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Whey protein phospholipid concentrate and delactosed permeate: Applications in caramel, ice cream, and cake

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ABSTRACT

Whey protein phospholipid concentrate (WPPC) and delactosed permeate (DLP) are 2 coproducts of cheese whey processing that are currently underutilized. Past research has shown that WPPC and DLP can be used together as a functional dairy ingredient in foods such as ice cream, soup, and caramel. However, the scope of the research has been limited to a single WPPC supplier. The variability of the composition and functionality of WPPC was previously studied. The objective of this research was to expand on the previous study and examine the potential applications of WPPC and DLP blends in foods. In ice cream, WPPC was added as a natural emulsifier to replace synthetic emulsifiers. The WPPC decreased the amount of partially coalesced fat and increased the drip-through rate. In caramel, DLP and WPPC replaced sweetened condensed skim milk and lecithin. Cold flow increased significantly, and hardness and stickiness decreased. In cake, DLP and WPPC were added as a total replacement of eggs, with no change in yield, color, or texture. Overall, WPPC and DLP can be utilized as functional dairy ingredients at a lower cost in ice cream and cake but not in chewy caramel.

Key words: whey protein phospholipid concentrate, delactosed permeate, ice cream, caramel, cake

INTRODUCTION

Whey protein phospholipid concentrate (**WPPC**) and delactosed permeate (**DLP**) are products produced from the processing of cheese whey that are currently a utilization issue for the dairy industry. WPPC is a coproduct of whey protein isolate, produced from the microfiltration of whey protein concentrate, which separates the majority of the undenatured whey proteins from the fat, phospholipids, lactose, and denatured whey proteins. In 2015, the American Dairy Product Institute (2015) instituted a standard for WPPC composition: minimum of 50% protein (dry basis), minimum of 12% fat, maximum of 8% ash, and maximum of 6% moisture.

In previous research, WPPC composition, DLP composition, and the functionality, variability, and drying capabilities of both products were studied (Liang et al., 2009). Delactosed permeate is high in lactose, mineral, and organic acids and low in fat and protein, making it difficult to dry and incorporate into foods for human consumption. Whey protein phospholipid concentrate is high in fat and protein while being low in ash and lactose. Previous research showed that when WPPC and DLP were blended, they had key functional properties that could make them useful ingredients in food [R. Bund (University of Wisconsin–Madison) and R. Hartel, unpublished data]. Blends of WPPC and DLP have been studied in several food applications to replace other dairy products, emulsifiers, salt, and eggs in food applications such as ice cream, soups, and confections (Burrington, 2011; Bund and Hartel, 2013). However, the scope of the WPLC research was limited to one supplier (Burrington, 2011).

The aim of this research was to investigate different suppliers of WPPC and WPPC:DLP blends in food applications to replace other ingredients. Sweetened condensed skim milk was replaced in chewy caramel, and synthetic emulsifiers were replaced in ice cream. In cake, a full egg replacement was done. The results will provide valuable guidance for product developers to use these dairy coproducts in various food applications.

MATERIALS AND METHODS

Materials

Several WPPC powders were obtained: Perham P_c–PROTEIN from Bongards Creameries (Minneapolis, MN), Whey Phospholipid Protein Concentrate from Milk Specialties Global (Eden Prairie, MN), and Whey Protein Concentrate High Fat from Leprino Foods

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Table 1. Proximate composition (±SD) of whey protein phospholipid concentrates from each supplier (n = 2; M. Levin, R. Hartel, and K. Burrington, unpublished data)

	Component				
Supplier	Moisture (%)	Fat (%)	Protein (%)	Lactose (%)	Ash (%)
A	4.53 ± 0.04	13.70 ± 0.04	69.97 ± 0.02	2.88 ± 0.02	2.07 ± 0.01
B	3.57 ± 0.02	15.63 ± 0.25	54.67 ± 0.2	3.48 ± 0.29	3.50 ± 0.01
C	4.33 ± 0.01	15.50 ± 0.01	50.26 ± 0.19	3.95 ± 0.12	3.61 ± 0.03

(Denver, CO). The composition of the WPPC powders can be found in Table 1, listed as A, B, and C. The only commercially dried delactosed permeate, Dairy Products Solid, was obtained from Leprino Foods.

