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EFFECT OF STORAGE ON THE FLAVOR OF CHOCOLATE
FORTIFIED WITH NUTRITIONAL YEAST



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cessing, storage, and preparation on
nutrient retention in ration items to
assure presence of adequate amounts of
nutrients at times of consumption.

Work Phase - Evaluation of vitamin
fortified ration components.

Problem - Yeast Fortification of
Chocolate.

EFFECT OF STORAGE ON THE FLAVOR OF CHOCOLATE
FORTIFIED WITH NUTRITIONAL YEAST

Interim Report

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ABSTRACT

To provide operational rations with potentially important vitamin factors, chocolate was individually supplemented with three brands of primary yeasts and five brands of debittered yeasts at 0, $1\frac{1}{2}$, 2, 3, and 4 percent levels. Samples were packed in rigid and flexible containers and stored at 70° and 100° F. The acceptability of the control and fortified chocolate was measured at four-month intervals for one year.

After storage, unsupplemented chocolate was slightly preferred to the supplemented chocolate. No significant difference was observed between primary and debittered yeast. Chocolate containing $1\frac{1}{2}$ and 2 percent levels of yeast was preferred to chocolate containing yeast at the 3 and 4 percent levels. With respect to brand, all of the debittered yeasts had equivalent stability, whereas one brand of primary yeast appeared to be slightly more stable than the others.

EFFECT OF STORAGE ON THE FLAVOR OF CHOCOLATE FORTIFIED WITH NUTRITIONAL YEAST

Introduction

Although it is probable that the vitamins already well characterized are those of greatest nutritional and therapeutic importance, it cannot be assumed that other vitamins of nutritional significance, whose importance has not yet been recognized, do not exist. In this respect, it is known (1, 2) that some natural materials produce growth responses in experimental animals over and above those obtained with all known vitamins. Furthermore, Ershoff has reported that diets adequate under normal conditions may be inadequate for optimal protection under certain forms of climatic stress (4).

When a variety of common foods are consumed, such as occurs in normal civilian feeding and in the maintenance of troops on Field Rations A or B, not only are the recommended daily allowances of known vitamins supplied, but other vitamins for which requirements are less well known are also provided. However, in packaged operational rations, the original vitamin content is considerably decreased by processing and storage. Moreover, the present plan to develop a system of rations made up entirely of precooked dehydrated foods increases the probability that nutritional deficiencies will develop in operational rations. Consequently, as a safeguard against the above mentioned potential hazards, it is important to supplement operational rations with natural concentrates known to supply unidentified vitamin factors. Evidence has been presented that such factors are present in yeast.

It has been established that chocolate has adequate stability and acceptability after storage for six months at 100° F. and is satisfactory for use in present and proposed rations. Therefore, a study was undertaken to determine the suitability of chocolate for fortification with yeast.

In a preliminary experiment it was found that at levels up to 2 percent, chocolate fortified with either primary or debittered yeast had satisfactory acceptance ratings. However, at the 3 and 4 percent levels there was a doubt as to the acceptability of debittered yeast. Consequently, a new study was started to determine more definitively the suitability of debittered yeast at the higher concentration levels, and to ascertain the flavor stability during storage of yeast-supplemented chocolate. As several sources of both debittered and primary yeasts were available, a comparison was also made of five brands of debittered and three brands of primary yeast.

Experimental

Chocolate bars were prepared¹ according to military specification. Supplementation of the chocolate with yeast was made at 0, 1½, 2, 3, and 4 percent levels. Samples were packed in both rigid and flexible containers and stored at either 70° or 100° F.

¹ Prepared by the Hershey Chocolate Co.

The experimental plan used in the storage study is presented in Table 1. Palatability tests were made initially and at four-month intervals on samples stored in the flexible packages. Samples stored in rigid containers were not to be analyzed unless samples stored in flexible containers were unacceptable. Each level of fortification was tested at each examination period, 1½ and 3 percent at 70° F., 2 and 4 percent at 100° F., alternating at each withdrawal (Table 1). The control was tested at every withdrawal at each temperature. A minimum of 16 judgments was obtained on each sample, using a nine-point scale ranging from excellent to extremely poor.

