AMRL-TR-67-164

THE BIOCHEMICAL, PHYSIOLOGICAL, AND METABOLIC EFFECTS OF APOLLO NOMINAL MISSION AND CONTINGENCY DIETS ON HUMAN SUBJECTS WHILE ON A SIMULATED APOLLO MISSION

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DECEMBER 1967

JOINT NASA/USAF STUDY

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AEROSPACE MEDICAL RESEARCH LABORATORIES
AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

NOTICES

The voluntary informed consent of the subjects used in this research was obtained as required by Air Force Regulation 169–8.

600 - April 1968 - CO455 - 31-668

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FOREWORD

This research was initiated by the Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio, and was accomplished by the Department of Research of the Miami Valley Hospital, Dayton, Ohio, and the Biotechnology Branch, Life Support Division, Biomedical Laboratory, Aerospace Medical Research Laboratories. This effort was supported jointly by the USAF under Project No. 7164, "Biomedical Criteria for Aerospace Flight," Task No. 716405, "Aerospace Nutrition," and NASA Manned Spacecraft Center, Houston, Texas, under Defense Purchase Request R-85, "The Protein, Water, and Energy Requirements of Man Under Simulated Aerospace Conditions." This contract was initiated by 1st Lt John E. Vanderveen, monitored by 1st Lt Keith J. Smith, and completed by Alton E. Prince, PhD, for the USAF. Technical contract monitor for NASA was Paul A. Lachance, PhD. The research effort of the Department of Research of the Miami Valley Hospital, was accomplished under Contract AF 33 (657)-11716. Bernard J. Katchman, PhD, and George M. Homer, PhD, were technical contract administrators, and Robert E. Zipf, MD, Director of Research, had overall contractual responsibility.

The authors wish to acknowledge the assistance of Elaine R. Edwards, Jerome C. Fox, and Winifred H. Harden, chemists; James R. Broxey, James R. Cree, James F. LaPierre, Samuel J. Rice, and Larry L. Ross, physiological monitors; and Ellis Patrick, MD, medical monitor. Psychiatric, psychological, and dental evaluations were carried out by Gregory G. Young, MD, Howard H. Fink, PhD, and Duncan D. Powell, DDS, respectively. The investigating psychologist was Maj Victor H. Thaler, Environmental Physiology Branch, Biomedical Laboratory. Other military personnel were SSgt Earl T. Rawls and A2C James E. Gentry of the Biospecialties Branch.

This technical report has been reviewed and is approved.

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ABSTRACT

Four human male subjects participated in a 90-day experiment which consisted of 60-day and 30-day periods of confinement with a 5-day break between the confinement periods. The subjects were confined either to the controlled activity facility of the chamber of the Life Support Systems Evaluator at altitude with pressure suits worn unpressurized and pressurized at 3.7 psi. The subjects ate a fresh food diet, an Apollo nominal mission diet, or an Apollo contingency diet; the diets provided 2200, 2500, and 900 kcal/day, respectively. The rod form of the contingency diet was the most acceptable from an organoleptic standpoint although the tube form was more easily handled from a functional standpoint. However, the formulation of the tube food as well as the tube itself needs to be improved to make it operationally more effective than it is at present. The subjects lost about 500 g/day of body weight while on the contingency diet of which about 50% is estimated to be water. About 40 g/day of body weight was lost because of protein catabolism. Blood levels of sodium, potassium, phosphorus, chloride, calcium, and magnesium were maintained in the normal range of clinical values. Oral body temperature, pulse rate, respirations, blood pressure, and basal metabolic rate all were in the normal range of clinical values. However, the 17-hydroxycorticoids of the urine decreased to low normal and lower than normal ranges of clinical values. Three of the four subjects were able to complete a simulated Apollo emergency mission while in a pressure suit pressurized at 3.7 psi and on a 900-calorie contingency diet. There were no adverse effects upon their health and no evidence that their capacity to function in a normal manner was in any way impaired.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES, continued

