Effect of Hydrocolloids on Sensory Properties of the Fermented Whey Beverage from Different Types of Milk

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Abstract

Whey from cow, goat and buffalo milk was separated after heat-acid coagulation of casein using 4% acetic acid at 93°C. The whey was then pasteurized at 73°C for 15 s, cooled and kept at 4°C. The whey was warmed to 45°C and three types of hydrocolloids; high methoxyl pectin (HMP), carboxymethyl cellulose (CMC) and alginate were added at 0.3, 0.5, and 0.7% for HMP; and 0.1, 0.2 and 0.3% for CMC and alginate. The fermentation was performed at 45°C for 4 hrs using 3% yogurt cultures. pH and acidity of whey was measured after fermentation. Three per cent of 50% sucrose syrup was added into fermented whey including 0.06% orange color and 0.06% orange flavor. The whey beverage was then kept at 4°C for sensory analysis. Type and concentration of hydrocolloids did not affect the acidity and pH of the product before and after fermentation, while they affected the sensory properties of whey beverage. Addition of pectin (0.7%) in whey provided the highest scores for all attributes for cow (8.0-8.2) and goat milk (6.5-6.7). For buffalo milk, CMC (0.2%) seemed to be the most suitable hydrocolloid with the preference scores of all attributes as 7.2-7.7. Moreover, whey beverage from cow milk obtained the highest scores for color, aroma, flavor, texture and overall attributes as 8.2, 8.1, 8.2, 8.3 and 8.3, respectively, compared with those of goat and buffalo milk.

Keywords*: Cow, goat and buffalo, heat-acid coagulation, casein, pectin.*

1. Introduction

Whey is a liquid by-product obtained from cheese industry. In the past whey was disposed as a waste resulting in environmental pollution. Whey and its protein are now produced and used as food ingredients in food industries generally as foaming and emulsifying agents (Ji and Hauque 2003). Moreover, the whey protein can be used for fortification of food in order to increase nutritional value of many dairy products such as ice cream, cheese and bakery products (Kenny *et al*. 2001; Carunchia Whetstine *et al*. 2005). Although the whey based beverage is of interest due to a widespread increase in consumption of lactic beverage such as drinking yogurt and milk-like drink (Jellen *et al*. 2003), the poor mouth-feel and watery characteristic of the product drawback its consumption. The watery characteristic of whey based beverage is caused by low total solid content of liquid whey approximately 6%, therefore, addition of hydrocolloids such as high methoxyl pectin (HMP), carboxy-methylcellulose (CMC) and alginate was required to improve texture of product to be as homogenous as milk (Driesen and van den Berg 1990; Sienkiewicz and Riedel 1990). Hydrocolloids in dairy industry are mainly used to improve texture of the product by interacting with casein network (Syrbe *et al*. 1998; Thaiudom and Goff 2003). They also enhance product viscosity and prevents precipitation of disperse particles when the low concentrations are used. The effectiveness of hydrocolloids depends on their ability to dissolve in water and/or intermolecular associations (Baeza *et al*. 2003). For the use of hydrocolloids in dairy products, there are two important aspects needed to be concerned.

Firstly, the hydrocolloids should not affect the natural flavor of the product. Moreover they should be effective at the low pH of the product 4.0-4.6. Williams and Phillips (2003) also reported that the hydrocolloids that suitable for the use in dairy beverage include carboxy-methylcellulose (CMC), pectin, alginate and xanthan gum (XG). Although the addition of hydrocolloids improved the texture of the whey beverage, it influenced in a decline of perceived flavor intensity in the product (Boland *et al*. 2006). Furthermore, many studies reported the effect of added hydrocolloids only in cow's whey model emphasizing on rheological properties (Hegedusic *et al*. 2000) more willing than sensory properties of the product. Therefore, this research, initiated by Cabraal (2010), aimed to study the effects of hydrocolloid addition on the sensory properties of fermented whey beverage from different types of milk such as cow, goat and buffalo milk.

