A STUDY OF THE METHOD FOR DETECTION OF ADDED MILK POWDER IN MILK AND PROCESSED MILK

BENJAPORN NARINRAK

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Benjaporn Narinrak
....
Miss Benjaporn Narinrak
Candidate

....
Mr. Pairoj Luangpituksa, Ph.D.
Major-Advisor

....
Assoc.Prof.Saiyavit Varavinit, Ph.D.
Co-Advisor

....
Mr. Suchat Udomsopagit, Ph.D.
Co-Advisor

....
Assoc.Prof. Rassmidara Hoonsawat,
Ph.D.
Dean
Faculty of Graduate Studies

....
Assoc.Prof. Manop Suphantharika,
Ph.D.
Chair
Master of Science Programme in
Biotechnology
Faculty of Science

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Benjaporn Narinrak
....
Miss Benjaporn Narinrak
Candidate

....
Mr. Pairoj Luangpituksa, Ph.D.
Chair

....
Assoc.Prof.Saiyavit Varavinit, Ph.D.
Member

....
Mr. Suchat Udomsopagit, Ph.D.
Member

....
Mrs. Warunee Varanyanond, Ph.D.
Member

....
Assoc.Prof.Rassmidara Hoonsawat, Ph.D.
Dean
Faculty of Graduate Studies
Mahidol University

....
Prof. Amaret Bhumiratana, Ph.D.
Dean
Faculty of science
Mahidol University

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Benjaporn Narinrak

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BENJAPORN NARINRAK 4536516 SCBT/M

M.Sc. (BIOTECHNOLOGY)

THESIS ADVISORS: PAIROJ LUANGPITUKSA, Ph.D., SAIYAVIT VARAVINIT, Ph.D., SUCHAT UDOMSOPAGIT, Ph.D.

ABSTRACT

Currently, fresh milk products available in the market have been produced from pure fresh milk and raw milk combined with reconstituted milk. Due to the price of locally produced raw milk in Thailand, it is usually higher than the cost of imported milk powder. Some manufacturers want to reduce the cost of production so they combining reconstituted milk with raw milk during the production. This takes advantage of the consumer. Therefore, the development of the method for the detection of added milk powder in fresh milk is needed by the government in order to investigate whether the fresh milk available in the market is produced from only pure fresh milk as indicated on the label. This study was based on some changes in milk constituents including deoxyketone (lactulosyllysine) determination, biochemical analysis, ratios of milk composition, and milk fat particle size analysis. Results indicate that the ratios of milk composition can used as an index to differentiate between fresh milk and fresh milk that has been combined with reconstituted milk. This can be applied to the detection in market fresh milk (pasteurized and UHT milk). Deoxyketone determination and milk fat particle size analysis can differentiate between raw milk and raw milk combining with reconstituted milk. Biochemical analysis showed different values but not clear when compared with the ratios of milk composition. Therefore, biochemical analysis could not differentiate between fresh milk and fresh milk combined with reconstituted milk.

KEY WORDS: DEOXYKETONE/ FRESH MILK/ LACTULOSYLLYSINE/
MILK COMPOSITION / MILK POWDER / PARTICLE SIZE

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เบญจพร นารินทร์รักษ์ 4536516 SCBT/M

วท.ม. (เทคโนโลยีชีวภาพ)

คณะกรรมการควบคุมวิทยานิพนธ์: ไพโรจน์ หลวงพิทักษ์, Ph.D., ไสยวิชญ์ วรวินิต, Ph.D., สุชาต อุดมโสภกิจ, Ph.D.

บทคัดย่อ

ในปัจจุบันนี้ผลิตภัณฑ์นมสดที่จำหน่ายตามท้องตลาด มีทั้งที่ผลิตโดยใช้วัตถุดิบซึ่งมาจากน้ำนมดิบโดยตรงและผลิตโดยใช้วิธีการผสมระหว่างน้ำนมดิบและนมผงที่นำมาละลายน้ำ ทั้งนี้เนื่องจากต้นทุนในการผลิตน้ำนมดิบในประเทศมีราคาสูง จึงส่งผลให้น้ำนมดิบมีราคาสูงกว่านมผงที่นำเข้าจากต่างประเทศ ผู้ผลิตบางรายต้องการลดต้นทุนในการผลิตจึงผสมนมผงลงในน้ำนมดิบในระหว่างการผลิตซึ่งถือเป็นการเอาเปรียบผู้บริโภค ดังนั้นการพัฒนาวิธีการตรวจสอบการผสมนมผงลงในนมสดจึงมีความจำเป็นสำหรับหน่วยงานของรัฐ ในการตรวจสอบนมสดที่จำหน่ายตามท้องตลาดว่าผลิตมาจากนมสด 100% ตามที่ระบุไว้ในฉลากหรือไม่ ในการศึกษานี้อาศัยการเปลี่ยนแปลงคุณสมบัติบางอย่างของส่วนประกอบน้ำนม ได้แก่ การตรวจหาปริมาณ deoxyketone หรือ lactulosyllysine, การตรวจหาส่วนประกอบทางชีวเคมีของน้ำนม, การวิเคราะห์อัตราส่วนของส่วนประกอบน้ำนมและการตรวจหา milk fat particle size จากการศึกษาพบว่า การวิเคราะห์อัตราส่วนของส่วนประกอบน้ำนม สามารถนำมาใช้เป็นดัชนีสำหรับจำแนกความแตกต่างระหว่างนมสดและนมสดที่มีการผสมนมผงได้อย่างชัดเจน และสามารถนำไปตรวจสอบนมสดที่จำหน่ายในท้องตลาดได้ ส่วนวิธีการตรวจหาปริมาณ deoxyketone และการตรวจหา milk fat particle size สามารถจำแนกความแตกต่างระหว่างน้ำนมดิบและน้ำนมดิบที่ผสมนมผงได้ สำหรับวิธีการตรวจหาส่วนประกอบทางชีวเคมีของน้ำนมนั้น ค่าที่ได้แตกต่างกันแต่ไม่ชัดเจนเมื่อเปรียบเทียบกับวิธีการวิเคราะห์อัตราส่วนของส่วนประกอบน้ำนม ทำให้ไม่สามารถแยกแยะความแตกต่างระหว่างนมสดและนมสดที่ผสมนมผงได้

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ABBREVIATION

^{o}C	Degree Celsius
etc.	Et cetera
e.g.	Exempli gratia
g	Grams
i.e.	Id est
kg	Kilograms
L	Liter
mg	Milligrams
ml	Milliliters
mM	Millimolar
nm	Nanometers
µm	Micrometers
RM	Raw milk
SMP	Skimmed milk powder
WMP	Whole milk powder

CHAPTER I
INTRODUCTION

Thailand is an agricultural country in which many people work on the land (Jedsadabundit P, 1998). Raw milk production is one of the important agriculture occupations in Thailand. Since the 1980s, local milk production has been increasing rapidly. As might be expected, not every region of Thailand is suitable for commercial milk production, and an indication of this variability is shown in Table 1. The reasons for these differences are primarily ecological, because whereas forage feeding is available all the year round in Ratchaburi Province, Khon Kaen is located in a much drier area. Other serious problems that often occur on dairy farms are low fertility and low conception rates, a high incidence of mastitis and low milk yields; the latter mainly result from a shortage of quality roughage, such as silage and hay, to provide the animals with sufficient feed, especially during the dry season (Kiyothong K, 1998).

Table 1 The 10 provinces in Thailand that had the highest numbers of dairy cows in 1995; all figures as the totals for each group.

Province	Dairy cows	Milking cows	Farms	Milk produced (kg/day)
Ratchaburi	55,186	22,465	5,036	180,017
Saraburi	30,899	20,480	2,221	230,434
Nakhon Ratchasima	28,737	15,955	1,111	98,731
Lopburi	28,219	13,677	1,600	87,721
Prachuap khirikhan	13,104	7,196	975	53,990
Nakhon Pathom	11,039	5,482	622	32,587
Chiang Mai	10,673	5,935	1,757	53,990
Phetchaburi	9,812	5,448	936	28,496
Khon Kaen	7,457	2,038	394	15,117
Sa Kaew	6,081	3,329	297	25,181

Source: Planning Division, Department of Livestock Development, 2000

In Thailand, ready to drink milk production use local raw milk for main material but amount of raw milk not enough for produced ready to drink milk. Therefore, some ready to drink milk are made from milk powder import from a foreign country. From Table 2 indicated that raw milk produced in Thailand insufficient for ready to drink milk production so skimmed milk powder was came in some ready to drink milk industry (skimmed milk powder 1kg. was recombined to ready to drink milk about 10kg.).

Table 2 Raw milk production and ready to drink milk production in 1992-1999.

Year	Raw milk production (tonnes)	Ready to drink milk production (tonnes)	Skimmed milk powder for produced ready to drink milk (tonnes)
1992	227,784	293,669	6,580
1993	293,255	352,240	5,890
1994	326,381	413,848	8,740
1995	350,196	527,467	17,700
1996	380,622	607,687	22,700
1997	385,477	608,883	22,340
1998	429,000	556,140	12,700
1999	444,000	589,480	14,500

Source: 1) Office of Agricultural Economics

- Raw milk production in 1992-1996
- Ready to drink milk production in 1992-1995

2) Department of Livestock Development

- Raw milk production in 1997-1998
- Ready to drink milk production in 1996-1998
- Year 1999 was estimated

According to the Notification of the Ministry of Public Health No.265 (B.E. 2545), fresh milk refers to milk obtained from a cow and is required to be free from colostrums, infectious disease, antibiotic, insecticide residues and no preservative. It must contain not less than 2.8% by weight of milk protein. Fresh milk can be divided into three groups as follows:

1. Whole milk is defined as fresh milk from a cow with nothing removed or added. It contains at least 3.2% by weight of milk fat and at least 8.25% by weight of solid-not-fat.

2. Low-fat milk or partially skimmed milk contains 0.1% to 3.2% by weight of milk fat while most common products contain 2% milk fat. Low-fat milk must contain not less than 8.5% by weight of solid-not-fat.

3. Skimmed milk refers to milk that most of fat removed. It contains not less than 0.1% by weight of milk fat and at least 8.8% by weight of solid-not-fat.

Reconstituted milk is the liquid milk obtained from the addition of water to skimmed milk powder or whole milk powder (Alfa-laval, 1995). At present, there are three types of raw materials used for production of fresh milk including raw milk, raw milk combined with whole milk powder, and raw milk combined with skimmed milk powder (Hankunakul, 1999). The price of locally produced fresh milk in Asia is usually higher than the cost of imported milk powder (FFTC, 2001). To reduce the cost of production, some manufacturers produce fresh milk from milk powder or combination of raw milk and milk powder (Panaphon, 1999). However, manufacturers have to indicate the type of raw material used on labels of product. Nevertheless some manufacturers indicate that the raw material is raw milk although their milk products are produced from milk powder or combination of raw milk and milk powder (Hankunakul, 1999).

At present there are two factors that can be used to indicate added reconstituted milk, i.e. furosine and lactulose.

Furosine is a product of maillard reaction and can be obtained by acid hydrolysis of heated milk or milk product (Fennema, 1996). Addition of reconstituted milk during the production of consumption milk leads to abnormally high furosine value for pasteurized milk and to abnormally high ratio of furosine to lactulose for UHT milk (Leen, et al, 2000). Furosine can be determined by a HPLC method (Roland and Jan, 1996).

Lactulose, the formation of lactulose in heated milk due to the alkaline isomerization of lactose catalyzed by the free amino group of casein (Jan, et al, 1996). There are several analytical methods for detection of lactulose mainly, i.e. gas chromatography, enzymatic method based on spectrophotometric detection or amperometric detection (Amine, et al, 2000).

In order to develop the new methods for determination of pure fresh milk or it produced by combined with reconstituted milk, we focus in some constituents of milk that can be used to differentiate between fresh milk and milk combined with milk powder. In this study we investigated four factors including deoxyketone (Lactulosyllysine) determination, biochemical analysis, ratios of milk composition, and milk fat particle size analysis.

The purposes of this study were:

1. To evaluate the factors, that can differentiate between fresh milk and fresh milk combined with milk powder
2. To develop the method for detection of added milk powder into fresh milk
3. To develop appropriate method for detection of the presence of milk powder added to market fresh milk

CHAPTER II
LITERATURE REVIEW

Milk is a normal product of mammary gland secretion. It is composed of water, carbohydrate (lactose), fat, protein, minerals and vitamins. It is a complex, nutritious product that contains more than 100 substances that are either in solution, suspension or emulsion in water (Table 3). For example

- Casein, the major protein of milk, is dispersed as a great number of solid particles so tiny that they do not settle, but remain in suspension. These particles are called micelles. The dispersion of the micelles in milk is referred to as a colloidal suspension.
- Fat and fat soluble vitamins in the milk are in the form of an emulsion; a suspension of small liquid globules that does not mix with the water in milk.
- Lactose (milk sugar), some proteins (whey protien), mineral salts and other substances are soluble. They are entirely dissolved in the water in milk.

Casein micelles and fat globules play a major role on physical characteristics of milk and affect taste and flavor to dairy products such as butter, cheese, yoghurt, etc. The composition of milk varies considerably with the breed of cow, stage of lactation, feed, season of the year, and many other factors. However, some relationships between constituents are very stable and can be used to indicate whether any tampering with the milk composition has occurred. For example, milk of normal composition has a specific gravity in a range of 1.023 to 1.040 (at 20 ^{o}C) and a freezing point that varies from -0.518 to -0.534 ^{o}C. Any alteration, by addition of water for example, can be easily identified because these characteristics of milk will no longer be in the normal range. Milk is a highly perishable product that should be cooled to about 4 ^{o}C as soon as possible after collection. Extremes of temperature, acidity (pH) or contamination by microorganisms can rapidly decrease its quality.

Table 3 Nutritional composition of milk

NUTRITIONAL COMPOSITION OF MILK
PER 100ML

NUTRIENT	Pasteurised Channel Islands	Pasteurised Whole	Pasteurised Semi-Skimmed	Pasteurised Skimmed
Energy, kcal	80	68	48	34
kJ	336	284	202	145
Protein, g	3.7	3.3	3.4	3.4
Carbohydrate, g	4.9	4.9	5.2	5.2
of which sugars, g	4.9	4.9	5.2	5.2
Fat, g	5.2	4.0	1.7	0.1
of which saturates, g	3.4	2.5	1.0	0.1
monounsaturates, g	1.3	1.1	0.5	Trace
polyunsaturates, g	0.1	0.1	Trace	Trace
Cholesterol, mg	16	14	7	2
Sodium, mg	56	57	57	57
Water, g	88.9	90.5	92.9	94.4
Vitamin A, µg	60*	58*	23*	1*
Thiamin, mg	0.04†	0.04†	0.04†	0.04†
Riboflavin, mg	0.20*	0.18*	0.19*	0.19*
Niacin, mg	0.9†	0.8†	0.9†	0.9†
Vitamin B_6, mg	0.06†	0.06†	0.06†	0.06†
Vitamin B_{12}, µg	0.4†	0.4†	0.4†	0.4†
Vitamin C, mg	1*†	1*†	1*†	1*†
Vitamin D, µg	0.03	0.03	0.01	Trace
Vitamin E, mg	0.11	0.09	0.03	Trace
Folate, µg	6†	6†	6†	6†
Pantothenate, mg	0.37	0.36	0.33	0.33
Biotin, µg	2.0	2.0	2.1	2.0
Calcium, mg	134	119	124	124
Chloride, mg	103	103	103	104
Copper, mg	Trace	Trace	Trace	Trace
Iodine, µg	N	15	(16)	(16)
Iron, mg	0.05	0.05	0.05	0.05
Magnesium, mg	12	11	11	12
Manganese, mg	Trace	Trace	Trace	Trace
Phosphorus, mg	103	95	98	98
Potassium, mg	144	144	155	155
Selenium, µg	(1)	1	(1)	(1)
Zinc, mg	0.4	0.4	0.4	0.4

Source: McCance and Widdowson's The Composition of Foods. Fifth Edition. Ministry of Agriculture, Fisheries and Food, and The Royal Society of Chemistry (1991).

* Will reduce if exposed to sunlight.

† Will be subject to degree of processing.

( ) Estimated value.

2.1 Milk and dairy products

2.1.1 Fluid milk products

2.1.1.1 Beverage milks

Milk for direct human consumption must be passed heat treatment. Being a high nutritional value and complete food, it is an excellent medium for microbial growth. The heat treatment is used for destruction of microorganisms and increase storage life of milk. The fluid milk is heated after clarification to improve its durability and to kill pathogenic microorganisms. Heat treatments used can be classified as pasteurization, ultra high temperature, and sterilization.

2.1.1.1.1 Pasteurization

Pasteurization is the most common practice of heat-processing milk for safety. The International Dairy Federation has defined pasteurization as "a process applied to a product with the object of minimizing possible health hazards arising from pathogenic microorganisms associated with milk, by heat treatment, which is consistent with minimal chemical, physical and organoleptic changes in the product" (Varnam and Sutherland, 1994). There are two main systems of milk pasteurization:

- **Low temperature long time (LTLT)** or batch process or low temperature holding method. The batch heating process involves bringing the milk to a suitable temperature, usually at 62-65 ^{o}C and holding it at that point for at least 30 minutes followed by rapid cooling to a temperature lower than 10 ^{o}C (Belitz and Grosch, 1987; Varnam and Sutherland, 1994).

- **High temperature short time (HTST)** or flash pasteurization. HTSH is the process of heating milk rapidly to a temperature of not less than 71 ^{o}C for 15-40 seconds (Belitz and Grosch, 1987; Varnam and Sutherland, 1994).

2.1.1.1.2 Ultra high temperature (UHT) treatment

UHT milk was developed to meet the demand for milk to be stable for extended periods at room temperature and yet free of the unpleasant taste associated with sterilized milk. Plant for UHT milk may be placed in two categories:

- **Direct heating system.** The production of UHT milk by direct heating involves the mixing of superheated steam with milk, which is consequently heated almost instantaneously to the required sterilizing temperature at 140-150 ^{o}C for 2-4 seconds followed by aseptic packaging (Belitz and Grosch, 1987; Varnam and Sutherland, 1994; Vidal et al, 1993).

- **Indirect heating system.** A novel indirect method is carried out using tubular or plate heat exchangers similar to those used for pasteurization. The conditions used are 135-140 °C for 6-10 seconds (Belitz and Grosch, 1987; Varnam and Sutherland, 1994; McCarthy et al, 1985).

2.1.1.1.3 Sterilization

Sterilized milk is milk which is filtered or clarified and homogenized before maintaining at a temperature above 100 °C for a sufficient time to destroy all organisms present and is packaged in hermetically sealed containers. (Belitz and Grosch, 1987; Varnam and Sutherland, 1994).

2.1.1.2 Cream

During the separation of whole milk, two streams are produced: the fat-depleted stream, which produces the beverage milks as described above or skim milk for evaporation and possibly for subsequent drying, and the fat-rich stream, the cream. This usually comes off the separator with fat contents in the range of 35-45%. Cream is used for further processing in the dairy industry for the production of ice cream or butter, or can be sold to other food processing industries.

2.1.2 Concentrated and Dried Dairy Products

Fluid milk contains approximately 88% of water. Concentrated milk products are obtained through partial water removal. Dried dairy products have even greater amounts of water removed to usually less than 4%. The benefits of both processes include an increased shelf-life, convenience, product flexibility, decreased transportation costs, and storage.

2.1.2.1 Condensed milk

The process is known as “condensing” or “evaporating” depending upon whether a vacuum pan or an evaporator is used as a means of removing the water. Condensed milk products include evaporated skim or whole milk, sweetened condensed milk, condensed buttermilk and condensed whey.

2.1.2.2 Dry milk or milk powder

Drying denotes that the water in a liquid product is removed, so that the product acquires a solid form. The water content of milk powder ranges between 2.5 and 5% to ensure that no bacteria growth takes place at such low water content. Commercial methods of drying are based on heat being supplied to the product. The water is then evaporated and removed as steam. The residue is a dried product or milk powders. Two principal methods used for drying in the dairy industry involve roller drying and spray drying. Drying extends the shelf life of the milk, simultaneously reducing the weight and volume. This reduces the cost of product transportation and storage.

2.1.3 Cultured Dairy Products

2.1.3.1 Cheese

Cheese is one type of cultured milk product. In this case, the starting material, milk is mixed with rennet and bacteria or other microorganisms to change lactose to lactic acid. Rennet is a mixture of enzymes that include rennin and pepsin. These enzymes make the milk curdle (clot or coagulate), leaving curds (the solid part) and whey (the liquid part). The curds are cut up and then lightly heated, causing them to shrink. The resulting cheese is allowed to age from 1 month (for example, brie) to 1 year (like cheddar). Some types of cheese can be consumed immediately, for example mozzarella.

2.1.3.2 Yoghurt

Yoghurt is a semi-solid fermented milk product which originated centuries ago in Bulgaria. Its popularity has grown and is now consumed in most parts of the world. The consistency, flavor and aroma may vary from one region to another. In some area yoghurt is produced in the form of a highly viscous liquid, whereas in other countries it is in the form of a softer gel. Yoghurt is usually classified as follow:

- Set type yoghurt, which is filled immediately after inoculation with bulk starter and incubated in the package
- Stirred type yoghurt, which is inoculated and incubated in the tank. After incubation the product is cooled before filling.

- Drink type yoghurt, which is based on the stirred type. The coagulum is broken down to liquid before filling.

2.1.4 Ice cream

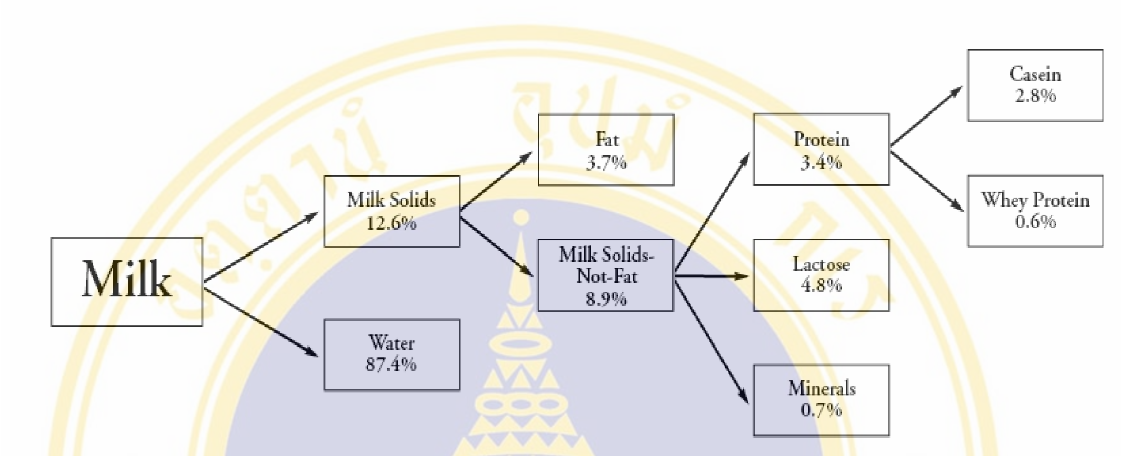
Ice cream and other frozen treats can be made from a variety of milks, buttermilk, condensed milk, cream or whey (the liquid part in cheese production). Ice cream must contain at least 10% fat and 20% milk solids to be called ice cream in the United States. Ice cream is a mixture of milk, sugar, cream, flavoring and stabilizer. The stabilizer is used to prevent ice crystals formation in the ice cream. The ingredients are mixed, pasteurized, and then homogenized to keep a smooth texture. The mix is then quickly cooled down to 40 ^{o}F.

2.1.5 Butter

Butter is a very concentrated form of milk. Butter is composed of 82% fat, 16% water and 2% milk solids. Fat in milk is suspended in the mixture by churning or agitating unhomogenized milk. Fat breaks out of the mixture in the size of rice grains. The butterfat clumps together and separates from the water, which is known as buttermilk.

2.2 Milk composition

The major constituents of milk are illustrated in Figure 1. Milk is made up of 87.4% water and 12.6% milk solids (3.7% fat, 8.9% milk solids-not-fat). The milk solids-not-fat contains protein (3.4%), lactose (4.8%), and minerals (0.7%).



Source: http://www.nationaldairycouncil.org/Nutrition/Products/figure02.pdf

Figure1 Major constituents of milk (Chandan R., 1997).

2.2.1 Water

Water content of milk is dependent upon the synthesis of lactose. Without some water in milk, it would be a viscous secretion composed mostly of lipid and protein and would be extremely difficult to remove from the gland. Water content of milk can be range from a low content in marine mammals to a high content in human milk and others. Cow milk contains approximately 87% water, so the transport of milk from the dairy farm to the processing plant involves hauling considerable amounts of water.

2.2.2 Lipids

Milk fat is a natural fat with unique physical, chemical, and biological properties. It contributes to the appearance, texture, flavor, and satiability of dairy foods. Milk fat is a source of energy, essential fatty acids, fat-soluble vitamins, and several other potential health-promoting components. Milk lipids are mainly triacylglycerols (triglycerides) or esters of fatty acids with glycerol (97-98%), 0.2 to 1.0% phospholipids, 0.2 to 0.4% free sterols (cholesterol, waxes, and squalene, an intermediate of cholesterol), traces of free fatty acids, and varying amounts of the fat-soluble vitamins A, D, E, and K (Table 4).

Table 4 Composition of milk lipids

Class of Lipid	Per 100 Grams Whole Fluid Milk (3.3% Fat)	Per Cup (8 oz., 244g) Whole Fluid Milk
Vitamin A activity	126 IU (31 RE)	307 IU (76 RE)
Vitamin D	1-3 IU	2.44 -7.32 IU
Vitamin E	0.100 mg	0.244 mg
Vitamin K	0.00334 mg	0.008 mg
Triacylglycerols (Triglycerides)	3.23-3.27 g	7.88-7.98 g
Diglycerides	0.01-02 g	0.02-0.05 g
Monoglycerides	0.53-1.27 mg	1.29-3.10 mg
Keto acid glycerides (total)	28.4-42.75 mg	69.3-104.3 mg
Ketonogenic glycerides	1.00-4.3 mg	2.44-10.5 mg
Hydroxy acid glycerides (total)	20.0-26.05 mg	48.8-63.56 mg
Lactonogenic glycerides	2.00 mg	4.88 mg
Neutral glyceryl ethers	0.53-0.67 mg	1.293-1.635 mg
Neutral plasmalogens	1.34 mg	3.270 mg
Free fatty acids	3.34-14.7 mg	8.15-35.87 mg
Phospholipids (total)	6.7-33.4 mg	16.30-81.50 mg
Sphingolipids (less sphingomyelin)	2.00 mg	4.88 mg
Free sterols	7.35-13.69 mg	17.93-33.40 mg
Cholesterol	14 mg	33 mg
Squalene	0.2338 mg	0.570 mg
Carotenoids	0.0233-0.0301 mg	0.057-0.073 mg

Source: Wong, et al., 1988 and USDA Nutrient Database.

More than 400 different fatty acids and fatty acid derivatives are found in milk, ranging from butyric acid with 4 carbon atoms to fatty acids with 26 carbon atoms. Milk fat is characterized not only by numerous different fatty acids, but also by their chain lengths. Among animal fats, milk fat is unique because it contains a relatively high proportion of short-chain and medium-chain saturated fatty acids, many of which are not found in other fats. Milk fat contains about 7% short-chain fatty acids (C4 to C8), 15 to 20% medium-chain fatty acids (C10 to C14), and 73-78% long-chain fatty acids (C16 and higher). Although the composition of milk fat varies according to such factors as the breed of the cow and composition of the feed, the fatty acids in milk fat are approximately 65% saturated, 32% monounsaturated, 3% polyunsaturated, with minor amounts of other types of fatty acids (Table 5).

Table 5 Fatty acid composition of bovine milk lipid

Type of Fatty Acid	Percent of Total Fat	Fatty Acid	Composition	Percent of Total Fat
Saturated	62.3	Butyric	4:0	3.3
		Caproic	6:0	1.7
		Caprylic	8:0	1.2
		Capric	10:0	2.3
		Lauric	12:0	2.6
		Myristic	14:0	10.2
		Paltmitic	16:0	26.3
		Stearic	18:0	12.0
Monounsaturated	28.7	Oleic	18:1	25.1
Polyunsaturated	3.6	Linoleic	18:2	2.4

Source: www.anslab.iastate.edu/Class/AnS270/milkfat.pdf

2.2.3 Protein

Bovine's milk is a heterogeneous mixture of proteins (Table 6). About 80% of the total protein in milk is casein and 20% is whey protein. Milk also contains small amounts of various enzymes (e.g., lipoprotein lipase, alkaline phosphatase, lactoperoxidase) and traces of non-protein nitrogenous compounds (e.g., ammonia, urea, creatinine, creatine, and uric acid).

Casein, the dominant protein in bovine's milk, can be fractionated electrophorecally into four major components: alpha-, beta-, gamma-, and kappa-casein. Casein is generally defined as the protein precipitated at pH 4.6, a property used in the manufacturing of cheese. Whey protein, which is more heterogeneous than casein, consists predominantly of beta-lactoglobulin and alpha-lactalbumin. Alpha-lactalbumin has a high content of the amino acid tryptophan, a precursor of niacin. Other whey proteins present in smaller amounts are serum albumin, immunoglobulins (e.g., IgA, IgG, IgM), protease peptones, lactoferrin, and transferrin. Each of these proteins has unique characteristics.

Table 6 The concentration of proteins in milk.

	grams/ liter	% of total protein
Total Protein	33	100
Total Caseins	26	79.5
alpha s1	10	30.6
alpha s2	2.6	8.0
beta	9.3	28.4
kappa	3.3	10.1
Total Whey Proteins	6.3	19.3
alpha lactalbumin	1.2	3.7
beta lactoglobulin	3.2	9.8
BSA	0.4	1.2
Immunoglobulins	0.7	2.1
Proteose peptone	0.8	2.4

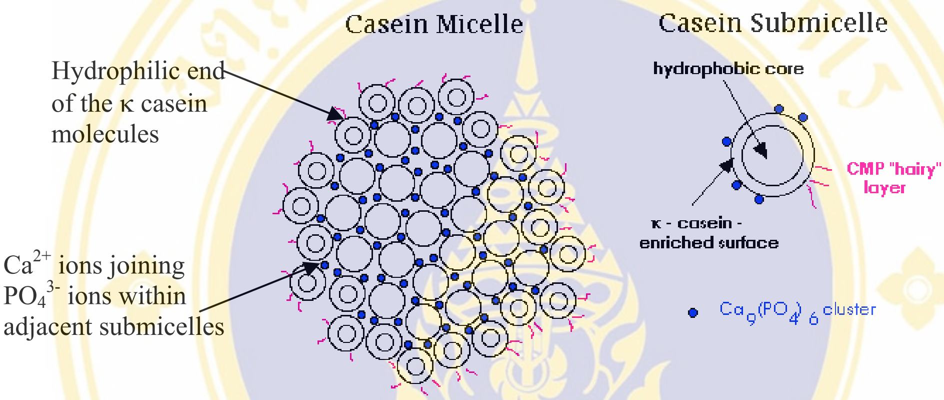
Source: Douglas, 1995

Casein is composed of several similar proteins which form a multi-molecular, granular structure called a casein micelle. In addition to casein molecules, the casein micelle contains water and salts (mainly calcium and phosphorous). Some enzymes are associated with casein micelles, too. Casein is one of the most abundant organic components of milk, along with the lactose and milk fat. Individual molecules of casein alone are not very soluble in the aqueous environment of milk. However, the casein micelle granules are maintained as a colloidal suspension in milk. If the micellar structure is disturbed, the micelles may come apart and the casein may come out of solution, forming the gelatinous material called the curd. This is part of the basis for formation of all non-fluid milk products. The main forms of casein present in milk are called α, β and κ ("kappa") casein.

- α and β casein are dominated by amino acids in which the side chains are insoluble in water but are attracted to each other (Figure 2). These "hydrophobic" forces cause the casein molecules to join in small particles called submicelles. The κ casein molecules also have a hydrophobic end which joins inside these submicelles.

- However one side of the κ casein molecule has a large number of amino acids containing the –OH group which attracts water and which protrude outside the submicelle as the 'hairy layer'. These "hydrophilic" forces enable the submicelle as a whole to dissolve in water.

- The submicelles contain phosphate PO_4^{3-} ions at the surface. Calcium Ca^{2+} ions can attach to the phosphate ions in adjacent submicelles, in effect 'gluing' the submicelles together into a much larger micelle.



Source: http://class.fst.ohio-state.edu/FST822/lectures/Milk.htm

Figure 2 Casein micelle and casein submicelle formed by k-casein.

2.2.4 Carbohydrate

The principal carbohydrate in milk is lactose, a natural disaccharide composed of the monosaccharides D-glucose and D-galactose, joined in a ß-1, 4-glycosidic linkage. The chemical name for lactose is 4-O-ß-D-galactopyranosyl-D-glucopyranose. Lactose accounts for about 54% of the total solids-not-fat content of whole milk and about 30% of its calories (about 9% of the calories of 2% reduced fat milk). The lactose content of milk varies by species. Bovine's milk contains about 4.8% lactose (12 to 12.5% lactose/cup), whereas human milk has 7% lactose (15 to 18 g lactose/cup). Minor quantities of glucose, galactose, and oligosaccharides are also present in milk. Glucose and galactose are the products of lactose hydrolysis by the enzyme lactase. Carbohydrates other than lactose are found in milk, but at low concentrations. Low concentrations of free glucose (about 0.1 mM) and free galactose (about 0.2 mM) are found in cow milk and milk of other species. Other carbohydrates found free in milk include amino sugars, sugar phosphates, neutral and acid oligosaccharides, and nucleotide sugars. Some of the complex oligosaccharides are thought to be important in helping establish the microflora of the neonate intestine (such as the bifidis factor identified in human milk).

2.2.5 Vitamins

Vitamins are organic substances essential for many life processes. Milk includes fat soluble vitamins A, D, E, and K (Table 7). Vitamin A is derived from retinol and ß-carotene. Because milk is an important source of dietary vitamin A, fat reduced products which have lost vitamin A with the fat are required to supplement the product with vitamin A.

Milk is also an important source of dietary water soluble vitamins, i.e. B1–thiamine, B2-riboflavin, B6-pyridoxine, B12-cyanocobalamin, niacin, and pantothenic acid

There is also a small amount of vitamin C (ascorbic acid) presents in raw milk but is very heat-labile and easily destroyed by pasteurization.

Table 7 The vitamin content of fresh milk.

Vitamin	Contents per litter
A (ug RE)	400
D (IU)	40
E (ug)	1000
K (ug)	50
B1 (ug)	450
B2 (ug)	1750
Niacin (ug)	900
B6 (ug)	500
Pantothenic acid (ug)	3500
Biotin (ug)	35
Folic acid (ug)	55
B12 (ug)	4.5
C (mg)	20

Source: Douglas, 1995

2.2.6 Minerals

All 22 minerals considered to be essential to the human diet are present in milk (Table 8). These include three families of salts:

1. Sodium (Na), Potassium (K) and Chloride (Cl): These free ions are negatively correlated to lactose to maintain osmotic equilibrium of milk with blood.
2. Calcium (Ca), Magnesium (Mg), Inorganic Phosphorous (P(i)), and Citrate: This group consists of 2/3 of the Ca, 1/3 of the Mg, 1/2 of the P(i), and less than 1/10 of the citrate in colloidal (no diffusible) form and present in the casein micelle.
3. Diffusible salts of Ca, Mg, citrate, and phosphate: These salts are very pH dependent and contribute to the overall acid-base equilibrium of milk.

Table 8 The mineral content of fresh milk

Mineral	**Content per liter**
Sodium (mg)	350-900
Potassium (mg)	1100-1700
Chloride (mg)	900-1100
Calcium (mg)	1100-1300
Magnesium (mg)	90-140
Phosphorus (mg)	900-1000
Iron (ug)	300-600
Zinc (ug)	2000-6000
Copper (ug)	100-600
Manganese (ug)	20-50
Iodine (ug)	260
Fluoride (ug)	30-220
Selenium (ug)	5-67
Cobalt (ug)	0.5-1.3
Chromium (ug)	8-13
Molybdenum (ug)	18-120
Nickel (ug)	0-50
Silicon (ug)	750-7000
Vanadium (ug)	tr-310
Tin (ug)	40-500
Arsenic (ug)	20-60

Source: Douglas, 1995

2.2.7 Milk enzymes

Milk is also rich in native enzymes, and about 50 different enzyme activities have been reported. However, only a small number of enzymes are of practical significant.

The principal lipase in milk is lipoprotein lipase, an enzyme which catalyses the hydrolysis of triglycerides to free fatty acid. This reaction results in the production of soapy, bitter, rancid and unclean flavors in dairy products. The enzyme is present in freshly drawn milk in great excess and, under curtain conditions, spoils the milk within a few minutes. Spontaneous lipolysis is sometimes encountered in raw milk and seems to be influenced by a number of factors. These include the stage of lactation, season, diet and plane of nutrition.

The major proteinase in milk is plasmin, a serine proteinase with trypsin-like activity. At neutral pH values, milk plasmin is very heat stable. The enzyme survives pasteurization, and residual activity can still be traced after UHT sterilization.

Lactoperoxidase is another milk enzyme that is present at high concentrations. It catalyses the transfer of oxygen from hydrogen peroxide to other substrates such as thiocyanate. Lactoperoxidase has the potential to catalyse oxidation of unsaturated fatty acids, leading to the development of oxidized flavors. On the other hand, if the levels of thiocyanate and peroxide in milk are supplemented, lactoperoxidase acts as a powerful bacteriocide which can kill coliforms, Salmonellae, Shigellae and Pseudomonads.

Xanthine oxidase is present in milk and can catalyse non-specific oxidation of dairy products. Nevertheless, its overall significance in unlikely to be high.

Although not a degradative enzyme, alkaline phosphatase is worthy of mention since it is almost completely inactivated by pasteurization, and is therefore used as an index of the efficiency of such heat treatments.

2.3 Physical properties of milk

The physical properties of milk are summarized in Table 9

2.3.1 Density

Density, the mass of a certain quantity of material divided by its volume, is dependant on the following factors:

- Temperature at the time of measurement
- Temperature history of the material
- Composition of the material (especially the fat content)
- Inclusion of air (a complication with more viscous products)

The density of milk normally varies between 1.028 and 1.034 kg/l, depending on the composition. Milk is therefore only slightly denser than water (Alfa-Laval, 1995)

2.3.2 Viscosity

Viscosity of milk and milk products is important in determining the following characteristics:

- The rate of creaming
- Rates of mass and heat transfer
- The flow conditions in dairy processes

Milk and skim milk, excepting cooled raw milk, exhibit Newtonian behavior in which the viscosity is independent of the rate of shear. The viscosity of these products depends on the following factors:

Temperature:

- Cooler temperatures increase viscosity due to the increased voluminosity of casein micelles

- Temperatures above 65° C increase viscosity due to the denaturation of whey proteins

pH:

- An increase or decrease in pH of milk also causes an increase in casein micelle voluminosity.

Cooled raw milk and cream exhibit non-Newtonian behavior in which the viscosity is dependant on the shear rate. Agitation may cause partial coalescence of the fat globules (partial churning) which increases viscosity. Fat globules that are under gone cold agglutination, may be dispersed due to agitation, causing a decrease in viscosity.

2.3.3 Freezing point

Freezing point is a colligative property, which is determined by the molarity of solutes rather than by the percentage by weight or volume. In the dairy industry, freezing point is mainly used to determine added water but it can also been used to determine lactose content in milk, to estimate whey powder contents in skim milk powder, and to determine water activity of cheese. The freezing point of milk is usually in the range of -0.512 to -0.550 °C with an average of about -0.522 °C (Douglas, 1995).

2.3.4 Acid-Base Equilibrium

Both titratable acidity and pH are used to measure milk acidity. The pH of milk at 25° C normally varies within a relatively narrow range of 6.5 to 6.7. The normal range for titratable acidity of milks is 13 to 20 mmol/l. Because of the large inherent variation, the measure of titratable acidity has little practical value except to measure changes in acidity (eg, during lactic fermentation) and even for this purpose, pH is a better measurement.

Table 9 General physical properties of milk

Property	Value	Definition and Significance
Titratable acidity, % max	0.16	The total acidity or the amount of alkali required to neutralize the acidic constituents. Generally expressed as lactic acid. Used to determine bacterial growth in fermentations and compliance standards.
pH	6.6 ± 0.2 at 25° C	Fresh milk is slightly acid (pH of drinking water is 7.0-8.5). Generally the pH is lower (pH 6.0) in colostrum and higher (up to 7.5) during mastitis than in normal milk of mid-lactation.
Surface tension	50-52 dynes at 20° C	Normally, cow's milk's surface tension is about 70% of that of water. Involved in adsorption and formation and stability of emulsions. Important to creaming, functions of fat globule membranes, foaming, and emulsifier use.
Specific gravity	1.032 at 15° C	Ratio of the density of the product and the density of water at the same temperature. Many milk constituents have a specific gravity (sg) greater than that of water which has a sg of one. The more fat in milk, the lower the sg as fat has an sg less than one. Used to estimate solids not fat.
Freezing point	-0.540° C	Lower than that of pure water (0° C) due to dissolved substances in milk. Used to detect adulteration of milk with water.
Boiling point	100.17° C	Greater than that of pure water (100° C) due to dissolved substances in milk. Used to detect adulteration of milk with added water.
Specific heat at 0° C 15° C 40° C	 0.92 0.94 0.93	The specific heat of milk products depends on their composition and the temperature. Important in processing as the amount of heat or refrigeration required may be calculated from the weight and specific heat of the different products being pasteurized or cooled.
Coefficient of expansion at 10° C 15.6° C 21.1° C	 0.9975 0.9985 1.0000	The ratio of an increase in volume per unit increase in temperature. Milk expands when heated and contracts when cooled. Used for design of dairy equipment.
Viscosity	2.0-2.1 cp at 20° C	Refers to resistance to flow measured in centipoise (cp). Used to assess aggregation of protein micelles or fat globules. Also used for design of dairy equipment.
Electrical conductivity	$45\text{-}55 \times 10^{-4}$ mho	In milk, fat and colloidally dispersed substances decrease conductivity. Used to detect added neutralizers, follow fermentation, and monitor demineralization of whey.
Osmolality*	275 m Osm/kg	The osmolality of a solution is based on the number of particles in solution – the greater the number of particles, the higher the osmolality. Osmolality of foods is important in planning diets of low osmolality for certain patients. Since a solution of lower osmolality requires transfer of less water to the stomach and gastrointestinal tract to dilute it, it should be better tolerated than one of higher osmolality.

* Source: The Doyle Pharmaceutical Company, Minneapolis, Minn.

2.4 Effects of heat treatment on milks and their properties

The effects of heat treatment on the components of milk (proteins, lipids, carbohydrates and minerals) are very important for the final product character, since they undergo modifications that affect the sensory and nutritional quality of milk (Burton, 1984). The effects of the wide range of technological processes used in the dairy industry may be evaluated by determining several chemical compounds specifically related to such processes, either through degradation of original milk components or as a result of reactions at the high temperatures used (Francisco et al, 2000). There are two groups of reactions that may be used to assess heat treatment.

- Type I includes the denaturation, degradation and inactivation of heat-labile components, these are mainly whey proteins, enzymes and vitamins.

- Type II reactions includes the formation of new substances which are not present, or only at trace levels, in the unprocessed milk including lactulose or products of the maillard reaction e.g. furosine, hydroxymethylfurfural (Pellegrino et al, 1995; Mortier et al, 2000).

2.4.1 Heat-induced changes in milk related to coagulation

The coagulation of milk on extended heating at high temperatures (120–140 ^{o}C) is a consequence of loss of casein micelle stability, as a result of numerous physical and chemical changes in its components. The surface of the micelle has a number of dissociated carboxyl and some ester phosphate groups, providing a high negative charge and thus electrostatic stabilization. Then there is a diffuse surface layer of flexible, hydrophilic polypeptide chains consisting mostly of C-terminal segments of κ-casein, providing steric stabilization (Holt 1992).

Several factors influence the colloidal stability of milk. Important factors are calcium ions and pH, both of which diminish electrostatic repulsions and possibly alter the conformation of κ-casein at the micelle surface (indirectly reducing steric repulsions). Heat treatment markedly changes the serum phase environment around the casein micelles (e.g. change in pH and soluble minerals, in particular calcium ions, breakdown of lactose and urea) as well as the casein micelles themselves (association of whey proteins, dephosphorylation, casein dissociation). Some of these changes are listed in Table 10 (Singh, 2004).

