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Food Freezing

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*Effect of Different Levels of Monosodium Glutamate on
Acceptability of Components of Pre-Cooked Frozen Meals*

By MARY B. BROWN and MARION C. BOLLMAN

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FROZEN FOODS

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MUCH excellent work has gone into the study of monosodium glutamate (MSG) as a flavor improver (5). Its usefulness in processed foods and in frozen foods appears to be well established. There are areas, however, where further work on MSG should be valuable.

For example, precooked frozen meals, which are well accepted by the military and by the public on account of their convenience and time-saving characteristics, are benefited by MSG. More data are needed, however, on (1) the specific components where adding MSG would be most beneficial and (2) the most desirable concentration of MSG in these foods.

It is the purpose of this study to contribute experimental data to both of these areas of concern. To furnish further insight into the purpose of the present study, a brief review of certain previous findings is presented.

Prolongs Storage Life

It has been demonstrated by Norton, Tressler, and Farkas (6) that the quality of frozen foods during low temperature storage is prolonged by the addition of MSG. These same investigators found that by the use of MSG the color of green vegetables was better retained during storage.

They further reported that peas treated with MSG were more tender than the untreated. The addition of the proper amount of MSG was found by Kearns, Fagerson, and Fellers (4) to improve the flavor of frozen prepared foods, and the improvement was still apparent after a year's storage at -10°F .

The optimal levels of MSG, as determined by these investigators on the basis of palatability tests, were: clam chowder, .125% haddock fillets, .2%; rosefish fillets, .2%; codfish cakes, .2%; chicken *a la king*, .2%; and beef stew, .25%.

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10 Pre-Cooked Meals

Ten commercially processed precooked frozen meals, packed with and without MSG, were submitted to a comparative preference study at this Institute (1). It was demonstrated that MSG increased preference of the components. Meals stored under conditions where temperature was allowed to fluctuate were shown to be significantly improved by the addition of MSG.

This finding has definite application in military feeding systems that utilize the precooked frozen meal. Snavelly (8) found that MSG added to frozen veal breakfast patties prevented storage effects such as flavor staling, e.g., the off flavor described as "warmed-over," and loss of color.

Further background on the use of MSG in foods is provided in a study by Hac, Long, and Blish (3) to determine the role of naturally occurring glutamic acid in raw vegetables. They concluded that a part, at least, of the superior flavor of young, newly harvested vegetables derives from their glutamic acid content, which is definitely higher than that of stored vegetables.

It is not unreasonable to infer from this study that restoration of the glutamic acid content by addition of MSG will assist in restoring flavor.

The nature of the MSG effect has received considerable attention (3, 5). Pilgrim, Schutz, and Peryam (7) suggested that MSG acts as a seasoning rather than a flavor "intensifier." The level of free glutamic acid in a vegetable varies according to type of vegetable, maturity, and holding conditions.

With regard to the type of food benefited, Girardot and Peryam (2) found that of 50 foods tested, 25 were benefited, three showed a trend toward improved flavor, eight were not changed one way or the other, and four were definitely affected adversely. The results on the remaining

10 were indeterminate.

Thus, it would seem that before MSG can be used effectively for the purpose of stabilizing the flavor of precooked meals, more information is needed on what foods are benefited and what concentration of MSG is the most desirable for each of the foods.

Materials and Methods

Items in this study were selected from 10 precooked frozen meal menus specified in Military Specification (MIL-M-13966, February 1955) Meals, Precooked, Frozen. Each item was selected to be representative of the food type or method of preparation. In order to simulate actual using conditions, these items were arranged in four menus as follows:

MENU 1: Roast turkey with dressing, oven brown potatoes, green beans.

MENU 2: Chicken pot pie.

MENU 3: Beef patty, mashed potatoes, corn, whole kernel.

MENU 4: Beef pot roast, au gratin potatoes, peas.

Each menu item was prepared in four batches. Three batches were treated with an increasing concentration of MSG, the fourth was left untreated, to be used as the control.

The levels of MSG used were based on results of preference studies for various food items (2) and the usual recommended commercial concentrations. These concentrations were as follows:

Oven browned potatoes, mashed potatoes, au gratin potatoes, beef patty, and beef pot roast—.15%, .30%, and .45%.

Green beans, peas, corn, chicken pot pie, and roast turkey with dressing—.10%, .20%, and .30%.

Preparation of Samples: All items were prepared and assembled^a in accordance with the specification, with the exception of treatment with MSG. For treating the samples, a stock batch of each item was prepared and divided into four parts. The MSG was weighed by means of a torsion balance calibrated to one-tenth of a gram and was added to the hot cooked product.

