A High Quality Protein, Vitamin, and Mineral Fortified Chocolate-Flavored Powder for Beverage Use

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Abstract

A chocolate-flavored beverage powder containing high-quality protein was formulated with milk, sugar, eggs, vitamins, and minerals. The powder has adequate storage stability and when reconstituted with water to a 26% total solids beverage, has taste acceptability.

Introduction

Because of concern with low quality protein in the diets of substantial segments of the population of the United States, our laboratory developed a powdered beverage base which is processed from milk and eggs. Chocolate was added for taste appeal. Vitamins and minerals were added for nutritional enhancement. High quality animal protein was used in the formulation. As such, the protein efficiency ratio (PER) of the product can be depended upon to be high and not subject to decreases as might occur if plant protein were added.

Because diets of infants were as much as 50% deficient in iron, and those of young girls and women up to 54 yr of age as much as 30% to 35% below recommended allowances (11), attention was focused on addition of iron to this product. Gutelius (3) reported that many infants from low income groups drink large quantities of milk to the exclusion of other available foods and develop iron deficiency anemia. At age 12 to 17 mo, as many as 65% of these infants had below normal hemoglobin concentrations. These children were not malnourished in the traditional sense.

Some controversy has arisen over the biological availability of different iron compounds in food fortification. Generally, ferrous and soluble forms of iron salts are the most effective. Food sources of iron are less well utilized than inorganic compounds. Even infant formula fortified with inorganic iron may require time for release of iron. Vaughan and Knauff (10) found that iron in dietary drinks is associated with the protein and is not available until the protein portion of the soluble iron-protein complex is digested.

Fritz et al. (2) found, providing that there was some biological availability, increased dietary poorly utilized iron sources as ferric orthophosphate were effective for the cure of iron deficiency anemia. The authors state ferric orthophosphate has only a relative biological value of 14% of ferrous sulfate iron added at 20 mg/kg. At higher levels the effectiveness was in the order of magnitude that would be expected from the relative biological value (RBV) established in earlier tests with the material. In some applications, technological problems such as rancidity and discoloration may make it impractical to use soluble iron compounds that have maximum availability. Where chocolate is involved, addition of soluble iron tends to discolor the product. Thus, the use of the more insoluble form of iron may be the best route available for iron fortification. Hodson (4) showed, that during the storage of liquid dietaries for 2 to 5 mo, insoluble ferric orthophosphate will change to the more biologically available ferrous iron.

Cocoa does not stimulate the growth of rats. Mueller and Ritchie (7) reported 1% cocoa in the fluid milk has no inhibitory effect on the growth of rats; more than 2.5% causes retardation. In an attempt to determine the cause of this growth retardation, Mueller (6) reported 2% crystallized tannic acid is toxic to rats. Since tannic acid occurs to a variable extent in cocoa, it is desirable to select cocoa in which the percent is low. He found iron reduced the toxicity of crystalline tannic acid in cocoa by preventing the reduction of hemoglobin by the acid.

Chocolate is a widely accepted and increasingly popular flavoring agent for beverages. From 1954 to 1972 per capita sales of flavored milk and drinks (estimated to be 90 to 95% chocolate) have increased from 3.31 to 4.34 kg (1).

Materials

Milk was received from the Agricultural Research Center, Beltsville, MD. Pasteurized and frozen whole eggs were purchased from commercial sources. Sugar and Hershey's breakfast cocoa used in blending and also for processing in the concentrates were purchased through General Services Administration. Nutritional Biochemical Company[2] made the vitamins. Virginia Dare dry vanilla flavoring was used. Equipment used for processing was conventional dairy plant equipment.

Methods

Liquid ingredients, skim milk, whole milk, and whole eggs were mixed in a 380 liter tank and pumped with a sanitary centrifugal pump to a Gaulin triplex pump and then through a Mallory heater. The mix was pasteurized at 77 C for 16 s, homogenized at 175.5 kg/cm^2 and 35 kg/cm^2 with a two-stage homogenizer valve and condensed in a single stage Wiegand falling film evaporator to 42% total solids. Concentrates were atomized at 154.4 kg/cm^2 pressure through a nozzle of .75 mm diameter into a Gray-Jensen spray-drier using air at an inlet temperature of 138 to 144 C.