Table 10 Changes in milk during heating and their possible impact on heat stability

Changes that promote instability	**Changes that enhance stability**
- Decrease in pH	- Reduction in calcium ion activity
- Deposition of calcium phosphate onto micelles	- Association of whey proteins casein micelles
- Association of whey protein with casein micelles	- Reduced sensitivity of casein to calcium ions
- Dephosphorylation of casein	- Thermal degradation products of lactose
- Dissociation and hydrolysis of casein, in particular κ-casein	
- Reduction in zeta potential and hydration	
- Covalent bond formation	

2.4.2 Changes in casein micelles

Heating milk at the heat stability assay temperatures causes denaturation of whey proteins and their interactions with casein micelles. κ-Casein on the surface of casein micelles is involved in the formation of a specific disulphide-linked complex with β-lactoglobulin (Singh and Fox 1987a; Jang and Swaisgood 1990). Concentration of milk prior to heating has a marked effect on the dissociation of κ-casein. The extent of dissociation of κ-casein at any particular pH increases with the dissociation–pH curve shifting towards lower pH values (Nieuwenhuijse *et al*.1991; Singh and Creamer 1991a). Most of the dissociated κ-casein was covalently linked to whey proteins (Singh, 2004). The pH of heating has a large effect on the extent of the association of whey proteins with the casein micelles (Smits and van Brouwershaven 1980; Singh and Fox 1985a, b). At pH values < 6.8, a majority of whey protein complexes remain associated with the casein micelle surface whereas at higher pH values, these complexes remain in the serum. On heating at pH values > 6.8, not only do the whey protein aggregates remain in the serum but also micellar κ-casein dissociates in the serum (Singh, 2004).

2.4.3 Changes in the serum phase

A crucial change in the serum is the decrease in pH, which plays a key role in creating an environment that favors coagulation of the milk proteins (Fox, 1981b). Heat treatment has been shown to reduce the concentration of soluble phosphate and of both soluble and ionic calcium. The calcium ion activity, which depends on the initial pH of the milk, also decreases upon heating. This decrease is reversible and some or all of the calcium ion activity is recovered after heating. (Van Boekel et al. 1989a,b). Another factor of importance in the serum phase is the whey proteins. These proteins are easily denatured by heat treatments above 70 ^{o}C and then react with each other or casein micelles (Singh, 2004). The major mechanism is the formation of intermolecular disulfide bonds by sulfydryl–disulfide interchange (Havea et al, 2001), especially by β-lactoglobulin (β-Lg), which dominates the aggregation behavior of whey protein (Havea et al, 2001; Schokker et al, 2000a, b) by forming oligomers that combine into large aggregates (Fuente et al, 2002; Havea et al, 2001; Schokker et al, 2000a; Bon et al, 2002; Hong and Creamer, 2002).

2.4.4 Effects on vitamins

The fat soluble vitamins A, D, and E and the vitamin B2, pantothenic acid, biotin, and nicotinic acid are relatively insensitive to heat. There are generally no losses of these vitamins when milk is heated. However, vitamins B1, B6, B12, folic acid, and vitamin C, on the other hand, are less stable to heat as shown in Table 11 (Kessler and Horak, 1981; Zadow, 1980).

Table 11 Effect of difference methods of heat treatment on the vitamin losses

Procedure	Losses (%) of				
	Vitamin B1	Vitamin B6	Vitamin B12	Folic acid	Vitamin C
Pasteurization	<10	0-8	<10	<10	10-25
UHT treatment	0.20	<10	5-20	5-20	5-30
Boiling	10-20	10	20	15	15-30
Sterilization	20-50	20-50	20-100	30-50	30-100

Source: Renner, 1983

2.4.5 Effects of heat via Maillard reaction

Heat treatment results in many chemical and structural changes in milk, the extent of which depends on the temperature and duration of heating (Evangelisti et al, 1999; Villamiel et al, 1996). One mechanism involved in the deleterious consequence of heat treatment is the Maillard reaction that leads to the decreased in nutritional value of proteins and formation of brown compounds in milk. The Maillard reaction can be divided into three stages: the early Maillard reaction, the advanced Maillard reaction and the final Maillard reaction (Mauron, 1981).

The early Maillard reaction consists of condensation of the reducing sugar with the amino group and leads, via formation of a Schiffs base and the Amadori rearrangement, to the so-called Amadori product (Figure 3). In milk, this Amadori product is lactulosyllysine (bound to protein).

The advanced Maillard reaction consists of the breakdown of the Amadori product (or other products related to the Schiffs base) into numerous fission products of the sugar-amino compound (Figure 4 and 5).

The final Maillard reaction consists of the condensation of amino compounds and sugar fragments into polymerized protein and brown pigments, called the melanoidins.

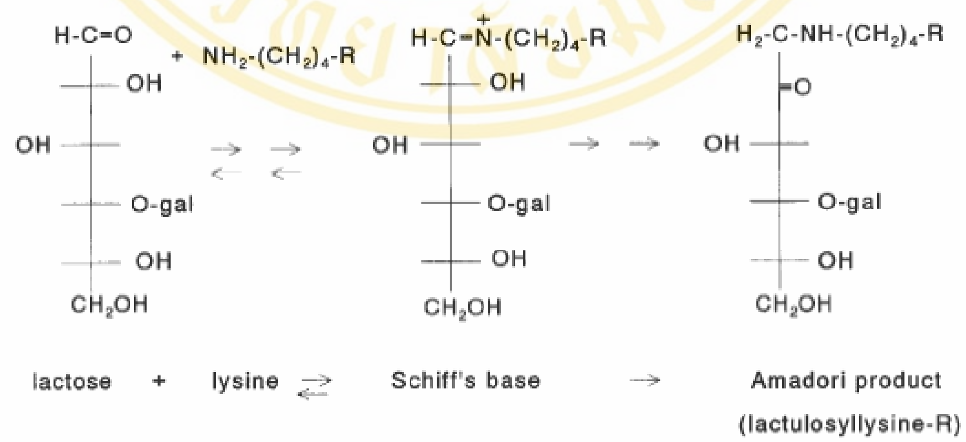


Figure 3 Schematic overview of the early Maillard reaction in milk, leading to Amadori product (gal=galactose, R=protein chain)

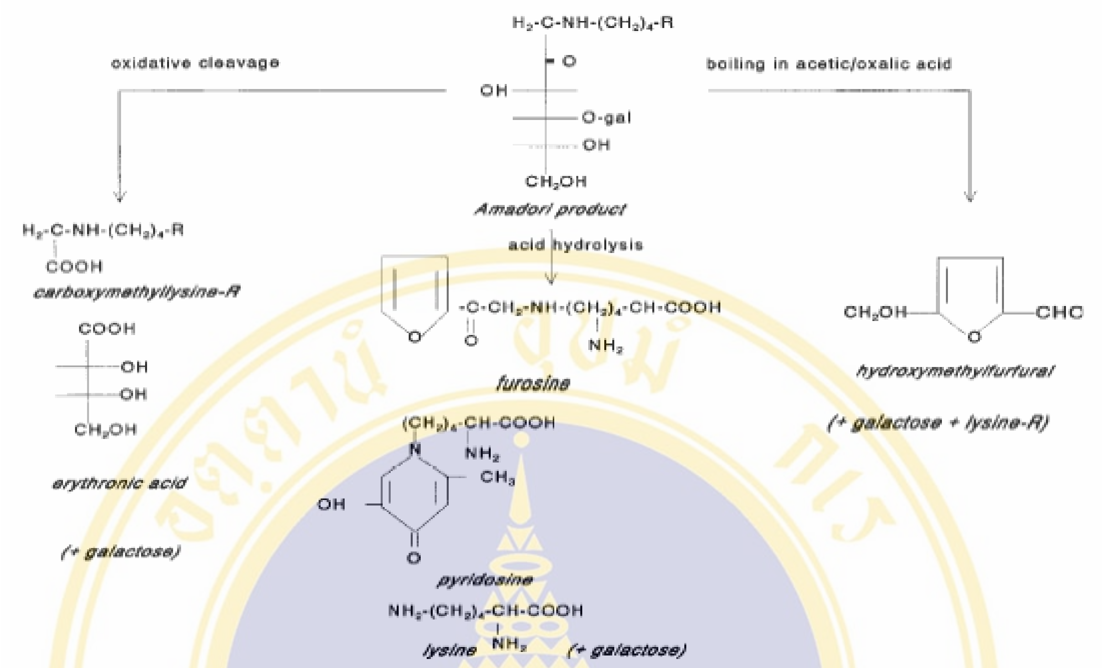


Figure 4 Degradation of the Amadori product via oxidative cleavage, acid hydrolysis, or boiling in acetic/oxalic acid (gal=galactose, R=protein chain).

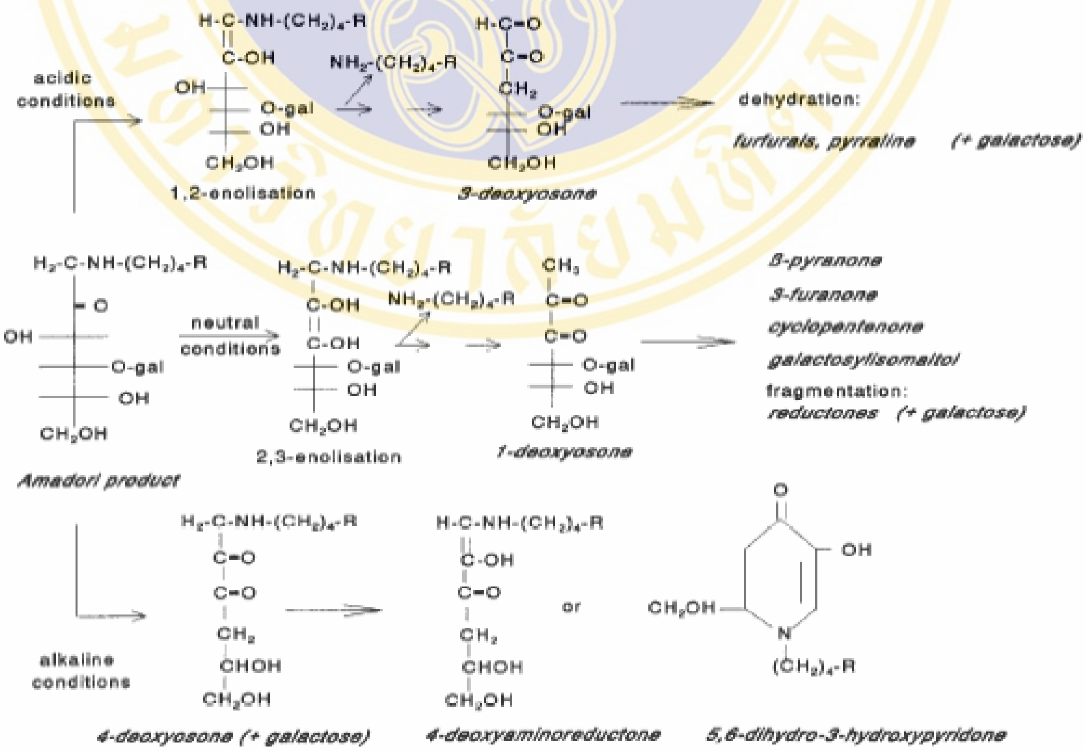


Figure 5 Breakdown of the Amadori product in the advanced Maillard reaction under acidic, neutral and basic conditions (gal=galactose, R=protein chain).

The consequences of the Maillard reaction for milk and milk products are considerable:

(a) Loss of nutritive value due to blockage of lysine residues, which are no longer available for digestion (early, advanced and final Maillard reaction, Finot, 1990), reduced digestibility and inhibition of enzymes (Friedman, 1996a,b)

(b) Flavor compounds are formed. These are mainly low molecular fission compounds from degradation of the Amadori compund (advanced Maillard reaction, e.g. Danehy, 1986)

(c) Antioxidative compounds are formed in the advanced Maillard reaction (Namiki, 1988; Bressa et al., 1996)

(d) Mutagenic (Shibamoto, 1982), as well as anti-mutagenic (Kato et al., 1987; Yen et al., 1992) and anticarcinogenic compounds (Aeschbacher, 1990), are formed. However, it should be noted that Berg *et al.* (1990) could not detect any mutagenicity in normally heat-treated milk, only in milk burnt to the pan. Formation of hetero- cyclic amines during heating (Jagerstad et al., 1991) is not relevant for milk, on the one hand because heating temperatures applied in dairy technology are too low for formation of hetero- cyclic amines, and on the other hand because an important precursor for heterocyclic amines, creatin(in)e is not present in significant quantities in milk.

(e) Antibacterial compounds may be formed (Einarsson et al., 1983).

(f) Antigenicity of heated cow's milk may be less for people allergic to cow's milk (Friedman, 1996a).

(g) Milk proteins polymerize because of the Maillard reaction (e.g. Zin El-Din et al., 1991; Ames, 1992; Zin El-Din and Aoki, 1993; Henle et al., 1996).

(h) A brown color develops due to melanoidins (advanced and final Maillard reaction, e.g. Patton, 1955; Namiki, 1988; Ames, 1992).

The extent of the reaction can be evaluated by the determination of the content of furosine (ε-N-2-furoylmethyl-L-lysine), the main stable Amadori compound in the early Maillard reaction, and lactulose (4-O-β-galactopyranosyl-D-fructose), respectively. Furosine and lactulose can be used as indicators of heat damage of milk and for distinction of UHT milk, pasteurized milk and in-container sterilized milk

(Acquistucci et al, 1996; Andrew, 1984; Corzo et al, 1994a; Corzo et al, 1994b; De Rafael et al, 1997; Geier and Klostermeyer, 1983; Villamiel and Corzo, 1998). The combination of lactulose and furosine values for UHT milk provides information on the quality and genuineness of commercial milks (Pellegrino et al, 1995), particularly to detect the presence of reconstituted milk powder in consumption milk (Ding and Chang, 1986; van Renterghem and De Block, 1996).

CHAPTER III
MATERIALS AND METHODS

3.1 Chemicals

- Gracial acetic acid was purchased from Lab-Scan, Ireland.
- Butanol was purchased from APS, Australia.
- Sodium hydroxide and urea was from Merck, Germany.
- 2, 3, 5-Triphenyltetrazolium chloride was purchased from Fluka, Switzerland. All chemicals were analytical grade.

3.2 Equipment

- Filter paper was purchased from Whatman, England.
- Hot plate stirrer was from Fisher Scientific, USA.
- Mastersizer 2000 was from Malvern, UK.
- Milkoscan™ 4000 was from Foss Electric, Denmark.
- Pipetman 1 ml and 5 ml. were from Gilson Medical Electronics, France.
- Shaking water bath was from Heto SBD-50, Denmark.
- Spectronic was from Spectronic Unicam, USA.

3.3 Milk samples

Three types of milk samples were used in this experiment i.e. raw milk, milk powder, and market fresh milk.

3.3.1 Raw milk samples were obtained from Zonta Chombung Cooperative in Ratchaburi Province. They were used within 24 hour after milk collection.

3.3.2 Milk powder was purchased from a supermarket in Bangkok. There were two types of milk sample used i.e. whole milk powder, and skimmed milk powder

3.3.3 Market fresh milk was purchased from a supermarket in Bangkok. There were two types of market fresh milk used in this study i.e. pasteurized milk, and UHT milk.

3.4 Preparation of milk samples

Whole milk powder and skimmed milk powder was reconstituted with distilled water. For reconstituted whole milk, 167.0 g. of whole milk powder was dissolved in 1.0 L. of distilled water. Reconstituted skimmed milk was prepared by dissolving 150.0 g. of skimmed milk powder in 1.0 L. of distilled water. Raw milk and reconstituted milk (whole milk and skimmed milk) were mixed for varied percentage of milk powder as shown in Table 12.

Table 12 Ratio of milk samples as varied percentage of reconstituted milk

% milk powder	Raw milk (ml.)	Reconstituted milk (ml.)
0	100	0
5	95	5
10	90	10
15	85	15
20	80	20
30	70	30
40	60	40
50	50	50
60	40	60
70	30	70
80	20	80
90	10	90
100	0	100

The combination of milk samples were analyzed for deoxyketone, biochemical analysis, ratios of milk composition, and milk fat particle size analysis. Pasteurized and UHT milk samples purchased from supermarkets were subjected to deoxyketone determination, biochemical analysis, ratios of milk composition, and milk fat particle size analyses.

3.5 Determination of deoxyketone in milk samples

The principle for deoxyketone determination is based on colorimetric reaction. Deoxyketone occur in maillard reaction can reduced 2, 3, 5 Triphenyltetrazolium chloride (TTC) to formazan, which can be determined by spectrophotometer.

Deoxyketone +

2, 3, 5 Triphenyltetrazolium chloride Formazan

The combination of milk samples and market fresh milk were analyzed for deoxyketone content by a total volume 10.0 ml. of milk sample was pipetted into 50 ml. Erlenmeyer flask and 1.0 ml. of 10% acetic acid was added, the resulting solution was stirred gently for 5 minutes. Place the Erlenmeyer flask into a water bath at 40.0°C for 10 minutes then filter through a paper filter. Rinse carefully the precipitate at least 200 ml. with 40.0°C distilled water and then weigh 0.5 g. of filtrate into test tube and 5.0 ml. of saturated urea solution was added. The solution was then well mixed and place into a water bath at 40.0°C for 5 minutes. Add 1.0 ml. of TTC (2, 3, 5-Triphenyltetrazolium chloride), alkaline solution shake and place into a water bath at 40.0°C for 10 minutes. Follow by 1.0 ml. of acetic acid and 5.0 ml. of 1-butanol were added. Mixed for 5-10seconds and measured the upper phase by spectrophotometer at 486 nm.

3.6 Biochemical analysis of milk samples

A total volume of 20.0ml of milk samples was poured to plastic vial and preheated to 40 °C for 15 minute to melt the fat and make it homogeneous before fat, protein, lactose, urea, Cit.Ac, SNF, and TS analysis by MilkoScan™ 4000 (Foss, Denmark).

Figure 6 MilkoScan™ 4000 for milk proximate analysis

The principle of MilkoScan™ 4000 is based on infrared analysis. MilkoScan™ 4000 works with the mid-Infrared region of the spectrum from 3 - 10 µm (Figure 7) corresponding to 1000 – 5000 cm $^{-1}$.

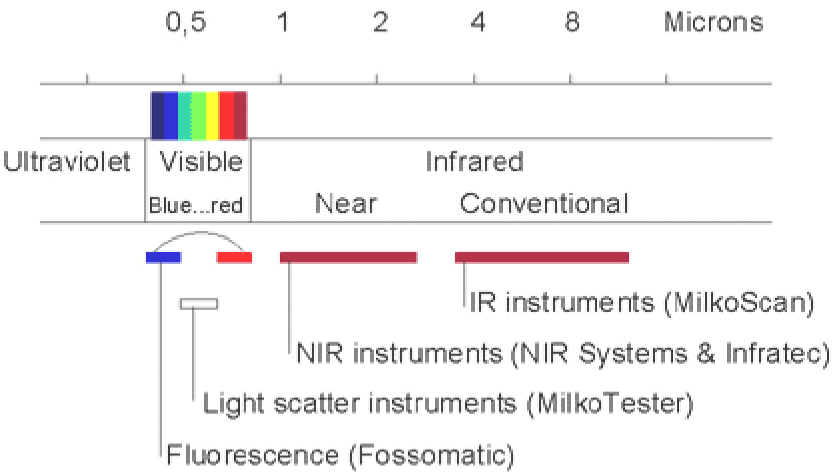


Figure 7 The electromagnetic spectrum and some region for milk analysis

The infrared analysis principle employed in the filter instruments is based on the well-proven Single Beam Infrared System. An infrared source provides light spanning the range of the infrared region. The light passes through different filters that only admit certain specific wavelengths, corresponding to absorption frequencies of the components in question. Then the light passes through a cuvette containing the product sample and finally hits the detector (Figure 8).

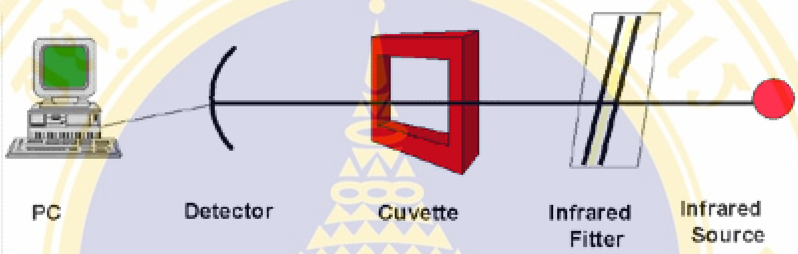


Figure 8 Schematic for the IR principle

The four main infrared filters

Fat

The fat molecule consists of a glycerol backbone to which three fatty acids are bound. Two different fat filters are used in the IR instruments, Fat A and Fat B.

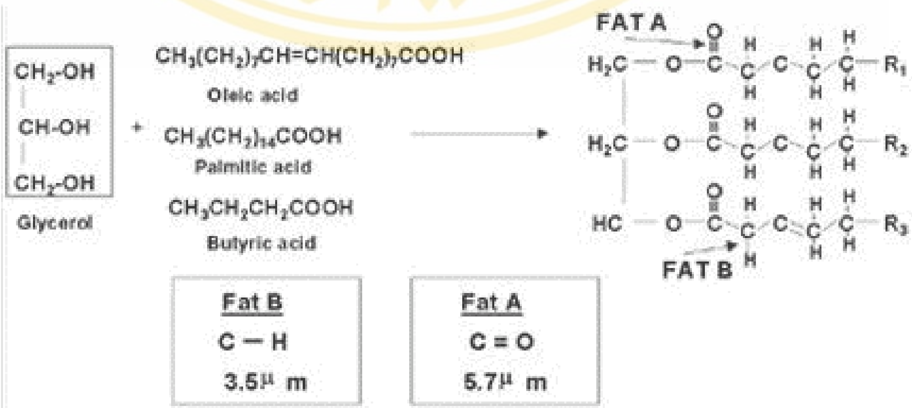


Figure 9 Fat A and Fat B molecule

Fat A absorption is due to stretching vibrations in the C=O bond of the carbonyl group in fat. This filter counts the number of fat molecules regardless of the length and the molecular weight of the individual fatty acids. This is a drawback if the length of the fatty acids changes.

Fat B absorption is due to stretching vibrations in the C-H bonds of fatty acid chains. The measurement is therefore related both to the size and to the number of fat molecules in the sample.

Lactose

The lactose molecule is a disaccharide consisting of two monosaccharides glucose and galactose joined together. The hydroxyl group, (-OH) is a characteristic of carbohydrates and the lactose absorption is due to the C-OH bond.

Protein

The protein molecule consists of amino acid units joined together with peptide bonds. Protein absorption is due to stretching vibrations in the N-H bonds within the peptide bonds.

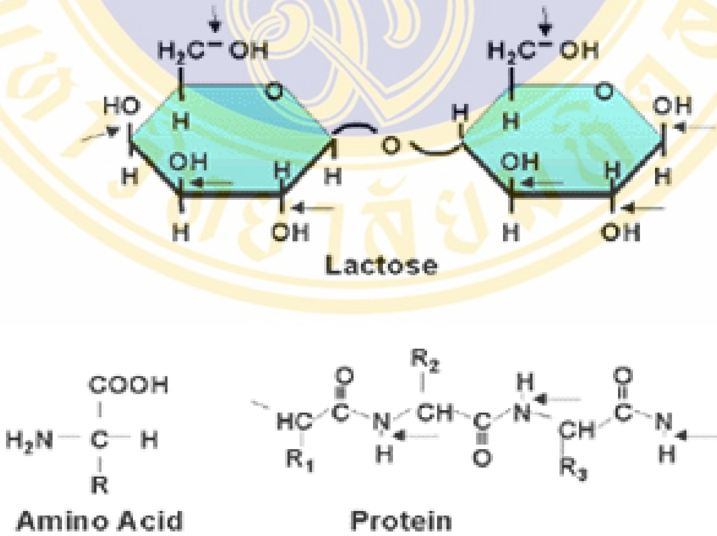


Figure 10 The protein and lactose molecules

In addition to the four main filters mentioned about, specific filters for urea, citric acid and H-index are also included in the instrument. Reference filters to stabilize readings of the main filters are present in MilkoScan™ 4000.

3.7 Determination of ratios of milk compositions in milk samples

From the results of biochemical analysis the ratios of milk compositions were calculated using the values of every component for determining suitable factors that could differentiate pure fresh milk and fresh milk combined with reconstituted milk powder (whole milk powder and skimmed milk powder).

3.8 Determination of milk fat particle size in milk samples

Milk samples were subjected to milk fat particle size measurement using Mastersizer 2000 based on the Mie theory. This theory employs knowledge of the light refractive index of the particles and the dispersion media and the imaginary part of the refractive index of the particles. The pattern of diffraction light (He-Ne laser) is dependent on the particle size. The laser diffraction pattern is measured and correlated to the particle size distribution based on Fraunhofer or Mie theory.

Figure 11 Mastersizer 2000 for milk fat particle size analysis.

3.9 Statistical analysis

The effect of percentage of milk powder versus the deoxyketone content of raw milk combined with reconstituted milk powder (whole milk powder and skimmed milk powder) and market fresh milk (pasteurized milk and UHT milk) were compared using analysis of variance (ANOVA) with the 95% confidence interval ($p<0.05$). The analysis of variance (ANOVA) was also used to test the different of biochemical analysis and ratios of milk composition in each percentage of milk sample combined with reconstituted milk powder. The effect of percentage of milk samples combined with reconstituted milk powder versus milk fat particle size was compared by using correlation with the 95% confidence interval ($p<0.05$).

CHAPTER IV
RESULTS

4.1 Determination of deoxyketone in milk samples

The absorbances of deoxyketone determination in raw milk combined with reconstituted whole milk powder and skimmed milk powder are shown in Table 13 and Table 14. In this study, the absorbances of deoxyketone in raw milk combined with reconstituted whole milk powder were increased as the percentage of milk powder increased. The increment of the absorbance of deoxyketone in raw milk combined with reconstituted skimmed milk powder was in the same manner but with higher slope. The absorbance value of deoxyketone contents in pasteurized milk samples and UHT milk samples were presented in Table 15 and Table 16. In pasteurized milk samples, the average absorbance of deoxyketone content in pasteurized whole fresh milk (n=5) was 1.34 with ranging from 1.27 to 1.52. The results indicated that milk samples might be produced by combined raw milk and reconstituted whole milk powder or combined raw milk and reconstituted skimmed milk powder in a range of 30 to 50 percent or 15 to 30 percent, respectively. In pasteurized low-fat milk samples (n=5), the average absorbance of deoxyketone content was 1.34 ranging from 0.81 to 2.03. These indicated that pasteurized low-fat milk samples investigated might be produced by combining raw milk with 15 to 80 percent of reconstituted whole milk powder or might be combining raw milk with 5 to 40 percent of reconstituted skimmed milk powder.

In UHT whole fresh milk (n=7) and UHT low-fat milk (n=2) samples, the average absorbance of deoxyketone content was 2.807, ranging from 1.90 to 3.80. The results indicated that most of the UHT milk samples by investigated were produced by combining raw milk with reconstituted whole milk powder or skimmed milk powder at high levels (60-100% and 30-80%), respectively.

Table 13 The absorbance of deoxyketone content in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder.

% WMP*	Average absorbance at 486 nm.	SD
100% RM	0.32	0.034
RM + 5%WMP	0.49	0.046
RM + 10%WMP	0.66	0.031
RM + 15%WMP	0.77	0.021
RM + 20%WMP	0.84	0.026
RM + 30%WMP	1.05	0.095
RM + 40%WMP	1.37	0.057
RM + 50%WMP	1.69	0.089
RM + 60%WMP	1.85	0.076
RM + 70%WMP	2.02	0.113
RM + 80%WMP	2.22	0.106
RM + 90%WMP	2.58	0.095
100% WMP	2.95	0.112

* %WMP = percentage of reconstituted whole milk powder

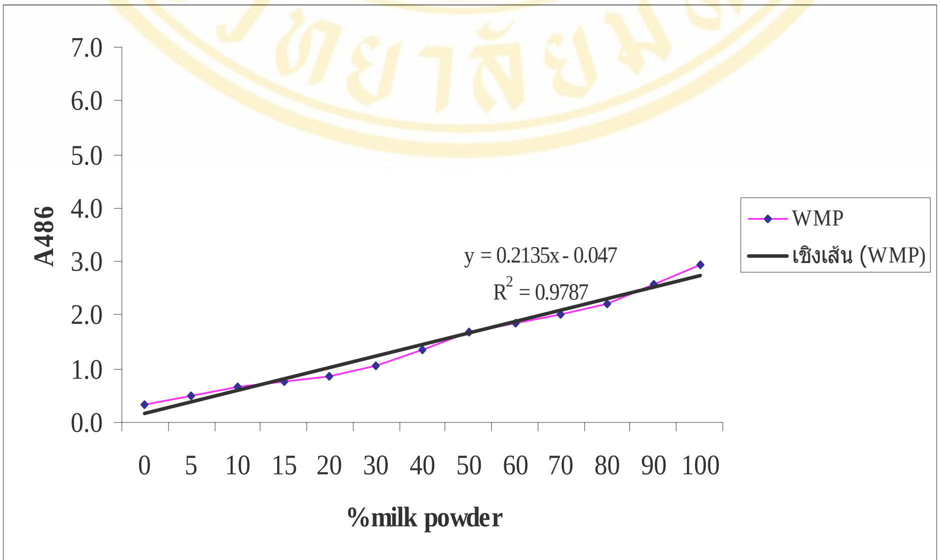


Figure 12 The absorbance of deoxyketone content in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder.

Table 14 The absorbance of deoxyketone content in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder.

% SMP*	Average absorbance at 486 nm.	SD
100% RM	0.36	0.033
RM + 5%SMP	0.67	0.076
RM + 10%SMP	0.87	0.044
RM + 15%SMP	0.90	0.037
RM + 20%SMP	1.29	0.083
RM + 30%SMP	1.71	0.142
RM + 40%SMP	2.21	0.115
RM + 50%SMP	2.64	0.153
RM + 60%SMP	3.06	0.197
RM + 70%SMP	3.27	0.215
RM + 80%SMP	3.89	0.181
RM + 90%SMP	4.27	0.347
100% SMP	6.18	0.791

* %SMP = percentage of reconstituted skimmed milk powder

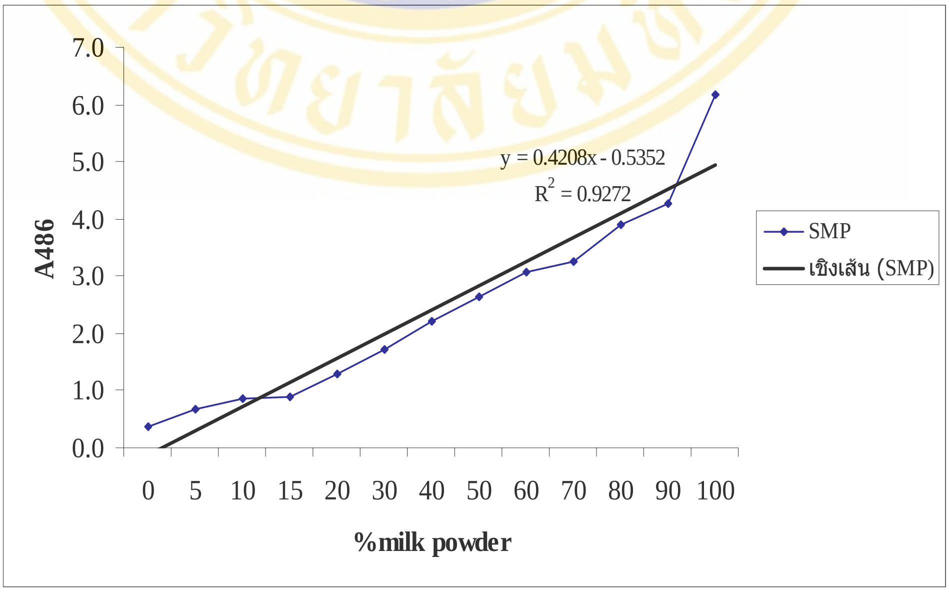


Figure 13 The absorbance of deoxyketone content in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder.

Table 15 The absorbance of deoxyketone content in pasteurized milk samples purchased from supermarket in Bangkok.

Company	Average absorbance at 486 nm.	SD
Whole milk		
A	1.329	0.163
B	1.273	0.121
C	1.519	0.272
D	1.238	0.240
E	1.354	0.241
Low-fat milk		
A	1.826	0.192
B	1.127	0.021
C	2.027	0.376
D	0.927	0.114
E	0.810	0.076

Table 16 The absorbance of deoxyketone content in UHT milk samples purchased from supermarket in Bangkok.

Company	Average absorbance at 486 nm.	SD
Whole milk		
A	2.924	0.178
B	3.354	0.280
C	2.365	0.213
D	3.800	0.094
E	2.602	0.048
F	1.902	0.090
G	2.818	0.254
Low-fat milk		
A	3.121	0.240
B	2.382	0.438

4.2 Biochemical analysis of milk samples

All of milk samples were subjected to biochemical analysis using Milkoscan^{TM} 4000. The contents of milk compositions including fat, protein, lactose, urea, citric acid, solid not fat (SNF), and total solid (TS) in raw milk combined with reconstituted whole milk powder and those in raw milk combined with reconstituted skimmed milk powder were presented in Table 17 and Table 18, respectively.

The results showed that all of the components in samples prepared by combining raw milk with reconstituted whole milk powder were slightly increased when the level of whole milk powder was higher. The results obtained from the biochemical analysis of the samples prepared by combining raw milk with reconstituted skimmed milk powder were in the same manner. An exception was that fat content tended to decrease with higher level of skimmed milk powder. The levels of compositions in pasteurized milk and UHT milk purchased from supermarkets in Bangkok were shown in Table 19 and Table 20, respectively.

Table 17 Biochemical analysis of samples prepared by combining raw milk with various amounts of reconstituted whole milk powder

%WMP*	Content (g/100 ml) Mean ± SD						
	Proximate analysis					Chemical analysis	
	Fat	Protein	Lactose	SNF	TS	Urea	Cit.Ac
100% RM	4.31 ± 0.226	3.12 ± 0.007	4.56 ± 0.049	8.37 ± 0.049	12.68 ± 0.276	0.02 ± 0.011	0.14 ± 0.003
RM + 5%WMP	4.26 ± 0.233	3.14 ± 0.021	4.60 ± 0.049	8.43 ± 0.057	12.39 ± 0.134	0.03 ± 0.012	0.14 ± 0.004
RM + 10%WMP	4.25 ± 0.226	3.17 ± 0.021	4.67 ± 0.035	8.54 ± 0.049	12.50 ± 0.127	0.03 ± 0.010	0.14 ± 0.004
RM + 15%WMP	4.27 ± 0.205	3.20 ± 0.028	4.74 ± 0.028	8.64 ± 0.057	12.65 ± 0.106	0.03 ± 0.012	0.14 ± 0.004
RM + 20%WMP	4.26 ± 0.205	3.23 ± 0.035	4.83 ± 0.042	8.76 ± 0.078	12.76 ± 0.071	0.03 ± 0.012	0.14 ± 0.004
RM + 30%WMP	4.25 ± 0.198	3.25 ± 0.007	4.97 ± 0.021	8.90 ± 0.028	13.15 ± 0.226	0.03 ± 0.012	0.15 ± 0.004
RM + 40%WMP	4.22 ± 0.163	3.26 ± 0.000	5.11 ± 0.000	9.07± 0.000	13.29 ± 0.163	0.04 ± 0.006	0.15 ± 0.002
RM + 50%WMP	4.21 ± 0.148	3.28 ± 0.000	5.28 ± 0.007	9.26 ± 0.007	13.46 ± 0.134	0.04 ± 0.006	0.15 ± 0.006
RM + 60%WMP	4.17 ± 0.099	3.30 ± 0.007	5.42 ± 0.014	9.41 ± 0.014	13.58 ± 0.085	0.04 ± 0.004	0.15 ± 0.001
RM + 70%WMP	4.15 ± 0.071	3.30 ± 0.007	5.57 ± 0.000	9.57 ± 0.007	13.72 ± 0.078	0.04 ± 0.001	0.16 ± 0.002
RM + 80%WMP	4.13 ± 0.057	3.31 ± 0.014	5.74 ± 0.007	9.75 ± 0.007	13.88 ± 0.064	0.05 ± 0.001	0.16 ± 0.002
RM + 90%WMP	4.10 ± 0.028	3.33 ± 0.014	5.92 ± 0.000	9.95 ± 0.000	14.05 ± 0.042	0.05 ± 0.002	0.16 ± 0.001
100% WMP	4.10 ± 0.021	3.36 ± 0.021	6.08 ± 0.007	10.13 ± 0.021	14.22 ± 0.049	0.06 ± 0.001	0.16 ± 0.001

* %WMP = percentage of reconstituted whole milk powder

Table 18 Biochemical analysis of samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder

%SMP*	Content (g/100 ml) Mean ± SD						
	Proximate analysis					Chemical analysis	
	Fat	Protein	Lactose	SNF	TS	Urea	Cit.Ac
100% RM	4.31 ± 0.226	3.12 ± 0.007	4.56 ± 0.049	8.37 ± 0.049	12.68 ± 0.276	0.02 ± 0.011	0.14 ± 0.003
RM + 5%SMP	4.14 ± 0.191	3.19 ± 0.000	4.68 ± 0.035	8.57 ± 0.035	12.70 ± 0.226	0.03 ± 0.008	0.14 ± 0.003
RM + 10%SMP	3.93 ± 0.205	3.27 ± 0.007	4.81 ± 0.000	8.78 ± 0.007	12.71 ± 0.205	0.04 ± 0.008	0.15 ± 0.004
RM + 15%SMP	3.74 ± 0.205	3.34 ± 0.014	4.96 ± 0.007	9.00 ± 0.007	12.73 ± 0.219	0.04 ± 0.006	0.15 ± 0.008
RM + 20%SMP	3.53 ± 0.205	3.42 ± 0.007	5.10 ± 0.014	9.22 ± 0.007	12.74 ± 0.198	0.05 ± 0.008	0.15 ± 0.002
RM + 30%SMP	3.11 ± 0.205	3.57 ± 0.021	5.40 ± 0.035	9.66 ± 0.007	12.76 ± 0.198	0.07 ± 0.008	0.16 ± 0.004
RM + 40%SMP	2.71 ± 0.156	3.70 ± 0.014	5.69 ± 0.021	10.09 ± 0.021	12.79 ± 0.141	0.08 ± 0.006	0.17 ± 0.002
RM + 50%SMP	2.31 ± 0.120	3.84 ± 0.021	5.99 ± 0.000	10.53 ± 0.021	12.84 ± 0.134	0.09 ± 0.002	0.18 ± 0.002
RM + 60%SMP	1.90 ± 0.092	3.98 ± 0.014	6.28 ± 0.014	10.96 ± 0.000	12.86 ± 0.085	0.11 ± 0.006	0.19 ± 0.001
RM + 70%SMP	1.49 ± 0.078	4.11 ± 0.014	6.59 ± 0.035	11.39 ± 0.042	12.88 ± 0.042	0.12 ± 0.002	0.19 ± 0.001
RM + 80%SMP	1.09 ± 0.049	4.25 ± 0.007	6.87 ± 0.042	11.82 ± 0.049	12.90 ± 0.000	0.14 ± 0.001	0.20 ± 0.001
RM + 90%SMP	0.66 ± 0.028	4.38 ± 0.007	7.23 ± 0.021	12.30 ± 0.028	12.96 ± 0.000	0.15 ± 0.000	0.21 ± 0.001
100% SMP	0.26 ± 0.014	4.52 ± 0.007	7.54 ± 0.028	12.76 ± 0.035	13.02 ± 0.021	0.17 ± 0.002	0.22 ± 0.001

* %SMP = percentage of reconstituted skimmed milk powder

Table 19 Biochemical analysis of pasteurized milk samples purchased from supermarkets in Bangkok

Company	Content (g/100 ml) Mean ± SD						
	Proximate analysis					Chemical analysis	
	Fat	Protein	Lactose	SNF	TS	Urea	Cit.Ac
Whole milk							
A	3.60 ± 0.007	3.14 ± 0.021	4.71 ± 0.014	8.54 ± 0.028	12.14 ± 0.035	0.03 ± 0.001	0.15 ± 0.002
B	3.93 ± 0.000	3.13 ± 0.007	4.72 ± 0.014	8.55 ± 0.021	12.47 ± 0.014	0.03 ± 0.004	0.14 ± 0.002
C	3.96 ± 0.000	3.29 ± 0.023	5.27 ± 0.028	9.26 ± 0.042	13.22 ± 0.042	0.04 ± 0.001	0.15 ± 0.000
D	3.68 ± 0.007	3.04 ± 0.007	4.56 ± 0.000	8.30 ± 0.007	11.97 ± 0.014	0.04 ± 0.004	0.15 ± 0.001
E	3.35 ± 0.007	3.24 ± 0.014	4.83 ± 0.007	8.77 ± 0.014	12.11 ± 0.028	0.04 ± 0.001	0.16 ± 0.000
Low-fat milk							
A	1.67 ± 0.007	3.15 ± 0.021	4.76 ± 0.021	8.61 ± 0.035	10.27 ± 0.042	0.06 ± 0.001	0.18 ± 0.001
B	0.55 ± 0.007	3.22 ± 0.007	6.33 ± 0.014	10.25 ± 0.021	10.80 ± 0.035	0.09 ± 0.001	0.23 ± 0.002
C	0.97 ± 0.007	3.68 ± 0.014	6.12 ± 0.014	10.50 ± 0.028	11.47 ± 0.028	0.09 ± 0.002	0.21 ± 0.002
D	2.20 ± 0.007	3.14 ± 0.007	4.73 ± 0.014	8.57 ± 0.028	10.77 ± 0.035	0.06 ± 0.004	0.18 ± 0.004
E	1.64 ± 0.007	3.32 ± 0.021	4.96 ± 0.014	8.98 ± 0.035	10.60 ± 0.042	0.08 ± 0.001	0.19 ± 0.001

Table 20 Biochemical analysis of UHT milk samples purchased from supermarkets in Bangkok

Company	Content (g/100 ml) Mean ± SD						
	Proximate analysis					Chemical analysis	
	Fat	Protein	Lactose	SNF	TS	Urea	Cit.Ac
Whole milk							
A	3.65 ± 0.000	2.87 ± 0.014	4.67 ± 0.007	8.24 ± 0.021	11.89 ± 0.021	0.05 ± 0.004	0.15 ± 0.001
B	3.79 ± 0.007	3.16 ± 0.007	4.65 ± 0.000	8.51 ± 0.007	12.29 ± 0.014	0.04 ± 0.004	0.15 ± 0.000
C	4.13 ± 0.000	3.21 ± 0.014	4.78 ± 0.007	8.68 ± 0.021	12.81 ± 0.028	0.04 ± 0.002	0.15 ± 0.000
D	4.53 ± 0.014	3.29 ± 0.007	4.51 ± 0.007	8.49 ± 0.014	13.02 ± 0.021	0.04 ± 0.004	0.14 ± 0.002
E	3.79 ± 0.007	3.12 ± 0.007	4.58 ± 0.000	8.40 ± 0.007	12.18 ± 0.014	0.05 ± 0.004	0.14 ± 0.001
F	3.96 ± 0.007	3.13 ± 0.021	4.57 ± 0.007	8.40 ± 0.021	12.35 ± 0.035	0.04 ± 0.002	0.16 ± 0.004
G	3.94 ± 0.007	3.15 ± 0.014	4.54 ± 0.000	8.40 ± 0.007	12.33 ± 0.021	0.04 ± 0.001	0.15 ± 0.001
Low- fat milk							
A	1.47 ± 0.000	3.44 ± 0.014	5.60 ± 0.014	9.74 ± 0.035	11.21 ± 0.028	0.10 ± 0.000	0.19 ± 0.004
B	1.37 ± 0.007	3.66 ± 0.010	5.76 ± 0.007	10.12 ± 0.021	11.48 ± 0.028	0.09 ± 0.003	0.19 ± 0.001

4.3 Determination of the ratios of milk composition in milk samples

The results obtained from the biochemical analysis were used to calculate for 42 ratios of milk compositions. However, there were only six ratios that can be used to differentiate between fresh milk and combined milk. The six ratios selected were Fat/Urea, Fat/Cit.Ac, Protein/Urea, Lactose/Urea, SNF/Urea, and TS/Urea. The results were shown in Table 21 for samples prepared by combining raw milk with various amounts of reconstituted whole milk powder and Table 22 for samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder, respectively. Figure 14 to Figure 25 represented the selected ratios of milk composition in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder and those prepared by combining raw milk with reconstituted skimmed milk powder. The regression coefficients (R^2) and linear regression equations for the relationships for each type of milk samples were also shown. Table 23 and Table 24 showed the ratios of milk composition in market fresh milk (pasteurized milk and UHT milk) purchased from supermarkets in Bangkok.

