

Research Article

## Development of low fat set-type probiotic yoghurt from goat milk

W. Seelee<sup>2</sup>, W. Tungjaroenchai\*<sup>1</sup>, and M. Natvaratat\*<sup>2</sup>

<sup>1</sup>Faculty of Agro-Industry, King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand.

<sup>2</sup>Royal Chitralada Projects, Dusit Palace, Bangkok 10303, Thailand.

\*Authors to whom correspondence should be addressed, email: [wannat79@yahoo.com](mailto:wannat79@yahoo.com) and [mayarachatn@hotmail.com](mailto:mayarachatn@hotmail.com)

This paper was originally presented at Food Innovation Asia, Bangkok, Thailand, August 2009.  
Received 22 June 2009, Revised 25 December 2009, Accepted 27 December 2009.

---

### Abstract

Pasteurized cow's and goat's milk were fortified with 3% skim milk powder (SKM). Goat's milk was also fortified with 3% or 5% whey protein concentrate (WPC). Yoghurt milks had 1.0±0.05% fat and 10.0±1.0% total solids. Milk was inoculated with DVS-mixed cultures containing *Streptococcus thermophilus*, *L. delbrueckii subsp. Bulgaricus*, *Lactobacillus acidophilus* and *Bifidobacterium lactis*. Incubation was carried out at 43°C until pH 4.5 was reached and yoghurts were stored at 4°C for 21 days. Yoghurts were investigated during fermentation and refrigerated storage for pH, titratable acidity (TA), viability of microorganisms and sensory quality. Enrichment of milk with 5% WPC reduced fermentation time, improved gel viscosity of yoghurt, and increased viable counts of *S. thermophilus*, *L. bulgaricus*, *L. acidophilus* and *B. lactis* by 1.0, 0.6, 1.3, and 1.1 log units. Goat's milk yoghurt with WPC had better sensory characteristics in terms of flavour, smoothness and viscosity than those of cow's milk yoghurt.

**Keywords:** Goat's milk, probiotics, yoghurt, dairy, Thailand.

---

### Introduction

Fermented dairy products have been a major part of the diet of people around the world. Several scientific papers [10, 13, and 17] have been published on the health benefits associated with the consumption of fermented dairy product. Over the past decade considerable interest has developed in the applications of probiotic organisms in foods. Presence of live microorganism, in particular lactic acid bacteria (LAB), in food has been traditionally associated with certain health benefits. In order to exert any beneficial health

impact, the concentration of probiotics in a product that serves as a delivery system need to be high. Suggested minimum level for therapeutic benefit of probiotic bacteria in fermented milk is from  $10^6$  to  $10^7$  cfu/ml [11].

Goat's milk has special nutritional properties that attract to consumers. Goat's milk product has been described as having a higher digestibility and lower allergenic properties than cow's milk [16], thus reasonable demand of goat' milk product is growing. The use of goat's milk is an opportunity to expand the dairy market; it allows us to develop fermented products with particular characteristics. Goat's milk has been attributed with certain therapeutic benefits led to an increase in the incorporation of probiotics such as *Lactobacilli* and *Bifidobacteria*, in human nutrition [1]. Goat's milk has slightly lower casein content than cow's milk, with a very low proportion or absence of  $\alpha_{s1}$ -casein, and a higher degree of casein micelle dispersion [18, 23], thus, coagulum of goat's milk was almost semi liquid.

The aim of this work was to develop set-type yoghurt from goat's milk with whey protein concentrate fortification. Survivals of probiotic bacteria during cold storage were determined, and sensory characteristics of goat's milk yoghurt were evaluated.

## Materials and Methods

### *Preparation of yoghurts*

Cow's milk (fat  $1\pm 0.05\%$ , Total solid (TS)  $10\pm 0.05\%$ ) was fortified with 3% skim milk powder (SKM) (TS 95.5%, protein 36% and fat 0.09%, Bonlac, Australia) as treatment (A), and goat's milk fortified with 3% SKM as treatment (B). Goat's milk was fortified with 3 % whey protein concentrate (WPC) (TS 96.0%, protein 40% and fat 0.08%, Enka U.S.A) for treatment (C), and goat's milk fortified with 5% WPC for treatment (D). Stabilizer (5842 Palsgard, Denmark) 0.7 % (w/w) was added to the milk treatments, then pre-heated to  $65^\circ\text{C}$  for 15 min. Yoghurt milks were pasteurized at  $85^\circ\text{C}$  for 15 sec and cooled to  $43 \pm 0.5^\circ\text{C}$ . Direct vat culture ABY-2 (Chr. Hansen, Denmark) containing *Streptococcus thermophilus*, *Lactobacillus acidophilus*, *L. delbrueckii subsp. Bulgaricus* and *Bifidobacterium* were used for inoculation yoghurt milks. Starter culture 0.02 % (w/w) was added to yoghurt milks and incubation was controlled at  $43 \pm 0.5^\circ\text{C}$  until pH  $4.5\pm 2$  was reached.

