THE USE OF A CEREAL LEAF PRODUCT AS HUMAN FOOD

by

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TABLE OF CONTENTS

INTRODUCTION

Surveys made on the diets of under-privileged people reveal the need for a rich but economical source of vitamins and minerals. The cereal leaf product, Cerophyll, formerly known as Viota, appeared to be such a material; analyses as hereinafter reported indicated a good vitamin and mineral content and it could be produced economically.

A number of persons had used the product medicinally and believed that it was helping them; however, there were no recorded results. There was a feeling that the cereal leaf product was effective in increasing the amount of hemoglobin in the blood but there was no evidence to substantiate this belief. The material has a grassy flavor which is not especially pleasing when taken alone so the idea of adding it to foods was conceived.

The purpose of this investigation was to find ways to make this cereal leaf product palatable in the everyday diet. When it had been satisfactorily combined with foods, some individual and physiological reactions of human subjects to the product were noted.

REVIEW OF LITERATURE

Chemical and biological analyses of the cereal leaf product have been made as here reported but the work has not been published. The results of the analyses were as follows:[1]

Minerals

Fe(Mg/Kg) - total 854 available 214	(5 samples)
Cu " 11.5	(3 ")
Mn " 46.3	(14 ")
Co " .7	(1 sample)
Ca % .525	(13 samples)
Mg % .188	(13 ")

Bio-Assays

Flavin (Mg/Kg)	Biol. 25-35	
	Chem. 25-35	(2 samples)
B_1(I U/g)	total 3	(1 sample)
B_2	10% not effective	(1 ")
B_4	10%-15% not effective	(2 samples)
W(units/g)	½ as active as liver	(1 sample)
Gizzard factor	15% poor	(1 ")
Grass juice factor	----------	(12 samples)

Analyses indicate these additional results:

B-carotene[2]	19.84 mg/100 g	(33,000 units/100 g)
	25.8 mg/100 g	(43,000 " ")
C[3]	4.9 mg/g	

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[1]Personal communication from American Butter Company of Kansas City, Missouri. 1937.

[2]Analyses run by Dr. W. J. Peterson, Department of Chemistry, Kansas State College of Agriculture and Applied Science. 1937.

[3]Analyses run by Dr. C. H. Whitnah, Department of Chemistry, Kansas State College of Agriculture and Applied Science. 1937.

The B-carotene figures given here are considerably lower than samples tested earlier which contained as high as 50 mg/100 g. Conditions of storage, stage of development of grain when cut, and conditions under which the product was prepared all influenced its potency.

Palatability of foods is measured largely by flavor, which is defined as a combination of taste and odor. A study of individual reaction to flavor of evaporated milk was made by Hollinger and Roberts (4). Subjects included both school children and adults. The infectious effect of both unfavorable and favorable reactions to food was emphasized throughout the experiment. As an illustration, an electric juice extractor and electric mixer were used in combining a fruit juice and evaporated milk beverage to serve each evening to children at a neighborhood club. The soda fountain atmosphere pleased them and the loud praise of children who did like the drink tended to make the ones disliking it fall into line. The amounts of orange or lemon juice in evaporated milk were varied from time to time, and one evening only sweetened evaporated milk was served in the same fashion as before. Everyone liked it and the authors attributed it to the fact that the children were drinking with an open-minded attitude. Similar results

were obtained with adults. The authors state that,-

> Prejudice can be overcome at any age provided the individual really desires to do so - - - Repeated tastings together with the right mental attitude are essential to learning to like a new or disliked food. Repetition alone will not suffice. A person may go on indefinitely tasting a disliked food, under compulsion and with an attitude of revulsion, and with his dislike becoming greater instead of less - - - The moral of this obviously is that those responsible should see to it, so far as possible, that children never hear anything but favorable comments about the foods they are expected to eat and like.

Group instruction and opportunity for the food to be tasted with no prejudice in mind but rather with an open-minded, even favorably expectant attitude as in the soda fountain procedure will change adverse to favorable reaction in older children and adults.

The fact that the taste and odor of a substance may affect different people in different ways is shown by Blakeslee (1). He found that any substance must have a certain concentration before it can be tasted, the concentration varying from person to person.

