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**RESEARCH ARTICLE**

# STUDY ON THE EFFECTS OF CULTURE AND pH VARIATIONS ON QUALITY OF *GHEE*

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**ABSTRACT**

Milk was analyzed for several parameters like pH, acidity, fat, protein, solids-not-fat, total solids and moisture content. The values obtained were found to be satisfactory in comparison to composition of normal cow milk. Cream was separated from milk using hand-operating cream separator. Analysis of cream showed satisfactory results in comparison to cream obtained by cream separation process. The cream was divided into three parts of which first was directly made ghee without culturing, second was cultured with *dahi* culture and third with yoghurt culture. Chemical analysis of all ghee samples gave satisfactory results in comparison to normal ghee composition. Sensory evaluation of the three samples were performed taking attributes like flavor, acidity, color, texture, absence of impurities and overall. Ghee prepared from *dahi* cultured cream showed the highest. Again, *dahi* cultured cream was treated to different pH (4.5, 4.0 and 3.6). Ghee was prepared and subjected to sensory evaluation. The cream cultured to pH 3.6 showed the highest score. This finding indicates that flavor is produced in ghee in greater extent by *dahi* cultured cream in respect to yoghurt cultured and non-cultured cream and greater the extent of culturing, more is the flavor yielding diacetyl produced.



## INTRODUCTION

*Ghee* is the name for anhydrous butterfat prepared chiefly from cow or buffalo milk (De, 2000). *Dahi* or curd is the traditional fermented milk product obtained from pasteurized or boiled milk by souring with natural microflora or by the harmless lactic acid or other bacterial culture. The conversion of milk into *dahi* is an important intermediary step in the manufacture of *nauni, ghee* (Kharel *et al.,* 2010). *Ghee* is a clarified fat obtained by cooking/heating *nauni* or butter. The *ghee* produced from *nauni* contains somewhat lesser fat than the *ghee* obtained from butter. Since *nauni* has more intense cultured flavor than butter, *ghee* prepared from *nauni* is naturally more flavorful than that from butter. Because of the low moisture content, *ghee* is relatively more stable than *nauni* (Kharel *et al.,* 2010). *Ghee* is the chief form of cooking oil in many Nepali regional cuisines; it is also used medicinally and plays a part in some Hindu religious ceremonies (Anon.[1], 2009). In India and Nepal, ghee is made from both Cow and Buffalo milk. Buffalo ghee is white and Cow ghee is more yellow. Also, the ghee of a Cow is in liquid form at body temperature. The ghee of a Buffalo is still slightly solid. Buffalo milk and ghee are more *tama sic* (dulling), while Cow milk and ghee are believed to be more *sattvic* i.e. pure and purifying (Malakoff, 2005). Nowadays life has become very fast and a lot of transformation is taking place worldwide. The post-WTO situation presents a big challenge to our current dairy industry where competitiveness with global market has become unavoidable. Although ghee is our indigenous product, it has to meet the international standard with respect to aflatoxin, heavy metals, pathogens, pesticides residues, ghee residues, etc. For that innovative and cost effective methods have to be developed (Patel *et al*., 2006). Ghee is generally used with other foods for energy and palatability reasons. The home made ghee i.e. obtained from culture method has better flavor and is more palatable than dairy ghee which uses non-culture method. In non-culture method, flavor giving diacetyl, acid and acrolein like components are lacking due to which ghee has less flavor. Despite poor results, dairies use non-culture method because of simplicity as a result of which people are forced to consume less flavored ghee. The general objective of the study was to improve the sensory quality of ghee by varying the culture and extent of culturing of cream during ghee preparation.

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## MATERIALS AND METHODS

### Materials

### Milk

Freshly drawn bovine milk was taken from the breed of Nepali Jersey cross cow. The cow was of second lactation period. The milk had temperature of 19˚C at the time of receipt. pH was recorded to be 6.5 and acidity to be 0.16 percent as lactic acid.