LIST OF TABLES, continued

LIST OF FIGURES

SECTION I

INTRODUCTION

In 1966, a series of tests were accomplished to verify, functionally, Apollo food concepts, contingency procedures, and in-suit waste management in a simulated aerospace environment. During these tests, 4 human male subjects were confined for 60 days either in a controlled activity facility (CAF)* or in the chamber of the Life Support Systems Evaluator (LSSE).* The subjects ate either metabolically balanced diets of fresh foods, Apollo nominal mission (ANM) food, or the 900-calorie contingency food. The organoleptic acceptability, nutritional balances, and water and energy requirements were evaluated with special emphasis upon the simulated Apollo contingency period. Medical and physiological parameters were monitored regularly to insure that normal health was maintained throughout these tests.

At the conclusion of these preliminary tests, the subjects were given a 5-day leave and upon their return, they completed a 30-day test during which time two separate 5-day Apollo contingency missions were simulated in the LSSE. The results of this study in which one subject completed 120 hours continuous confinement and 2 subjects completed 100 hours continuous confinement while in a pressurized suit** at 3.7 psi have been reported elsewhere (1).

Other studies pertaining to the nutritional, biochemical, physiological, and microbiological parameters of man in a life support system have been reported (2-13).

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* The controlled activity facility (CAF) and the Life Support Systems Evaluator (LSSE) at the Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio, were used to provide the simulated aerospace environment.

** The pressure suits were furnished for these experiments by the Manned Spacecraft Center, NASA, Houston, Texas.

SECTION II

METHODS

Four human male subjects were confined for 60 consecutive days, and after a 5-day leave, were confined for an additional 30 days either in the CAF or LSSE. Each of the subjects was selected after intensive medical and psychiatric examinations. The medical examination consisted of a routine history and physical examination with special attention to underlying valvular disease. A class III physical examination was performed by a flight surgeon. Fasting and 2-hour postprandial blood sugar determinations were done to rule out latent diabetes. The Master's tolerance test, electrocardiogram, and electroencephalogram were also accomplished. A dental examination including x-rays, in compliance with Form SF-603, was accomplished. Objective psychological tests, clinical psychological interview, and psychiatric evaluations were accomplished. The physical characteristics of the subjects are listed in table I.

Each subject was required to follow a controlled activity schedule designed to provide work, exercise, relaxation, and sleep. During the 60-day experimental period, the subjects followed a daily work schedule as shown in table II. While in the CAF, a 122 m^3 air conditioned room maintained at 23 ± 2°C and at ambient pressure, all the subjects followed the routine as shown for subjects 41 and 42. While in the chamber, a 30 m^3 area, in a mixed gas atmosphere of 50% oxygen and 50% nitrogen, with pressure maintained at 382 ± 2.6 mmHg, and temperature of 78.5 ± 0.9 °F (25.6°C), the subjects followed the routine as shown in table II. Subjects 41 and 42 were on the day shift and subjects 43 and 44 were on the night shift. During the 30-day experimental period, the daily schedule was followed in general, but the subjects were not confined to the CAF during the day as it was necessary for them to be fitted for the pressure suit and to undergo familiarization and training for the simulated Apollo contingency mission. Similarly, during the simulated Apollo mission, the subjects wearing pressure suits and their aides did not follow any prescribed routine. Basal metabolic rates were taken on each subject on alternate days, upon awakening but before getting out of bed. Physiological measurements including oral temperature, blood pressure, pulse rate, and nude body weight (when applicable) were taken twice each day. Weather reports were made only while in the chamber, and these included cabin pressure, temperature, and relative humidity in the fore and aft cabin areas. Paper work refers to the data each subject recorded each day (physiological measurements, organoleptic ratings, water consumption). During free time, television was available and the subjects could write letters, read, study, or work on handicraft projects.

