



## International Journal of Research Publications

# Effects of somatic cell counts in milk on physical and chemical characteristics of yoghurt

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### Abstract

Mastitis is one of the most serious diseases that can affect quality of milk and milk products, it's derived from it. In the present study, yoghurts were made from cows' milk with four different somatic cell count (P1:  $3.6 \times 10^5$  cells/ml; P2:  $4.5 \times 10^5$  cells/ml; P3:  $5.4 \times 10^5$  cells/ml; P4:  $7.2 \times 10^5$  cells/ml). The yoghurts made from different range of SCC were analyzed for chemical parameters (dry matter, ash, fat, protein, total sugar, reducing sugar content and titrable acidity), physical parameter (pH and syneresis) and sensory evaluation during the storage period. Yoghurt made with different SC counts of milk except reducing sugar and total protein had no significant effects on the dry matter, ash, fat, reducing sugar, total sugar, pH and titratable acidity at day 1 but syneresis was gradually increased in yoghurt made milk with higher SC counts. During the storage period, dry matter, ash, fat, total protein, total sugar, reducing sugar, pH, and titratable acidity were ( $p < 0.05$ ) varied yoghurts made from milk with different SC counts. At the end of storage yoghurt made from milk with  $5.4 \times 10^5$  cells/ml showed higher average value of dry matter content ( $25.83 \pm 0.06\%$ ) and yoghurt made from milk with  $3.6 \times 10^5$  cells/ml SC counts range showed higher average value of fat ( $2.67 \pm 0.06\%$ ), reducing sugar ( $2.02 \pm 0.09\%$ ), total sugar ( $11.89 \pm 0.02\%$ ) and pH ( $4.09 \pm 0.08$ ) while yoghurt made from milk with  $7.2 \times 10^5$  cells/ml showed higher values of total protein ( $3.72 \pm 0.10\%$ ) and titratable acidity ( $1.18 \pm 0.03\%$ ). During the storage period, dry matter, ash and titratable acidity contents of yoghurt were ( $p < 0.05$ ) increasing with storage period while reducing sugar, total sugar and pH were ( $p < 0.05$ ) decreasing with storage period. The sensory evaluation of the produced yogurts revealed that milk with high SC counts yoghurt received the lowest grading score of attributes and all sensory scores of yoghurts were significantly reduced from week 1 to week 4 of storage. Based on the sensory evaluation most of the pannelist prefer or higher score obtained, yoghurt made from milk with low SC counts ( $3.6 \times 10^5$  cells/ml) at the 1<sup>st</sup> week of storage.

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**Keywords:** Somatic cell; Yoghur; Syneresis; Organoleptic quality; Chemical parameters

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## 1. Introduction

Yoghurt is one of the major dairy products in Sri Lanka. Yoghurt having high nutritional and therapeutic properties is being highly consumed and produced<sup>[1]</sup>. Variety of milks has been used for yoghurt production in various species and regions of the county, most of the industrialized yoghurt production uses cow's milk, whole milk, partially skimmed milk and skim milk may be used<sup>[2]</sup>

All milk contains some level of somatic cells (SC). White blood cells comprise the major cell type in milk from uninfected cow and goat. When there is bacterial infection, like mastitis affecting the mammary tissue the number of SCs in milk increases drastically. This increase in SC count results from a transfer of white blood cells from the blood into the milk. In addition, the relative proportions of different types of SCs present in milk changing the quality of milk significantly<sup>[3]</sup>. Most of the dairy industries, somatic cell counts (SCCs) are widely used as monitors of milk quality<sup>[4]</sup>. Somatic cell (SC) is an indicator of the quality of milk<sup>[5]</sup>. General agreement results on the values of less than 100,000 cells/ml for uninfected cows and greater than 250,000 for cows infected with significant pathogens in milk<sup>[6]</sup> which may defect quality of dairy product due to enzymatic breakdown of milk protein and fat<sup>[6]</sup>

Yoghurts made from high SC counts milk (800,000 to 1,000,000 cells per ml) also have a higher incidence of off flavors and pasty textures. Although, the negative effects of using high SC counts milk in yoghurt production reported. Physical and chemical properties of yoghurt may vary from different SC counts in milk as a result, yoghurt quality is also determined by SC counts in milk<sup>[1]</sup>. There is very little information on the influence of SC counts on the quality of yoghurt. Therefore, the objective of the present work is to determine the effects of SC counts levels in milk on physical, chemical and sensory properties of whole plain yoghurt.

