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FURTHER STUDIES ON THE DEVELOPMENT OF A NUTRITIONALLY ADEQUATE FALLOUT SHELTER RATION

FINAL REPORT (Part II of II)
March 1966

MRI Project No. 2769-B

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Work Unit 1315A

MRI
425 VOLKER BOULEVARD/KANSAS CITY, MISSOURI 64110/AC 816 LO 1-0202

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by

H. E. Newlin
G. L. Hayes

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TABLE I

RECOMMENDED ANALYSIS FOR THE PRESENT SHELTER RATIONS

	Author			
	D. H. Calloway et al., 1960[10/a/]	R. E. Johnson, 1961[11/]	NRC Advisory Committee on Civil Defense, 1962	Longenecker and Sarett, 1963[4/]
Protein	< 7 - 8% of total calories	15% of total calories	5 - 10% of total calories, 35 g/day	About 8% of total calories
Fat	Adjust for maximum caloric density	33% of total calories	< 50% of total calories	To complete caloric requirement
Carbohydrate	75 - 100 g/day	52% of total calories	To complete caloric requirement	65 - 75% of total calories
NaCl	4.5 g/day	For total mineral intake of 0.7 osmol/-day	3 g/day	1.1 - 1.6% in ration
Biological value	Need not yet shown experimentally	-	Equivalent to that in unprocessed cereal grains	Equivalent to that in whole wheat kernels
Vitamins	Some vitamin A, B, and C	-	B vitamins equivalent to those in cereal protein	-
Minerals	Need not yet shown experimentally	-	-	-
Calories/day	> 900	2,000	1,500	-
Water/day	> 800 cc.	2 - 3 liters	1 - 2 quart	-

a/ Numbered references refer to the Bibliography, Part I of II, pages 21-22.

TABLE II

REPORTED PROXIMATE VALUES FOR THE PRESENT SHELTER RATIONS

Item	Reference	Moisture, %	Protein, %	Fat, %	Fiber, %	Ash, %	NFE, %	Carbohydrates, %	Cal/g
Biscuit	Longenecker[4]/a/		8.7	8.2					
	Morris[13]/	2.55	8.55	8.20	0.35	1.80	78.55	78.90	
	Wells[14]/	3.32	8.81	7.83	1.11	1.23		77.7	3.98
	Wilcox[5]/	3.17	7.99	8.13	—	1.28	—	79.43	4.42
	Avg.	3.01	8.51	8.09	0.73	1.44	78.55	78.60	4.20
	Military specifications[1]/b/	3.5	7.24-8.20	7.24-11.58		< 2.41			
Cracker	Longenecker[4]/		8.7	9.0					
	Morris[13]/	3.40	8.25	7.15	0.40	1.75	79.05	79.45	
	Wells[14]/	5.97	7.31	8.68	3.30	1.74	—	73.0	3.99
	Avg.	4.69	8.08	8.27	1.85	1.75	79.05	76.23	3.99
	Military specifications[2]/b/	3.5	7.24-8.20	7.24-9.65	< 3.38				
Wafer	Morris[13]/	4.50	9.10	9.65	1.30	2.05	73.40	74.70	
	Shepherd[15]/		7.9	10.5					4.0
	Wells[14]/	4.75	9.25	10.90	2.09	1.99		71.0	4.1
	Wilcox[5]/	4.53	9.65	9.55	—	1.74	—	74.43	4.51
	Avg.	4.59	8.98	10.15	1.70	1.92	73.40	73.30	4.20
	Military specifications[3]/c/	4.5	7.16-8.12	9.55-11.46		< 3.34			

a/ Numbered references refer to the Bibliography, Part I of II, pages 21-22.
b/ Calculated to a 3.5 per cent moisture basis.
c/ Calculated to a 4.5 per cent moisture basis.

TABLE III

ESTIMATED AVERAGE MINERAL AND VITAMIN ANALYSIS
OF RATION BISCUIT, CRACKER, AND WAFER
(milligrams per 100 g.)

