuing good name of the funder, and therefore the funding organisation must have confidence in, and be assured of the technical competence of the appointed programme administrators.

For the donor, the critical technical control points that require extra focus are, assurance that the nutritional efficacy of the product is correctly determined by qualified and competent nutritional expertise, the processing plant has the skills and capacity to conduct the required quality assurance system and operations according to best practices, and the final product is rigorously tested for chemical and bacteriological compliance with national standards before release from the plant.

The nutritionist will determine the prevalence of micronutrient deficiencies in the target group of children, and assess the intake from a dietary survey. Government support from policy makers and legislators should be sought in creating the micronutrient formulation. The fortification technology can be developed together with studies on interaction, potency, stability and organoleptic quality. The bioavailability of the nutrients to be delivered will be reviewed and a field trial to determine efficacy and effectiveness should be included.

Kenya Bureau of Standards should be encouraged to create and issue a National Standard for School Milk Products.

Candidate plants must be audited and assessed before contract, and subsequently audited routinely when batches of product are being processed. The auditor should be the dairy technologist from the programme administrator's team mentioned below. Ideally, all production batches should be processed only in the presence of the auditor, and any evidence of non-conformance should immediately trigger a response with possible non-acceptance of the batch. For this purpose by terms of the contract with the processor, the auditor should have the authority to stop a production run and reject the batch.

5. Programme Administrators

The administrators should establish a team of specialists to oversee the development of the product and the performance of the processing plant operations. At a minimum, the team should include a nutritionist responsible for the product formulation, a dairy processing technologist responsible for overseeing and approving operations in the processing plant, and an accountant to track the purchase of ingredients, product pricing and financials.

Based on a single site visit, the selection of the plant to be contracted to process the product is difficult and uncertain. It should be based on a technical assessment which includes the following criteria,

a) There should be evidence of an implemented and maintained HACCP plan. Some plants have a plan but do not maintain it, the plan existing only as a file in the manager's office. A request should be made not only to view the plan itself, but also to see the minutes of the HACCP meetings as evidence that the plan is under constant review.
b) Inspect the type and condition of the equipment available in the plant, assessing the state of its maintenance. The pasteuriser and/or sterilizer should be given priority attention to confirm that its associated safety devices are in place, are calibrated and operating correctly.
c) Examine the quality control records to judge if there is a gap between what they say they do, and what they actually do. Plants are keen to get filling contracts and may stretch the truth to impress technically unwary and unknowledgeable programme administrators.
d) View the general appearance of the plant, its surroundings, the distribution vehicles, the cold stores and the dry stores.
e) Assess the attitudes of the key personnel you will be dealing with.

The product development and chosen formulations must be done in accordance with current Recommended Daily Allowance data recommendations. The quality of all raw materials must be food grade and supporting documentary evidence must be kept on file, together with batch nos.

The contract with the processor must specify which ingredients are to be used, their product nos., and from which suppliers they must be purchased, together with the maximum quantities permitted to be purchased per order. The latter will help prevent deterioration of ingredients in storage in the processing plant. The specifications provided to the processor should include a requirement that products which have passed the manufacturer's shelf-life date cannot be used.

The administrators should provide the processor with a comprehensive set of Standard Operating Procedures describing the following,

a) The chemical, bacteriological and physical specifications and quality of the final product. Non-attainment of the parameters should activate a notification procedure leading to non-acceptance of the batch
b) Specifications for the chemical and bacteriological quality and limits of the raw or reconstituted milk to be used for the product.
c) The packaging to be used must be agreed between the sides, and its technical specifications defined. The packaging supplier must be selected, the packaging design and branding to be provided by the administrators.

d) A packaging quality control acceptance/rejection plan should be implemented by the processor.
e) A description of the process and the agreed process flow diagram provided in writing.
f) The product formula, agreed batch size, and a list of the ingredients and the weights/volumes to be used per production batch. A double check system for the ingredients weighing stage should be implemented to prevent the wrong weight of any ingredient entering the product.
g) The agreed process operating parameters, heat exchanger temperatures, holding times and pressures, homogenisation pressure parameters, product final temperature before filling and after filling.
h) Premix preparation which includes the mixing procedures and order of mixing of powders, liquids and vitamin/mineral premixes
i) A sampling plan. Precise requirements for quality control procedures covering the entire process. This is to include the exact tests to be used at each stage of the process, frequency of testing, and the test parameter limits must be defined. The test methods must be agreed and defined. The processor should be required to retain samples from each production batch for at least 30 days after the 'Use by' date. The conditions of storage of the samples must be defined.
j) Record keeping must be comprehensive, to include all raw material data sheets, raw material test results, process records, heat exchanger temperature charts. All individually signed by the operators and supervisors.
k) Weights or volumes of the final product packages. Filling machine weight records must be maintained.
l) Plant raw and process target water quality should be defined and test results maintained.

