

PENELITIAN SUSU SKIM DAN HOMOGENISASI MEDIA BESAR MENGUNAKAN MEDIA *LACTIC* M37 DAN PENGARUHNYA PADA NILAI GIZI KEJU

*(A STUDY OF SKIM MILK AND BULK CULTURE HOMOGENIZATION USING
LACTIC CULTURE M37 AND ITS EFFECT ON CHEESE YIELD)*

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Abstrak

Homogenisasi susu skim pada 7 (satu tahap), 71 dan 176 kg/cm² dua tahap, 35 kg/cm² tahap kedua) sering digunakan pada pabrik keju. Sebagian besar dari susu skim terbentuk menjadi keju kotak yang diinokulasi dengan media *Lactic* M37. Awalnya sebagian besar dari media *Lactic* M30 dihomogenkan pada 0,35 (satu tahap), 106 dan 246 kg/cm² (dua tahap, 35 kg/cm² pada tahap kedua). Penggunaan 4 media *bulk* yang berbeda dengan 3 perlakuan skim susu menghasilkan 12 kombinasi perlakuan susu skim *starter*. Semua kombinasi perlakuan tersebut dihitung menggunakan rancangan acak menurut pembuatannya. Percobaan tersebut dilakukan 4 kali untuk membuat 48 tong bangkahan keju. Homogenisasi susu skim pada 71 kg/cm² (dua tahap, 35 kg/cm² pada tahap kedua) atau lebih atau homogenisasi dari media *bulk* pada 246 kg/cm² (dua tahap, 35 kg/cm² pada tahap kedua) keduanya dapat mengurangi nilai gizi keju.

Kata kunci : kotak keju, homogenisasi, media *lactic* M37

Abstract

Skim milk homogenization at 7 (single stage), 71 and 176 kg/cm² (dual stage, 35 kg/cm² second stage) was used in the manufacture of cottage cheese. Each lots of skim milk manufactured into cottage cheese was inoculated with lactic culture M37. Bulk starter of lactic culture M30 was homogenized at 0, 35 (single stage), 106, and 246 kg/cm² (dual stage, 35 kg/cm² second stage). The use of 4 different bulk culture with 3 different skim milk treatments produced a total of 12 bulk starter skim milk treatment combinations. All 12 bulk starter skim milk treatment combinations were randomized prior to their manufacture. The experiment was replicated four times to the manufacture of 48 vats of cottage cheese. Either homogenization of skim milk at 71 kg/cm² (dual stage, 35 kg/cm² second stage) or greater or homogenization of bulk culture at 246 kg/cm² (dual stage, 35 kg/cm² second stage) reduced yield loss.

Key words : cottage cheese, homogenization, lactic culture M37

INTRODUCTION

Research has been done to increase cheese yield using protease-negative starter cultures (Ekart et al., 1986; Stoddard and Richardson, 1986). The advantages of protease-negative starter culture include: (1) reduction of

the bitter-flavor defect associated with some protease-positive starter cultures; (2) enhanced phage resistant; and (3) increase cheese yield. The level of protease activity for protease-negative starter cultures can vary from almost no activity to nearly the activity of a

protease-positive starter culture. The most protease-negative mutants from agglutination resistant cultures would also agglutinate, however some do not. They suggested that it may be possible to reduce agglutination sensitivity of some strains by proper mutant selection.

There were three species of lactic *Streptococci*; *Streptococcus lactis*, *Streptococcus cremoris* and *Streptococcus diacetylactis*. These organisms have been renamed in the current nomenclature. There are now two species of lactic *Lactococci*; *Lactococcus lactis* subsp. *lactis* (formerly *Streptococcus lactis*) and *Lactococcus lactis* subsp. *cremoris* (formerly *Streptococcus cremoris*).

Agglutination of some Lactic *Lactococci* occurs less than 1 hour after inoculation of the culture into skim milk. They suggested that high concentrations of naturally-occurring agglutinins or immune-proteins in bulk milk could result in inconsistent product quality and yield loss for manufacture of rennet-coagulated cheeses.

METHODS OF RESEARCH

Design of Experiment

A model systems was developed to determine the effect of agglutination on cheese yield. One agglutination sensitive culture was selected which produced the type of problems that are present in commercial culture in the manufacture of cottage cheese. Severity of agglutination was set by homogenizing skim milk at three different pressures. Effect of culture chain length on agglutination was determined by homogenizing the bulk culture at four different pressures. All four homogenized bulk cultures were added to each of the homogenized skim milk treatments. Each treatment combination was replicated four times. This randomized split block design was used to study the effect of severity of agglutination in skim milk on the resulting cheese yield.