The subjects were in complete isolation all during the 60-day experimental period and had limited contact only with authorized personnel. This consisted of daily visits while in the CAF by the medical monitor for a physical examination. All other contacts were by voice communications. There were certain exceptions when familiarization and training in the use of the pressure suits was carried out. The subjects were monitored continuously by the subject monitors while in the CAF. While in the chamber, there was only voice and television communications. The chamber was operated by trained Air Force personnel. The subjects did not smoke, shave, groom or cut hair, or change clothing except as required when the sweat tests were done. Medications were taken only as prescribed and provided by the medical monitor. The subjects wore light weight cotton pajamas, cotton socks, and moccasins while in the CAF. During the sweat tests the subjects wore cotton long underwear under the pajamas. In the chamber, the subjects wore cotton long underwear under the pressure suits. Personal hygiene was kept to a minimum. Dry paper wipes were used to wipe the face and hands after eating and defecating. Oral hygiene consisted of the use of 2 dry toothbrushes on alternate days. Microbiological samplings were accomplished on fecal samples, selected body areas, and gingival scrappings only during the first 60 days of the experiment. The microbiological analyses were made by Republic Aviation Division of Fairchild-Hiller Corporation and have been reported elsewhere (14).

TABLE I

AGE, HEIGHT, WEIGHT, AND BODY MEASUREMENTS OF TEST SUBJECTS

Physical characteristic	Subject 41	42	43	44
Age	21	21	23	23
Height, inches	70	66	71	70
Weight, pounds	172.5	158.8	161.1	155.0
Chest, inches	41	40	39	37
Waist, inches	33	32	35	32
Hips, inches	38	37	37	35
Shoulder circumference, inches	51	47	44	45
Sleeve length, inches	32-33	30-31	30	33
Foot size	10	$8\frac{1}{2}$D	$9\frac{1}{2}$D	$9\frac{1}{2}$D-10

TABLE II

DAILY WORK SCHEDULE

Time	Subject No. 41	Subject No. 42		Subject No. 43	Subject No. 44	Time
0700	BMR, arise, physiological measurements, fasting blood samples					0700
0730			Transfer urine, feces, and water from chamber			0730
0800	Eat meal A		Weather report		Eat meal D	0800
0900	Microbiological specimens collected					0900
1000			All trips to and from LSSE and CAF started			1000
1100					Subjects to bed	1100
1200	Eat meal B		Weather report		Sleep	1200
1300						1300
1400			Transfer refuse from chamber			1400
1500						1500
1600	Eat meal C		Weather report			1600
1700						1700
1800						1800
1900	Physiological measurements		Television on		BMR, arise, physiological measurements, fasting blood samples	1900
2000	Eat meal D		Weather report		Eat meal A	2000
2100						2100
2200						2200
2300	Subjects to bed		Television off			2300
2400	Sleep		Weather report		Eat meal B Transfer paperwork from chamber	2400
0100			Weather report			0100
0200						0200
0300						0300
0400			Weather report		Eat meal C	0400
0500						0500
0600						0600

TABLE III

EXPERIMENTAL TEST PLAN

Test period	Time, days	Location	Diet	Cabin pressure mmHg	Cabin temperature °F	Pressure suit
I	15	CAF	Fresh food			
II	5	CAF	Contingency Foil pack (A)			
III	15	CAF	Fresh food			
IV	5	CAF	Contingency Rods (B)			
V	5	CAF	Fresh food			
VI	5	Chamber	ANM (A)	total, 380 O_2, 160	74	None
VII	5	Chamber	Contingency Rods (B) and Tube pack (C)	total, 380 O_2, 160	74	Open
VIII	5	CAF	Fresh food			
IX	10	CAF	ANM (B)			
X	5	Chamber	Contingency Rods (D) and Tube pack (C)	Air, 520	74	Air, 3.7 psi
XI	5	CAF	ANM (B)			
XII	5	Chamber	Contingency Rods (D) and Tube pack (C)	Air, 520	74	Air, 3.7 psi
XIII	5	CAF	Fresh food			

Table III shows the experimental test plan. For data analysis, the test periods have been grouped sequentially by the time in days on a particular diet. It had been initially planned for each test period to be 5 days in duration, but due to the difficulty experienced in obtaining the experimental food and space suits as anticipated, it was not possible to execute an experimental plan as symmetric as desired.