Too, he states that the perception of sweet and bitter depends on the individual thresholds which may be different for these two sensations. People may differ in the threshold at which odor is first detected; this also depends upon

the concentration. He concludes that no two people are alike in sensory reactions but that these reactions may be influenced by training and environment.

The mental performance tests in this study were evaluated by means of formulas from Kent (7), Guilford (3), Kelly (6), Hull (5), and Lindquist and Foster (8).

Hemoglobin readings in this study were made by the Newcomer method. Elvejehm (2) states that the thick Newcomer disc which has been calibrated by comparing to standard acid hematin gives accurate results when hemoglobin is determined colorimetrically.

PART I. SELECTION OF FOODS TO BE TESTED

Procedure

Eighty recipes were selected and prepared, adding the cereal leaf product to each. Five members of the Department of Food Economics and Nutrition acted as judges. Foods in each of the following groups were prepared: beverages, soups, sandwiches, meat substitutes, main dishes containing some meat, vegetables, salads, and desserts.

Discussion of Results

As the cereal leaf product contained some vitamin C, the original plan was to prepare as many uncooked dishes as possible to preserve the vitamin. Beverages were found to be unsatisfactory from the standpoint of appearance and also from that of flavor. The material quickly settled to the bottom and the beverage had to be stirred frequently in order to keep the cereal leaf in suspension. Coffee with cereal leaf material added tasted somewhat like green tea. Most of the soups were also unsatisfactory with the exception of an onion soup using a meat broth base. The flavor was not so evident and the green color enhanced the appearance of the clear soup, making it more attractive. Cream of pea and cream of asparagus soups which might have been expected to be were not palatable. A good sandwich was made from scrambled egg to which the product was added. The best meat substitute was a cheese souffle containing the product. Palatable main dishes containing meat and added cereal leaf product were Italian macaroni and stuffed pepper. The meat used in stuffing the pepper was smoked ham; it disguised the grassy flavor well and made a

delicious food. Most green vegetables carried the cereal leaf product well from the standpoint of flavor. However, the texture was often gritty or "fuzzy" as one judge described it and if there was liquid on the food, the material seemed to settle to the bottom of the dish. Onions stuffed with nuts and bread crumbs were palatable and spinach and buttered cabbage were fairly good when they contained cereal leaves. Gelatin salads were neither attractive nor tasty with the material added; the dull green particles dispersed through the gelatin did not present a pleasing appearance. Cabbage salad containing some green pepper and parsley was fairly good. Some desserts, for example, caramel ice cream, a green colored lemon ice, and butterscotch bread pudding were found to be palatable when cereal leaf product was added.

Because of the decided flavor and color, it was found impossible to add the cereal leaf product to recipes in amounts as large as 1 teaspoon per cup of food. An individual serving of food would probably not exceed 1/2 cup; therefore, it would appear necessary to add the cereal leaf product to a number of different foods during the day in order to secure appreciable amounts of mineral and vitamin from this source. This would be difficult because few foods were found which carried the product well and a diet

made up of these few foods would soon grow monotonous. Too, heat under certain conditions causes loss of vitamin C and the more palatable recipes found were those in which the material was cooked.

From recipes tested, it is evident that highly flavored or seasoned foods, some green vegetables, and cooked foods as a class can be used most satisfactorily with this cereal leaf product.

PART II. INDIVIDUAL REACTIONS TO FOODS SELECTED

Procedure

The 15 foods rated the highest by the judges were suggested for use to the person in whose dining room the individual reactions were to be noted. Ten foods were selected, 9 of which were served 3 times and 1, 4 times. Usually 6 foods per week were served in varying order so that they would not be monotonous. The basic recipes were constant but the amount of cereal leaf product was usually varied to include as much as possible and yet have an acceptable food. There were 26 subjects, 22 of whom were faculty members or graduate students and 4 of whom were under-graduate.

The study of individual reactions to foods tested was carried on in a manner similar to that of Hollinger and Roberts (4). The subjects were especially interested in the investigation as many of them were doing research work. Probably their reactions were more favorable than those of other groups would have been. At the beginning of the experiment they were instructed not to discuss the food before marking the individual reaction sheet shown and to make a note if they usually disliked any of the foods served. The sheets were placed at each plate at the beginning of the meal and collected at the end. Occasionally a person missed a meal or the food ran out before every one had tasted it so the number of subjects per day varies.