## 2. Materials and Methods

### 2.1 Collection of milk samples

The study was conducted at Department of Animal Science Laboratory, Faculty of Agriculture, Eastern University, Sri Lanka. Milk was collected from different places namely livestock farm, Faculty of Agriculture, Eastern University, Sri Lanka, Chenkalady, Sithandy and Kommanthurai milk collecting centre throughout the study period.

### 2.2 Counting of somatic cells in different samples

Fresh milk of 500 ml was taken from collected samples. Those milk samples were analyzed for SC counts under the laboratory condition. Direct microscopic count method was used to count the somatic cells in milk. For direct microscopic count, initially milk fat was removed from milk by pasteurization. Then 0.4% methylene blue solution of 10  $\mu$ l was added into a conical microfuge tube. After that milk sample of 10  $\mu$ l was mixed with the methylene blue into the microfuge tube. The solution was mixed well and allowed to stand for 15 minutes. The mixed sample was filled uniformly into a heamacytrometer by using micropipette. The chamber should fill with optimum level. Somatic cells were counted by using light microscope at 100 X magnifications which were possessing dark blue nucleus<sup>[7]</sup>. The number of somatic cells was counted in 4 different squares on the heamacytrometer and it was recorded. The counting was repeated two or three times by the standard procedure described by Pelvan and Unluturk<sup>[8]</sup>.

### 2.3 Treatment plan

Milk was collected from four different places. Those places are Siddandy milk collecting centre (Place-1), Kommanthurai milk collecting centre – (Place-2), Livestock farm Eastern University Sri Lanka– (Place-3) and Chencalady milk collecting centre – (Place-4). Milk samples were grouped according to SC counts range.

Place 1 (P1):  $3.6 \times 10^5$  cells/ml;  
Place 2 (P2):  $4.5 \times 10^5$  cells/ml;  
Place 3 (P3):  $5.4 \times 10^5$  cells/ml;  
Place 4 (P4):  $7.2 \times 10^5$  cells/ml.

## 2.4 Yoghurt preparation

The standardized milk was pasteurized at 65 °C for 30 min, and milk temperature was gradually declined at this time, meanwhile sugar and gelatine (stabilizer) were added and cooled to 37 °C. The milk was inoculated with freeze-dried commercial starter yoghurt culture (DVS, CHR HANSEN, Denmark) composed of *Streptococcus thermophilus* (St) and *Lactobacillus delbrueckii subsp. bulgaricus* (Lb). Then, flavors and coloring were added and mixed well. Then mixture of inoculated milk was poured into plastic containers, and incubated at 40 °C for overnight. The yoghurt samples were stored in a refrigerator at about 4-5 °C for analysis at week 1, week 2, week 3 and week 4 of storage.

## 2.5 Analysis of chemical composition

Chemical composition of yoghurt samples such as dry matter, fat and ash content were analyzed. The dry matter content of yoghurt was determined using oven dry at 105 °C as described by AOAC<sup>[9]</sup> and ash content was determined by using muffle furnace at 550 °C for 4 hrs. The fat content of yoghurt sample was determined by the Gerber method as described by Marshall<sup>[10]</sup>. The protein content was estimated by following the Kjeldahl techniques (AOAC<sup>[9]</sup> according to the method described by Keli *et al.*<sup>[11]</sup>. Total sugar and reducing sugar contents were estimated by Lane and Eynon method (AOAC<sup>[9]</sup>). All analyses were carried out in triplicate.

## 2.6 Measurement of pH and titratable acidity

pH of samples was measured at 20 °C using a pH meter (Hanna Instruments pH Meter) as described by Akpakpunam and Safa- Dedeh<sup>[12]</sup>. The pH meter was calibrated with buffer standard pH 4 and pH 7 before measurement. The titratable acidity (as % lactic acid) was determined by titration with a 0.1 N NaOH solution using phenolphthalein as an indicator, according the method described by Dave and Shah<sup>[13]</sup>.

