

## Chapter 3

### Study of physical property in fresh milk

#### 3.1 Introduction to Chemical in Milk

Milk production began 6000 years ago or even earlier. The dairy animals of today have been developed untamed animals, which, though thousands of years, lived at different altitudes and latitudes exposed to natural and, many times, severe and extreme conditions.

Normally, animals were chosen because they are less dangerous and easier to handle than carnivorous animals. The former did not compete directly with man for nourishment, since they ate plants which man could not use himself. The herbivorous animals used were all ruminants with the exception of the mare and ass. Ruminants can eat quickly and great quantities, and later ruminate the feed. Today, the same animals are still kept for milk production, milk being one of the essential food components for man. The most widespread milking animal in the world is the cow, which is found on all continents and in nearly all countries.

#### Composition of milk from different types of animals

Animal	Protein total %	Casein	Whey protein %	Fat %	Carbohydrate %	Ash %
Human	1.2	0.5	0.7	3.8	7	0.2
Horse	2.2	1.3	0.9	1.7	6.2	0.5
Cow	3.5	2.8	0.7	3.7	4.8	0.7
Buffalo	4	3.5	0.5	7.5	4.8	0.7
Goat	3.6	2.7	0.9	4.1	4.7	0.8
Sheep	5.8	4.9	0.9	7.9	4.5	0.8

Table 1: The composition of milk in other animal  
 Source: Dairy processing handbook, Tetra Pak.

However, we should not forget the other milking animals whose milk is of great importance to the local population as a source of highly valuable animals protein and other constituents. Sheep are of exceptional importance among this group, especially in the Mediterranean countries and in large areas of Africa and Asia. The number of sheep in the world exceeds one billion, and they are thus the most numerous of all milk and meat producing domestic animals.

#### 3.1.1 Cow Milk

Milk is the only food of the young mammal during the first period of its life. The substances in milk provide the both energy and the building materials necessary for growth. Milk also contains antibodies, which protect the young mammal against infection. A calf needs about 1000 liters of milk for growth, and that is the quantity, which the primitive cows, produces for each calf.

There has been an enormous change since man took the cow into his service. Selective breeding has resulted in dairy cows which yield an average of more than 6000 liters of milk per calf.

Before a cow can start to produce milk she must have calved first. Heifers reach sexual maturity at the age of seven or eight months but are not usually bred until they are 15-18 months old. The period of gestation is 265-300 days, varying according to the breed of cow, so a heifer produces her first calf at the age of about 2-2.5 years.

### 3.1.2 Secretion of Milk

Milk is secreted in the cow's udder, a hemispherical organ divided into right and left halves by a crease. Each half is divided into quarters by a shallower transverse crease. Each quarter has one teat with its own separate mammary gland, which makes it theoretically possible to get four different quantities from the same cow.

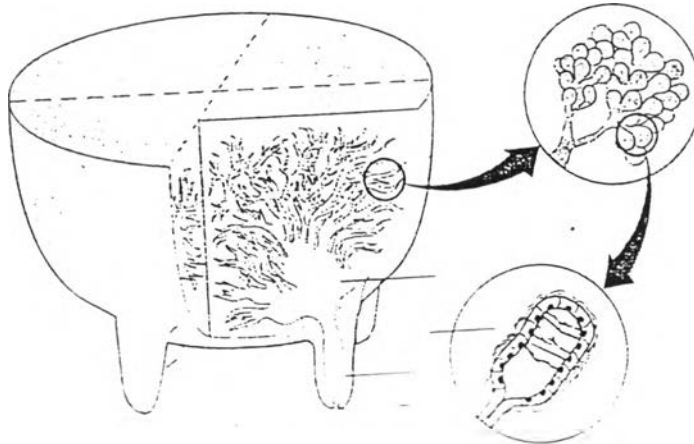


Figure 5: The secretion of cows' milk  
Source: Dairy processing handbook, Tetra Pak.

### 3.2 Basic physical-chemical properties of cows' milk

Cows' milk consists of about 87% water and 13% dry substance. The dry substance is suspended or dissolved in the water. Depending on the type of solids there are different distribution systems of them in the water phase.