The results showed that all of the ratios of milk composition in samples prepared by combining raw milk with reconstituted whole milk powder were obviously decreased when the level of whole milk powder was higher. The results obtained from the ratios of milk composition of the samples prepared by combining raw milk with reconstituted skimmed milk powder were in the same manner.

Table 21 Ratios of milk composition in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder

%WMP*	Fat/Urea	Fat/Cit.Ac	Protein/Urea	Lact./Urea	SNF/Urea	TS/Urea
100% RM	189.01	30.89	135.26	198.13	363.49	552.50
RM + 5%WMP	173.12	30.06	126.23	185.18	339.42	496.75
RM + 10%WMP	170.40	29.81	125.82	185.49	339.25	495.40
RM + 15%WMP	165.93	29.82	123.47	182.78	333.22	486.14
RM + 20%WMP	152.69	29.54	114.89	171.99	311.77	453.09
RM + 30%WMP	136.73	28.90	103.57	158.53	284.11	420.84
RM + 40%WMP	122.40	28.19	94.38	147.93	262.57	384.98
RM + 50%WMP	102.81	27.85	79.98	128.61	225.65	328.33
RM + 60%WMP	106.11	27.08	83.75	137.75	239.17	345.28
RM + 70%WMP	95.43	26.52	75.76	128.06	219.92	315.34
RM + 80%WMP	89.84	26.22	72.00	124.73	211.95	301.79
RM + 90%WMP	84.60	25.79	68.72	122.18	205.35	289.95
100% WMP	74.48	25.36	61.03	110.49	184.16	258.55

* %WMP = percentage of reconstituted whole milk powder

Table 22 Ratios of milk composition in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder

% SMP*	Fat/Urea	Fat/Cit.Ac	Protein/Urea	Lact./Urea	SNF/Urea	TS/Urea
100% RM	196.31	31.45	140.36	205.63	377.22	573.53
RM + 5%SMP	136.17	28.91	104.45	153.22	280.60	416.77
RM + 10%SMP	106.55	26.78	88.14	129.82	236.85	343.51
RM + 15%SMP	85.90	24.98	76.56	113.54	206.15	291.94
RM + 20%SMP	70.43	22.96	67.91	101.38	183.21	253.64
RM + 30%SMP	48.39	18.98	55.34	83.68	149.81	198.20
RM + 40%SMP	34.28	15.89	46.70	71.73	127.25	161.47
RM + 50%SMP	24.67	13.06	41.03	64.08	112.60	137.32
RM + 60%SMP	18.02	10.16	37.80	59.63	104.08	122.14
RM + 70%SMP	12.13	7.66	33.56	53.76	92.99	105.16
RM + 80%SMP	7.95	5.32	31.10	50.33	86.56	94.51
RM + 90%SMP	4.43	3.17	29.36	48.49	82.55	86.98
100% SMP	1.55	1.21	26.96	45.02	76.16	77.71

* %SMP = percentage of reconstituted skimmed milk powder

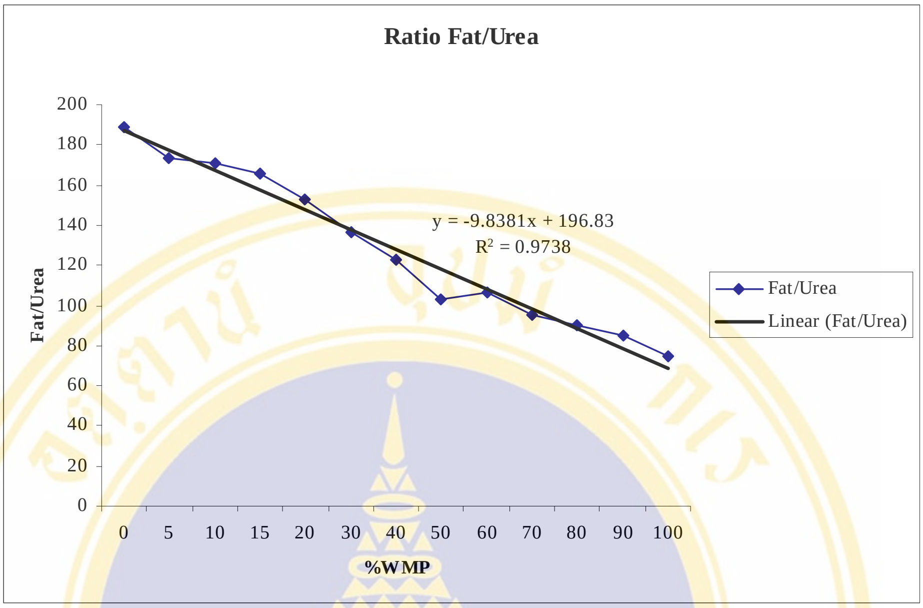


Figure 14 Fat/Urea ratios in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder.

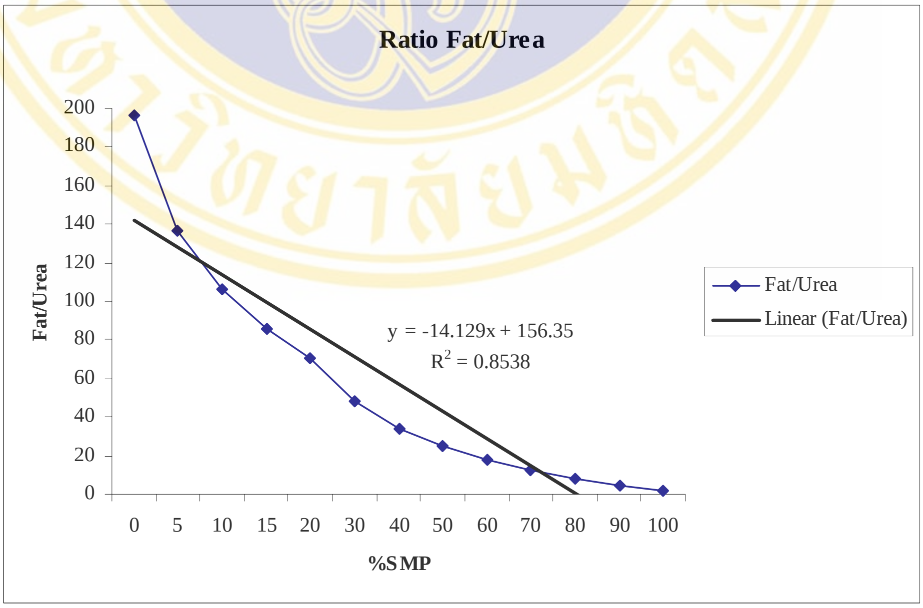


Figure 15 Fat/Urea ratios in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder.

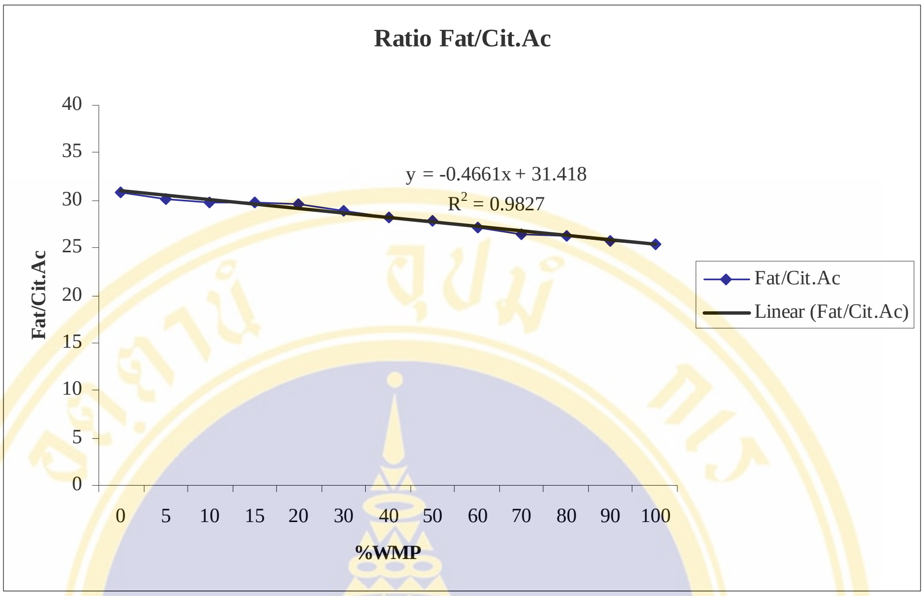


Figure 16 Fat/Cit.Ac ratios in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder.

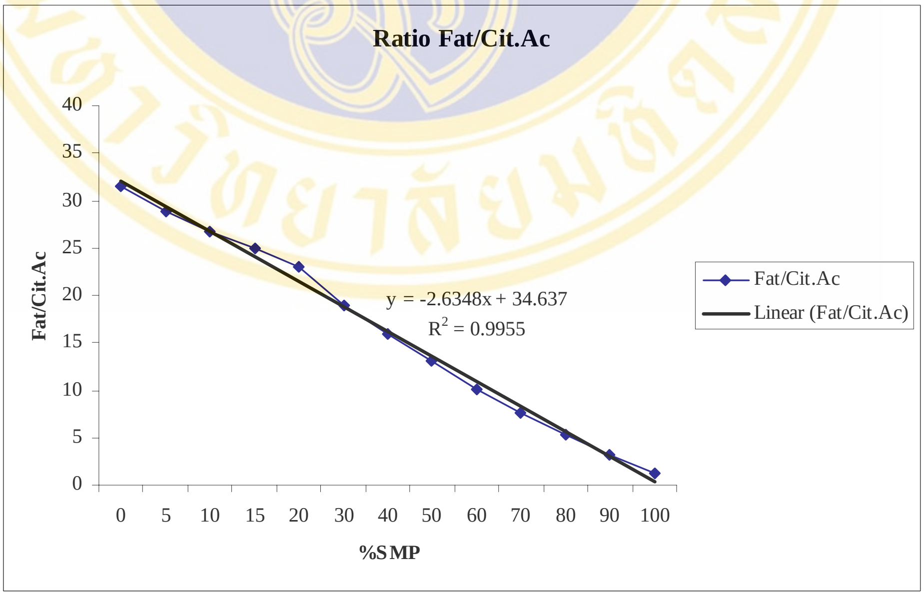


Figure 17 Fat/Cit.Ac ratios in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder.

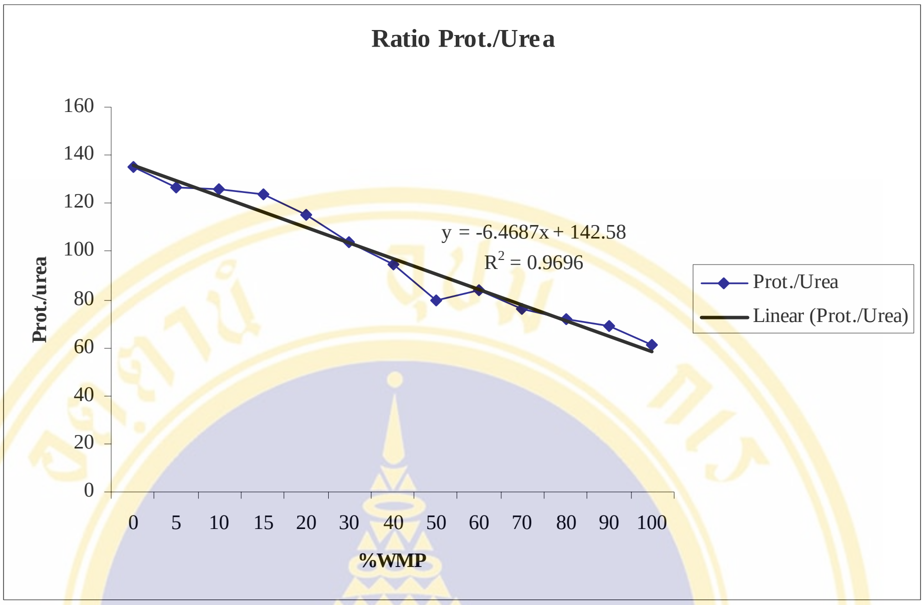


Figure 18 Protein/Urea ratios in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder.

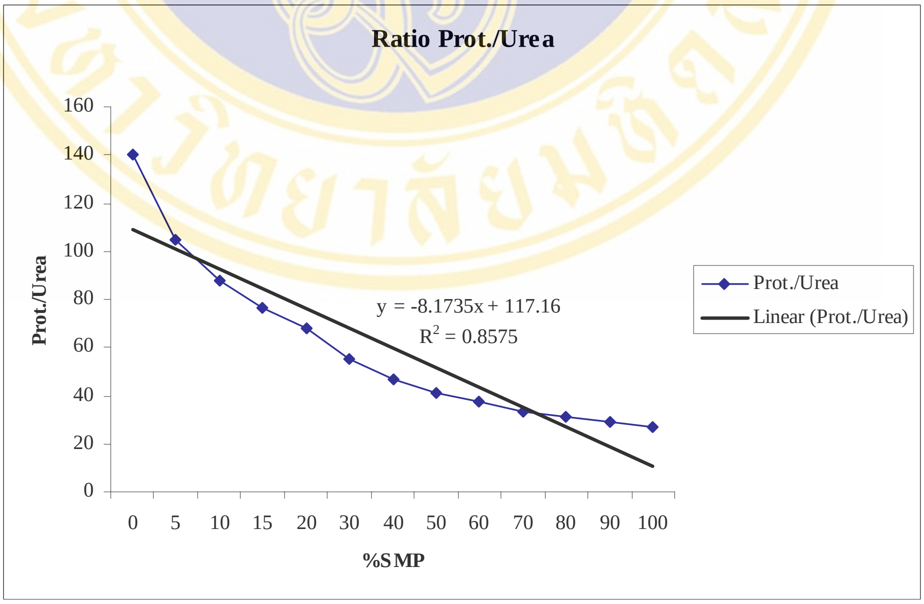


Figure 19 Protein/Urea ratios in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder.

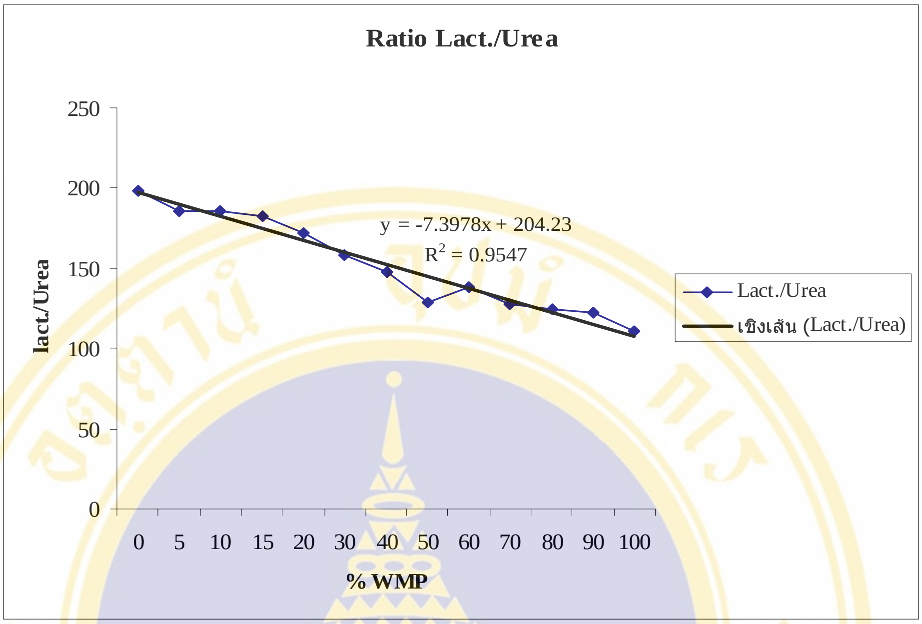


Figure 20 Lactose/Urea ratios in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder.

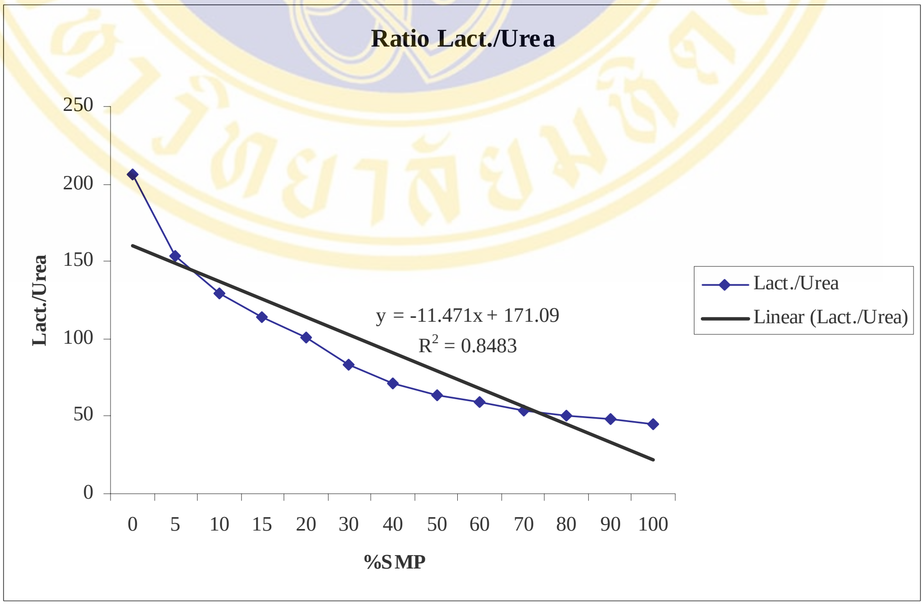


Figure 21 Lactose/Urea ratios in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder.

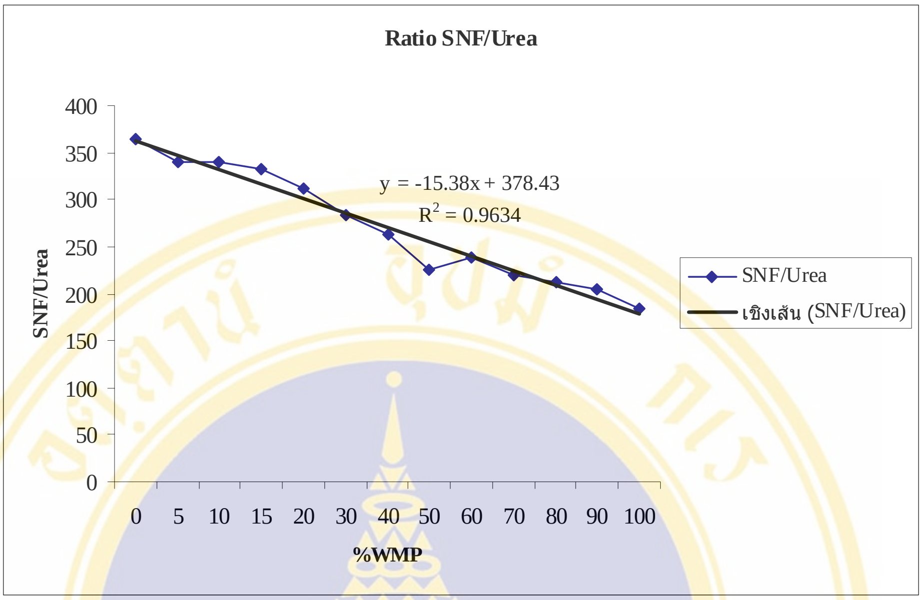


Figure 22 SNF/Urea ratios in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder.

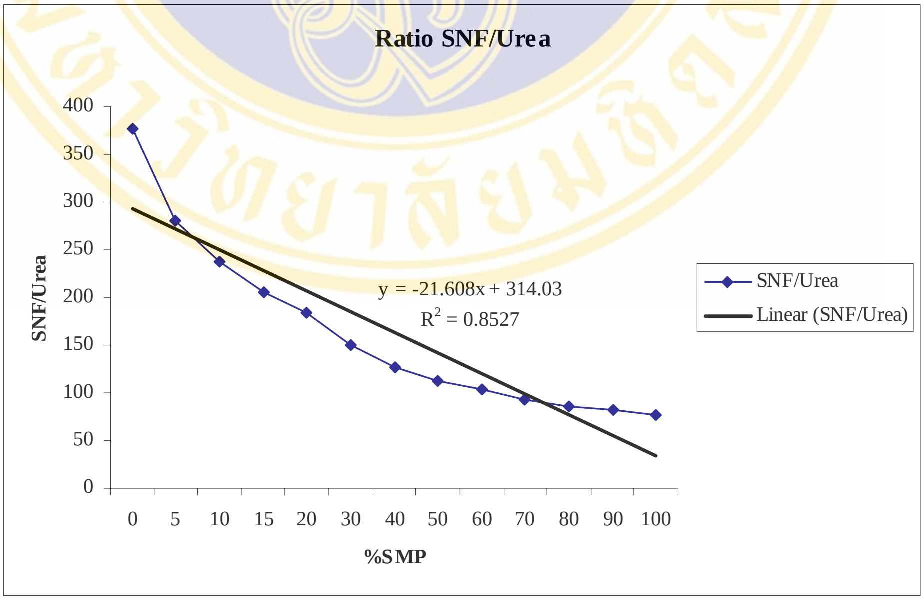


Figure 23 SNF/Urea ratios in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder.

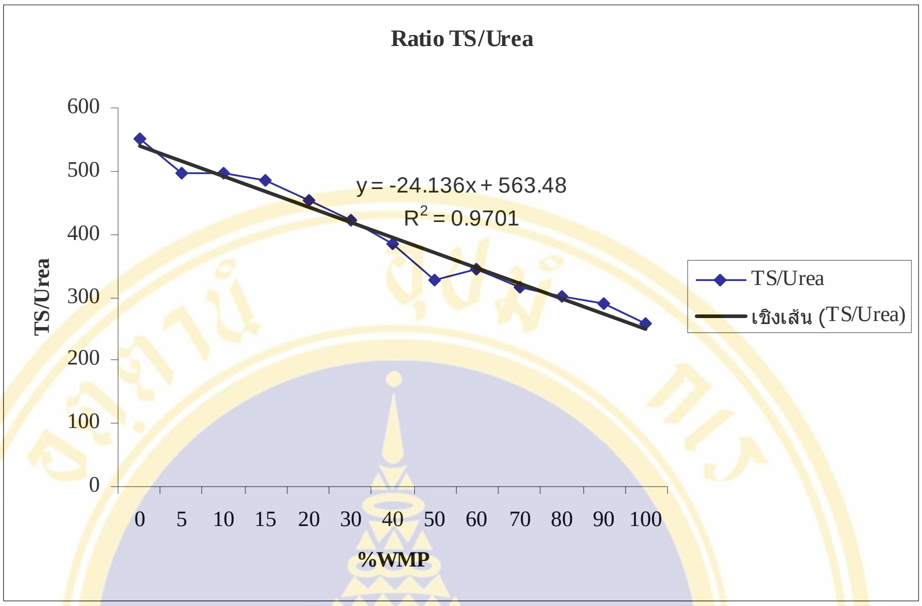


Figure 24 TS/Urea ratios in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder.

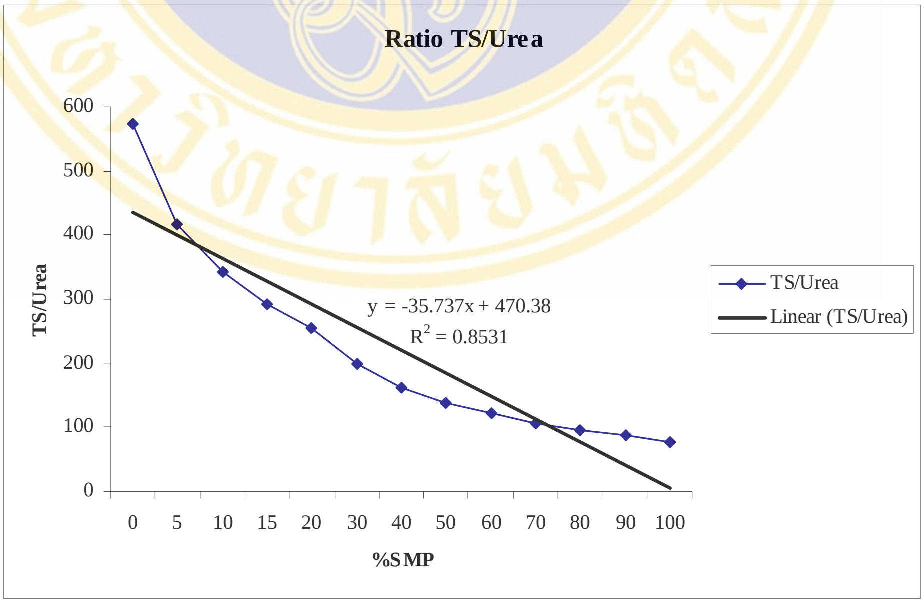


Figure 25 TS/Urea ratios in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder.

Table 23 Ratios of milk composition in pasteurized milk purchased from supermarkets in Bangkok.

Company	Fat/Urea	Fat/Cit.Ac	Protein/Urea	Lact./Urea	SNF/Urea	TS/Urea
Whole milk						
A	110.64	23.73	96.48	144.95	262.82	373.46
B	117.97	27.39	93.79	141.66	256.47	374.30
C	101.61	26.40	84.42	135.23	237.61	339.22
D	95.85	23.79	79.16	118.94	216.36	312.21
E	84.70	20.78	82.04	122.17	222.06	306.63
Low-fat milk						
A	26.02	9.15	49.16	74.32	134.49	160.52
B	6.12	2.37	36.13	71.13	115.13	121.30
C	10.32	4.63	39.37	65.47	112.33	122.71
D	38.24	12.37	54.62	82.41	149.31	187.55
E	21.66	8.84	43.91	65.70	118.88	140.41

Table 24 Ratios of milk composition in UHT milk purchased from supermarkets in Bangkok.

Company	Fat/Urea	Fat/Cit.Ac	Protein/Urea	Lact./Urea	SNF/Urea	TS/Urea
Whole milk						
A	69.68	24.09	54.78	89.05	157.20	226.88
B	101.38	24.74	84.50	124.55	227.80	329.18
C	116.55	28.10	90.60	134.75	244.82	361.51
D	112.26	32.02	81.41	111.65	210.42	322.56
E	76.66	26.94	63.09	92.76	170.02	246.68
F	97.78	24.50	77.25	112.87	207.55	305.21
G	89.48	25.89	71.62	103.24	190.89	280.25
Low-fat milk						
A	14.70	7.84	34.40	56.00	97.35	112.10
B	14.68	7.38	39.37	61.91	108.81	123.49

4.4 Determination of milk fat particle size in milk samples

The milk fat particle size in sample prepared by combining raw milk with various amounts of reconstituted whole milk powder was shown in Table 25. The milk fat particle size in raw milk was 4.372 µm. whereas these in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder (5-100%) ranged from 4.312 to 0.253 µm.

Table 26 showed the milk fat particle size in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder. The results indicated that the milk fat particle size sharply decreased when more than 30% of reconstituted skimmed milk powder was added. Figure 26 and Figure 27 showed the regression coefficients (R^2) and linear regression equations of the relationships between the milk fat particle size and the amounts of added reconstituted milk powder. For the milk fat particle size in pasteurized milk and UHT milk were shown in Table 27 and Table 28, respectively.

4.4.1 Milk fat particle size in samples prepared by combining raw milk with various amount of reconstituted whole milk powder.

Table 25 Milk fat particle size in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder

% WMP*	Milk fat particle size (μm)
100% RM	4.372
RM + 5%WMP	4.312
RM + 10%WMP	4.229
RM + 15%WMP	4.118
RM + 20%WMP	3.854
RM + 30%WMP	3.099
RM + 40%WMP	1.241
RM + 50%WMP	0.674
RM + 60%WMP	0.478
RM + 70%WMP	0.382
RM + 80%WMP	0.330
RM + 90%WMP	0.284
100% WMP	0.253

* %WMP = percentage of reconstituted whole milk powder

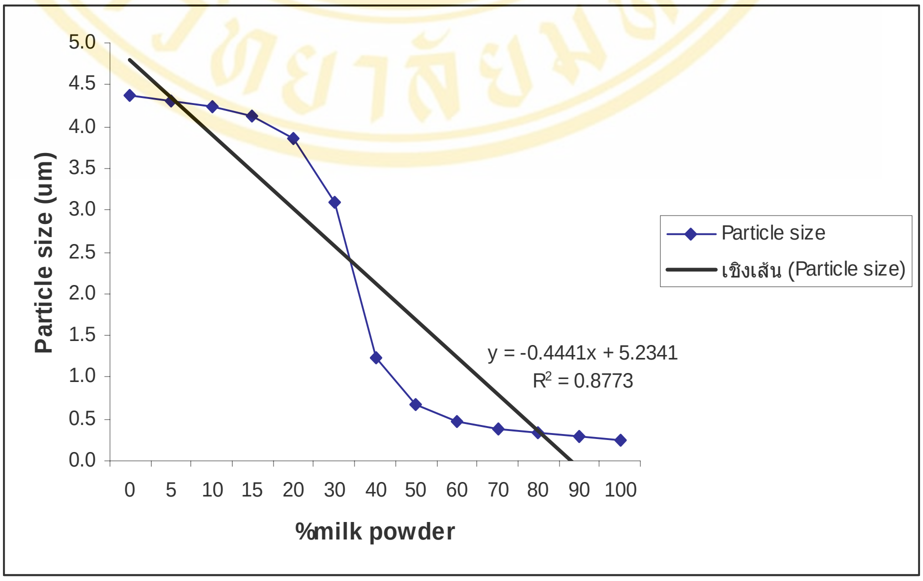


Figure 26 Milk fat particle size in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder.

4.4.2 Milk fat particle size in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder.

Table 26 Milk fat particle size in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder.

%SMP*	Milk fat particle size (µm)
100% RM	4.372
RM + 5%SMP	4.342
RM + 10%SMP	4.397
RM + 15%SMP	4.403
RM + 20%SMP	4.333
RM + 30%SMP	4.214
RM + 40%SMP	3.868
RM + 50%SMP	3.452
RM + 60%SMP	2.675
RM + 70%SMP	0.496
RM + 80%SMP	0.173
RM + 90%SMP	0.138
100% SMP	0.124

* %SMP = percentage of reconstituted skimmed milk powder

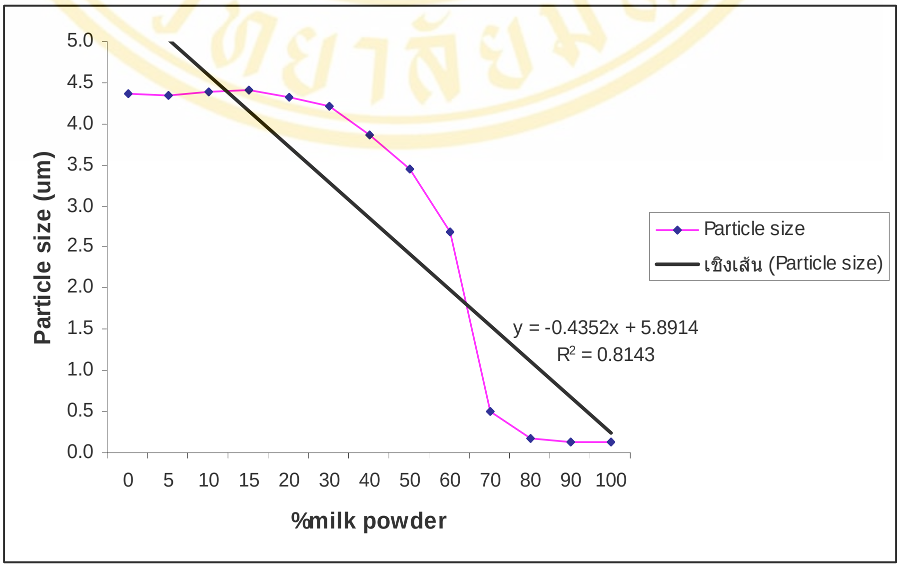


Figure 27 Milk fat particle size in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder.

Table 27 Milk fat particle size in pasteurized milk samples purchased from supermarkets in Bangkok.

Company	Milk fat particle size (µm)
Whole milk	
A	0.254
B	0.278
C	0.208
D	0.197
E	0.286
Low-fat milk	
A	0.161
B (skimmed milk)	0.132
C	0.156
D	0.165
E	0.158

Table 28 Milk fat particle size in UHT milk samples purchased from supermarkets in Bangkok.

Company	Milk fat particle size (µm)
Whole milk	
A	0.228
B	0.192
C	0.188
D	0.201
E	0.201
F	0.164
G	0.213
Low-fat milk	
A	0.157
B	0.142

CHAPTER V
DISCUSSION

5.1 Determination of deoxyketone content in milk samples

Deoxyketone content in milk samples was determined by colorimetric method. The results indicated a significant difference ($p < 0.05$) in deoxyketone content of both groups of combined milk (raw milk combined with reconstituted whole milk powder and raw milk combined with reconstituted skimmed milk powder). The results showed higher absorbance of deoxyketone content in raw milk combined with reconstituted skimmed milk powder than that in raw milk combined with reconstituted whole milk powder. Higher ratios of milk powder to raw milk showed higher contents of deoxyketone than those of lower ratio. It was found that, raw milk combined with reconstituted whole milk powder (0-100%) contained 0.32-2.95 of absorbance of deoxyketone whereas raw milk combined with reconstituted skimmed milk powder (0-100%) contained 0.36-6.18 of absorbance of deoxyketone content (Table 13 and Table 14).

The method was used to determine deoxyketone content in market fresh milk (pasteurized milk and UHT milk) purchased from supermarket. The results could be concluded as follows.

1. Pasteurized milk of company A, B, D, and E

Pasteurized milk samples of company A, B, D, and E were found to have 1.329, 1.273, 1.238, and 1.354 of absorbance of deoxyketone, respectively. Thus, pasteurized milk of company A, B, D, and E may be produced by combining 15-40% of reconstituted milk powder or may be produced at a higher temperature than that used for pasteurization.

2. Pasteurized milk of company C

Pasteurized milk of company C was found to have 1.519 of absorbance of deoxyketone. This indicated that pasteurized milk of company C may be produced by combining raw milk with approximately 20-50% reconstituted milk powder or may be produced at a higher temperature than that used for pasteurization.

3. Pasteurized low-fat milk of company A and C

Pasteurized low-fat milk samples of company A and C were found to have 1.826 and 2.027 of absorbance of deoxyketone, respectively. The result indicated that pasteurized low-fat milk of company A and C may be produced by combining 30-60% reconstituted milk powder or produced at a higher temperature than that used for pasteurization.

4. Pasteurized low-fat milk of company B

The absorbance of deoxyketone content of pasteurized low-fat milk of company B was found to have 1.127. Therefore, the sample may be produced from raw milk combined with approximately 15-40% reconstituted milk powder or may be produced at a temperature higher than that used for pasteurization.

5. Pasteurized low-fat milk of company D

Pasteurized low-fat milk of company D contained 0.927 of absorbance of deoxyketone. The result indicated that it may be produced by combining approximately 15-30% reconstituted milk powder with fresh milk or may be produced at a temperature higher than that used for pasteurization.

6. Pasteurized low-fat milk of company E

The deoxyketone content of pasteurized low-fat milk company E was found to be 0.810 of absorbance of deoxyketone. Thus, the product of company E may be produced by combining approximately 5-20% reconstituted milk powder with fresh milk or may be produced at a temperature higher than that used for pasteurization.

The absorbance of deoxyketone contents in UHT milk products of company A, B, C, D, E, F, and G were in range of 1.902–3.800. These indicated that the UHT milk products may be produced by combining approximately 40-100% of reconstituted milk powder.

There were a few reports on the deoxyketone content in milk samples. The minimum concentration of added milk powder in raw milk detectable by deoxyketone determination was 0.89% (Wanarat, 2001). Heat treatment results in many chemical and structural changes in milk, the extent of which depends on the temperature and duration of heating (Evangelisli ed al, 1999; Villamiel and CorZo, 1998). One mechanism involved in the deleterious consequence of heat treatment is the maillard reaction that leads to the decrease in nutritional value of proteins and formation of brown compounds in milk (Asylbek and Eric, 2002). The first stable product of this reaction is deoxyketone or lactulosyllysine, which leads to a loss of nutritional value due to blockage of the essential amino acid lysine (Aragon et al, 2004). The effect of the maillard reaction depends on the following factors.

1. pH and Buffers. The maillard reaction can develop in acidic or alkaline media, although it is favored under alkaline conditions, where the amine groups of the amino acids, peptides, and proteins are in the basic form. Increasing the pH also ensures that more of the hexoses are in the open chain or reducing form (Burton and McWeeney, 1963). Several studies have reported an increase in reaction rate as the pH increases. Thus, foods of high acidity are less susceptible to these reactions. Ionic strength of buffers has been shown to increase the rate of browning for sugar-amino acid systems as a result the influence of the ionic environment in which the reaction takes place (Eskin, 1990).

2. Temperature. The temperature dependence of this reaction has been demonstrated in a number of quantitative studies, where increased rates were reported with rise in temperature (Eskin, 1990).

3. Moisture content. The maillard reaction proceeds rapidly in a solution, although complete dehydration or excessive moisture levels inhibit this process (Wolfrom and Rooney, 1953). An increase in humidity was also shown by Dworschak and Hegedus (1974) to cause an increase in the loss of lysine and tryptophan with the concomitant increase in hydroxymethylfurfural (HMF) formation and browning. In general, it appears that this reaction is favored at an optimum moisture content corresponding to fairly low moisture levels (Danehy, 1986).

4. Sugars. Reducing sugars are essential ingredients in this reaction, providing the carbonyl groups for the interaction with the free amino groups of amino

acids, peptides, and proteins. The initial rate of this reaction is dependent on the rate at which the sugar ring opens to the oxo or reducible form (Eskin, 1990).

5. Metals. The formation of metal complexes with amino acids can influence the maillard reaction. This reaction was catalyzed by copper and iron, while manganese and in inhibit this reaction (Ellis, 1959; Markuze, 1963).

In this experiment, deoxyketone analysis was developed to determine deoxyketone content as an indicator of the addition of reconstituted whole milk powder or skimmed milk powder to raw milk and market fresh milk (pasteurized milk and UHT milk). The results indicated that deoxyketone content could be employed to detect the addition of reconstituted whole milk powder and reconstituted skimmed milk powder in raw milk, pasteurized milk and UHT milk. However, since deoxyketone is one of the maillard products, the temperature during processing many have impact on deoxyketone content in pasteurized and UHT milk. It may be effect to higher deoxyketone content than the reality.

5.2 Biochemical analysis in milk samples

The contents of milk composition in raw milk combined with reconstituted whole milk powder and skimmed milk powder are measured by using Milkocsan™ 4000. The quantity of milk composition in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder and skimmed milk powder indicated resemble results. In samples prepared from raw milk combined with reconstituted whole milk powder almost of factors increased to conform to the higher percentage of milk powder except fat content which decreased. This could also observe in samples prepared from raw milk combined with reconstituted skimmed milk powder. Nevertheless in raw milk combined with reconstituted skimmed milk powder was showed more obviously trend in each factors than raw milk combined with reconstituted whole milk powder.

The results of biochemical analysis might not be clearly discriminating the differences between raw milk and combined milk. Therefore, to overcome this problem the ratios of milk composition were set up in this study.

5.3 Determination of the ratios of milk composition in milk samples

5.3.1 Ratios of milk composition in samples prepared by combining raw milk with various amounts of reconstituted whole milk powder

From the biochemical analysis 42 ratios of milk composition were calculated. Among these, six ratios were chose to differentiate between fresh milk and fresh milk combined with reconstituted whole milk powder. The distributions of six ratios were showed in Table 21 and Table 22 including Fat/Urea, Fat/Cit.Ac, Protein/Urea, Lactose/Urea, SNF/Urea, and TS/Urea. Almost of ratios were selected contain urea for the significant of urea in milk is used as an indicator for protein degradation, which reflects the shelf life of milk. The linear regression and regression coefficient (R^2) represent in Figure 14 to Figure 25.

From this result, all of six ratios indicated high regression coefficient (>0.95), while Fat/Urea was the highest one (0.9738). For linear regression, ratios of TS/Urea were showed to be the highest value. Statistical analysis showed that the Fat/Cit.Ac ratios of different amount reconstituted whole milk powder added were significantly different ($p<0.05$).

5.3.2 Ratios of milk composition in samples prepared by combining raw milk with various amounts of reconstituted skimmed milk powder

There were six ratios of milk composition (Table 22) selected to differentiate between fresh milk and fresh milk combined with reconstituted skimmed milk powder. All of ratios were decreased consecutively while percentage of skimmed milk powder was higher. The linear regression and regression coefficient (R^2) were shown in Figure 15, 17, 19, 21, 23, and 25. The results, showed that Fat/Cit.Ac provided the best value of R^2 (0.9955), whereas TS/Urea provided the best value of linear regression equation ($y = -35.737x + 470.38$) with the highest slop when compared to other ratios. Statistical analysis showed that all of six ratios selected were significantly different among different amount of skimmed milk powder added.

In this experiment, ratios of milk compositions were developed to determine the different between fresh milk and fresh milk combined with reconstituted milk powder (whole milk powder and skimmed milk powder), as an indicator of the addition of whole milk powder or skimmed milk powder to pasteurize and UHT milk.

From this study, the ratios of milk composition exhibited more differentiating power than biochemical analysis. Therefore this method could be used to identify milk samples which may be combined with reconstituted milk powder.

At present, skimmed milk powder might be added into raw milk during processing rather than whole milk powder in order to maintain fat content of the products. In addition the cost of skimmed milk powder, as a raw material, was cheaper than whole milk powder. For the most suitable ratio that can be apply or use as an index for detect fresh milk and fresh milk combined with reconstituted milk powder depend on several factors including period of time for measure, complicated or easy method, cost, instrument support, safety, etc.

However, fresh milk is divided into three groups i.e. whole milk, low-fat milk or partially skimmed milk, and skimmed milk based on percentage of milk fat and solid-not-fat (SNF). Whole milk must contain at least 3.2% by weight of milk fat and at least 8.25% by weight of solid-not-fat. Low-fat milk contains 0.1% to 3.2% by weight of milk fat and not less than 8.5% by weight of solid-not-fat. Skimmed milk contains not less than 0.1% by weight of milk fat and at least 8.8% by weight of solid-not-fat. All of them must contain not less than 2.8% by weight of milk protein. Therefore, the parameters used to calculate the ratios that can be applied as an indication of addition of reconstituted milk into pasteurized milk and UHT milk should exclude fat, protein, and solid-not-fat due to bylaw of Notification of the Ministry of Public Health No.265 (B.E. 2545) as described above. In this study, there were six ratios exhibited difference values between fresh milk and fresh milk combined with milk powder. Nevertheless, there were only two ratios i.e. Lactose/Urea and TS/Urea that could be apply for detect addition of reconstituted milk in pasteurized milk and UHT milk. Besides, all of six ratios could be apply to investigate the addition of reconstituted milk powder into unprocessed milk or raw milk.

5.3.3 Ratios of milk composition in pasteurized milk purchased from supermarket in Bangkok

In this study, ratios of Lactose/Urea and TS/Urea denoted similar R^2 but TS/Urea showed the best linear regression. Therefore TS/Urea was used to differentiate between fresh milk and fresh milk combined with reconstituted milk powder. The TS/Urea values in pasteurized milk samples purchased from supermarket could be concluded as follows.

1. Pasteurized whole milk of companies A and B

TS/Urea of whole fresh milk of companies A and B were found to be 373.46 and 374.30. When compared these values to those in Table 22 whole fresh milk of companies A and B might be produced by combining 5-10% of reconstituted milk powder with raw milk during production.

2. Pasteurized whole milk companies C, D, and E

TS/Urea of whole fresh milk of companies C, D, and E were found to be 312.21, 306.63, and 339.22, respectively. When compared these values to those in Table 22 whole fresh milk of companies C, D, and E might be produced by combining 10-15% of reconstituted milk powder with raw milk during production.

3. Pasteurized low-fat milk of companies A and E

TS/Urea of low-fat milk of companies A and E were found to be 160.52 and 140.41, respectively. When compared these values to those in Table 22 low-fat milk of companies A and E might be produced by combining 40-50% of reconstituted milk powder with raw milk during production.

4. Pasteurized low-fat milk of company B

TS/Urea of low fat milk of company B was found to be 121.30. When compared these values to those in Table 22 low-fat milk of company B might be produced by combining 60-70% of reconstituted milk powder with raw milk during production.