The administrators need to create and establish a response and product recall procedures plan. The expectation is that if in the first instance a comprehensive monitoring and control plan is put into place then the response and recall plan will not need to be activated. However, things do happen and go wrong and therefore everybody should know the response procedure.

The most likely event is food poisoning. Administrators need to know how to recognise it and be able to guide the client schools on how to respond to parents and medical specialists. Programme administrators should consider cooperating with a medical specialist to be called in to supply the necessary medical expertise in the event there is a food poisoning incident attributed to the school milk.

The use of dispensers in school milk programmes has been the subject of much thought and discussion. Dispensers can come with a range of useful features, including operation by pre-paid smart cards. But dispensers also bring their own set of problems and issues. The first requirement is that they require a reliable power supply to keep the milk chilled, and this is not always available in schools located in regions where a dispenser might be most useful. The other major issue is the requirement to maintain a high level of sanitation and hygiene in the milk tanks, pumps, piping, tubing and valves. Dispensers with a built-in CIP system would be recommended for school milk programmes, but the level of sophistication of the machine of course impacts on the purchase price.

6. Products and Formulations

Calcium enriched milk

A 200ml portion of whole cow's milk will supply approximately 238mg of calcium if the cow's milk holds true to this level.

Because protein, and sodium, increase urinary calcium loss, they must be consumed in an appropriate ratio. The recommended ratio for calcium to protein is 20mg of calcium to 1 gm of protein (20:1) or higher. The calcium to protein ratio of unfortified cow's milk is already approximately 36:1 so adding more calcium is not a problem. High protein intake contributes to the excretion of calcium. Sodium increases urinary calcium loss even more that protein.

On the other hand, lactose produces lactic acid in the gut and this has been shown to enhance the absorption and utilization of calcium. The presence of vitamin D is also essential to stimulate intestinal absorption of calcium. Phosphorous Daily Recommended Intake (DRI) is 500mg per day for 4 to 8 year olds and 1250mg for 9 to 18 year olds. 200ml of milk contains 186mg and contributes to nutrition in a complimentary way with calcium, being essential to bone mass and tooth enamel formation. Phosphorous is more available than calcium in most diets and less critical as a target ingredient for school milk. Soluble and partly soluble sugar beet fibre, inulin, has been shown to enhance calcium absorption by 30%. Though the inclusion of inulin in the product increases costs, it is a useful contributor to the nutritional package.

The utilization rate cited generally in the literature is 30% of dietary calcium being actually used by the body.

Selecting the most suitable calcium source

The properties to be considered are,

- Bioavailability
- Calcium content
- Solubility
- Organoleptic characteristics
- Effects on the stomach
- Effect on kidney stone formation
- Interaction with other ingredients

The choice between organic or inorganic calcium

The bioavailability of organic calcium is agreed to be significantly greater than that of inorganic calcium, approximately 2 to 5 times higher than that of calcium carbonate. Comparison of various forms of organic calcium shows a slight advantage to calcium citrate.

Organic Calcium Form	Calcium Content (%)	Solubility (%)
Calcium citrate	21	0.85
Calcium lactate	13	3.1
Calcium gluconate	9	3.3
Inorganic Calcium Form		
Calcium carbonate	40	0.001
Tri Calcium Phosphate	39	0.002
Di Calcium Phosphate	23	0.007

Typical Mouth-feel and Taste Characteristics*

Organic Calcium Form	Mouth feel and Taste
Calcium citrate	Neutral
Calcium lactate	Slightly bitter
Calcium gluconate	Dry and slightly bitter
Inorganic Calcium Form	
Calcium carbonate	Chalky and soapy
Tri Calcium Phosphate	Sandy and bland
Di Calcium Phosphate	Sandy

* Data derived from tasting trials conducted for development of a school milk product.

