DEVELOPMENT OF GREEK YOGURT FROM GOAT'S MILK

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ABSTRACT

Mango flavored Greek yogurt or strained yogurt was developed from goat's milk. Yogurt, strained for 4, 8 and 12 h at refrigerated temperature (4°C) were prepared and compared with unstrained yogurt in terms of pH, total titratable acidity, and protein content. The most preferred yogurt was determined by means of preference ranking test involving 30 panelists and its acceptability was evaluated by subjecting the yogurt samples to consumer testing with 80 panelists. The pH of the mango-flavored yogurt was unaffected by increasing duration of straining; however, total titratable acidity and protein content increased ($P<0.05$) as the straining period was lengthened. Mango-flavored yogurt strained for 8 h was the most preferred by the panelists. It had the following characteristics: pH of 3.83, titratable acidity of 1.16, and a protein content of 2.01 ± 0.12% estimated using the formol method. Consumer testing indicate that the yogurt strained for 8 h was also found to be acceptable in terms of firmness, flavor, off-flavor and sourness with a mode of 7, 8, 7 and 7, respectively, using the 9-point hedonic scale. Therefore, Greek yogurt from goat's milk can be prepared by straining for 8 h at refrigerated temperature. It is most acceptable in terms of consistency, flavor and sourness.

Keywords: Acceptability, acidity, goat's milk, strained yogurt

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INTRODUCTION

Most people consider yogurt as a nutritious snack or dessert especially those individuals who are watching their carbohydrate, fat and calorie intake. This fermented dairy product is typically prepared from cow's milk with the aid of two strains of bacterial cultures–*Lactobacillus bulgaricus* and *Streptococcus thermophilus* - which confer various beneficial health effects to the consumer (Tamime and Robinson, 2007).

One type of yogurt that is currently gaining popularity is the Greek yogurt, otherwise known as strained yogurt. It is produced using the same process as regular yogurt except that Greek yogurt is strained whereas regular yogurt is not. The straining process concentrates the protein in the yogurt. Thus, it is most suited for people who need more protein intake in their diet such as growing children, pregnant women, athletes and body builders. Removal of most of the whey gives the Greek yogurt a richer, thicker and creamier texture than conventional yogurt (Julien *et al.*, 1985). It can be used as a healthier alternative for milk and cream in many dishes, baked products, dressings, dips, sauces and cool beverages like smoothies, shake and ice cream (US News Health, 2011).

Greek yogurt is not yet popular in the Philippine market as opposed to the recognition and demand that it currently receives in the United States. Most American consumers, irrespective of the price, prefer its thicker and creamier texture, tanginess, and its nutritional characteristics (Foxnews.com, 2012). This study will make use of caprine milk in producing strained yogurt. This milk is considered as an underutilized local resource and developing Greek yogurt from this milk can add to its many potential uses. Goat's milk generally has more fat, protein, minerals and calories; however, it has less total solids, lactose and casein contents (Hui, 2007).

Therefore, the objective of this study was to develop Greek (strained) yogurt from goat (*Capra hircus*) milk by employing five strains of probiotics composed of *Lactobacillus bulgaricus, Streptococcus thermophilus, Lactobacillus casei, Lactobacillus acidophilus* and *Bifidobacterium longum* microorganisms.

MATERIALS AND METHODS

Materials

A commercial pasteurized goat's milk was obtained from Summer's Goat Milk along National Highway, Malandag, Malungon, Sarangani Province, Philippines. Freeze-dried Yogurt starter culture #2 produced by Custom Probiotics Inc. was used. This consist of *Lactobacillus bulgaricus*, *Streptococcus thermophilus*, *Lactobacillus acidophilus*, *Lactobacillus casei* and *Bifidobacterium longum*. Euro Cuisine Yogurt Maker model YM260 was used in making the yogurt which maintains a temperature of 40°C. After the manufacture of Greek yogurt, mango flavor was added.

Production of strained yogurt

Fresh goat's milk was batch pasteurized. Thereafter, it was immediately cooled to 38°C, then the starter culture was added. The mixture was incubated for 9 h and the yogurt was strained inside the refrigerator at a temperature of 5-10°C. Three sets of straining periods was employed: 4 h which indicated the first set, 8 h which signified the second set and 12 h for the third set. The product was stored at 4°C until analyzed for pH, total titratable acidity and protein content.

