Production of powdered baby foods

By Ib Haugaard Sørensen, NIRO A/S
Erik Jørgensen, Kolding-Gruppen
Vagn Westergaard, NIRO A/S

**Reprint from
Scandinavian Dairy Information 4/1992**

Production of powdered baby foods

By Ib Haugaard Sørensen, NIRO A/S
Erik Jørgensen, Kolding-Gruppen
Vagn Westergaard, NIRO A/S

Introduction

An infant formula is a milk-like food which is intended to supplement or replace the milk of the baby's mother. Such a food will be composed of the same main ingredients as are found in human milk. It is, however, not always the intention to exactly duplicate the composition of human milk. First of all human milk varies in composition when comparing milk from different individuals and also comparing different periods in the lactation. Secondly, studies of the needs of babies at various ages have shown that mother's milk is not always of the optimum composition.

Selection of raw materials

In the manufacture of infant formula, one of the main concerns is to design a product composition that is adequate for the needs of the babies. There is an abundance of information on the needs of the food for babies as regards the main components for building the cells in the body and for supplying energy. There is also quite comprehensive recommendations on which vitamins and minerals that are needed for a healthy development of babies.
If we look at the guidelines from for example the EC we find that these authorities give recommendation for two types of infant formula for babies up to one year.

The types are:

- infant formula for babies up to 4 to 6 months old,
- follow-up formula for babies over the age of 4 to 6 months.

The recommendations give quite a wide range of compositions which are reflected in the different types of infant formulas available on the market.
The manufacturers of infant formula will consider not only the gross composition of the product. Also the individual components that constitute the fat or protein or carbohydrates are chosen to give a resemblance of human milk.
The profile of fatty acids in the fat should contain a sufficient amount of essential fatty acids. In this context linoleic acid is important and the structure of the triglycerides and monoglycerides regarding the position of stearic and palmitic acids will determine how efficiently the fats are absorbed.
The protein is usually adapted in milk-based infant formula to give a proper relation between whey protein and casein.
A certain part of the carbohydrate must be milk sugar (lactose) but the rest of the carbohydrates could be a mixture of various types of carbohydrate such as maltodextrine, glucose and modified starch.
In order not to increase the osmolarity of the milk the content of monosaccharides should be kept on a low level.
As the raw materials for the manufacture of infant formula, be they milk-based or vegetable-based, are deficient in certain minerals and vitamins, addition and adjustment of these are always done.
It should be noted that for nearly all ingredients in an infant formula there are upper limits as well as lower limits. This is because the digestive system in newborn babies is not fully developed and therefore cannot cope with higher amounts of certain food components.
Especially, for some of the minerals or trace elements there are narrow limits between too little and too much.
Many producers of infant formula also produce products for babies with allergic reactions to specific food components. In these products the composition will be quite different from the ones shown in the table.

Table 1: Composition of different baby foods

Type of product		Infant formula		Follow-up	
Product name		"A"	"B"	"C"	"D"
Protein	%	15	12	17	18
Hereof					
Casein	%	7.5	4.5	13.5	14
Whey protein	%	7.5	7.5	3.5	4
Fat	%	26	26	21	24
Hereof					
Milk fat	%	6	10	4	19
Vegetable fat	%	20	16	8	5
Other fat	%	–	–	7	–
Carbohydrate	%	54	57	55	51
Hereof					
Lactose	%	38	57	42	24
Maltodextrin	%	16	–	13	12
Sucrose	%	–	–	–	15
Minerals	%	3	3	4	3
Moisture	%	2	2	3	3

