

Syneresis and Sensory Acceptability of Desserts Based on Whey Proteins Concentrates

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Abstract Syneresis and sensory acceptability of dairy desserts based on whey proteins concentrate were investigated. Samples were prepared with whey protein concentrate, modified corn starch, cocoa and sucrose or sucralose. For sensory acceptability evaluation samples were compared to a semisolid low in calories commercial dessert based on skim milk. Syneresis was lower than 5% in all the samples studied. This is a *successful outcome* because this is a visual sensory attribute that strongly determines the acceptability of this type of products. Energy values of the samples were similar and minor than the commercial dessert. Samples were qualified mainly by positive degrees of overall liking, though with qualifications lower than those of the commercial dessert. The acceptability of the samples may be improved changing the concentrations of cocoa, sweeteners and flavoring agent.

Keywords: dairy desserts, whey proteins, syneresis, sensory acceptability

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1. Introduction

Nowadays, an increasing interest exists for a healthy supply. Foods reduced in calories and with high nutritional value are preferred. Therefore, the food industry is in a constant search of new ingredients that allow to replace fats and sugars [1].

Whey proteins (WP), a byproduct from cheese and casein manufacture, are considered as functional ingredients. They act as gelling agents, emulsifiers, texture modifiers, thickening agents and foaming agents. In addition, they have high nutritional value, such biological functions (as increment of satiety response and increment of glutathione levels) and are generally recognized as safe [2,3,4,5]. However, in spite of investigations of WP properties and health benefits are in growth, products for human consumption based on them are still scarce.

Dairy desserts are products of wide consumption. Their nutritional and sensory characteristics make them accepted by children and adults, but usually they have high energy density. They are semisolid foods produced with milk, sugars, native and/or modified starches, flavoring agents and colorants [6,7]. The final texture of them mainly results from the interaction between proteins and polysaccharides. Therefore, it is necessary to obtain a balance sheet between these components to reach formulations with a texture accepted by the consumers and to control the physical stability of these products, that is to say to avoid such undesirable phenomena as flocculation, syneresis and the phase separation [8].

Mleko (1997) [6] and Mleko and Gustaw (2002) [9] studied the substitution of total milk proteins by whey proteins isolates in dairy desserts and observed that the obtained desserts had low syneresis, pseudoplastic and thixotropic flow behaviour. Also, in reference [10] the effect of heating and storage on the rheological properties of dairy desserts based on potato starch (PS) and whey proteins concentrates (WPC) was studied. The authors found that formulation with 4% WPC, 3% PS, 0.1% i-carrageenan, 10% sucrose, 3% milk fat and 3% chocolate produce products that had acceptable rheological properties. These results suggest that whey proteins can be used as protein source in desserts. Nevertheless, it is known very little on the sensory characteristics of these products.

From the sensory point of view, the appearance is one of the attributes that more influences the choice of a dairy dessert. As soon as the food has been tasted, the color and the appearance go on to a background, and thickness, texture and flavor are synonymous of quality and of degree of acceptance [11,12]. Therefore, information relating to the global acceptability is valuable for the formulation of a new product. This work deals specifically with sensory acceptability evaluation of dairy desserts based on whey proteins concentrates.

2. Materials and Methods

2.1. Sample Preparation

For samples preparation, whey protein concentrate (WPC) (LACPRODAN®-80) was obtained from Arla

Food Ingredients S.A. (Martinez, Buenos Aires, Argentina). WPC composition was provided by the industry ($78 \pm 2\%$ (w/w) protein, $7 \pm 2\%$ (w/w) lactose, 8% (w/w) fat, 3.5% (w/w) ash and 5.5% (w/w) moisture). Also, modified corn starch by acid hydrolysis (Glucovil Argentina S.A., Villa Mercedes, San Luis, Argentina), sucrose (Ingenio Ledesma S.A., Ledesma, Jujuy, Argentina), sucralose (Glutal Argentina S.A., Esperanza, Santa Fe, Argentina), cocoa (El Quillá, Santa Fe, Argentina) and chocolate flavoring agent were used (Saporiti S.A., Buenos Aires, Argentina).