Discussion of Results

Foods served, the proportion of cereal leaf product to food and the number of subjects indicating a like, dislike or indifference for each food are shown in Table 1.

Individual Reaction to Cerophyll

Name _____

	Date	Food	Like	Indifference	Dislike
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

Table 1. Summary sheets of individual reaction to Cerophyll

Date	Food	Amount Cerophyll per Cup	Like		Indifference		Dislike	
			Number	Per Cent	Number	Per Cent	Number	Per Cent
12-6-37	Beet salad	1/2 t.*	18	72.0	5	20.0	2	8.0
12-7-37	Cabbage salad	3/4 t.	14	53.8	7	26.9	5	19.3
12-8-37	Bread dressing	1/2 t.	12	48.0	10	40.0	3	12.0
12-9-37	Escalloped corn	5/6 t.	7	29.2	11	45.8	6	25.0
12-10-37	Mashed sweet potato	1/4 t.	10	38.5	5	19.2	11	42.3
12-11-37	Spanish rice	1/4 t.	15	60.0	7	28.0	3	12.0
12-14-37	Carrot, apple, raisin salad	1/4 t.	6	24.0	10	40.0	9	36.0
12-15-37	Green beans	3/8 t.	8	34.8	11	47.8	4	17.4
12-16-37	Italian macaroni	1/4 t.	19	76.0	5	20.0	1	4.0
12-17-37	Buttered peas	1/2 t.	13	59.1	4	18.2	5	9.1
1-3-38	Beet salad	4/5 t.	6	26.1	8	34.8	9	39.1
1-4-38	Green beans	1/2 t.	7	26.9	9	34.6	10	38.5
1-5-38	Cabbage salad	3/4 t.	15	65.2	5	21.7	3	13.1
1-6-38	Escalloped corn	1/3 t.	21	84.0	2	8.0	2	8.0
1-7-38	Mashed sweet potato	1/4 t.	12	54.5	6	27.3	4	18.2
1-8-38	Spanish rice	1/4 t.	19	76.0	3	72.0	3	12.0
1-10-38	Carrot, apple, raisin salad	1/3 t.	12	63.2	4	21.0	3	15.8
1-11-38	Buttered peas	1/2 t.	19	73.1	6	23.1	1	3.8
1-12-38	Bread dressing	1/2 t.	11	45.8	5	20.8	8	33.4
1-13-38	Cabbage salad	1/2 t.	12	48.0	7	28.0	6	24.0
1-14-38	Spanish rice	1/3 t.	7	29.2	8	33.3	9	37.5
1-15-38	Italian macaroni	3/4 t.	19	79.2	3	12.5	2	8.3
1-17-38	Mashed sweet potato	1/3 t.	11	47.8	6	26.1	6	26.1
1-18-38	Cabbage salad	1/2 t.	11	44.0	9	36.0	5	20.0
1-19-38	Green beans	3/8 t.	16	66.7	5	20.8	3	12.5
1-20-38	Beet salad	4/5 t.	14	60.9	6	26.1	3	13.0
1-21-38	Carrot, apple, raisin salad	1/2 t.	10	43.5	6	26.1	7	30.4
1-22-38	Italian macaroni	3/4 t.	16	72.7	4	18.2	2	9.1
1-25-38	Buttered peas	1/2 t.	15	71.5	4	19.0	2	9.5
1-26-38	Escalloped corn	1/2 t.	17	68.0	6	24.0	2	8.0
1-27-38	Bread dressing	4/5 t.	9	36.0	7	28.0	9	36.0

*t.= teaspoon.

When the scores were totaled, it was found, as shown in Table 2, that escalloped corn with cheese was best liked, with Italian macaroni, Spanish rice, buttered peas, beet salad, cabbage salad, and carrot, apple, and raisin salad following in the order given. Mashed sweet potatoes and bread dressing were least liked. In general, the more highly flavored and seasoned foods disguised the flavor of the cereal leaf product better and were better liked. The grassy flavor is less evident in foods containing acid so some salads carry it well but the tiny green particles tend to settle out when combined with the ingredients, so the salad dressing at the bottom of the dish contains much of the cereal leaf product. Carrot, apple, and raisin salad was not pleasing either in appearance or flavor.