Preference ranking test

Four sets of yogurt were prepared composed of unstrained yogurt and strained yogurt for 4, 8, and 12 h, respectively. Each yogurt was placed in a container labeled as A, B, C and D in that order. A master sheet was also readied. Approximately, a tablespoon of each yogurt was placed in four (4) small cups separately. All containers were labeled with three-digit random code numbers as indicated in the master sheet. The four (4) samples were placed in a small tray in random order as specified in the master sheet. A total of 30 panelists were selected to assess the samples. The judges were asked to evaluate and rank the samples. Scores were recorded and analyzed using the Chi-square formula in Friedman's test (Lawless and Heymann, 2010).

Determination of the physico-chemical characteristics of yogurt

The pH and titratable acidity (TA) expressed as % of lactic acid were measured according to the International Dairy Federation (IDF, 1991) standards. Protein content was estimated using the Formol Titration Method.

Consumer testing

The most preferred yogurt that emerged from the ranking test was subjected to consumer testing using the 9-point hedonic scale. Approximately a tablespoon of the yogurt sample was placed in small cups. A total of 80 panelists were requested to assess the samples. The judge was instructed to evaluate each of the attributes such as firmness, flavor, off-flavor and sourness from a scale of 1-9 with 1 corresponding to the highest degree of dislike and 9 as highest degree of liking. Results were recorded and interpreted using the sign test (Lawless and Heymann, 2010).

RESULTS AND DISCUSSION

pH

The yogurt samples had pH values ranging from 3.83 to 3.86 (Table 1). According to USDA specifications, yogurt must have a maximum pH of 4.6. Therefore, all of the yogurt samples conformed to this specification.

Table 1. Mean pH values of unstrained and strained mango-flavored yogurt at three straining periods.

Straining period, h	Mean pH^{ns}
0 (unstrained)	3.86
4	3.85
8	3.83
12	3.83

^{ns}No significant difference at α=0.05

There was no effect of straining period on the mean pH of the mango-flavored yogurt. This may be attributed to the buffering capacity of milk, which is defined as a measure of its ability to resist

changes in pH in addition of an acid or base (Tamime, 2009). This is mostly because of the presence of amino acid residues of caseins and whey proteins and colloidal salts such as calcium phosphate complex, citrates and bicarbonate (Hui, 2007).

Goat milk has better buffering capacity than cow's milk and is therefore good in the treatment of ulcers (Sinha, 2007). Caseins display a maximum buffering capacity of 5 to 5.5 while whey proteins are measured around pH 3 to 4. The exact values of their respective buffering capacities depend on the presence of acidic amino acids, phosphoserine and histidine residues (Tamime, 2009).The buffering capacity of milk will change seasonally in terms of species and breed of the milking animal. Generally, the higher the protein content of the milk, the higher its buffering capacity (Caldwell, 2009).

Total titratable acidity

Total titratable acidity of strained mango-flavored yogurt increased (P<0.05) the longer it is strained because in the process, whey is drained off which constitutes 93.8% water (Julien *et al*., 1985). When more water is removed from yogurt, it results in a thicker texture and a more concentrated flavor. Straining yogurt that is already acidic in the first place will yield an even sharper taste (Garlough, 2010). According to USDA specifications, total titratable acidity of yogurt must not be less than 0.9%. Only the unstrained yogurt was less than this specification while the rest of the mango-flavored yogurt strained for 4, 8 and 12 h conformed within the specifications.

Table 2. Mean total titratable acidity per 100 ml of unstrained and strained mango-flavored yogurt at three straining periods.

Straining period, h	Mean total titratable acidity, g per 100 ml
0 (unstrained)	0.85^{d}
4	1.01^{c}
8	1.16^{b}
12	1.26^{a}

$^{a-d}$Within a column, means without a common superscript differ (P<0.05).

Percent protein

Formol titration method was used in estimating the amount of protein in mango-flavored unstrained and strained yogurt. In the absence of literature value for the formol factor of goat's milk, cow's milk was used instead because in general, it was found to closely resemble the proximate composition of goat's milk (Hui, 2007). Strained yogurt had higher (P<0.05) protein content than unstrained yogurt (Table 3). After just 4 h of straining, its protein content already increased (P<0.05) by 39% in comparison to unstrained yogurt. The percentage of protein further increased (P<0.05) the longer the yogurt was strained, which may be due to the elimination of water.

Table 3. Mean percent protein of unstrained and strained mango-flavored yogurt at three straining periods.

Straining period, h	Protein, %
0 (unstrained)	0.83 ± 0.12^{d}
4	1.37 ± 0.23^{c}
8	2.01 ± 0.12^{b}
12	2.76 ± 0.34^{a}

[a-d]Within a column, means without a common superscript differ (P<0.05).