Emulsion is a suspension of droplets of one liquid in another. Milk is an emulsion of fat in water; butter an emulsion of water in fat. The finely divided liquid is known as the dispersed phase and the other as the continuous phase.

Colloidal solution is when matter exists in a state of division intermediate to true solution, e.g. sugar in water, and suspension. It is said to be in colloidal solution or colloidal suspension. The typical characteristics of a colloid are small particle size, electrical charge and affinity of the particles for water molecules.

The quantities of the various main constituents of milk can vary considerably between cows of different breeds and between individual cows of the same breed. Therefore, only limit values can be started for the variations.

### Physical-chemical status of cows' milk

	Average composition %	Emulsion typeoil/water	Colloidal solution/suspension	TRUE solution
Moisture	87			
Fat	4	x		
Proteins	3.5		x	
Lactose	4.7			x
Ash	0.8			x

Table 2: the physical- chemical in cow milk  
Source: Source: Dairy processing handbook, Tetra Pak.

### 3.3 Introduction of milk powder

The method of preserving various foodstuffs by drying them, and thereby depriving microorganism of water necessary for their growth, has been known for centuries.

#### 3.3.1 Drying

Drying means that the water in a liquid product, in this case is milk, is removed, so that the product acquires a solid form. The water content of milk powder ranges between 2.5 and 5%, and no bacteria growth occurs at such low water content. Drying extends the shelf life of the milk, simultaneously reducing its weight and volume. This reduces the cost of transporting and storing product.

#### 3.3.2 Whole milk powder

Spray dried whole milk powder is normally produced from fat standardized milk. After standardization the milk need not be homogenized provided that it is thoroughly agitated, without air inclusion, before evaporation and again between evaporation and spray drying. The concentrate is however homogenized in certain cases for production of instant whole milk.

Whole milk powder unlike skim milk powder, is not categorized. Milk intended for whole milk powder is normally pasteurized at 80-85 °C to inactivate most of the lipolytic enzymes that would otherwise degrade the milk fat during storage.

### 3.3 Solid Non Fat

In composition of milk, it has 3 mainly of components that are moisture fat and Solid Non Fat (SNF). Moisture is the amount of water in the product compare to the weight. Fat is the amount of milk fat comparing to the weight. The remaining of component they call Solid Non Fat or the other substance, which was remaining Normally, in each component will show in term of percentage per kilogram of milk

### Composition of Whole Milk Powder

Moisture content	2.23 %
Fat content	29.80 %
Solid Non Fat content (SNF)	69.97 %

### Composition of Fresh Milk

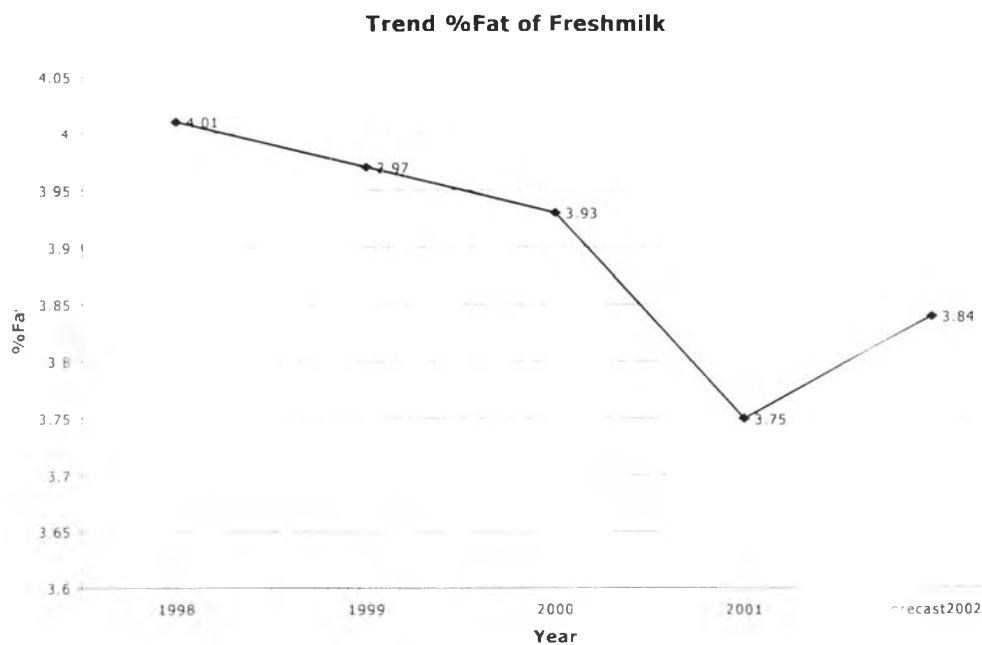
Moisture content	87.41 %
Fat content	4.10 %
Solid Non Fat content (SNF)	8.49 %