2. Materials and Methods

2.1 Preparation of Whey from Different Types of Milk

Three types of pasteurized milk, cow, goat and buffalo milk, were used in this experiment. Whey was obtained by heat-acid coagulation of milk. Milk was heated to 93°C and then 12 mL of 4% acetic acid was added into 1 L of milk. After the curd was separated, the whey was then pasteurized at 73°C for 15 s, cooled and kept at 4°C for further processing.

2.2 Addition of Hydrocolloids

The whey was warmed to 45°C. Three types of hydrocolloids, high methoxyl pectin (HMP), carboxymethylcellulose (CMC) and alginate, were added separately at the concentrations of 0.3, 0.5, and 0.7% for HMP, and at 0.1, 0.2 and 0.3% for CMC and alginate. The whey was then mixed well to avoid clumping of hydrocolloids.

2.3 Fermentation

Three per cent of commercial yogurt cultures were added into whey from three types of milk. The fermentation of whey was then performed at 45°C for 4 hrs. The fermented whey was kept at 4°C. pH and acidity of whey was measured before and after fermentation.

2.4 Preparation of Whey Beverage

The fermented whey (150 ml) was blended with 50% syrup (5 ml). Orange color (0.06%) and orange flavor (0.06%) were added and mixed well. The whey beverage was then kept at 4°C for sensory analysis.

2.5 Sensory Analysis

Sensory evaluation was performed by using 9-point hedonic scale and 30 panelists.

2.6 Statistical Analysis

A randomized block design with 3 replications was used in this experiment. Means comparison was analyzed using Duncan's Multiple Range Test.

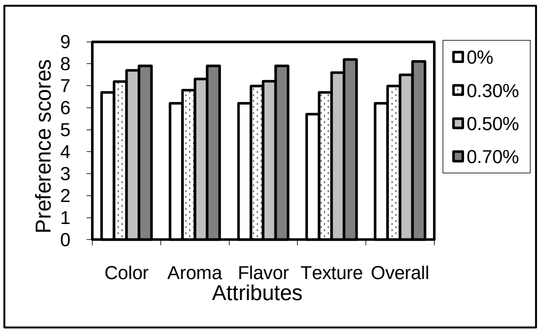
3. Results and Discussion

3.1 Effect of Concentration of Added Hydrocolloids

Three types of hydrocolloids, high methoxyl pectin (HMC), carboxy-methylcellulose (CMC) and alginate were added in whey from different types of milk (cow, goat and buffalo) at different concentrations as 0.3, 0.5 and 0.7% for HMP; and 0.1, 0.2 and 0.3% for CMC and alginate. The hydrocolloids were added in whey before fermentation with yogurt cultures at 45°C for 4 hrs. It was recognized that the concentration and types of added hydrocolloids had no influence on the pH and acidity of whey after fermentation in all types of milk (the result was not shown). After fermentation the pH of the product was in the range of 4.41-4.50 and the acidity was 0.7-1.1% for all treatments, indicating that addition of hydrocolloids did not influence the activity of yogurt cultures either increase or inhibit their growth. This result was parallel to the studies of Athar *et al*. (2000).

On the other hand, addition of hydrocolloid significantly (p<0.05) enhanced the sensory properties of fermented whey beverage (Figs 1, 2 and 3). The preference scores of all attributes increased when the concentration of hydrocolloids increased. These occurred for all types of hydrocolloids and milk, except pectin and CMC in whey from buffalo milk. When the maximum concentrations of pectin (0.7%) and CMC (0.3%) were used, the preference scores in all attributes declined (Figs. 1 and 2). Addition of hydrocolloids initially improved the texture of the product, followed by the subsequent decrease in viscosity as increasing levels of hydrocolloid were added (Gaonkar 1995). The initial texture improvement was obtained by the interaction between hydrocolloid (negatively charge) and protein (positively charge). High amount of hydrocolloid increased the charges of the particles, resulting in the low texture improvement. The sedimentation increased, leading to less product acceptability. Nevertheless, if the amount of hydrocolloids used further increased, the texture of the product was also further improved due to the sedimentation was inhibited. This was caused by a decrease in the protein-hydrocolloid interaction, resulting in higher level of hydrocolloids to influence the texture of the product (Gaonkar 1995).