Items requiring special handling were treated as follows:

Beef patty. The MSG and other seasonings were blended with the breadcrumbs and incorporated during the final grinding of the meat.

Beef pot roast and au gratin potatoes. The MSG was added to the pot roast gravy and to the au gratin potato sauce.

Roast turkey. The MSG was blended with the salt and added to the raw, boned turkey.

Chicken pot pie. The MSG was added to the sauce.

Procedure

Approximately 250 meals of each treatment were filled into individual three-compartment aluminum trays and covered by crimping aluminum foil over the tray flange. The samples entered a freezer maintained at -10°F. (plus 2°F.) within 30 minutes after filling.

After freezing (12 to 16 hours), the meals were packaged in labeled

a. The samples for this study were produced on a limited procurement contract by Frigidinner, Inc., Philadelphia. Mrs. Mary B. Brown of the QMF&CI supervised treatment of samples with MSG and observed the entire production of the meals.

cartons and stored at 0°F. for a period of 12 days prior to shipment to the Quartermaster Food and Container Institute for the Armed Forces. Upon arrival, the samples were examined for condition and stored at 0°F. until withdrawn for testing initially and after six and 12 months storage.

Test Procedure: Twelve meals, three of each treatment, were withdrawn from storage and heated to serving temperature in two B-4 air force ovens. From 25 to 28 minutes were required to thaw and heat the meals. Only one item from the menu was tested at a time.

Method of serving was to remove all trays from the oven immediately after heating time had elapsed and to serve the samples directly from the trays. Crusts were removed from the chicken pot pies, and the fillings of the samples representing each treatment were combined.

This gave a more homogenous sample and eliminated crust quality influencing sample ratings.

Samples of the four treatments were presented in a complete block design in randomized order to each of 24 judges. The judges were randomly selected from personnel of the QMF&CI. Preference for treatment of each product was determined by rating on the hedonic scale.

For analysis the values 1 to 9 were assigned to the successive points on the scale beginning with "Dislike Extremely." The test subjects were requested to write in comments on each sample.

Results and Discussion

In this study, three levels of MSG

and a control were compared on various components of precooked frozen meals, initially, and at six and 12 months storage. The mean rating for each treatment at each storage period is given in Table 1.

The actual levels of MSG depend on the specific component of the meals. For several items, there were only 23 ratings at one of the storage periods. To simplify the analysis, one rating was randomly removed from the other withdrawals so that there was an equal number of ratings at each time period.

A separate analysis of variance was prepared for each product at each storage period. The Hartley modification of the Tukey Multiple Comparisons Test (10) was applied (Table 2) to determine which specific levels of MSG were significantly different from one another at the 5% level of significance.

Statistical analysis for the initial evaluation shows no difference in preference among levels of MSG except for chicken pot pie where the highest concentration (.3%) was evidently too high, since this treatment was less preferred than Treatments 1 and 2.

After Six Months

Analysis at the six-month storage period showed significant preference for level 3 (.45%) of MSG in beef patty over the control. Turkey with dressing at level 3 (.3%) was preferred over all other levels. All levels of MSG were preferred in mashed potatoes over the control.

In green beans, level 1 (.1%) MSG was preferred over other levels but not over the control. A borderline

(Table 1)—AVERAGE MEAN RATINGS

Treatments*	Menu No.	Items	Initial Evaluation				6 Months Storage 0°F.				12 Months Storage 0°F.			
			0	1	2	3	0	1	2	3	0	1	2	3
I		Turkey w/Dressing	7.3	7.1	7.3	7.3	5.5	5.8	5.5	7.0	6.9	6.0	6.8	6.8
		Oven-brown Potatoes	7.1	6.3	6.7	6.4	6.0	6.9	6.0	6.1	6.3	6.8	7.0	6.5
		Green Beans	6.2	6.6	6.4	6.3	5.7	6.2	5.1	5.2	4.8	5.9	5.7	5.2
II		Chicken Pot Pie	7.1	7.4	7.4	6.5	6.6	6.8	6.9	6.6	6.6	6.6	7.2	7.2
		Beef Patty	7.0	6.5	7.0	6.9	5.9	6.4	6.6	6.9	7.0	7.1	6.6	7.0
III		Mashed Potatoes	6.6	6.4	6.5	6.6	5.6	6.6	6.5	6.2	6.6	6.4	6.4	6.7
		Corn	6.4	6.4	6.4	6.6	5.7	5.9	6.3	6.1	6.1	6.0	6.2	6.5
		Beef Pot Roast	6.9	6.6	7.0	7.4	6.1	6.3	6.5	6.0	6.3	5.2	6.2	6.6
IV		Au Gratin Potatoes	5.6	5.7	5.5	5.8	5.5	5.9	6.0	6.1	5.9	6.0	5.9	6.2
		Peas	7.0	6.9	7.0	7.2	6.6	6.9	7.0	6.3	7.0	6.5	6.3	6.5