In conclusion, from the data presented, organic calcium apparently has better bioavailability and organoleptic characteristics.

Selection of the Organic Calcium Form

Organic Calcium Form	Calcium Content (%)	Solubility (%)	Mouthfeel and Taste
Citrate	21	0.85	Neutral
Lactate (neutral)	13	3.1	Slightly bitter
Gluconate	9	3.3	Slightly bitter

For the product developer, despite the fact that Calcium Citrate has the lowest solubility, it will probably be the most effective calcium source. The reason is the cost. Per unit of cost, the relative delivery percentages of calcium with each of the forms are 100% calcium as Citrate, 62% of calcium as Lactate, and only 43% of calcium as Gluconate.

In the development of a product for a school programme, experience showed that calcium citrate was more cost effective than any other organic calcium source. The experience at both pilot plant and industrial scale-up verified the success of the selection as the product was easy to use and incorporate into the milk, while the residual calcium content in the final product met the specification requirements.

The solubility of calcium citrate allows 1700-1800mg to be dissolved in 1 litre of water, which represents 120-130% of the Recommended Daily Intake (RDI). This calculates to approximately 350mg per 200ml serving, which represents 25% of the RDI. The citrate form's relatively lower solubility enhances the creation of a stable suspension without formation of precipitation. Suspension stability performance is improved by addition of a natural fibre, the amount to be used to be determined by the product developer.

Similar calcium fortification can be achieved in yoghurt. The technological issues in developing the product are different, due to the low pH and possible interactions between the calcium and acid. However, it is achievable.

Nutritional Fibre

Dietary fibre as an addition in a school milk is beneficial both as a contributor to health, but also as a mechanism which enhances the suspension of added calcium, reducing precipitation. Fibre is not digested or absorbed. It does not impact on flavour or taste and is therefore simple to include into a product formulation.

Minerals and Vitamins

Premixes of minerals and vitamins should be purchased from specialist supply companies. The composition must be determined by the nutritionist. However, the formulation determined by the nutritionist is not always deployable in the processed product. For this reason, pre-production trials in a pilot plant are essential.

Personal experience with such premixes has revealed that sometimes there can be catastrophic effects when used. UHT processes tend to lower the pH of milk, more so in a direct steam injection process than in an indirect tubular or plate steriliser, but invariably there is a depression effect on the pH.

Depending on the chemical forms of the minerals used in the premix, whether acidic or basic forms, coagulation of product can occur unexpectedly. When developing the premix, each individual mineral should be tested in boiling milk, simply done in any laboratory, to confirm that it does not cause coagulation. This simple procedure will prevent large scale disasters.

Stabilizers

Incorporation of powders of various kinds in milk requires the use of a stabilizer to hold them in a homogenous dispersion. They prevent the separation of the various components in the product. The selection of the stabilizer is largely based on the pH of the milk product, and by adjusting the dosage rate the viscosity and mouth feel of the product can be optimised to give a smooth creamy texture which is important in products aimed at children.

Carrageenans (E407) are the usual choice for milk products. They are easy to use and once the dosage has been determined, seldom cause difficulties in formulations. There is a huge selection offered by manufacturers and the product developer should not have any difficulties finding the correct one for the product.

7. Products Developed for School Milk Programmes

Flavoured Milks

Occasionally, school milk programmes specify flavoured milk. These products are perhaps more controversial as they usually include substantial percentages of sugar in the formulation, but because of the sugar, the products are more palatable and favoured by children.

The basic ingredients are milk, sugar, colour and flavour, making it an easy product to pre-mix, process and package. For school programmes, the colour and flavours used should be naturally sourced, as opposed to nature-identical or synthetic, though the natural forms do increase the unit costs.

Fruit flavours are generally used for these products. Alternatively, chocolate milk has been shown to be a ‘brand leader’ in the category.

A typical formulation for basic pasteurized chocolate milk is milk, cocoa, sugar and chocolate flavour. The product flavour is improved by the addition of vanilla.

*Pasteurized Chocolate Milk Example Formulation**

Milk 2.0%Fat	92.5%
Sugar	6.5%
Cacao	1.0%
Vanilla	50gm per 1000 litres (approx)
Chocolate flavour	50gm per 1000 litres (approx)

* Developed and distributed extensively for a school milk programme.