Table 2. Descending order of preference for foods containing Cerophyll

Food	Amount Cerophyll per Cup	Percentage of Likes
Escalloped corn	1/3 t.*	84.0
Italian macaroni	3/4 t.	79.2
Spanish rice	1/4 t.	76.0
Italian macaroni	1/4 t.	76.0
Buttered peas	1/2 t.	73.1
Italian macaroni	3/4 t.	72.7
Beet salad	1/2 t.	72.0
Buttered peas	1/2 t.	71.5
Escalloped corn	1/2 t.	68.0
Green beans	3/8 t.	66.7
Cabbage salad	3/4 t.	65.2
Carrot, apple, raisin salad	1/3 t.	63.2
Beet salad	4/5 t.	60.9
Spanish rice	1/4 t.	60.0
Buttered peas	1/2 t.	59.1
Mashed sweet potato	1/4 t.	54.5
Cabbage salad	3/4 t.	53.8
Bread dressing	1/2 t.	48.0
Cabbage salad	1/2 t.	48.0
Mashed sweet potato	1/3 t.	47.8
Bread dressing	1/2 t.	45.8
Cabbage salad	1/2 t.	44.0
Carrot, apple, raisin salad	1/2 t.	43.5
Mashed sweet potato	1/4 t.	38.5
Bread dressing	4/5 t.	36.0
Green beans	3/8 t.	34.8
Escalloped corn	1 t.	29.2
Spanish rice	1/3 t.	29.2
Green beans	1/2 t.	26.9
Beet salad	4/5 t.	26.1
Carrot, apple, raisin salad	1/4 t.	24.0

*t.= teaspoon.

Table 3 shows the series of reactions for each food. Reactions are for the most part not consistent and it would appear that the subject's mental and emotional state is a stronger factor in influencing his judgment than is the flavor of the cereal leaf product added. The Italian macaroni appears to be the best liked and during the experiment was the only food of which many desired second portions. The bread dressing and mashed sweet potato were generally not liked, perhaps because the bland flavor and smooth texture inadequately concealed the experimental material. Variations in reaction to green beans and buttered peas might be due to the fact that amounts of liquid used in cooking the vegetables were not constant each time they were served. The larger the amount of liquid, the more the cereal leaf material settled out and therefore, less was included in each serving.

From the reactions noted and comments overheard the appearance of the material in the food was often a stronger factor than flavor when judging it. If a colorless material with less grassy flavor could be prepared from the cereal leaves in place of the green product now available, it would lend itself much more readily to usage in food. The decided character of flavor, color, and texture make it impossible to add very large amounts of cereal leaf

product to food and have a palatable product; yet according to assays, one assumes it should be taken in rather large amounts, viz., several teaspoonsful per day, to be of practical value.

The results of this part of the experiment indicate that in its present form this cereal leaf product does not lend itself satisfactorily to use in foods.

