# Nonfat Dairy Coffee Whitener Made from Ultrafiltered Skimmilk Retentates

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## ABSTRACT

Retentates of different protein concentrations obtained by ultrafiltration of skimmilk were freeze-dried and evaluated as nonfat dairy coffee whiteners. Blended in hot coffee the retentate whiteners containing added riboflavin gave a pH of 6.3–6.55, coffee whitening capacity comparable to a commercial nondairy coffee creamer, and acceptable dispersibility. The retentate nondairy whitener with optimum qualities contained 56% total protein, 0.5% fat, 31.0% carbohydrates, 1.92% calcium, and 27 mg sodium/100g.

## INTRODUCTION

NONDAIRY COFFEE CREAMERS (NDCC) are composed largely of corn syrup solids and vegetable fats, according to Lampert (1970). Posati and Orr (1976) and Jolly and Kosikowski (1978) report that a very high percentage of the fatty acids in commercial NDCC are saturated.

Ultrafiltration (UF) can produce dried skimmilk retentates that display different composition and physical properties and improved nutritional value compared to standard skimmilk powders (Jimenez-Flores, 1984; Jimenez-Flores and Kosikowski, 1985). The objective of the present study was to assess the potential of ultrafiltered skimmilk retentate powders as nonfat dairy coffee whiteners.

## MATERIALS & METHODS

FOR EACH TRIAL 320 liters of freshly drawn, raw Holstein milk from the Cornell University Veterinary farm were heated to 54°C. Three-quarters of this milk volume was ultrafiltered in an Abcor 22S UF unit with 2 $m^2$ of polysulfone high flux membranes, possessing a molecular weight cut-off of 20,000 daltons. Inlet and outlet pressures were 310.3 and 103.4 kPa, respectively. Three retentate lots at 2:1, 3:1, and 4:1 volume concentration were produced. A fourth lot, that of the heated raw milk, serving as a control, was concentrated to 20% total solids (T.S.) in an APV falling film plate evaporator (model J.P.W.). Condensed milk control and the retentates then were mechanically separated in a De Laval (Model 242) separator and pasteurized at 72°C and 15 sec. These lots were freeze-dried in a Virtis UE 800 unit and resulting flakes were mechanically milled. Powder A was a control from condensed skimmilk. Powders B, C, and D were from skimmilk retentates ultrafiltered to 2:1, 3:1 and 4:1 volume concentration. For comparative purposes commercial NDCC were obtained as well as a commercial low-heat skimmilk powder.

Riboflavin (Eastman Kodak reagent) and beta-carotene (Sigma Chemicals) were added to retentate nonfat dairy whiteners at 10 mg/100g powder to enhance color.

### Analysis

A HunterLab Color Difference-meter, Model D25, (Hunter Associates Laboratory, Fairfax, VA) was used to quantitate whitening capacity and color differences in 80°C coffee of nonfat retentate dairy whiteners and a NDCC. Two grams powder were dissolved in 250 mL of a 'standard coffee solution', (4g Maxwell House instant coffee in 500 mL hot water). Color analyses made in triplicate are described elsewhere with more detail (Jimenez-Flores, 1984). Also, color photographs were taken of the coffees.

Dispersibility of the powders was measured in 24°C water as percentage values by the method of Baldwin (1977) and in hot coffee visually by the authors. The pH of the whitened coffee was determined by a Beckman Expandomatic potentiometer.

*Table 1—Properties of individual skimmilk retentate powders*

| | Freeze-dried powders[a] | | | | Nondairy coffee creamer powder |
|---|---|---|---|---|---|
| | A | B | C | D | Y |
| pH in hot coffee[b] | 6.00 | 6.30 | 6.45 | 6.55 | 6.30 |
| Total color difference in hot coffee | 6.52 | 5.48 | 4.37 | 3.40 | 7.20 |
| Percent dispersability in water[c] | 34 | 32 | 32 | 33 | 100 |

[a] A produced from laboratory skimmilk powder control, B from 2:1 UF retentate, C from 3:1 UF retentate, D from 4:1 UF retentate, Y = national brand.
[b] Fresh unwhitened coffee pH = 5.30.
[c] Commercial low heat skimmilk powder displayed a dispersability value of 37.

## RESULTS

TOTAL COLOR DIFFERENCE, pH and dispersibility of the five experimental powders are shown (Table 1). Nonfat dairy whiteners, identified as skimmilk retentate powders, adding to hot, black coffee (pH 5.3) shifted the pH from 6.3 to 6.55, equalling, or slightly exceeding, the pH when the same black coffee was colored by a NDCC. Color difference ($\Delta E$) of hot coffee containing nonfat dairy whiteners compared against a white standard, were less than those for a commercial skimmilk powder control and a NDCC. Value for NDCC dispersibility in water was 100% and for nonfat dairy whiteners 32–34%. Powder 1, and commercial low heat skimmilk powder, both controls, showed dispersibility values between 34–39%. In hot coffee NDCC was observed to disperse immediately whereas nonfat dairy coffee whiteners dispersed more slowly but uniformly.