Calcium	30
Phosphorus	90
Iron	1.0
Thiamine	0.10
Riboflavin	0.08
Niacin	0.8

TABLE IV

REPORTED ESSENTIAL AMINO ACID ANALYSIS
OF PRESENT SHELTER RATIONS[a]
(Amino acid content as per cent of total protein)

Amino Acid	Biscuit	Cracker	Wafer
Arginine	2.0	3.3	3.8
Histidine	1.2	1.8	1.7
Threonine	3.5	2.7	4.4
Valine	4.0	4.0	3.2
Leucine	6.9	7.4	6.1
Isoleucine	3.0	3.4	2.6
Lysine	0.9	0.8	2.0
Methionine	1.4	1.6	1.3
Phenylalanine	4.7	4.5	4.8
Tryptophan	0.4	0.4	0.4

a/ Compiled from the reports of Wilcox[5] and Longenecker,[4] and from analysis of the ration ingredients.

TABLE V

DAILY NUTRITION PROVIDED BY UNSUPPLEMENTED AND SUPPLEMENTED MIXTURES OF RATION BISCUIT, CRACKER, AND WAFER, CONSUMED AT A 1,500 CALORIE LEVEL

Factor	Rations	3 Parts Rations Plus 1 Part Supplement	Factor	Rations	3 Parts Rations Plus 1 Part Supplement
Protein, g.	31	60	Histidine, g.	490	640
Vitamin A, I.U.	-	5,000	Isoleucine, g.	930	900
Thiamine, g.	0.4	1.2	Leucine, g.	2,100	1,900
Riboflavin, g.	0.3	1.7	Lysine, g.	370	800
Niacin, g.	3	19	Methionine, g.	430	1,100
Vitamin C, g.	-	70	Phenylalanine, g.	1,450	1,300
Calcium, g.	0.1	0.8	Threonine, g.	1,080	900
Iron, g.	4	10	Tryptophan, g.	120	250
			Valine, g.	1,140	1,000

TABLE VI

ANALYSIS OF A 1:1:1 MIXTURE OF RATION BISCUIT, CRACKER, AND WAFER, AND SPECIFICATIONS FOR A SUPPLEMENT TO BE FED AT A 25% LEVEL

Factor	Rations	Supplement	Factor	Rations	Supplement
Moisture, %	4.0	< 5.0	Iron, mg/100 g.	1.9	6
Protein, %	9.00	> 42	Vitamin A, I.U./100 g.	None	5,500
Fat, %	8.70	8 - 9	Thiamine, mg/100 g.	0.41	1.0
Fiber, %	0.90	0.8 - 1.8	Riboflavin, mg/100 g.	0.18	1.7
Ash, %	1.80	< 5	Niacin, mg/100 g.	1.28	19
Calcium, %	0.03	0.79	Vitamin C, mg/100 g.	0.25	77

TABLE VII

COMPOSITION OF EXPERIMENTAL PROTEIN MIXTURES
(Per Cent)

	Mixture No.									
	1	2	3	4	5	6	7	8	9	10
Sheftone 60[a]			10							
Proflo[b]			40							
Egg albumen	27	27								
Casein				25	25	25	25	25	25	41
Defatted peanut flour	73	33		49		31			59	30
Extracted soybean grits		40	50		43	32	68			29
Defatted wheat germ				16	29			58		
Promine[c]					3			17		
Diluent - carbohydrate				10		12	7		16	

a/ Protein supplement based on nonfat milk, Sheffield Chemical, Norwich, New York.
b/ Defatted cottonseed flour, Traders Protein Division, Fort Worth, Texas.
c/ Isolated soybean protein, Central Soya Company, Inc., Chicago, Illinois.