### *Determination of pH and acidity*

Acidity of yoghurt was determined by a standard method [2] and pH value was measured using a pH meter (Hanna Instrument- model 221, U.S.A.). Yoghurt samples were monitored for acidity and pH during the fermentation (0-12h), after fermentation for 0, 7, 14 and 21 days at  $4^\circ\text{C}$  storage.

### *Determination of viability*

Viable counts were determined after fermentation for 1, 7, 14 and 21 days. An 11-g yoghurt sample was diluted with 99 ml of 0.1% sterile peptone water (Oxoid, England). Enumerations of *S. thermophilus*, *L. acidophilus*, *L. bulgaricus* and *B. lactis* were performed as described by [4, 5, and 6]. Counts of *S.thermophilus* were enumerated on M-17 agar (Oxoid,U.K.), and aerobically incubated at  $43^\circ\text{C}$  for 72 h. *L. bulgaricus* were enumerated on MRS agar (Scharlau, Spain), and anerobically incubated at  $37^\circ\text{C}$  for 72 h (Gas-pack, Anaerogen ; Oxoid,U.K.). Enumeration of *L. acidophilus* was on MRS agar plates (Scharlau, Spain) supplemented with  $20 \text{ gml}^{-1}$  maltose (Merck, Germany), and anaerobical incubation at  $37^\circ\text{C}$  for 72 h. (Gas-pack, Anaerogen; Oxoid, U.K.). *B. lactis* was enumerated on MRS agar (Scharlau, Spain) supplemented with  $0.1 \text{ gL}^{-1}$  dichloxallin (Sigma, U.S.A), 2

$\text{gL}^{-1}$  LiCl (Unilab, California),  $0.1 \text{ gL}^{-1}$  Cysteine (Merck, Germany), and  $20 \text{ gml}^{-1}$  glucose (Merck, Germany). Anaerobic incubation at  $37^{\circ}\text{C}$  for 72 h was controlled (Gas-pack, Anaerogen; Oxoid, U.K.).

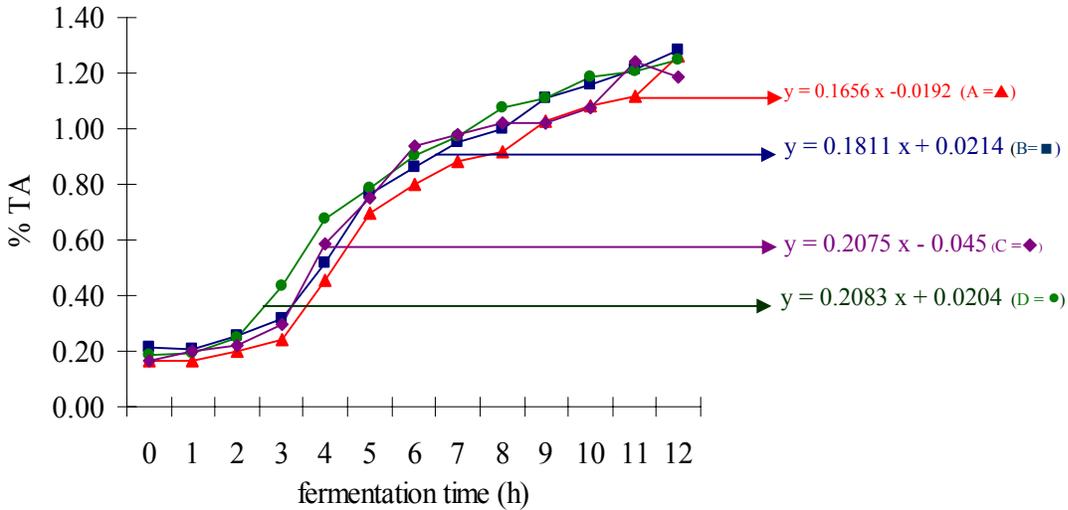
### ***Descriptive sensory evaluation***

Ten sensory panelists were selected on their willingness basis, experience and knowledge on sensory evaluation of dairy products. Panelists were staff members of the quality control division at Royal Chitralada Dairy Plant, Bangkok. Range of their ages was between 24 to 34 years. The Spectrum descriptive analysis was performed on yogurts, and the universal intensity scale from 0 to 15 was followed [17], where 0 = not detected and 15 = extremely strong. During training sessions, panelists were asked to identify, and define appearance, texture, and aroma and flavor attributes for yoghurts. Panelists were familiar with the intensity scale and some references from previous sensory analysis. Panelists received approximately 30-hour training with focus on yogurt. All samples were removed from the refrigerator and serving temperature range for samples was 10 to  $12^{\circ}\text{C}$  for evaluation.