Dry blending of spray-dried milk and egg powder, sugar, cocoa, and vanilla flavoring was in a Patterson Kelly V shell blender for 6 min. Premixes of concentrated vitamins and minerals were made with a small portion of this blend and then further mixed with the blend to make batch-sized lots of powder.

Different iron compounds as well as $CuCO_3$ were added to these powders. The iron compounds were ferric orthophosphate, ferric ammonium citrate, and ferrous sulfate at 45 ppm iron.

Dry blended powders containing ferric orthophosphate were stored in sealed No. 2 cans at −10, 24, and 37 C. Ferric ammonium citrate as well as ferrous sulfate were blended in powders and sealed in No. 2 cans for storage at 24 C.

Analysis and Evaluation

Powders were analyzed for protein by the Micro-Kjeldahl method and fat by Roese-Gottlieb extraction. Moisture was determined by the toluene distilation procedure (5).

Chocolate beverages were organoleptically evaluated in a 9 point preference scale (8). Scores for any one storage period were statistically tested by analysis of variance (9).

Samples for the taste panel were reconstituted to 26% total solids with distilled water at 25 C. The reconstituted samples were then refrigerated for 3 to 4 h before testing. Fifteen to 20 tasters were provided with rinse water at 25 C to use between samples. The tasters were also instructed to mix the samples before tasting to suspend any settled chocolate in the cups.

TABLE 1. Percent of ingredients of chocolate-flavored beverage powder.

Milk fat	3.2
Whole egg solids	8.8
Nonfat milk solids	60.5
Sucrose	19.9
Breakfast cocoa	4.0
Dry vanilla flavoring	1.0
Vitamins and minerals	.15

Results and Discussion

Table 1 lists the ingredients and Table 2 the average composition of this chocolate-flavored powder. By calculation, one 85 g serving furnishes 352 calories. Carbohydrate and ash were determined by calculation from average composition of ingredients.

Table 3 shows that all fresh powders when reconstituted were acceptable. With few exceptions, Dairy Products Laboratory panelists scored all powders stored for 1 mo or longer at 24 C, 5.4 to 6.1. Those powders containing ferric orthophosphate stored at −10 C rated no better than those stored at a higher temperature. The slight to moderate loss in panel acceptability due to storage could not be defined. Even though the iron in ferric orthophosphate may not be completely available, it is recommended as the source of iron because it does not discolor the chocolate color of the beverage. Additional quantities of this iron source can be added. Acceptability of the

TABLE 2. Percent average composition of chocolate-flavored beverage powder.

Protein	27.0
Fat	9.5
Moisture	2.5
Carbohydrates	55.5
Ash	5.5

[2] Reference to brand or firm name does not constitute endorsement by the U.S. Department of Agriculture over others of a similar nature not mentioned.

TABLE 3. Effect of iron source on panel scores of chocolate-flavored beverage powders stored at −10, 24, and 37 C.[a]

Storage period (months)	Iron compound-45 ppm $FePO_4$ H_2O			$Fe(NH_4)_3$ $(C_6H_5O_7)_2$	$FeSO_4$
	−10 C	24 C	37 C	24 C	24 C
0	...	6.75	...	6.30	6.35
1	6.30	5.60	...	5.40	5.75
2	6.38	5.69	...	5.38	5.40
3	6.00	6.10	...	6.00	5.53
4	5.35	5.60	5.45	4.65	5.05
5	5.66	5.55	5.05	5.72	5.78
6	5.67	5.87	5.55	...	...
9	5.60	4.80	...	...	...