Results and Discussion

The initial palatability ratings of chocolate supplemented with various concentrations of yeast are presented in Table 2. Statistical analyses of these data indicate chocolate containing 1½ and 2 percent levels of yeast to be preferred to chocolate containing yeast at 3 and 4 percent levels. In addition, the initial flavor of chocolate was not significantly affected by the type of yeast (Table 3).

The post-storage mean palatability ratings combined for all three brands of each type of yeast are presented in Table 4.

Similar to the results obtained with freshly prepared samples, the ratings following 8 and 12 months' storage were significantly higher for chocolate containing 1½ and 2 percent as compared to that containing 3 and 4 percent yeast. There was little difference between types of yeast in stability over various storage times, both types, on the average (total mean), deteriorating to some extent during storage. In addition, comparison of ratings for either type of yeast at each level of supplementation showed that no significant difference existed between samples stored at 70° and 100° F.

The variation between individual brands at various levels of fortification following storage is shown in Tables 5 and 6. Since no difference in acceptability was observed between chocolate stored at 70° and 100° F., ratings of the samples stored at both temperatures were combined for each individual brand. The stability of one brand of primary yeast (#2) appeared to be more satisfactory than that of the other two brands tested, especially at the higher levels of fortification (Table 5). All brands of debittered yeast were found to have equivalent stability (Table 6).

Although no significant differences were observed between chocolate supplemented with primary or debittered yeast, the ratings of samples containing debittered yeast appeared to be more variable. For example, the palatability rating of one sample of chocolate supplemented with debittered yeast at the 4 percent level declined from an initial value of 6.4 to 5.8 after 4 months storage. The rating continued to decline after 8 months storage, but was identical with the initial value at the end of the storage period (Table 6). However, comparison of the two groups by the "F" test (4) showed no significant

difference in variance between ratings of chocolate containing primary or that containing debittered yeast. Therefore, either type of yeast can be used in chocolate to supply the unidentified vitamin factors.

Recommendations

That existing specification for sweet chocolate should be amended to include supplementation with nutritional yeast.

Level of fortification. The sweet chocolate should contain 2 percent nutritional yeast.

Quality of fortification. The yeast should be either primary or debittered type, granular, and particulate with a moisture content not to exceed 8 percent. The product should be prepared, processed, and packaged under modern sanitary conditions and by such methods as will reflect good standards of workmanship and quality in the finished product.

Acknowledgment

The authors wish to express their appreciation to the General Food Products Section, Applications Engineering Branch, for procurement of the chocolate and to the Acceptance Branch for conducting the palatability tests.

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Table 1
Schedule of Palatability Tests

Yeast	Storage		Level of Supplementation					
	Time	Temperature	Percent					
	Mo.	° F.	0	1½	2	3	4	
Primary	0	70	X	X		X		
	1-3	100	X		X		X	
		4	70	X		X		X
	8	100	X	X			X	
		70	X	X			X	
		100	X		X			X
		70	X		X			X
	12	70	X		X		X	
		100	X	X		X		
	Debittered	0	70	X	X		X	
1-3		100	X		X		X	
		4	70	X		X		X
8		100	X	X			X	
		70	X	X			X	
		100	X		X			X
		70	X		X			X
12		70	X		X		X	
		100	X	X		X		
12		70	X	X	X	X	X	
	100	X	X	X	X	X		

Table 2

Effect of Yeast Concentration in Chocolate
on Initial Palatability Ratings

The mean ratings of chocolate supplemented with both types and all brands of yeast are combined at the various levels.

Level	Rating
%	Av.
0	6.7
$1\frac{1}{2}$	6.5
2	6.7
3	6.1
4	6.2

Table 3
Effect of Type of Yeast in Chocolate Upon
Initial Palatability Ratings

The ratings for all brands constituting one type are averaged and compared at the various levels.

Type	Level				
	0	1 $\frac{1}{2}$	2	3	4
Primary	6.8	6.8	6.7	6.4	6.2
Debittered	6.6	6.3	6.9	5.8	6.2

Table 4

A Comparison of the Mean Palatability Ratings of Chocolate Bars Fortified with Primary or Debittered Yeast after Storage at 70° and 100° F.