## **Results and Discussion**

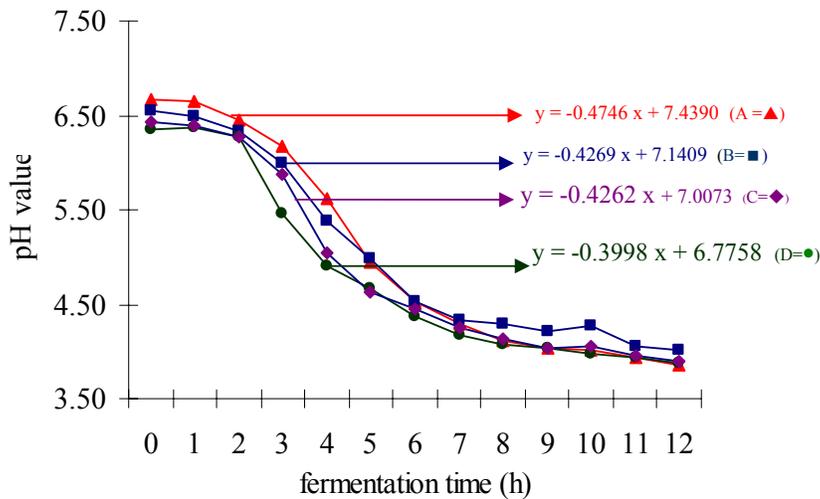
### ***pH and acidity***

Titrateable acidity (TA) of yoghurt during fermentation for 12 h. is shown in Fig 1. Increasing TA values was detected in all treatments, algebraic straight line equations of increasing acidity in four milk treatments during 2-7 h. fermentation at  $43 \pm 0.5^{\circ}\text{C}$  was calculated. Slope of TA value in sample D was 0.2083, thus increasing period of fermentation resulted in increasing acid values, and the algebraic equation was:  $y = 0.2083 x + 0.0204$ . Thus, fermentation period increased for 1 hour affected an increase in acid quantity for 0.2287 %. Treatment C yielded a slope of 0.2075 and the algebraic equation was  $y = 0.2075 x - 0.0045$ . This algebraic equation showed that fermentation time increased for 1 hour effected increase in acid quantity for 0.2030 %. In addition, treatment B had a smaller slope value of 0.1811, and an expansion character of acid quantity was similar to samples C and D. Thus, the %TA value was 0.2025% change, when the fermentation period passed by 1 h. Cow's milk yoghurt (A) had the lowest rate of acid production with the algebraic equation of  $0.1656 x + 0.0192$ . This finding of better acid production in goat's milk corresponded to [12, 20] who found that goat milk yoghurt had a fast rate of acid production more than the cow's milk yoghurt. Moreover, WPC in milk increased higher TA than that of SKM, [7] reported that lower value of pH was found in yoghurt milk supplemented with 2% WPC compared to that of 2% SKM.



**Figure 1.** Changes in %TA during milk fermentation

(A: cow's yoghurts = ▲, B : goat's yoghurts + 3% SKM = ■, C : goat yoghurt + 3% WPC = ◆ and D : goat yoghurt + 5% WPC = ●)



**Figure 2.** Changes in pH value during milk fermentation

(A: cow's yoghurts = ▲, B : goat's yoghurts + 3% SKM = ■, C : goat yoghurt + 3% WPC = ◆ and D : goat yoghurt + 5% WPC = ●)

Decreases in pH values with fermentation time in milks were illustrated in Fig 2. Algebraic straight line equations for changes in pH in A, B, C and D milks during 2-7 h. fermentation yielded rates of acid production (slope): -0.4746, -0.4269, -0.4262 and -0.3998, respectively. The longer fermentation time the lower the pH values. Samples A and B were incubated at 43°C for 6h. To reach a pH value between  $4.53 \pm 0.21$  and  $4.54 \pm 0.14$  respectively. Both obtained a character of set-style yoghurt (semi-solid), this was due to coagulation of milk protein [22]. Meanwhile samples C and D were fermented for 5 h. with pH values of  $4.64 \pm 0.35$  and  $4.66 \pm 0.31$  respectively, and apparent curds were resembled to A and B.