Table 3: The composition comparison between fresh milk and Whole Milk Powder  
Source: Source: Dairy processing handbook, Tetra Pak.

In general, the substitution of these will be calculated base on the amount of fat and SNF as dry matter that they want. Because of milk powder is one type of milk which was remove moisture. So, the substitution can be expressed according to the manufacturing recipe. For example, 1000 Kg of whole milk powder, which has the composition as above. We can substitute with fresh milk by calculating according to the composition of fresh milk as above. By 1000 Kg of whole milk powder will be equivalent to fresh milk as under calculation

1000 Kg. whole milk powder will give solid non-fat 699.7 Kg and fat 298 Kg. So, calculate base on solid non-fat will get fresh milk equivalent to 8241.46 Kg

### 3.4 Trend of composition in fresh milk



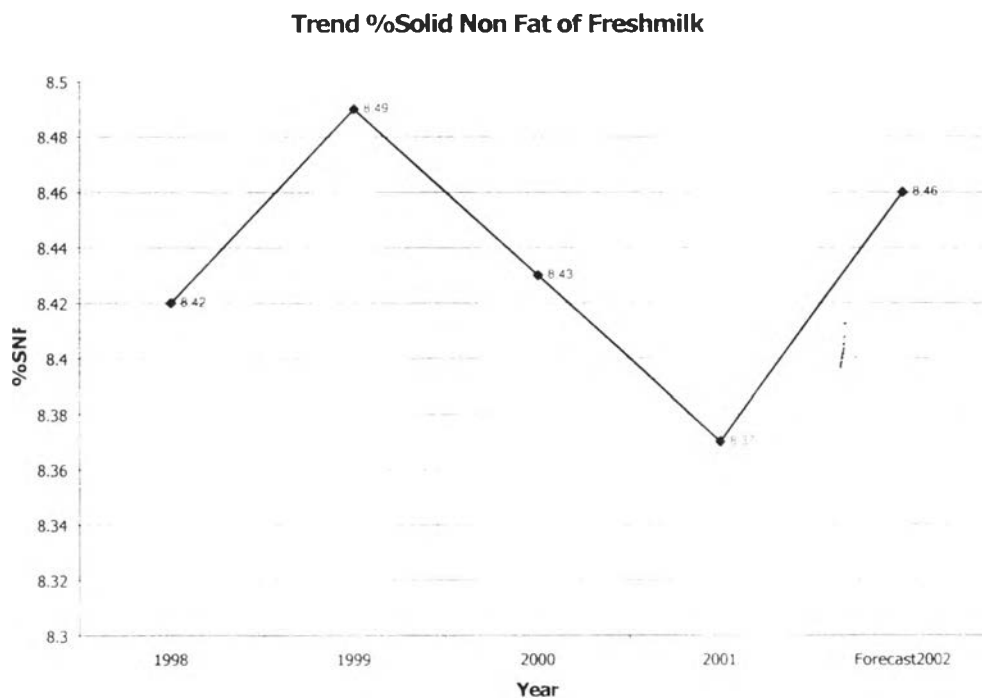
Graph 17: Trend of %fat content from receiving fresh milk  
Source: Fresh milk quality history 2001, Nestle Thailand

As mention earlier that fresh milk has main 3 components, milk fat, water, and solid non fat. This 3 components will use to calculate the production recipe and from lots to lots, it has more variation in term of these 3 component. In fact, these 3 components will be varied with mainly climate factor. Colder climate, cows will give milk, which has more higher %fat content. In the hot climate, cows will give low both %fat and %solid non fat milk.