Table 3. Changes in reaction to Cerophyll

Date	Food	Amount Cerophyll per Cup	Like		Indifference		Dislike	
			Number	Per Cent	Number	Per Cent	Number	Per Cent
12-6-37	Beet salad	1/2 t.*	18	72.0	5	20.0	2	8.0
1-3-38	" "	4/5 t.	6	26.1	8	34.8	9	39.1
1-20-38	" "	4/5 t.	14	60.9	6	26.1	3	13.0
12-7-37	Cabbage salad	3/4 t.	14	53.8	7	26.9	5	19.3
1-5-38	" "	3/4 t.	15	65.2	5	21.7	3	13.1
1-13-38	" "	1/2 t.	12	48.0	7	28.0	6	24.0
1-18-38	" "	1/2 t.	11	44.0	9	36.0	5	20.0
12-8-37	Bread dressing	1/2 t.	12	48.0	10	40.0	3	12.0
1-12-38	" "	1/2 t.	11	45.8	5	20.8	8	33.4
1-27-38	" "	4/5 t.	9	36.0	7	28.0	9	36.0
12-9-37	Escalloped corn	5/6 t.	7	29.2	11	45.8	6	25.0
1-6-38	" "	1/3 t.	21	84.0	2	8.0	2	8.0
1-26-38	" "	1/2 t.	17	68.0	6	24.0	2	8.0
12-10-37	Mashed sweet potatoes	1/4 t.	10	38.5	5	19.2	11	42.3
1-7-38	" " "	1/4 t.	12	54.5	6	27.3	4	18.2
1-17-38	" " "	1/3 t.	11	47.8	6	26.1	6	26.1
12-11-37	Spanish rice	1/4 t.	15	60.0	7	28.0	3	12.0
1-8-38	" "	1/4 t.	19	76.0	3	12.0	3	12.0
1-14-38	" "	1/3 t.	7	29.2	8	33.3	9	37.5
12-14-37	Carrot, apple, raisin salad	1/4 t.	6	24.0	10	40.0	9	36.0
1-10-38	" " " "	1/3 t.	12	63.2	4	21.0	3	15.8
1-21-38	" " " "	1/2 t.	10	43.5	6	26.1	7	30.4
12-15-37	Green beans	3/8 t.	8	34.8	11	47.8	4	17.4
1-4-38	" "	1/2 t.	7	26.9	9	34.6	10	38.5
1-19-38	" "	3/8 t.	16	66.7	5	20.8	3	12.5
12-16-37	Italian macaroni	1/4 t.	19	76.0	5	20.0	1	4.0
1-15-38	" "	3/4 t.	19	79.2	3	12.5	2	8.3
1-22-38	" "	3/4 t.	16	72.7	4	18.2	2	9.1
12-17-37	Buttered peas	1/2 t.	13	59.1	4	18.2	5	22.7
1-11-38	" "	1/2 t.	19	73.1	6	23.1	1	3.8
1-25-38	" "	1/2 t.	15	71.5	4	19.0	2	9.5

t.= teaspoon.

PART III. MENTAL PERFORMANCE

Procedure

A group of 20 college women enrolled in an upper class course in nutrition served as the subjects for this experiment. They took the cereal leaf product in tablet form in the amount of 10 tablets per day for 7 weeks. This was approximately 5 grams of the experimental material per day. Peterson's Uniform Test of Mental Performance (9) was given to the group and to 44 control subjects at the beginning and the end of the experiment. The controls were enrolled in different sections of the same course. The tests were given at the same hour in the same room by one person to each of two sections; the first test was started on page 1 of the leaflet and the second one was begun on page 3 to prevent overlapping.

Examples of equations making up the test are as follows.

Directions. Make each series of numbers in the list below a true equation by inserting at the proper points the necessary signs of addition (+), subtraction (-), multiplication (x), or division (÷).

Completed equation: 1 + 5 = 7 - 1

8 = 2 + 9 - 3

Equation to be completed: 4 = 9 3 1

7 = 5 3 5

At the end of each 5-minute period as announced by the one conducting the test, the subject was asked to draw a line under the equation last completed. Eight periods were allowed. Tests were scored on the basis of total equations completed, total correct equations completed, number of equations wrong, and number of equations omitted.

Controls were chosen by matching each experimental subject with another subject showing comparable performance in the first test. This was determined by the following points: score of first period, score of last period, average score, and gain or difference between first and last period scores. Each group was then averaged.

Discussion of Results

The left-hand portion of Table 4 shows the performance of each experimental subject and the right-hand portion of the table shows on the same line the control subject with whom she was matched. Thus, Experimental Subject 2 solved an average of 39.6 problems for each 5-minute period during Test I and an average of 54.8 problems per period in Test II. Control Subject 62 solved 38.0 and 58.4 problems per period in Tests I and II respectively. Subjects were carefully matched using especial care that the control group be given a slight advantage as may be noted by a comparison of the means per period for Test I in the experimental and control groups. These are respectively 30.360 and 31.160. The control group was given this advantage in order that any differences in performance might be attributed to the known variable, viz., the cereal leaf product.