**Table 1.** Changes of pH and % titratable acidity during storage of yoghurts at 4°C

	TRT	Storage time (day)				
		0	1	7	14	21
pH	A	4.52±0.01 <sup>Aa</sup>	4.49±0.25 <sup>Aa</sup>	4.49±0.32 <sup>Aa</sup>	4.52±0.35 <sup>Aa</sup>	4.54±0.36 <sup>Aa</sup>
	B	4.53±0.02 <sup>Aa</sup>	4.46±0.01 <sup>Ab</sup>	4.46±0.46 <sup>Ab</sup>	4.49±0.45 <sup>Ab</sup>	4.47±0.17 <sup>Ab</sup>
	C	4.48±0.02 <sup>Aa</sup>	4.49±0.03 <sup>Aa</sup>	4.50±0.04 <sup>Aa</sup>	4.51±0.05 <sup>Aa</sup>	4.50±0.03 <sup>Aa</sup>
	D	4.53±0.02 <sup>Aa</sup>	4.47±0.02 <sup>Aa</sup>	4.46±0.03 <sup>Aa</sup>	4.49±0.01 <sup>Aa</sup>	4.47±0.01 <sup>Aa</sup>
%TA	A	0.82±0.02 <sup>Bd</sup>	0.88±0.02 <sup>Bc</sup>	0.93±0.02 <sup>Bb</sup>	0.88±0.02 <sup>Bab</sup>	0.92±0.02 <sup>Ba</sup>
	B	0.85±0.02 <sup>Ad</sup>	0.87±0.02 <sup>Ac</sup>	0.92±0.02 <sup>Ab</sup>	0.92±0.02 <sup>Aab</sup>	0.94±0.02 <sup>Aa</sup>
	C	0.84±0.02 <sup>Ad</sup>	0.88±0.02 <sup>Ac</sup>	0.92±0.02 <sup>Ab</sup>	0.92±0.02 <sup>Aab</sup>	0.97±0.02 <sup>Aa</sup>
	D	0.90±0.02 <sup>ABd</sup>	0.88±0.02 <sup>ABc</sup>	0.90±0.02 <sup>ABb</sup>	0.91±0.02 <sup>ABab</sup>	0.93±0.02 <sup>ABa</sup>

<sup>A</sup>Means in column with the same letters are not significantly different from each other at  $P \geq 0.05$

<sup>a</sup>Means in row with the same letters are not significantly different from each other at  $P \geq 0.05$

Values of pH of 4 yoghurt treatments after complete fermentations (0 day) were similar ( $P \geq 0.05$ ). Sample B had a slight decrease in pH during storage at 4°C for 3 weeks. [15] Reported the change of pH value was related to viability of microorganism in yoghurt. [9] Reported the decrease in pH values of cow's milk or goat's milk yoghurt supplemented with 2% SKM during storage at 4°C for 3 week was no with that of goat's milk containing 3% WPC. Sample A had smaller increase in acidity compared to those of than B, C, and D during storage at 4°C for 3 week ( $P < 0.05$ ). WPC was reported to decrease pH value [9]. The increase of acid and decrease of pH value was during expansion of microorganism numbers, such as *Lactobacillus acidophilus* and *L. casei* that utilized lactose in milk [8].

