Some Factors Affecting the Flavor of Sodium Caseinate[1]

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Sodium caseinate has been prepared from commercial hydrochloric acid casein and from freeze-dried and tunnel-dried wet curd, thrice-washed wet curd, and thrice-washed, reprecipitated, wet curd. Tastes of the various preparations have been evaluated by the direct two-sample comparison technique. The results indicated that a fairly tasteless sodium caseinate can be prepared from well washed, freshly precipitated casein.

Webb and Williams (*9*) described a method for the removal of lactose from condensed skimmilk. They showed that ice cream mixes containing 11 to 13% of this low-lactose, condensed skimmilk possessed an improved body and texture and were capable of withstanding adverse handling conditions without development of sandiness. Other workers have reported similar observations (*5, 8*).

Teichert *et al.* (*7*) studied the effects of incorporating freshly prepared sodium caseinate solutions with ice cream mixes. They reported that the mixes showed rapid whipping ability and a high maximum overrun but that the finished ice cream possessed a curdlike flavor. Whittier and Webb (*10*) have suggested a procedure for the preparation of sodium caseinate suitable for incorporation in ice cream mixes. However, it has been observed in this laboratory that commercial sodium caseinate preparations differ markedly in their flavor. At the same time, there seems to be a serious sparsity of information on various factors that may affect the flavor of sodium caseinate. The work reported here was designed to provide more information on the organoleptic properties of sodium caseinate preparations as influenced by the conditions of processing of hydrochloric acid casein.

Experimental

Skimmilk. The milk was obtained from the Macdonald College herd (Holsteins and Aryshires) which is maintained on a diet of hay, corn silage, and dairy ration (300 pounds each of oats, barley, and corn gluten, and 50 pounds each of wheat bran and linseed oil cake). The freshly drawn milk was cooled to 40° F. and then pasteurized at 142° to 145° F. It was then separated to yield skimmilk containing 0.038% butterfat (*2*).

Preparation of Casein Samples. Sample No. 1. Fresh skimmilk (7 gal.) was placed in a stainless steel tank provided with a mechanical stirrer, and the temperature of the milk was adjusted to 95° F. Hydrochloric acid (10% v./v.) was added slowly to the milk until pH 4.1 was reached. The curd was separated from the whey by filtration and the use of a casein press similar to the one described by Whittier and Webb (*10*). The moisture content of the pressed curd was approximately 55%. This product (Sample No. 1) was immediately converted to sodium caseinate and was spray-dried (sodium caseinate Sample No. 1).

Sample No. 2. A second batch of Sample No. 1 was ground in a meat grinder to give particles of approximately 3 to 5 mm. in diameter and then freeze-dried (Virtis Laboratory Freeze Drier). The drying operation required approximately 24 hours and yielded a product (Sample No. 2) containing 7 to 8% moisture (*8*).

Sample No. 3. A third batch of Sample No. 1 was ground and then dried in a tunnel drier (inlet temperature 100° C., outlet temperature 35° to 50° C.). This operation required approximately 5 hours and yielded a product (Sample No. 3) containing 7 to 8% moisture (*4*).

Sample No. 4 and Sample No. 5. A fourth batch of Sample No. 1 was suspended in cold distilled water (7 gal.) and the mixture ground in a Waring Blendor. The wash water was removed from the curd by filtration and by filter-pressing. This washing procedure was repeated twice. The thrice-washed curd (Product A) was ground and divided into two lots. One was freeze-dried (Virtis Laboratory Freeze Drier) (Sample No. 4) and the other tunnel-dried (Sample No. 5).