Table 4. Summary of results of mental performance test

Experimental			Control		
Subject's Number	Average Score per 5-Minute Period Test I	Average Score per 5-Minute Period Test II	Subject's Number	Average Score per 5-Minute Period Test I	Average Score per 5-Minute Period Test II
2	39.6	54.8	62	38.0	58.4
3	19.9	27.5	59	21.5	25.0
14	27.6	34.5	40	27.4	36.3
15	27.6	35.0	5	28.8	42.3
18	31.4	51.1	63	33.5	43.8
24	34.1	38.1	52	31.1	37.6
27	32.4	55.3	20	31.0	41.1
28	32.5	45.1	10	33.4	40.5
31	23.1	24.4	32	22.1	28.3
33	31.5	44.4	8	31.1	32.6
34	35.5	49.3	13	34.6	42.5
37	17.3	24.9	53	22.0	27.4
38	27.8	34.9	55	27.8	31.9
43	22.6	26.0	46	23.0	34.4
47	33.8	38.6	39	39.9	53.8
49	48.0	61.8	19	48.0	51.6
50	19.3	28.8	16	23.1	23.1
51	46.8	61.5	48	49.9	71.1
61	35.4	43.1	25	36.0	43.1
45	21.0	21.3	29	21.0	26.4
Total	607.2	800.4	Total	623.2	791.2
Mean	30.36	40.02	Mean	31.16	39.51
σ dis$_1$	8.307	12.331	σ dis$_1$	8.151	11.887
σ M$_2$	1.905	2.828	σ M$_2$	1.870	2.727

[1] σdis = Standard deviation of distribution of average scores.

[2] σM = Standard deviation of mean of average scores.

Table 4 (concl.)

Correlation	.915 ± .025	.919	± .024
Gains in score	9.660	8.350	
	Differences between gains	1.310	
	σ D G_1	1.824	
	Critical ratio	.716	
	763 chances to 237 chances that experimental group would be first in a similar experiment.		

The standard deviation of distribution of average scores (σ dis) for Test I is 8.307 for the experimental group and 8.151 for the control group; for Test II these values were respectively 12.331 and 11.887.

The standard deviation of the means of average scores (σ M) for Test I is 1.905 for the experimental group and 1.870 for the control group while the Test II values are respectively 2.828 and 2.727.

Correlations for the two tests were .915 with a probable error of .025 for the experimental group and .919 with a probable error of .024 for the control group.

The experimental subjects made an average gain of 9.660 equations per period from Tests I to II while the gain of the control subjects was only 8.350 equations per period. Thus, the experimental group gained 1.310 equations per period more than did the controls. The standard error

[1] σ D G = Standard error of difference between gains.

of difference between gains (σ D G) was found to be 1.824 and the critical ratio was .716 in favor of the experimental group.

σ distribution was calculated from the formula ($\sigma X = \frac{\sqrt{\Sigma (X)^2 - (\Sigma X)^2}}{N}$) (7). σ M was calculated according to the correction formula for smallness of numbers observed ($\sigma M = \frac{\sigma \text{ dis}}{\sqrt{N - 1}}$) (3). Corrections were done by Pearson's product-moment method (6) ($r = \frac{\Sigma X Y}{N \sigma 1 \sigma 2}$) as adapted by Hull (5)

($r = \frac{M a \times b - M a \times M b}{\sqrt{M a^2 \times (M a)^2}\ \sqrt{M b^2 - (M b)^2}}$)

as expressed in terms of this test is

$r = \frac{M I \times II - M I \times M II}{\sqrt{M I^2 \times (M I)^2}\ \sqrt{M II^2 \times (M II)^2}}$).

σ D G was calculated as proposed by Lindquist and Foster (8) by the long formula ($\sigma D G = \sqrt{\sigma 1^2 + \sigma 2^2 + \sigma 3^2 + \sigma 4^2 - 2r\ 12\ \sigma 1 \sigma 2 - 2\ r\ 34\ \sigma 3\ \sigma 4}$ in which 1 and 2 = first and second scores of the experimental group and 3 and 4 = first and second scores of control group; g = gain).

The critical ratio is equal to the difference in gains divided by the standard error of difference between gains $\left(\frac{D\,G}{\sigma\,D\,G}\right)$.

Since the critical ratio is in favor of the experimental group, the chances are 763 to 237 that the repetitions of the experiment with other subjects similarly chosen would give results favoring this group. The subjects were, as stated earlier, well nourished and capable college upper classmen; performance on the test tended to be rather uniform because the subjects were unusual from the standpoint of ability, scholarship, and knowledge of nutrition. Too, the duration of the experiment was short. Further work on a larger number of subjects with less adequate diets would be of interest.

One would conclude, in view of the results, that the addition of a cereal leaf product to the diet had little effect on the mental performance of a highly selected group of college women over a 7-week period but results obtained indicate that further work for a longer time with poorly nourished subjects would be desirable.