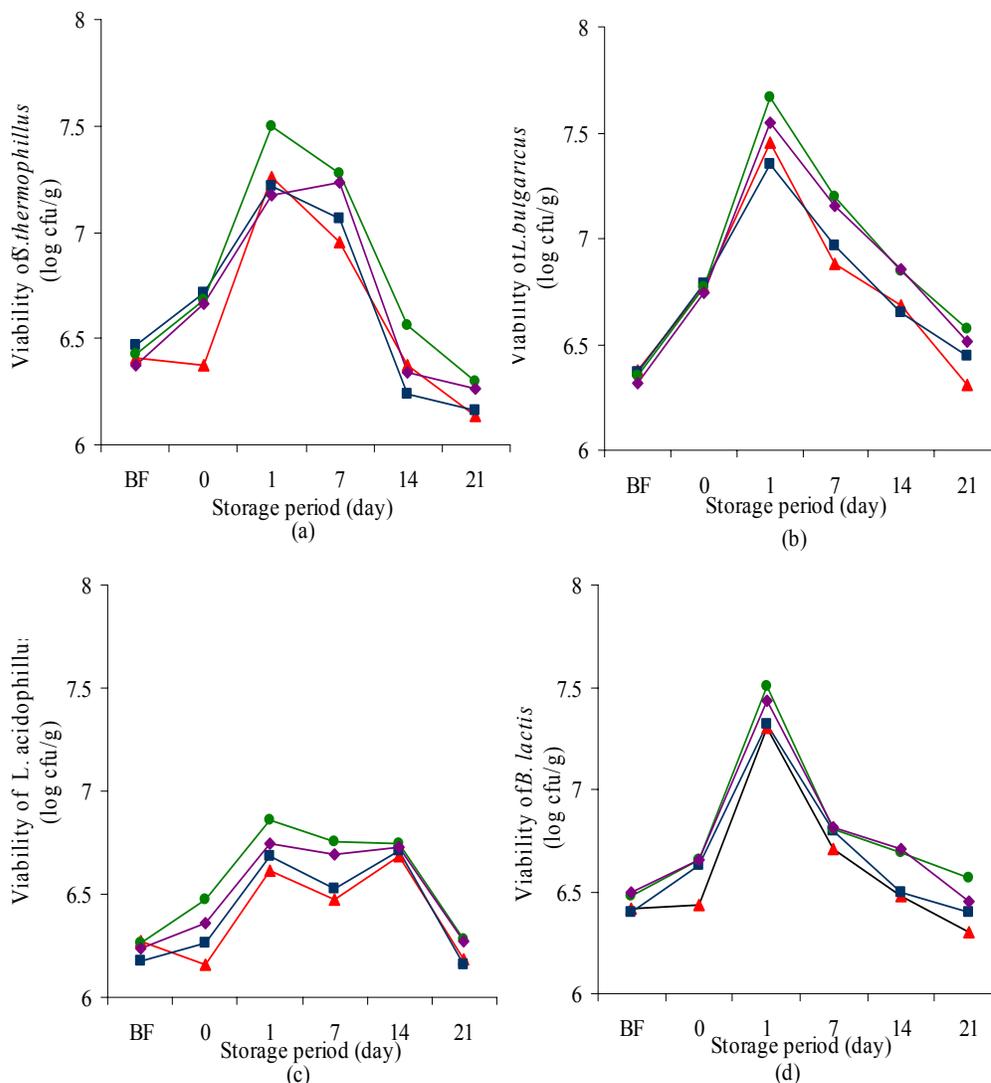
#### **Viability of probiotic bacteria during cold storage**

Viable bacterial counts of yogurt samples during storage at 4°C for 3 weeks are shown in Fig. 3.

Yoghurt A, B, C, and D storage at 4°C for 1 day contained viable counts of *S. thermophilus*  $7.26 \pm 0.06$ ,  $7.22 \pm 0.01$ ,  $7.32 \pm 0.24$  and  $7.49 \pm 0.18$  log cfu/g respectively, *L. bulgaricus*  $7.45 \pm 0.49$ ,  $7.35 \pm 0.77$ ,  $7.55 \pm 0.68$  and  $7.66 \pm 0.57$  log cfu/g respectively, *L. acidophilus*  $6.61 \pm 0.18$ ,  $6.69 \pm 0.17$ ,  $6.75 \pm 0.12$  and  $6.86 \pm 0.11$  log cfu/g and *B. lactis*  $7.30 \pm 0.06$ ,  $7.32 \pm 0.10$ ,  $7.43 \pm 0.21$  and  $7.55 \pm 0.11$  log cfu/g respectively. During storage, the microorganisms used lactose and oxygen in milk for their growth for acid production [22].

During fermentation *S. thermophilus* produced lactic acid and formic acid which activated growth of *L. bulgaricus* that produced diacetyl and acetaldehyde. These compounds gave typical yoghurt flavor [21]. The viability of microorganisms decreased after 7 day of storage. In day 14, *L. acidophilus* increased 0.1 log cfu/g because the poor adaptability of this probiotic was in low pH [24].

Sample C had higher viable counts of *S. thermophilus*, *L. bulgaricus*, *L. acidophilus* and *B. lactis* than those of B. WPC influenced amount expansion of microorganisms, which correspond to the research of [9] and [16]. They found that addition of 3% WPC in goat's milk yoghurt increased in counts of *S. thermophilus*, *L. acidophilus* and *B. Lactis*.



**Figure 3.** The viability of *S. thermophilus* (a), *L. bulgaricus* (b), *Lactobacillus acidophilus* (c) and *B. lactis* (d) before fermentation (BF) and during storage

(A: cow's yoghurts = ▲, B: goat's yoghurts + 3% SKM = ■, C: goat yoghurt + 3% WPC = ◆ and D: goat yoghurt + 5% WPC = ●)