## 2.7 Syneresis analysis

The yoghurt syneresis was measured by placing yoghurt sample of 20 g on a filter paper. The filter paper was rested on top of a funnel with beaker. After 1/2 hours and 2 hours of drainage, the volume of the whey collected in a beaker. Then weight of the whey was weighed and syneresis was calculated<sup>[14]</sup>.

## 2.8 Sensory analysis

Sensory analyses were carried out using thirty panel members of students, and staff to evaluate the organoleptic attributes of the four different yoghurts. The quality factors such as colour, taste, texture, flavour and overall acceptability were measured by adopting nine point Hedonic structure scale (9 for like very much and 1 for dislike very much) as described by Larmond<sup>[15]</sup>.

## 2.9 Statistical analysis

Data were collected and analysis using Multivariate Analysis of Variance (MANOVA) test was used to determine the significance level of the treatments, while the Duncan's Multiple Range Test (DMRT) was used

for mean separation. Descriptive statistics was done on sensory attributes and the means were compared using the friedman test using the Minitab (version 2015).

### 3. Results and Discussion

#### 3.1 Chemical and physical attributes of raw milk

Chemical and physical composition of those raw milk samples such as ash, dry matter content, titrable acidity, pH, total sugar, reducing, total protein and fat content did not significantly differ among the SC counts categories shown in Table 1. It might due to most of animals in those area are local and local shahiwal breeds. Furthermore, similar feeds are using for animal feeding.

#### 3.2 Physical and chemical properties of yoghurts at day one

At day1, except reducing sugar and total protein other chemical and physical attributes showed no significant ( $p > 0.05$ ) variation among different types of yogurt (Table 2). It may due to considerable amount of biochemical and microbial reactions are not occurred. Trends of reducing sugar and total sugar were decreasing with increasing of SC count in milk. It might be breakdown of lactose sugar by starter culture and secondary bacteria at day 1 storage<sup>[16]</sup>.

**Table 1: Chemical attributes of different raw milk**

| Attributes           | P1                      | P2                      | P3                      | P4                      |
|----------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Dry matter (%)       | 12.06±0.01 <sup>a</sup> | 12.04±0.01 <sup>a</sup> | 12.05±0.02 <sup>a</sup> | 12.07±0.01 <sup>a</sup> |
| Ash (%)              | 0.75±0.06 <sup>a</sup>  | 0.77±0.01 <sup>a</sup>  | 0.76±0.05 <sup>a</sup>  | 0.78±0.1 <sup>a</sup>   |
| Fat (%)              | 4.2±0.11 <sup>a</sup>   | 4.1±0.10 <sup>a</sup>   | 4.0±0.01 <sup>a</sup>   | 3.9±0.01 <sup>a</sup>   |
| Total protein (%)    | 3.17±0.01 <sup>a</sup>  | 3.33±0.01 <sup>a</sup>  | 3.48±0.01 <sup>a</sup>  | 3.62±0.01 <sup>a</sup>  |
| Reducing sugar (%)   | 3.46±0.23 <sup>a</sup>  | 3.39±0.16 <sup>a</sup>  | 3.36±0.06 <sup>a</sup>  | 3.31±0.12 <sup>a</sup>  |
| Total sugar (%)      | 12.86±0.3 <sup>a</sup>  | 12.71±0.33 <sup>a</sup> | 12.56±0.63 <sup>a</sup> | 12.27±0.85 <sup>a</sup> |
| Titrable acidity (%) | 0.16±0.86 <sup>a</sup>  | 0.16±0.35 <sup>a</sup>  | 0.15±0.74 <sup>a</sup>  | 0.14±0.59 <sup>a</sup>  |
| pH                   | 7.06±0.03 <sup>a</sup>  | 7.26±0.01 <sup>a</sup>  | 7.11±0.05 <sup>a</sup>  | 7.16±0.01 <sup>a</sup>  |

Values are means ± standard deviations of triplicate determination. Mean with the same letters are not significantly different at ( $p < 0.05$ ). P1-  $3.6 \times 10^5$  cells/ml, P2-  $4.5 \times 10^5$  cells/ml, P3-  $5.4 \times 10^5$  cells/ml and P4-  $7.2 \times 10^5$  cells/ml.