Skim Milk Preparation

Grade A raw milk (am and pm milking) was separated to produce skim milk. To set the degree of agglutination severity that would occur the skim milk was divided into three lots and homogenized at 7 kg/cm² (single stage), and 71 and 176 kg/cm² (dual stage, 35 kg/cm² second stage). All lots of skim milk were pasteurized at 63 °C for 30 min, cooled to 4 °C and refrigerated until the following day. Immediately before each trial, the skim milk was warm to 31 °C.

Media Preparation

Non-fat dried milk was reconstituted to 10% solids with water and autoclaved at 121 °C for 10 minutes. After cooling to room temperature (approximately 25 °C), the transfer culture medium was ready to be used.

Bulk Culture Medium

Internal pH control medium (ICM), was prepared by mechanically mixing 75.7 g/l water. Therefore, 12.14 kg of ICM medium was added to 200 liter of water, heated for 45 minutes at 85 °C in a batch tank, cooled to approximately 22 °C and inoculated with the appropriate transfer culture.

Source of Culture

Commercially mixed strain culture, lactic culture M37 (Miles Laboratory, Inc.) as frozen stock cultures and was stored at -80 °C. A different frozen stock culture of lactic culture M30 was used to prepare bulk culture for each replication.

Transfer Culture

Approximately 1 g of frozen stock culture was inoculated into 9 ml of transfer culture medium and inoculated at 26 °C for about 5 hours or until coagulation occurred. Each tube of the coagulated culture was then transferred into 100 ml transfer culture medium (total volume was 110 ml of fortified NFDM) and incubated at 26 °C for about 8 hours or until coagulation occurred. Propagation of the culture was repeated

one time to obtained actively growing culture of the desired quantity of 1000 ml for each culture. This culture was now ready to inoculate 100 liter of the prepared bulk starter medium.

Bulk Starters

Active transfer culture was used to inoculate each ICM bulk starter medium at the rate of 1%. Bulk starter was incubated with continuous agitation at room temperature (22 to 25 °C) overnight. Finished bulk starter had a final pH ranging between 5.0 and 5.2.

Homogenization of Bulk Starter

The bulk culture was divided into four fraction that were homogenized at 0,35 (single stage) and 105, and 246 kg/cm² dual stage, 35 kg/cm² second stage). This prosedur produced 4 different bulk cultures.

Manufacture of Cottage Cheese

In randomization of treatment combinations, skim milk homogenization at 7 kg/cm² (single stage), 71, and 176 kg/cm² (dual stage, 35 kg/cm² second stage) was used in the manufacture of cottage cheese. Each lots of skim milk manufactured into cottage cheeses was inoculated with an assaigned bulk starter. Therefore, the use of 4 different bulk starters with 3 different skim mik treatments produced a total of 12 bulk starter-skim milk treatment combinations. All 12 bulk starter-skim milk treatment combinations were randomized prior to their manufacture. The experiment was replicated four times resulting in the manufacture of 48 vats of cottage cheese.

Only six randomized treatment combinations could be manufacture at one times. After the first six vats had been incubated for 3 hours, a second group of 6 vats was started.

Immediately before cheese manufacture, skim milk (4 °C) was warmed to 31 °C. Approximately 7000 g of skim milk were weighed into each of 6 pre-tared experimental cheese vats (Hicks et al., 1981). Prepared bulk starter culture was added at 5%

inoculation level. The inoculated skim milk was agitated (1 min) and set with a small amount of rennet (0.006 ml/7000 g milk). When the pH reached 4.7 to 4.8 the curd was cut and allowed to heal for 15 min. The curd was cooked by raising the temperature to 52 °C in 1 hour and holding at the temperature for 15 min. The curd was drained through a double layer of cheesecloth. After draining the outside layer of cheesecloth was removed and the remaining single layer of cheesecloth was gathered around the curd, tied with string and suspended to complete drainage. After 1 hour the string was removed and the cottage cheese curd weighed. The weight of the cheesecloth was subtracted from the cheese.

Cheese Total Solids

Duplicate 3 g of cottage cheese curd samples were placed in pre-weighed aluminum dishes and dried immediately (after the sample was collected) in an oven at 98-100oC for 16 hours (AOAC, 1980). Dishes were then cooled in a desicator and reweighed.

Percent total solids was calculated as:

$$\% \text{ Total solids} = (\text{dry weight}) \times 100 / \text{wet weight}$$

Dry matter cheese yield (DMYIELD) was calculated as follow:

$$\text{DMYIELD} = (\text{cheese wet weight} \times \text{cheese total solids}) \times 100 / \text{skim milk weight}$$

Statistical Analysis.