Finally, the suitable concentrations of each hydrocolloid for each type of milk were 0.7% and 0.5% pectin for cow and goat milk; and buffalo milk, respectively. For CMC, 0.3% was suitable for cow and goat milk, whereas, 0.2% was used in buffalo milk. Moreover, 0.3% alginate was suitable for all types of milk.



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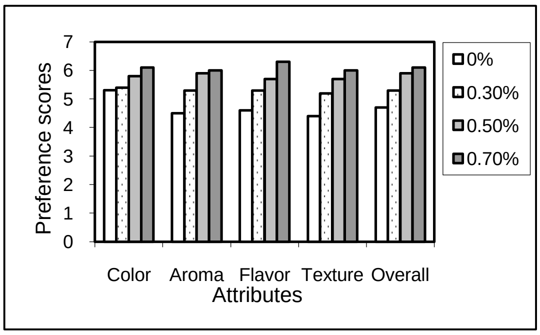

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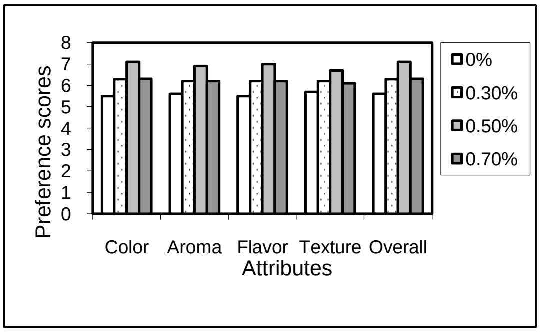

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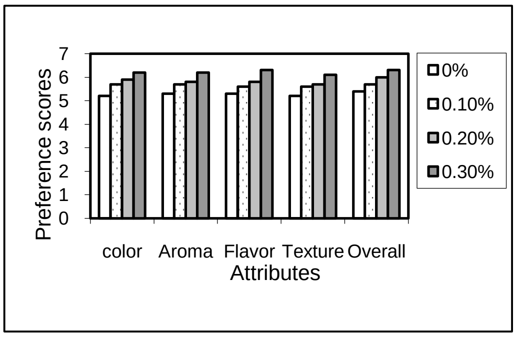
Figure 1: Effect of added pectin on sensory evaluation of fermented whey beverage produced by using different types of milk: (a) cow milk, (b) goat milk, and (c) buffalo milk.



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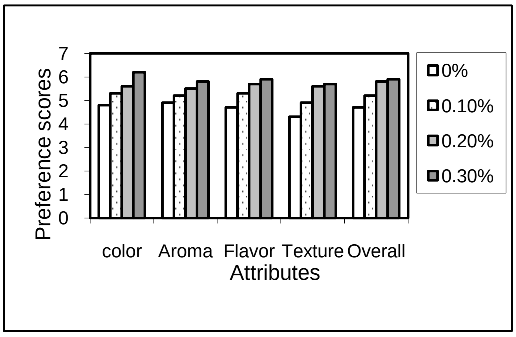

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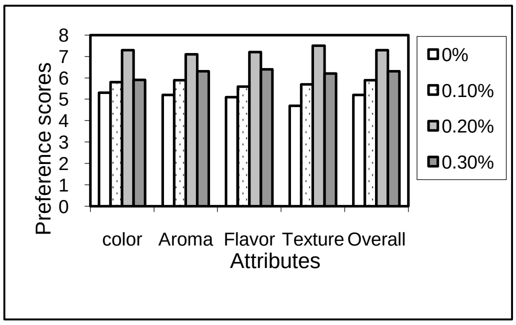