The whitening capacity and color difference of only UF skimmilk retentate powders C and D in hot coffee are presented in Table 2. These powders were selected because of their higher nutritional qualities. Small additions of riboflavin in particular enhanced color quality and equalized to a great extent color differences, eliminating a greyish cast which was apparent visually.

Color photographs, not shown, record that a commercial low heat skimmilk powder compared to retentate nonfat dairy whiteners or to a NDCC appears deficient in hot coffee whitening power. Conversely nonfat dairy whiteners C and D containing added riboflavin show good whitening power in hot coffee, equal to that of a NDCC.

## DISCUSSION

NONFAT DAIRY COFFEE WHITENER C contained 56.4% protein, 0.5% fat, 31.4% carbohydrate, 1.9% calcium, and 27.5 mg sodium per 100g. By contrast Posati and Orr (1976)

*Table 2—Whitening capacity nonfat dairy whiteners C and D in hot coffee*

| Whitener powder[a] | L[a] | A[a] | B[a] | DL[b] | Da | Db | DE | dL[c] | da | db | dE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 46.9 (1.2) | 3.7 (0.1) | 15.3 (0.9) | 46.2 | 4.5 | 25.9 | 49.06 | 1.4 | 0 | 3.5 | 3.77 |
| C+R+Beta | 47.3 (1.3) | 3.7 (0.1) | 15.7 (0.8) | 45.8 | 4.5 | 16.3 | 48.5 | 1.0 | 0 | 3.1 | 3.26 |
| C+R | 47.1 (1.2) | 3.5 (0.1) | 26.0 (1.0) | 46.0 | 4.3 | 16.6 | 49.1 | 1.2 | 0.2 | 2.8 | 3.05 |
| C+Beta | 47.3 (1.2) | 3.7 (0.1) | 15.4 (0.9) | 45.8 | 4.5 | 16.0 | 48.7 | 1.0 | 0 | 3.4 | 3.54 |
| D | 48.55 (1.3) | 3.3 (0.1) | 14.6 (1.1) | 44.6 | 4.1 | 15.2 | 47.3 | 0.25 | 0.2 | 4.2 | 4.2 |
| D+R+Beta | 48.9 (1.2) | 3.1 (0.1) | 15.4 (1.0) | 48.6 | 3.9 | 16.0 | 47.2 | −0.6 | 0.6 | 3.4 | 3.5 |
| D+R | 49.0 (1.2) | 2.8 (0.1) | 15.3 (0.1) | 44.1 | 3.6 | 15.9 | 47.0 | −0.7 | 0.9 | 3.5 | 3.5 |
| D+Beta | 48.8 (1.4) | 3.2 (0.1) | 14.8 (1.2) | 44.3 | 4.0 | 15.4 | 47.1 | −0.5 | 0.5 | 4.0 | 4.1 |
| White Standard | 93.1 | −0.8 | −0.6 | 0 | 0 | 0 | — | — | — | — | — |
| NDCC | 48.3 | 3.7 | 18.8 | 44.8 | 4.5 | 19.4 | 49.03 | 0 | 0 | 0 | 0 |

[a] Arithmetic mean of 2 determinations for 4 samples, values in ( ) are standard deviations. L = Lightness, 100 perfect white, 0 perfect black; A = redness; B = yellowness.
[b] D — (columns 5–8) indicates that the difference has been taken from the white standard.
[c] d — (columns 9–12) indicates that the difference is with respect to the NDCC.
[d] a = Redness when +, greeness when −, gray when 0; b = Yellowness when +, blueness when −, gray when 0; E = Total color difference.
[e] Powders C and D were 3:1 and 4:1 skimmilk retentates, respectively. NDCC = Nondairy coffee creamer; R and Beta (column 1) = riboflavin and beta-carotene.

list NDCC powders on the average as containing 4.8% protein, 35.5% fat, 54.9% carbohydrate, 0.02% calcium and 181 mg sodium per 100g. Nonfat dairy coffee whitener C is preferred over whitener D because greater opportunity exists for sedimentation at protein levels above 60% as observed visually and because it is less expensive to produce.

Although NDCC powders dispersed into hot coffee immediately, under the same conditions, retentate nonfat dairy whitener C and D dispersed satisfactorily after one spoon rotation. Spray dried, nonfat dairy whiteners were also produced in the laboratory from the same liquid retentates. Dispersibility of the higher protein spray-dried retentates was not fully satisfactory, a condition which may be corrected by instantizing or agglomerating the powder and attaining better control over variables during commercial spray drying.

Three additional commercial NDCC powders obtained for more detailed studies involving functionality, influenced whitening of hot coffee to approximately the same degree as the NDCC used specifically for the coffee creamer study. NDCC whitening effects are mainly achieved from fat and artificial colors while those of retentate nonfat dairy whiteners are obtained through milk protein and added riboflavin or beta-carotene. Such whiteners may have the potential also for use in concentrated liquid form, perhaps aseptically packaged.

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Ms received 7/31/85; accepted 9/29/85.

The authors express their appreciation to Dairy Research Incorporated (DRINC) (Rosemont, IL) for supporting this study in part.