TABLE VIII

COMPOSITION OF SUPPLEMENTS A6-4 AND A7-2

Ingredient	Description or Type	Manufacturer	Particle Size[a]	A6-4 (%)	A7-2 (%)
Casein	High nitrogen	Sheffield Chemical Norwich, New York	100% through No. 30	17.5	17.5
Defatted soybean grits	Coarse F	A.E. Staley Mfg. Co. Decatur, Illinois	100% through No. 12	22.4	42.5
Bean bread	Survival ration[b]	Holsum Bakers Kansas City, Kansas	95% through No. 12 and 96% on No. 60	-	23.0
Defatted peanut meal	From blanched peanuts	Gold Kist Peanut Growers Graceville, Florida	100% through No. 12	20.2	-
Dehydrated mashed potato	"Potato Flakes"	Rogers Brothers Idaho Falls, Idaho	100% through No. 10	20.98	-
Hydrogenated cottonseed oil	"Keap"	Hunt-Wesson Sales Co. Fullerton, California	-	7.9	5.9
Vitamin-mineral mix	See Table IV	-	Powdered	3.0	3.0
DL Methionine	Purified	Nutritional Biochemicals Corp., Cleveland, Ohio	Powdered	0.12	0.08
Sorbitol	Purified	Fisher Scientific Co. St. Louis, Missouri	Powdered	8.0	8.0
				100.0	100.0

a/ U. S. Standard Sieves.

b/ This bread is baked to our specifications for use in survival rations. It consists of bean flour, unbleached flour, vital wheat gluten, shortening, cerelose, yeast, salt, sodium propionate, yeast food, bran, and farina. The formula can be released.

TABLE IX

COMPOSITION OF VITAMIN-MINERAL MIX USED FOR SUPPLEMENTS A6-4 AND A7-2

	Grams
Dry vitamin A palmitate beadlets, type 500A/50D2[a]	0.220
Rocoat thiamine mononitrite 33-1/3 per cent	0.60
Rocoat riboflavin 33-1/3 per cent	0.102
Rocoat niacinamide 33-1/2 per cent	1.110
Coated ascorbic acid	1.580
Calcium carbonate[b]	39.460
Sodium iron pyrophosphate[c]	0.828
Cerelose[d]	16.610
	60.000

a/ All vitamins were obtained from Hoffmann-LaRoche, Inc., Nutley, New Jersey.
b/ Merck, precipitated.
c/ Victor Chemical Division, Stauffer Chemicals, New York, New York.
d/ Glucose, Corn Product Company.

TABLE X

EFFECT OF ACCELERATED STORAGE ON TABLETED NUTRITIONAL SUPPLEMENTS A6-4 AND A7-2

	A6-4					A7-2				
Storage Temperature, °F	0	100		120		0	100		120	
Storage Time, Months	4	2	4	2	4	4	2	4	2	4
Thiamine, mg/100 g	1.28	1.31	1.20	1.16	1.26	1.37	1.88	1.37	1.26	1.23
Fat, %	8.25	6.24	7.53	6.42	7.20	8.10	8.46	8.39	8.28	8.39
Free fatty acids, % of fat	0.85	1.20	1.23	1.45	1.70	1.25	1.47	1.72	1.84	2.33
Acid value, mg. KOH/g	1.69	2.39	2.45	2.89	3.38	2.48	2.93	3.42	3.66	4.64
Peroxide value, m.e./1,000 g	1.8	2.0	1.9	2.1	2.0	2.9	1.5	1.5	2.8	2.4
Odor, rating	7.4	6.8	6.6	5.4	5.8	7.2	6.2	7.2	5.2	5.8
Flavor, rating	5.4	5.8	5.4	4.8	4.8	6.6	6.4	5.8	5.4	5.2
Texture, rating	6.0	6.4	6.2	6.2	6.4	6.0	6.4	5.8	6.0	5.2

TABLE XI

ANALYSIS OF TWO TABLETED NUTRITIONAL SUPPLEMENTS AND A MIXTURE OF EQUAL PARTS OF RATION BISCUIT, CRACKER, AND WAFER

	Supplement A6-4	Supplement A7-2	Ration Mixture
Moisture, %	3.60	3.30	4.00
Protein, %	42.10	44.05	9.00
Fat, %	8.90	9.00	8.70
Fiber, %	1.75	1.90	0.90
Ash, %	4.40	5.10	1.80
Calcium, %	0.86	0.96	0.03
Iron, mg/100 g	9.00	10.60	1.90
Vitamin A, units/100 g	6,200	6,400	None
Thiamine, mg/100 g	1.00	0.96	0.41
Riboflavin, mg/100 g	2.50	2.50	0.18
Niacin, mg/100 g	23.60	23.20	1.28
Vitamin C, mg/100 g	78.07	82.91	0.25