The appropriate amount of dry ingredients were weighted and dissolved in enough distilled water to achieve the desired concentration. Dispersions were kept under magnetic stirring for two hours at room temperature. Then, they were heated at 80°C during 30 minutes under mechanical stirring at 60 rev/min (Ika Labortechnik, Brasilia, Brazil). Later, the samples were placed in a thermostatic bath at 25°C for 30 minutes. Finally they were stored at 4°C overnight. To ensure reproducibility, two different batches were prepared. The composition of prepared samples and codes are shown in Table 1. Flavouring agent was added to all samples at 0.1% w/w as was suggested by the supplier. It is relevant to note that due to the fact that the principal components that determine the structure and the texture of these products are proteins and polysaccharides, in this work samples with 5% w/w of proteins and 9% w/w of modified starch were studied on the basis of previous studies reported by [13] who determined the suitable concentrations of hydrocolloids and thermal treatment to obtain a texture similar to that of a dessert based on milk.

Table 1. Codes and composition of the formulated samples

Sample code	WP (% w/w)	Starch (% w/w)	Cocoa (% w/w)	Sucrose (% w/w)	Sucralose* (% w/w)
P5A9	5	9	-	-	-
P5A9-C	5	9	2	-	-
P5A9-S	5	9	-	10	-
P5A9-S-C	5	9	2	10	-
P5A9-SI	5	9	-	-	0.024
P5A9-SI-C	5	9	2	-	0.024

*Amount recommended by the supplier to achieve the same sweetness provided by the sucrose added in the other samples.

2.2. Syneresis

Ten grams of each sample were transferred to previously weighted centrifugation tubes and were held vertically at 4°C during 14 days. Syneresis was quantified as the loss of weight of the sample after the removal of the exuded water [14,15]. The extent of syneresis was expressed as a percentage of exuded water as is referred in equation (1).

$$\text{Syneresis (\%)} = \frac{\text{exuded water (g)}}{\text{total weight of the sample}} \times 100 \quad (1)$$

2.3. Sensory Evaluation

Sensory acceptability of samples P5A9-S-C and P5A9-SI-C, which contain all the ingredients of a dessert, was evaluated. These ones were compared to a semisolid low in calories commercial dairy dessert based on skim milk,

acquired in a local market. This product presents the following composition: 4.2% (w/w) of proteins, 16% (w/w) of modified starch, 8% (w/w) of sucrose y 0% (w/w) of fat.

The information about the tastes and distastes, preferences and requirements of acceptability of a food product is obtained using methods of analysis adapted to the needs of the consumer and sensory evaluations with not trained panelists. Therefore, one hundred consumers of dairy desserts, females and males between 18 and 67 years old were selected among students, employees and academic staff members of the Universidad Nacional del Litoral (UNL). Prior to be enlisted in the consumer's panel, members were briefed about the study to enable them to take an informed decision. Those who agreed to participate had to sign consent forms. Members were free to withdraw from the study at any time.

Portions of approximately 20g of dessert were presented on white ceramic cups, coded with three random numbers. The panelists were spaced at least 2 m in a booth area under white light to avoid interaction. Water and bread was provided to each evaluator for palate cleansing between samples. Samples were cooled at 6°C before being offered [16]. Panelists scored their overall liking of desserts using a 9-point hedonic box scale from "I dislike extremely" to "I like extremely" and centered in "It turns out to me indifferent". In addition, they were asked to rank the samples and the commercial dessert according to their preference from the more accepted in the ranking position 1 to the least accepted in the ranking position 3 according to visual appearance and overall taste [16]. Finally, they were asked to indicate the attributes by which the samples were selected in the first and the last position and to add some comment.