Sample No. 6 and Sample No. 7. A second batch of Product A was suspended in cold distilled water (7 gal.), and the temperature of this mixture was adjusted to 30° C. Sodium hydroxide solution (1*N*) was added slowly to the mixture until pH 7.0 was reached. The casein at this point was completely dispersed. Hydrochloric acid (10% v./v.) was added slowly to the casein dispersion until pH 4.1 was reached. The curd was separated from the mother liquor by filtration and by filter-pressing. The thrice-washed and reprecipitated casein was ground and divided into two lots. One was freeze-dried (Sample No. 6) and the other tunnel-dried (Sample No. 7).

Preparation of Sodium Caseinate. Casein (100 grams, 7 to 8% moisture) was ground in a Mikro-Samplemill (Pulverizing Machinery Co., Summit, N. J.) using a screen with openings of 1 mm. in diameter, and the ground material was suspended in 1800 ml. of distilled water (when Sample No. 1 was converted to sodium caseinate, 200 grams of casein, 50 to 55% moisture, was suspended in 1700 ml. of water). The suspension (65° to 69° C.) was stirred mechanically and 1*N* sodium hydroxide solution was added slowly to maintain a reaction of pH 6.6. A period of 2 to 3 hours was required to disperse the casein completely. The casein dispersion was dried in a Niro Laboratory Spray Drier (inlet temperature 230° to 240° C., outlet temperature 97° to 100° C.).

Casein samples Nos. 1 to 7 and three samples of commercial hydrochloric acid casein were converted into spray-dried sodium caseinate. Table I lists the various sodium caseinate samples, summarizes their preparation, and shows the moisture (*4*) and sodium contents (*1*) of the casein samples.

Taste Evaluation of Sodium Caseinate Samples. Direct Two-Sample Comparison. Each member of the taste panel which comprised three judges.

[1] This is the fifth paper in a series, earlier papers of which have appeared in *J. Dairy Sci.* **41,** 233 (1958); **42,** 1463 (1959); *J. Sci. Food Agr.* **11,** 640 (1960); *J. Dairy Sci.* **45,** 706 (1962).

Table I. Designation and Composition of Sodium Caseinate Preparations

Sodium Caseinate Sample	Casein from Which Caseinate Was Prepared	Moisture, %	Sodium, %
1	Wet curd (casein sample No. 1)	2.55	0.95
2	Wet curd, freeze-dried (casein sample No. 2)	2.70	0.95
3	Wet curd, tunnel-dried (casein sample No. 3)	2.75	0.99
4	Wet curd, thrice-washed, freeze-dried (casein sample No. 4)	2.90	0.99
5	Wet curd, thrice-washed, tunnel-dried (casein sample No. 5)	2.95	0.82
6	Wet curd, thrice-washed, reprecipitated, freeze-dried (casein sample No. 6)	2.65	0.88
7	Wet curd. thrice-washed, reprecipitated, tunnel-dried (casein sample No. 7)	2.60	0.70
8	Commercial hydrochloric acid casein (A)	2.70	1.16
9	Commercial hydrochloric acid casein (B)	2.75	1.10
10	Commercial hydrochloric acid casein (C)	2.75	1.13
11	Commercial sodium caseinate	2.90	1.53

Table II. Point Distribution for each Comparison in Two-Sample Preference Test

Sample Preferred	Degree of Difference	Points Allotted: Sample a	Points Allotted: Sample b
a	Very gross	10	0
a	Gross	9	1
a	Moderate	8	2
a	Slight	7	3
a	Very slight	6	4
No difference	. . .	5	5
b	Very slight	4	6
b	Slight	3	7
b	Moderate	2	8
b	Gross	1	9
b	Very Gross	0	10

Table III. Taste Evaluation of Sodium Caseinate Samples

(Total number of points per round based on modified hedonic scale)