TABLE XII

ATTEMPTED REFINEMENT OF SPREADS CONSISTING OF 10 PARTS GRANULAR PROTEIN CONCENTRATE, 2 PARTS FAT AND 10 PARTS CORN SYRUP[a]

Experiment	Results
1. Effect of steeping 30 - 50 U.S. Standard screen size extracted soybean grits in hydrogenated cottonseed oil.	
A. Melt fat and pour on room temperature grits. Add corn syrup.	A. Excessively granular spread.
B. Hold grits plus melted fat for 1/2 hr. at 55 - 60°C before adding syrup.	B. Spread consistency slightly rough, but acceptable.
2. Effect of soy grits of finer screen sizes than 30 - 50 spreads prepared as in (1B).	
Grit Screen Size	Spread Consistency
A. 30 - 50 (Control)	A. Slightly rough, acceptable.
B. 45 - 50	B. Smoother than (A), but drier and harder to spread.
C. 50 - 70	C. Smooth, but hard to spread.
D. 70 - 120	D. Stiff, crumbles when spread.
E. Through 120	E. A dough, breaks when pressed.
3. Effect of various fats on soy grit spread prepared as in (1B).	
Type Fat	Spread Consistency
A. Hydrogenated cottonseed oil (Control)	A. Acceptable, slightly stiff.
B. Corn oil	B. Only slightly [illegible] stiff than control.
C. Beeswax	C. Excessively st[illegible]
D. Paraffin	D. About same as [illegible]
E. Myvacet 5-00[b]	E. Slightly stiffer [illegible] (A).
F. Myvacet 7-00[b]	F. Slightly stiff tha[illegible] (A).
G. Myverol 18-00[b]	G. Similar to (B).
H. Myverol 18-07[b]	H. Similar to (B).
I. Myrj 53[c]	I. Similar to (B).
J. Tween 60[c]	J. Similar to (B).
K. Fluid natural lecithin[d]	K. Similar to (B).
4. Effect of type of 30 - 50 screen size granule on spreads prepared as in (1B).	
Type Granule	Spread Consistency
A. Extracted soy grits	A. Acceptable, slightly stiff.
B. Casein	B. Highly granular.
C. Silica sand	C. No spread. Syrup and sand separated.
D. Vermiculite[e]	D. No spread. Granules completely absorbed syrup.

a/ See Appendix A-3 for general procedure for preparing fatted grit spreads.
b/ Distillation Products Industries, Rochester, New York.
c/ Atlas Powder Company, Wilmington, Delaware.
d/ General Mills, Inc., Minneapolis, Minnesota.
e/ Zonolite Company, Chicago, Illinois.

TABLE XIII

COMPOSITION OF THREE BLAND NUTRITIONAL SPREAD BASES, FOR USE IN FLAVOR SURVEYS

	Sweet Base No. 55 (%)	Neutral Base No. 57 (%)	Sour Base No. 61 (%)
Dried whip cream substitute[a]	40	-	-
Dried cream substitute[b]	-	40	40
Dried skim milk[c]	40	40	30
Dried demineralized whey[d]	-	-	10
Precooked tapioca[e]	20	20	20
Fumaric acid, added[f]	-	-	0.5

a/ Dream Whip, General Foods Corporation, White Plains, New York.
b/ Coffee Mate, Carnation Company, Los Angeles, California.
c/ Sanalac, Sanna Dairies, Inc., Madison, Wisconsin.
d/ Nutritek 250, Foremost Dairies, Inc., Burlingame, California.
e/ Minute Tapioca, General Foods Corporation, White Plains, New York. (Ground to 100 per cent through No. 50 U.S. Standard screen.)
f/ Food Grade, National Aniline Division, Allied Chemical and Dye Corporation, New York, New York.