Storage Time Mo.	Level of Supplementation														
	0	1 $\frac{1}{2}$	2	3	4	Total 70°F	Total 100°F	Total 70°F	Total 100°F	Total 70°F	Total 100°F	Total Mean			
				Primary Yeast											
0	6.8	6.7	7.0	6.8	6.6	6.8	6.6	6.7	6.5	6.2	6.4	6.2	6.6	6.6	
4	6.8	7.2	6.6	6.8	5.5	6.8	7.0	6.7	7.1	6.4	6.6	6.7	6.5	6.7	
8	6.6	6.3	6.1	6.2	7.0	6.2	6.1	6.4	6.3	5.8	6.1	5.8	5.8	6.1	
12	6.6	5.7	6.5	6.2	6.8	6.2	6.3	6.6	5.1	6.1	5.8	5.4	6.0	6.3	
Total Mean	6.7	6.5	6.5	6.5	6.7	6.5	6.5	6.6	6.3	6.2	6.2	6.0	6.1	6.5	
				Debittered Yeast											
0	6.6	6.4	6.2	6.3	6.7	6.3	7.2	6.9	5.8	5.8	5.8	6.3	6.2	6.6	6.4
4	6.8	6.4	6.9	6.6	6.9	6.6	6.4	6.6	6.4	6.4	6.4	6.2	5.8	6.6	6.5
8	6.3	5.9	6.1	6.0	6.1	6.0	6.4	6.2	5.4	5.3	5.3	5.9	5.8	6.0	6.0
12	6.4	5.8	6.9	6.2	6.2	6.2	5.1	5.5	5.7	6.1	5.8	6.0	5.8	6.0	6.0
Total Mean	6.5	6.1	6.4	6.3	6.4	6.3	6.1	6.3	5.9	5.8	5.8	6.1	5.8	6.3	6.2

Table 5

Effect of Storage Time on Mean Palatability Ratings of Chocolate
Bars Fortified with Various Levels of Primary Yeast¹

Yeast	Storage Time	Levels of Supplementation				
		Percent				
		0 ²	1 $\frac{1}{2}$	2	3	4
	Mo.	Mean Ratings				
1	0	6.8	6.6	6.8	6.4	6.1
	4	6.8	7.1	6.2	6.8	6.2
	8	6.6	6.4	5.8	6.3	5.1
	12	6.5	6.2	6.9	5.6	6.5
2	0	6.8	6.7	6.9	6.6	6.2
	4	6.8	6.2	6.8	5.9	6.5
	8	6.7	6.2	6.4	6.4	6.4
	12	6.8	6.7	6.8	6.6	6.2
3	0	6.9	7.0	6.6	6.2	6.2
	4	7.0	7.2	7.0	7.1	6.7
	8	6.6	6.1	7.0	5.8	5.8
	12	6.3	5.7	6.3	5.1	5.4

¹ N = 16 except where otherwise indicated.

² N = 32

Table 6

Effect of Storage Time on Mean Palatability Ratings of Chocolate Bars Fortified with Various Levels of Debittered Yeast¹

Yeast	Storage Time	Levels of Supplementation				
		Percent				
		0 ²	1½	2	3	4
	Mo.	Mean Ratings				
1	0	6.4	5.7	6.9	5.2	6.4
	4	6.8	6.4	6.1	6.6	5.8
	8	5.8	6.3	5.9	5.2	5.2
	12	6.4	5.3	4.9	5.6	6.4
2	0	6.7	6.4	7.2	5.8	6.1
	4	7.2	6.9	6.9	6.4	6.2
	8	6.4	5.9	6.4	5.4	5.8
	12	6.4	6.9	6.2	6.1	6.0
3	0	6.7	6.7	6.4	6.4	6.2
	4	6.6	6.4	6.8	6.2	5.8
	8	6.8	5.9	6.3	5.4	6.6
	12	6.4	6.3	5.2	5.8	5.0
4 ³	12	6.6 ⁴	6.6	6.7	6.0	5.9
5	12	6.3 ⁴	6.0	5.6	5.5	5.5

¹N = 16 for yeasts #1, 2, and 3 except where otherwise indicated.

²N = 32

³N = 18 for yeasts #4 and 5 except where otherwise indicated.

⁴N = 36