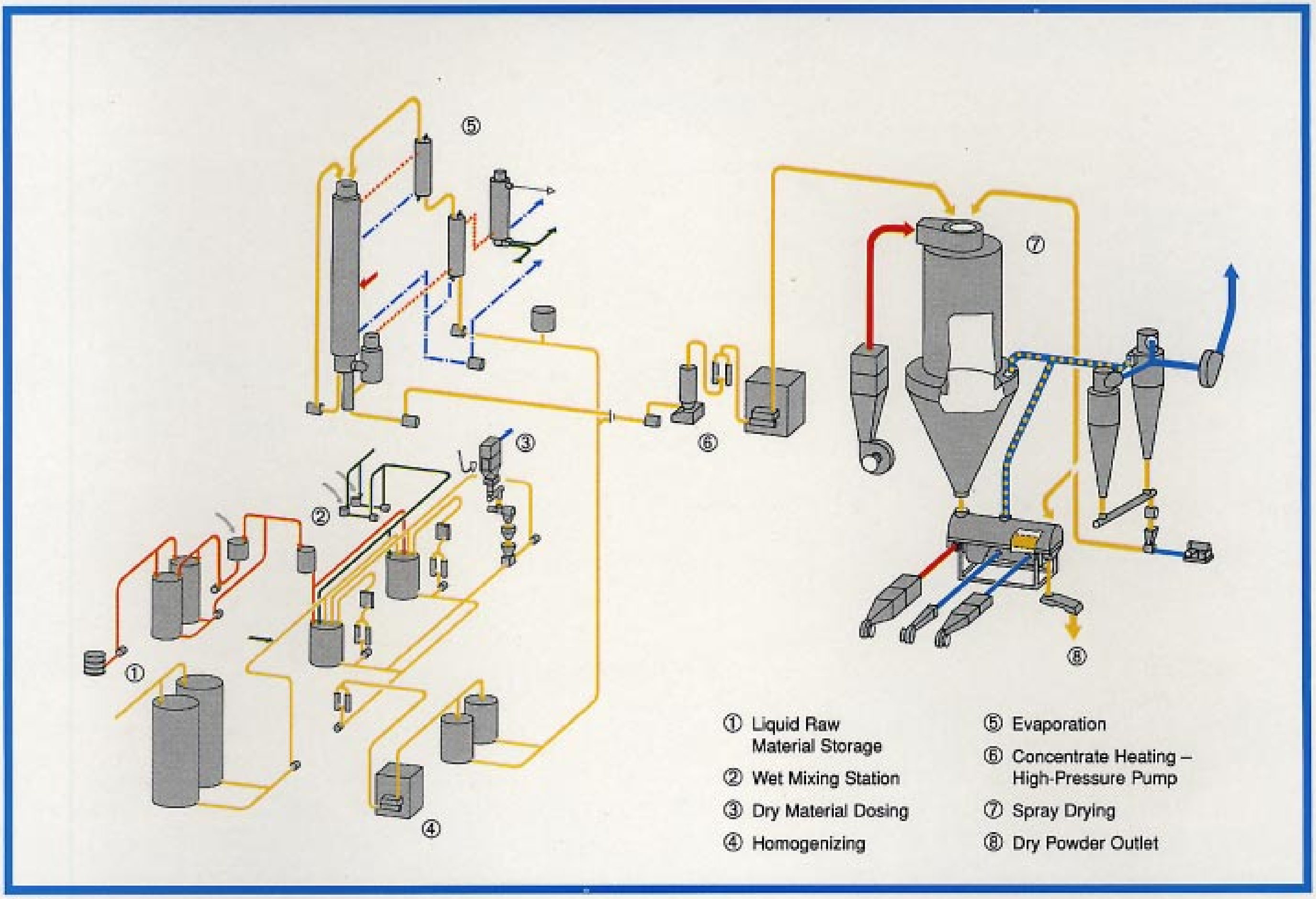

Fig. 1

Wet mixing plant

For a modern plant it must be taken into account that recipes and production methods are being continuously developed in the laboratories. Just as nutrition – in addition to the constant observance from the public – is constantly being observed and analyzed.

Producers of baby food have a natural interest in not revealing the ingredients of individual products, and most often the information released will include only the main groups in the physical and chemical composition of the individual additives.