5. Pasteurized low-fat milk of company C

TS/Urea of low-fat milk of company C was found to be 122.71. When compared these values to those in Table 22 low-fat milk of company C might be produced by combining 50-60% of reconstituted milk powder with raw milk during production.

6. Pasteurized low-fat milk of company D

TS/Urea of low-fat milk of company D was found to be 187.55. When compared these values to those in Table 22 low-fat milk of company D might be produced by combining 30-40% of reconstituted milk powder with raw milk during production.

5.3.4 Ratios of milk composition in UHT milk samples purchased from supermarket in Bangkok

Based on the results of TS/Urea in UHT milk that purchased from supermarket can be concluded as follow:

1. UHT whole milk of companies A and E

TS/Urea of whole milk of company A and E were found to be 226.88 and 246.68. When compared these values to those in Table 22 whole milk of companies A and E might be produced by combining 20-30% of reconstituted milk powder with raw milk during production.

2. UHT whole milk of companies B, D and F

TS/Urea of whole milk of companies B, D and F were found to be 329.18, 322.51 and 305.21, respectively. When compared these values to those in Table 22 whole milk of companies B, D, and F might be produced by combining 10-15% reconstituted milk powder with raw milk during production.

3. UHT whole milk of company C

TS/Urea of whole milk of company C was found to be 361.51. When compared these values to those in Table 22 whole milk of company C might be produced by combining 5-10% of reconstituted milk powder with raw milk during production.

4. UHT whole milk of company G

TS/Urea of low-fat milk of company G was found to be 280.25. When compared these values to those in Table 22 whole milk of company G might be produced by combining 15-20% of reconstituted milk powder with raw milk during production.

5. UHT low-fat milk of company A

TS/Urea of low-fat milk of company A was found to be 112.10. When compared these values to those in Table 22 whole milk of company A might be produced by combining 60-70% of reconstituted milk powder with raw milk during production.

6. UHT low-fat milk of company B

TS/Urea of low-fat milk of company B was found to be 123.49. When compared these values to those in Table 22 whole milk of company B might be produced by combining 50-60% of reconstituted milk powder with raw milk during production.

5.4 Determination of milk fat particle size in milk samples

The results of milk fat particle size in raw milk combining with reconstituted whole milk powder and skimmed milk powder were shown in Table 25 and 26. The results demonstrated decreased in milk fat particle size when the percentage of milk powder was increased in both raw milk combining with various amounts of reconstituted whole milk powder and skimmed milk powder. For milk fat particle size in market fresh milk (pasteurized and UHT milk) were shown in Table 27 and 28. Milk fat particle size in market pasteurized and UHT milk samples showed nearly about 0.1-0.3µm. that very small when compared with raw milk combining with reconstituted milk powder.

Due to raw milk combining with various amounts of reconstituted whole milk powder and skimmed milk powder not pass homogenize process before milk fat particle size determination that effect to larger size than homogenized milk. In market fresh milk involved homogenization during processing so, it made smaller milk fat particle size than raw milk. Therefore, in this study milk fat particle size could not be used as an index to differentiate the addition of reconstituted whole milk powder or reconstituted skimmed milk powder in market fresh milk (pasteurized and UHT). Nevertheless, milk fat particle size could be used as an index to differentiate between raw milk and raw milk combining with reconstituted milk powder that usefulness for milk factory and cooperation.

CHAPTER VI
CONCLUSION

The purpose of this study was to develop an analytical method to determine deoxyketone, biochemical analysis, ratios of milk composition, and milk fat particle size in order to differentiate pure fresh milk from fresh milk combined with reconstituted whole milk powder or skimmed milk powder. The selected parameters were then employed for analyses of market fresh milk products (pasteurized and UHT milk). The results of this study can be concluded as follows.

1. Deoxyketone content of raw milk combined with various percentage of reconstituted whole milk powder and skimmed milk powder were significantly different ($p<0.05$). Nevertheless, it might be unsuitable to be used to discriminate fresh milk from fresh milk combined with reconstituted milk powder in market fresh milk. This is due to the fact that deoxyketone is the product of maillard reaction, heat processing effects higher amount of deoxyketone content. Therefore, deoxyketone in market fresh milk (pasteurized and UHT milk) might be higher than the reality when compared with raw milk combined with reconstituted whole milk powder and reconstituted skimmed milk powder.

2. Biochemical analysis by Milkoscan™ 4000 might not be used to detect the addition of reconstituted whole milk powder or skimmed milk powder in milk samples. Because the content of each factor were found to have similar so, this method could not be able to differentiate fresh milk and fresh milk combined with reconstituted milk powder.

3. Ratios of milk composition could be used as an index for discriminate the addition of reconstituted milk powder (whole milk powder and skimmed milk powder) into raw milk and market fresh milk. In particularly lactose/urea and TS/urea ratios are able to differentiate fresh milk from fresh milk combined with reconstituted milk powder.

4. Milk fat particle size could not be used to detect the addition of reconstituted whole milk powder or skimmed milk powder in market fresh milk. Nevertheless it can be used to differentiate between fresh milk and fresh milk combined with reconstituted whole milk powder and reconstituted skimmed milk powder in raw milk.

Nowadays, there are other reports for determination of milk powder that present in ready-to-drink milk such as furosine and lactulose that can be examined by HPLC or enzymatic method. Although these method provides absolutely result, it is the complicated method, time consuming, and high cost for operation. This study presents alternative methods for detection of reconstituted whole milk powder and reconstituted skimmed milk powder that might be added into fresh milk during production.

REFERENCES

Acquistucci R., Panfili G., Marconi E., (1996). Application of the microwave hydrolysis to furosine determination in cereal and dairy foods. Journal Agric. Food Chem. 44, 3855-3857

Aeschbacher H.U. (1990). Anticarcinogenic effect of browning reaction products. In The maillard reaction in food processing. Human nutrition and Physiology, eds P.A. Finot H., Aeschbacher R.F., Hurrell and R.Liardon. Birkhauser Verlag, Basel. 335-348

Alfa-laval. (1995). Dairy handbook. Lund, Sweden

Ames., J.M. (1992). The Maillard reaction. In Biochemistry of Food Proteins, ed. Hudson B.J.F., Elsevier Applied Science, London. 99-153

Amine A., Moscone D., Bernado R.A., Marconi E., Palleschi G. (2000). A new enzymatic spectrophotometric asay for the determination of lactulose in milk. Analytica Chimica Acta. 406, 217-224.

Andrew G.R., (1984). Distinguishing pasteurized, UHT and sterilized milk by their lactulose content. J. Soc. Dairy Technol. 37, 92-95

AOAC International. (2000). Official Methods of Analysis, 17th ed., AOAC International, Giathersburg, MD.

Aragon I. Birlouez, Pischetsrieder M, Leclere J., Morales F.J., Hasenkopf K., Rutledge D., Kientsch-Engel R., Ducauze C.J., (2004). Assessment of protein glycation markers in infant formulas. Food Chemistry 87, 253–259

Asylbek Kulmyrzaev, Eric Dufour. (2002). Determination of lactulose and furosine in milk using front-face fluorescence spectroscopy. Lait. 82, 725-735

Belitz H.D., Grosch W., editors. (1987). Food chemistry. Berlin (GM): Springer-Verlag.

Berg H.E., Van Boekel M.A.J.S., Jongen W.M.F. (1990). Heating milk: a study on mutagenicity. Journal of Food Science. 55, 1000-1003 and 1007

Bressa F., Tesson N., Dalla Rosa M., Sensidoni A., Tubaro F. (1996). Antioxidant effect of Maillard reaction products: application to butter cookie of a competition kinetics analysis. Journal of Agricultural and Food Chemistry. 44, 692-695

Burton H., (1984). Reviews of the progress of dairy science: The bacteriological, chemical biochemical and physical changes that can occur in milk at temperatures of 100-150 °C. Journal of dairy research. 51, 341-363

Burton H.S. and McWeeney D.J. (1963). Non-enzymic browning reactions. Consideration of sugar stability. Nature (London). 197, 266

Ceirwyn S.J. (1995). Analytical Chemistry of Foods. Chapman & Hall., Glasgow, NZ.

Corzo N., Delgado T., Troyano E., Olano A. (1994). Ratio of lactulose and furosine as indicator of quality of commercial milks. Journal of food protechtion. 57, 737-739

Corzo N., Lopez-Fandino R., Delgano T., Ramos M., Olano A., (1994). Changes in furosine and protein of UHT-treated milks stored at high ambience temperatures. Z.Lebensm.Unters.Forsch. 198, 302-306

Danehy J.P. (1986). Maillard reactions: nonenzymatic browning in food systems with special reference to the development of flavor. Advances in food research. 30, 77-138

De Rafael D., Villamiel M., Olano A., (1997). Formation of lactulose and furosine during heat treatment of milk at temperatures of 100-120 °C. Milchwissenschaft. 52, 76-78

Ding C.H., and Chang T.C. (1986). Detection of reconstituted milk in fresh milk. Journal Chinese Agric.Chem.Soc. 24, 406-411

Douglas Goff. (1997). Dairy product technology study note.

Dworshak E. and Hegedus M. (1974). Effect of heat treatment on the nutritive value of proteins in milk powder. Acta Aliment. Acad.Sci.Hung. 3, 337

Early R. (1992). The technology of dairy products. VCH Publishers, Inc. New York. 1-2.

Einarsson H.S., Goran Snygg B.G., Eriksson C. (1983). Inhibition of bacterial growth by Maillard reaction products. Journal of Agricultural and Food Chemistry. 31, 1043-1047

Ellis G.P. (1959). The maillard reaction. Advance carbohydrate chemistry. 14, 63

Evangelisti F., Calcagno C., Nardi S., Zunin P. (1999). Deterioration of protein fraction by maillard reaction in dietetic milks. Journal of dairy research. 66, 237-243

Fennema Owen R. (1996). Food chemistry, third edition. 873-874.

Food and Fertilizer Technology Center (FFTC). (2001). Commercial Livestock Production by Asian Smallholders. FFTC International Seminar. http://www.agnet.ort

Fox P.F. (1981b). Heat stability of milk: significance of heat induced acid formation in coagulation. Irish Journal of Food Science Technology. 5, 1-11

Francisco-J., Morales, Carmen Romero, and Salvio Jimenez-Perez. (2000). Characterization of industrial processed milk by analysis of heat-induced changes. International Journal of Food Science and Technology. 35, 193-200

Friedman M. (1996a). Food browning and its prevention: an overview. Journal of Agricultural and Food Chemistry. 44, 631-653

Friedman M. (1996b). The impact of the maillard reaction on the nutritional value of food proteins. In the Maillard reaction: Consequences for the chemical and life sciences, ed. R. Ihan, Wiley and Sons, New York. 105-128

Geier H., and Klostermeyer H. (1983). Formation of lactulose during heat treatment of milk. Milchwissenschaft. 38, 475-477

Hankunakul P. (1999). Development of analytical method for detection of milk powder in ready to drink milk.

Harjinder Singh. (2004). Heat stability of milk. International Journal of Dairy Technology. 57, No 2/3 May/August

Havea P., Singh H., Cremer L.K., (2001). Characterization of heat induced aggregates of β-lactoglobulin, α-lactalbumin and bovine serum albumin in a whey protein concentrate environment. Journal dairy research. 68, 483-497

Henle T., Schwarzenbolz U., Klostermeyer H. (1996). Irreversible crosslinking of casein during storage of UHT treated milk. In heat treatments and alternative methods. International Dairy Federation, Special Issue no.9602, Brussels. 290-298

Holt C. (1992). Structure and stability of bovine casein micelles. Advances in protein chemistry. 43, 64-151

Hong Y.H., Creamer LK., (2002). Heat-induced aggregation behavior of bovine β-lactoglobulin B. Food Sci Biotechnol. 11, 161-164

Jagerstad M., Skog K., Grivas S., Olson K. (1991). Formation of heterocyclic amines using model systems. Mutation research. 259, 219-233

Jan De Block, et al. (1996). Evaluation of two methods for the determination of lactulose in milk. International Dairy Journal. 6, 217-222.

Jang H.D. and Swaisgood H.E. (1990). Disulphide bond formation between thermally denatured β-lactoglobulin and k-casein in casein micelles. Journal of dairy science. 73, 900-904

Jedsadabundit P. (1998). Final report on Feed production and Utilization Technology for Ruminant Animals. Thailand: Nakhonsawan College of Agriculture and Technology, Department of Vocational Education.

Jensen G.K. and Nielsen P. (1982). Reviews in the progress of dairy science: Milk powder and recombination of milk and milk products. Journal of dairy research. 49, 515

Jensen R.G. (1973). Composition of bovine milk fat, JAOCS, 50,186-192

Jensen R.G., Ferris A.M., Lammi-Keefe C.L. (1991). The composition of milk fat. Journal Dairy Science. 74, 3228-3243

Kato H., Lee I.E., Chuyen N.V. (1987). Inhibition of nitrosamine formation by nondialyzable melanoidins. Agricultural and Biological Chemistry. 51, 1333-1338

Kessler H.G., and Horak P., (1981). Objective evaluation of UHT milk heating by standardization of bacteriological and chemical effects (in German). Milchwissenschaft. 36, 129-133

Kiyothong K., (1998). Final report on Feed production and Utilization Technology for Ruminant Animals. Thailand: Khon Kaen Animal Nutrition Research Center, Department of Livestock, Ministry of Agriculture and Cooperatives.

Le Bon C., Durand D., Nicolai T., (2002). Influence of genetic variation on the genetic variation on the aggregation of heat-denatured β-lactoglobulin. International of dairy journal. 12, 671-678

Leen Mortier, An Braekman, Dagmar Cartuyvels, Roland Van Renterghem, Jan De Block. (2000). Intrinsic indicators for monitoring heat damage of consumption milk. Biotechnol. Agron. Soc.Environ. 4(4), 221-225

Louis J., Ronsivalli and Ernest R. Vieira. (1992). Elementary food science, third edition. 204-205.

Markuze Z. (1963). Effect of traces of metals on the browning of glucose-lysine solutions. Chem.Abstrr. 59, 4980

Mauron J. (1981) The maillard reaction in food: a critical review from the nutritional standpoint. Progress in food nutrition sciences. 5, 5-35

McCarthy D.A., Kakuda Y., Arnott D.R. (1985). Vitamin A stability in ultra-high temperature processed milk. Journal Dairy Science. 69, 2045-2051.

Michael Eskin N.A. Biochemistry of foods (Biochemistry of food processing: Browning reactions in foods). Second edition. Academic Press, Inc. San Diego USA.

Namiki M. (1988). Chemistry of Maillard reactions: recent studies on the browning reaction mechanism and the development of antioxidants and mutagens. Advances in Food Research. 32, 115-184

Nielsen S. (2003). Food analysis. 3rd ed. Plenum Publishers, New York.

Nieuwenhuijse J.A., Sjollema A., van Boekel M.A.J.S., van Vliet T., and Walstra P. (1991). The heat stability of concentrated milk. Netherlands Milk Dairy Journal. 45, 193-224

Patton S. (1955). Browning and associated changes in milk and its products: a review. Journal of Dairy Science. 38, 457-478

Pellegrino L., Noni I. Resmini P. (1995). Coupling of lactulose and furosine indices for quality evaluation of sterilized milk. International Dairy Journal. 5, 647-659

Pellegrino L., Resmini P., and Luf W., (1995). Assessment (indices) of heat treatment. In: II eat Induced changes in milk, (edited by). International Dairy Federation, Brussels, Belgium. 409-457

Planning Division, Department of Livestock Development. (2000). Statistics of dairy cattle in Thailand (1989-1999). Thailand: Royal Thai Government.

Renner E., (1983). Milk and dairy products in human nutrition. Volkswirtsch. Verlag, Munich

Roderbourg H., and Kuzdzal-Savoie S. (1979). The hydrocarbons of anhydrous butterfat: influence of technological treatments. JAOCS. 56(4), 485-488

Roland Van Renterghem and Jan De Block. (1996). Furosine in comsumption milk and milk powders. Int.Dairy Journal 6, 371-382.

Schokker EP., Singh H., Creamer LK., (2000b). Heat-induced aggregation of β-lactoglobulin A and B with α-lactalbumin. International of dairy journal. 10, 843-853

Schokker E.P., Singh H., Pinder D.N., Norris G.E., Creamer L.K. (2000a). Characterization of intermediates formed during heat-induced aggregation of β-lactoglobulin AB at neutral pH. International of dairy journal. 9, 791-800

Shibamoto T. (1982). Occurrence of mutagenic products in browning model systems. Food Technology. 36(3), 59-63

Singh H., and Cremer L.K., (1991a). Influence of concentration of milk solid on the dissociation of micellar k-casein on heating reconstituted skim milk at 120 ^{o}C. Journal of dairy research. 58, 99-105

Singh H., and Fox P.F. (1985a). Heat stability of milk: The mechanism of stabilization by formaldehyde. Journal of dairy research. 52, 65-76

Singh H., and Fox P.F. (1985b). Heat stability of milk: pH dependent dissociation of micellar k-casein on heating milk at ultrahigh temperature. Journal of dairy research. 52, 529-538

Singh H., and Fox P.F. (1987a). Heat stability of milk: Role of β-lactoglobulin in the pH-dependent dissociation of micellar k-casein. Journal of dairy research. 54, 509-521

Smits P., and van Brouwershaven J.H. (1980). Heat-induced association of β-lactoglobulin and casein micelles. Journal of dairy research. 47, 313-325

Van Boekel M.A.J.S., Nieuwenhuijse J.A., and Walstra P (1989a). The heat coagulation of milk: mechanisms. Netherlands Milk Dairy Journal. 43, 97-127

Van Boekel M.A.J.S., Nieuwenhuijse J.A., and Walstra P (1989b). The heat coagulation of milk: 3. Comparison of theory and experiment. Netherlands Milk Dairy Journal. 43, 147-162

van Renterghem R., De Block J. (1996). Furosine in consumption milk and milk powders. International dairy journal. 6, 371-382

Varnam A.H., Sutherland J.P., editors. (1994). Milk and milk products. UK: Chapman & Hall.

Vidal-Valverde C., Ruiz R., Medrano A., (1993). Effects of frozen and other storage conditions on α-tocopherol content of cow milk. Journal Dairy Science. 76, 1520-1525.

Villamiel M., Corzo N. (1998). Lactulose formation during batch microwave treatment of different types of dairy products. Milchwissenschaft. 53, 487-490

Villamiel M., Corzo N., Martinez-Castro I., Olano A. (1996). Chemical changes during microwave treatment of milk. Food chemistry. 56, 385-388

Wolfrom M.L. and Rooney C.C. (1953). Chemical interactions of amino compounds and sugars. VIII. Influence of water. J.Am. Chem. Soc. 75, 5435

Yen G.C., Tsai L.C. and Lii J.D. (1992). Antimutagenic effect of Maillard browning products obtained from amino acids and sugars. Food and Chemical Toxicology. 30, 127-132

Zadow J.G. (1980). UHT milk – Standards and quality assurance. Australian journal dairy technology. 35, 140-144

Zegarska Z., Jaworski J. (1981). Effect of lactation period and seasonal feeding system on quantitative trigleceride composition of milk fat. Milchwissenschaft. 36(7), 396-398

Zin El-Din M., Aoki T., Kayo Y. (1991). Polymerization and degradation of casein in UHT milk during storage. Milchwissenschaft. 46, 284-287

Zin El-Din M., Aoki T. (1993). Polymerization of casein on heating milk. International Dairy Journal. 3, 581-588

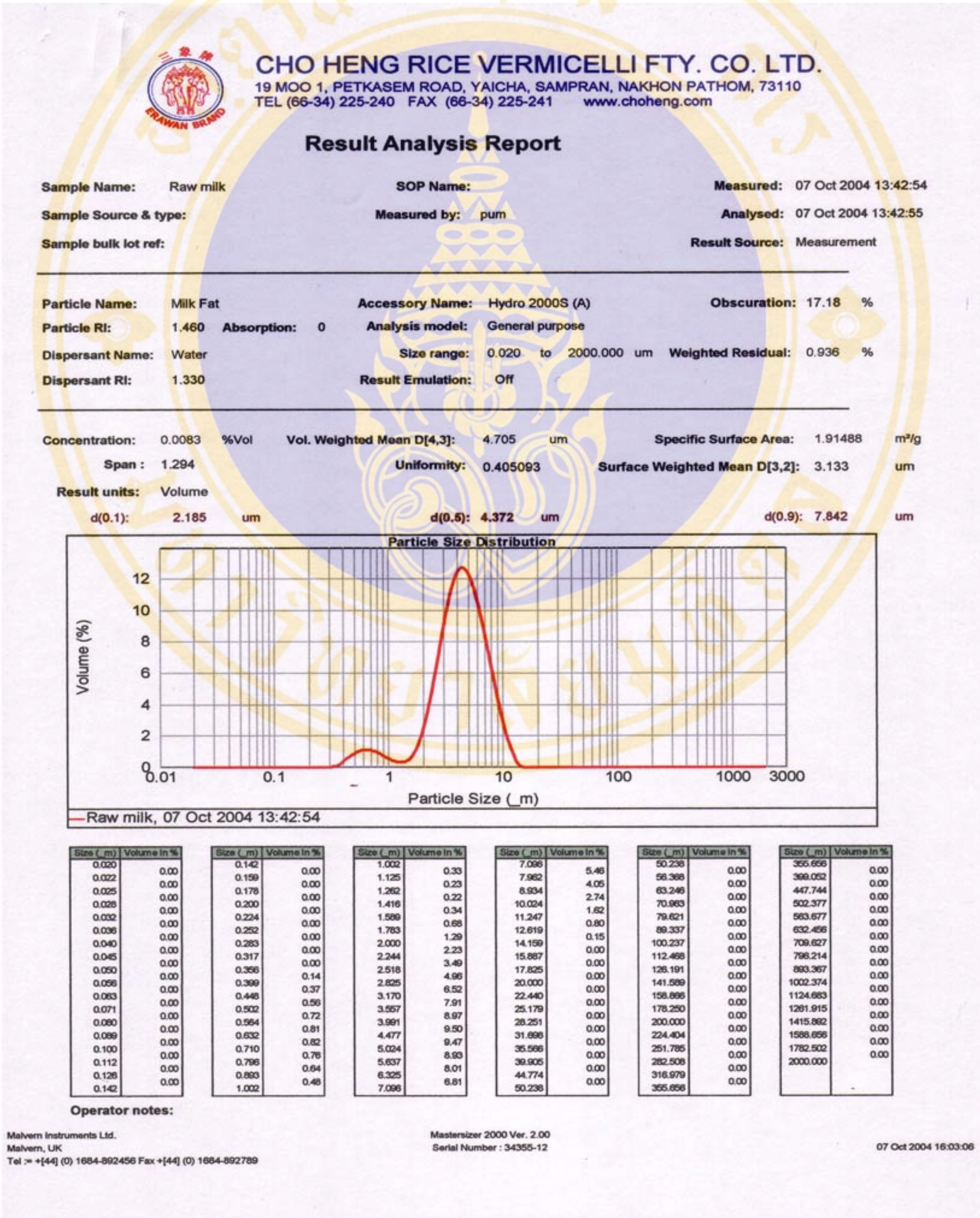
วิภาวรรณ ปาณะพล. (2542). เอกสารทางวิชาการเรื่องน้ำนมดิบและอุตสาหกรรมต่อเนื่อง. กองส่งเสริมการปศุสัตว์ กรมปศุสัตว์.

APPENDIX

APPENDIX A

Particle size in milk samples

1. Particle size in raw milk combined with reconstituted whole milk powder



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Result Analysis Report

Sample Name: Raw milk **SOP Name:** **Measured:** 07 Oct 2004 13:42:54
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 13:42:55
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.18 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.936 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0083 %Vol **Vol. Weighted Mean D[4,3]:** 4.705 um **Specific Surface Area:** 1.91488 m²/g
Span : 1.294 **Uniformity:** 0.405093 **Surface Weighted Mean D[3,2]:** 3.133 um
Result units: Volume
d(0.1): 2.185 um **d(0.5): 4.372** um d(0.9): 7.842 um

Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.00
0.050	0.00
0.056	0.00
0.063	0.00
0.071	0.00
0.080	0.00
0.089	0.00
0.100	0.00
0.112	0.00
0.126	0.00
0.142	

Size (_m)	Volume In %
0.142	0.00
0.159	0.00
0.178	0.00
0.200	0.00
0.224	0.00
0.252	0.00
0.283	0.00
0.317	0.00
0.356	0.14
0.399	0.37
0.448	0.56
0.502	0.72
0.564	0.81
0.632	0.82
0.710	0.76
0.796	0.64
0.893	0.48
1.002	

Size (_m)	Volume In %
1.002	0.33
1.125	0.23
1.262	0.22
1.416	0.34
1.589	0.68
1.783	1.29
2.000	2.23
2.244	3.49
2.518	4.96
2.825	6.52
3.170	7.91
3.557	8.97
3.991	9.50
4.477	9.47
5.024	8.93
5.637	8.01
6.325	6.81
7.096	

Size (_m)	Volume In %
7.096	5.46
7.962	4.05
8.934	2.74
10.024	1.62
11.247	0.80
12.619	0.15
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

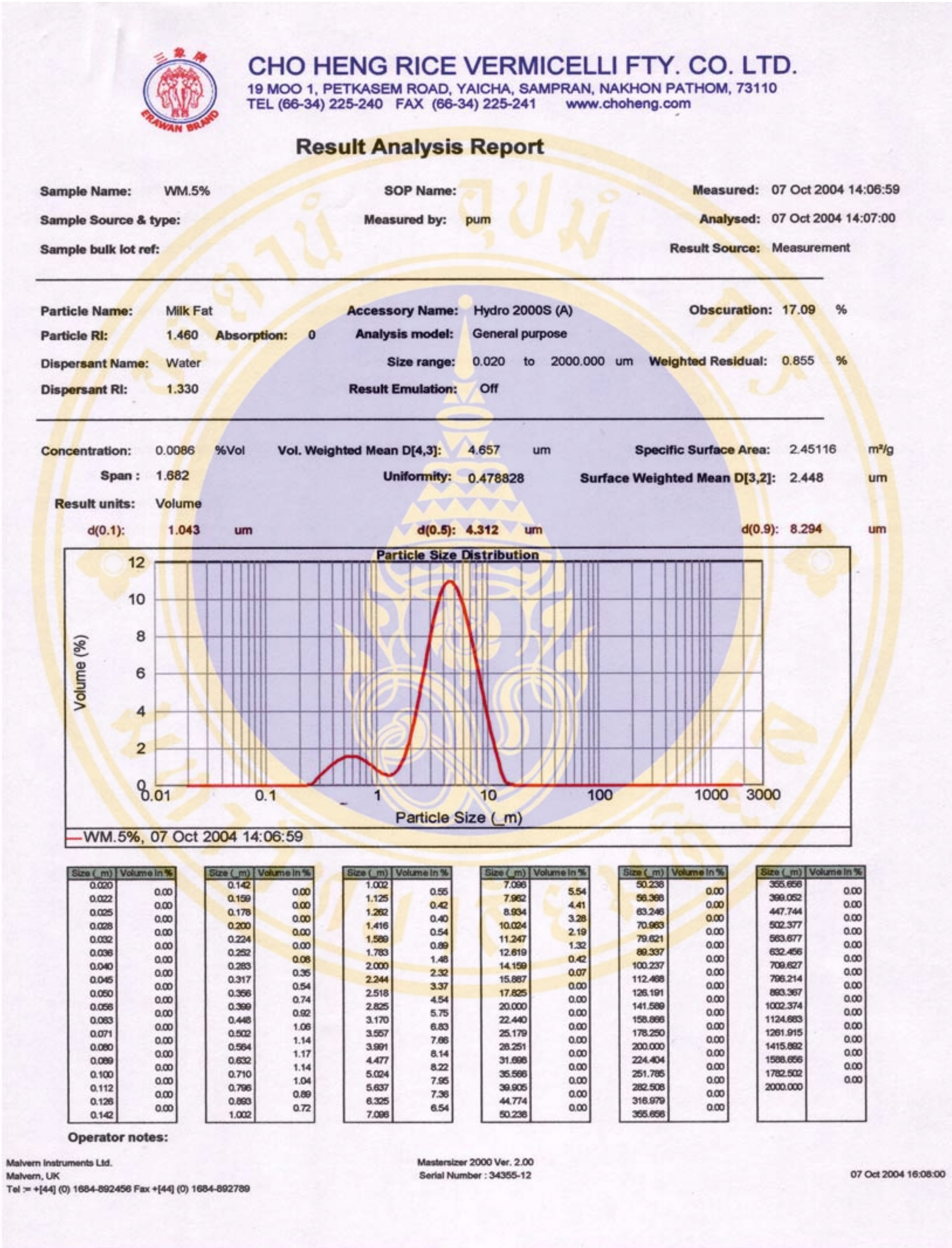
Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

Mastersizer 2000 Ver. 2.00
Serial Number : 34355-12

07 Oct 2004 16:03:06

Figure 28 Particle size in raw milk



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Result Analysis Report

Sample Name: WM.5% SOP Name: Measured: 07 Oct 2004 14:06:59
Sample Source & type: Measured by: pum Analysed: 07 Oct 2004 14:07:00
Sample bulk lot ref: Result Source: Measurement

Particle Name: Milk Fat Accessory Name: Hydro 2000S (A) Obscuration: 17.09 %
Particle RI: 1.460 Absorption: 0 Analysis model: General purpose
Dispersant Name: Water Size range: 0.020 to 2000.000 um Weighted Residual: 0.855 %
Dispersant RI: 1.330 Result Emulation: Off

Concentration: 0.0086 %Vol Vol. Weighted Mean D[4,3]: 4.657 um Specific Surface Area: 2.45116 m²/g
Span : 1.682 Uniformity: 0.478828 Surface Weighted Mean D[3,2]: 2.448 um
Result units: Volume
d(0.1): 1.043 um d(0.5): 4.312 um d(0.9): 8.294 um

Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.00
0.050	0.00
0.056	0.00
0.063	0.00
0.071	0.00
0.080	0.00
0.089	0.00
0.100	0.00
0.112	0.00
0.126	0.00
0.142	

Size (_m)	Volume In %
0.142	0.00
0.159	0.00
0.178	0.00
0.200	0.00
0.224	0.00
0.252	0.08
0.283	0.35
0.317	0.54
0.356	0.74
0.399	0.92
0.448	1.06
0.502	1.14
0.564	1.17
0.632	1.14
0.710	1.04
0.796	0.89
0.893	0.72
1.002	

Size (_m)	Volume In %
1.002	0.55
1.125	0.42
1.262	0.40
1.416	0.54
1.589	0.89
1.783	1.48
2.000	2.32
2.244	3.37
2.518	4.54
2.825	5.75
3.170	6.83
3.557	7.66
3.991	8.14
4.477	8.22
5.024	7.95
5.637	7.36
6.325	6.54
7.096	

Size (_m)	Volume In %
7.096	5.54
7.962	4.41
8.934	3.28
10.024	2.19
11.247	1.32
12.619	0.42
14.159	0.07
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

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Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

Mastersizer 2000 Ver. 2.00
Serial Number : 34355-12

07 Oct 2004 16:08:00

Figure 29 Particle size in raw milk combined with 5% reconstituted WMP

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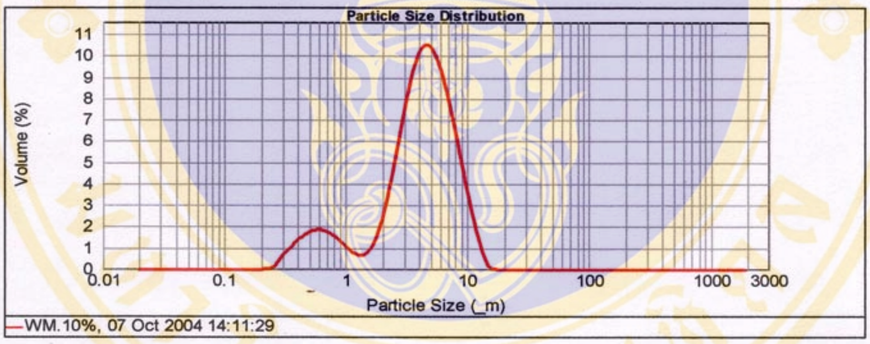
Result Analysis Report

Sample Name: WM.10% **SOP Name:** **Measured:** 07 Oct 2004 14:11:29
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 14:11:30
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.98 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.851 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0086 %Vol **Vol. Weighted Mean D[4,3]:** 4.559 um **Specific Surface Area:** 2.71588 m²/g
Span : 1.776 **Uniformity:** 0.506728 **Surface Weighted Mean D[3,2]:** 2.209 um
Result units: Volume
d(0.1): 0.787 um d(0.5): 4.229 um d(0.9): 8.297 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.00
0.050	0.00
0.056	0.00
0.063	0.00
0.071	0.00
0.080	0.00
0.089	0.00
0.100	0.00
0.112	0.00
0.126	0.00
0.142	

Size (_m)	Volume In %
0.142	0.00
0.159	0.00
0.178	0.00
0.200	0.00
0.224	0.04
0.252	0.17
0.283	0.49
0.317	0.70
0.356	0.92
0.399	1.12
0.448	1.27
0.502	1.37
0.564	1.41
0.632	1.37
0.710	1.27
0.796	1.11
0.893	0.91
1.002	

Size (_m)	Volume In %
1.002	0.71
1.125	0.55
1.262	0.49
1.416	0.59
1.589	0.90
1.783	1.44
2.000	2.23
2.244	3.23
2.518	4.35
2.825	5.52
3.170	6.56
3.557	7.37
3.991	7.83
4.477	7.92
5.024	7.67
5.637	7.12
6.325	6.33
7.096	

Size (_m)	Volume In %
7.096	5.38
7.962	4.30
8.934	3.22
10.024	2.19
11.247	1.30
12.619	0.56
14.159	0.09
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

Mastersizer 2000 Ver. 2.00
Serial Number : 34355-12

07 Oct 2004 16:08:06

Figure 30 Particle size in raw milk combined with 10% reconstituted WMP

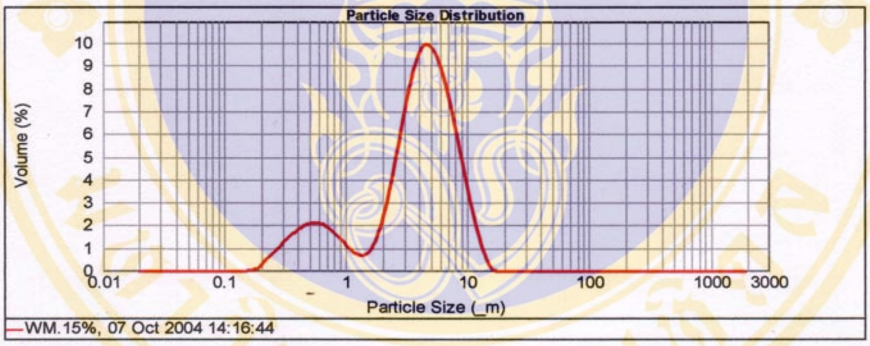
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: WM.15% **SOP Name:** **Measured:** 07 Oct 2004 14:16:44
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 14:16:45
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.22 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 1.296 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0090 %Vol **Vol. Weighted Mean D[4,3]:** 4.430 um **Specific Surface Area:** 3.36661 m²/g
Span : 1.884 **Uniformity:** 0.551279 **Surface Weighted Mean D[3,2]:** 1.782 um
Result units: Volume
d(0.1): 0.588 um d(0.5): 4.118 um d(0.9): 8.347 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.00
0.050	0.00
0.056	0.00
0.063	0.00
0.071	0.00
0.080	0.00
0.089	0.00
0.100	0.00
0.112	0.00
0.126	0.00
0.142	

Size (_m)	Volume In %
0.142	0.00
0.159	0.02
0.178	0.09
0.200	0.31
0.224	0.50
0.252	0.69
0.283	0.90
0.317	1.10
0.356	1.28
0.399	1.42
0.448	1.53
0.502	1.58
0.564	1.58
0.632	1.51
0.710	1.37
0.796	1.19
0.893	0.97
1.002	

Size (_m)	Volume In %
1.002	0.76
1.125	0.59
1.262	0.52
1.416	0.59
1.589	0.86
1.783	1.35
2.000	2.08
2.244	3.00
2.518	4.05
2.825	5.15
3.170	6.13
3.557	6.91
3.991	7.36
4.477	7.48
5.024	7.27
5.637	6.78
6.325	6.06
7.096	

Size (_m)	Volume In %
7.096	5.19
7.962	4.19
8.934	3.18
10.024	2.21
11.247	1.37
12.619	0.69
14.159	0.19
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:08:10

Figure 31 Particle size in raw milk combined with 15% reconstituted WMP

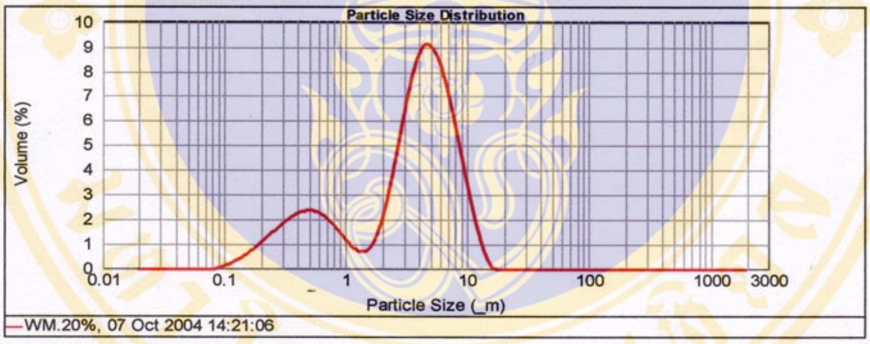
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: WM.20% **SOP Name:** **Measured:** 07 Oct 2004 14:21:06
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 14:21:07
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.92 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.799 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0093 %Vol **Vol. Weighted Mean D[4,3]:** 4.120 um **Specific Surface Area:** 4.98939 m²/g
Span : 2.024 **Uniformity:** 0.619124 **Surface Weighted Mean D[3,2]:** 1.203 um
Result units: Volume
d(0.1): 0.396 um d(0.5): 3.854 um d(0.9): 8.197 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.00
0.050	0.00
0.056	0.00
0.063	0.00
0.071	0.00
0.080	0.00
0.089	0.06
0.100	0.12
0.112	0.22
0.126	0.31
0.142	

Size (_m)	Volume In %
0.142	0.43
0.159	0.57
0.178	0.72
0.200	0.88
0.224	1.05
0.252	1.22
0.283	1.38
0.317	1.52
0.356	1.64
0.399	1.73
0.448	1.78
0.502	1.78
0.564	1.72
0.632	1.61
0.710	1.44
0.796	1.24
0.893	1.01
1.002	

Size (_m)	Volume In %
1.002	0.79
1.125	0.61
1.262	0.53
1.416	0.58
1.589	0.81
1.783	1.25
2.000	1.90
2.244	2.74
2.518	3.70
2.825	4.70
3.170	5.60
3.557	6.32
3.991	6.75
4.477	6.86
5.024	6.68
5.637	6.25
6.325	5.60
7.096	

Size (_m)	Volume In %
7.096	4.81
7.962	3.90
8.934	2.97
10.024	2.08
11.247	1.29
12.619	0.65
14.159	0.18
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:08:16

Figure 32 Particle size in raw milk combined with 20% reconstituted WMP

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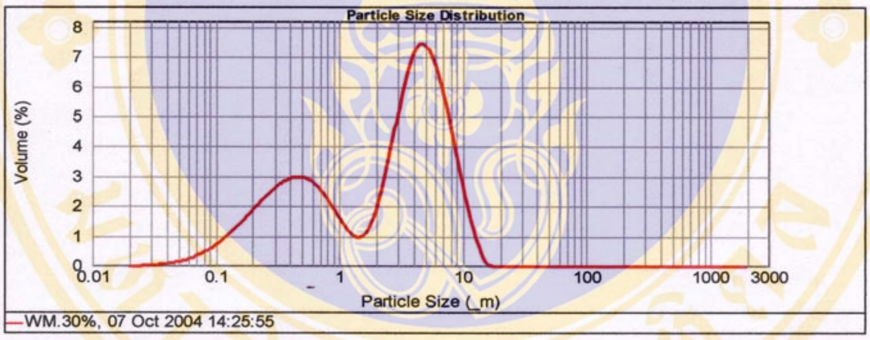
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: WM.30% **SOP Name:** **Measured:** 07 Oct 2004 14:25:55
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 14:25:56
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.62 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.772 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0105 %Vol **Vol. Weighted Mean D[4,3]:** 3.474 um **Specific Surface Area:** 9.13052 m²/g
Span : 2.429 **Uniformity:** 0.808952 **Surface Weighted Mean D[3,2]:** 0.657 um
Result units: Volume
d(0.1): 0.238 um **d(0.5):** 3.099 um **d(0.9):** 7.768 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.01
0.032	0.03
0.036	0.04
0.040	0.07
0.045	0.09
0.050	0.13
0.056	0.16
0.063	0.22
0.071	0.30
0.080	0.39
0.089	0.49
0.100	0.60
0.112	0.73
0.126	0.86
0.142	

Size (_m)	Volume In %
0.142	1.01
0.159	1.17
0.178	1.33
0.200	1.50
0.224	1.66
0.252	1.82
0.283	1.96
0.317	2.08
0.356	2.17
0.399	2.23
0.448	2.25
0.502	2.21
0.564	2.13
0.632	1.99
0.710	1.81
0.796	1.58
0.893	1.34
1.002	

Size (_m)	Volume In %
1.002	1.09
1.125	0.89
1.262	0.76
1.416	0.74
1.589	0.87
1.783	1.18
2.000	1.67
2.244	2.31
2.518	3.07
2.825	3.86
3.170	4.58
3.557	5.17
3.991	5.51
4.477	5.61
5.024	5.46
5.637	5.11
6.325	4.59
7.096	

Size (_m)	Volume In %
7.096	3.95
7.962	3.20
8.934	2.45
10.024	1.72
11.247	1.09
12.619	0.57
14.159	0.17
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:08:23

Figure 33 Particle size in raw milk combined with 30% reconstituted WMP

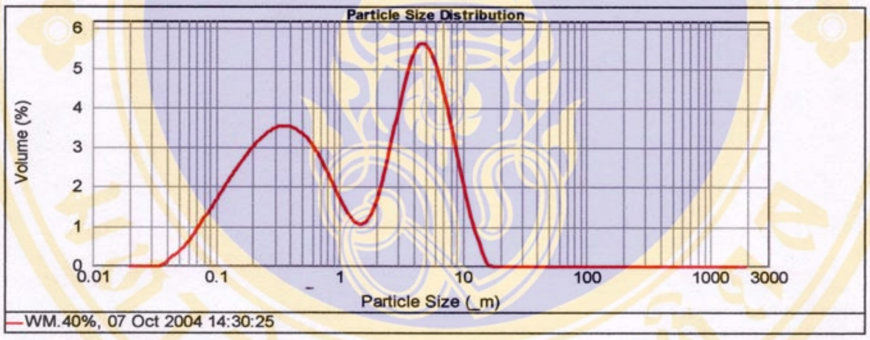
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: WM.40% **SOP Name:** **Measured:** 07 Oct 2004 14:30:25
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 14:30:26
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.32 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.752 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0118 %Vol **Vol. Weighted Mean D[4,3]:** 2.778 um **Specific Surface Area:** 14.5835 m²/g
Span : 5.686 **Uniformity:** 1.92671 **Surface Weighted Mean D[3,2]:** 0.411 um
Result units: Volume
d(0.1): 0.148 um d(0.5): 1.241 um d(0.9): 7.205 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.01
0.040	0.14
0.045	0.23
0.050	0.33
0.056	0.45
0.063	0.61
0.071	0.79
0.080	0.98
0.089	1.17
0.100	1.36
0.112	1.54
0.126	1.72
0.142	

Size (_m)	Volume In %
0.142	1.89
0.159	2.05
0.178	2.20
0.200	2.34
0.224	2.46
0.252	2.56
0.283	2.63
0.317	2.67
0.356	2.67
0.399	2.65
0.448	2.58
0.502	2.47
0.564	2.32
0.632	2.13
0.710	1.91
0.796	1.67
0.893	1.43
1.002	

Size (_m)	Volume In %
1.002	1.19
1.125	0.99
1.262	0.85
1.416	0.80
1.589	0.86
1.783	1.06
2.000	1.39
2.244	1.84
2.518	2.37
2.825	2.95
3.170	3.48
3.557	3.91
3.991	4.17
4.477	4.24
5.024	4.14
5.637	3.88
6.325	3.50
7.096	