TABLE XIV

SUPPLEMENTARY AND INCOMPATIBLE SPREAD FLAVORS FOR RATION CRACKERS

Enhance Flavor of Cracker	Negligible Effect on Flavor of Cracker	Detract From Flavor of Cracker
Chili	Most vegetables	Beef
Onion (as adjunct to other flavors)	Fish, clam	Pronounced HVP or MSG
Ham	Marshmallow	Smoke
Cheese		Barbecue
Chicken		Pronounced fruit and berry flavors (grape, strawberry, etc.)
Most sweet, mildly flavor puddings		Chocolate
Peanut butter		Sour salad dressings
Margarine		

TABLE XV

FLAVOR SPECIFICITY OF COMMERCIAL READY-TO-EAT SPREADS APPLIED TO SHELTER RATIONS

Spread	Flavor Rating on Ration[a]		
	Biscuit	Cracker	Wafer
Peanut butter[b]	A	A	A
Dark molasses[c]	C	C	A
Grape preserves[d]	B	B	C
Sweet pickle relish[e]	B	B	B
Chive dip[f]	B	B	A
Bacon flavored cheese[g]	A	A	A

a/ Ratings by three experienced tasters. Significance of ratings as follows:
- A. Spread improved acceptability of ration.
- B. Spread had little effect on acceptability of ration.
- C. Spread flavor was incompatible and detracted from that of ration.

b/ "Peter Pan," Derby Foods, Inc., Chicago, Illinois.

c/ "Brer Rabbit, Green Label," Penick and Ford, Ltd., Inc., New Orleans, Louisiana.

d/ Kroger Company, Cincinnati, Ohio.

e/ Heifetz Pickling Company, St. Louis, Missouri.

f/ "Party Snack - Chive," Kraft Foods, Chicago, Illinois.

g/ "Cheese 'N Bacon," The Borden Company, New York, New York.

TABLE XVI

COMPOSITION OF EIGHT NUTRITIONAL - PALATABILITY SUPPLEMENT DEHYDRATED SPREADS
(Per Cent)

Ingredient	66C Chicken	71C Chicken-Onion	73B Chicken-Onion	67A Cheddar Cheese	72B Blue Cheese	63B Chili	76A Ham	77A Ham
Nonfat milk solids	41	39	39	13	64		26	
Sodium caseinate	17	23	23		4	1	5	12
Sheftene 60[a]						38	30	
Lolac 451[b]				64				
Coffee White[c]	24	25	25	3			25	
Egg albumen	5	5	5					
Promine D[d]					10		6	
Low fat soy flour						32		
Redisol No. 78-D[e]						7		18
Prodex 15[f]						2.7		6
Beaded shortening[g]						6.3		
Monosodium glutamate				1				
Salt				1	1		1	
Vitamin-mineral mix[h]	3	3	3	3	3	3	3	3
Flavoring[i]	10[j]	5[k]	5[l]	15[m]	18[n]	10[o]	4[p]	61[q]