	Taster A			Taster B			Taster C		
Sample	Av. Three Rounds	Std. Error	Coeff. of Variation	Av. Three Rounds	Std. Error	Coeff. of Variation	Av. Three Rounds	Std. Error	Coeff. of Variation
1	32	(6.2)	(19)	33	(6.9)	(21)	20	(1.7)	(8.6)
2	39	(1.4)	(3.6)	47	(2.4)	(5.1)	38	(4.1)	(11)
3	45	(1.6)	(37)	51	(2.9)	(5.8)	34	(5.3)	(16)
4	43	(6.4)	(15)	38	(5.1)	(13)	33	(1.9)	(5.8)
5	45	(5.3)	(12)	46	(0.57)	(1.2)	53	(18.4)	(16)
6	46	(1.0)	(23)	45	(3.8)	(8.4)	64	(6.8)	(11)
7	47	(6.4)	(14)	54	(7.3)	(13)	64	(5.0)	(7.8)
8	69	(6.4)	(9.2)	63	(3.3)	(5.2)	60	(9.8)	(16)
9	68	(3.7)	(5.4)	61	(2.2)	(3.5)	61	(3.8)	(6.2)
10	58	(3.6)	(6.1)	55	(4.1)	(7.4)	69	(1.7)	(2.5)
11	60	(9.7)	(16)	57	(1.7)	(3.1)	54	(4.3)	(8.0)

Table IV. Sodium Caseinate Samples Ranked According to Taste Preference

	Taste Rating		
Sample	Taster A	Taster B	Taster C
1	6	7	6
2	5	9	4
3	6	5	2
4	1	2	5
5	2	1	3
6	4	3	1
7	3	4	7
8	11	11	11
9	10	8	8
10	9	5	9
11	8	10	10

Table V. Description of the Flavor of Sodium Caseinate Preparations

Sample	Taster A	Taster B	Taster C
1	Acrid	Soapy	Gluey
2	Soapy	Soapy	Bland, slightly sweet
3	Cooked flavor	Mildly basic, milky	Bland, milky
4	Somewhat tasteless	Tasteless	Bland
5	Bland	Very slightly oily	Bland
6	Bland	Tasteless	Very bland
7	Bland	Slightly soapy	Very slightly gluey
8	Oily, bitter	Bitter	Very gluey
9	Gluey	Gluey	Gluey
10	Gluey, oily	Soapy	Gluey, oily
11	Acrid	Oily	Oily

was requested to supply the following information: whether or not there was a difference in palatability between the two samples of any pair presented to them, and if there was a difference, which sample in the pair was the more palatable; the degree of difference in palatability between dissimilar samples by one of the following terms—very slight, slight, moderate, gross, very gross; and a description of the flavor of each sample. Test samples were 10% solutions of sodium caseinate maintained at 40° to 50° C.

Each panelist compared the taste of each sample with that of every other sample (a total of 55 comparisons) on three different occasions. Table II outlines the basis on which points were allotted for each comparison on the two-sample preference tests. This method is an adaptation of Peryam's hedonic scale method (*6*) and is similar to Hopkins' method (*3*) but differs in that the same number of points is allotted to each comparison. Table III and Table IV summarize results of the two-sample preference test. Table V shows the results of the attempts of each panelist to describe the flavor of the sodium caseinate samples.

Discussion

Sodium caseinate samples (No. 8, No. 9, No. 10) prepared from commercial hydrochloric acid casein possessed objectionable flavors described as gluey, bitter, and oily. The low taste rating of the commercial sodium caseinate sample might suggest that this caseinate also had been prepared from commercial hydrochloric acid casein. The wet pressed curd (Sample No. 1) and the freeze-dried curd (Sample No. 2) yielded products of similar taste, whereas the tunnel-dried wet curd yielded a product (Sample No. 3) which possessed a milky flavor. Taster C seemed to like this milky flavor and hence rated this sample second best. The sodium caseinate (Samples No. 4, No. 5), prepared from thrice-washed casein, was fairly tasteless although Taster B described the product prepared from the tunnel-dried casein as slightly oily. The tunnel-dried casein yielded products (Samples No. 3, No. 5) which were slightly preferred by the taste panel, as a whole, to the corresponding samples (No. 2, No. 4) which had been prepared from freeze-dried casein. Reprecipitation of the thrice-washed casein did not improve the flavor of the caseinate. It is difficult to account for the low taste rating of Sample No. 7, which had been prepared from tunnel-dried, reprecipitated, thrice-washed casein.