With reference to the data record of company, Nestle Thailand, we can see the trend of %fat content and forecast by estimation from receiving volume, receiving composition as above figure. In year 2002, an average %fat content should be more than last year because of the colder climate in Thailand from year.

From figure above, it is an average of %fat content of receiving fresh milk in each year. These average was done by the average of both receiving quantity and %fat content.

With reference to the data record of company, Nestle Thailand, we can see the trend of %solid non-fat and forecast by estimation from receiving volume and receiving composition as below figure.



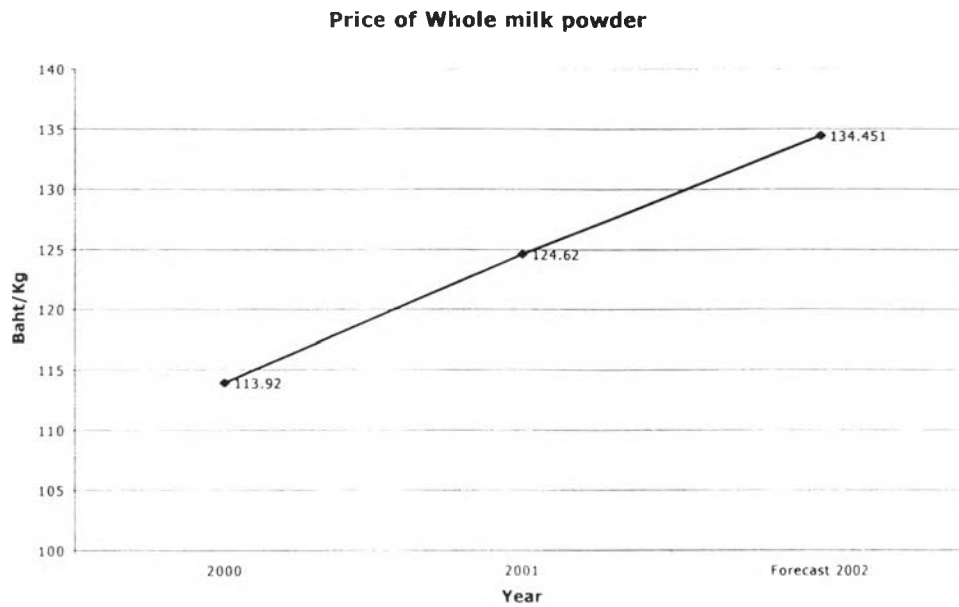
Graph 18: Trend of %Solid non-fat content from receiving fresh milk  
Source: Fresh milk quality history 2001, Nestle Thailand.

### 3.5 Trend of composition and price in receiving Whole Milk Powder

Whole milk powder had been import from abroad. It has a duty rate, which is charged to import milk, and this rate still raising. This duty charge has a purpose to protect and force factories used raw milk in the country before decision to use import milk. This rate has been increase from 5 percent at the beginning of 2000 and raise up to around 17.2 percent by end of year 2000. This effect is directly to the cost of product, which is used whole milk powder as ingredient.

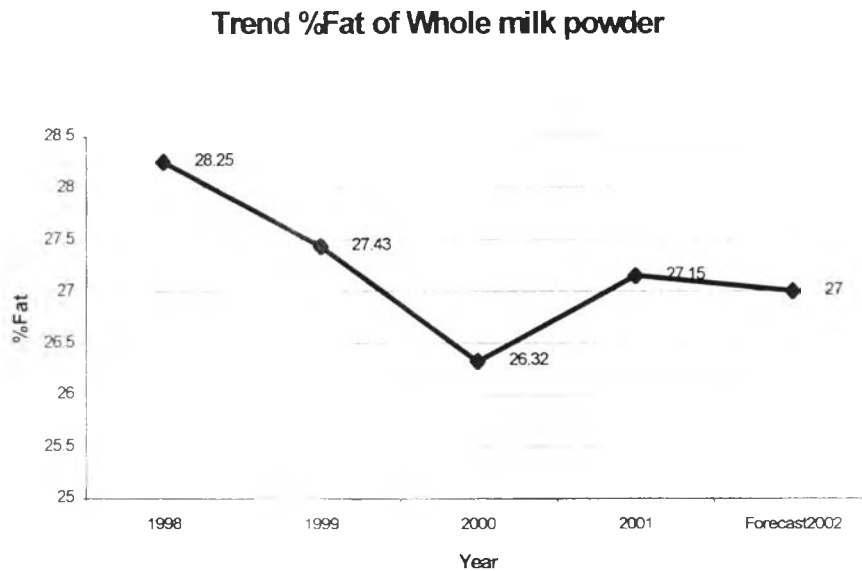
However, the composition of incoming didn't change according to the price. When variation of composition is coming from the physically and regional of cow's farm. When received from many sources, it is mix milk and also mixes in different composition and gives to variation of component.

