

## DAIRY FOODS RESEARCH PAPERS

### Fortification of Cottage Cheese with Vitamins A and C

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#### ABSTRACT

Regular (4% fat) and lowfat (1.5% fat) cottage cheese were fortified in plant under actual production conditions with vitamin A palmitate and ascorbic acid (vitamin C) at levels of 2500 IU and 35 mg per serving (113.6 g), respectively. Fortified cheese samples along with unfortified control samples were stored immediately at 3°C for 2 wk. Some fortified samples were also stored in the dairy case of a local store for 2 wk under actual display conditions. Cheese samples were analyzed at zero time and after 2 wk of storage for pH, acidity, and vitamins A and C. Selected fortified samples were also evaluated for odor, taste, and appearance by 21 untrained panelists. The results indicated that the level of fortification used provided at least 25% of US RDA of both vitamins per serving. The results also indicated that the level of fortification used did not significantly change pH, titratable acidity, or sensory attributes of fortified cottage cheese. Moreover, fat content or size of container had no significant effect on retention of both vitamins during refrigerated storage.

#### INTRODUCTION

Acceptability of food products, including cottage cheese by nutrition-conscious consumers may depend on their content of essential nutrients, especially vitamins (4, 5). Unfortunately, cottage cheese at the present time is a poor source of two important vitamins, A and C (less than 4% of the US RDA per serving), and this fact may adversely affect its marketability.

It is not clear to us why it is a common practice to fortify milk with vitamins it lacks, but not to fortify cottage cheese and other dairy products. We considered it our task to correct this deficiency and have reported earlier the successful fortification of yogurt with both vitamin A and C (3). Cottage cheese was the next logical dairy product for fortification with the two important vitamins, A and C. Information obtained from the yogurt fortification study was applied to this one.

The main objectives of carrying out this study are to fortify regular and lowfat cottage cheese with levels of vitamins A and C that provide at least 25% of US RDA throughout the normal shelf life of the cheese; to study the stability of vitamins A and C in cottage cheese under controlled laboratory conditions and actual retail display conditions; to study the effect of fat content and size of container on the retention of vitamins A and C in cottage cheese; and finally, to study the effect of fortification with vitamins A and C on pH, titratable acidity, and sensory characteristics of cottage cheese.

#### MATERIALS AND METHODS

##### Cottage Cheese Samples

Regular (4% fat, 21% total solids) and low fat (1.5% fat, 19.5% total solids) cultured cottage cheese were processed under actual production conditions in batches ranging from 4086 kg to 6129 kg (55% curd, 45% cream mix) at Carnation Co., Phoenix, AZ. All of the cheese samples were kindly donated to us by Carnation Co.

##### Vitamins

Ascorbic acid USP-FCC Type S, and water dispersible dry vitamin A palmitate beadlets (Palma-Sperse) containing 250,000 IU/g were donated to us by Roche Chemical Division, Hoffman-LaRoche Inc., Nutley, NJ.

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Received May 2, 1988.

Accepted September 26, 1988.

### Fortification of Cottage Cheese

Vitamins A and C were added at levels of 35 mg of vitamin C and 10 mg (2500 IU) of vitamin A palmitate per serving of cottage cheese (113.6 g). The appropriate amount of each vitamin was added in the dry form to the cream mix with stirring. The cream mix was then pasteurized (82.2 to 85°C for 18 s), homogenized, and added to the curd with continuous stirring. The cottage cheese was packaged in 227.2, 454.4, or 908.8-g containers. Samples of fortified and unfortified (control) cheese were transferred immediately to our laboratory and stored at 3°C for 2 wk. In addition, fortified cheese packaged in 227.2-g containers from the same batch as the ones stored under controlled laboratory conditions were stored in the dairy case of a local store for 2 wk. Fluorescent lighting was kept on in the dairy case for 24 h, and light intensity varied at different spots of the dairy case between 215 and 1076 lx. The temperature in the dairy case ranged from 3 to 6°C during storage.

### Sample Preparation

The content of each cottage cheese container was first stirred well in the container

with a plastic spoon. Weights required for the different analyses were then taken from the stirred cheese and processed immediately to avoid vitamin losses due to oxidation.

### pH Determination

A weight of 9.0 g was taken from the prepared cottage cheese sample and suspended in 100 ml of distilled and degassed water. The pH of the suspended cottage cheese was then determined with a standardized pH meter.

### Titrateable Acidity

Cottage cheese suspension used for pH determination was titrated with a standardized .1 N NaOH solution to a phenolphthalein end point (pH 8.2). Percent titrateable acidity was calculated in terms of g lactic acid per 100 g of cottage cheese.

### Vitamin Analysis

Twenty-five grams of the prepared cottage cheese were analyzed for vitamin A by the method of Ashoor and Knox (2), and 10 g of the same sample were analyzed for vitamin C by the method of Ashoor et al. (1).