As will be seen from the above, each mixing plant must be specially designed for each individual baby food factory. However, the following description of a complete wet mixing plant could be considered a good example of how a modern production line is constructed, in order to mix the following raw materials (see fig. 1):

Fat

Vegetable and/or animal oil, supplied in drums or in bulk from insulated tank lorries. From the drums, which must be heated prior to emptying, the oil is conveyed via double jacketed piping to storage tanks. The number depends on choice of product and storage time. The tanks are provided with double jacketing, making individual temperature regulation possible.

Equipment for supply of inactive gases can be provided.

For some recipes it is a must that vitamins are added at this time in the process, and dosing equipment can be coupled to the oil tanks which often are on load cells.

Liquid milk concentrate

Milk concentrate, pasteurized, standardized for fat and protein percentages, and evaporated to the solids content needed in the recipes. At discharge from the evaporator the concentrate is cooled prior to storage in insulated tanks.

The tanks can be placed on load cells.

Raw materials in powder form

Skim milk, whole milk, casein, whey, lactose, maltodextrine etc. are mixed into the liquid via bags/silos and powder emptying plants by means of in-line mixers of the venturi type.

The below listed conditions should be considered before designing wet mixing plants for baby foods:

- selection of raw materials, number of raw materials, as well as substitute possibilities,
- determination of extremes for the composition of recipes,
- determination of process time/temperatures in the process,
- training of personnel/level of automation,
- daily production routines, as well as complete cleaning prior to change of recipe,
- flexibility enabling changes of all conditions already determined.

Usually there are two tanks in the system, and the design of this part must be considered the heart of the mixing plant. Besides the main raw materials, vitamins, minerals, as well as the additives giving the characteristics of the final product are added.

The tanks are equipped with a strong turbo agitator, and often another agitator is included.

The product can be heated/cooled in external systems which also contain special pumps and filter systems.

Processing time and storage time

– p.t.o.

must be carefully adapted to the further processing in the spray drying plant.
Before being supplied to the storage or intermediate tanks, the concentrate is filtered and homogenized.
A large flexibility must be incorporated in the valve and pipe system because many different process tests, production mixes and re-works may be encountered.
The final product tanks – the size being adapted to the spray drying plant - are normally insulated and provided with two-speed agitators. For certain products having thixotropic properties it will be advantageous to have double jacketing for temperature regulation of the tanks. Further, it is recommended to use double jacketed pipe systems up to the feed tank of the spray drying plant.

Evaporation

It is an accepted fact that it is cheaper to remove water in an evaporator than in a spray dryer.
The raw materials used in the different formulations are often recombined to a lower solids content than can be dried. This is because the redissolving of the powdered materials is better at lower solids.
An evaporator working as a one-stage finisher is therefore used to concentrate the premix before the final drying. This has the following advantages:

- economy, due to higher solids content,
- it is possible to pasteurize the premix to a higher temperature without viscosity problems,
- the concentrate is deaereated resulting in a powder with lower content of occluded air,
- the high-concentrator will work as feed system for the spray dryer – the product is therefore not exposed to any contamination risk.

Spray drying

The next step in the process is the drying in order to produce a powder with a long shelf-life.
All NIRO equipment is designed with the strictest hygienic requirements in mind. Hollow spaces in the drying plant are avoided, and insulation material with double air-gap sandwich panels, which are dismantable for inspection of the drying chamber, is standard.
When designing a spray drying plant for powder production the following must be taken into consideration:

- production time between CIP cleaning,
- powder structure,
- drying parameters.

Production time between CIP cleaning

An important aspect in baby food powder manufacture is a long continuous operation time between cleanings. Downtime means lack of production and risk of contamination during start-up again.
The reason for cleaning is either change of product composition or powder deposits in the drying chamber.
The NIRO Tall-Form drying chamber is designed to minimize the powder deposits, due to the air disperser which is designed for a multi-head

Lower part of spray drying chamber and Vibro-Fluidizer for after drying/cooling of powder.