Size (_m)	Volume In %
7.096	3.03
7.962	2.48
8.934	1.92
10.024	1.38
11.247	0.90
12.619	0.53
14.159	0.19
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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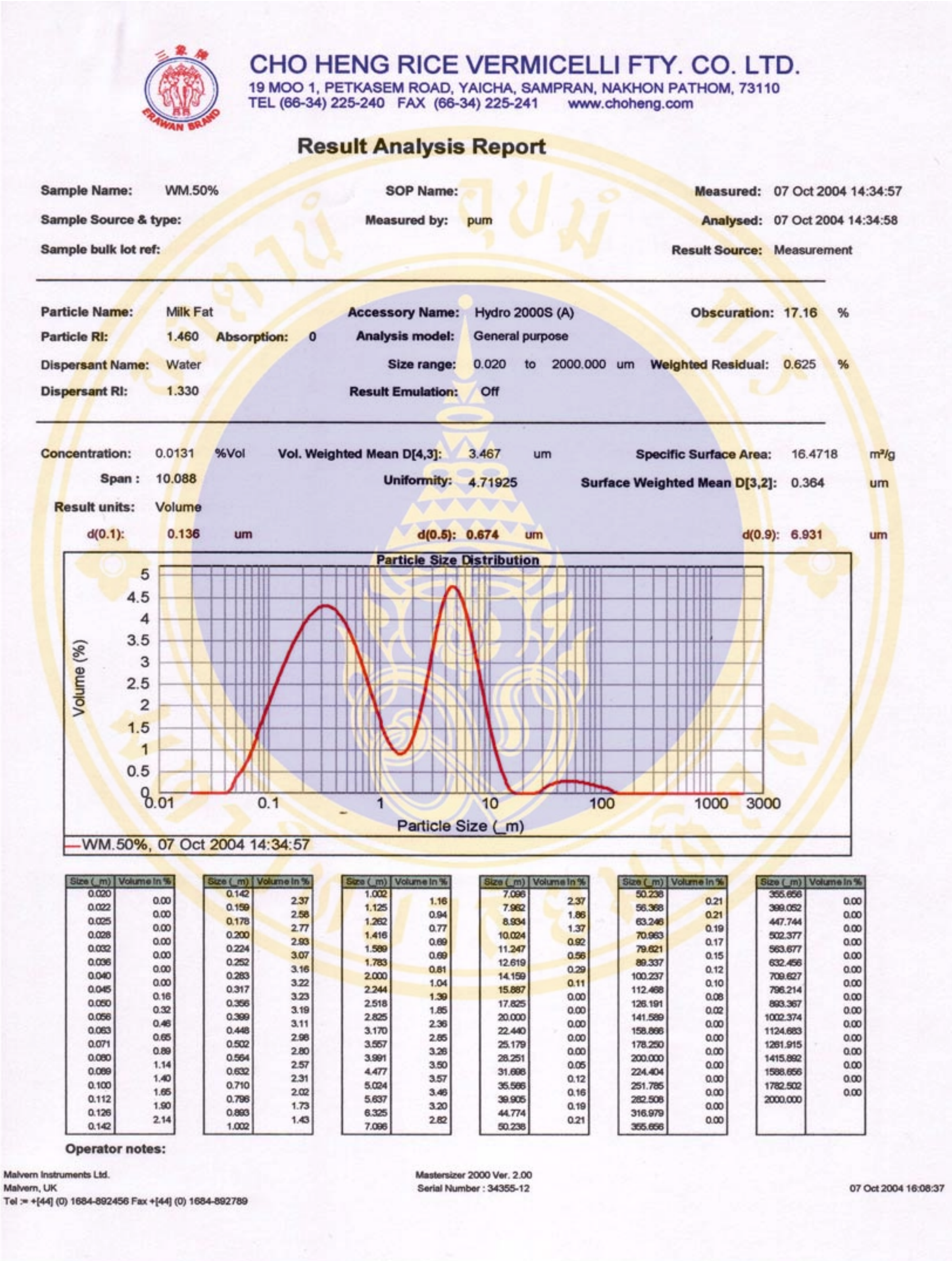
07 Oct 2004 16:08:32

Figure 34 Particle size in raw milk combined with 40% reconstituted WMP



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19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: WM.50% **SOP Name:** **Measured:** 07 Oct 2004 14:34:57
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 14:34:58
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.16 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.625 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0131 %Vol **Vol. Weighted Mean D[4,3]:** 3.467 um **Specific Surface Area:** 16.4718 m²/g
Span : 10.088 **Uniformity:** 4.71925 **Surface Weighted Mean D[3,2]:** 0.364 um
Result units: Volume
d(0.1): 0.136 um d(0.5): 0.674 um d(0.9): 6.931 um

Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.16
0.050	0.32
0.056	0.46
0.063	0.65
0.071	0.89
0.080	1.14
0.089	1.40
0.100	1.65
0.112	1.90
0.126	2.14
0.142	

Size (_m)	Volume In %
0.142	2.37
0.159	2.58
0.178	2.77
0.200	2.93
0.224	3.07
0.252	3.16
0.283	3.22
0.317	3.23
0.356	3.19
0.399	3.11
0.448	2.98
0.502	2.80
0.564	2.57
0.632	2.31
0.710	2.02
0.796	1.73
0.893	1.43
1.002	

Size (_m)	Volume In %
1.002	1.16
1.125	0.94
1.262	0.77
1.416	0.69
1.589	0.69
1.783	0.81
2.000	1.04
2.244	1.39
2.518	1.85
2.825	2.36
3.170	2.85
3.557	3.26
3.991	3.50
4.477	3.57
5.024	3.46
5.637	3.20
6.325	2.82
7.096	

Size (_m)	Volume In %
7.096	2.37
7.962	1.86
8.934	1.37
10.024	0.92
11.247	0.56
12.619	0.29
14.159	0.11
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.05
31.698	0.12
35.566	0.16
39.905	0.19
44.774	0.21
50.238	

Size (_m)	Volume In %
50.238	0.21
56.368	0.21
63.246	0.19
70.963	0.17
79.621	0.15
89.337	0.12
100.237	0.10
112.468	0.08
126.191	0.02
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

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Malvern, UK
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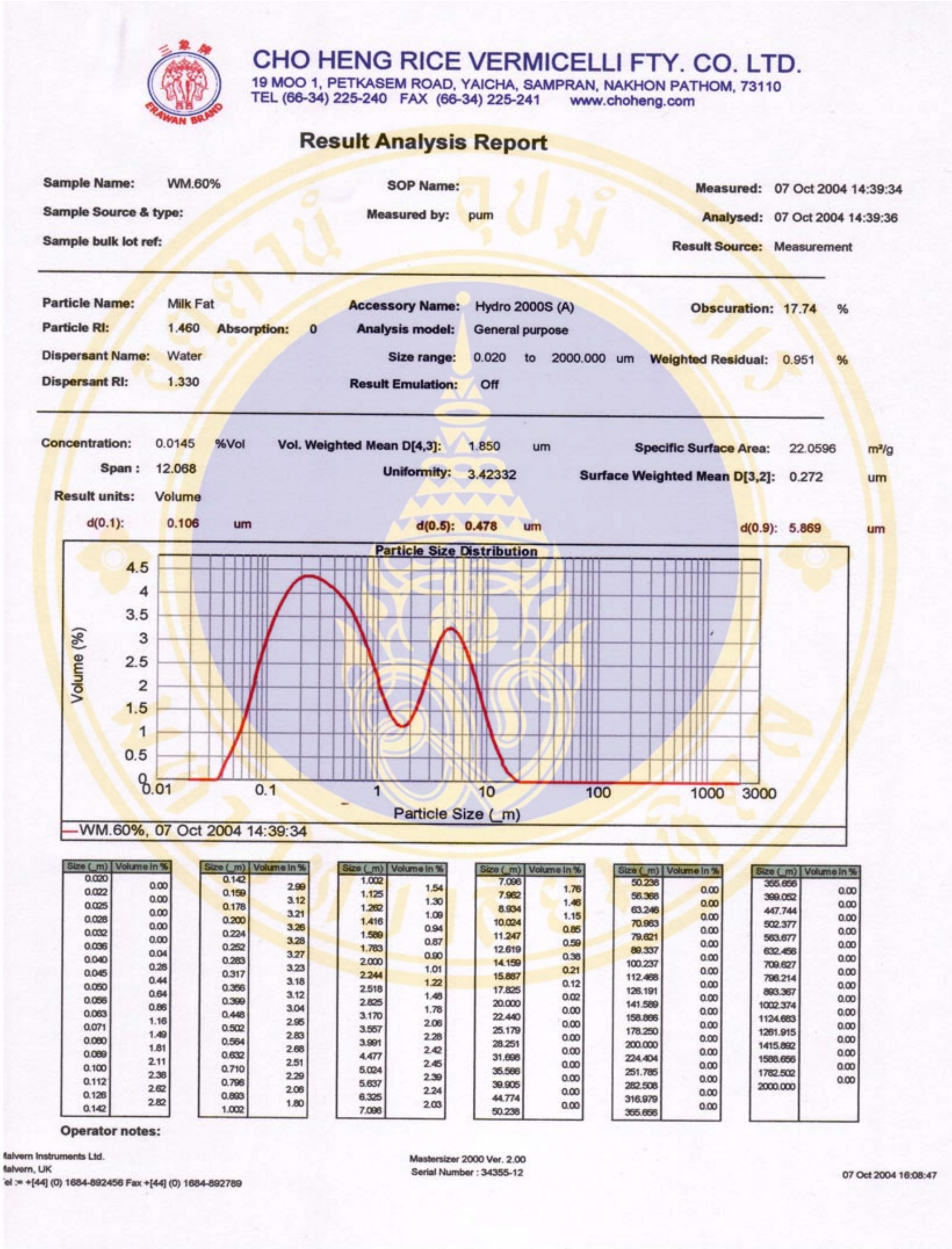
07 Oct 2004 16:08:37

Figure 35 Particle size in raw milk combined with 50% reconstituted WMP



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Result Analysis Report

Sample Name: WM.60% **SOP Name:** **Measured:** 07 Oct 2004 14:39:34
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 14:39:36
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.74 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.951 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0145 %Vol **Vol. Weighted Mean D[4,3]:** 1.850 um **Specific Surface Area:** 22.0596 m²/g
Span : 12.068 **Uniformity:** 3.42332 **Surface Weighted Mean D[3,2]:** 0.272 um
Result units: Volume
d(0.1): 0.106 um d(0.5): 0.478 um d(0.9): 5.869 um

Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.04
0.040	0.28
0.045	0.44
0.050	0.64
0.056	0.86
0.063	1.16
0.071	1.49
0.080	1.81
0.089	2.11
0.100	2.38
0.112	2.62
0.126	2.82
0.142	

Size (_m)	Volume In %
0.142	2.99
0.159	3.12
0.178	3.21
0.200	3.26
0.224	3.28
0.252	3.27
0.283	3.23
0.317	3.18
0.356	3.12
0.399	3.04
0.448	2.95
0.502	2.83
0.564	2.68
0.632	2.51
0.710	2.29
0.796	2.06
0.893	1.80
1.002	

Size (_m)	Volume In %
1.002	1.54
1.125	1.30
1.262	1.09
1.416	0.94
1.589	0.87
1.783	0.90
2.000	1.01
2.244	1.22
2.518	1.48
2.825	1.78
3.170	2.06
3.557	2.28
3.991	2.42
4.477	2.45
5.024	2.39
5.637	2.24
6.325	2.03
7.096	

Size (_m)	Volume In %
7.096	1.76
7.962	1.46
8.934	1.15
10.024	0.85
11.247	0.59
12.619	0.38
14.159	0.21
15.887	0.12
17.825	0.02
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

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Malvern, UK
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Figure 36 Particle size in raw milk combined with 60% reconstituted WMP

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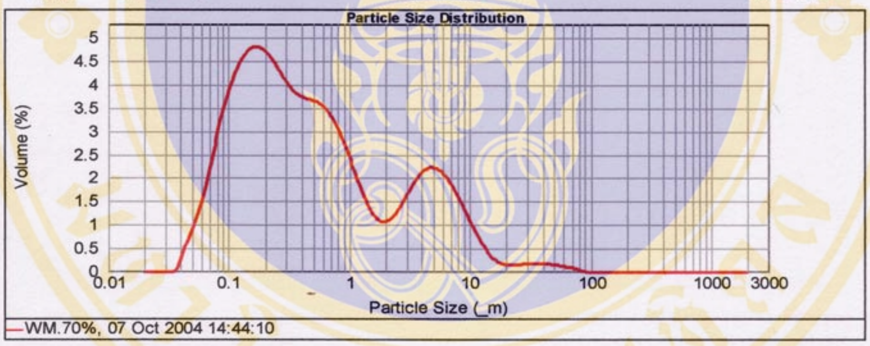
Result Analysis Report

Sample Name: WM.70% **SOP Name:** **Measured:** 07 Oct 2004 14:44:10
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 14:44:11
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.40 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 1.775 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0159 %Vol **Vol. Weighted Mean D[4,3]:** 2.045 um **Specific Surface Area:** 25.9472 m²/g
Span : 14.353 **Uniformity:** 4.89714 **Surface Weighted Mean D[3,2]:** 0.231 um
Result units: Volume
d(0.1): 0.094 um d(0.5): 0.382 um d(0.9): 5.572 um



Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %
0.020	0.00	0.142	3.57	1.002	1.72	7.096	1.30	50.238	0.10	355.656	0.00
0.022	0.00	0.159	3.62	1.125	1.47	7.962	1.11	56.368	0.09	399.052	0.00
0.025	0.00	0.178	3.59	1.262	1.22	8.934	0.91	63.246	0.07	447.744	0.00
0.028	0.00	0.200	3.51	1.416	1.01	10.024	0.71	70.963	0.06	502.377	0.00
0.032	0.00	0.224	3.37	1.589	0.87	11.247	0.52	79.621	0.01	563.677	0.00
0.036	0.06	0.252	3.21	1.783	0.81	12.619	0.37	89.337	0.00	632.456	0.00
0.040	0.37	0.283	3.06	2.000	0.82	14.159	0.26	100.237	0.00	709.627	0.00
0.045	0.59	0.317	2.93	2.244	0.91	15.887	0.18	112.468	0.00	796.214	0.00
0.050	0.85	0.356	2.84	2.518	1.05	17.825	0.13	126.191	0.00	893.367	0.00
0.056	1.15	0.399	2.79	2.825	1.22	20.000	0.11	141.589	0.00	1002.374	0.00
0.063	1.54	0.448	2.76	3.170	1.39	22.440	0.11	158.866	0.00	1124.683	0.00
0.071	1.96	0.502	2.73	3.557	1.54	25.179	0.12	178.250	0.00	1261.915	0.00
0.080	2.36	0.564	2.67	3.991	1.64	28.251	0.13	200.000	0.00	1415.892	0.00
0.089	2.73	0.632	2.56	4.477	1.68	31.698	0.14	224.404	0.00	1588.656	0.00
0.100	3.03	0.710	2.40	5.024	1.66	35.566	0.14	251.785	0.00	1782.502	0.00
0.112	3.28	0.796	2.20	5.637	1.58	39.905	0.13	282.508	0.00	2000.000	
0.126	3.46	0.893	1.96	6.325	1.46	44.774	0.12	316.979	0.00		
0.142		1.002		7.096		50.238		355.656			

Operator notes:

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Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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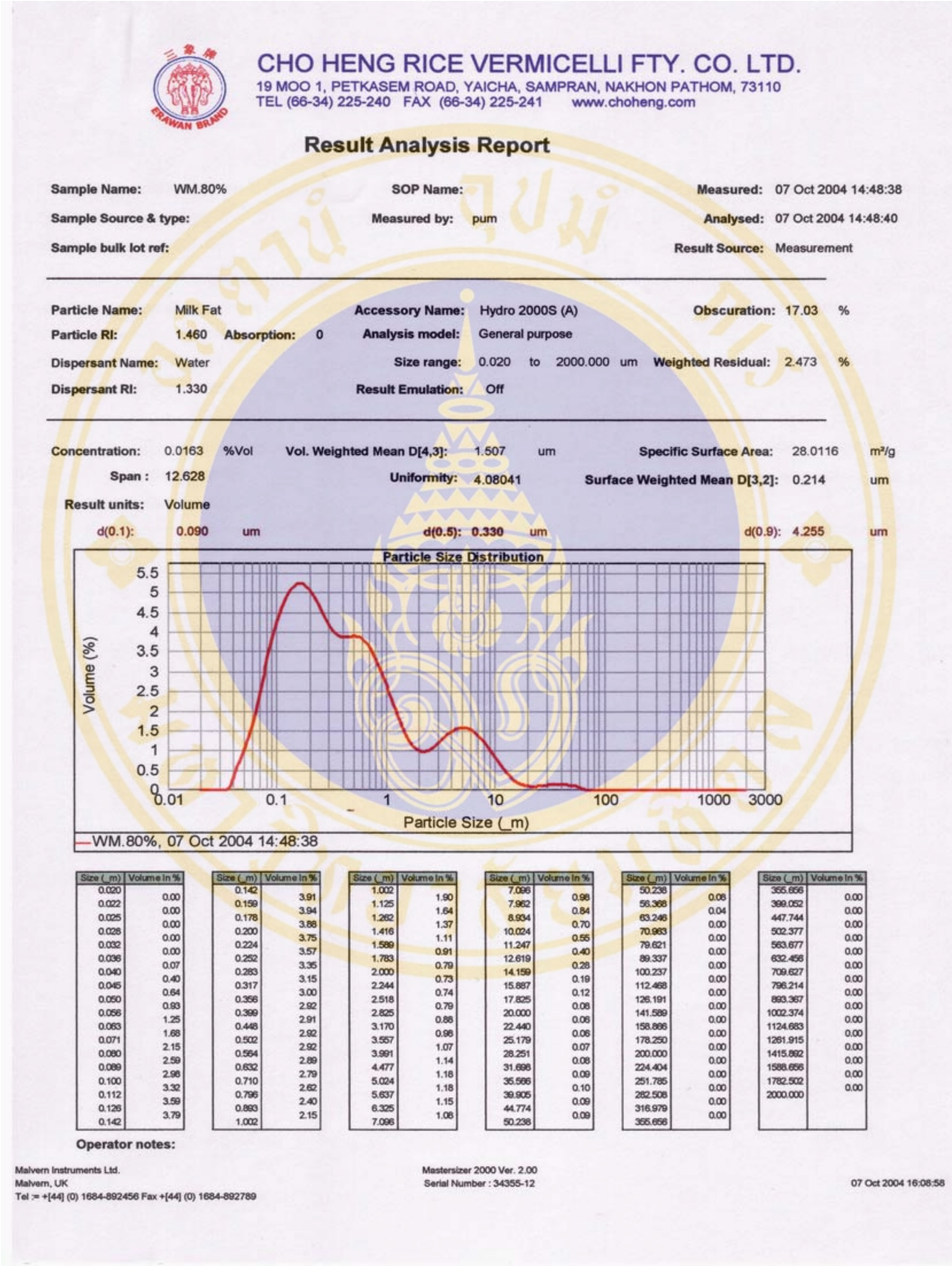
07 Oct 2004 16:08:52

Figure 37 Particle size in raw milk combined with 70% reconstituted WMP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Result Analysis Report

Sample Name: WM.80% SOP Name: Measured: 07 Oct 2004 14:48:38
Sample Source & type: Measured by: pum Analysed: 07 Oct 2004 14:48:40
Sample bulk lot ref: Result Source: Measurement

Particle Name: Milk Fat Accessory Name: Hydro 2000S (A) Obscuration: 17.03 %
Particle RI: 1.460 Absorption: 0 Analysis model: General purpose
Dispersant Name: Water Size range: 0.020 to 2000.000 um Weighted Residual: 2.473 %
Dispersant RI: 1.330 Result Emulation: Off

Concentration: 0.0163 %Vol Vol. Weighted Mean D[4,3]: 1.507 um Specific Surface Area: 28.0116 m²/g
Span : 12.628 Uniformity: 4.08041 Surface Weighted Mean D[3,2]: 0.214 um
Result units: Volume
d(0.1): 0.090 um d(0.5): 0.330 um d(0.9): 4.255 um

Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %
0.020	0.00	0.142	3.91	1.002	1.90	7.096	0.98	50.238	0.06	355.656	0.00
0.022	0.00	0.159	3.94	1.125	1.64	7.962	0.84	56.368	0.04	399.052	0.00
0.025	0.00	0.178	3.88	1.262	1.37	8.934	0.70	63.246	0.00	447.744	0.00
0.028	0.00	0.200	3.75	1.416	1.11	10.024	0.55	70.963	0.00	502.377	0.00
0.032	0.00	0.224	3.57	1.589	0.91	11.247	0.40	79.621	0.00	563.677	0.00
0.036	0.07	0.252	3.35	1.783	0.79	12.619	0.28	89.337	0.00	632.456	0.00
0.040	0.40	0.283	3.15	2.000	0.73	14.159	0.19	100.237	0.00	709.627	0.00
0.045	0.64	0.317	3.00	2.244	0.74	15.887	0.12	112.468	0.00	796.214	0.00
0.050	0.93	0.356	2.92	2.518	0.79	17.825	0.08	126.191	0.00	893.367	0.00
0.056	1.25	0.399	2.91	2.825	0.88	20.000	0.06	141.589	0.00	1002.374	0.00
0.063	1.68	0.448	2.92	3.170	0.98	22.440	0.06	158.866	0.00	1124.683	0.00
0.071	2.15	0.502	2.92	3.557	1.07	25.179	0.07	178.250	0.00	1261.915	0.00
0.080	2.59	0.564	2.89	3.991	1.14	28.251	0.08	200.000	0.00	1415.892	0.00
0.089	2.98	0.632	2.79	4.477	1.18	31.698	0.09	224.404	0.00	1588.656	0.00
0.100	3.32	0.710	2.62	5.024	1.18	35.566	0.10	251.785	0.00	1782.502	0.00
0.112	3.59	0.796	2.40	5.637	1.15	39.905	0.09	282.508	0.00	2000.000	
0.126	3.79	0.893	2.15	6.325	1.08	44.774	0.09	316.979	0.00		
0.142		1.002		7.096		50.238		355.656			

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:08:58

Figure 38 Particle size in raw milk combined with 80% reconstituted WMP

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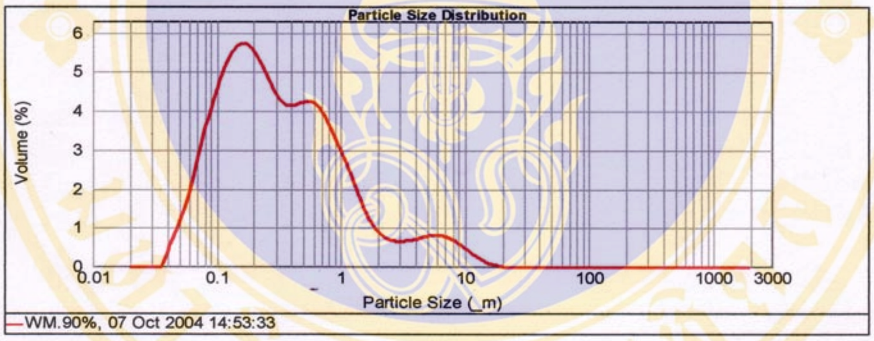
Result Analysis Report

Sample Name: WM.90% **SOP Name:** **Measured:** 07 Oct 2004 14:53:33
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 14:53:34
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.93 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.109 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0171 %Vol **Vol. Weighted Mean D[4,3]:** 0.851 um **Specific Surface Area:** 30.3707 m²/g
Span : 5.419 **Uniformity:** 2.48099 **Surface Weighted Mean D[3,2]:** 0.198 um
Result units: Volume
d(0.1): 0.087 um **d(0.5): 0.284** um d(0.9): 1.624 um



Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %
0.020	0.00	0.142	4.28	1.002	2.11	7.096	0.56	50.238	0.00	355.656	0.00
0.022	0.00	0.159	4.31	1.125	1.83	7.962	0.50	56.368	0.00	399.052	0.00
0.025	0.00	0.178	4.24	1.262	1.52	8.934	0.42	63.246	0.00	447.744	0.00
0.028	0.00	0.200	4.08	1.416	1.21	10.024	0.33	70.963	0.00	502.377	0.00
0.032	0.00	0.224	3.86	1.589	0.95	11.247	0.24	79.621	0.00	563.677	0.00
0.036	0.07	0.252	3.60	1.783	0.77	12.619	0.16	89.337	0.00	632.456	0.00
0.040	0.44	0.283	3.36	2.000	0.64	14.159	0.09	100.237	0.00	709.627	0.00
0.045	0.70	0.317	3.19	2.244	0.54	15.887	0.05	112.468	0.00	796.214	0.00
0.050	1.01	0.356	3.11	2.518	0.50	17.825	0.01	126.191	0.00	893.367	0.00
0.056	1.36	0.399	3.11	2.825	0.49	20.000	0.00	141.589	0.00	1002.374	0.00
0.063	1.83	0.448	3.16	3.170	0.50	22.440	0.00	158.866	0.00	1124.683	0.00
0.071	2.33	0.502	3.19	3.557	0.52	25.179	0.00	178.250	0.00	1261.915	0.00
0.080	2.82	0.564	3.17	3.991	0.55	28.251	0.00	200.000	0.00	1415.892	0.00
0.089	3.26	0.632	3.07	4.477	0.58	31.698	0.00	224.404	0.00	1588.656	0.00
0.100	3.63	0.710	2.88	5.024	0.61	35.566	0.00	251.785	0.00	1782.502	0.00
0.112	3.93	0.796	2.63	5.637	0.61	39.905	0.00	282.508	0.00	2000.000	
0.126	4.15	0.893	2.37	6.325	0.60	44.774	0.00	316.979	0.00		
0.142		1.002		7.096		50.238		355.656			

Operator notes:

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Malvern, UK
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07 Oct 2004 16:09:04

Figure 39 Particle size in raw milk combined with 90% reconstituted WMP

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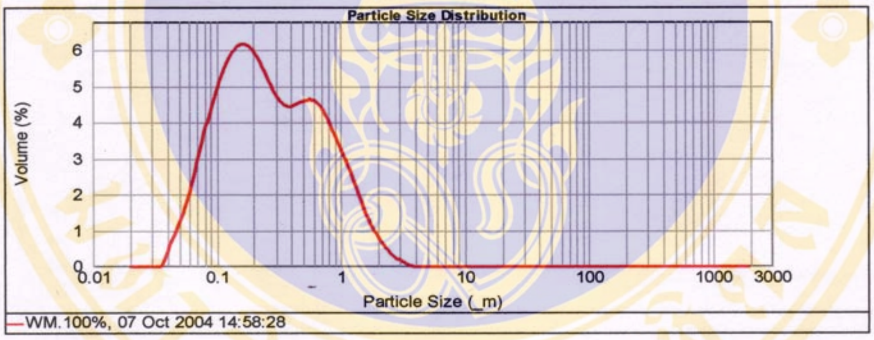
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: WM.100% **SOP Name:** **Measured:** 07 Oct 2004 14:58:28
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 14:58:29
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.80 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.639 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0180 %Vol **Vol. Weighted Mean D[4,3]:** 0.431 um **Specific Surface Area:** 32.5664 m²/g
Span : 3.672 **Uniformity:** 1.15403 **Surface Weighted Mean D[3,2]:** 0.184 um
Result units: Volume
d(0.1): 0.085 um **d(0.5): 0.253** um d(0.9): 1.016 um



Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %
0.020	0.00	0.142	4.61	1.002	2.31	7.096	0.00	50.238	0.00	355.656	0.00
0.022	0.00	0.159	4.64	1.125	2.00	7.962	0.00	56.368	0.00	399.052	0.00
0.025	0.00	0.178	4.57	1.262	1.65	8.934	0.00	63.246	0.00	447.744	0.00
0.028	0.00	0.200	4.39	1.416	1.29	10.024	0.00	70.963	0.00	502.377	0.00
0.032	0.00	0.224	4.14	1.589	0.98	11.247	0.00	79.621	0.00	563.677	0.00
0.036	0.07	0.252	3.85	1.783	0.74	12.619	0.00	89.337	0.00	632.456	0.00
0.040	0.47	0.283	3.60	2.000	0.54	14.159	0.00	100.237	0.00	709.627	0.00
0.045	0.75	0.317	3.41	2.244	0.36	15.887	0.00	112.468	0.00	796.214	0.00
0.050	1.08	0.356	3.34	2.518	0.24	17.825	0.00	126.191	0.00	893.367	0.00
0.056	1.46	0.399	3.35	2.825	0.12	20.000	0.00	141.589	0.00	1002.374	0.00
0.063	1.96	0.448	3.42	3.170	0.06	22.440	0.00	158.866	0.00	1124.683	0.00
0.071	2.51	0.502	3.47	3.557	0.00	25.179	0.00	178.250	0.00	1261.915	0.00
0.080	3.03	0.564	3.46	3.991	0.00	28.251	0.00	200.000	0.00	1415.892	0.00
0.089	3.50	0.632	3.37	4.477	0.00	31.698	0.00	224.404	0.00	1588.656	0.00
0.100	3.90	0.710	3.17	5.024	0.00	35.566	0.00	251.785	0.00	1782.502	0.00
0.112	4.23	0.796	2.90	5.637	0.00	39.905	0.00	282.508	0.00	2000.000	
0.126	4.47	0.893	2.61	6.325	0.00	44.774	0.00	316.979	0.00		
0.142		1.002		7.096		50.238		355.656			

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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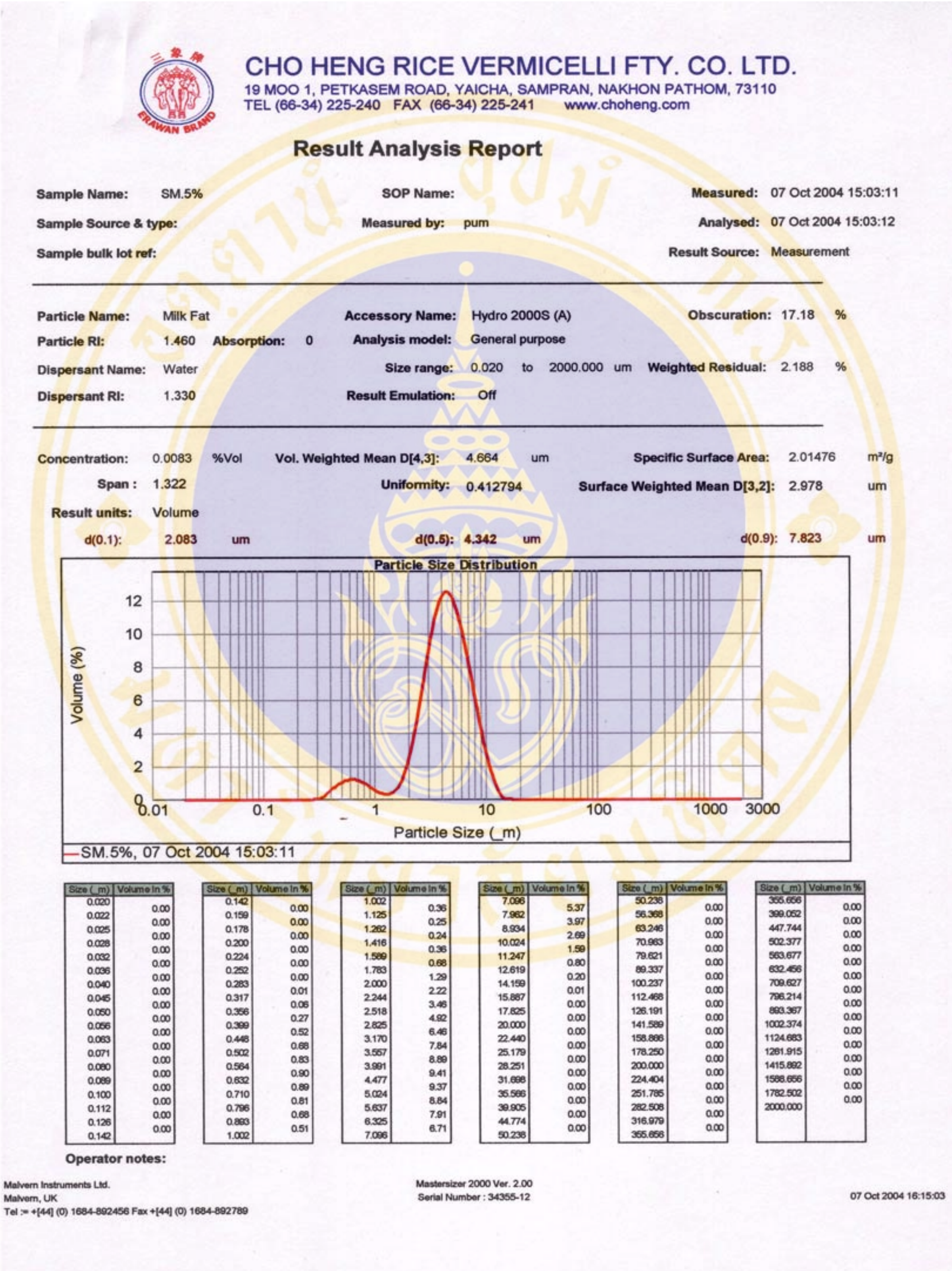
07 Oct 2004 16:09:12

Figure 40 Particle size in raw milk combined with 100% reconstituted WMP

2. Particle size in raw milk combined with reconstituted skimmed milk powder



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TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: SM.5% SOP Name: Measured: 07 Oct 2004 15:03:11
Sample Source & type: Measured by: pum Analysed: 07 Oct 2004 15:03:12
Sample bulk lot ref: Result Source: Measurement

Particle Name: Milk Fat Accessory Name: Hydro 2000S (A) Obscuration: 17.18 %
Particle RI: 1.460 Absorption: 0 Analysis model: General purpose
Dispersant Name: Water Size range: 0.020 to 2000.000 um Weighted Residual: 2.188 %
Dispersant RI: 1.330 Result Emulation: Off

Concentration: 0.0083 %Vol Vol. Weighted Mean D[4,3]: 4.664 um Specific Surface Area: 2.01476 m²/g
Span : 1.322 Uniformity: 0.412794 Surface Weighted Mean D[3,2]: 2.978 um
Result units: Volume
d(0.1): 2.083 um d(0.5): 4.342 um d(0.9): 7.823 um

Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.00
0.050	0.00
0.056	0.00
0.063	0.00
0.071	0.00
0.080	0.00
0.089	0.00
0.100	0.00
0.112	0.00
0.126	0.00
0.142	

Size (_m)	Volume In %
0.142	0.00
0.159	0.00
0.178	0.00
0.200	0.00
0.224	0.00
0.252	0.00
0.283	0.01
0.317	0.06
0.356	0.27
0.399	0.52
0.448	0.68
0.502	0.83
0.564	0.90
0.632	0.89
0.710	0.81
0.796	0.68
0.893	0.51
1.002	

Size (_m)	Volume In %
1.002	0.36
1.125	0.25
1.262	0.24
1.416	0.36
1.589	0.68
1.783	1.29
2.000	2.22
2.244	3.46
2.518	4.92
2.825	6.46
3.170	7.84
3.557	8.89
3.991	9.41
4.477	9.37
5.024	8.84
5.637	7.91
6.325	6.71
7.096	

Size (_m)	Volume In %
7.096	5.37
7.962	3.97
8.934	2.69
10.024	1.59
11.247	0.80
12.619	0.20
14.159	0.01
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:15:03

Figure 41 Particle size in raw milk combined with 5% reconstituted SMP

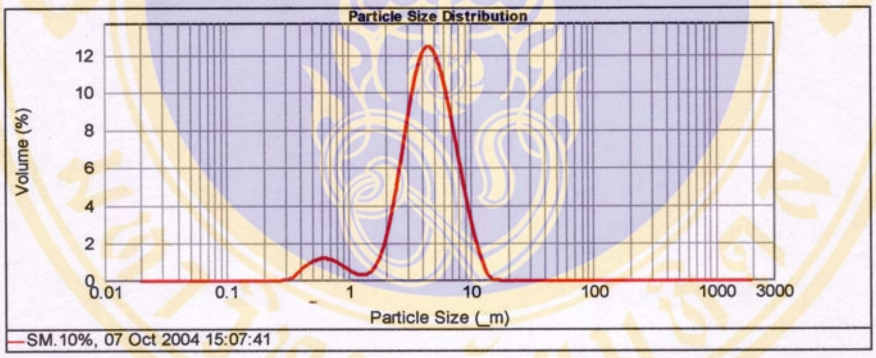
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: SM.10% **SOP Name:** **Measured:** 07 Oct 2004 15:07:41
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 15:07:43
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.06 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.828 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0084 %Vol **Vol. Weighted Mean D[4,3]:** 4.739 um **Specific Surface Area:** 1.99576 m^2/g
Span : 1.335 **Uniformity:** 0.418384 **Surface Weighted Mean D[3,2]:** 3.006 um
Result units: Volume
d(0.1): 2.108 um **d(0.5): 4.397** um **d(0.9):** 7.980 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.00
0.050	0.00
0.056	0.00
0.063	0.00
0.071	0.00
0.080	0.00
0.089	0.00
0.100	0.00
0.112	0.00
0.126	0.00
0.142	

Size (_m)	Volume In %
0.142	0.00
0.159	0.00
0.178	0.00
0.200	0.00
0.224	0.00
0.252	0.00
0.283	0.01
0.317	0.08
0.356	0.28
0.399	0.52
0.448	0.68
0.502	0.82
0.564	0.88
0.632	0.88
0.710	0.80
0.796	0.66
0.893	0.50
1.002	

Size (_m)	Volume In %
1.002	0.35
1.125	0.24
1.262	0.22
1.416	0.34
1.589	0.65
1.783	1.24
2.000	2.15
2.244	3.36
2.518	4.79
2.825	6.31
3.170	7.68
3.557	8.74
3.991	9.29
4.477	9.30
5.024	8.82
5.637	7.96
6.325	6.82
7.096	

Size (_m)	Volume In %
7.096	5.53
7.962	4.16
8.934	2.89
10.024	1.77
11.247	0.95
12.619	0.28
14.159	0.05
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:14:58

Figure 42 Particle size in raw milk combined with 10% reconstituted SMP

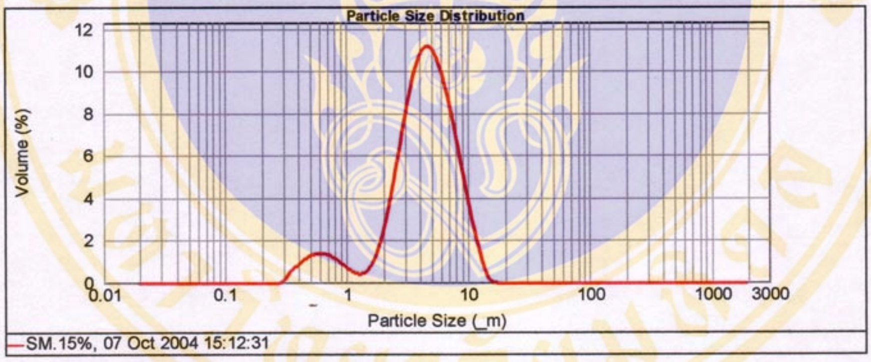
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: SM.15% **SOP Name:** **Measured:** 07 Oct 2004 15:12:31
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 15:12:32
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.12 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.926 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0086 %Vol **Vol. Weighted Mean D[4,3]:** 4.782 um **Specific Surface Area:** 2.21194 m²/g
Span : 1.528 **Uniformity:** 0.46433 **Surface Weighted Mean D[3,2]:** 2.713 um
Result units: Volume
d(0.1): 1.677 um d(0.5): 4.403 um d(0.9): 8.402 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.00
0.050	0.00
0.056	0.00
0.063	0.00
0.071	0.00
0.080	0.00
0.089	0.00
0.100	0.00
0.112	0.00
0.126	0.00
0.142	

Size (_m)	Volume In %
0.142	0.00
0.159	0.00
0.178	0.00
0.200	0.00
0.224	0.00
0.252	0.00
0.283	0.03
0.317	0.36
0.356	0.56
0.399	0.74
0.448	0.91
0.502	1.01
0.564	1.05
0.632	1.03
0.710	0.94
0.796	0.80
0.893	0.63
1.002	

Size (_m)	Volume In %
1.002	0.46
1.125	0.34
1.262	0.33
1.416	0.48
1.589	0.84
1.783	1.45
2.000	2.32
2.244	3.39
2.518	4.61
2.825	5.85
3.170	6.96
3.557	7.82
3.991	8.31
4.477	8.41
5.024	8.13
5.637	7.55
6.325	6.71
7.096	

Size (_m)	Volume In %
7.096	5.70
7.962	4.55
8.934	3.40
10.024	2.30
11.247	1.37
12.619	0.57
14.159	0.08
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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Serial Number : 34355-12

07 Oct 2004 16:14:52

Figure 43 Particle size in raw milk combined with 15% reconstituted SMP

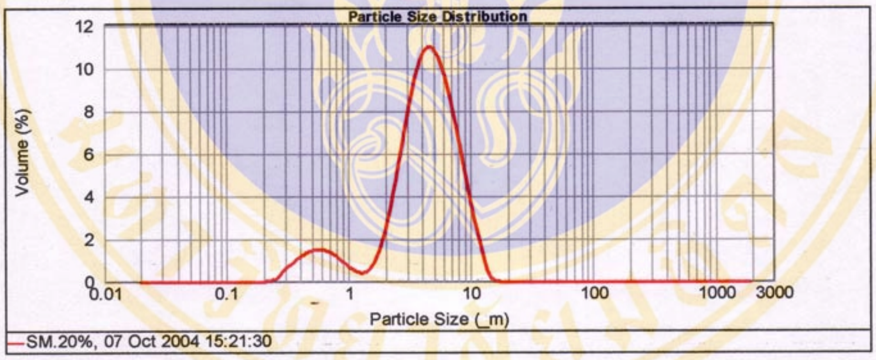
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: SM.20% **SOP Name:** **Measured:** 07 Oct 2004 15:21:30
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 15:21:31
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.44 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 1.240 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0088 %Vol **Vol. Weighted Mean D[4,3]:** 4.681 um **Specific Surface Area:** 2.47829 m²/g
Span : 1.676 **Uniformity:** 0.476032 **Surface Weighted Mean D[3,2]:** 2.421 um
Result units: Volume
d(0.1): 1.056 um **d(0.5): 4.333** um d(0.9): 8.317 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.00
0.050	0.00
0.056	0.00
0.063	0.00
0.071	0.00
0.080	0.00
0.089	0.00
0.100	0.00
0.112	0.00
0.126	0.00
0.142	

Size (_m)	Volume In %
0.142	0.00
0.159	0.00
0.178	0.00
0.200	0.00
0.224	0.05
0.252	0.17
0.283	0.43
0.317	0.61
0.356	0.79
0.399	0.95
0.448	1.06
0.502	1.12
0.564	1.13
0.632	1.08
0.710	0.96
0.796	0.81
0.893	0.62
1.002	

Size (_m)	Volume In %
1.002	0.45
1.125	0.33
1.262	0.32
1.416	0.47
1.589	0.84
1.783	1.44
2.000	2.29
2.244	3.35
2.518	4.55
2.825	5.77
3.170	6.86
3.557	7.71
3.991	8.19
4.477	8.28
5.024	8.00
5.637	7.41
6.325	6.58
7.096	

Size (_m)	Volume In %
7.096	5.57
7.962	4.44
8.934	3.30
10.024	2.21
11.247	1.34
12.619	0.44
14.159	0.09
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:14:46

Figure 44 Particle size in raw milk combined with 20% reconstituted SMP

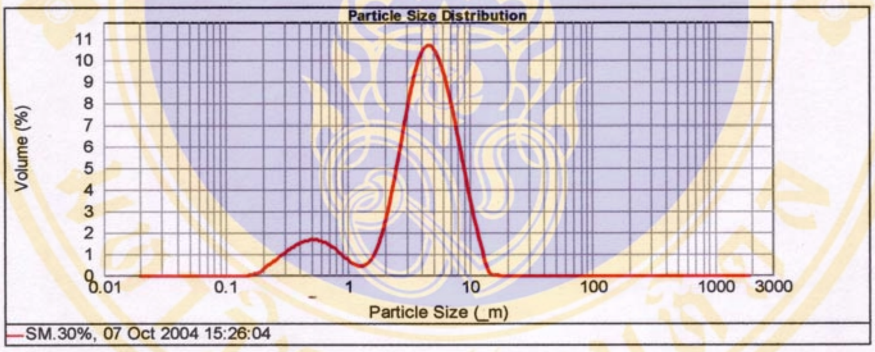
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: SM.30% **SOP Name:** **Measured:** 07 Oct 2004 15:26:04
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 15:26:05
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.23 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.925 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0088 %Vol **Vol. Weighted Mean D[4,3]:** 4.510 um **Specific Surface Area:** 3.03413 m²/g
Span : 1.780 **Uniformity:** 0.502242 **Surface Weighted Mean D[3,2]:** 1.978 um
Result units: Volume
d(0.1): 0.688 um d(0.5): 4.214 um d(0.9): 8.188 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.00
0.050	0.00
0.056	0.00
0.063	0.00
0.071	0.00
0.080	0.00
0.089	0.00
0.100	0.00
0.112	0.00
0.126	0.00
0.142	