Good chocolate milk is judged not only on taste, but also colour, visual appearance, presence or absence of sedimentation, curdling and top separation. Texture and viscosity are also important. Consumer perception and judgment is very much based on the pouring characteristics. Viscosity is a very important parameter when a consumer, particularly a child, drinks chocolate milk. Chocolate milk must be stable and have a good texture and flavour.

Chocolate milk contains 1-2% cocoa powder, and cocoa particles are generally insoluble. In a product that does not contain a stabilizer, the cocoa particles soon settle out of suspension to the bottom of the container where they form a sediment that can only be dispersed by shaking. To prevent cocoa sediment from forming, it is possible to create a thixotropic solution by adding a suitable stabilizer.

The principle of a thixotropic system is that it forms a very weak gel when the product is left to stand. Breaking down the gel by stirring, pumping or drinking will cause the product to change from a gel to a thin liquid. A thixotropic solution is one where a gel is formed when the liquid is allowed to stand undisturbed, but reverts to a liquid when agitated or poured. In the gel state the liquid is stable and homogenous.

To obtain a thixotropic system in chocolate milk, it is necessary to add a stabilizer. The stabilizer normally contains mono-glycerides, carrageenan and guar gum, though each commercial supplier offers a specific combination of the emulsifier and stabilizer, and the precise combination remains a commercial secret. The mono-glycerides improve the fat dispersion of the chocolate milk, thus inhibiting fat separation, and add creaminess and texture, giving the product a rich creamy texture. Only the carrageenan has thixotropic properties.

UHT Chocolate Milk Example Formulation

Milk 2.0% Fat	92.0%
Sugar	6.5%
Cocoa	1.0%
Skim milk powder	0.5%
Stabiliser	To be determined in the formulation
Caramel	To be determined in the formulation
Vanilla	To be determined in the formulation

Working Instructions for Preparation of Fruit Flavoured Milk

The following fruit flavoured product was developed and processed for a school milk programme in the Philippines. There was a shortage of fresh milk and reconstituted powder was used in its place. Juice concentrate was purchased from a local supermarket. The product was provided in a school programme and ultimately sold commercially.

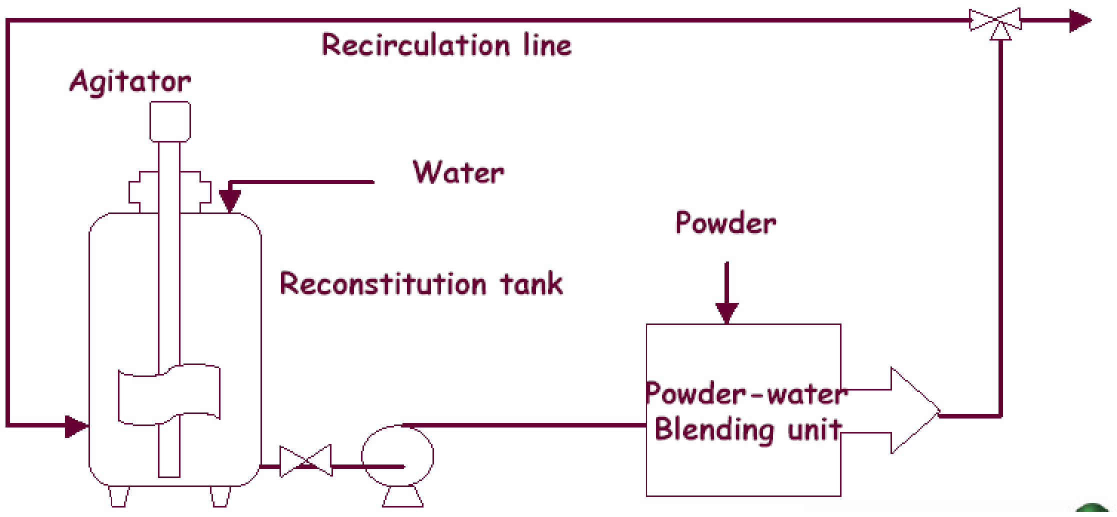
Step 1: Preparation of Base Milk

Preparation of Recombined Milk

Ingredient	Percent of Total Formula	Kgs per 100 litres
Pure water	88.0	88.00
Skim Milk Powder	8.5	8.5
Anhydrous Milk fat	3.5	3.5