Mixing tanks – pasteurizer – homogenizer

nozzle atomization and a plug flow air stream.
The cyclone fraction is low due to the ring-formed air exhaust system, referred to as the "bustle". Thereby the risk of cyclone blockages is minimized.
After the primary drying, the powder is discharged into the Vibro-Fluidizer for final drying and cooling. The cyclone fraction can either be returned to the Vibro-Fluidizer for production of non-agglomerated powders, or to the nozzle atomizer for agglomeration.

Powder structure

Powdered baby food sold today is to a great extent marketed as agglomerated powders. The agglomeration improves the reconstitution properties. It is therefore important that the degree of agglomeration and the compactness of the agglomerates can be controlled.
This is done by adjusting the nozzle pressure and the position of each nozzle in relation to each other and the returned cyclone fraction.
However, the obtainable degree of agglomeration is also a question of product composition. Thus, with increased content of carbohydrates it becomes easier to agglomerate, whereas products with a high content of proteins will result in smaller agglomerates.

Drying parameters

In order to improve the production economy the drying temperatures and solids content in the concentrate are selected to be as high as possible. The product composition, however, is a decisive factor as to what parameters can be selected.
As a rule of thumb the following applies:

High fat content	allows high solids, requires low drying temperature.
High protein content	allows high drying temperature, requires low solids content.
High carbohydrate content	allows high solids, requires low drying temperature.

Automation

From the very start this point must be evaluated, and the key word must be flexibility. Raw material composition, temperature and pressure conditions are different for each recipe. Complicated pipe systems must under all circumstances include the highest possible hygienic standard. The individual processes can be split up and controlled separately, and overall control and registration can be included, depending on philosophy and money.
Automatic start/stop of the dryer is recommended, as this reduces the risk of deposit formation in the drying chamber and offers short time wasted during the start/stop sequence.

CIP plant

A plant involving so many raw materials and process possibilities will require a CIP plant, which can be applied at almost any time, for cleaning of part of the process equipment or a complete cleaning at change of product.
Here it applies that the better process layout prior to building, the simpler the CIP plant.
Detergents can be re-used in this part of the process. However, the pre-flush processes must be carefully observed. Automation with PLC control is considered necessary.

Conclusion

Experience shows that it is good policy during the design phase that the factory management and the machinery supplier spend the adequate time in order to make the production plant flexible, in order to maximize the utilization of the equipment and produce a powder meeting the requirements from the market today and in the future. ■

References

- CODEX ALIMENTARIUS VOL. IX. Codex Standards for Foods for special dietary uses, including foods for infants and children and related code of hygienic practice. 1982.
- COMMISSION DIRECTIVE of 14 May 1991 on infant formulae and follow-on formulae.
- Pacard, U.S. Human Milk and Infant Formula. 1982.

DLG-FoodTec'92
Hall 8 - Stand C157

Products by Design

Providing the new generation of dried dairy and food products requires something special when it comes to plant and equipment design. Standard plants no longer suffice.

Advanced process and product know-how, coupled with engineering expertise is the key – and the key is NIRO.

NIRO
DANISCO

Denmark:	Niro A/S . Gladsaxevej 305 . DK-2860 Soeborg . Tel. +45 39 69 10 11 . Fax +45 39 69 14 14
Finland:	Niro-Oy . Koivuhaankuja 2 . SF-01510 Vantaa . Tel. 358 0 8702122 . Fax 358 0 8702229
Norway:	Trygve Andersen A/S . Osterhausgt. 6 . N-0134 Oslo . Tel. 47 2 200655 . Fax 47 2 360735
Sweden:	Christian Berner AB . Gamla Kronvägen . S-433 24 Partille . Tel. 46 31 447100 . Fax 46 31 448679

PRINTED IN DENMARK · PHØNIX A/S