Size (_m)	Volume In %
0.142	0.00
0.159	0.03
0.178	0.11
0.200	0.29
0.224	0.45
0.252	0.61
0.283	0.78
0.317	0.93
0.356	1.07
0.399	1.17
0.448	1.24
0.502	1.25
0.564	1.22
0.632	1.13
0.710	0.99
0.796	0.82
0.893	0.63
1.002	

Size (_m)	Volume In %
1.002	0.46
1.125	0.34
1.262	0.34
1.416	0.48
1.589	0.84
1.783	1.42
2.000	2.24
2.244	3.27
2.518	4.42
2.825	5.60
3.170	6.65
3.557	7.47
3.991	7.93
4.477	8.02
5.024	7.74
5.637	7.17
6.325	6.35
7.096	

Size (_m)	Volume In %
7.096	5.37
7.962	4.27
8.934	3.15
10.024	2.09
11.247	1.24
12.619	0.36
14.159	0.03
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:14:40

Figure 45 Particle size in raw milk combined with 30% reconstituted SMP

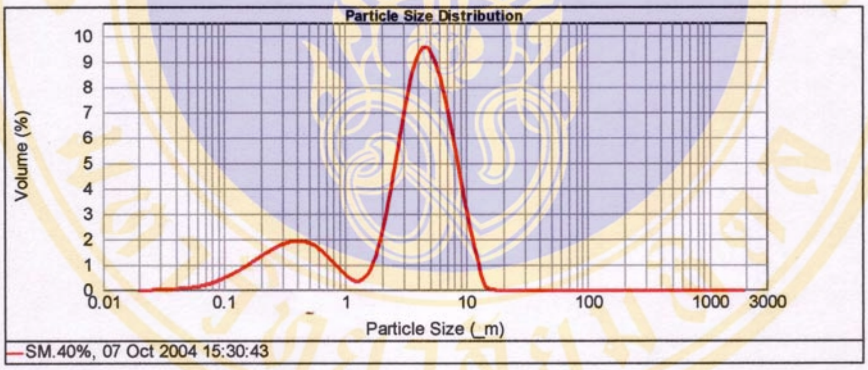
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: SM.40% **SOP Name:** **Measured:** 07 Oct 2004 15:30:43
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 15:30:44
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.05 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.911 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0095 %Vol **Vol. Weighted Mean D[4,3]:** 4.071 um **Specific Surface Area:** 6.42192 m²/g
Span : 1.976 **Uniformity:** 0.591557 **Surface Weighted Mean D[3,2]:** 0.934 um
Result units: Volume
d(0.1): 0.318 um **d(0.5):** 3.868 um **d(0.9):** 7.958 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.01
0.032	0.02
0.036	0.03
0.040	0.04
0.045	0.06
0.050	0.08
0.056	0.10
0.063	0.14
0.071	0.19
0.080	0.25
0.089	0.32
0.100	0.40
0.112	0.49
0.126	0.59
0.142	

Size (_m)	Volume In %
0.142	0.70
0.159	0.82
0.178	0.93
0.200	1.05
0.224	1.17
0.252	1.27
0.283	1.35
0.317	1.42
0.356	1.46
0.399	1.46
0.448	1.43
0.502	1.36
0.564	1.25
0.632	1.10
0.710	0.92
0.796	0.72
0.893	0.53
1.002	

Size (_m)	Volume In %
1.002	0.37
1.125	0.28
1.262	0.29
1.416	0.44
1.589	0.77
1.783	1.31
2.000	2.05
2.244	2.97
2.518	4.00
2.825	5.06
3.170	6.00
3.557	6.72
3.991	7.13
4.477	7.19
5.024	6.93
5.637	6.41
6.325	5.66
7.096	

Size (_m)	Volume In %
7.096	4.80
7.962	3.81
8.934	2.81
10.024	1.87
11.247	1.11
12.619	0.34
14.159	0.05
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

Mastersizer 2000 Ver. 2.00
Serial Number : 34355-12

07 Oct 2004 16:14:24

Figure 46 Particle size in raw milk combined with 40% reconstituted SMP

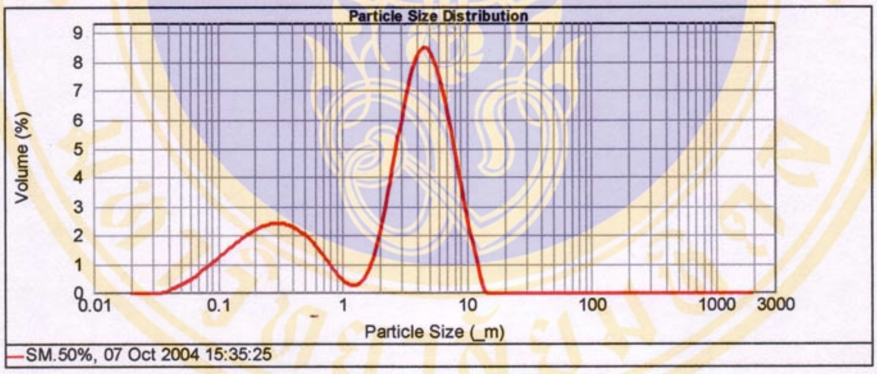
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: SM.50% **SOP Name:** **Measured:** 07 Oct 2004 15:35:25
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 15:35:26
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.91 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 1.032 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0103 %Vol **Vol. Weighted Mean D[4,3]:** 3.620 um **Specific Surface Area:** 10.5297 m²/g
Span : 2.171 **Uniformity:** 0.69956 **Surface Weighted Mean D[3,2]:** 0.570 um
Result units: Volume
d(0.1): 0.183 um d(0.5): 3.452 um d(0.9): 7.679 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.10
0.045	0.16
0.050	0.24
0.056	0.32
0.063	0.44
0.071	0.57
0.080	0.71
0.089	0.85
0.100	0.98
0.112	1.12
0.126	1.25
0.142	

Size (_m)	Volume In %
0.142	1.37
0.159	1.49
0.178	1.59
0.200	1.68
0.224	1.75
0.252	1.80
0.283	1.82
0.317	1.81
0.356	1.76
0.399	1.69
0.448	1.57
0.502	1.43
0.564	1.25
0.632	1.05
0.710	0.83
0.796	0.62
0.893	0.43
1.002	

Size (_m)	Volume In %
1.002	0.28
1.125	0.20
1.262	0.22
1.416	0.37
1.589	0.68
1.783	1.16
2.000	1.83
2.244	2.65
2.518	3.56
2.825	4.50
3.170	5.32
3.557	5.97
3.991	6.32
4.477	6.38
5.024	6.15
5.637	5.69
6.325	5.04
7.096	

Size (_m)	Volume In %
7.096	4.26
7.962	3.38
8.934	2.49
10.024	1.65
11.247	1.00
12.619	0.23
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:14:18

Figure 47 Particle size in raw milk combined with 50% reconstituted SMP

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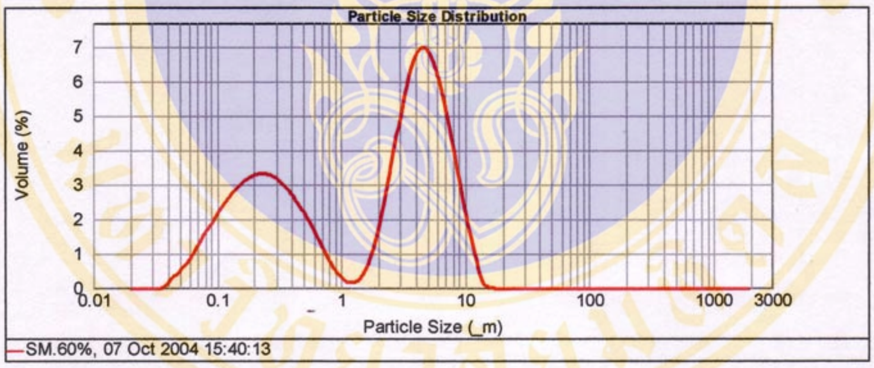
ERAWAN BRAND

Result Analysis Report

Sample Name: SM.60% **SOP Name:** **Measured:** 07 Oct 2004 15:40:13
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 15:40:15
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.48 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 1.081 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0123 %Vol **Vol. Weighted Mean D[4,3]:** 3.060 um **Specific Surface Area:** 15.9941 m²/g
Span : 2.690 **Uniformity:** 0.936863 **Surface Weighted Mean D[3,2]:** 0.375 um
Result units: Volume
d(0.1): 0.126 um d(0.5): 2.675 um d(0.9): 7.322 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.02
0.040	0.20
0.045	0.31
0.050	0.45
0.056	0.61
0.063	0.83
0.071	1.07
0.080	1.30
0.089	1.53
0.100	1.73
0.112	1.92
0.126	2.09
0.142	

Size (_m)	Volume In %
0.142	2.24
0.159	2.35
0.178	2.44
0.200	2.49
0.224	2.50
0.252	2.48
0.283	2.41
0.317	2.30
0.356	2.16
0.399	1.97
0.448	1.76
0.502	1.52
0.564	1.26
0.632	1.00
0.710	0.74
0.796	0.51
0.893	0.31
1.002	

Size (_m)	Volume In %
1.002	0.18
1.125	0.11
1.262	0.15
1.416	0.29
1.589	0.57
1.783	0.98
2.000	1.53
2.244	2.20
2.518	2.95
2.825	3.72
3.170	4.39
3.557	4.92
3.991	5.21
4.477	5.26
5.024	5.08
5.637	4.71
6.325	4.18
7.096	

Size (_m)	Volume In %
7.096	3.54
7.962	2.82
8.934	2.10
10.024	1.40
11.247	0.85
12.619	0.27
14.159	0.05
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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Serial Number : 34355-12

07 Oct 2004 16:14:13

Figure 48 Particle size in raw milk combined with 60% reconstituted SMP

CHO HENG RICE VERMICELLI FTY. CO. LTD.
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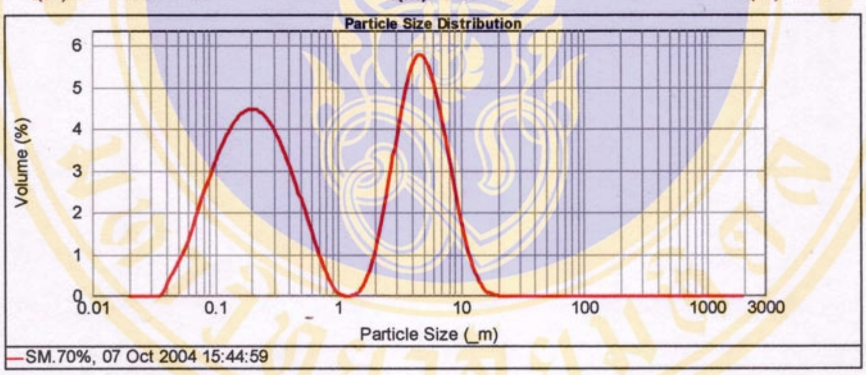
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: SM.70% **SOP Name:** **Measured:** 07 Oct 2004 15:44:59
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 15:45:00
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.88 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 0.782 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0147 %Vol **Vol. Weighted Mean D[4,3]:** 2.542 um **Specific Surface Area:** 21.9249 m²/g
Span : 13.727 **Uniformity:** 4.71177 **Surface Weighted Mean D[3,2]:** 0.274 um
Result units: Volume
d(0.1): 0.102 um d(0.5): 0.496 um d(0.9): 6.910 um



Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %
0.020	0.00	0.142	3.19	1.002	0.01	7.096	2.87	50.238	0.00	355.656	0.00
0.022	0.00	0.159	3.30	1.125	0.00	7.962	2.26	56.368	0.00	399.052	0.00
0.025	0.00	0.178	3.36	1.262	0.00	8.934	1.67	63.246	0.00	447.744	0.00
0.028	0.00	0.200	3.36	1.416	0.08	10.024	1.14	70.963	0.00	502.377	0.00
0.032	0.00	0.224	3.31	1.589	0.26	11.247	0.70	79.621	0.00	563.677	0.00
0.036	0.04	0.252	3.19	1.783	0.56	12.619	0.39	89.337	0.00	632.456	0.00
0.040	0.30	0.283	3.03	2.000	0.98	14.159	0.17	100.237	0.00	709.627	0.00
0.045	0.48	0.317	2.81	2.244	1.52	15.887	0.05	112.468	0.00	796.214	0.00
0.050	0.69	0.356	2.54	2.518	2.16	17.825	0.01	126.191	0.00	893.367	0.00
0.056	0.94	0.399	2.24	2.825	2.84	20.000	0.00	141.589	0.00	1002.374	0.00
0.063	1.26	0.448	1.90	3.170	3.47	22.440	0.00	158.866	0.00	1124.683	0.00
0.071	1.62	0.502	1.55	3.557	3.97	25.179	0.00	178.250	0.00	1261.915	0.00
0.080	1.98	0.564	1.20	3.991	4.27	28.251	0.00	200.000	0.00	1415.892	0.00
0.089	2.28	0.632	0.86	4.477	4.35	31.698	0.00	224.404	0.00	1588.656	0.00
0.100	2.57	0.710	0.56	5.024	4.20	35.566	0.00	251.785	0.00	1782.502	0.00
0.112	2.82	0.796	0.30	5.637	3.88	39.905	0.00	282.508	0.00	2000.000	
0.126	3.02	0.893	0.10	6.325	3.42	44.774	0.00	316.979	0.00		
0.142		1.002		7.096		50.238		355.656			

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
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07 Oct 2004 16:14:06

Figure 49 Particle size in raw milk combined with 70% reconstituted SMP

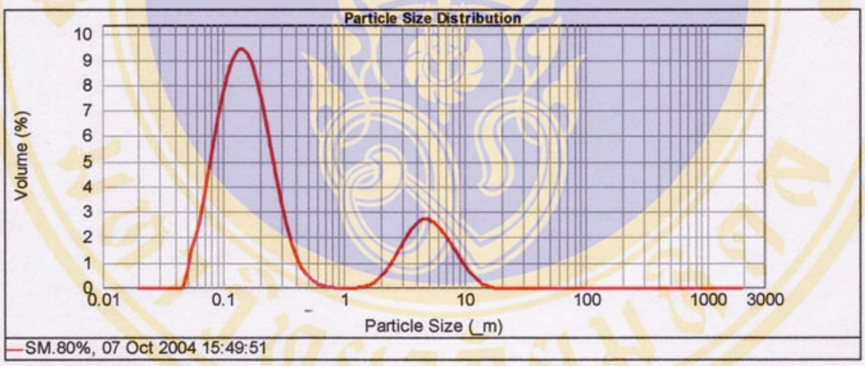
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: SM.80% **SOP Name:** **Measured:** 07 Oct 2004 15:49:51
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 15:49:52
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.51 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 1.133 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0296 %Vol **Vol. Weighted Mean D[4,3]:** 1.246 um **Specific Surface Area:** 36.35 m²/g
Span : 28.137 **Uniformity:** 6.55287 **Surface Weighted Mean D[3,2]:** 0.165 um
Result units: Volume
d(0.1): 0.084 um d(0.5): 0.173 um d(0.9): 4.942 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.02
0.050	0.99
0.056	1.55
0.063	2.35
0.071	3.37
0.080	4.39
0.089	5.35
0.100	6.14
0.112	6.73
0.126	7.06
0.142	

Size (_m)	Volume In %
0.142	7.09
0.159	6.81
0.178	6.26
0.200	5.47
0.224	4.55
0.252	3.57
0.283	2.65
0.317	1.85
0.356	1.22
0.399	0.76
0.448	0.45
0.502	0.25
0.564	0.13
0.632	0.06
0.710	0.02
0.796	0.00
0.893	0.00
1.002	

Size (_m)	Volume In %
1.002	0.00
1.125	0.00
1.262	0.00
1.416	0.04
1.589	0.11
1.783	0.24
2.000	0.42
2.244	0.67
2.518	0.96
2.825	1.29
3.170	1.59
3.557	1.85
3.991	2.00
4.477	2.05
5.024	1.99
5.637	1.84
6.325	1.62
7.096	

Size (_m)	Volume In %
7.096	1.36
7.962	1.06
8.934	0.78
10.024	0.52
11.247	0.33
12.619	0.15
14.159	0.07
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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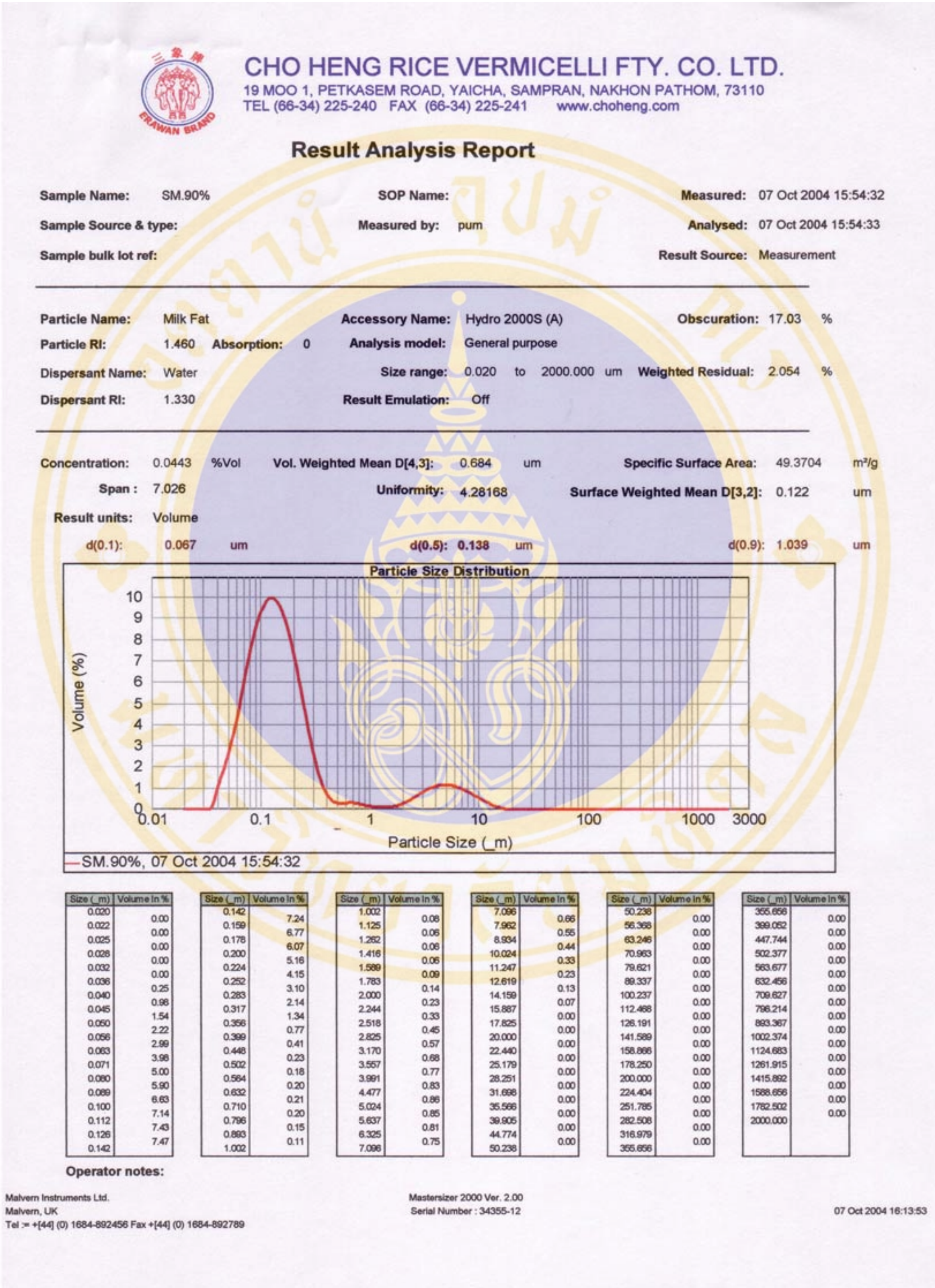
Serial Number : 34355-12

07 Oct 2004 16:13:59

Figure 50 Particle size in raw milk combined with 80% reconstituted SMP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19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: SM.90% **SOP Name:** **Measured:** 07 Oct 2004 15:54:32
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 15:54:33
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.03 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 2.054 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0443 %Vol **Vol. Weighted Mean D[4,3]:** 0.684 um **Specific Surface Area:** 49.3704 m²/g
Span : 7.026 **Uniformity:** 4.28168 **Surface Weighted Mean D[3,2]:** 0.122 um
Result units: Volume
d(0.1): 0.067 um d(0.5): 0.138 um d(0.9): 1.039 um

Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.25
0.040	0.98
0.045	1.54
0.050	2.22
0.056	2.99
0.063	3.98
0.071	5.00
0.080	5.90
0.089	6.63
0.100	7.14
0.112	7.43
0.126	7.47
0.142	

Size (_m)	Volume In %
0.142	7.24
0.159	6.77
0.178	6.07
0.200	5.16
0.224	4.15
0.252	3.10
0.283	2.14
0.317	1.34
0.356	0.77
0.399	0.41
0.448	0.23
0.502	0.18
0.564	0.20
0.632	0.21
0.710	0.20
0.796	0.15
0.893	0.11
1.002	

Size (_m)	Volume In %
1.002	0.08
1.125	0.06
1.262	0.06
1.416	0.06
1.589	0.09
1.783	0.14
2.000	0.23
2.244	0.33
2.518	0.45
2.825	0.57
3.170	0.68
3.557	0.77
3.991	0.83
4.477	0.86
5.024	0.85
5.637	0.81
6.325	0.75
7.096	

Size (_m)	Volume In %
7.096	0.66
7.962	0.55
8.934	0.44
10.024	0.33
11.247	0.23
12.619	0.13
14.159	0.07
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:13:53

Figure 51 Particle size in raw milk combined with 90% reconstituted SMP

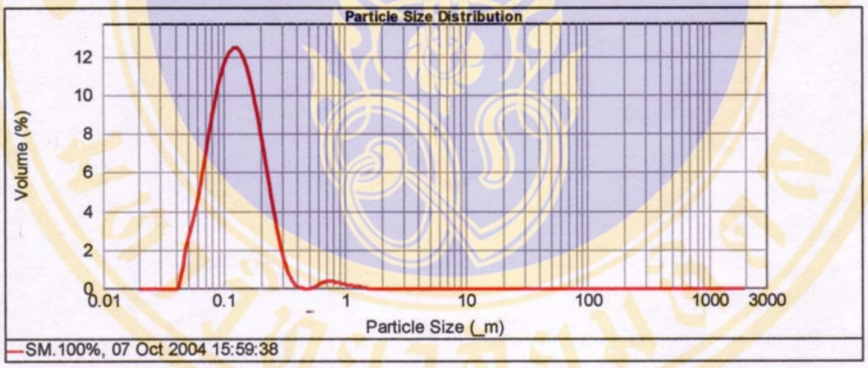
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: SM.100% **SOP Name:** **Measured:** 07 Oct 2004 15:59:38
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 15:59:39
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.56 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.007 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0952 %Vol **Vol. Weighted Mean D[4,3]:** 0.145 um **Specific Surface Area:** 53.7427 m²/g
Span : 1.269 **Uniformity:** 0.457442 **Surface Weighted Mean D[3,2]:** 0.112 um
Result units: Volume
d(0.1): 0.069 um **d(0.5):** 0.124 um **d(0.9):** 0.227 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	1.36
0.050	2.29
0.056	3.23
0.063	4.52
0.071	5.94
0.080	7.22
0.089	8.26
0.100	8.97
0.112	9.33
0.126	9.29
0.142	

Size (_m)	Volume In %
0.142	8.84
0.159	8.01
0.178	6.86
0.200	5.47
0.224	4.02
0.252	2.62
0.283	1.48
0.317	0.66
0.356	0.20
0.399	0.02
0.448	0.00
0.502	0.00
0.564	0.15
0.632	0.25
0.710	0.28
0.796	0.25
0.893	0.19
1.002	

Size (_m)	Volume In %
1.002	0.14
1.125	0.09
1.262	0.06
1.416	0.00
1.589	0.00
1.783	0.00
2.000	0.00
2.244	0.00
2.518	0.00
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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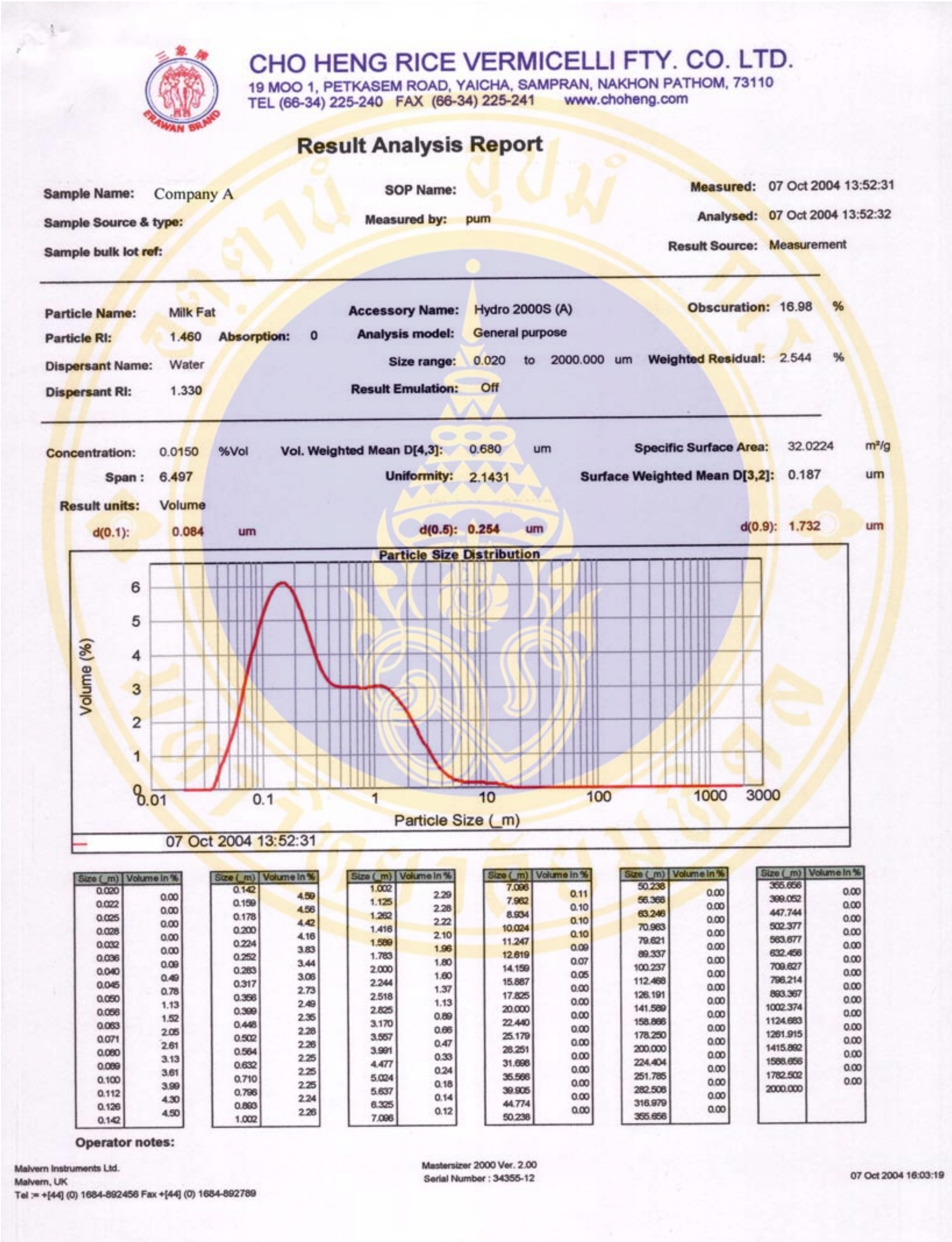
07 Oct 2004 16:13:44

Figure 52 Particle size in raw milk combined with 100% reconstituted SMP

3. Particle size in pasteurized milk purchased from supermarkets in Bangkok



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19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: Company A
SOP Name:
Measured: 07 Oct 2004 13:52:31
Sample Source & type:
Measured by: pum
Analysed: 07 Oct 2004 13:52:32
Sample bulk lot ref:
Result Source: Measurement

Particle Name: Milk Fat
Accessory Name: Hydro 2000S (A)
Obscuration: 16.98 %
Particle RI: 1.460 Absorption: 0
Analysis model: General purpose
Dispersant Name: Water
Size range: 0.020 to 2000.000 um
Weighted Residual: 2.544 %
Dispersant RI: 1.330
Result Emulation: Off

Concentration: 0.0150 %Vol
Vol. Weighted Mean D[4,3]: 0.680 um
Specific Surface Area: 32.0224 m²/g
Span : 6.497
Uniformity: 2.1431
Surface Weighted Mean D[3,2]: 0.187 um
Result units: Volume
d(0.1): 0.084 um
d(0.5): 0.254 um
d(0.9): 1.732 um

Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.09
0.040	0.49
0.045	0.78
0.050	1.13
0.056	1.52
0.063	2.05
0.071	2.61
0.080	3.13
0.089	3.61
0.100	3.99
0.112	4.30
0.126	4.50
0.142	

Size (_m)	Volume In %
0.142	4.59
0.159	4.56
0.178	4.42
0.200	4.16
0.224	3.83
0.252	3.44
0.283	3.06
0.317	2.73
0.356	2.49
0.399	2.35
0.448	2.28
0.502	2.26
0.564	2.25
0.632	2.25
0.710	2.25
0.796	2.24
0.893	2.26
1.002	

Size (_m)	Volume In %
1.002	2.29
1.125	2.28
1.262	2.22
1.416	2.10
1.589	1.96
1.783	1.80
2.000	1.60
2.244	1.37
2.518	1.13
2.825	0.89
3.170	0.66
3.557	0.47
3.991	0.33
4.477	0.24
5.024	0.18
5.637	0.14
6.325	0.12
7.096	

Size (_m)	Volume In %
7.096	0.11
7.962	0.10
8.934	0.10
10.024	0.10
11.247	0.09
12.619	0.07
14.159	0.05
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel :=+[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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Serial Number : 34355-12

07 Oct 2004 16:03:19

Figure 53 Particle size in pasteurized milk of company A

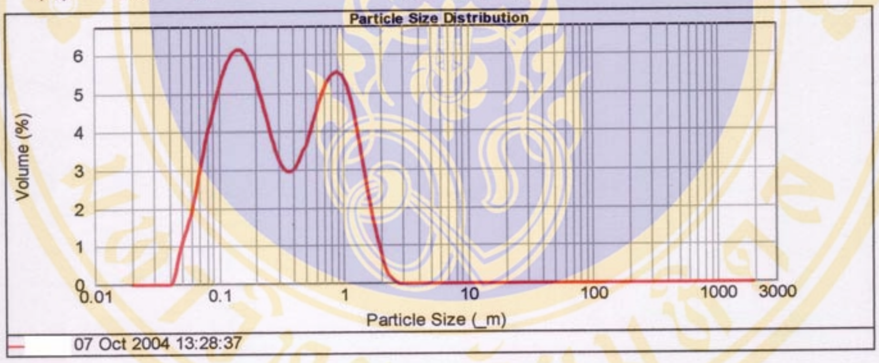
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: Company B
Sample Source & type:
Sample bulk lot ref:
SOP Name:
Measured by: pum
Measured: 07 Oct 2004 13:28:37
Analysed: 07 Oct 2004 13:28:38
Result Source: Measurement

Particle Name: Milk Fat
Particle RI: 1.460 **Absorption:** 0
Dispersant Name: Water
Dispersant RI: 1.330
Accessory Name: Hydro 2000S (A)
Analysis model: General purpose
Size range: 0.020 to 2000.000 um
Result Emulation: Off
Obscuration: 16.99 %
Weighted Residual: 3.342 %

Concentration: 0.0154 %Vol
Span : 3.921
Result units: Volume
Vol. Weighted Mean D[4,3]: 0.491 um
Uniformity: 1.25329
Specific Surface Area: 30.0745 m²/g
Surface Weighted Mean D[3,2]: 0.200 um
d(0.1): 0.088 um
d(0.5): 0.278 um
d(0.9): 1.177 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.00
0.040	0.00
0.045	0.53
0.050	0.95
0.056	1.34
0.063	1.89
0.071	2.52
0.080	3.11
0.089	3.65
0.100	4.08
0.112	4.39
0.126	4.57
0.142	

Size (_m)	Volume In %
0.142	4.60
0.159	4.48
0.178	4.21
0.200	3.82
0.224	3.37
0.252	2.91
0.283	2.53
0.317	2.28
0.356	2.21
0.399	2.32
0.448	2.59
0.502	2.95
0.564	3.35
0.632	3.72
0.710	4.00
0.796	4.14
0.893	4.13
1.002	

Size (_m)	Volume In %
1.002	3.92
1.125	3.50
1.262	2.88
1.416	2.15
1.589	1.45
1.783	0.90
2.000	0.41
2.244	0.14
2.518	0.01
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:02:44

Figure 54 Particle size in pasteurized milk of company B

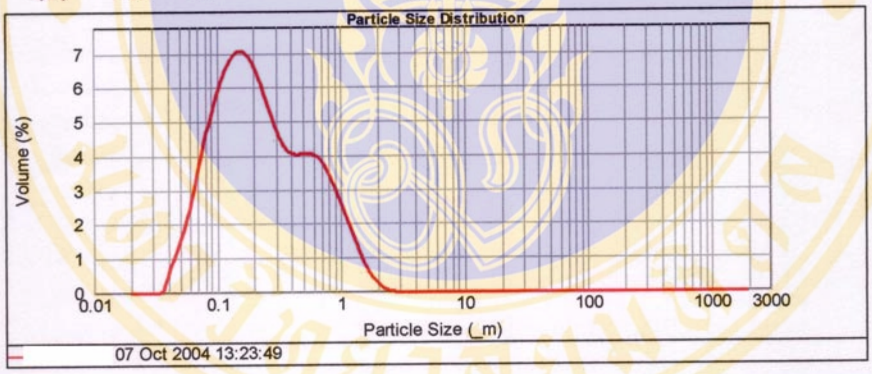
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: Company C **SOP Name:** **Measured:** 07 Oct 2004 13:23:49
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 13:23:50
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.10 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.864 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0233 %Vol **Vol. Weighted Mean D[4,3]:** 0.344 um **Specific Surface Area:** 36.8306 m²/g
Span : 3.546 **Uniformity:** 1.06922 **Surface Weighted Mean D[3,2]:** 0.163 um
Result units: Volume
d(0.1): 0.079 um **d(0.5):** 0.208 um **d(0.9):** 0.816 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.10
0.040	0.57
0.045	0.91
0.050	1.31
0.056	1.77
0.063	2.38
0.071	3.03
0.080	3.64
0.089	4.18
0.100	4.63
0.112	4.98
0.126	5.20
0.142	

Size (_m)	Volume In %
0.142	5.30
0.159	5.27
0.178	5.10
0.200	4.80
0.224	4.43
0.252	4.00
0.283	3.61
0.317	3.30
0.356	3.11
0.399	3.04
0.448	3.03
0.502	3.05
0.564	3.03
0.632	2.93
0.710	2.73
0.796	2.45
0.893	2.12
1.002	

Size (_m)	Volume In %
1.002	1.79
1.125	1.44
1.262	1.08
1.416	0.74
1.589	0.46
1.783	0.28
2.000	0.13
2.244	0.05
2.518	0.00
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:02:37

Figure 55 Particle size in pasteurized milk of company C

CHO HENG RICE VERMICELLI FTY. CO. LTD.

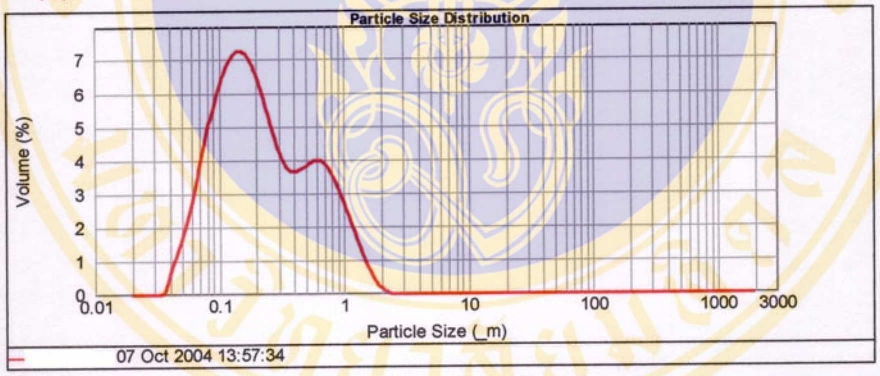
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: Company D
SOP Name:
Measured: 07 Oct 2004 13:57:34
Sample Source & type:
Measured by: pum
Analysed: 07 Oct 2004 13:57:35
Sample bulk lot ref:
Result Source: Measurement

Particle Name: Milk Fat
Accessory Name: Hydro 2000S (A)
Obscuration: 17.17 %
Particle RI: 1.460 **Absorption:** 0
Analysis model: General purpose
Dispersant Name: Water
Size range: 0.020 to 2000.000 um
Weighted Residual: 3.999 %
Dispersant RI: 1.330
Result Emulation: Off

Concentration: 0.0239 %Vol
Vol. Weighted Mean D[4,3]: 0.336 um
Specific Surface Area: 38.1384 m²/g
Span : 3.759
Uniformity: 1.1185
Surface Weighted Mean D[3,2]: 0.157 um
Result units: Volume
d(0.1): 0.077 um
d(0.5): 0.197 um
d(0.9): 0.817 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.12
0.040	0.62
0.045	0.99
0.050	1.43
0.056	1.92
0.063	2.58
0.071	3.27
0.080	3.91
0.089	4.47
0.100	4.91
0.112	5.23
0.126	5.41
0.142	

Size (_m)	Volume In %
0.142	5.45
0.159	5.33
0.178	5.07
0.200	4.67
0.224	4.19
0.252	3.69
0.283	3.24
0.317	2.92
0.356	2.75
0.399	2.74
0.448	2.82
0.502	2.93
0.564	3.00
0.632	2.97
0.710	2.80
0.796	2.53
0.893	2.20
1.002	

Size (_m)	Volume In %
1.002	1.84
1.125	1.47
1.262	1.09
1.416	0.72
1.589	0.44
1.783	0.20
2.000	0.09
2.244	0.00
2.518	0.00
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:03:24

Figure 56 Particle size in pasteurized milk of company D

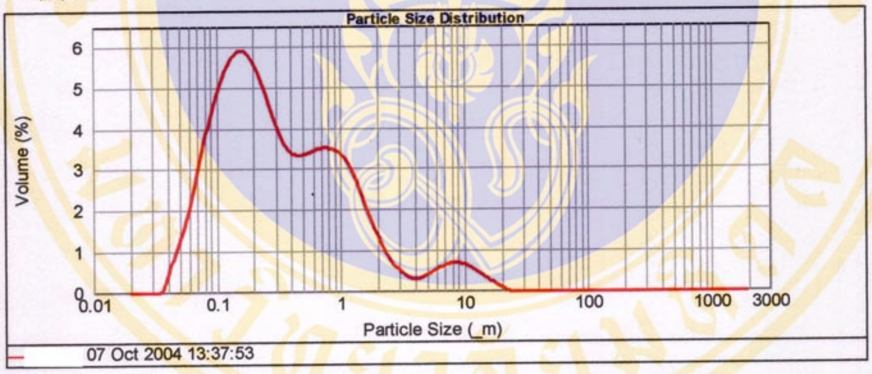
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: Company E
SOP Name:
Measured: 07 Oct 2004 13:37:53
Sample Source & type:
Measured by: pum
Analysed: 07 Oct 2004 13:37:54
Sample bulk lot ref:
Result Source: Measurement

Particle Name: Milk Fat
Accessory Name: Hydro 2000S (A)
Obscuration: 17.20 %
Particle RI: 1.460 **Absorption:** 0
Analysis model: General purpose
Dispersant Name: Water
Size range: 0.020 to 2000.000 um
Weighted Residual: 2.792 %
Dispersant RI: 1.330
Result Emulation: Off

Concentration: 0.0168 %Vol
Vol. Weighted Mean D[4,3]: 0.942 um
Specific Surface Area: 31.2433 m²/g
Span : 5.959
Uniformity: 2.99045
Surface Weighted Mean D[3,2]: 0.192 um
Result units: Volume
d(0.1): 0.085 um
d(0.5): 0.268 um
d(0.9): 1.681 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.06
0.040	0.48
0.045	0.75
0.050	1.09
0.056	1.47
0.063	1.97
0.071	2.51
0.080	3.02
0.089	3.47
0.100	3.84
0.112	4.13
0.126	4.33
0.142	

Size (_m)	Volume In %
0.142	4.43
0.159	4.41
0.178	4.29
0.200	4.07
0.224	3.77
0.252	3.43
0.283	3.10
0.317	2.82
0.356	2.62
0.399	2.52
0.448	2.50
0.502	2.53
0.564	2.58
0.632	2.62
0.710	2.64
0.796	2.62
0.893	2.57
1.002	

Size (_m)	Volume In %
1.002	2.47
1.125	2.30
1.262	2.05
1.416	1.75
1.589	1.44
1.783	1.17
2.000	0.93
2.244	0.70
2.518	0.52
2.825	0.38
3.170	0.29
3.557	0.24
3.991	0.23
4.477	0.28
5.024	0.34
5.637	0.41
6.325	0.46
7.096	

Size (_m)	Volume In %
7.096	0.51
7.962	0.52
8.934	0.51
10.024	0.47
11.247	0.41
12.619	0.34
14.159	0.26
15.887	0.18
17.825	0.10
20.000	0.04
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:03:01

Figure 57 Particle size in pasteurized milk of company E

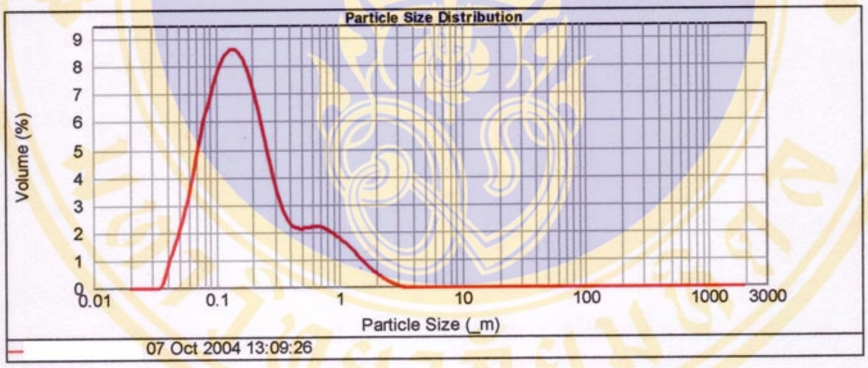
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: Company A (low-fat) **SOP Name:** **Measured:** 07 Oct 2004 13:09:26
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 13:09:27
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.72 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.271 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0287 %Vol **Vol. Weighted Mean D[4,3]:** 0.294 um **Specific Surface Area:** 43.9405 m²/g
Span : 4.102 **Uniformity:** 1.19749 **Surface Weighted Mean D[3,2]:** 0.137 um
Result units: Volume
d(0.1): 0.072 um **d(0.5): 0.161** um d(0.9): 0.731 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.17
0.040	0.79
0.045	1.24
0.050	1.79
0.056	2.42
0.063	3.23
0.071	4.08
0.080	4.85
0.089	5.51
0.100	6.00
0.112	6.34
0.126	6.48
0.142	

Size (_m)	Volume In %
0.142	6.43
0.159	6.17
0.178	5.72
0.200	5.10
0.224	4.37
0.252	3.60
0.283	2.88
0.317	2.30
0.356	1.90
0.399	1.68
0.448	1.60
0.502	1.61
0.564	1.65
0.632	1.66
0.710	1.61
0.796	1.51
0.893	1.40
1.002	

Size (_m)	Volume In %
1.002	1.27
1.125	1.13
1.262	0.96
1.416	0.77
1.589	0.60
1.783	0.45
2.000	0.33
2.244	0.21
2.518	0.13
2.825	0.04
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:02:02

Figure 58 Particle size in pasteurized low-fat milk of company A

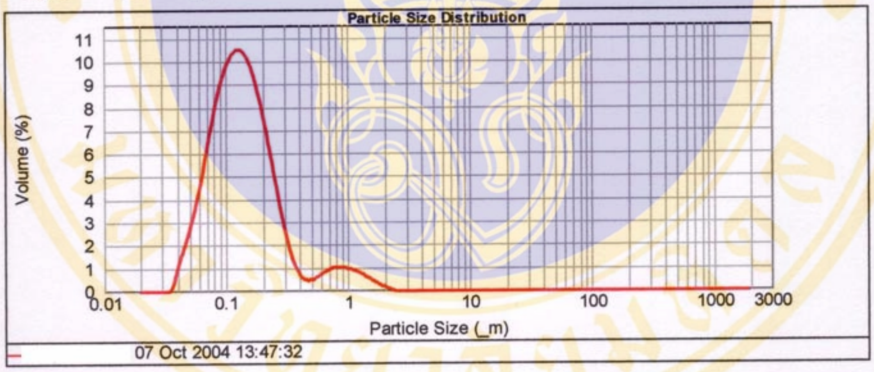
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: Company B (low-fat) **SOP Name:** **Measured:** 07 Oct 2004 13:47:32
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 13:47:33
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.41 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.003 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0483 %Vol **Vol. Weighted Mean D[4,3]:** 0.199 um **Specific Surface Area:** 52.4332 m²/g
Span : 1.819 **Uniformity:** 0.837294 **Surface Weighted Mean D[3,2]:** 0.114 um
Result units: Volume
d(0.1): 0.066 um d(0.5): 0.132 um d(0.9): 0.306 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.27
0.040	1.05
0.045	1.65
0.050	2.38
0.056	3.19
0.063	4.26
0.071	5.33
0.080	6.29
0.089	7.06
0.100	7.58
0.112	7.87
0.126	7.88
0.142	

Size (_m)	Volume In %
0.142	7.61
0.159	7.07
0.178	6.30
0.200	5.31
0.224	4.23
0.252	3.11
0.283	2.10
0.317	1.29
0.356	0.73
0.399	0.43
0.448	0.34
0.502	0.40
0.564	0.54
0.632	0.67
0.710	0.75
0.796	0.77
0.893	0.75
1.002	

Size (_m)	Volume In %
1.002	0.70
1.125	0.63
1.262	0.52
1.416	0.40
1.589	0.29
1.783	0.17
2.000	0.09
2.244	0.00
2.518	0.00
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:03:11

Figure 59 Particle size in pasteurized low-fat milk of company B

CHO HENG RICE VERMICELLI FTY. CO. LTD.