**Table 2: Physical and chemical properties of yoghurts at day one**

| Properties       | Places                  |                         |                         |                         |
|------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|                  | P1                      | P2                      | P3                      | P4                      |
| Dry matter       | 18.70±0.1 <sup>a</sup>  | 18.64±0.14 <sup>a</sup> | 18.32±0.15 <sup>a</sup> | 18.62±0.08 <sup>a</sup> |
| Ash              | 1.03±0.03 <sup>a</sup>  | 1.02±0.03 <sup>a</sup>  | 1.04±0.01 <sup>a</sup>  | 1.05±0.03 <sup>a</sup>  |
| Fat              | 2.74±0.12 <sup>a</sup>  | 2.70±0.19 <sup>a</sup>  | 2.69±0.16 <sup>a</sup>  | 2.69±0.11 <sup>a</sup>  |
| Total protein    | 3.06±0.05 <sup>b</sup>  | 3.10±0.07 <sup>ab</sup> | 3.14±0.08 <sup>ab</sup> | 3.16±0.06 <sup>a</sup>  |
| Reducing sugar   | 2.85±0.09 <sup>a</sup>  | 2.78±0.02 <sup>ab</sup> | 2.75±0.04 <sup>ab</sup> | 2.50±0.15 <sup>b</sup>  |
| Total sugar      | 12.84±0.04 <sup>a</sup> | 12.78±0.12 <sup>a</sup> | 12.72±0.15 <sup>a</sup> | 12.70±0.12 <sup>a</sup> |
| Titrable acidity | 0.76±0.02 <sup>a</sup>  | 0.78±0.01 <sup>a</sup>  | 0.81±0.04 <sup>a</sup>  | 0.86±0.02 <sup>a</sup>  |
| pH               | 4.49±0.01 <sup>a</sup>  | 4.47±0.06 <sup>a</sup>  | 4.45±0.06 <sup>a</sup>  | 4.44±0.01 <sup>a</sup>  |

Values are means ± standard deviations of triplicate determination. Mean with the same letters are not significantly different at ( $p < 0.05$ ). P1-  $3.6 \times 10^5$  cells/ml, P2-  $4.5 \times 10^5$  cells/ml, P3-  $5.4 \times 10^5$  cells/ml and P4-  $7.2 \times 10^5$  cells/ml.

Syneresis is one of the key quality parameters for curd formation<sup>[17]</sup>. The result of syneresis shows the Table 3. The syneresis percentage was increased with SCC range and time. It might be due to decreasing consistence of yoghurt with increasing SC counts in milk. As the result, poor consistency of the coagulum of milk was increased syneresis and its inability to retain serum of yoghurt. The milk from animals with mastitis had a high level of serum proteins, and low level of casein, causing milk with high SCC would give rise to soft coagula with a reduced ability to retain serum<sup>[3]</sup>.

**Table 3: Syneresis of yoghurt**

| Place | After ½ hours            | After 2 hours           |
|-------|--------------------------|-------------------------|
| P1    | 38.58±0.08 <sup>g</sup>  | 40.7±0.19 <sup>d</sup>  |
| P2    | 39.43±0.17 <sup>f</sup>  | 41.47±0.09 <sup>c</sup> |
| P3    | 39.65±0.06 <sup>ef</sup> | 42.57±0.12 <sup>b</sup> |
| P4    | 39.73±0.05 <sup>e</sup>  | 44.32±0.08 <sup>a</sup> |

Values are means ± standard deviations of triplicate determination. Mean with the same letters are not significantly different at ( $p < 0.05$ ). P1-  $3.6 \times 10^5$  cells/ml, P2-  $4.5 \times 10^5$  cells/ml, P3-  $5.4 \times 10^5$  cells/ml and P4-  $7.2 \times 10^5$  cells/ml.

### 3.3 Dry matter, ash, fat and protein contents of yoghurts made from different SC count in milk during storage

Dry matter content of yoghurt is presented in Table 4. Dry matter content of all types of yoghurt range vary from 21.53% to 26.70% and dry matter contents of yoghurt was ( $p < 0.05$ ) increased throughout the storage period. Dry matter content of all SCC range of yoghurt was gradually increased with storage period. It might be due to the evaporation rate of moisture content during storage at refrigerated condition. It might be a reason for increased dry matter content of yoghurt [18, 19].