2.4. Statistical Analysis

Equal variances and normality tests of syneresis data were performed using Minitab (Minitab Inc., State College, PA, USA) [17]. Frequency distribution was built with the collected hedonic scale data and the percentages of degrees of taste were analyzed. The non-parametric Friedman's test was used to verify possible significant differences ($p < 0.05$) among the data distributions [16].

3. Results and Discussion

It was observed that the experimental data of syneresis for the different formulations and batches did not satisfy equal variances and normality tests [19]. Therefore, the analysis of variance in order to analyze if some of the ingredients affect significantly the syneresis was not possible. Table 2 presents the average values of syneresis obtained.

Table 2. Experimental values of syneresis of the formulated samples

Sample code	Syneresis (%)
P5A9	2.96 ± 0.44
P5A9-C	2.80 ± 0.40
P5A9-S	4.59 ± 1.78
P5A9-S-C	4.43 ± 1.99
P5A9-SI	3.26 ± 0.17
P5A9-SI-C	3.99 ± 0.31

It is observed that all values of syneresis are lower than 5%. This is a *successful outcome* because syneresis is a visual sensory attribute that strongly determines the acceptability of this type of products [9]. This amount of water expelled outside the matrix is almost undetectable at sight. These results are attributed to that whey proteins and modified starch retained the water during the evaluated time. The amount of proteins and polysaccharides allowed a positive interaction between them, avoiding undesirable phenomena as the phase separation or coacervation [8].

Energy values (EV) of the samples P5A9-S-C and P5A9-SI-C and of the commercial dessert were estimated by applying Atwater's general factors to each composition [18]. EV of the samples P5A9-S-C, P5A9-SI-C and of the commercial dessert are 107.45 kcal/100g, 67.45 kcal/100g and 112.8 kcal/100g, respectively. It is observed that the EV of the sample P5A9-S-C and of the commercial dessert are similar, while the EV of the sample P5A9-SI-C is 40% minor than the commercial dessert. Therefore, the replacement of milk by WPC allows obtain desserts with high nutritional value and low energy content.

Figure 1 shows frequency distribution of the hedonic scale data. It is observed that the sample P5A9-S-C was qualified mainly by positive degrees of overall liking

(51% of the panelists), being the predominant qualifications "I like it little" with 29% and "I like it moderately" with 17%. 8% of the panelists qualified to this sample as "it turns out to me indifferent" and the rest of the panelists attributed qualifications with different degrees of displeasure, being the predominant qualifications of "I dislike it little" with 17% and "I dislike it moderately" with 12%. The sample P5A9-SI-C was qualified mainly by positive degrees of overall liking (48% of the panelists) being the predominant qualifications "I like it little" with 26% and "I like it moderately" with 17%. 8% of the panelists qualified to this sample as "it turns out to me indifferent" and the rest of the panelists attributed qualifications with different degrees of displeasure, being the predominant qualifications of "I dislike it little" with 22% and "I dislike it moderately" with 13%. The commercial dessert was also qualified mainly by positive degrees of overall liking (95% of the panelists) being the predominant qualifications "I like it much" with 43%.

Also, it was observed a bimodal response in the frequency distribution. This can be due to wide range of age of the members of the panel. The young panelists are more frequent consumers of this type of products than the adults. Therefore the overall liking might be a bit different.