The fresh food diet was a 1-day cycle menu composed of fresh, frozen, and heat processed foods served as 4 equal meals and designed to provide 2500 calories per day (table IV). The ANM diet was obtained as bulk packed bite sized compressed and dehydrated foods from the Natick Laboratories and the Pillsbury Company as 2 separate batches (A and B). These foods were arranged into a 4-day cycle menu (table IV). All the food items were packaged in individual servings, assembled into meal units, arranged in cycles, and dated according to when they were to be served. Table V shows the rehydration schedule for the ANM food. Since the experimental periods were 5 days in duration, cycle I was repeated on the fifth day of each test period. These diets were to provide about 2600 calories per day. Rehydration by the subjects was accomplished as shown in table V. The contingency diets were designed to provide about 900 calories per day and were served as 2 feeding units per day. The chocolate flavored diets were provided in two forms, as a semisolid and as a rod. Foil pack (A) designates a semisolid food received in foil pouches. As it was difficult to remove all the contents from the pouches, 140 g of food was weighed into a styrofoam cup for each meal unit (2 units per day). The rods were long spaghetti-like in form, of which 13 feet per day provided the specified nutrients. The pouches in which the food was supplied were opened but not weighed before being sent in to the subjects. Two different batches of food from the manufacturer are designated (B) and (D). The tube food was of a semisolid consistency capable of being squeezed through an aluminum toothpaste-type tube. The tubes were sealed and this aluminum seal was broken before the tubes (2 units per day) were sent in to the subjects. The tubes were weighed before and after use to ascertain the amount of food consumed. For test periods X and XII (table III), 2 types of mouthpieces provided by NASA were used to allow transfer of food to the subjects in the pressure suits. An aperture in the faceplate of the helmet was designed so that the tubes containing food could be screwed directly onto the aperture and the food squeezed into the mouth of the subject. For the rod food, a separate aluminum tube and plunger were screwed onto the faceplate and small pieces of the rod food were forced through the tube by means of the plunger. As no provision had been made to transfer water to the subjects while in the pressure suits, a plastic water bottle was fitted with an aluminum tube that screwed onto the faceplate so that water could be transferred as desired.

During test periods I through VIII (table III), the subjects were instructed to, and did eat all food served. During test periods IX through XIII (table III), the emphasis was upon the accomplishment of the Apollo contingency missions in tests periods X and XII, and the subjects were permitted to reject food items of the ANM diet that they did not wish to eat. All food not eaten was recorded and corrections made in the balances. Food acceptability was rated on a 9-point hedonic scale. The nutrient composition as calculated by the dietitian for the fresh food diet is shown in table VI (15). The compositions of the ANM diet and contingency diet are shown in tables VII and VIII, respectively.* Distilled water was provided for ad libitum intake and food rehydration, and the 24-hour consumption both for drinking and rehydration was recorded by the subjects.

While in the chamber of the LSSE, Air Force qualified chamber operators and monitors were on duty 24 hours per day. All monitors and chamber operators were trained and qualified to carry out emergency procedures. Gas analyses of the chamber environment were done at periodic intervals and the environment monitored continually for total hydrocarbon content. Charcoal cannisters were used to maintain the level of contaminants below the allowable level as recommended by the U.S. Public Health standards; the critical level of hydrocarbon is 220 ppm (175 ppm methane). The carbon dioxide level was maintained at less than 1% of the environmental atmosphere.