**Table 4: Dry matter, ash, fat and protein contents of yoghurts made from different SC count in milk**

| Properties        | Places | Storage Period          |                         |                         |                         |
|-------------------|--------|-------------------------|-------------------------|-------------------------|-------------------------|
|                   |        | Week 1                  | Week 2                  | Week 3                  | Week 4                  |
| Dry matter (%)    | P1     | 22.62±0.18 <sup>e</sup> | 23.44±0.05 <sup>d</sup> | 25.47±0.14 <sup>b</sup> | 25.83±0.06 <sup>b</sup> |
|                   | P2     | 19.63±0.15 <sup>h</sup> | 21.57±0.12 <sup>f</sup> | 23.57±0.12 <sup>d</sup> | 24.30±0.61 <sup>c</sup> |
|                   | P3     | 21.53±0.23 <sup>f</sup> | 24.47±0.51 <sup>c</sup> | 25.77±0.38 <sup>b</sup> | 26.70±0.22 <sup>a</sup> |
|                   | P4     | 20.62±0.08 <sup>g</sup> | 22.64±0.23 <sup>e</sup> | 23.43±0.15 <sup>d</sup> | 25.53±0.31 <sup>b</sup> |
| Ash (%)           | P1     | 1.05±0.03 <sup>a</sup>  | 1.05±0.02 <sup>a</sup>  | 1.06±0.06 <sup>a</sup>  | 1.07±0.03 <sup>a</sup>  |
|                   | P2     | 1.03±0.02 <sup>a</sup>  | 1.04±0.02 <sup>a</sup>  | 1.05±0.04 <sup>a</sup>  | 1.07±0.03 <sup>a</sup>  |
|                   | P3     | 1.05±0.03 <sup>a</sup>  | 1.06±0.01 <sup>a</sup>  | 1.06±0.02 <sup>a</sup>  | 1.09±0.01 <sup>a</sup>  |
|                   | P4     | 1.06±0.03 <sup>a</sup>  | 1.07±0.02 <sup>a</sup>  | 1.08±0.09 <sup>a</sup>  | 1.09±0.13 <sup>a</sup>  |
| Fat (%)           | P1     | 2.72±0.10 <sup>a</sup>  | 2.68±0.06 <sup>ab</sup> | 2.67±0.07 <sup>ab</sup> | 2.67±0.06 <sup>ab</sup> |
|                   | P2     | 2.68±0.06 <sup>ab</sup> | 2.67±0.06 <sup>ab</sup> | 2.67±0.06 <sup>ab</sup> | 2.65±0.08 <sup>ab</sup> |
|                   | P3     | 2.67±0.06 <sup>ab</sup> | 2.66±0.06 <sup>ab</sup> | 2.65±0.06 <sup>ab</sup> | 2.64±0.04 <sup>ab</sup> |
|                   | P4     | 2.67±0.11 <sup>ab</sup> | 2.65±0.06 <sup>ab</sup> | 2.64±0.06 <sup>ab</sup> | 2.63±0.06 <sup>ab</sup> |
| Total protein (%) | P1     | 3.08±0.61 <sup>b</sup>  | 3.20±0.35 <sup>ab</sup> | 3.14±0.90 <sup>ab</sup> | 3.33±0.80 <sup>ab</sup> |
|                   | P2     | 3.13±0.73 <sup>ab</sup> | 3.22±0.41 <sup>ab</sup> | 3.31±0.47 <sup>ab</sup> | 3.43±0.60 <sup>ab</sup> |
|                   | P3     | 3.21±0.22 <sup>ab</sup> | 3.31±0.24 <sup>ab</sup> | 3.42±0.65 <sup>ab</sup> | 3.62±0.60 <sup>ab</sup> |
|                   | P4     | 3.22±0.08 <sup>ab</sup> | 3.51±0.10 <sup>ab</sup> | 3.53±0.20 <sup>ab</sup> | 3.72±0.10 <sup>a</sup>  |

Values are means ± standard deviations of triplicate determination. Mean with the same letters are not significantly different at ( $p < 0.05$ ). P1-  $3.6 \times 10^5$  cells/ml, P2-  $4.5 \times 10^5$  cells/ml, P3-  $5.4 \times 10^5$  cells/ml and P4-  $7.2 \times 10^5$  cells/ml.