These experiments indicate that a fairly tasteless sodium caseinate can be prepared from well washed, freshly precipitated casein. Whether or not sodium caseinate of this type can be used in food products, such as ice cream, without impairment of the product remains to be seen.

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FLAVOR ENHANCEMENT REVIEW

Enzymatic Enhancement of Flavor

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Flavor enzymes acting on dehydrated cabbage were assayed by paper and gas liquid chromatography and by mass spectrometry. Sensory studies established flavor formation in processed string beans treated with enzymes. Protein fractions from fresh onions were active on S-alkyl cysteine sulfoxide and enhanced the flavor of dried onions. Interaction of an enzyme and substrate derived from raspberries resulted in the simultaneous formation of volatiles and raspberry aroma. The number of flavor enzyme preparations which have been reported indicates these agents may soon find wide application in upgrading the flavor and acceptability of processed foods.

Processing fresh foods often causes loss or unfavorable change in natural flavor. This is particularly noticeable in severely heat-processed foods, such as those which have been dehydrated. This laboratory has been working on the problem of improving the flavor of processed foods by treating them with enzymes. It is the purpose of this article to review this work and that of others which has a bearing on this problem.

Figure 1 illustrates the loss of flavor in a fresh food on processing and the restoration of natural flavor by addition of flavor enzymes. Previous publications (*2–6, 8–10*) have reported that this process for the restoration of natural flavor to processed food has wide application and can be applied to canned, frozen, and dehydrated foods.

The restoration of flavor by enzymes is based upon the concept that the flavor in fresh foods results from the action of enzymes upon substrates or flavor precursors present in the foods. Figure 2 is a flow diagram of natural flavor development, loss in processing, and restoration of natural flavor by enzyme additives.

Enzyme Sources

A commercial process employing flavor enzymes requires an inexpensive enzyme source. As it may be impractical to use the fresh food as the source of enzymes to treat the processed food, other possible enzyme sources have been investigated (*4*). Certain biologically related materials in the Cruciferae family, such as cabbage, mustard, horseradish, watercress, radish, cauliflower, and turnips, have been shown to be an effective enzyme source for the enhancement of the flavor of processed cabbage (*4, 9*). The nonedible part of the string bean plant, i.e., leaves, stems, stalks, and roots, has been reported as an enzyme source for the treatment of dehydrated, frozen, or canned string beans (*2*); microbial materials, such as thioglucosidase from *Aspergillus sydowi*, have been studied as an enzyme source (*4*) to treat processed cabbage (*11*).

It is possible to screen the flavor-enhancing qualities of an enzyme preparation upon a processed food by sensory analysis. The effect of adding flavor-producing enzymes to processed food is easiest to observe where the flavor, especially the aroma factor of the processed food, is low and that of the fresh food is high and distinctive, as in dehydrated cabbage and fresh cabbage, respectively. For sensory analysis, optimum conditions are obtained when processed food is treated to remove all of its flavor, leaving the flavor precursors intact. These preparations are referred to as deodorized flavor precursors. A crude enzyme preparation from any source, as long as it is active and flavorless, may be screened by adding it to a deodorized flavor precursor. The precursor alone and the enzyme alone can be used as controls.

Source, Specificity, and Properties of Flavor Enzymes for Processed Cabbage

To locate an enzyme source other than the fresh food itself, biologically related materials, namely other members of the Cruciferae family, were investigated (*4, 9*). Cruciferae are noted for their pungency, which is largely due to their mustard oil content. This makes it possible to study flavor propagation in this family with ease by sensory analysis.

Studies were limited to cabbage, mustard, horseradish, and watercress.