### Starter cultures

Yoghurt culture (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*) was taken from Dairy Development Corporation, Biratnagar whereas *dahi* culture (*Streptococcus*

*lactis*, *Strptococcus cremoris*, *Streptococcus diacetilactis and Leuconostoc cremoris*) was taken from local level.

### Equipments and glassware

All required equipments and glassware were collected from Central Campus Technology laboratory.

### Chemicals

All chemicals used were of analytical grade. They were collected from Central Campus Technology laboratory.

## METHODOLOGY

First, the raw milk of cow was taken. Analysis of milk was as done for various parameters. Cream was separated from milk by using the cream separator (hand operating type) and then yield of cream and cream percentage were calculated. After that, the cream was divided into three parts of which first (Sample A) was directly churned and boiled for ghee preparation whereas second was cultured with yoghurt culture (Sample B) and the third one with *dahi* culture (Sample C). Culturing for *dahi* culture was done at 28-33°C and for yoghurt culture at 40-43°C up to pH 4.5. Then, the cultured ones were also churned and separated, and in turn were boiled to 120˚C and thus the three ghee samples were obtained. Ghee samples were then taken for the analyses of several parameters like moisture content, refractive index, acid value, peroxide value and RM value. Sensory evaluation of the samples, which was the most important part of the study, was than carried out. *Dahi* cultured sample was observed best, so again three cream parts (fresh) were cultured with *dahi* culture at 28-33°C to several pH i.e. pH 4.5 (Sample $C_{4.5}$), pH 4.0 (Sample $C_{4.0}$) and pH 3.6 (Sample $C_{3.6}$) and sensory evaluation was carried out.

**Preparation of ghee in laboratory**

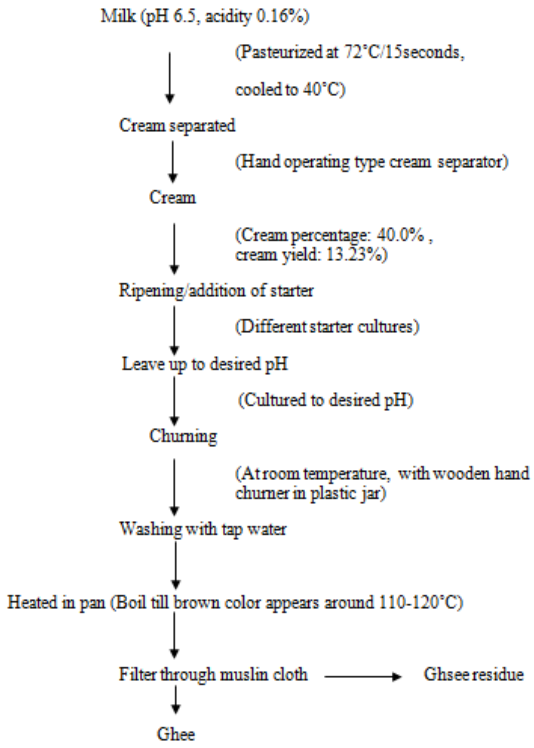


**Fig. 1. Flow chart for the preparation of ghee in laboratory**

### Production of ghee in Laboratory

For the production of ghee, methods similar to that of dairies were taken except the culturing method since all the parameters are to be compared with that of dairy ghee. For the production of ghee, flow chart similar to the creamery butter method was followed as in fig 1.

### *Chemical analysis for milk*

For the analytical portion of milk, it was first heated in water bath to about 35 – 40˚C so that during the treatment no water may evaporate. The milk samples were then cooled to 20±2˚C and test were carried out. Several parameters like pH, acidiy, fat percentage, SNF, total solids and moisture content were measured.