Ash contents in all yoghurt samples within the 4 weeks of storage period were slightly increased. The end of storage higher and lower average values of ash contents of yoghurt was observed P3 (1.29%) and P2 (1.07 %), respectively. The increase trends of ash contents were because of the loss of CO<sub>2</sub> and water contents during storage of yoghurt samples. It may also increasing total solids content of yoghurt sample during storage leads to increases the ash content in yoghurt<sup>[20]</sup>. Very minute changes were observed in fat content in all yoghurt samples within the 4 weeks of storage period. Fat content was decreased with SCC range of yoghurt during storage period. It might be due to lipolysis activity of yoghurt reduced the fat contents in yoghurt, which is in agreement with previous data reported by Hachana *et al.*<sup>[21]</sup>. Total protein of yoghurt was ( $p < 0.05$ ) increased with increasing SCC range during storage periods. The higher total protein content (3.7%) was observed at the 4<sup>th</sup> week of the storage period in yoghurt made by high SCC range ( $7.2 \times 10^5$

cells/ml) of milk. Lower total protein content (2.9%) was obtained at 1<sup>st</sup> week of the storage period in yoghurt made by low SCC ( $3.6 \times 10^5$  cells/ml) of milk. As the result high SCC range of yoghurt sample may cause decrease in the casein but increase serum protein level during the breakdown of casein protein [22,23].

### 3.4 Reducing sugar and total sugar in yoghurt during the storage period

Reducing sugar content was ( $p < 0.05$ ) decreased from 1<sup>st</sup> week to 4<sup>th</sup> week of storage periods. The reducing sugar content of yoghurt was decreased with increasing SC counts range count (Table 5). However, reducing sugar content significantly decreased with storage period. This decrease was due to the fermentation by starter cultures [24]. Similarly, Total sugar content was decreased from 1<sup>st</sup> week to 4<sup>th</sup> week of storage periods (Table 5). According to the Pinheiro *et al.* [25], decreasing total sugar might be fermentation of lactose sugar was converted into lactic acid. It was changed the total sugar content of yoghurt during storage period.

**Table 5: Reducing sugar and total sugar in yoghurt during the storage period**

| Properties         | Places | Storage period            |                          |                           |                          |
|--------------------|--------|---------------------------|--------------------------|---------------------------|--------------------------|
|                    |        | Week 1                    | Week 2                   | Week 3                    | Week 4                   |
| Reducing sugar (%) | P1     | 2.71±0.14 <sup>a</sup>    | 2.66±0.04 <sup>a</sup>   | 2.53±0.15 <sup>abcd</sup> | 2.02±0.09 <sup>g</sup>   |
|                    | P2     | 2.67±0.09 <sup>a</sup>    | 2.64±0.09 <sup>ab</sup>  | 2.43±0.21 <sup>cdef</sup> | 1.97±0.01 <sup>g</sup>   |
|                    | P3     | 2.65±0.12 <sup>a</sup>    | 2.61±0.16 <sup>abc</sup> | 2.34±0.02 <sup>def</sup>  | 1.94±0.01 <sup>g</sup>   |
|                    | P4     | 2.45±0.04 <sup>bcd</sup>  | 2.33±0.10 <sup>ef</sup>  | 2.25±0.12 <sup>f</sup>    | 1.86±0.01 <sup>g</sup>   |
| Total sugar (%)    | P1     | 12.63±0.03 <sup>a</sup>   | 12.46±0.09 <sup>ab</sup> | 12.13±0.15 <sup>de</sup>  | 11.89±0.02 <sup>fg</sup> |
|                    | P2     | 12.45±0.08 <sup>ab</sup>  | 12.32±0.12 <sup>bc</sup> | 12.34±0.09 <sup>efg</sup> | 11.70±0.06 <sup>hi</sup> |
|                    | P3     | 12.40±0.01 <sup>b</sup>   | 12.21±0.18 <sup>cd</sup> | 11.99±0.05 <sup>efg</sup> | 11.55±0.01 <sup>i</sup>  |
|                    | P4     | 12.63±0.02 <sup>def</sup> | 11.91±0.10 <sup>fg</sup> | 11.83±0.09 <sup>gh</sup>  | 11.46±0.23 <sup>j</sup>  |

Values are means ± standard deviations of triplicate determination. Mean with the same letters are not significantly different at ( $p < 0.05$ ). P1-  $3.6 \times 10^5$  cells/ml, P2-  $4.5 \times 10^5$  cells/ml, P3-  $5.4 \times 10^5$  cells/ml and P4-  $7.2 \times 10^5$  cells/ml.