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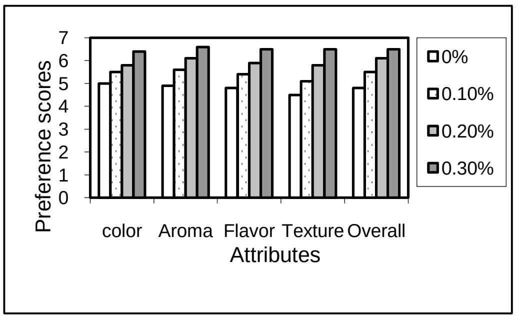
Figure 2: Effect of added CMC on sensory evaluation of fermented whey beverage produced by using different types of milk: (a) cow milk, (b) goat milk, and (c) buffalo milk.



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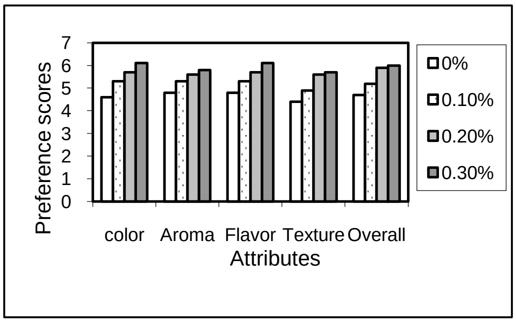

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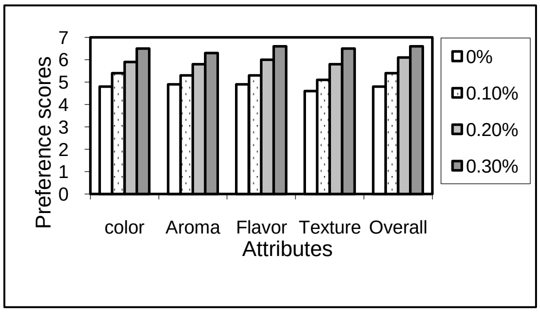

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Figure 3: Effect of added alginate on sensory evaluation of fermented whey beverage produced by using different types of milk: (a) cow milk, (b) goat milk, and (c) buffalo milk.

3.2 Effect of Types of Hydrocolloids

The fermented whey beverages were produced by using the suitable concentration of each type of hydrocolloids for each type of milk. These were 0.7% pectin, 0.3% CMC and 0.3% alginate for cow and goat milk; and 0.5% pectin, 0.2% CMC and 0.3% alginate for buffalo milk. The sensory evaluation was performed by using 9-point hedonic scale and 30 panelists and the result has been shown in Table 1.

It was recognized that among three selected hydrocolloids used in this experiment, pectin was the most suitable for improving the sensory qualities of fermented whey beverage from cow milk. It provided the highest preference scores of color, aroma, flavor, texture and overall liking as 8.1, 8.0, 8.0, 8.2 and 8.1, respectively, indicating that the panelists liked this product very much. For goat milk, although there were no significant differences ($p>0.05$) of the preference scores of all attributes between pectin and CMC, those of pectin showed slightly higher scores. HMP is often recommended to use as a stabilizer in acid foods such as drinking yogurt. It provided thermal irreversible gel and acts as protective colloid, preventing the casein particles from coagulating and sedimenting when added to milk before fermentation. It is formed gel after the milk is immediately acidified by fermentation, resulting in good maintaining of gel at low pH values (Phillips and Williams 2000).

In addition, CMC seemed to be suitable for fermented whey beverage from buffalo milk with the scores of color, aroma, flavor, texture and overall liking as 7.3, 7.2, 7.3, 7.7 and 7.4, respectively. Although addition of alginate in the products from all types of milk improved the sensory quality of the products comparing with control; the preference scores for all attributes were the lowest. CMC, in dairy products, forms heat-stable, soluble complexes by interacting with casein at the isoelectric point (Imeson 1997). Due to the 11.42% higher protein content of buffalo milk than cow and goat milk (Zicarelli 2004), whey milk after heat-acid coagulation of casein, resulting in higher casein to form complex with CMC.