- **Determination of fat in milk**
  Fat in milk was determined by Gerber method (2001).
- **Determination of pH in milk**
  The pH in milk was determined directly with a pH meter.
- **Determination of acidity of milk**
  The acidity of milk was determined according Nepal Bureau of Standard (NDDB, 2001).
- **Determination of SNF, total solids and moisture content**
  Total solids, SNF and moisture content were determined according to Nepal Bureau of Standard (NDDB, 2001).

### *Chemical analysis for ghee*

For the analytical portion of the ghee, each sample was first melted at about 40˚C before taken for analysis. The parameters such as moisture content, refractive index, acid value peroxide value and RM value were measured. All the parameters were measured by the standard method adopted at DFTQC, Babarmahal, Kathmandu as given in laboratory manual of fats and oils (2003).

- **Moisture content**
  Moisture content of ghee was measured by hot-plate method (DFTQC, 2003).
- **Refractive index**
  It was measured by Abbe refractometer at room temperature and the value was converted at 40˚C (DFTQC, 2003).
- **Free fatty acids**
  It was measured by titrating with standard alkali (DFTQC, 2003).

### Sensory analysis

Sensory analysis was done according to the ghee scoring card (De, 2000).

### Statistical analysis

The data were subjected to ANOVA by GenStat programming (GenStat Discovery version). The ANOVA treatment was two-way ANOVA and means were compared by L.S.D method at 5% level of significance.

## RESULTS AND DISCUSSION

### Analysis of milk

Analysis of milk for various parameters is shown in the Table 1.

**Table 1. Analysis of milk**

| Parameters | Mean values |
|---|---|
| pH | 6.5(0.1) |
| Acidity (%) | 0.16(0.01) |
| Fat (%) | 4.1(0.12) |
| Protein (%) | 3.4(0.45) |
| SNF (%) | 9.2(0.6) |
| Total solids (%) | 13.3(0.72) |
| Moisture content (%) | 86.7(1.33) |

The values are the means of two determinations. The figures in the parenthesis are standard deviations.

### Analysis of cream

Analysis of cream for various parameters is shown in the Table 2. The values for the cream percentage and cream yield were found to be satisfactory to the cream obtained from normal cream separation process.

**Table 2. Analysis of cream**

| Parameters | Mean values |
|---|---|
| Cream (%) | 40.0(2.27) |
| Cream yield (%) | 13.23(1.84) |

The values are the means of two determinations. The figures in the parenthesis are standard deviations.

### Analysis of ghee

Analysis of ghee for various parameters is shown in the Table 3. Different parameters determined were found to be satisfactory in comparison to that of normal cow ghee.

**Table 3. Analysis of ghee**

| Parameters | Mean values |
|---|---|
| Moisture content (%) | 0.35 |
| Refractive index | 1.455 |
| Acid value(mg/g ghee) | 3.0 |
| Peroxide value(meq per kg of ghee) | 1.3 |
| RM value | 29.5 |

The values are the means of two determinations. The figures in the parenthesis are standard deviations.

### Effects of culture variation on sensory attributes of ghee

Ghee was prepared by using different cultured cream i.e. (*dahi* cultured, yoghurt cultured and non-cultured cream), and effect of variation on sensory attributes of ghee was studied. The results are expressed in the Table 4.It was found that there was significant difference in flavor, acidity and overall ($p<0.05$) between all three samples. The L.S.D value in the table indicates that samples differ significantly from each other. The average values of sensory score for flavor, acidity and overall was found to be greater for ghee prepared from *dahi* cultured (mixed cultured) cream rather than yoghurt cultured and non-cultured cream. Starter culture is a product with a high concentration of lactic acid bacteria which can activate an acidification process in milk and acid formation is one of the major properties of starter cultured. The advantage of standard cultured cream and, consequently, of standard butter is pleasantly aromatic smell and taste i.e. flavor in respect to non-cultured one (Nielsen and Ullum, 1989). It was found that no significant difference in color, texture and absence of impurities ($p<0.05$) between the samples. The average value of the sensory score for the above attributes was found to be almost same for all the samples. Based on the frequency of the occurrence as 'best' in each attribute type and the weightage on each attribute for describing the sensory quality, sample C appears to be the best formulation.