### 3.5 pH and titratable acidity in yoghurt during the storage period

The pH and titratable acidity values of the yoghurt stored at refrigerated condition for 4 weeks are shown in Table 6. The pH values of all the yoghurts decreased and acidity values increased with storage time. There were significant ( $p < 0.05$ ) differences in the pH and acidity between the yoghurts made from the milk with different SC counts during storage. However, in the case of yoghurt milk with high SC Counts ( $7.2 \times 10^5$  cells/ml), the pH values at 4<sup>th</sup> week storage were significantly lower (pH4.04) than those of the yoghurt made from others milks. The SC counts in the milk was significantly influence the titratable acidity of the yoghurts during storage. Higher value of titratable acidity (1.18%) was observed in yoghurt made from milk with high SC Counts ( $7.2 \times 10^5$  cells/ml) at the 4<sup>th</sup> weeks of storage and lower value of titratable acidity (0.81%) was observed in yoghurt made from milk with low SC counts ( $3.6 \times 10^5$  cells/ml) at the 1<sup>st</sup> week of storage. This can be attributed to acid production during cold storage (post-acidification) as a result of the conversion of lactose to lactic acid by the bacterial cultures [24]. The result of study agrees with the report of Akın *et al.* [18] who stated that in general, the pH values of all yoghurt samples decreased during storage while titratable acidity increased in yoghurt during storage period.

Table 6: pH and titratable acidity in yoghurt during the storage period

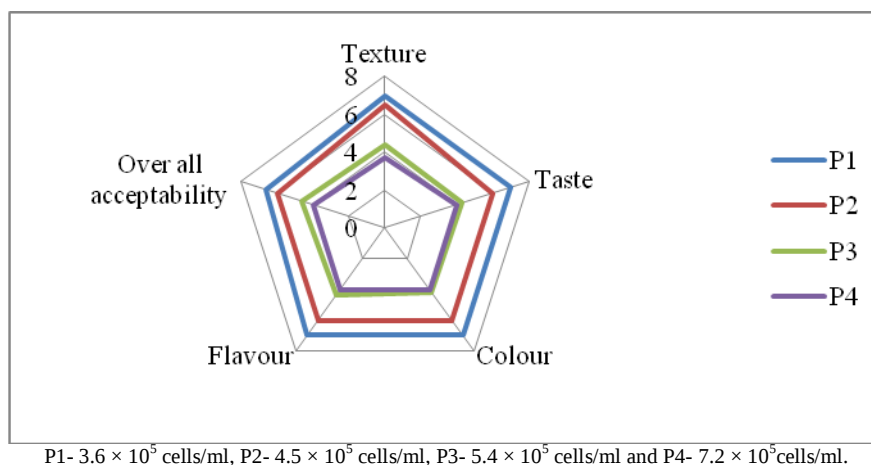
| Properties           | Places | Storage period          |                         |                         |                         |
|----------------------|--------|-------------------------|-------------------------|-------------------------|-------------------------|
|                      |        | Week 1                  | Week 2                  | Week 3                  | Week 4                  |
| pH                   | P1     | 4.43±0.01 <sup>a</sup>  | 4.36±0.05 <sup>b</sup>  | 4.16±0.06 <sup>e</sup>  | 4.09±0.08 <sup>gh</sup> |
|                      | P2     | 4.34±0.0 <sup>bc</sup>  | 4.29±0.01 <sup>cd</sup> | 4.13±0.04 <sup>ef</sup> | 4.07±0.05 <sup>gh</sup> |
|                      | P3     | 4.33±0.01 <sup>bc</sup> | 4.29±0.02 <sup>cd</sup> | 4.13±0.01 <sup>ef</sup> | 4.05±0.03 <sup>h</sup>  |
|                      | P4     | 4.26±0.06 <sup>d</sup>  | 4.19±0.01 <sup>e</sup>  | 4.1±0.01 <sup>fg</sup>  | 4.04±0.03 <sup>h</sup>  |
| Titrable acidity (%) | P1     | 0.81±0.02 <sup>e</sup>  | 0.86±0.01 <sup>d</sup>  | 0.87±0.01 <sup>d</sup>  | 0.98±0.03 <sup>c</sup>  |
|                      | P2     | 0.84±0.04 <sup>de</sup> | 0.87±0.02 <sup>d</sup>  | 0.88±0.02 <sup>d</sup>  | 1.04±0.07 <sup>b</sup>  |
|                      | P3     | 0.86±0.02 <sup>d</sup>  | 0.94±0.03 <sup>c</sup>  | 0.95±0.02 <sup>c</sup>  | 1.04±0.03 <sup>b</sup>  |
|                      | P4     | 0.88±0.01 <sup>d</sup>  | 0.97±0.01 <sup>c</sup>  | 0.98±0.12 <sup>c</sup>  | 1.18±0.03 <sup>a</sup>  |