Caramel

Ingredients. Sucrose was obtained from United Sugars (Edina, MN). Corn syrup (42-dextrose equivalent) was provided by Archer Daniels Midland (Decatur, IL). Sweetened condensed skim milk was provided by Galloway Company (Neenah, WI). Partially hydrogenated palm kernel oil (Silko 32-05) was supplied by Aarhus Karlshamn (Port Newark, NJ). The water used was deionized in Babcock Hall (University of Wisconsin, Madison). Salt was supplied by Morton Salt Inc. (Chicago, IL). Soy lecithin (Clearate B-60) was supplied by W.A. Cleary Product Inc. (Somerset, NJ). Lactose was obtained from Foremost Farms (Baraboo, WI). All ingredients used were from the same lots.

Formulation. Caramel formulations were based on representative industry formulas for cut and wrap caramel (Jackson, 2000; Hofberger, 2009). All caramels were formulated for a final moisture content of 10.5%, fat content of 12.5%, protein content of 2.5%, reducing sugar content of 18.1%, and a corn syrup solids to sucrose ratio of 50:50. The initial premix had a moisture content of 30% to ensure all sucrose and lactose were dissolved. The WPPC and DLP blends were added to fully replace the protein provided by the sweetened condensed milk. Additionally, the lecithin was removed in the negative control and test formulations to investigate the emulsifying capabilities of WPPC. Whey protein phospholipid concentrate samples A, B, and C were added both alone and with a 30:70 DLP:WPPC blend. Lactose was added to maintain a reducing sugar content of 18.1% to ensure that any difference in Maillard browning was due to the protein source and not the reducing sugar content. The formulas of the premixes are shown in Table 2.

Cooking Procedure. Each batch of caramel was prepared in 1-kg batches. The WPPC and DLP:WPPC blends were prehydrated for 1 h with 150 mL of deionized water to ensure full hydration of the proteins. All ingredients were weighed into a 3.8-L (4-quart) induction saucepan (Carlisle, Oklahoma City, OK) and cooked on a SR-951T, 120-V, 1400-W induction cooker (Sunpentown, City of Industry, CA). A scraped surface

Table 2. Caramel formulation

	Formula[2]							
Ingredient[1]	+C	−C	A	30:70 A	B	30:70 B	C	30:70 C
Water	23.67	23.67	28.69	28.69	29.18	28.87	28.83	28.89
Sucrose	17.49	17.40	25.18	24.97	24.75	24.52	24.75	24.37
HFCS	31.31	31.42	31.49	31.22	30.92	30.66	30.92	30.4
SCSM	17.98	17.99	0.00	0.00	0.00	0.00	0.00	0.00
PKO	8.88	8.96	8.69	8.67	8.45	8.50	8.45	8.45
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Lecithin	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lactose	0.00	0.00	2.88	2.29	2.92	2.23	2.96	2.19
WPPC A	0.00	0.00	2.57	2.75	0.00	0.00	0.00	0.00
WPPC B	0.00	0.00	0.00	0.00	3.28	3.30	0.00	0.00
WPPC C	0.00	0.00	0.00	0.00	0.00	0.00	3.59	3.59
DLP	0.00	0.00	0.00	0.92	0.00	1.42	0.00	1.54

[1]HFCS = 42-dextrose equivalent high fructose corn syrup; SCSM = sweetened condensed skim milk; PKO = palm kernel oil; WPPC = whey protein phospholipid concentrate; DLP = delactosed permeate.

[2]Formulas: +C = positive control; −C = negative control; A = WPPC A; 30:70 A = 30% DLP and 70% WPPC A; B = WPPC B; 30:70 B = 30% DLP and 70% WPPC B; C = WPPC C; 30:70 C = 30% DLP and 70% WPPC C.