### Sensory evaluation

Ten panelists were trained for descriptive analysis of goat's yoghurts containing probiotic. All samples were evaluated triplicates. The results are shown in Table 2 for all treatments. The presence of WPC in yoghurt effected the viscosity ( $7.82 \pm 0.14$ ) and sourness ( $13.66 \pm 0.37$ ) for day 1 storage ( $p < 0.05$ ). [16] reported that WPC supplemented in goat's milk yoghurt wasn't effect texture, odor, flavor, or acceptance. Samples A, B, C and D of the 14 day storage had viscosity of yoghurts increased to  $7.57 \pm 0.22$ ,  $7.45 \pm 0.28$ ,  $7.45 \pm 0.32$  and  $7.86 \pm 0.13$ , respectively. Yoghurt odor increased to  $9.44 \pm 0.60$ ,  $9.15 \pm 1.21$ ,  $9.06 \pm 1.17$  and  $9.29 \pm 1.07$  respectively. In addition, yoghurt flavor increased to  $12.81 \pm 0.86$ ,  $13.18 \pm 0.71$ ,  $13.06 \pm 1.02$  and  $12.99 \pm 1.11$ , respectively ( $p < 0.05$ ). Yoghurts B, C and D had decreased goaty odor of

4.89±0.83, 4.90±0.43 and 4.83±0.44, respectively, at 14 day storage. Meanwhile, goaty flavor of these yoghurts were 7.24±1.31, 7.22±1.31 and 7.25±1.32, respectively ( $p < 0.05$ ). [3, 14] suggested that changes in organoleptic quality of yoghurt was due to the increase in acetaldehyde.

**Table 2.** Descriptive sensory quality of four treatments of yoghurt during 3 weeks storage at 4°C.

Day	TRT	Attributes (0-15 intensity scale)							
		curd firmness	viscosity	smoothness	sourness	Yoghurt odor	Yoghurt flavor	Goaty odor	Goaty flavor
1	A	3.43±0.45 <sup>Ac</sup>	7.46±0.07 <sup>Bb</sup>	9.22±0.25 <sup>Ab</sup>	13.25±0.45 <sup>Ba</sup>	9.21±0.24 <sup>Ac</sup>	12.54±1.13 <sup>Ab</sup>	-	-
	B	3.41±0.31 <sup>Ac</sup>	7.29±0.03 <sup>Cb</sup>	8.24±0.01 <sup>Cb</sup>	13.61±0.20 <sup>ABa</sup>	8.44±0.52 <sup>BCc</sup>	12.65±1.17 <sup>Ab</sup>	4.86±0.30 <sup>Aa</sup>	7.85±0.15 <sup>Aa</sup>
	C	3.42±0.37 <sup>Ac</sup>	7.31±0.17 <sup>Cb</sup>	8.24±0.13 <sup>Cb</sup>	13.46±0.21 <sup>Aa</sup>	8.46±0.55 <sup>Cc</sup>	12.77±1.27 <sup>Ab</sup>	4.84±0.28 <sup>Aa</sup>	7.81±0.17 <sup>Aa</sup>
	D	3.52±0.35 <sup>Ac</sup>	7.82±0.14 <sup>Ab</sup>	8.60±0.22 <sup>Bb</sup>	13.66±0.37 <sup>Aa</sup>	8.71±0.59 <sup>Bc</sup>	12.71±1.23 <sup>Ab</sup>	4.75±0.32 <sup>Aa</sup>	7.90±0.11 <sup>Aa</sup>
7	A	3.66±0.69 <sup>Ab</sup>	7.46±0.07 <sup>Bb</sup>	9.11±0.51 <sup>Ab</sup>	13.27±0.41 <sup>Ba</sup>	9.27±0.34 <sup>Ab</sup>	12.65±0.92 <sup>Aab</sup>	-	-
	B	3.56±0.64 <sup>Ab</sup>	7.31±0.03 <sup>Cb</sup>	8.30±0.27 <sup>Cb</sup>	13.42±0.33 <sup>ABa</sup>	8.88±1.08 <sup>BCb</sup>	13.01±0.89 <sup>Aab</sup>	4.89±0.36 <sup>Aa</sup>	7.70±0.60 <sup>Aa</sup>
	C	3.61±0.62 <sup>Ab</sup>	7.29±0.17 <sup>Cb</sup>	8.32±0.30 <sup>Cb</sup>	13.56±0.36 <sup>Aa</sup>	8.78±1.02 <sup>Cb</sup>	12.89±1.11 <sup>Aab</sup>	4.91±0.32 <sup>Aa</sup>	7.68±0.60 <sup>Aa</sup>
	D	3.70±0.60 <sup>Ab</sup>	7.82±0.14 <sup>Ab</sup>	8.59±0.30 <sup>Bb</sup>	13.60±0.48 <sup>Aa</sup>	9.03±0.96 <sup>Bb</sup>	12.88±1.13 <sup>Aab</sup>	4.85±0.36 <sup>Aa</sup>	7.73±0.59 <sup>Aa</sup>
14	A	3.84±0.73 <sup>Aa</sup>	7.57±0.22 <sup>Ba</sup>	9.09±0.51 <sup>Ab</sup>	13.36±0.38 <sup>Ba</sup>	9.44±0.60 <sup>Aa</sup>	12.81±0.86 <sup>Aa</sup>	-	-
	B	3.78±0.80 <sup>Aa</sup>	7.45±0.28 <sup>Ca</sup>	8.38±0.34 <sup>Cb</sup>	13.50±0.21 <sup>ABa</sup>	9.15±1.21 <sup>BCa</sup>	13.18±0.71 <sup>Aa</sup>	4.89±0.43 <sup>Aa</sup>	7.24±1.31 <sup>Ab</sup>
	C	3.88±0.77 <sup>Aa</sup>	7.45±0.32 <sup>Ca</sup>	8.40±0.36 <sup>Cb</sup>	13.64±0.18 <sup>Aa</sup>	9.06±1.17 <sup>Ca</sup>	13.06±1.02 <sup>Aa</sup>	4.90±0.43 <sup>Aa</sup>	7.22±1.31 <sup>Ab</sup>
	D	3.88±0.77 <sup>Aa</sup>	7.86±0.13 <sup>Aa</sup>	8.66±0.30 <sup>Bb</sup>	13.70±0.34 <sup>Aa</sup>	9.29±1.07 <sup>Ba</sup>	12.99±1.11 <sup>Aa</sup>	4.83±0.44 <sup>Aa</sup>	7.25±1.32 <sup>Ab</sup>
21	A	4.09±1.03 <sup>Aa</sup>	7.65±0.56 <sup>Ba</sup>	9.08±0.52 <sup>Aa</sup>	13.36±0.38 <sup>Ba</sup>	9.35±0.07 <sup>Aa</sup>	12.89±0.88 <sup>Aa</sup>	-	-
	B	3.90±0.93 <sup>Aa</sup>	7.41±0.31 <sup>Ca</sup>	8.49±0.66 <sup>Ca</sup>	13.50±0.21 <sup>ABa</sup>	9.19±1.19 <sup>BCa</sup>	13.04±0.76 <sup>Aa</sup>	4.87±0.41 <sup>Aa</sup>	7.25±1.37 <sup>Ab</sup>
	C	3.97±1.00 <sup>Aa</sup>	7.39±0.29 <sup>Ca</sup>	8.57±0.72 <sup>Ca</sup>	13.64±0.18 <sup>Aa</sup>	9.07±1.17 <sup>Ca</sup>	13.06±1.02 <sup>Aa</sup>	4.81±0.41 <sup>Aa</sup>	7.27±1.38 <sup>Ab</sup>
	D	3.93±0.74 <sup>Aa</sup>	7.90±0.25 <sup>Aa</sup>	8.84±0.70 <sup>Ba</sup>	13.70±0.34 <sup>Aa</sup>	9.33±1.05 <sup>Ba</sup>	13.05±1.09 <sup>Aa</sup>	4.80±0.43 <sup>Aa</sup>	7.28±1.38 <sup>Ab</sup>