19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: Company C (low-fat) **SOP Name:** **Measured:** 07 Oct 2004 13:19:10

Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 13:19:11

Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.29 %

Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose

Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.823 %

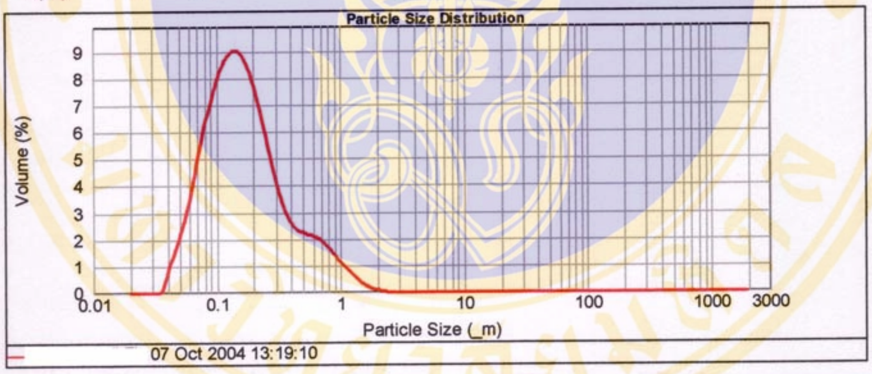
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0388 %Vol **Vol. Weighted Mean D[4,3]:** 0.237 um **Specific Surface Area:** 45.5578 m²/g

Span : 2.881 **Uniformity:** 0.875736 **Surface Weighted Mean D[3,2]:** 0.132 um

Result units: Volume

d(0.1): 0.071 um d(0.5): 0.156 um d(0.9): 0.520 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.17
0.040	0.81
0.045	1.28
0.050	1.84
0.056	2.48
0.063	3.32
0.071	4.20
0.080	5.00
0.089	5.70
0.100	6.23
0.112	6.60
0.126	6.78
0.142	

Size (_m)	Volume In %
0.142	6.76
0.159	6.53
0.178	6.10
0.200	5.49
0.224	4.76
0.252	3.96
0.283	3.22
0.317	2.59
0.356	2.14
0.399	1.86
0.448	1.71
0.502	1.64
0.564	1.59
0.632	1.51
0.710	1.36
0.796	1.16
0.893	0.95
1.002	

Size (_m)	Volume In %
1.002	0.76
1.125	0.59
1.262	0.42
1.416	0.26
1.589	0.15
1.783	0.07
2.000	0.04
2.244	0.00
2.518	0.00
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:02:32

Figure 60 Particle size in pasteurized low-fat milk of company C

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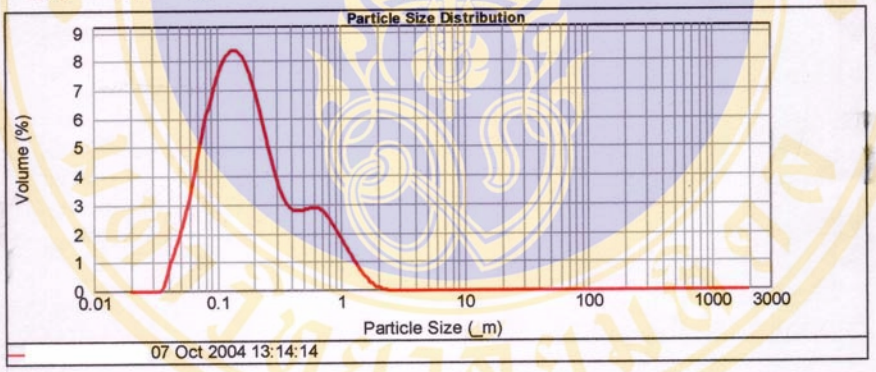
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: Company D (low-fat) **SOP Name:** **Measured:** 07 Oct 2004 13:14:14
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 13:14:15
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.93 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.799 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0305 %Vol **Vol. Weighted Mean D[4,3]:** 0.276 um **Specific Surface Area:** 43.2867 m²/g
Span : 3.643 **Uniformity:** 1.04395 **Surface Weighted Mean D[3,2]:** 0.139 um
Result units: Volume
d(0.1): 0.072 um d(0.5): 0.165 um d(0.9): 0.673 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.17
0.040	0.77
0.045	1.21
0.050	1.75
0.056	2.35
0.063	3.15
0.071	3.97
0.080	4.72
0.089	5.36
0.100	5.84
0.112	6.16
0.126	6.30
0.142	

Size (_m)	Volume In %
0.142	6.25
0.159	6.00
0.178	5.58
0.200	5.01
0.224	4.34
0.252	3.64
0.283	3.01
0.317	2.52
0.356	2.22
0.399	2.09
0.448	2.09
0.502	2.14
0.564	2.18
0.632	2.14
0.710	2.00
0.796	1.77
0.893	1.50
1.002	

Size (_m)	Volume In %
1.002	1.23
1.125	0.96
1.262	0.69
1.416	0.45
1.589	0.26
1.783	0.12
2.000	0.05
2.244	0.00
2.518	0.00
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

Mastersizer 2000 Ver. 2.00
Serial Number : 34355-12

07 Oct 2004 16:02:11

Figure 61 Particle size in pasteurized low-fat milk of company D

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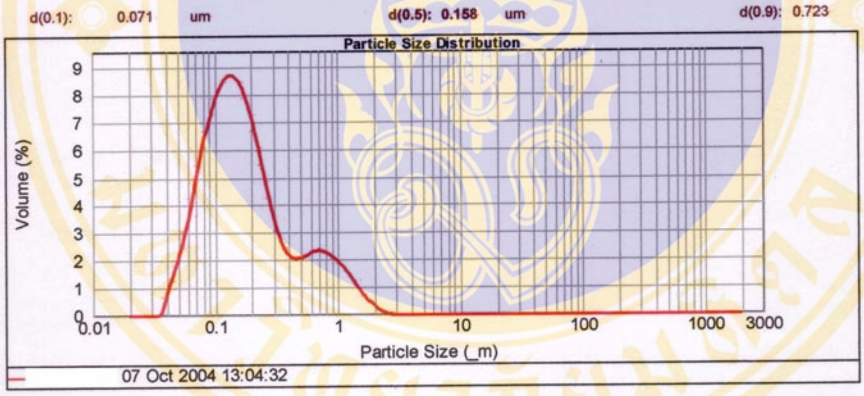
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: Company E (low-fat) **SOP Name:** **Measured:** 07 Oct 2004 13:04:32
Sample Source & type: **Measured by:** pum **Analysed:** 07 Oct 2004 13:04:33
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.87 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.0... um **Weighted Residual:** 3.441 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0299 %Vol **Vol. Weighted Mean D[4,3]:** 0.283 um **Specific Surface Area:** 44.5979 m²/g
Span : 4.130 **Uniformity:** 1.15448 **Surface Weighted Mean D[3,2]:** 0.135 um
Result units: Volume
d(0.1): 0.071 um d(0.5): 0.158 um d(0.9): 0.723 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.19
0.040	0.82
0.045	1.29
0.050	1.85
0.056	2.50
0.063	3.33
0.071	4.20
0.080	4.99
0.089	5.64
0.100	6.13
0.112	6.44
0.126	6.55
0.142	

Size (_m)	Volume In %
0.142	6.46
0.159	6.16
0.178	5.67
0.200	5.00
0.224	4.24
0.252	3.44
0.283	2.72
0.317	2.14
0.356	1.76
0.399	1.58
0.448	1.55
0.502	1.61
0.564	1.70
0.632	1.76
0.710	1.75
0.796	1.67
0.893	1.54
1.002	

Size (_m)	Volume In %
1.002	1.38
1.125	1.19
1.262	0.96
1.416	0.71
1.589	0.49
1.783	0.33
2.000	0.18
2.244	0.08
2.518	0.01
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

lvern Instruments Ltd.
lvern, UK
l := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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07 Oct 2004 16:01:54

Figure 62 Particle size in pasteurized low-fat milk of company E

4. Particle size in UHT milk samples purchased from supermarket in Bangkok

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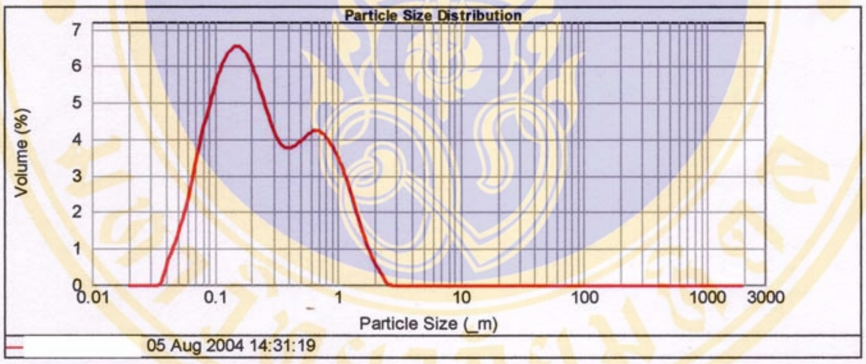
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: UHT company A **SOP Name:** **Measured:** 05 Aug 2004 14:31:19
Sample Source & type: **Measured by:** pum **Analysed:** 05 Aug 2004 14:31:20
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.49 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.581 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0185 %Vol **Vol. Weighted Mean D[4,3]:** 0.405 um **Specific Surface Area:** 34.6721 m²/g
Span : 4.023 **Uniformity:** 1.21776 **Surface Weighted Mean D[3,2]:** 0.173 um
Result units: Volume
d(0.1): 0.081 um d(0.5): 0.228 um d(0.9): 0.998 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.10
0.040	0.54
0.045	0.85
0.050	1.23
0.056	1.66
0.063	2.23
0.071	2.84
0.080	3.41
0.089	3.91
0.100	4.32
0.112	4.64
0.126	4.84
0.142	

Size (_m)	Volume In %
0.142	4.92
0.159	4.87
0.178	4.69
0.200	4.39
0.224	4.02
0.252	3.61
0.283	3.24
0.317	2.97
0.356	2.83
0.399	2.83
0.448	2.92
0.502	3.04
0.564	3.15
0.632	3.19
0.710	3.13
0.796	2.98
0.893	2.77
1.002	

Size (_m)	Volume In %
1.002	2.50
1.125	2.17
1.262	1.77
1.416	1.34
1.589	0.94
1.783	0.63
2.000	0.38
2.244	0.17
2.518	0.01
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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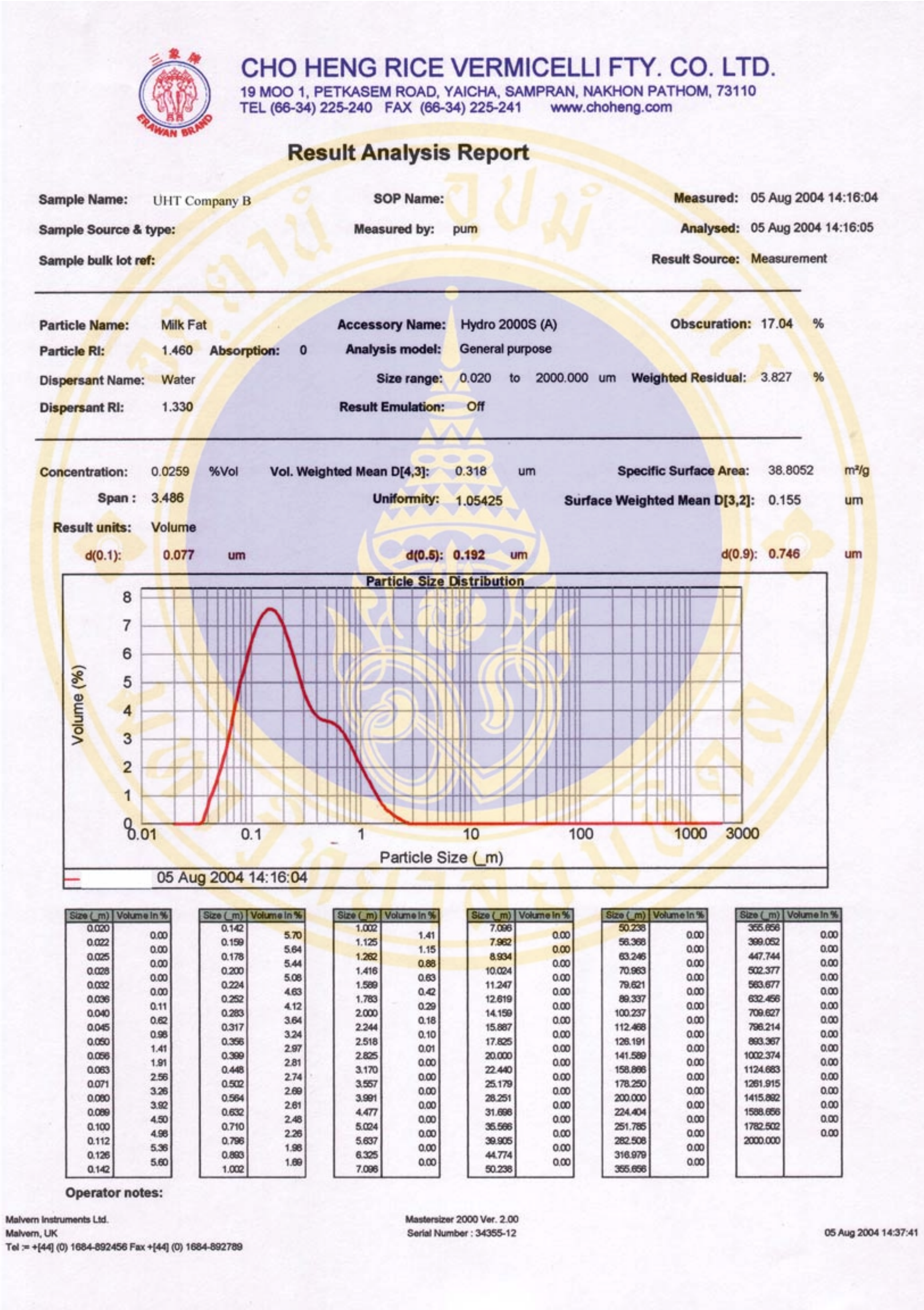
05 Aug 2004 14:37:29

Figure 63 Particle size in UHT milk of company A



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19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: UHT Company B **SOP Name:** **Measured:** 05 Aug 2004 14:16:04
Sample Source & type: **Measured by:** pum **Analysed:** 05 Aug 2004 14:16:05
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.04 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.827 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0259 %Vol **Vol. Weighted Mean D[4,3]:** 0.318 um **Specific Surface Area:** 38.8052 m²/g
Span : 3.486 **Uniformity:** 1.05425 **Surface Weighted Mean D[3,2]:** 0.155 um
Result units: Volume
d(0.1): 0.077 um d(0.5): 0.192 um d(0.9): 0.746 um

Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.11
0.040	0.62
0.045	0.98
0.050	1.41
0.056	1.91
0.063	2.56
0.071	3.26
0.080	3.92
0.089	4.50
0.100	4.98
0.112	5.36
0.126	5.60
0.142	

Size (_m)	Volume In %
0.142	5.70
0.159	5.64
0.178	5.44
0.200	5.08
0.224	4.63
0.252	4.12
0.283	3.64
0.317	3.24
0.356	2.97
0.399	2.81
0.448	2.74
0.502	2.69
0.564	2.61
0.632	2.48
0.710	2.26
0.796	1.98
0.893	1.69
1.002	

Size (_m)	Volume In %
1.002	1.41
1.125	1.15
1.262	0.88
1.416	0.63
1.589	0.42
1.783	0.29
2.000	0.18
2.244	0.10
2.518	0.01
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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05 Aug 2004 14:37:41

Figure 64 Particle size in UHT milk of company B

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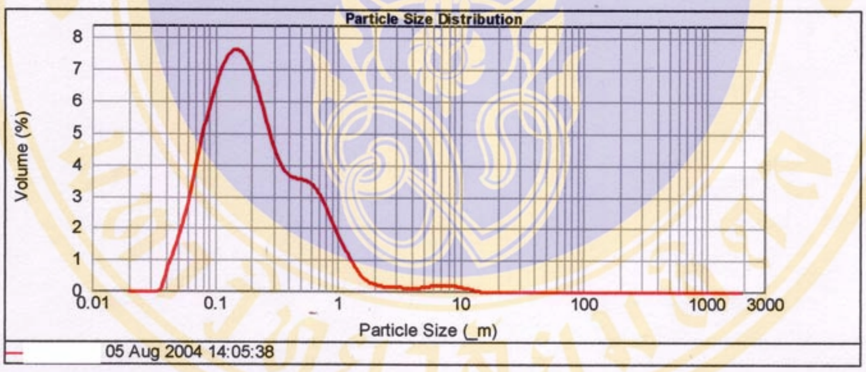
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: UHT Company C **SOP Name:** **Measured:** 05 Aug 2004 14:05:38
Sample Source & type: **Measured by:** pum **Analysed:** 05 Aug 2004 14:05:39
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.55 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.688 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0260 %Vol **Vol. Weighted Mean D[4,3]:** 0.397 um **Specific Surface Area:** 39.2338 m²/g
Span : 3.595 **Uniformity:** 1.50618 **Surface Weighted Mean D[3,2]:** 0.153 um
Result units: Volume
d(0.1): 0.077 um **d(0.5):** 0.188 um **d(0.9):** 0.753 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.12
0.040	0.64
0.045	1.01
0.050	1.46
0.056	1.97
0.063	2.64
0.071	3.35
0.080	4.02
0.089	4.61
0.100	5.09
0.112	5.45
0.126	5.67
0.142	

Size (_m)	Volume In %
0.142	5.74
0.159	5.65
0.178	5.41
0.200	5.01
0.224	4.53
0.252	3.99
0.283	3.50
0.317	3.10
0.356	2.85
0.399	2.72
0.448	2.67
0.502	2.64
0.564	2.57
0.632	2.42
0.710	2.17
0.796	1.85
0.893	1.52
1.002	

Size (_m)	Volume In %
1.002	1.21
1.125	0.94
1.262	0.68
1.416	0.45
1.589	0.29
1.783	0.20
2.000	0.16
2.244	0.12
2.518	0.11
2.825	0.11
3.170	0.09
3.557	0.08
3.991	0.08
4.477	0.10
5.024	0.12
5.637	0.13
6.325	0.14
7.096	

Size (_m)	Volume In %
7.096	0.15
7.962	0.14
8.934	0.12
10.024	0.10
11.247	0.07
12.619	0.02
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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05 Aug 2004 14:37:51

Figure 65 Particle size in UHT milk of company C

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TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

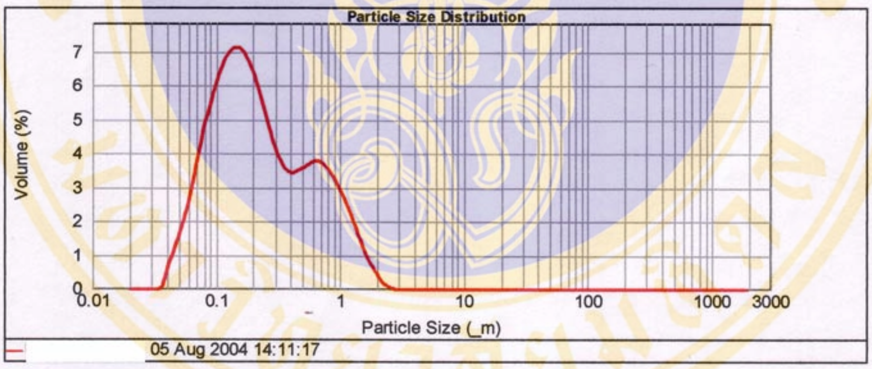
ERAWAN BRAND

Result Analysis Report

Sample Name: UHT Company D
SOP Name:
Measured: 05 Aug 2004 14:11:17
Sample Source & type:
Measured by: pum
Analysed: 05 Aug 2004 14:11:18
Sample bulk lot ref:
Result Source: Measurement

Particle Name: Milk Fat
Accessory Name: Hydro 2000S (A)
Obscuration: 17.12 %
Particle RI: 1.460 Absorption: 0
Analysis model: General purpose
Dispersant Name: Water
Size range: 0.020 to 2000.000 um
Weighted Residual: 3.689 %
Dispersant RI: 1.330
Result Emulation: Off

Concentration: 0.0221 %Vol
Vol. Weighted Mean D[4,3]: 0.361 um
Specific Surface Area: 37.5072 m²/g
Span : 4.086
Uniformity: 1.21062
Surface Weighted Mean D[3,2]: 0.160 um
Result units: Volume
d(0.1): 0.078 um
d(0.5): 0.201 um
d(0.9): 0.898 um



Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %	Size (_m)	Volume In %
0.020	0.00	0.142	5.37	1.002	2.07	7.096	0.00	50.238	0.00	355.656	0.00
0.022	0.00	0.159	5.26	1.125	1.76	7.962	0.00	56.368	0.00	399.052	0.00
0.025	0.00	0.178	5.00	1.262	1.40	8.934	0.00	63.246	0.00	447.744	0.00
0.028	0.00	0.200	4.61	1.416	1.03	10.024	0.00	70.963	0.00	502.377	0.00
0.032	0.00	0.224	4.14	1.589	0.70	11.247	0.00	79.621	0.00	563.677	0.00
0.036	0.12	0.252	3.63	1.783	0.46	12.619	0.00	89.337	0.00	632.456	0.00
0.040	0.61	0.283	3.18	2.000	0.23	14.159	0.00	100.237	0.00	709.627	0.00
0.045	0.97	0.317	2.83	2.244	0.09	15.887	0.00	112.468	0.00	796.214	0.00
0.050	1.40	0.356	2.64	2.518	0.01	17.825	0.00	126.191	0.00	893.367	0.00
0.056	1.88	0.399	2.59	2.825	0.00	20.000	0.00	141.589	0.00	1002.374	0.00
0.063	2.53	0.448	2.65	3.170	0.00	22.440	0.00	158.866	0.00	1124.683	0.00
0.071	3.20	0.502	2.75	3.557	0.00	25.179	0.00	178.250	0.00	1261.915	0.00
0.080	3.83	0.564	2.83	3.991	0.00	28.251	0.00	200.000	0.00	1415.892	0.00
0.089	4.39	0.632	2.84	4.477	0.00	31.698	0.00	224.404	0.00	1588.656	0.00
0.100	4.82	0.710	2.76	5.024	0.00	35.566	0.00	251.785	0.00	1782.502	0.00
0.112	5.14	0.796	2.58	5.637	0.00	39.905	0.00	282.508	0.00	2000.000	
0.126	5.33	0.893	2.35	6.325	0.00	44.774	0.00	316.979	0.00		
0.142		1.002		7.096		50.238		355.656			

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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05 Aug 2004 14:37:46

Figure 66 Particle size in UHT milk of company D

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19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

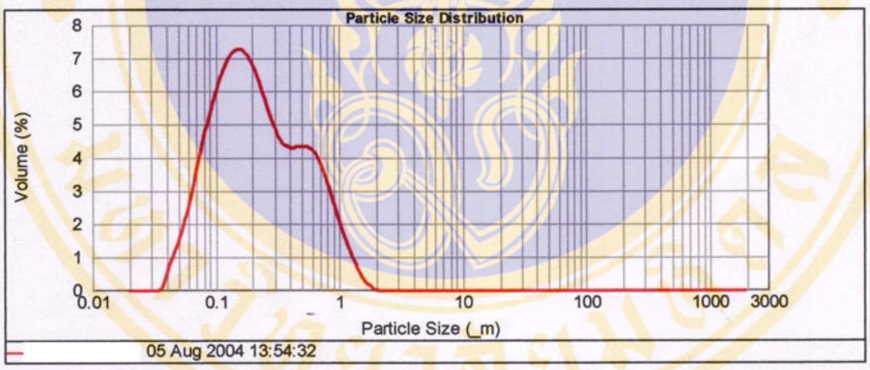
Result Analysis Report

Sample Name: UHT company E **SOP Name:** **Measured:** 05 Aug 2004 13:54:32
Sample Source & type: **Measured by:** pum **Analysed:** 05 Aug 2004 13:54:33
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.83 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 4.168 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0256 %Vol **Vol. Weighted Mean D[4,3]:** 0.312 um **Specific Surface Area:** 37.6713 m²/g
Span : 3.171 **Uniformity:** 0.957202 **Surface Weighted Mean D[3,2]:** 0.159 um
Result units: Volume

d(0.1): 0.079 um **d(0.5):** 0.201 um **d(0.9):** 0.718 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.10
0.040	0.58
0.045	0.92
0.050	1.34
0.056	1.80
0.063	2.43
0.071	3.09
0.080	3.72
0.089	4.29
0.100	4.75
0.112	5.12
0.126	5.36
0.142	

Size (_m)	Volume In %
0.142	5.47
0.159	5.44
0.178	5.26
0.200	4.95
0.224	4.55
0.252	4.11
0.283	3.72
0.317	3.43
0.356	3.28
0.399	3.24
0.448	3.26
0.502	3.28
0.564	3.21
0.632	3.01
0.710	2.68
0.796	2.24
0.893	1.79
1.002	

Size (_m)	Volume In %
1.002	1.36
1.125	0.99
1.262	0.65
1.416	0.37
1.589	0.15
1.783	0.05
2.000	0.00
2.244	0.00
2.518	0.00
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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05 Aug 2004 14:38:09

Figure 67 Particle size in UHT milk of company E

CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: UHT Company F **SOP Name:** **Measured:** 05 Aug 2004 13:49:51

Sample Source & type: **Measured by:** pum **Analysed:** 05 Aug 2004 13:49:53

Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 17.58 %

Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose

Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 4.351 %

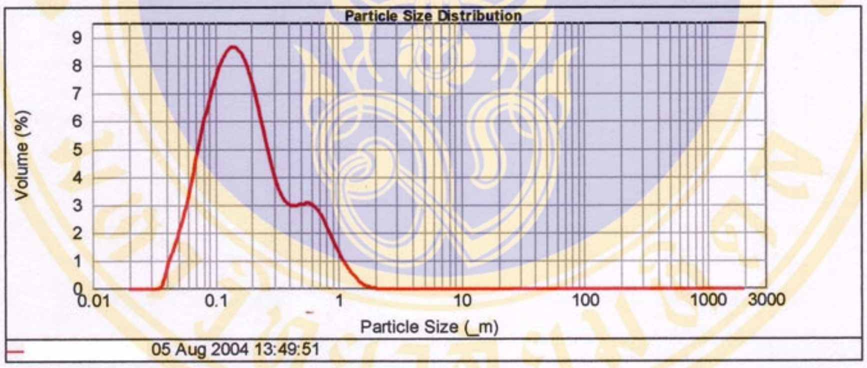
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0357 %Vol **Vol. Weighted Mean D[4,3]:** 0.253 um **Specific Surface Area:** 43.6332 m²/g

Span : 3.178 **Uniformity:** 0.911525 **Surface Weighted Mean D[3,2]:** 0.138 um

Result units: Volume

d(0.1): 0.073 um d(0.5): 0.164 um d(0.9): 0.592 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.14
0.040	0.75
0.045	1.19
0.050	1.72
0.056	2.31
0.063	3.10
0.071	3.93
0.080	4.71
0.089	5.38
0.100	5.91
0.112	6.29
0.126	6.48
0.142	

Size (_m)	Volume In %
0.142	6.48
0.159	6.27
0.178	5.86
0.200	5.27
0.224	4.56
0.252	3.80
0.283	3.13
0.317	2.62
0.356	2.33
0.399	2.23
0.448	2.25
0.502	2.29
0.564	2.28
0.632	2.15
0.710	1.88
0.796	1.51
0.893	1.15
1.002	

Size (_m)	Volume In %
1.002	0.83
1.125	0.57
1.262	0.36
1.416	0.19
1.589	0.06
1.783	0.02
2.000	0.00
2.244	0.00
2.518	0.00
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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Figure 68 Particle size in UHT milk of company F

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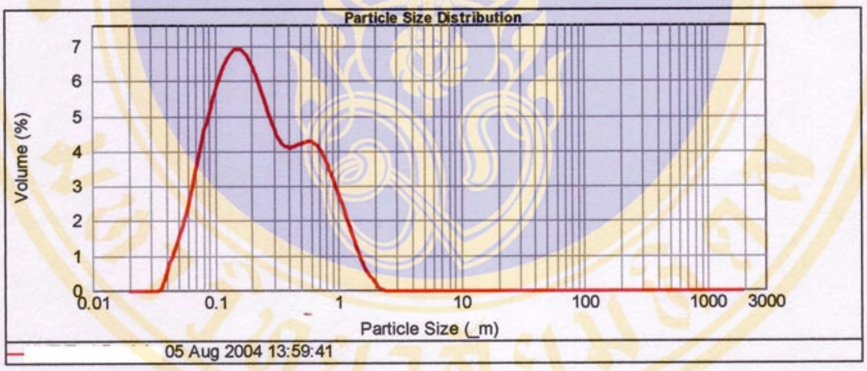
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: UHT Company G **SOP Name:** **Measured:** 05 Aug 2004 13:59:41
Sample Source & type: **Measured by:** pum **Analysed:** 05 Aug 2004 13:59:43
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.59 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.905 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0218 %Vol **Vol. Weighted Mean D[4,3]:** 0.351 um **Specific Surface Area:** 36.2143 m²/g
Span : 3.532 **Uniformity:** 1.0673 **Surface Weighted Mean D[3,2]:** 0.166 um
Result units: Volume
d(0.1): 0.080 um **d(0.5):** 0.213 um **d(0.9):** 0.833 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.10
0.040	0.56
0.045	0.89
0.050	1.28
0.056	1.73
0.063	2.32
0.071	2.96
0.080	3.56
0.089	4.09
0.100	4.53
0.112	4.88
0.126	5.10
0.142	

Size (_m)	Volume In %
0.142	5.20
0.159	5.17
0.178	5.00
0.200	4.71
0.224	4.33
0.252	3.92
0.283	3.54
0.317	3.26
0.356	3.11
0.399	3.09
0.448	3.14
0.502	3.20
0.564	3.21
0.632	3.13
0.710	2.93
0.796	2.64
0.893	2.28
1.002	

Size (_m)	Volume In %
1.002	1.91
1.125	1.53
1.262	1.14
1.416	0.76
1.589	0.46
1.783	0.27
2.000	0.09
2.244	0.00
2.518	0.00
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
Tel := +[44] (0) 1684-892456 Fax +[44] (0) 1684-892789

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Figure 69 Particle size in UHT milk of company G

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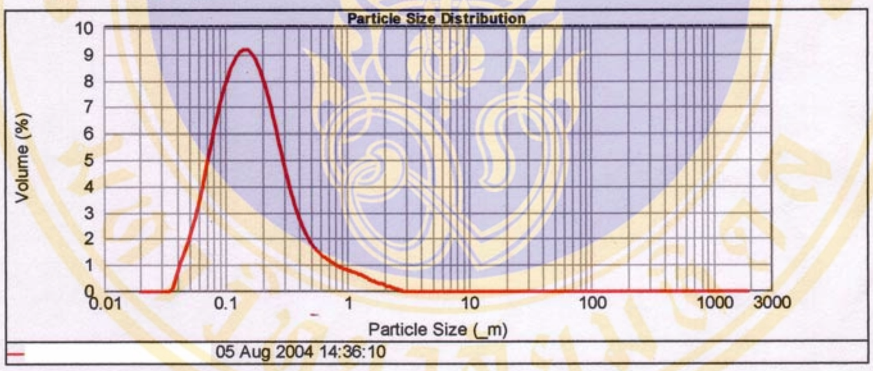
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: UHT (low-fat) company A **SOP Name:** **Measured:** 05 Aug 2004 14:36:10
Sample Source & type: **Measured by:** pum **Analysed:** 05 Aug 2004 14:36:11
Sample bulk lot ref: **Result Source:** Measurement

Particle Name: Milk Fat **Accessory Name:** Hydro 2000S (A) **Obscuration:** 16.05 %
Particle RI: 1.460 **Absorption:** 0 **Analysis model:** General purpose
Dispersant Name: Water **Size range:** 0.020 to 2000.000 um **Weighted Residual:** 3.333 %
Dispersant RI: 1.330 **Result Emulation:** Off

Concentration: 0.0379 %Vol **Vol. Weighted Mean D[4,3]:** 0.232 um **Specific Surface Area:** 45.5112 m²/g
Span : 2.304 **Uniformity:** 0.830431 **Surface Weighted Mean D[3,2]:** 0.132 um
Result units: Volume
d(0.1): 0.072 um **d(0.5):** 0.157 um **d(0.9):** 0.434 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.15
0.040	0.78
0.045	1.23
0.050	1.78
0.056	2.40
0.063	3.22
0.071	4.09
0.080	4.90
0.089	5.61
0.100	6.17
0.112	6.60
0.126	6.85
0.142	

Size (_m)	Volume In %
0.142	6.91
0.159	6.77
0.178	6.44
0.200	5.92
0.224	5.25
0.252	4.48
0.283	3.70
0.317	2.98
0.356	2.36
0.399	1.88
0.448	1.51
0.502	1.25
0.564	1.07
0.632	0.93
0.710	0.82
0.796	0.72
0.893	0.64
1.002	

Size (_m)	Volume In %
1.002	0.57
1.125	0.51
1.262	0.44
1.416	0.34
1.589	0.26
1.783	0.21
2.000	0.14
2.244	0.09
2.518	0.01
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

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Malvern, UK
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Figure 70 Particle size in UHT low-fat milk of company A

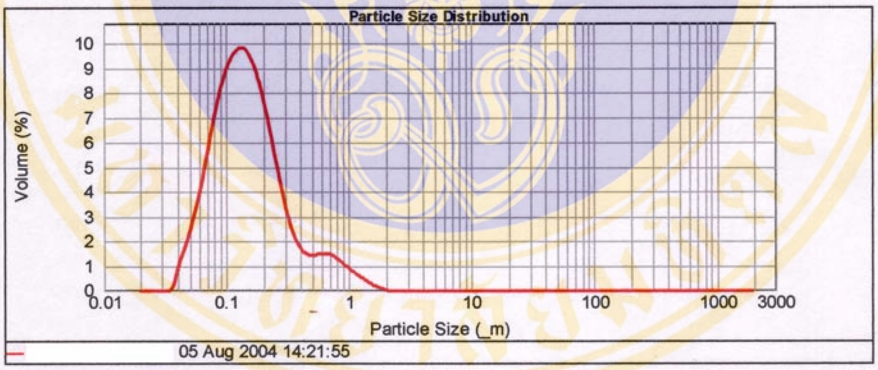
CHO HENG RICE VERMICELLI FTY. CO. LTD.
19 MOO 1, PETKASEM ROAD, YAICHA, SAMPRAN, NAKHON PATHOM, 73110
TEL (66-34) 225-240 FAX (66-34) 225-241 www.choheng.com

Result Analysis Report

Sample Name: UHT (low-fat) Company B
SOP Name:
Measured: 05 Aug 2004 14:21:55
Sample Source & type:
Measured by: pum
Analysed: 05 Aug 2004 14:21:56
Sample bulk lot ref:
Result Source: Measurement

Particle Name: Milk Fat
Accessory Name: Hydro 2000S (A)
Obscuration: 16.38 %
Particle RI: 1.460 **Absorption:** 0
Analysis model: General purpose
Dispersant Name: Water
Size range: 0.020 to 2000.000 um
Weighted Residual: 3.492 %
Dispersant RI: 1.330
Result Emulation: Off

Concentration: 0.0445 %Vol
Vol. Weighted Mean D[4,3]: 0.208 um
Specific Surface Area: 49.3292 m²/g
Span : 2.360
Uniformity: 0.807919
Surface Weighted Mean D[3,2]: 0.122 um
Result units: Volume
d(0.1): 0.068 um
d(0.5): 0.142 um
d(0.9): 0.403 um



Size (_m)	Volume In %
0.020	0.00
0.022	0.00
0.025	0.00
0.028	0.00
0.032	0.00
0.036	0.22
0.040	0.93
0.045	1.47
0.050	2.12
0.056	2.85
0.063	3.81
0.071	4.80
0.080	5.69
0.089	6.43
0.100	6.96
0.112	7.30
0.126	7.40
0.142	

Size (_m)	Volume In %
0.142	7.26
0.159	6.87
0.178	6.26
0.200	5.44
0.224	4.51
0.252	3.54
0.283	2.66
0.317	1.94
0.356	1.45
0.399	1.19
0.448	1.09
0.502	1.09
0.564	1.13
0.632	1.13
0.710	1.05
0.796	0.91
0.893	0.75
1.002	

Size (_m)	Volume In %
1.002	0.60
1.125	0.46
1.262	0.33
1.416	0.21
1.589	0.12
1.783	0.04
2.000	0.00
2.244	0.00
2.518	0.00
2.825	0.00
3.170	0.00
3.557	0.00
3.991	0.00
4.477	0.00
5.024	0.00
5.637	0.00
6.325	0.00
7.096	

Size (_m)	Volume In %
7.096	0.00
7.962	0.00
8.934	0.00
10.024	0.00
11.247	0.00
12.619	0.00
14.159	0.00
15.887	0.00
17.825	0.00
20.000	0.00
22.440	0.00
25.179	0.00
28.251	0.00
31.698	0.00
35.566	0.00
39.905	0.00
44.774	0.00
50.238	

Size (_m)	Volume In %
50.238	0.00
56.368	0.00
63.246	0.00
70.963	0.00
79.621	0.00
89.337	0.00
100.237	0.00
112.468	0.00
126.191	0.00
141.589	0.00
158.866	0.00
178.250	0.00
200.000	0.00
224.404	0.00
251.785	0.00
282.508	0.00
316.979	0.00
355.656	

Size (_m)	Volume In %
355.656	0.00
399.052	0.00
447.744	0.00
502.377	0.00
563.677	0.00
632.456	0.00
709.627	0.00
796.214	0.00
893.367	0.00
1002.374	0.00
1124.683	0.00
1261.915	0.00
1415.892	0.00
1588.656	0.00
1782.502	0.00
2000.000	

Operator notes:

Malvern Instruments Ltd.
Malvern, UK
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05 Aug 2004 14:37:35

Figure 71 Particle size in UHT low-fat milk of company B

Appendix B

(สำเนา)

ประกาศกระทรวงสาธารณสุข

(ฉบับที่ 265) พ.ศ. 2545

เรื่อง นมโค

โดยที่เป็นการสมควรปรับปรุงประกาศกระทรวงสาธารณสุขว่าด้วยเรื่อง นมโค

อาศัยอำนาจตามความในมาตรา 5 และมาตรา 6(1) (2) (4) (5) (6) (7) (9) และ (10) แห่งพระราชบัญญัติอาหาร พ.ศ.2522 อันเป็นพระราชบัญญัติที่มีบทบัญญัติบางประการเกี่ยวกับการจำกัดสิทธิและเสรีภาพของบุคคล ซึ่งมาตรา 29 ประกอบกับมาตรา 35 มาตรา 48 และมาตรา 50 ของรัฐธรรมนูญแห่งราชอาณาจักรไทยบัญญัติให้กระทำได้โดยอาศัยอำนาจตามบทบัญญัติแห่งกฎหมาย รัฐมนตรีว่าการกระทรวงสาธารณสุขออกประกาศไว้ ดังต่อไปนี้

ข้อ 1 ให้ยกเลิก

(1) ประกาศกระทรวงสาธารณสุข ฉบับที่ 26 (พ.ศ.2522) เรื่อง กำหนดนมโคเป็นอาหารควบคุมเฉพาะและกำหนดคุณภาพหรือมาตรฐานและวิธีการผลิต ลงวันที่ 13 กันยายน พ.ศ.2522

(2) ประกาศกระทรวงสาธารณสุข ฉบับที่ 149 (พ.ศ.2536) เรื่อง กำหนดนมโคเป็นอาหารควบคุมเฉพาะและกำหนดคุณภาพหรือมาตรฐานและวิธีการผลิต (ฉบับที่ 2) ลงวันที่ 11 ตุลาคม พ.ศ.2536

(3) ประกาศกระทรวงสาธารณสุข (ฉบับที่ 218) พ.ศ.2544 เรื่อง กำหนดนมโคเป็นอาหารควบคุมเฉพาะและกำหนดคุณภาพหรือมาตรฐานและวิธีการผลิต (ฉบับที่ 3) ลงวันที่ 8 มิถุนายน พ.ศ.2544

ข้อ 2 ให้นมโคเป็นอาหารควบคุมเฉพาะ

ข้อ 3 ในประกาศนี้ “น้ำนมดิบ” หมายความว่า น้ำนมที่รีดจากแม่โค

ข้อ 4 นมโค หมายความว่า ผลิตภัณฑ์ที่ได้จากการนำน้ำนมดิบมาผ่านกรรมวิธีการผลิตต่าง ๆให้มีลักษณะตามกระบวนการผลิตนั้น ๆ มี 5 ชนิด ได้แก่

(1) น้ำนมดิบที่ผ่านกรรมวิธีฆ่าเชื้อ

(2) นมผง

(3) นมข้น

(4) นมคืนรูป

(5) นมแปลงไขมัน

ข้อ 5 น้ำนมดิบที่ผ่านกรรมวิธีฆ่าเชื้อ มี 3 ชนิด ได้แก่

(1) น้ำนมดิบชนิดเต็มมันเนยที่ผ่านกรรมวิธีฆ่าเชื้อ หมายถึง น้ำนมดิบที่มิได้แยกออกหรือเติมเข้าไปซึ่งวัตถุอื่นใด เว้นแต่การปรับปริมาณมันเนยโดยการแยกหรือเติมมันเนย และต้องผ่านกรรมวิธีฆ่าเชื้อตามข้อ 11

(2) น้ำนมดิบชนิดพร่องมันเนยที่ผ่านกรรมวิธีฆ่าเชื้อ หมายถึง น้ำนมดิบที่ได้แยกมันเนยออกบางส่วน และต้องผ่านกรรมวิธีฆ่าเชื้อตามข้อ 11

(3) น้ำนมดิบชนิดขาดมันเนยที่ผ่านกรรมวิธีฆ่าเชื้อ หมายถึง น้ำนมดิบที่ได้แยกมันเนยออกเกือบทั้งหมด และต้องผ่านกรรมวิธีฆ่าเชื้อตามข้อ 11