On the other hand, alginate seemed not to be suitable for this experiment. This hydrocolloid is chemically formed gel with calcium ion, which already has presences in whey; however, it is not stable in acidic condition due to insoluble alginic acid forms. This might cause improper texture of the product compared to other hydrocolloids.

Moreover, it was noticed that the preference scores of all the products were in the commercially acceptable range of 4-9 as per the 9-point hedonic scale (Tamime and Robinson 1999).

Table 1. Effect of types of hydrocolloids on sensory properties of fermented whey beverage produced by using different types of milk.

Milk	Attributes	Hydrocolloid			
		Control	0.7% pectin (cow/goat) 0.5% pectin (buffalo)	0.3% CMC (cow/goat) 0.2% CMC (buffalo)	0.3% alginate
Cow	Color	4.8[a*]	8.1[d]	7.0[c]	6.6[b]
	Aroma	4.9[a]	8.0[c]	6.9[b]	6.8[b]
	Flavor	4.8[a]	8.0[c]	6.8[b]	6.7[b]
	Texture	4.5[a]	8.2[c]	6.8[b]	6.7[b]
	Overall	4.7[a]	8.1[d]	7.0[c]	6.8[b]
Goat	Color	5.2[a]	6.6[c]	6.6[c]	6.0[b]
	Aroma	4.5[a]	6.5[c]	6.3[c]	5.7[b]
	Flavor	4.6[a]	6.7[c]	6.5[c]	5.9[b]
	Texture	4.3[a]	6.5[c]	6.5[c]	5.5[b]
	Overall	4.6[a]	6.6[c]	6.5[c]	5.9[b]
Buffalo	Color	4.8[a]	7.1[c]	7.3[c]	6.6[b]
	Aroma	4.9[a]	6.9[c]	7.2[c]	6.4[b]
	Flavor	4.8[a]	7.0[b,c]	7.3[c]	6.8[b]
	Texture	4.7[a]	7.0[b]	7.7[c]	7.0[b]
	Overall	5.0[a]	7.1[c]	7.4[d]	6.8[b]

***** The different letters mean that there were significant differences at $p<0.05$. The statistical analysis was done separately for each type of milk.

3.3 Effect of Types of Milk

The fermented whey beverages were produced by using the suitable type and concentration of hydrocolloids for each type of milk. Pectin (0.7%) was used for cow and goat milk, while CMC (0.2%) was used for buffalo milk. The result of sensory evaluation has been shown in Table 2.

There were significant difference ($p<0.05$) in all attributes among these milk. The fermented whey beverage from cow milk obtained the highest scores (8.1-8.3), followed by buffalo (7.3-7.5) and goat milk (6.8-6.9), respectively. This might be mainly caused by the goaty flavor that would not be masked by fermentation process. Moreover, most of the panelists were familiar with cow milk rather than buffalo and goat milk. However, all of the scores were in the commercial acceptable range.

Table 2. Effect of milk type on sensory evaluation of fermented whey beverage.

Attributes	Milk		
	Cow	Goat	Buffalo
Color	8.2[c]	6.8[a]	7.5[b]
Aroma	8.1[c]	6.8[a]	7.3[b]
Flavor	8.2[c]	6.9[a]	7.4[b]
Texture	8.3[c]	6.9[a]	7.7[b]
Overall	8.3[c]	6.9[a]	7.3[b]

***** The different letters mean that there were significant differences at $p<0.05$.

4. Conclusion

Addition of hydrocolloids improved the sensory quality of fermented whey beverage from different types of milk. Type and concentration of hydrocolloids strongly affected the sensory characteristics of the products. High methoxyl pectin (0.7%) was suitable for sensory improvement of fermented whey beverage from cow and goat milk, while the sensory characteristics of whey beverage from buffalo milk were improved when CMC (0.2%) was added. However, the panelists liked fermented whey beverage from cow milk very much with scores of all attributes as 8.1-8.3.

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