<sup>A</sup>Means in column (treatment) with the same letters are not significantly different from each other at  $P < 0.05$

<sup>a</sup>Means in column (storage time) with the same letters are not significantly different from each other at  $P < 0.05$

## Conclusions

Fermentation of goat's milk supplemented with whey protein concentrate for yoghurt related to the reduction of fermentation time. Addition of 3% and 5% WPC markedly reduced the level of pH and increased the acidity content of yoghurts. Incubation period for goat's milk yoghurts with WPC was five hours. The viability of *L. acidophilus* was adversely affected and improved on addition of WPC in yoghurt. The counts of *L. acidophilus* and *B. lactis* remained  $> 10^6$  cfu  $g^{-1}$  throughout the storage in all yoghurts. An important criterion for quality assessment of set-style cultured milk products is texture of the gel. Goat's yoghurts with WPC had better viscosity and smoothness. Adding 3% WPC in goat' yoghurt milk was recommended in terms of reducing fermentation time, increasing cultures viability compared to 3% SKM, or reducing cost compared to 5% WPC.

## Acknowledgement

This research was fully supported by the Thailand Research Fund Master Research Grants (TRF-MAG) and The Royal Chitralada Projects, Bangkok.

## References

1. Alferez, M.J., Barrionuevo, M., Lopez-Aliaga, I., Sanz-Sampelayo, M.R., Lisbona, F., Robles, J.C., & Campos, M.S. (2001). Digestive utilization of goat and cow milk fat in malaabsorption syndrome. **Journal of Dairy Research**, 68, 451-461.