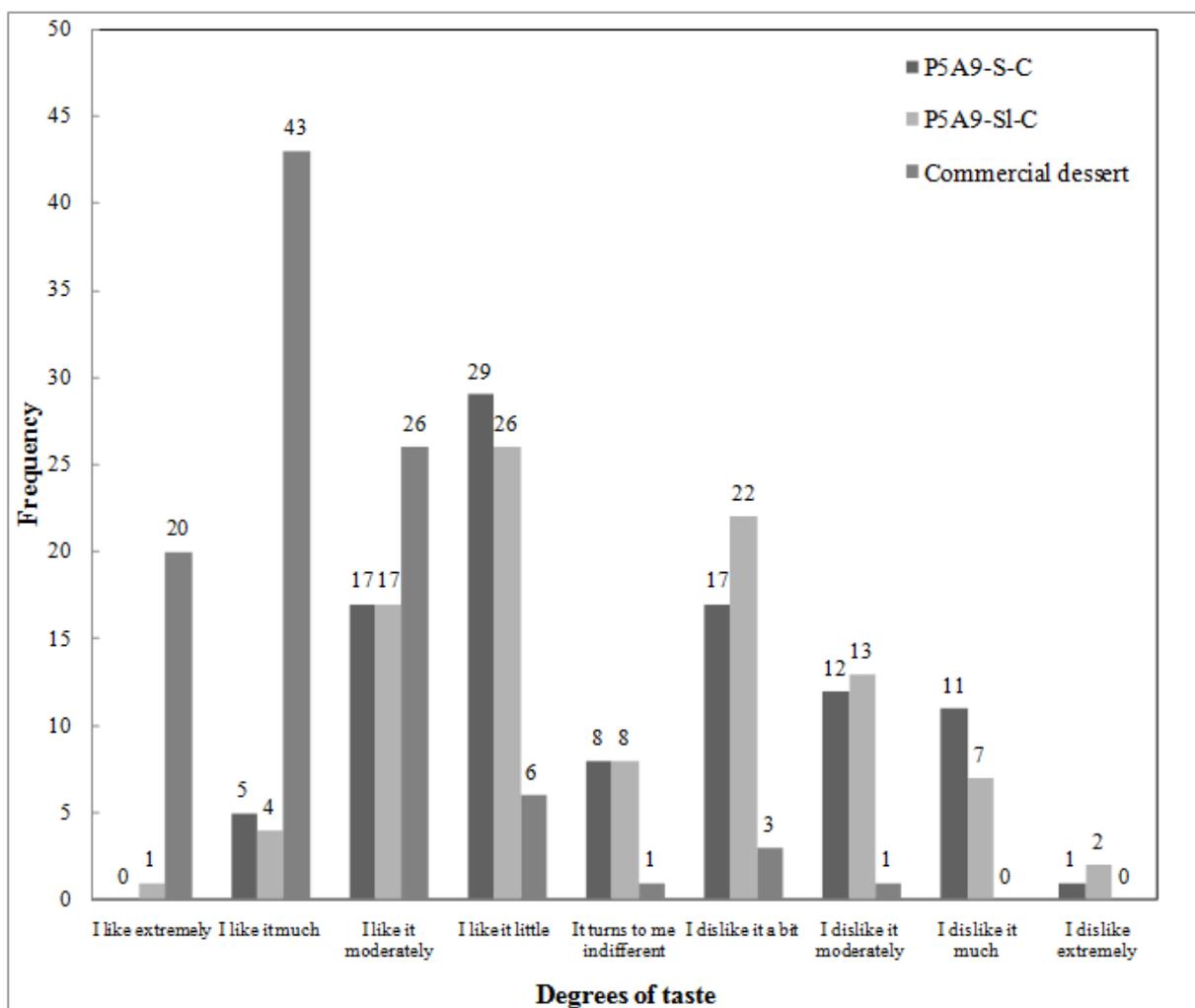


Figure 1. Frequency distribution of the hedonic scale data of the samples

The ranking of the samples and of the commercial dessert according to the preference of the panelists is presented in Figure 2. They positioned first to the

commercial dessert (88%), in the second position to the sample P5A9-S-C (53%) and in the third position to the sample P5A9-SI-C (54%). Friedman test for 100 panelists

and 3 samples indicated that significant differences existed between the formulated samples and the commercial dessert. Also, this test revealed that do not exist significant differences between formulated samples (P5A9-S-C and P5A9-SI-C).