a/ Derivative of nonfat dry milk, with increased protein, Sheffield Chemical, Norwich, New York.
b/ Low lactose nonfat dry milk, Foremost Dairies, Inc., Burlingame, California.
c/ Dry fat, emulsified in milk proteins, Sheffield Chemical, Norwich, New York.
d/ Isolated soybean protein, Central Soya Company, Inc., Chicago, Illinois.
e/ Instant potato starch, Morningstar-Paisley, Inc., Chicago, Illinois.
f/ Low dextrose dry corn syrup, American Maize-Products Company, New York, New York.
g/ ZA Fraction, formed in spray atomizer, Durkee Famous Foods, Cleveland, Ohio.
h/ Composition is shown in Table IX.
i/ Composition of flavorings is detailed in footnotes (j) - (q).
j/ Ten per cent Spray Dried Chicken Broth, Henningsen Foods, Inc., New York, New York.
k/ Five per cent Spray Dried Chicken Broth, Henningsen Foods, Inc., New York, New York, plus these flavorings added to 100 per cent of base: 0.04 per cent Fresh Flavor Chopped Onion, Basic Vegetable Products, Inc., Vacaville, California; 0.50 per cent sugar; and 0.40 per cent monosodium glutamate.
l/ Five per cent Spray Dried Chicken Broth, Henningsen Foods, Inc., New York, New York, plus these flavorings added to 100 per cent of base: 0.12 per cent Fresh Flavor Chopped Onion, Basic Vegetable Products, Inc., Vacaville, California; 0.50 per cent sugar; and 0.50 per cent salt.
m/ Fifteen per cent Sharp Cheddar Cheese, Spray Processed, Armour Creameries, Chicago, Illinois.
n/ Eighteen per cent Blue Cheese with Milk Solids, Spray Processed, Armour Creameries, Chicago, Illinois.
o/ Five per cent Instant Beef Bouillon, Wyler and Company, Chicago, Illinois; 2.6 per cent Fresh Flavor Chopped Onion, Basic Vegetable Products, Inc., Vacaville, California; 2.2 per cent Chili Powder, Durkee Famous Foods, Cleveland, Ohio; 0.1 per cent Ground Oregano, McCormick and Company, Inc., Baltimore, Maryland; and 0.1 per cent Ground Cumin, McCormick and Company, Inc., Baltimore, Maryland.
p/ One per cent Ham Flavored Seasoning, William J. Stange Company, Chicago, Illinois; and 3 per cent Ham Style Soup Base, Kraft Foods, Chicago, Illinois.
q/ Fifty-five per cent Ham Type Granules (flavored purified soybean protein), Ralston Purina Company, St. Louis, Missouri; 0.1 per cent CVC Parsley Flakes, California Vegetable Concentrates, Modesto, California; 3.8 per cent Sharp Cheddar Cheese, Spray Processed, Armour Creameries, Chicago, Illinois; 0.5 per cent Dry Mustard, Crown Colony, Safeway Stores, Inc., (distributor), Oakland, California; 0.3 per cent Lawry's Seasoned Salt, Lawry's Foods, Inc., Los Angeles, California; 0.9 per cent Mushroom Powder, William J. Stange, Chicago, Illinois; and 0.4 per cent Mertaste (mixture of monosodium glutamate, disodium inosinate and disodium guanylate), Merck and Company, Inc., Rahway, New Jersey.

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TABLE XVII

CALCULATED ANALYSIS AND COST, AND HEDONIC RATINGS OBTAINED ON EIGHT NUTRITIONAL - PALATABILITY SUPPLEMENT SPREADS

	66C Chicken	71C Chicken-Onion	73B Chicken-Onion	67A Cheddar Cheese	72B Blue Cheese	63B Chili	76A Ham	77A Ham
Analysis								
Moisture, %	4.0	4.1	4.1	3.3	3.2	4.9	[illegible]	[illegible]
Protein, %	41.2	42.7	42.7	43.1	42.0	42.1	[illegible]	[illegible]
Fat, %	9.5	9.7	9.7	8.5	9.6	8.6	[illegible]	[illegible]
Ash, %	8.5	7.4	7.4	9.0	9.6	9.8	[illegible]	[illegible]
Cost, ¢/lb	48.6	41.0	40.9	47.0	35.3	32.2	[illegible]	[illegible]
Average Hedonic Ratings[b]								
Consistency	7.4	5.8	6.0	7.8	6.9	4.2[c]	[illegible]	[illegible]
Flavor	6.0	7.0	6.8	6.6	6.4	5.4	[illegible]	[illegible]

a. High cost was due to cost of ham type granules, used for flavoring. This item is now made in pilot plant [illegible], and will be cheaper when mass produced.

b. Obtained with five experienced tasters, using 0 - 10 hedonic scale shown in Ref. 9 in bibliography.

c. Low score was due to a granular consistency, which can be easily eliminated.

TABLE XVIII

COMPOSITION OF MINT-TYPE REVISED CARBOHYDRATE SUPPLEMENTS

	CH-26 (%)	CH-26 "Peppermint 1" (%)
Confectioner's sugar	100	100
Added salt	1	1
Added oil peppermint[a]	-	0.0022
Estimated cost, ¢/lb	10.9	10.9
Average hedonic flavor rating[b]	6.2	6.2

a/ Oil Peppermint, Terpeneless, Fritzsche Brothers, Inc., New York, New York.
b/ Obtained with five experienced tasters, using 0 - 10 hedonic scale shown in Ref. 9 in the bibliography (see Part I of II, pp. 21-22).