2. AOAC. (1995). Official Method of Analysis of Association of Official Analytical Chemists. 15th Ed. Gaithersburg, Maryland.
3. Bonczar, G., M. Wszolek and A. Siuta. (2002). The effects of certain factors on the properties of yogurt made from ewe s milk. **Food Chemistry**, 79, 85–91.
4. Chr. Hansen (2001). *L. acidophilus*, *L. casei* and *Bifidobacteria* in Fermented Milk Products. Guidelines method for counting probiotic bacteria. Chr. Hansen Denmark.
5. Chr. Hansen (a) (2002). Method for Counting *Lactobacillus bulgaricus* in Yoghurt-F-7 Technical Bulletin. Chr. Hansen Denmark.
6. Chr. Hansen (b) (2002). Method for Counting *Streptococcus thermophilus* in Yoghurt-F-8 Technical Bulletin. Chr. Hansen Denmark.
7. Dave, R.I., & Shah, N.P. (1998). Ingredient supplementation effect on viability of probiotic bacteria in yogurt. **Journal of Dairy Science**, 81, 2804-2816.
8. Donkor, O.N., Nilmini, S.L.I., Stolic, P., Vasiljevic, T., & Shah, N.P. (2006). Survival and activity of selected probiotic organism in set-type yoghurt during cold storage. **International Dairy Journal**, 16, 1181-1189.
9. Herrero, A.M. and T. Requena (2006). The effect of supplementing goats milk with whey protein concentrate on textural properties of set-type yoghurt. **International Journal of Food Science and Technology**, 41, 87–92.
10. Hughes, D.B. & Hoover D.G. (1991). *Bifidobacteria*: their potential for use in American dairy products. **Food Technolgy**, 45, 74-76.
11. IDF (1992). International Standard 163. General standard of identity for fermented milks. Brussels: International Dairy Federation.
12. Kurmann, J.A. (1986). Yoghurt made from ewe’s and goat’s milk. **Bulletin of the International Dairy Federation**, 202, 153-166.
13. Kurmann, J.A. & Rasic, J.L. (1991). The health potential of products containing *Bifidobacteria*. pp. 117-158. In Therapeutic Properties of fermented milk. Robinson, R.K., ed. Elsevier Appl. Food Science. London. United Kingdom.
14. LaTorre, L., A.Y. Tamime and D.D. Muir. (2003). Rheology and sensory profiling of set-type fermented milks made with different commercial probiotic and yogurt starter culture. **International Journal of Dairy Technology**, 56, 163–170.
15. Marshall, V. M. and A.Y. Tamime (1997). Starter cultures employed in the manufacture of biofermented milks. **International Dairy Journal**, 50: 35–39.
16. Martin-Diana, A.B., Janer, C., Pelaez, C. & Requena, T. (2003). Development of a fermented goat’s milk containing probiotic bacteria. **International Dairy Journal**, 13, 827-833.

17. Meilgaard, M., Civille, G.V. & Carr, B.T. (1999). Sensory Evaluation Techniques. 3rd ed. CRCPress, Inc., BocaRaton, FL.
18. Modler, H.W., McKellar, R.C. & Yaguchi, M. (1990). *Bifidobacteria* and bifidogenic factors. **Canadian International Food Science and Technology Journal**, 23, 29-41.
19. Remeuf, F. & Lenoir, J. (1986). Relationship between the physiochemical characteristics of goat's milk and its rennetability. **Bulletin of the International Dairy Federation**, 202, 68-72.
20. Rysstad, G. & Abrahamsen, R.K. (1983). Fermentation of goat's milk by two DL-type mixed strain starters. **Journal of Dairy Research**, 50, 349-356.
21. Tamime, A Y. (1990). Microbiology of starter culture, pp. 131-201 In R.K. Robinson (Eds). Dairy Microbiology: The Microbiology of Milk Products. Vol. 2. Elsevier Science Publisher. London.
22. Tamime, A.Y. & Robinson, R.K. (1999). Yogurt science and technology.2nd ed. Cambridge: Woodhead Publish Ltd.
23. Vegarud, G.E., Devold, T.G., Opheim, R., Loeding, E., Svenning, C., Abrahamsen, R.K., Lien, S. & Langsrud, T. (1999). Genetic variants of Norwegian goat's milk composition, micellar size and renneting properties. **International Dairy Journal**, 9, 367-368.
24. Vedamuthu, E.R. (1991). The Yoghurt Story-Past, Present and Future part 3. **Dairy, Food and Environmental Sanitation**, 11(6), 310-311.