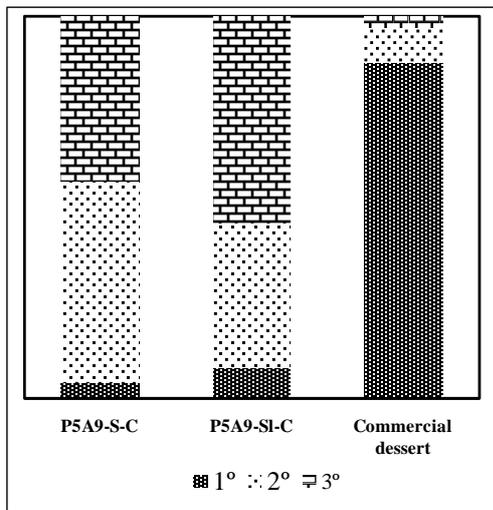


Figure 2. Accumulated percentages of ranking position of preference of the formulated samples and of the commercial dessert

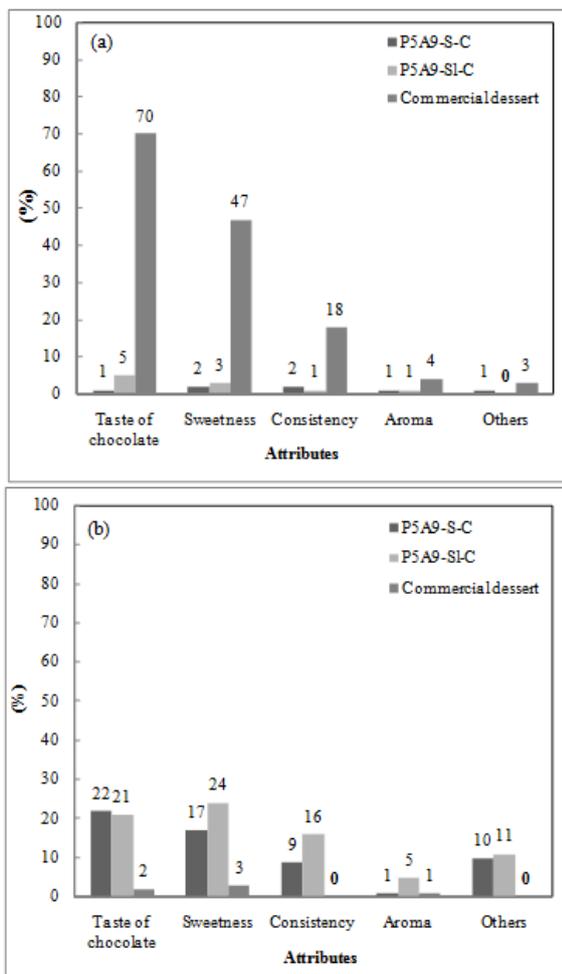


Figure 3. Attributes by which the samples were selected in: (a) the first position and (b) the last position

The attributes by which samples and commercial dessert were ranked in the first and the last position of preference are resumed in Figure 3. The preference of the

panelists to the commercial dessert was mainly due to the taste to chocolate, sweetness and consistency (Figure 3a). Also, the attributes by which samples and commercial dessert were ranked in the last position were mainly taste to chocolate, sweetness and consistency (Figure 3b).

These results indicate that in spite of differences between formulated samples and commercial dessert were significant, the acceptability of the formulated samples may be improved simply changing the concentrations of cocoa, sweeteners (sucrose or sucralose) and flavoring agent. In general, the panelists did not detect displeasing flavors or textures in the formulated samples.

4. Conclusions

Syneresis and sensory acceptability of dairy desserts based on whey proteins concentrates were investigated. Results showed that low percentages of syneresis occur during a period of storage similar to that of the useful life of the product. Formulated samples presented an EV similar and minor than the commercial dessert. From the sensory analysis it was observed that the formulated desserts were qualified mainly by positive degrees of overall liking, though with qualifications lower than those of the commercial dessert based on milk. All in all, it is concluded that is feasible the replacement of milk by WPC in low in calories desserts, although it is necessary to improve the sensory profile to reach a better acceptability.

This study demonstrates that is feasible the replacement of milk by WPC in desserts, although it is necessary to improve the sensory profile to reach a better acceptability.