Codex regulation for yogurt states that the minimum milk protein content is 2.7% and 5.6% for concentrated yogurt. The mean protein percentage of the strained yogurt even after 12 h of straining was less than the specified protein content as stipulated by Codex Alimentarius. This may have been due to the addition of flavor after the straining process which added to the bulk of the yogurt and notably reduced the protein content of concentrated yogurt (Thompson, 2011).

The yogurt strained for 8 and 12 h had almost the same amount of whey eliminated as well as yield percentage. The more whey is drained in yogurt, the more it will be less susceptible to wheying-off. Wheying-off has a negative effect on consumers because whey separation and viscosity are among the most crucial aspects of the quality and overall sensory consumer acceptance of yogurt. Moreover, it can be misconstrued as a sign of spoilage. Because of the strained yogurt's stability against wheying-off, there will be no more need for stabilizers such as pectin, gelatin and

starch. There is also no need for adding milk to prevent whey syneresis (Lee and Lucey, 2010).

Table 4. Estimated amount of whey removed and yield of yogurt after different straining periods.

Straining period, h	Amount of whey removed, g	Yield, %
4	74.55	70.18
8	102.93	58.83
12	106.31	57.48

One of the factors that can affect the whey drainage and yield is the milk solids since milk solids have good water holding capacity owing to the properties of proteins in binding moisture. Straining the fermented milk at 5° rather than 25° also contributes to the higher yield due to greater retention of moisture at low temperature. Polymer-producing starter cultures produce very viscous strained yogurt and longer time is required for whey extraction. Also, use of strains producing exopolysaccharides results in lower yield (Law, 1997). Chandan and Kilara (2013) also reported that the yield of the strained yogurt from sheep milk had the highest yield followed by goat's milk and cow's milk.

Preference ranking test

The most preferred (P<0.05) strained yogurt as evaluated by 30 panelists was the one strained for 8 h (Table 5). Most of the panelists commented that the 12 h-strained yogurt was a little too creamy and thick for their liking that it was almost similar to that of mayonnaise in terms of consistency (Figure 1). Some of them also remarked that the unstrained yogurt has a very watery consistency, which may be the reason why it was least preferred. The reason behind the unstrained yogurt's watery consistency is primarily due to the caseins in goat milk which form a softer and more fragile curd (Sinha, 2007). Furthermore, there was lack of added milk solids or stabilizers in the manufacture of this yogurt to improve its viscosity and consistency (Spanier *et al.*, 2001). The yogurt strained for 4 h had almost the same consistency as that of the unstrained one (Figure 1). Since the total titratable acidity and protein content of unstrained yogurt and yogurt strained for 4, 8 and 12 h were significantly different, it can be concluded that a titratable acidity of 1.16 g per 100 ml was most appropriate. This could be the key

actor why most of the panelists preferred the yogurt strained for 8 h which has the most preferred viscosity and consistency as llustrated in Figure 1. This quality is considered as a critical characteristic in terms of yogurt consumer acceptability (Lee and ucey, 2010).

Table 5. Rank sums of unstrained and strained mango-flavored yogurt at three straining periods.

Straining period, h	Rank sum[1]
0 (unstrained)	102[d]
4	80[c]
8	51[a]
12	67[b]

[1]The lowest rank sum is the most preferred.
[a-d]Within a column, means without a common superscript differ (P<0.05).