Values are means ± standard deviations of triplicate determination. Mean with the same letters are not significantly different at ( $p < 0.05$ ). P1-  $3.6 \times 10^5$  cells/ml, P2-  $4.5 \times 10^5$  cells/ml, P3-  $5.4 \times 10^5$  cells/ml and P4-  $7.2 \times 10^5$  cells/ml.

### 3.6 Sensory evaluation

Sensory evaluation was carried out to assess organoleptic quality characteristic of yoghurts prepared from milk with different SC counts. The panelists from various groups were served with the samples to evaluate certain attributes. The SC counts of the milk significantly influenced the grading score of yoghurts (Figure 1). The high-SC counts milk gave yoghurt which received the lowest grading score of attributes. Furthermore, the study shows that there were significance differences ( $p < 0.05$ ) between the overall sensory attributes of yoghurt during storage period. The all sensory scores of yoghurts were significantly reduced from week 1 to week 4 of storage. It might be attributed to the increase in total titratable acidity, yeasts and moulds of the yoghurts<sup>[26]</sup>.

Texture of yoghurt was significantly decreased during storage. It might be due to increasing gel firmness and loosing of water from yoghurt during storage period. The low pH and high total titratable acid values might have caused separation of whey from the solids. This result was supported with Amatayakul *et al.*<sup>[27]</sup>. Taste of yoghurt was significantly decreased during storage. The loss of taste in yoghurt samples may be due to development of acidity, oxidation of fat or proteolysis of proteins<sup>[28]</sup>. Colour of yoghurt was significantly decreased during storage. The change in colour yoghurt samples may be due to Maillard reaction between sugars and acids which, results in the formation of melanoidins.



**Figure 1: Sensory attributes of yoghurt made from milk with different level of SC counts**

This melanoidins was produced browning compounds in yoghurt [29]. In general, flavour of yoghurt significantly decreased during storage. It may be due to oxidation of milk fat (lipolysis) of yoghurt, which were developed off flavour in the yoghurts during storage period [30].

However, for high SC counts range of yoghurt, between 3<sup>rd</sup> and 4<sup>th</sup> weeks, sensory defects were detected, which resulted in low overall acceptability ratings. High SC counts range of yoghurt adversely affects the quality of the yoghurt by development of sensory defects such as rancidity and bitterness. These defects are caused by lipolysis and proteolysis, respectively [25]. Finally, most of the pannelist prefer or higher score obtained, yoghurt made from milk with low SC counts ( $3.6 \times 10^5$  cells/ml) at the 1<sup>st</sup> week of storage.

#### 4. Conclusion

The study revealed that yoghurt made with different SC counts of milk except reducing sugar and total protein had no significant effects on the dry matter, ash, fat, total sugar, pH and titratable acidity at day 1 but syneresis was gradually increased in yoghurt made milk with higher SC counts. Chemical and physical parameters of yoghurt such ash, dry matter, ash, total protein and titrable acidity were increased with storage period. On the other hand fat, pH, reducing sugar, and total sugar were reduced with storage period in all kinds of treatment. Sensory attributes of yoghurt was reduced with increasing SC counts and storage time period. The overall results indicate that higher milk SC counts has a negative effect on the physical, chemical and organoleptic quality of yoghurt. Yoghurt made with lower ( $3.6 \times 10^5$  cells/ml) SC counts range of milk was more preferred than yoghurt made from other higher range of SC counts in milk. However, further study is needed for industrial application.

#### Acknowledgements

The authors wish to thank Eastern University, Sri Lanka for financial support to conduct the research.

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