PART IV. BLOOD STUDY

Procedure

Eleven junior girls enrolled in a course in nutrition served as the subjects for blood analysis. They reported weekly to the laboratory on the same day and hour; blood samples were taken from the third or little finger by lancet puncture. If their hands were cold, the fingers were immersed in lukewarm water until they were warm; other than this there was no exercise such as swinging the arm or closing the hand into a fist several times to cause a greater concentration of blood in the part. If the drop were slow in coming the finger might be pressed gently from the lower palm down to the knuckle nearest the hand, or the sides of the cut might be gently spread apart; but at no time was there any squeezing.

Tests were made for amount of hemoglobin by diluting 20 cmm. of blood drawn in a pipette in 10 cc. of .1 N HCl. The solution was allowed to stand an hour and the acid hematin formed was compared to a standard disc in a colorimeter.

Results were expressed as grams hemoglobin per 100 cc. of blood. Red blood cell counts were made by drawing the straight portion of the pipette full of blood then diluting to volume with Hayem's solution, the final dilution being 1 : 200. The tubes were sealed to prevent escape of solution and laid on their sides until they were ready to be counted. At the time of counting they were shaken for 3 minutes and counted under the microscope in a counting chamber.

Cell volume was determined by drawing blood up to the level of 10, diluting to volume in potassium oxalate, sealing and centrifuging 20 minutes at 3,000 revolutions per minute. Then the packed column of blood was read directly from the tube, and when multiplied by 10, gave the cell volume expressed as per cent of the blood. Only a few cell volumes could be measured as there was no equipment for keeping the tube from going through the heavy rubber band used to seal it. Thus, most of the samples were lost while centrifuging and therefore, the results are not included.

Seven subjects were tested for hemoglobin only for 4 weeks, 2 for 5 weeks, and 2 for 3 weeks preceding the period in which the cereal leaf product was taken. The product was then taken daily in capsule form in the amount of 14 grams per week for 4 weeks; during this time tests were

made for hemoglobin and red blood cell count. (The week that final examinations were given, no blood tests were taken; the results would probably not have been representative because of the loss of sleep, fatigue, and nervous strain.) After concluding the administration of the cereal leaf product, the subjects were tested for hemoglobin and red blood cell count for at least 3 weeks, and in most cases for 4 weeks. Averages were made for the pre-test period, the cereal leaf period, and the post-test period.

Discussion of Results

Results of the experiment were as follows:

Table 5. Summary of results of blood analyses

	Pre-test I	Cereal Leaf II	Difference II - I	Post-test III	Difference III - II
Grams Hb/100 cc. blood	12.36	12.53	.17	12.61	.08
Red blood cell count	465.76	467.23	1.47	459.60	-7.63

Under the conditions of this experiment, it would appear that the cereal leaf product does not have a noticeable effect on blood since these differences are within the normal range of blood variation. Perhaps if the amount of cereal leaf product had been greater there would have been a more noticeable change in blood composition.

A blood test at the beginning and end of the mental performance test was run on 21 subjects taking 10 tablets per day for 7 weeks and on 10 control subjects. Not enough work was done to present conclusive data but indications are that the experimental group gained .843 grams hemoglobin per 100 cc. blood while the control group gained .676. The difference here is not great enough to attribute it to any factor other than normal variation of blood.

Some doubt was felt as to the reliability of the colorimeter readings. With the co-operation of the chemistry department, samples were read in both the colorimeter and spectrophotometer. From this work it would appear that data given in Table 5 are somewhat high and may be converted to the true readings by use of the factor .945.

It appears that there was no measurable effect on blood composition in the two groups given the cereal leaf product.

SUMMARY OF RESULTS

Under the conditions of this experiment, it appears that,-

1. Highly flavored or seasoned foods, some green vegetables, and cooked foods as a class can be used most satisfactorily to include cereal leaf product.
2. Reactions of human subjects would indicate that in its present form this cereal leaf product does not lend itself satisfactorily to use in foods.
3. Addition of cereal leaf product to the diet of highly selected college women had little effect on mental performance but results indicate that further work over a longer period of time with poorly nourished subjects would be of interest.
4. Cereal leaf product at two levels of intake had no measurable effect on blood composition.

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