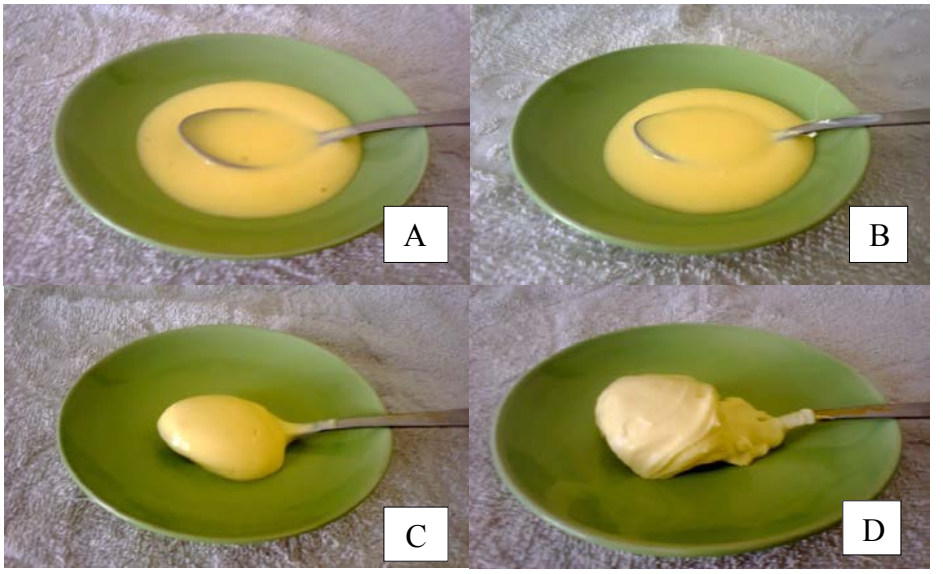

Figure 1. A) Unstrained mango-flavored yogurt, B) mango-flavored strained yogurt for 4 h, C) for 8 h and D) for 12 h.

Consumer Testing

Based on the results of the preference ranking test, the yogurt sample that was most preferred was the mango-flavored yogurt strained for 8 h. All of its attributes were acceptable based on the consumer study using the sign test (Table 6). Its firmness had a mode of 7 (40%) and this is equivalent to “like moderately”. About 28.75% of the panelists rated it as 8 and 13.75% evaluated it as 9. The flavor of the mango-flavored strained yogurt at 8 h had a mode of 8 which borders on “like very much” in the 9-point hedonic scale. About 16.25% of the consumers liked the flavor slightly, 21.25% liked it moderately, 37.5% liked it very much and 13.75% of them extremely liked the product. In terms of the off-flavor, most of the consumers rated it as 7 or “like moderately” which signifies that the “goaty” flavor of yogurt can be detected more or less but does not pose a problem for them as they find the flavor satisfactory. About 18.75% of the consumers evaluated it as 6, 30% as 7, 22.5% as 8 and 10% as 9. For the sourness of mango-flavored yogurt strained for 8 h, it had a mode of 7 which suggests that the consumers moderately liked the sourness of the yogurt. This can be related to the fact that Filipinos are not quite used to the sour taste of yogurt and that they are turned off by it. About 12.5% of the consumers rated the sourness of the strained yogurt as 6, 38.75% evaluated it as 7, 26.25% rated it as 8 and 8.75% extremely liked its sourness.

Table 6. Acceptability of attributes of yogurt strained for 8 h according to the consumer test.

Attributes	Decision
Firmness	acceptable
Flavor	acceptable
Off-flavor	acceptable
Sourness	acceptable

This product is suitable and favorable to people who need more protein intake in their diet such as growing children, pregnant women, athletes, bodybuilders and other people who wish to turn to high-protein diet. Each of these individuals has varying amount of protein required in their diet. For example, a growing child with a weight of 28 kg would require about 26.6 g of protein (Table 7). A 125 g serving of mango-flavored strained yogurt can already contribute about 9.4% of his/her daily protein requirement.

Table 7. Estimated percentage contribution of protein obtained from 125 g serving of mango-flavored yogurt strained for 8 h with 2.5 g protein.

Consumer contribution, %	Required protein, g	Estimated protein Contribution, %
Growing children (28 kg)	26.6[z]	9.40
Pregnant women	70[y]	3.57
Bodybuilders (198 kg)	356[x]	1.54
High protein diet patrons (50% in their diet)	235[w]	1.06

[z]based on Troy (2006)
[y]based on Kassem (2010)
[x]based on Insel *et al.* (2013)
[w]based on webmd.com (2012)

Protein estimates were computed on the basis of the protein content of mango-flavored strained yogurt derived from the results of formol titration method. Considering that this is a rapid method of analysis, the computations provided in Table 7 were conservative approximations. According to Hui (2007), 3.4% of protein is found in goat milk with casein as the major protein at 2.4% but formol titration method is based on the reaction of formaldehyde with the basic groups of lysine and arginine only (Pyne, 1932). The mango-flavored yogurt strained for 8 h contained 2.01% protein but if based on literature value; its protein content can reach up to 4.58% or 5.72 g per 125 serving. This is most favorable to individuals who need more protein in their diet.

For commercialization purposes, the cost of this product was estimated to be PhP 27.78 per 125g serving. This production cost was only computed based on 2 liters of goat's milk as starting material. This can further be reduced with an increase in the volume produced due to economy of scale.

CONCLUSION

Acceptable Greek yogurt from goat's milk can be prepared by straining for 8 h at refrigerated temperature. It was found to be acceptable in terms of consistency, flavor and sourness.

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