TABLE 1. Cottage cheese codes.

Code	Definition
RU-8	Regular unfortified cottage cheese with a minimum fat content of 4% and packaged in 227.2-g containers.
RF-8	Regular fortified <sup>1</sup> cottage cheese with a minimum fat content of 4% and packaged in 227.2-g containers.
ST-RF-8	Regular fortified cottage cheese with a minimum fat content of 4%, packaged in 227.2-g containers and stored under actual retail conditions in a local store.
RU-32	Regular unfortified cottage cheese with a minimum fat content of 4% and packaged in 908.8-g containers.
RF-32	Regular fortified cottage cheese with a minimum fat content of 4% and packaged in 908.8-g containers.
SU-16	"Slim" unfortified cottage cheese with a minimum fat content of 1.5% and packaged in 454.4-g containers.
SF-16	"Slim" fortified cottage cheese with a minimum fat content of 1.5% and packaged in 454.4-g containers.
SU-32	"Slim" unfortified cottage cheese with a minimum fat content of 1.5% and packaged in 908.8-g containers.
SF-32	"Slim" fortified cottage cheese with a minimum fat content of 1.5% and packaged in 908.8-g containers.

<sup>1</sup> Products fortified with 35 mg ascorbic acid (vitamin C) and 2500 IU (10 mg) vitamin A palmitate per serving (113.6 g) in all fortified cheese samples.

### Sensory Evaluation

Fortified along with control cottage cheese samples were evaluated by 21 untrained panelists for flavor, odor, and appearance at 0 and 2 wk of storage. The panelists used a nine-point hedonic scoring system (from 1, dislike extremely to 9, like extremely). Each panelist was given four samples, about 20 g each, to evaluate at a time and enough water to rinse mouth after each evaluation.

### Statistical Analysis

Data were statistically analyzed according to SAS (6).

## RESULTS AND DISCUSSION

Samples of cottage cheese with two milk fat levels and packaged in various containers (Table 1) were stored in our laboratory at 3°C for only 2 wk since retail cottage cheese in local stores is usually sold within 10 to 14 d of display in the dairy case (personal communication). To study the effect of storage conditions on the retention of vitamins, one sample (RF-8, Table 1) was kept refrigerated in our laboratory and another identical sample (ST-RF-8, Table 1) was stored in the dairy case of a local store under actual display conditions (3 to 6°C, and 215 to 1076 lx). The level of fortification of cottage cheese samples (35 mg vitamin C and

2500 IU of vitamin A palmitate per 113.6 g serving) was chosen to provide at least 25% of the US RDA throughout regular storage time. This was based on the retention of the vitamins in yogurt reported in a previous study (3). The choice of the vitamin form was also based on the yogurt study (3). The water-dispersible form of vitamin A palmitate disperses invisibly in the product and ascorbic acid seems to have higher retention than its sodium and calcium salts (3).

Fortification of cottage cheese at the level used did not result in significant differences ( $P < .05$ ) in pH values or percent titratable acidity of fortified cheese samples at either zero time or after 2 wk of storage (Table 2). Evidently, the amount of ascorbic acid added in fortification did not affect pH or titratable acidity of the fortified cheese significantly.

After 2 wk of storage, retention of vitamin C was more than 70% in all fortified cheese samples (Table 3), that of vitamin A was more than 75% (Table 4). This indicated that the level of fortification used provides at least 25% of the US RDA of both vitamins throughout the regular shelf life of cottage cheese. It should be noted that storage did not decrease the vitamins by more than 5%, and most vitamins losses occurred during processing (Tables 3 and 4).

The retention of vitamin C in all fortified cheese samples was not significantly different

TABLE 2. pH and percent titratable acidity (% TA) of cottage cheese samples.

Sample <sup>1</sup>	pH		% TA <sup>2</sup>	
	0 wk	2 wk	0 wk	2 wk
RU-8	5.4 <sup>a</sup>	5.3 <sup>a</sup>	.51 <sup>a</sup>	.62 <sup>a</sup>
RF-8	5.4 <sup>a</sup>	5.3 <sup>a</sup>	.50 <sup>a</sup>	.62 <sup>a</sup>
ST-RF-8	5.4 <sup>a</sup>	5.4 <sup>a</sup>	.54 <sup>a</sup>	.62 <sup>a</sup>
RU-32	5.4 <sup>a</sup>	5.3 <sup>a</sup>	.51 <sup>a</sup>	.61 <sup>a</sup>
RF-32	5.5 <sup>a</sup>	5.3 <sup>a</sup>	.48 <sup>a</sup>	.63 <sup>a</sup>
SU-16	5.5 <sup>a</sup>	5.3 <sup>a</sup>	.47 <sup>a</sup>	.62 <sup>a</sup>
SF-16	5.4 <sup>a</sup>	5.3 <sup>a</sup>	.49 <sup>a</sup>	.59 <sup>a</sup>
SU-32	5.5 <sup>a</sup>	5.4 <sup>a</sup>	.52 <sup>a</sup>	.61 <sup>a</sup>
SF-32	5.5 <sup>a</sup>	5.5 <sup>a</sup>	.49 <sup>a</sup>	.60 <sup>a</sup>

<sup>a</sup>Mean of two determinations; means within columns with unlike superscripts differ ( $P < .05$ ).