ข้อ 6 นมผง หมายความว่า น้ำนมดิบที่ผ่านกรรมวิธีฆ่าเชื้อที่ระเหยน้ำออกด้วยกรรมวิธีต่าง ๆจนเป็นผง และอาจมีการเติมวัตถุอื่นใดที่เป็นองค์ประกอบของนมอีกด้วยก็ได้ มี 3 ชนิด ได้แก่

(1) นมผงชนิดเต็มมันเนย

(2) นมผงชนิดพร่องมันเนย

(3) นมผงชนิดขาดมันเนย

ข้อ 7 นมข้น หมายความว่า น้ำนมดิบที่ระเหยเอาน้ำบางส่วนออกและอาจเติมน้ำตาลหรือวัตถุอื่นใดที่เป็นองค์ประกอบของนมอีกด้วยก็ได้ มี 6 ชนิด ได้แก่

(1) นมข้นไม่หวานชนิดเต็มมันเนย

(2) นมข้นหวานชนิดเต็มมันเนย

(3) นมข้นไม่หวานชนิดพร่องมันเนย

(4) นมข้นหวานชนิดพร่องมันเนย

(5) นมข้นไม่หวานชนิดขาดมันเนย

(6) นมข้นหวานชนิดขาดมันเนย

ข้อ 8 นมคืนรูป หมายความว่า ผลิตภัณฑ์ที่ได้จากการนำเอาองค์ประกอบของน้ำนมดิบมาผสมกันให้มีลักษณะเช่นเดียวกับนมโคตามข้อ 4(1) หรือ (3) และอาจเติมน้ำนมดิบหรือวัตถุอื่นใดที่เป็นองค์ประกอบของนมอีกด้วยก็ได้ มี 9 ชนิด ได้แก่

(1) นมคืนรูปชนิดเต็มมันเนย

(2) นมคืนรูปชนิดพร่องมันเนย

(3) นมคืนรูปชนิดขาดมันเนย

(4) นมข้นคืนรูปไม่หวานชนิดเต็มมันเนย

(5) นมข้นคืนรูปหวานชนิดเต็มมันเนย

(6) นมข้นคืนรูปไม่หวานชนิดพร่องมันเนย

(7) นมข้นคืนรูปหวานชนิดพร่องมันเนย

(8) นมข้นคืนรูปไม่หวานชนิดขาดมันเนย

(9) นมข้นคืนรูปหวานชนิดขาดมันเนย

ข้อ 9 นมแปลงไขมัน หมายความว่า นมโคตามข้อ 4(1) (2) (3) หรือ (4) ที่ใช้ไขมันอื่นบางส่วนหรือทั้งหมดแทนมันเนยที่มีอยู่ มี 8 ชนิด ได้แก่

(1) นมแปลงไขมันชนิดเต็มไขมัน

(2) นมแปลงไขมันชนิดพร่องไขมัน

(3) นมผงแปลงไขมันชนิดเต็มไขมัน

(4) นมผงแปลงไขมันชนิดพร่องไขมัน

(5) นมข้นแปลงไขมันไม่หวานชนิดเต็มไขมัน

(6) นมข้นแปลงไขมันไม่หวานชนิดพร่องไขมัน

(7) นมข้นแปลงไขมันหวานชนิดเต็มไขมัน

(8) นมข้นแปลงไขมันหวานชนิดพร่องไขมัน

ข้อ 10 นมโคตามข้อ 6 ข้อ 7 ข้อ 8 หรือข้อ 9 อาจมีการเติมสารอาหารอื่น เพื่อเพิ่มชนิดและปริมาณสารอาหารนอกเหนือจากที่กำหนดในประกาศนี้ได้ โดยปฏิบัติตามหลักเกณฑ์วิธีการและเงื่อนไขที่กำหนดไว้ในประกาศกระทรวงสาธารณสุขว่าด้วยเรื่อง การเติมสารอาหารในผลิตภัณฑ์อาหาร

ข้อ 11 กรรมวิธีฆ่าเชื้อนมโคตามข้อ 4(1) ต้องเป็นกรรมวิธีฆ่าเชื้ออย่างใดอย่างหนึ่งดังต่อไปนี้

(1) พาสเจอร์ไรส์ หมายความว่า กรรมวิธีฆ่าเชื้อด้วยความร้อนที่อุณหภูมิไม่เกิน 100 องศาเซลเซียส โดยใช้อุณหภูมิและเวลาอย่างใดอย่างหนึ่ง ดังต่อไปนี้

(1.1) อุณหภูมิไม่ต่ำกว่า 63 องศาเซลเซียส และคงอยู่ที่อุณหภูมินี้ไม่น้อยกว่า 30 นาที แล้วทำให้เย็นลงทันทีที่อุณหภูมิ 5 องศาเซลเซียส หรือต่ำกว่า หรือ

(1.2) อุณหภูมิไม่ต่ำกว่า 72 องศาเซลเซียส และคงอยู่ที่อุณหภูมินี้ไม่น้อยกว่า 15 วินาทีแล้วทำให้เย็นลงทันทีที่อุณหภูมิ 5 องศาเซลเซียส หรือต่ำกว่า

(2) สเตอริไลส์ หมายความว่า กรรมวิธีฆ่าเชื้อนมโคตามข้อ 4(1) ที่บรรจุในภาชนะที่ปิดสนิทด้วยความร้อนที่อุณหภูมิไม่ต่ำกว่า 100 องศาเซลเซียส โดยใช้เวลาที่เหมาะสม ทั้งนี้จะต้องผ่านกรรมวิธีทำให้เป็นเนื้อเดียวกันด้วย

(3) ยู เอช ที หมายความว่า กรรมวิธีฆ่าเชื้อด้วยความร้อนที่อุณหภูมิไม่ต่ำกว่า 133 องศาเซลเซียส ไม่น้อยกว่า 1 วินาที แล้วบรรจุในภาชนะและในสภาวะที่ปราศจากเชื้อ ทั้งนี้จะต้องผ่านกรรมวิธีทำให้เป็นเนื้อเดียวกันด้วย

(4) กรรมวิธีอย่างอื่นที่มีมาตรฐานเทียบเท่ากรรมวิธีตาม (1) (2) หรือ (3) โดยได้รับความเห็นชอบจากคณะกรรมการอาหาร

ข้อ 12 น้ำนมดิบที่ผ่านกรรมวิธีฆ่าเชื้อ ต้องมีคุณภาพหรือมาตรฐาน ดังต่อไปนี้

(1) ต้องปราศจากเชื้อโรคอันอาจจะติดต่อคนได้ เช่น เชื้อที่ทำให้เกิดวัณโรค เชื้อที่ทำให้เกิดโรคแท้งติดต่อ เป็นต้น

(2) ไม่มีน้ำนมน้ำเหลืองเจือปน

(3) มีกลิ่นตามลักษณะเฉพาะของน้ำนมดิบที่ผ่านกรรมวิธีฆ่าเชื้อชนิดนั้น

(4) มีลักษณะเหลวเป็นเนื้อเดียวกัน

(5) ไม่มีสารที่อาจเป็นพิษ สารเป็นพิษจากจุลินทรีย์ และสารปนเปื้อน ในปริมาณที่อาจเป็นอันตรายต่อสุขภาพ เช่น สารตกค้างจากยาฆ่าแมลง สารปฏิชีวนะ แอฟลาทอกซิน เป็นต้น

(6) ไม่มีวัตถุกันเสีย

(7) ไม่มีวัตถุที่ให้ความหวานแทนน้ำตาล

(8) มีโปรตีนนมไม่น้อยกว่าร้อยละ 2.8 ของน้ำหนัก

(9) มีเนื้อนมไม่รวมมันเนยและมันเนย ดังนี้

(9.1) เนื้อนมไม่รวมมันเนยไม่น้อยกว่าร้อยละ 8.25 ของน้ำหนัก และมันเนยไม่น้อยกว่า ร้อยละ 3.2 ของน้ำหนัก สำหรับน้ำนมดิบชนิดเต็มมันเนยที่ผ่านกรรมวิธีฆ่าเชื้อ

(9.2) เนื้อนมไม่รวมมันเนยไม่น้อยกว่าร้อยละ 8.5 ของน้ำหนัก และมันเนยมากกว่า ร้อยละ 0.1 ของน้ำหนัก แต่ไม่ถึงร้อยละ 3.2 ของน้ำหนัก สำหรับน้ำนมดิบชนิดพร่องมันเนยที่ผ่านกรรมวิธีฆ่าเชื้อ

(9.3) เนื้อนมไม่รวมมันเนยไม่น้อยกว่าร้อยละ 8.8 ของน้ำหนัก และมันเนยไม่เกินร้อยละ0.1 ของน้ำหนัก สำหรับน้ำนมดิบชนิดขาดมันเนยที่ผ่านกรรมวิธีฆ่าเชื้อ

(10) ไม่มีจุลินทรีย์ที่ทำให้เกิดโรค

(11) ตรวจไม่พบแบคทีเรียชนิด อี.โคไล *(Escherichia coli)* ในน้ำนมดิบที่ผ่านกรรมวิธีฆ่าเชื้อ 0.1 มิลลิลิตร

(12) ตรวจพบแบคทีเรียในน้ำนมดิบที่ผ่านกรรมวิธีพาสเจอร์ไรส์ 1 มิลลิลิตร ได้ไม่เกิน 10,000 ณ แหล่งผลิตและไม่เกิน 50,000 ตลอดระยะเวลาเมื่อออกจากแหล่งผลิตจนถึงวันหมดอายุการบริโภคที่ระบุบนฉลาก

(13) ตรวจพบแบคทีเรียชนิดโคลิฟอร์มได้ไม่เกิน 100 ในน้ำนมดิบที่ผ่านกรรมวิธีพาสเจอร์ไรส์ 1 มิลลิลิตร ณ แหล่งผลิต

(14) ตรวจไม่พบแบคทีเรียในน้ำนมดิบที่ผ่านกรรมวิธีสเตอริไลส์และน้ำนมดิบที่ผ่านกรรมวิธียู เอช ที 0.1 มิลลิลิตร

ข้อ 13 น้ำนมดิบที่ผ่านกรรมวิธีพาสเจอร์ไรส์ต้องเก็บรักษาไว้ที่อุณหภูมิไม่เกิน 8 องศาเซลเซียสตลอดระยะเวลาหลังบรรจุจนถึงผู้บริโภค และระยะเวลาการบริโภคต้องไม่เกิน 10 วัน นับจากวันที่บรรจุในภาชนะบรรจุพร้อมจำหน่าย

กรณีที่จะแสดงระยะเวลาการบริโภคเกินกว่าที่กำหนดตามวรรคหนึ่ง ต้องมีมาตรการในการควบคุมคุณภาพหรือมาตรฐานผลิตภัณฑ์ตลอดระยะเวลาตั้งแต่หลังการบรรจุถึงการจำหน่ายถึงผู้บริโภคเป็นไปตามหลักเกณฑ์ที่ได้รับความเห็นชอบจากคณะกรรมการอาหาร

ข้อ 14 น้ำนมดิบที่ผ่านกรรมวิธีฆ่าเชื้อตามข้อ 11(2) หรือ (3) ต้องเก็บรักษาไว้ที่อุณหภูมิปกติในระยะเวลาไม่น้อยกว่า 5 วัน นับแต่วันที่บรรจุในภาชนะก่อนออกจำหน่าย เพื่อตรวจสอบว่ายังคงมีคุณภาพหรือมาตรฐานตามที่กำหนด และไม่เปลี่ยนแปลงไปจากลักษณะเดิมที่ทำขึ้น

ข้อ 15 นมผงต้องมีคุณภาพหรือมาตรฐาน ดังต่อไปนี้

(1) มีกลิ่นตามลักษณะเฉพาะของนมผงชนิดนั้น

(2) มีลักษณะเป็นผงไม่เกาะเป็นก้อน

(3) มีความชื้นไม่เกินร้อยละ 5 ของน้ำหนัก

(4) ไม่มีสารที่อาจเป็นพิษ สารเป็นพิษจากจุลินทรีย์ และสารปนเปื้อน ในปริมาณที่อาจเป็นอันตรายต่อสุขภาพ เช่น สารตกค้างจากยาฆ่าแมลง สารปฏิชีวนะ แอฟลาทอกซิน เป็นต้น

(5) ไม่มีวัตถุกันเสีย

(6) ไม่มีวัตถุที่ให้ความหวานแทนน้ำตาล

(7) มีโปรตีนนมในเนื้อนมไม่รวมมันเนยไม่น้อยกว่าร้อยละ 34 ของน้ำหนัก

(8) มีมันเนยดังนี้

(8.1) ไม่น้อยกว่าร้อยละ 26 ของน้ำหนัก สำหรับนมผงชนิดเต็มมันเนย

(8.2) มากกว่าร้อยละ 1.5 ของน้ำหนัก แต่ไม่ถึงร้อยละ 26 ของน้ำหนัก สำหรับนมผงชนิดพร่องมันเนย

(8.3) ไม่เกินร้อยละ 1.5 ของน้ำหนัก สำหรับนมผงชนิดขาดมันเนย

(9) ไม่มีจุลินทรีย์ที่ทำให้เกิดโรค

(10) ตรวจไม่พบแบคทีเรียชนิด อี.โคไล *(Escherichia coli)* ในนมผง 0.1 กรัม

(11) ตรวจพบแบคทีเรียได้ไม่เกิน 50,000 ในนมผง 1 กรัม

ข้อ 16 นมข้นต้องมีคุณภาพหรือมาตรฐาน ดังต่อไปนี้

(1) มีกลิ่นตามลักษณะเฉพาะของนมข้นชนิดนั้น

(2) มีลักษณะเป็นเนื้อเดียวกัน ไม่เป็นก้อน

(3) ไม่มีวัตถุกันเสีย

(4) ไม่มีวัตถุที่ให้ความหวานแทนน้ำตาล

(5) ไม่มีสารที่อาจเป็นพิษ สารเป็นพิษจากจุลินทรีย์ และสารปนเปื้อน ในปริมาณที่อาจเป็นอันตรายต่อสุขภาพ เช่น สารตกค้างจากยาฆ่าแมลง สารปฏิชีวนะ แอฟลาทอกซิน เป็นต้น

(6) มีโปรตีนนมในเนื้อนมไม่รวมมันเนยไม่น้อยกว่าร้อยละ 34 ของน้ำหนัก

(7) มีเนื้อนมและมันเนย ดังนี้

(7.1) เนื้อนมไม่น้อยกว่าร้อยละ 25 ของน้ำหนัก และมันเนยไม่น้อยกว่าร้อยละ 7.5 ของน้ำหนัก สำหรับนมข้นไม่หวานชนิดเต็มมันเนย

(7.2) เนื้อนมไม่น้อยกว่าร้อยละ 28 ของน้ำหนัก และมันเนยไม่น้อยกว่าร้อยละ 8 ของน้ำหนัก สำหรับนมข้นหวานชนิดเต็มมันเนย

(7.3) เนื้อนมไม่น้อยกว่าร้อยละ 20 ของน้ำหนัก และมันเนยมากกว่าร้อยละ 1 ของน้ำหนัก แต่ไม่ถึงร้อยละ 7.5 ของน้ำหนัก สำหรับนมข้นไม่หวานชนิดพร่องมันเนย

(7.4) เนื้อนมไม่น้อยกว่าร้อยละ 24 ของน้ำหนัก และมันเนยมากกว่าร้อยละ 1 ของน้ำหนัก แต่ไม่ถึงร้อยละ 8 ของน้ำหนัก สำหรับนมข้นหวานชนิดพร่องมันเนย

(7.5) เนื้อนมไม่น้อยกว่าร้อยละ 20 ของน้ำหนัก และมันเนยไม่เกินร้อยละ 1 ของน้ำหนัก สำหรับนมข้นไม่หวานชนิดขาดมันเนย

(7.6) เนื้อนมไม่น้อยกว่าร้อยละ 24 ของน้ำหนัก และมันเนยไม่เกินร้อยละ 1 ของน้ำหนัก สำหรับนมข้นหวานชนิดขาดมันเนย

(8) มีวิตามินเอไม่น้อยกว่า 330 ไมโครกรัมเรตินอล ต่อนมข้นหวาน 100 กรัม

(9) ไม่มีจุลินทรีย์ที่ทำให้เกิดโรค

(10) ตรวจพบยีสต์และเชื้อราวมกันได้ไม่เกิน 10 ในนมข้นหวาน 1 กรัม

(11) ตรวจไม่พบแบคทีเรียชนิดโคลิฟอร์มในนมข้นหวาน 0.1 กรัม

(12) ตรวจพบแบคทีเรียได้ไม่เกิน 10,000 ในนมข้นหวาน 1 กรัม

(13) ตรวจไม่พบแบคทีเรียในนมข้นไม่หวาน 0.1 มิลลิลิตร

ข้อ 17 นมคืนรูป ต้องมีคุณภาพหรือมาตรฐาน ดังต่อไปนี้

(1) นมคืนรูปชนิดเต็มมันเนยมีคุณภาพหรือมาตรฐานเช่นเดียวกับน้ำนมดิบชนิดเต็มมันเนยที่ผ่านกรรมวิธีฆ่าเชื้อ

(2) นมคืนรูปชนิดพร่องมันเนยมีคุณภาพหรือมาตรฐานเช่นเดียวกับน้ำนมดิบชนิดพร่องมันเนยที่ผ่านกรรมวิธีฆ่าเชื้อ

(3) นมคืนรูปชนิดขาดมันเนยมีคุณภาพหรือมาตรฐานเช่นเดียวกับน้ำนมดิบชนิดขาดมันเนยที่ผ่านกรรมวิธีฆ่าเชื้อ

(4) นมข้นคืนรูปไม่หวานชนิดเต็มมันเนยมีคุณภาพหรือมาตรฐานเช่นเดียวกับนมข้นไม่หวานชนิดเต็มมันเนย

(5) นมข้นคืนรูปหวานชนิดเต็มมันเนยมีคุณภาพหรือมาตรฐานเช่นเดียวกับนมข้นหวานชนิดเต็มมันเนย

(6) นมข้นคืนรูปไม่หวานชนิดพร่องมันเนยมีคุณภาพหรือมาตรฐานเช่นเดียวกับนมข้นไม่หวานชนิดพร่องมันเนย

(7) นมข้นคืนรูปหวานชนิดพร่องมันเนยมีคุณภาพหรือมาตรฐานเช่นเดียวกับนมข้นหวานชนิดพร่องมันเนย

(8) นมข้นคืนรูปไม่หวานชนิดขาดมันเนยมีคุณภาพหรือมาตรฐานเช่นเดียวกับนมข้นไม่หวานชนิดขาดมันเนย

(9) นมข้นคืนรูปหวานชนิดขาดมันเนยมีคุณภาพหรือมาตรฐานเช่นเดียวกับนมข้นหวานชนิดขาดมันเนย

ข้อ 18 นมคืนรูปตามข้อ 8(1)(2) และ (3) ต้องผ่านกรรมวิธีฆ่าเชื้อตามข้อ 11 และต้องปฏิบัติดังต่อไปนี้

(1) กรณีที่ผ่านกรรมวิธีฆ่าเชื้อตามข้อ 11(1) ต้องปฏิบัติตามข้อ 13

(2) กรณีที่ผ่านกรรมวิธีฆ่าเชื้อตามข้อ 11(2) หรือ (3) ต้องปฏิบัติตามข้อ 14

ข้อ 19 นมแปลงไขมัน ต้องมีคุณภาพหรือมาตรฐาน ดังต่อไปนี้

(1) นมแปลงไขมันชนิดเต็มไขมันต้องมีเนื้อนมไม่รวมไขมันไม่น้อยกว่าร้อยละ 8.25 ของน้ำหนักและมีไขมันทั้งหมดไม่น้อยกว่าร้อยละ 3.2 ของน้ำหนัก และต้องมีคุณภาพหรือมาตรฐานตามข้อ 12(1)(2)(3)(4)(5)(6)(7)(8)(10)(11)(12)(13) และ (14)

(2) นมแปลงไขมันชนิดพร่องไขมันต้องมีเนื้อนมไม่รวมไขมันไม่น้อยกว่าร้อยละ 8.5 ของน้ำหนักและมีไขมันทั้งหมดมากกว่าร้อยละ 0.1 ของน้ำหนัก แต่ไม่ถึงร้อยละ 3.2 ของน้ำหนัก และต้องมีคุณภาพหรือมาตรฐานตามข้อ 12(1)(2)(3)(4)(5)(6)(7)(8)(10)(11)(12)(13) และ (14)

(3) นมผงแปลงไขมันชนิดเต็มไขมัน ต้องมีไขมันทั้งหมดไม่น้อยกว่าร้อยละ 26 ของน้ำหนักและต้องมีคุณภาพหรือมาตรฐานตามข้อ 15(1) (2) (3 (4) (5) (6) (7) (9) (10) และ (11)

(4) นมผงแปลงไขมันชนิดพร่องไขมัน ต้องมีไขมันทั้งหมดมากกว่าร้อยละ 1.5 ของน้ำหนักแต่ไม่ถึงร้อยละ 26 ของน้ำหนัก และต้องมีคุณภาพหรือมาตรฐานตามข้อ 15(1) (2) (3) (4) (5) (6) (7) (9) (10) และ (11)

(5) นมข้นแปลงไขมันไม่หวานชนิดเต็มไขมัน ต้องมีเนื้อนมไม่รวมไขมันไม่น้อยกว่าร้อยละ 17.5 ของน้ำหนัก และมีไขมันทั้งหมดไม่น้อยกว่าร้อยละ 6 ของน้ำหนักและต้องมีคุณภาพหรือมาตรฐานตามข้อ16 (1) (2) (3) (4) (5) (6) (9) และ (13)

(6) นมข้นแปลงไขมันไม่หวานชนิดพร่องไขมัน ต้องมีเนื้อนมไม่น้อยกว่าร้อยละ 20 ของน้ำหนักและมีไขมันทั้งหมดมากกว่าร้อยละ 1 ของน้ำหนัก แต่ไม่ถึงร้อยละ 6 ของน้ำหนัก และต้องมีคุณภาพหรือมาตรฐานตามข้อ 16 (1) (2) (3) (4) (5) (6) (9) และ (13)

(7) นมข้นแปลงไขมันหวานชนิดเต็มไขมัน ต้องมีเนื้อนมไม่รวมไขมันไม่น้อยกว่าร้อยละ 20 ของน้ำหนัก และมีไขมันทั้งหมดไม่น้อยกว่าร้อยละ 7 ของน้ำหนัก และต้องมีคุณภาพหรือมาตรฐานตามข้อ16 (1) (2) (3) (4) (5) (6) (8) (9) (10) (11) และ (12)

(8) นมข้นแปลงไขมันหวานชนิดพร่องไขมันต้องมีเนื้อนมไม่น้อยกว่าร้อยละ 24 ของน้ำหนักและมีไขมันทั้งหมดมากกว่าร้อยละ 1 ของน้ำหนักแต่ไม่ถึงร้อยละ 7 ของน้ำหนัก และต้องมีคุณภาพหรือมาตรฐานตามข้อ 16(1) (2) (3) (4) (5) (6) (8) (9) (10) (11) และ (12)

ข้อ 20 นมแปลงไขมันตามข้อ 9(1) และ (2) ต้องผ่านกรรมวิธีฆ่าเชื้อตามข้อ 11 และต้องปฏิบัติดังต่อไปนี้

(1) กรณีที่ผ่านกรรมวิธีฆ่าเชื้อตามข้อ 11(1) ต้องปฏิบัติตามข้อ 13

(2) กรณีที่ผ่านกรรมวิธีฆ่าเชื้อตามข้อ 11(2) หรือ (3) ต้องปฏิบัติตามข้อ 14

ข้อ 21 การผลิตนมโคถ้าจำเป็นต้องใช้วัตถุเจือปนอาหารนอกจากวัตถุกันเสีย ให้ใช้ได้ตามหลักเกณฑ์ที่กำหนดไว้ในบัญชีแนบท้ายประกาศนี้

ข้อ 22 ผู้ผลิตหรือผู้นำเข้านมโคเพื่อจำหน่าย ต้องปฏิบัติตามประกาศกระทรวงสาธารณสุขว่าด้วยเรื่อง วิธีการผลิต เครื่องมือเครื่องใช้ในการผลิต และการเก็บรักษาอาหาร

ข้อ 23 การใช้ภาชนะบรรจุนมโค ให้ปฏิบัติตามประกาศกระทรวงสาธารณสุขว่าด้วยเรื่องภาชนะบรรจุ

ข้อ 24 การแสดงฉลากของนมโค ให้ปฏิบัติตามประกาศกระทรวงสาธารณสุขว่าด้วยเรื่องฉลาก เว้นแต่การใช้ชื่อนมโคและการแสดงข้อความสำหรับนมโคบางชนิด ให้ปฏิบัติดังต่อไปนี้

(1) การใช้ชื่ออาหารของนมโค ได้แก่

(1.1) น้ำนมดิบที่ผ่านกรรมวิธีฆ่าเชื้อตามข้อ 5 ให้ใช้ชื่อดังนี้

(1.1.1) "นม........" (ความที่เว้นไว้ให้ระบุกรรมวิธีฆ่าเชื้อตามข้อ 11) สำหรับชนิดเต็มมันเนย

(1.1.2) "นม......พร่องมันเนย" หรือ "นมพร่องมันเนย......" (ความที่เว้นไว้ให้ระบุกรรมวิธีฆ่าเชื้อตามข้อ 11) สำหรับชนิดพร่องมันเนย

(1.1.3) "นม......ขาดมันเนย" หรือ "นมขาดมันเนย......" (ความที่เว้นไว้ให้ระบุกรรมวิธีฆ่าเชื้อตามข้อ 11) สำหรับชนิดขาดมันเนย

(1.2) นมผงตามข้อ 6 ให้ใช้ชื่อดังนี้

(1.2.1) "นมผง" สำหรับนมผงชนิดเต็มมันเนย

(1.2.2) "นมผงพร่องมันเนย" สำหรับนมผงชนิดพร่องมันเนย

(1.2.3) "นมผงขาดมันเนย" สำหรับนมผงชนิดขาดมันเนย

(1.3) นมข้น ตามข้อ 7 ให้ใช้ชื่อดังนี้

(1.3.1) "นมข้นไม่หวาน" สำหรับนมข้นไม่หวานชนิดเต็มมันเนย

(1.3.2) "นมข้นหวาน" สำหรับนมข้นหวานชนิดเต็มมันเนย

(1.3.3) "นมข้นไม่หวานพร่องมันเนย"สำหรับนมข้นไม่หวานชนิดพร่องมันเนย

(1.3.4) "นมข้นหวานพร่องมันเนย" สำหรับนมข้นหวานชนิดพร่องมันเนย

(1.3.5) "นมข้นไม่หวานขาดมันเนย" สำหรับนมข้นไม่หวานชนิดขาดมันเนย

(1.3.6) "นมข้นหวานขาดมันเนย" สำหรับนมข้นหวานชนิดขาดมันเนย

(1.4) นมคืนรูปตามข้อ 8 ให้ใช้ชื่อดังนี้

(1.4.1) "นมคืนรูป........" (ความที่เว้นไว้ให้ระบุกรรมวิธีฆ่าเชื้อตามข้อ 11) สำหรับนมคืนรูปชนิดเต็มมันเนย

(1.4.2) "นมคืนรูปพร่องมันเนย........" หรือ "นมคืนรูป ....พร่องมันเนย"(ความที่เว้นไว้ให้ระบุกรรมวิธีฆ่าเชื้อตามข้อ11) สำหรับนมคืนรูปชนิดพร่องมันเนย

(1.4.3) "นมคืนรูปขาดมันเนย........" หรือ "นมคืนรูป ....ขาดมันเนย"
(ความที่เว้นไว้ให้ระบุกรรมวิธีฆ่าเชื้อตามข้อ 11) สำหรับนมคืนรูปชนิดขาดมันเนย

(1.4.4) "นมข้นคืนรูปไม่หวาน" สำหรับนมข้นคืนรูปไม่หวานชนิดเต็มมันเนย

1.4.5) "นมข้นคืนรูปหวาน" สำหรับนมข้นคืนรูปหวานชนิดเต็มมันเนย

(1.4.6) "นมข้นคืนรูปไม่หวานพร่องมันเนย" สำหรับนมข้นคืนรูปไม่หวานชนิดพร่องมันเนย

(1.4.7) "นมข้นคืนรูปหวานพร่องมันเนย" สำหรับนมข้นคืนรูปหวานชนิดพร่องมันเนย

(1.4.8) "นมข้นคืนรูปไม่หวานขาดมันเนย" สำหรับนมข้นคืนรูปไม่หวานชนิด
ขาดมันเนย

(1.4.9) "นมข้นคืนรูปหวานขาดมันเนย" สำหรับนมข้นคืนรูปหวานชนิดขาดมันเนย

(1.5) นมแปลงไขมันตามข้อ 9 ให้ใช้ชื่อดังนี้

(1.5.1) "นมแปลงไขมัน........" (ความที่เว้นไว้ให้ระบุกรรมวิธีฆ่าเชื้อตามข้อ11) สำหรับนมแปลงไขมันชนิดเต็มไขมัน

(1.5.2) "นมแปลงไขมันชนิดพร่องไขมัน ...." หรือ "นมแปลงไขมัน ....ชนิดพร่องไขมัน" (ความที่เว้นไว้ให้ระบุกรรมวิธีฆ่าเชื้อตามข้อ 11) สำหรับนมแปลงไขมันชนิดพร่องไขมัน

(1.5.3) "นมผงแปลงไขมัน" สำหรับนมผงแปลงไขมันชนิดเต็มไขมัน

(1.5.4) "นมผงแปลงไขมันชนิดพร่องไขมัน" สำหรับนมผงแปลงไขมันชนิดพร่องไขมัน

(1.5.5) "นมข้นแปลงไขมันไม่หวาน" สำหรับนมข้นแปลงไขมันไม่หวานชนิดเต็มไขมัน

(1.5.6) "นมข้นแปลงไขมันไม่หวานชนิดพร่องไขมัน" สำหรับนมข้นแปลงไขมันไม่หวานชนิดพร่องไขมัน

(1.5.7) "นมข้นแปลงไขมันหวาน" สำหรับนมข้นแปลงไขมันหวานชนิดเต็มไขมัน

(1.5.8) "นมข้นแปลงไขมันหวานชนิดพร่องไขมัน" สำหรับนมข้นแปลงไขมันหวานชนิดพร่องไขมัน

การใช้ชื่ออาหารของนมโคอาจใช้ชื่อทางการค้าได้ แต่ต้องมีข้อความตาม (1) แล้วแต่ชนิดของนมโคกำกับชื่ออาหารด้วย โดยจะแสดงอยู่ในบรรทัดเดียวกับชื่อทางการค้าก็ได้ และจะมีขนาดตัวอักษรต่างกับชื่อทางการค้าก็ได้ แต่ต้องสามารถอ่านได้ชัดเจน

(2) การแสดงข้อความสำหรับนมโคบางชนิด ดังนี้

(2.1) ข้อความว่า "อย่าใช้เลี้ยงทารก" ด้วยตัวอักษรเส้นทึบสีแดง ขนาดความสูงไม่น้อยกว่า 5 มิลลิเมตร ในกรอบสี่เหลี่ยมพื้นขาว สีของกรอบตัดกับสีพื้นของฉลาก สำหรับนมโคตามข้อ 6(2) และ (3) ข้อ 7(3) และ (5) ข้อ 8(6) และ (8) และข้อ 9(1)(2)(3)(4)(5) และ (6)

(2.2) ข้อความว่า "อย่าใช้เลี้ยงทารกอายุต่ำกว่า 1 ปี" ด้วยตัวอักษรเส้นทึบสีแดง ขนาดความสูงไม่น้อยกว่า 5 มิลลิเมตร ในกรอบสี่เหลี่ยมพื้นขาว สีของกรอบตัดกับสีของพื้นฉลาก สำหรับนมโคตามข้อ 7(2) (4) และ (6) ข้อ 8(5) (7) และ (9) และข้อ 9(7) และ (8)

ข้อ 25 ผู้ที่ได้รับใบสำคัญการขึ้นทะเบียนตำรับอาหาร ซึ่งออกให้ตามประกาศกระทรวงสาธารณสุข ฉบับที่ 26 (พ.ศ.2522) เรื่อง กำหนดนมโคเป็นอาหารควบคุมเฉพาะและกำหนดคุณภาพหรือมาตรฐานและวิธีการผลิต ลงวันที่ 13 กันยายน พ.ศ.2522 ซึ่งแก้ไขเพิ่มเติมโดยประกาศกระทรวงสาธารณสุขฉบับที่ 149 (พ.ศ.2536) เรื่อง กำหนดนมโคเป็นอาหารควบคุมเฉพาะและกำหนดคุณภาพหรือมาตรฐานและวิธีการผลิต (ฉบับที่ 2) ลงวันที่ 11 ตุลาคม พ.ศ.2536 และประกาศกระทรวงสาธารณสุข (ฉบับที่ 218) พ.ศ.2544 เรื่อง กำหนดนมโคเป็นอาหารควบคุมเฉพาะและกำหนดคุณภาพหรือมาตรฐานและวิธีการผลิต (ฉบับที่ 3) ลงวันที่ 8 มิถุนายน พ.ศ.2544 และผู้ที่ได้รับใบสำคัญการใช้ฉลากอาหารซึ่งออกให้ตามประกาศกระทรวงสาธารณสุข ฉบับที่ 68 (พ.ศ. 2525) เรื่อง ฉลาก ลงวันที่ 29 เมษายน พ.ศ.2525 ซึ่งแก้ไขเพิ่มเติมโดยประกาศกระทรวง

สาธารณสุข ฉบับที่ 95 (พ.ศ.2528) เรื่อง ฉลาก (ฉบับที่ 2) ลงวันที่ 30 กันยายน พ.ศ.2528 หรือประกาศกระทรวงสาธารณสุข (ฉบับที่ 194) พ.ศ.2543 เรื่อง ฉลาก ลงวันที่ 19 กันยายน พ.ศ.2543 ซึ่งแก้ไขเพิ่มเติมโดยประกาศกระทรวงสาธารณสุข (ฉบับที่ 252) พ.ศ.2545 เรื่อง ฉลาก (ฉบับที่ 2) ลงวันที่ 30 พฤษภาคม พ.ศ.2545 อยู่ก่อนวันที่ประกาศนี้ใช้บังคับให้ปฏิบัติ ดังนี้

(1) ยื่นคำขอแก้ไขรายละเอียดให้ถูกต้องตามประกาศนี้ ภายในหนึ่งร้อยแปดสิบวันนับแต่วันที่ประกาศนี้ใช้บังคับ และเมื่อได้ยื่นคำขอดังกล่าวแล้วให้ใช้ฉลากเดิมที่เหลืออยู่ต่อไปได้ ดังนี้

(1.1) ฉลากที่ไม่แสดงเลขสารบบอาหาร ให้ใช้ได้ไม่เกินวันที่ 23 กรกฎาคม พ.ศ.2546

(1.2) ฉลากที่แสดงเลขสารบบอาหาร ให้ใช้ได้ไม่เกินหนึ่งปีนับแต่วันที่ประกาศนี้ใช้บังคับ

(2) ดำเนินการให้เป็นไปตามข้อ 22 ภายในวันที่ 23 กรกฎาคม พ.ศ.2546

ข้อ 26 ประกาศนี้ ให้ใช้บังคับตั้งแต่วันถัดจากวันประกาศในราชกิจจานุเบกษาเป็นต้นไป

ประกาศ ณ วันที่ 19 ธันวาคม พ.ศ. 2545

ลงชื่อ สุดารัตน์ เกยุราพันธุ์

(นางสุดารัตน์ เกยุราพันธุ์)

รัฐมนตรีว่าการกระทรวงสาธารณสุข

(คัดจากราชกิจจานุเบกษาฉบับประกาศทั่วไป เล่ม 120 ตอนพิเศษ 4 ง. ลงวันที่ 10 มกราคม พ.ศ. 2546)

<u>บัญชีแนบท้ายประกาศกระทรวงสาธารณสุข (ฉบับที่ 265) พ.ศ.2545 เรื่อง นมโค</u>

1. หลักเกณฑ์การใช้วัตถุเจือปนอาหารในนมผงและนมผงแปลงไขมัน

อันดับ	วัตถุประสงค์	ชื่อวัตถุเจือปนอาหาร	ปริมาณสูงสุดที่ให้ใช้ได้ (มิลลิกรัมต่อ 1 กิโลกรัม)
1.	สเตบิไลเซอร์ (Stabilizers)	โซเดียมซิเตรต (Sodium citrates) โพแทสเซียมซิเตรต (Potassium citratess)	5,000 ใช้อย่างเดียว หรือใช้ร่วมกันคำนวณในสภาพปราศจากน้ำ
2.	วัตถุทำให้คงรูป (Firming agents)	โพแทสเซียมคลอไรด์ (Potassium chloride)	ปริมาณที่เหมาะสมตามความจำเป็นในการผลิต
		แคลเซียมคลอไรด์(Calcium chloride)	
3.	สารปรับความเป็นกรด - ด่าง (Acidity Regulators)	โซเดียมฟอสเฟต (Sodiumphosdphates) โพแทสเซียมฟอสเฟต (Potassiumphosphates) ไดฟอสเฟต (Diphosphates) ไตรฟอสเฟต (Triphosphates) โพลีฟอสเฟต (Polyphosphates) โซเดียม คาร์บอเนต (Sodium carbonates)โพแทสเซียมคาร์บอเนต (Potassium carbonates)	5,000 ใช้อย่างเดียว หรือใช้ร่วมกัน คำนวณในสภาพปราศจากน้ำ

4.	อีมัลซิไฟเออร์ (Emulsifiers)	เลซิติน (Lecithins or phospholipids from natural sources)	ปริมาณที่เหมาะสมตามความจำเป็นในการผลิต
		โมโนและไดกลีเซอไรด์ (Mono - and diglycerides of fatty acide)	2,500
5.	วัตถุกันการรวมตัวเป็นก้อน (Anti - caking Agents)	แคลเซียมคาร์บอเนต (Calcium carbonate) ไตรแคลเซียม ออโธฟอสเฟต (Tricalcium orthophosphate) ไตรแมกนีเซียม ออโธ ฟอสแฟต (Trimagnesium orthophosphate) แมกนีเซียมคาร์บอเนต (Magnesium carbonate) แมกนีเซียม ออกไซด์ (Magnesium oxide) ซิลิคอน ไดออกไซด์ (Silicon dioxide, amorphous) แคลเซียม ซิลิเคต (Calcium silicate) แมกนีเซียมซิลิเคต (Magnesium silicate) โซเดียม อะลูมิโนซิลิเคต (Sodium aluminosilicate)	10,000ใช้อย่างเดียวหรือใช้ร่วมกัน

		แคลเซียม อะลูมิเนียม ซิลิเคต (Calcium aluminium silicate) อะลูมิเนียม ซิลิเคต (Aluminium silicate)	
		โพลีไดเมทิลซิลอกเซน (Polydimethylsiloxane)	10
6.	วัตถุกันหืน (Antioxidants)	กรดแอล - แอสคอร์บิก (L - Ascorbic acid) โซเดียมแอสคอร์เบต (Sodium ascorbate) แอสคอร์บิลปาล์มิเตต (Ascorbyl palmitate)	500 คำนวณเป็นกรดแอสคอร์บิก
		บิวทิเลตเตตไฮดรอกซิอะนิโซล (Butylated hydroxyanisole BHA)	100

2. หลักเกณฑ์การใช้วัตถุเจือปนอาหารในนมข้น นมข้นคืนรูปและนมข้นแปลงไขมัน

อันดับ	วัตถุประสงค์	ชื่อวัตถุเจือปนอาหาร	ปริมาณสูงสุดที่ให้ใช้ได้ (มิลลิกรัมต่อ 1 กิโลกรัม)
1.	สเตบิไลเซอร์ (Stabilizers)	โซเดียมซิเตรต (Sodium citrates) โพแทสเซียมซิเตรต (Potassium citrates) แคลเซียมซิเตรต (Calcium citrates)	2,000 ใช้อย่างเดียว หรือ 3,000 ใช้ร่วมกันคำนวณในสภาพที่ปราศจากน้ำ
2.	วัตถุทำให้คงรูป (Firming agents)	โพแทสเซียม คลอไรด์ (Potassiumchloride) แคลเซียม คลอไรด์ (Calcium chloride)	2,000 ใช้อย่างเดียว หรือ 3,000 ใช้ร่วมกัน คำนวณในสภาพที่ปราศจากน้ำ
3.	สารปรับความเป็นกรด - ด่าง (Acidity Regulators)	แคลเซียม คาร์บอเนต (Calciumcarbonates) โซเดียม ฟอสเฟต (Sodium phosphates) โพแทสเซียม ฟอสเฟต (Potassiumphosphates) แคลเซียม ฟอสเฟต (Calciumphosphates) ไดฟอสเฟต (Diphosphates) ไตรฟอสเฟต (Triphosphates) โพลีฟอสเฟต (Polyphosphates)	2,000 ใช้อย่างเดียว หรือ 3,000 ใช้ร่วมกัน คำนวณในสภาพที่ปราศจากน้ำ

		โซเดียม คาร์บอเนต (Sodium carbonates) โพแทสเซียม คาร์บอเนต (Potassiumcarbonates)	
4.	อีมัลซิไฟเออร์ (Emulsifier)	เลซิติน (Lecithins)	ปริมาณที่เหมาะสมตามความจำเป็นในการผลิต
5.	สารทำให้ข้น (Thickener)	คาราจีแนน (Carrageenan)	150

Appendix C

Standard method for milk proximate analysis

1. Fat analysis

The traditional standard methods for fat analysis are based on gravimetric method or volumetric method. They involve destruction of the globule structure of the butterfat, separation and then either drying and weighing of the fat or reading off the amount on a calibrated tube. The most commonly used methods are:

1.1 Rose-Gottlieb method. These methods, widely used for dairy products. They involve dissolution of non-fat solids in ammonia rather than the acid. The fat is then extracted using solvents i.e. diethylether and petroleum ether, with the addition of ethanol to avoid emulsion formation. The solvent is then removed and fat residue weighed.

1.2 Mojonnier method. Fat is extracted with a mixture of ethyl ether and petroleum ether in a Mojonnier flask, and the extracted fat is dried to a constant weight and expressed as percent fat by weight.

1.3 Babcock method. In the Babcock method, H_2SO_4 is added to known amount of milk in the Babcock bottle. The sulfuric acid digests protein, generates heat, and releases the fat. Centrifugation and hot water addition isolate fat for quantification in the graduated portion of the test bottle. The fat is measured volumetrically, but the result is expressed as percent fat by weight.

1.4 Gerber method. The principle of the Gerber method is similar to that of the Babcock method, but it uses sulfuric acid and amyl alcohol. The sulfuric acid digests proteins and carbohydrates, release fat, and maintain the fat in a liquid state by generating heat.

2. Protein analysis

The traditional standard method for protein analysis is the Kjeldahl method, which is also the most accurate. In the Kjeldahl procedure and other organic food components in a sample are digested with sulfuric acid in the presence of catalysts.

The total organic nitrogen is converted to ammonium sulfate. The digest is neutralized with alkali and distilled into a boric acid solution. The borate anions formed are titrated with standardized acid, which is converted to nitrogen in the sample. The result of the analysis represents the crude protein content of the food since nitrogen also comes from non protein components.

3. Lactose analysis

The most commonly used standard method for determination of lactose is Polarimetric method. This procedure, which makes use of instruments known as polarimeters, is based on the principle that sugars such as lactose are optically active, i.e. they will rotate the direction of a beam of plane polarized light (light of one wavelength moving in one plane), the amount of rotation being dependent on the concentration of sugars in solution.

A second method of lactose analysis is an enzymatic method, which is specific for lactose. It is based on the enzymatic breakdown of lactose molecules into glucose and galactose. Finally, some carbohydrates including lactose can be measured by exploiting their ability to reduce other reagents, which are determined either gravimetrically.

4. Total solid (TS) and solid not fat (SNF) analysis

The most commonly used standard method for determination of total solid is Air oven drying method. In this method, the sample is heated under specified conditions, and the loss of weight is used to calculate the total solid content of the sample. For solid not fat can calculate by difference between total solid.

BIOGRAPHY

NAME	Miss Benjaporn Narinrak
DATE OF BIRTH	March 28, 1978
PLACE OF BIRTH	Udonthani, Thailand
INSTITUTION ATTENED	Srinakharinwirot University, 1997-2000: Bachelor of Science (Biology)
	Mahidol University, 2002-2004: Master of Science (Biotechnology)
WORK EXPERIENCE	Scientist at the Laboratory of Milk hygiene and Milk products, Department of Livestock Development, Ministry of Agriculture and Cooperatives, Thailand, 2000-2001