According to receiving data of whole milk powder, Nestle Thailand, we can see trend of both %fat, %solid non-fat and price as below figure;



Graph 19: The trend of Whole milk powder purchasing price  
Source: Milk solid price 2001, Nestle Thailand.

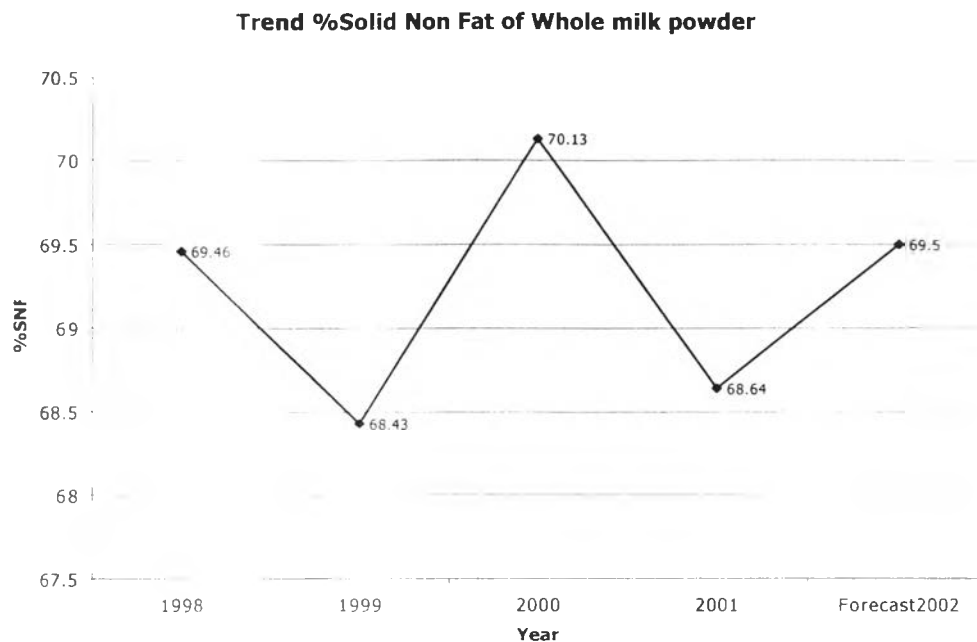
According to figure above, the price increase is coming from increase in duty rate of in coming. The forecasting price of whole milk powder will be 134.451 Baht/kg, this forecasting price has been calculated from trend of duty rate and shared quota at aboard market.



Graph 20 : Trend of %fat content in whole milk powder  
Source: Milk solid price 2001, Nestle Thailand.

%fat content had been varied from the factor of source of cow's milk. 1 year 2002, the % solid non-fat in milk should be more than last year because of the colder weather than last year original source. The forecast value was 27 percent fat content, statistic and average from the receiving volume together with experience generated.

The forecasting percent solid non-fat content will be 69.5, therefore, the percent of solid non-fat was varied from source to source like %fat content in milk.



Graph 21: Trend of %solid non-fat in whole milk powder  
Source: Milk solid price 2001, Nestle Thailand.