Data were analyzed using SAS (SAS Institute, Inc., 1985) procedures using the following general linear model.

$$\text{Model DMYIELD} = \text{SMP} + \text{BSP} + \text{SMP} \times \text{BSP SMTS/SS4}$$

Where: DMYIELD - dependent variable;
BSP = Bulk Starter Homogenization Pressure = Random - independent variable, SMP = Skim Milk Homogenization Pressure = Random -

independent variable, SMTS = Total Solids of Skim Milk - covariant

Least square means and predicted differences between means were computed for each dependent variable analyzed using type IV sum of square (SS4).

RESULT AND DISCUSSION

A. Skim Milk Composition.

Skim milk contained 9.54% total solids, 3.38% protein, and 0.24% fat. Composition of skim milk is shown in Table 1.

Table 1. Skim milk composition

Number	Composition	Average (%)
1	Total solids	9.54
2	Total protein	3.38
3	Total fat	0.24

B. Homogenization of Skim Milk

Dry matter is the amount of total solids retained in the cheese mass. This measurement determines the actual amount of cheese that can be obtained under a specific manufacturing condition. Dry matter measurements are not affected by variation in curd moisture contents. Therefore, dry matter measurements are an accurate measurement of actual cheese yield.

The data show that dry matter cheese yield increased linearly ($p < 0.0001$) (Table 2) as the homogenization pressure applied to skim milk increased.

Table 2. Effect of skim milk homogenization on dry matter yield when skim milk was set with lactic culture M37

SMH ^a kg/cm ²	DMYLD ^b LSMEANS	p>t	comparison of all means		
			1	2	3
7	3.12	---	0.0001	0.0001	
71	3.27		---	0.0362	
176	3.34			---	

C.V. = 2.24; ^aSMH = Skim Milk Homogenization; ^bDMYLD = Dry matter

cheese yields (kg/100kg skim milk) = (cheese wet weight x % cheese total solids) x 100/skim milk weight

No significant increase in dry matter cheese yield occurred when skim milk was homogenized at a pressure greater than 71 kg/cm² (dual stage, 35 kg/cm² second stage).

C. Homogenization of Bulk Culture

Dry matter cheese yield also increased ($p < 0.0001$) as the pressure of homogenization applied to bulk culture increased (Table 3).

No significant increase of dry matter cheese yield occurred when homogenization pressure applied to bulk culture increased from 35 kg/cm² (single stage) to 106 kg/cm² (dual stage, 35 kg/cm² second stage). Also no significant increase of dry matter cheese yield occurred when homogenization pressure applied to bulk culture increased from 106 kg/cm² (dual stage, 35 kg/cm² second stage) to 246 kg/cm² (dual stage, 35 kg/cm² second stage).

Table 3. Effect of bulk culture homogenization on dry matter yield when skim milk was set with lactic culture M37

BCH ^a kg/cm ²	DMYLD ^b LSMEANS	p>t	comparison of all means		
			1	2	3
0	3.11	---	0.0024	0.0001	0.0001
35	3.23		---	0.2167	0.0069
106	3.28			---	0.1045
246	3.35				---

C.V. = 2.24; ^aBCH = Bulk Culture Homogenization; ^bDMYLD = Dry matter cheese yields (kg/100kg skim milk) = (cheese wet weight x % cheese total solids) x 100/skim milk weight

When non-agglutinated milk was manufactured into cottage cheese a greater cheese yield was realized. As much as .22 kg cheese/100 kg milk was lost by manufacturing cottage cheese from agglutinated skim milk. If dry matter solids are computed to wet cottage cheese containing 80% moisture the loss would be (.22g/.2) 1.1 kg cheese curd loss/100 kg skim milk. This would represent a 6.9% loss of the total curd.

Normally cottage cheese is retailed after the curd has been mixed with a cream dressing that is approximately equal to the weight of the curd. This would also result in 7% less finished cottage cheese (approximately 2.2 kg finished cottage cheese/100 kg of initial skim milk) available to package.

If cottage cheese wholesale for \$2.20/kg and only the loss of curd is considered, a manufacture could loose up to \$2.42/100 kg of initial skim milk. This would be a loss of \$387.20 per 16.000 kg vat. Many cottage cheese manufacturers' produce as many as 10 vats/day and could incur a loses up to \$3,872.00/manufacturing day.

CONCLUSION

Agglutination of skim milk decreased the resulting cheese yield. However, either homogenization of skim milk at 71 kg/cm² (dual stage, 35 kg/cm² second stage) or greater or homogenization of bulk culture at 246 kg/cm² (dual stage, 35 kg/cm² second stage) would significantly reduce cheese yield loss.

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