<sup>1</sup> See Table 1 for code definition.

<sup>2</sup> Grams of lactic acid per 100 g of cheese.

TABLE 3. Percent retention of vitamin C in fortified cottage cheese.

Sample <sup>1</sup>	0 wk		2 wk	
	$\bar{X}$	SD	$\bar{X}$	SD
RU-8	ND <sup>2</sup>	...	ND	...
RF-8	72.1 <sup>a</sup>	1.3	72.2 <sup>a</sup>	.5
ST-RF-8	73.4 <sup>a</sup>	.6	71.8 <sup>a</sup>	.8
RU-32	ND	...	ND	...
RF-32	76.4 <sup>b</sup>	.6	72.6 <sup>a</sup>	1.5
SU-16	ND	...	ND	...
SF-16	75.6 <sup>b</sup>	1.3	71.4 <sup>a</sup>	1.6
SU-32	ND	...	ND	...
SF-32	73.0 <sup>a</sup>	1.4	72.8 <sup>a</sup>	1.0

<sup>a,b</sup>Mean of four determinations; means within columns with unlike superscripts differ ( $P < .05$ ).

<sup>1</sup> See Table 1 for code definition.

<sup>2</sup> Not detectable.

TABLE 4. Percent retention of vitamin A palmitate in fortified cottage cheese.

Sample <sup>1</sup>	0 wk		2 wk	
	$\bar{X}$	SD	$\bar{X}$	SD
RU-8	ND <sup>2</sup>	...	ND	...
RF-8	82.7 <sup>a</sup>	1.6	75.8 <sup>a</sup>	.9
ST-RF-8	82.2 <sup>a</sup>	2.3	78.9 <sup>b</sup>	.8
RU-32	ND	...	ND	...
RF-32	79.3 <sup>a</sup>	1.1	78.5 <sup>b</sup>	1.6
SU-16	ND	...	ND	...
SF-16	79.1 <sup>b</sup>	1.3	76.2 <sup>a</sup>	.7
SU-32	ND	...	ND	...
SF-32	80.7 <sup>a</sup>	.6	77.3 <sup>a</sup>	1.5

<sup>a,b</sup>Mean of four determinations; means within columns with unlike superscripts differ ( $P < .05$ ).

<sup>1</sup> See Table 1 for code definition.

<sup>2</sup> Not detectable.

( $P < .05$ ) after 2 wk of storage (Table 3). This finding indicated that storage conditions (samples RF-8 and ST-RF-8), percent fat (samples RF-32 and SF-32), and size of container (samples RF-8 and RF-32) are not major factors affecting the retention of vitamin C in fortified cottage cheese. Similar results were obtained with vitamin A, except that the retention of vitamin A in samples ST-RF-8 and RF-38 was significantly different ( $P < .05$ ) after 2 wk of storage (Table 4). However, the retention of vitamin A in these two samples at zero time was not significantly different ( $P < .05$ ) (Table 4).

Fortification of cottage cheese at the level used in this study did not change flavor, odor, or appearance of the fortified samples significantly ( $P < .05$ ) as indicated by the sensory evaluation scores shown in Table 5. It should be mentioned that in the yogurt fortification study (3), yogurt samples fortified with vitamins A and C developed a light yellow taint after a

TABLE 5. Sensory evaluation of fortified cottage cheese.

Sample <sup>1</sup>	0 wk		2 wk	
	$\bar{X}$	SD	$\bar{X}$	SD
SU-16	6.5 <sup>a</sup>	1.8	7.5 <sup>a</sup>	2.8
SF-16	6.8 <sup>a</sup>	1.5	6.5 <sup>a</sup>	2.0
SU-32	7.0 <sup>a</sup>	2.8	7.1 <sup>a</sup>	1.7
SF-32	7.5 <sup>a</sup>	1.5	7.3 <sup>a</sup>	1.5

<sup>a</sup>Mean of 21 scores; means within columns with unlike superscripts differ ( $P < .05$ ).

regular shelf life of 6 wk at 3°C. Fortified cottage cheese samples, however, did not develop this taint after 3 wk of storage at 3°C, which is 1 wk longer than cottage cheese regular shelf life.

#### ACKNOWLEDGMENTS

The authors thank Hoffman-LaRoche, Inc. for donating the vitamins, Raymond J. Karam and Carnation Co. for assistance in carrying out this study, and S. M. El-Agouri for statistical analysis.

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