The forecast value doesn't mean a correct value because in reality when received milk in each, it has a variation and difficult to forecast value. So all the forecasting value had been gotten from the experience and statistic record only together with an information of supplier and domestic import duty rate, not a clear scientific method

### 3.6 Comparison between fresh milk and whole milk powder

The table below can see the comparison between fresh milk and whole milk powder in term of physical property, we can summarize that;

	Whole milk powder	Fresh milk
<b>Taste</b>	Less milky	More milky
<b>Color</b>	Turbidity white	Turbidity white
<b>Smelling</b>	Butter milk	Butter milk and fresh
<b>Formation</b>	Dry powder	Liquid

Table 4: Physical property comparison between fresh milk and whole milk powder

According to the table, the similar thing between fresh milk and whole milk powder is color, turbidity white. In term of taste and smelling, fresh milk will give more milky taste and fresh of buttermilk smelling. Therefor buttermilk smelling will make an impression of fresh to the product, so more buttermilk smelling may say more freshness. It is clearly that milk powder is one preservative method of fresh milk, so the formation of these two materials is different, liquid and powders form.

### 3.7 Fresh milk SWOT Analysis

#### Strength

- Taste and smelling

Taste of fresh milk has more freshness than whole milk powder. In fact, whole milk powder has been made from fresh milk by using spray-drying process in order to remove water out. During this process, some of components, which will give aroma and buttermilk had been evaporated and remove.

- Rich in nutritional

Fresh milk will give more rich in term of nutritional. Therefore, during the drying process it used heat treatment process to remove water from milk. So, some protein has been destroyed with this process.

- Liquid form

In the liquid coffee process, they prefer to use milk in liquid form than powder form. Although, the receiving raw material is in powder form, in the operation they will make it to liquid form before starting production process. So, fresh milk has less step in production process to produce.

- Image of fresh

Fresh milk will give an image to the product that made from fresh raw material.

#### Weakness

- Storage time

Fresh milk, normally, can be kept at normal room temperature less than 8 hours. After that, the microorganism will digest activity by using fresh milk as a food. Consequently, fresh milk will turn to have more acidity and rotten.

If we are comparing with the whole milk powder, it has a longer storage time. Actually, the quantity of water inside is an inactivated factor in growth of microorganism. Powder form has less water inside, so they will have a longer storage time.

- Handling process

Fresh milk has to keep a cool condition, 4-6 °C, by the reason of low activity of microorganism. With this condition it can keep up to 16 hours storage time.



If we are comparing to milk powder form, it can keep at normal temperature room but it has to control moisture of environment and oxygen content at a low level also. With this condition, milk powder can keep up 6 months.

### Opportunity

- Local raw material

In term of purchase planning, it is easier to control the quantity and planning by the reason of shorter communication operation. Moreover, the transportation cost are less if compare to the import.

- Increase in fresh milk production volume

Trend of fresh milk production volume has been increase in each year. That means cow's farm has been expand or more effective in tem of production yield. Especially, Thai government tries to encourage having more cows' farm in country and prices is set at guarantee price if quality of fresh milk is correspond to the requirement.

- Image of fresh and more rich nutritional ingredient

The perception of customer to fresh milk is fresh and rich in nutritional. The behaviors of consumers are preferred to pay for healthy care products, which gives more valuables to them.

### Threat

- Consistency of quality

The quality of fresh milk is depending on the season and foods. Therefore, in winter season cows will give more %fat content than others season. Moreover, the knowledge of Thai cow's farmer is less and technological support is expensive. However, this situation will be improved by giving the cow's farming technology from both government and company

- Demand more than supply

The consumption demand in country is more than supply side. With this situation, sometime it may cause a fluctuation in supply side. However, this can be manage by the making a good relationship with suppliers and contract suppliers with cows' farm.

In conclusion, fresh milk can be used as whole milk powder, because of whole milk powder is one type of preservative. Moreover, the whole milk powder is milk standardize fat and bring it to spray dry process in order to remove the water from the fresh milk. The major component of whole milk powder is fat, solid non- fat, and moisture. It is the same as fresh milk, which is composed with fat, solid non- fat, and moisture, which is water. In term of physical property, fresh milk gives more fresh taste and buttermilk. The similar thing is color of milk when it is in liquid form. The storage time and supply of

fresh milk are weak point, however, because it is a local raw material so it is easier to manage.

Fresh milk and whole milk powder has different in term of percentage in composition. The value had been varied from source to source and also depending on the season climatic. The forecasting value of the composition has been generated by the expecting climate and statistical and experience. It is not so clear, however, the value doesn't change to much in each year.