[a] All scores for any one storage period not significantly different at P = .05.

beverage containing freshly mixed powder with 90 ppm of ferric orthophosphate was not significantly different from the beverage with either none or 45 ppm of this added iron. In an alternative process the vitamins and minerals were added to a liquid concentrate of all the other ingredients prior to spray drying. Since the product had a disagreeable taste, no further work on this method of processing was attempted.

Table 4 shows the percent minimum recommended daily requirements (RDR) for the vitamins and minerals added plus the vitamins and minerals before fortification as determined by calculation. The RDR given are those recommended by the National Research Council (1973) for a pregnant woman. Percentages calculated assume 100% availability of nutrients. The amounts of these materials added may be varied depending upon the requirements of the blend.

Three chocolate-flavored products were tested by the Special Survey Branch, Statistical Reporting Service, USDA. Thirty-seven judges rated the iron orthophosphate fortified chocolate product of the Dairy Products Laboratory significantly higher (6.32) than two commercial products, one a dried product reconstituted with fluid whole milk that rated 5.57, and the other a liquid dietary that rated 5.16.

Our product, containing over 27% total protein, derived from high quality milk and eggs, is an excellent protein and mineral supplement. Depending upon the availability of the iron (2), one serving with 45 ppm added iron is calculated to furnish an estimated 9% to 23% of the RDR for young girls, women, or pregnant women and up to 42% of the RDR for both young and adult males (1973 RDR).

TABLE 4. Percentage of recommended daily requirement (RDR)[a] provided by an 85 g serving of chocolate-flavored beverage powder.

Vitamin	RDR	mg per serving		% RDR
		Natural	Added	
Vitamin A	5000 IU	350 IU	1700 IU	41
Vitamin B_1	1.3 mg	.22 mg	.20 mg	32
Vitamin B_6	2.5 mg	.5 mg	.25 mg	30
Vitamin D_2	400 IU	40 IU	100 IU	35
Vitamin C (Na ascorbate)	60 mg	...	100 mg	167
Niacinamide	14.0 mg	4.0 mg	2.0 mg	43
Copper	2.0 mg[b]	.08 mg	.7 mg	38
Iron	18.0 mg	1.25 mg	3.8 mg	28
Phosphorus	1.2 g	.7 g	...	58
Calcium	1.2 g	.88 g	...	73

[a] For pregnant women (1973).
[b] Estimated as requirements not established.

References

(1) Economic Research Service, U.S. Dep. Agr. 1973. Dairy Situation, DS 346:15.

(2) Fritz, J. C., G. W. Pla, T. Roberts, J. W. Boehne, and E. L. Hove. 1970. Biological availability in animals of iron from common dietary sources. J. Agr. Food Chem. 18:647.

(3) Gutelius, M. F. 1971. Iron deficiency anemia in ghetto infants. Clin. Proc. Child. Hosp. Washington, DC 27:1.

(4) Hodson, A. Z. 1970. Conversion of ferric to ferrous iron in weight control dietaries. J. Agr. Food Chem. 18:946.

(5) Milk Industry Foundation. 1949. Laboratory manual: Methods of analysis of milk and its products, 2d ed., Washington, DC.

(6) Mueller, W. S. 1942. The significance of tannic substances and theobromine in chocolate milk. J. Dairy Sci. 25:221.

(7) Mueller, W. S., and W. S. Ritchie. 1937. Nutritive value of chocolate flavored milk. J. Dairy Sci. 20:359.

(8) Peryam, D. R., and F. J. Pilgrim. 1957. Hedonic scale method of measuring food preferences. Food Technol. 11(9): Insert p. 9.

(9) Snedecor, G. W. 1956. Statistical methods, 5th ed. Iowa State College Press, Ames, IA.

(10) Vaughan, O. W., and R. E. Knauff. 1961. Chemical state and nutritional availability of iron in a prepared infant formula. J. Dairy Sci. 44:1650.

(11) Agricultural Research Service, U. S. Dep. Agr. March 1969. Food intake and nutritive value of diets of men, women, and children in the United States, Spring 1965. ARS 62-18.