1. Mix water and Skim Milk Powder, 40-50°C
2. Add fat, 50-55°C
3. Filter
4. Homogenise, 175 bar/70°C
5. Pasteurise, 78°C/15 sec.
6. Cool to 4-5°C
7. Hydrate min. 4 hours

The skim milk powder is dissolved in water at 40 - 50ºC. Hydration time must be at least 20 minutes. After hydration, the milk is heated to 60 - 65ºC and the Anhydrous Milk Fat (or frozen unsalted butter) is added. The product is homogenized at 17MPa in a one stage homogenizer or in a two stage homogenizer at pressure of between 14-24 MPa first stage and 2-7 MPa second stage. After homogenization, the milk is pasteurized at 78ºC/15 sec and cooled to 4-6ºC before blending and packing.



Step 2: Preparation of Milk/Juice Drink

The product will be pasteurized.
The product must be distributed and stored at below 5ºC.
Expected shelf life is 7 – 10 days.

The final product will be assessed for:

- Precipitation
- Flavour
- Viscosity
- Mouth-feel
- Syneresis

Raw Materials*

Ingredient	Percentage	Analysis required	Remarks
Water	72.60	None	
Recombined Base Milk 3.5% fat	15.0	Fat pH Titratable acidity Cryoscopy	Fresh whole milk can be used in place of recombined milk
Sugar	8.00	None	
Pectin stabiliser	0.40	None	
Juice concentrate	4.00	Brix Acidity	Pineapple, peach as requested

* Developed for a school milk programme

No	Process step	Analysis	Remarks
1	Dry mix the pectin and the sugar		
2	Add stabilizer/sugar mix to water while stirring and heat to 80°C and hold for 10 minutes		Fast agitation required
3	Cool the stabilizer blend to 25°C		Continuous agitation
4	Add juice while stirring		Continuous agitation
5	Add milk to the juice blend	pH	Continuous agitation
6	Adjust pH to 3.6	pH	Use 50% citric acid
7	Homogenise at 75°C, 175 bar.	Pressure Temperature	
8	Pasteurise 85°C for 15 seconds		
9	Cool to below 10°C	Temperature	
10	Fill		
11	Store at 5°C		

Calcium Fortified Milk with Added Minerals and Vitamins

This product includes all the options, calcium enrichment, nutritional fibre, accompanied by a package of minerals and vitamins. It was targeted to provide a nutritional 'super boost' to nutritionally challenged children. Products of this complexity are problematic to develop because it contains multi ingredients and there may be interactions between them. In practice, the magnesium and iron in the minerals premix were found to be 'show stoppers' and alternative chemical forms that could be used had to be identified.

Ingredient
Sugar
Tri-calcium citrate
Carrageenan
Nutritional fibre
Vitamins and minerals premix
Milk

In terms of complexity, this product class is probably the top level of school milk programme products. It is expensive, it was challenging to develop, but it packs the maximum nutritional punch. Pricing played a significant role in development of the formulation. The product development required two visits to pilot plants to first develop the basic formulation, and then a return was necessary to correct issues which appeared at the scale up to commercial volume batches in the processing plant.

The selection of the ingredients and suppliers was done with great care to ensure primary quality and reliability. The development of the multi-minerals and multi-vitamins packages required a lot of spade work and consultations with the manufacturer and nutritionists. When the primary development of the formulation was completed, different combinations and percentage dosages were pilot plant tested until an optimum product was obtained.

The product was UHT processed and ultimately distributed for a year to half a million school children.

Conclusions

Milk as the primary product supplied to school feeding programmes can be readily fortified with calcium, minerals and vitamins to provide a more substantial nutritional package. In addition to regular milk, products requested in different countries include flavoured milk, chocolate milk, yoghurt, cultured milk, and juice-milk combos.

Examples of products developed and supplied in several countries have been given and discussed. Cultural and dietary preferences around the world lead to requests for different products for school feeding programmes. In Central Asia cultured milk was used, while in Vietnam calcium, minerals and vitamins fortified milk was requested and in the Philippines it was a milk-juice punch. Internationally, regular milk is the most commonly provided product.

Quality and safety are the prime concerns for program donors and administrators. School milk programs demand extra care and implementation of procedures that will ensure food safety.

Funding for the establishment of sustainable school feeding programs remains problematic, unless parents' contributions form a considerable part of cost recovery.