**Table 4. Mean values of different sensory attributes for culture variations**

| Formulation | Flavor | Acidity | Color | Texture | A.I* | Overall |
|---|---|---|---|---|---|---|
| A | $32.2^{c}(9.02)$ | $14^{c}(3.77)$ | 7.6(0.51) | 7.7(0.48) | 4.3(0.48) | $2.1^{c}(0.73)$ |
| B | $35.7^{b}(5.35)$ | $22^{b}(0.81)$ | 7.5(0.52) | 7.5(0.52) | 4.5(0.52) | $3.4^{b}(0.84)$ |
| C | $40^{a}(4)$ | $22^{a}(0.66)$ | 7.7(0.67) | 7.7(0.67) | 4.5(0.52) | $4.7^{a}(0.48)$ |
| L.S.D | 4.896 | 2.177 | | | | 0.4539 |

*absence of impurities.

The values are the means of two determinations. Values in the table bearing similar superscript in column do not differ significantly ($p<0.05$).

### Effect of pH variation on sensory attributes of ghee

Ghee was prepared from *dahi* cultured cream by culturing it to different pH i.e. (pH 4.5, pH 4.0 and pH 3.6), and effect of variation on sensory attributes of ghee was studied. The results are expressed in the Table 5.

**Table 5. Mean values of different sensory attributes for pH variations**

| Formulation | Flavor | Acidity | Color | Texture | A.I* | Overall |
|---|---|---|---|---|---|---|
| $C_{4.5}$ | $34.5^{c}(9.01)$ | $15.6^{c}(3.81)$ | 7.7(0.61) | 7.6(0.58) | 4.3(0.48) | $2.1^{c}(0.7)$ |
| $C_{4.0}$ | $39.1^{b}(5.02)$ | $18^{b}(0.69)$ | 7.5(0.52) | 7.5(0.52) | 4.5(0.52) | $3.0^{b}(0.8)$ |
| $C_{3.6}$ | $41.7^{a}(4)$ | $21.7^{a}(0.66)$ | 7.7(0.67) | 7.7(0.62) | 4.5(0.52) | $4.6^{a}$ (0.45) |
| L.S.D | 1.890 | 1.531 | | | | 0.539 |

*absence of impurities

The values are the means of two determinations. Values in the table bearing similar superscript in column do not differ significantly ($p<0.05$).

It was found that there was significant difference in flavor, acidity and overall ($p<0.05$) between all three samples. The L.S.D value in the table indicates that samples differ significantly from each other. The average values of sensory score for flavor, acidity and overall was found to be greater for ghee sample in which cream was cultured to pH 3.6 rather than cultured to pH 4.0 and pH 4.5. Starter culture is a product with a high concentration of lactic acid bacteria which can activate an acidification process in milk and acid formation is one of the major properties of starter cultured. The advantage of standard cultured cream and, consequently, of standard butter is pleasantly aromatic smell and taste i.e. flavor in respect to non-cultured one (Nielsen and Ullum, 1989). It was

found that no significant difference in color, texture and absence of impurities ($p<0.05$) between the samples. The average value of the sensory score for the above attributes was found to be almost same for all the samples. Based on the frequency of the occurrence as 'best' in each attribute type and the weightage on each attribute for describing the sensory quality, Sample C appears to be the best formulation.

**Conclusions**

Good flavored ghee was prepared when cream was cultured with starter culture rather than non-culture process. Flavor was found to be more intense in ghee prepared from *dahi* cultured (mixed culture) cream rather than that obtained from yoghurt cultured cream. Flavor of ghee obtained from *dahi* cultured cream was observed to be most that was cultured to pH 3.6, in between that was cultured to pH 4.0 and least that was cultured to pH 4.5.

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