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References

- [1] Meyer, D., Bayarri, S., Tárrega, A. and Costell, E. "Inulin as texture modifier in dairy products". *Food Hydrocolloid*, 25, 1881-1890, 2011.
- [2] Bryant, C.M. and McClement, D.J. "Molecular basis of protein functionality with special consideration of cold-set gels derived from heat-denatured whey". *Trends in Food Science and Technology*, 9, 143-151, 1998.
- [3] Madureira, A.R., Pereira, C. I., Gomes, A.M.P., Pintado, M.E. and Malcata, F.X. "Bovine whey proteins – Overview on their main biological properties". *Food Research International*, 40, 1197-1211, 2007.
- [4] Kilara, A. Whey and whey products. In Chandan, R., Kilara, A. and Shah, N.P. (Eds). *Dairy Processing and Quality assurance*, John Wiley and Sons Inc, Iowa, 2008, 337-355.
- [5] Meza, B.E., Verdini, R.A. and Rubiolo, A.C. "Effect of freezing on the viscoelastic behaviour of whey protein concentrate suspensions". *Food Hydrocolloids*, 24, 414-423, 2010.
- [6] Mleko, S. "Rheological properties of milk and whey protein desserts". *Milchwissenschaft*, 52, 262-266, 1997.

- [7] Tárrega, A. and Costell, E. "Effect of composition on the rheological behavior and sensory properties of semisolid dairy dessert". *Food Hydrocolloids*, 20, 914-922, 2006.
- [8] de Kruif, C. G. and Tuinier, R. "Polysaccharide protein interactions". *Food Hydrocolloids*, 15, 555-563, 2001.
- [9] Mleko, S. and Gustaw, W. "Rheological changes due to substitution of total milk proteins by whey proteins in dairy desserts". *Journal Food Science and Technology*, 39, 170-172, 2002.
- [10] El-Garawany, G.A. and Abd El Salam, M.H. "Preparation and rheological properties of a dairy dessert based on whey protein/potato starch". *Food Chemistry*, 91, 261-267, 2005.
- [11] Arcia, P.L., Costell, E. and Tárrega, A. "Thickness suitability of prebiotic dairy desserts: Relationship with rheological properties". *Food Research International*, 43, 2409-2416, 2010.
- [12] Arcia Cabrera, P. "Optimization of the acceptability of a dairy dessert with probiotic character". Thesis, Universitat Politècnica de València, Valencia, Spain, 2010.
- [13] Miccolo, M.E., Olivares M.L. and Rubiolo A.C. "Rheological characterization of desserts formulated with whey proteins" in *II International Congress of Food Engineering, Science and Technology*, Medellín, National University of Colombia, 464-465, 2015.
- [14] Turgeon, S.L. and Beaulieu, M. "Improvement and modification of whey protein gel texture using polysaccharides". *Food Hydrocolloids*, 15, 583-591, 2001.
- [15] Aichinger, P., Michel, M., Servais, C., Dillmann, M., Rouvet, M., D'Amico, N., Zink, R., Klostermeyer, H. and Horne, D. "Fermentation of a skim milk concentrate with *Streptococcus thermophilus* and *chymosin*: structure, viscoelasticity and syneresis of gels". *Colloids and Surface B: Biointerfaces*, 31, 243-255, 2003.
- [16] Watts, B.M., Ylimaki, G.L., Jeffrey, L.E. and Elias, L.G. *Basic Sensory Methods for Food Evaluation*, International Development Research Center, Ottawa, 1989, 24-43, 66-86.
- [17] Montgomery, D.C. *Design and Analysis of Experiments*, Fifth edition, John Wiley and Sons, Inc., New York, 2001, 51-54.
- [18] Smit, L.E., Schönfeldt, H.C. and de Beer, W.H.J. "Comparison of the energy values of different dairy products obtained by various methods". *Journal of Food Composition and Analysis*, 17, 361-370, 2004.