TABLE XIX

COMPOSITION OF STARCH AGGLOMERATE-TYPE REVISED CARBOHYDRATE SUPPLEMENTS

	CH-34B Unflavored (%)	CH-37 Unflavored (%)	CH-37 Molasses Flavored (%)
Potato flakes, coarse ground[a]	22.5	-	-
Cooked tapioca, coarse ground[b]	-	45.0	45.0
Cooked corn starch, coarse ground[c]	48.0	-	-
Cooked rice, coarse ground[d]	22.5	48.0	48.0
Sorbitol	5.0	5.0	4.0
NaCl	2.0	2.0	2.0
Dark molasses[e]	-	-	1.0
	100.0	100.0	100.0
Estimated cost, ¢/lb	23.3	40.7	40.4

a/ Rogers Brothers, Idaho Falls, Idaho.
b/ Minute Tapioca, General Foods Corporation, White Plains, New York.
c/ Prepared in laboratory as shown in Appendix A-5.
d/ Minute Rice, General Foods Corporation, White Plains, New York.
e/ Brer Rabbit, Green Label, Penick and Ford, Ltd., Inc., New Orleans, Louisiana.

TABLE XX

COST OF FEEDING RATION SUPPLEMENTS[a]

Type Supplement	Formula	Estimated Ingredient Cost (¢/lb)	Cost of Supplement Consumed Daily (91 gm.) (¢)
Nutritional Tablets	A6-4	29.2	5.85
	A7-2	24.0	4.81
Nutritional-Palatability Spreads[b]	66 C Chicken	48.6	9.74
	71 C Chicken-onion	41.0	8.22
	73 B Chicken-onion	40.9	8.20
	67 A Cheddar cheese	47.0	9.42
	72 B Blue cheese	35.3	7.08
	63 B Chili	32.2	6.45
	76 A Ham	34.0	6.81
	77 A Ham	79.2	15.87
Revised Carbohydrate Supplements	CH-26 Mint	10.9	2.18
	CH-26 Peppermint	10.9	2.18
	CH-34B Agglomerate	23.3	4.67
	CH-37 Agglomerate	40.7	8.16
	CH-37 Agglomerate-molasses flavored	40.4	8.10

a/ The nutritional supplements are designed for feeding at a 25 per cent by weight level with the fallout shelter rations. Nutritional needs are met when a 1,500 Cal. quantity of the ration-supplement mixture is consumed daily. On this basis, 91 gm. (3.21 oz.) of supplement will be provided daily to each shelter occupant. The same level of intake would also be a typical one for revised carbohydrate supplements.

b/ All figures for spreads are presented on the basis of the dehydrated spread mixtures, containing 3.0 - 5.0 per cent moisture. For application on the rations, an approximately equal quantity of water is added to these mixtures.

TABLE XXI

RAT FEEDING TESTS FOR BIOLOGICAL EVALUATION OF UNSUPPLEMENTED AND SUPPLEMENTED FALLOUT SHELTER RATIONS

UN = 1:1:1 mixture of ration biscuit, cracker, and wafer
SUP = 75% of 1:1:1 mixture, 25% nutritional supplement

Title of Test	Biological Value	Physiological Fuel Value	Efficiency of Energy and Water Utilization	Water and Food Intake Pattern
Feeding groups	A. Casein control B. UN C. SUP	A. UN B. SUP	A. UN (3 caloric levels x 3 water levels = 9 subgroups) B. SUP (9 subgroups as above)	A. Normal water intake B. 0.8 normal water C. 0.5 normal water (2 subgroups/-group)
Criterion of measurement	Growth in weanling rats	Energy balance (food vs. excretion in urine and feces)	Rations are fed at equivalent of 2,000, 1,500 and 900 cal., and normal, 0.8 and 0.5 normal amounts of water per day. Body weight maintenance is measured.	Pick diet and caloric level. One of each pair of subgroups is fed and watered once a day, the other 3 times a day. Body weight maintenance is measured.
Rats/group	10	10	6/subgroup	15/subgroup
Rats/test	30	20	108	90
Number of replications	1	1	3	1
Estimated duration of single test, weeks	5	7	[illegible]	8