*Treatment: 0—Control — No MSG added
 1—Lowest level of MSG
 2—Intermediate level of MSG
 3—Highest level of MSG

preference was shown for level 1 (.15%) MSG in oven browned potatoes.

At 12 months storage, analysis of variance shows a preference in green beans for level 1 (.1%) MSG over the control. In beef pot roast and turkey with dressing the control and levels 2 and 3 are better than level 1.

A borderline preference is shown for levels 2 and 3 (.2% and .3%) MSG in chicken pot pie. No preference is indicated at this storage period for any level of MSG in mashed potatoes, oven-browned potatoes, au gratin potatoes, peas, corn, and beef patty.

Items Benefited

These data indicate that during prolonged freezer storage, either at 6 or 12 months storage, the following items were benefited by the addition of MSG:

Beef patty .....	.45%
Turkey with dressing .....	.3%
Mashed potatoes .....	.15%
Green beans .....	.1%
Chicken pot pie .....	.2%
Oven-browned potatoes .....	.15%

Considering the limitations of this study in which the samples were obtained from a single commercial production, and after comparison of the findings with those of previous studies (1, 2, 4, 6, 8, and 9), the levels of MSG, as listed below, are suggested for optimum improvement of specific precooked frozen foods:

	% by Weight
Beef patty .....	.45
Beef pot roast and turkey with dressing .....	.3
Gravy and sauces .....	.2
Chicken pot pie filling and white potatoes ..	.15
Corn, peas, and green beans .....	.1
Potatoes, white .....	.15

Summary

Previous studies have established the beneficial effects of monosodium glutamate in frozen foods, and MSG has assumed much importance in the formulation of prepared frozen foods. This study was conducted to establish the levels of MSG that would effect the greatest benefits in various types of commercially prepared precooked frozen foods during extended storage at 0°F.

Ten different food items were each prepared with three increasing concentrations of MSG along with a con-

trol sample and were compared for preference by a consumer panel using the 9-point hedonic scale. Tests were run initially, and after six and 12 months of storage.

Separate analysis for each product showed a significant preference among levels of MSG after prolonged freezer storage for turkey with dressing, beef patty, mashed potatoes, and green beans. A borderline preference was found for levels of MSG in chicken pot pie and oven-browned potatoes. No preference was indicated for any level of MSG over the control for peas, corn, au gratin potatoes, and beef pot roast.

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(Table 2)

LEVEL OF MSG IN PRECOOKED FROZEN FOODS

Food Item	Evaluation Period	Comparisons of 0-1-2-3 Levels within Time	
		5% Level of Significance	
Beef Patty	Initial	Not significant.	
	6 Months	3 better than 0; no other differences.	
	12 Months	Not significant.	
Mashed Potatoes	Initial	Not significant.	
	6 Months	1 better than 0; 2 better than 0; 3 better than 0; no other significant differences.	
	12 Months	Not significant.	
Peas Corn Au Gratin Potatoes	Initial, 6 and 12 Months	Not significant.	
	Beef Pot Roast	Initial and 6 Months	Not significant.
		12 Months	3 better than 1; 0 better than 1; 2 better than 1; no other significant differences.
Chicken Pot Pie	Initial	1 better than 3; 2 better than 3; no other significant differences.	
	6 Months	Not significant.	
	12 Months	3 and 2 on borderline better than 0 and 1.	
Turkey and Dressing	Initial	Not significant.	
	6 Months	3 better than 2; 3 better than 0; 3 better than 1; no other significant differences.	
	12 Months	0 better than 1; 2 better than 1; 3 better than 1; no other significant differences.	
Oven-brown Potatoes	Initial	Not significant.	
	6 Months	1 on borderline better than 0, 2, 3.	
	12 Months	Not significant.	
Green Beans	Initial	Not significant.	
	6 Months	1 better than 2; 1 better than 3; no other significant differences.	
	12 Months	1 better than 0; no other significant differences.	