All urine and fecal samples were collected. In the event of spillage of urine or loss of fecal matter, the subject notified the monitor immediately and some estimation of the loss was recorded. The 24-hour urine volume was recorded and 5-day urine samples mixed and aliquots removed for analysis as required. Aliquots for the daily routine urine analysis were taken each morning from the last void of each 24-hour period. On the fifth day of each sample collection period, aliquots were taken for 17-hydroxycorticoids and creatinine analyses. Samples for urine osmolality were taken on selected days. Monitors were notified when a fecal sample was to be transferred to persons designated to receive them within 10 minutes of defecation for microbiological analysis. Individual fecal voids were collected and 5-day samples mixed for chemical analysis. The total diet for a single day was collected at random and analyzed. Fasting blood samples were drawn during the experiment by a 20 ml syringe. The procedure for venipuncture consisted of cleansing the arm area with alcohol-iodine solution followed by 70% alcohol. Requisite analyses were accomplished as follows: blood - hemoglobin (16), hematocrit (17), Schilling differential (17), and glucose (18); serum - sodium (19), potassium (19),

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* Analyses of the ANM diet and contingency diet were supplied by Mary Klicka, Food Division, U. S. Army Natick Laboratories, Natick, Massachusetts.

calcium (20), chloride (21), phosphorus (22), magnesium (23), osmolality (24), alkaline phosphatase (22), total protein, albumin, globulin, and A/G ratio (25), and cholesterol (26); urine - daily volume, daily complete urine analysis, 17-hydroxycorticoids (27), creatinine (28), calcium, phosphorus, potassium, sodium, and magnesium by emission spectrometer,* chloride (29), moisture (30), calorimetry (31), nitrogen (30, p 12), and osmolality (24); food and feces - calcium, phosphorus, potassium, sodium, and magnesium by emission spectrometer,* moisture (30), ash (30, p 284), fat (30, p 287), nitrogen (30, p 12), fiber (30, p 288), calorimetry (31), and chloride (29); sweat - calcium (32) and nitrogen (30, p 643).

Basal metabolic rates were determined by means of the Basal-Meter.**

The sweat tests were accomplished by a method published previously (11). The gross sweat rate was calculated as follows (33):

$$\text{Gross sweat rate} = \frac{\Delta W_{tis} + W_{ing} + O_{2m} - H_2O_{pulm} - CO_{2m} - W_{excr}}{\text{time (24 hr)}}$$

Where: ΔW_{tis} = Change in body weight, g/24 hr

W_{ing} = Weight of food and water intake, g/24 hr

O_{2m} and CO_{2m} = Weight of metabolic O_2 and CO_2, g/24 hr

H_2O_{pulm} = Weight of water evaporated from lungs, g/24 hr

W_{excr} = Weight of urine and feces, g/24 hr

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* Jarrell-Ash direct reading spectrometer, Wisconsin Alumni Research Foundation, Madison, Wisconsin.

** Basal-Meter manufactured by Liebel-Flarsheim Company, Cincinnati, Ohio and made available for this study by the Fidelity Medical Supply, Dayton, Ohio.

Pulmonary water was calculated using the body surface area–respiratory tract irrigation relationship of Boyer and Bailey (34) and the average rate of water loss from the respiratory tract as reported by Burch (35). The weight of O_2 and CO_2 was calculated from the daily caloric intake, assuming 90% utilization, an average daily respiratory quotient of 0.82, and the caloric value of 4.825 kcal per liter of oxygen (36).

The mean daily output in feces and urine and the mean daily output of various constituents of food were utilized for the calculation of nutrient digestibilities and balances. The coefficients of apparent digestibility were calculated by subtracting the daily fecal excretion from the dietary intake and determining the percent of total intake found in the feces.

Energy requirements were calculated by several methods. While on the fresh food and ANM diets, the energy required, $(kcal/kg)_o$, was calculated graphically by plotting $(kcal_{met}/kg_{initial\ body\ weight})$ versus weight loss, kilograms, for a particular time interval. The best straight line was extrapolated to intersect zero weight loss. It was also calculated from the weight loss by assuming that each gram of weight lost was equivalent to 5 kcal. The total metabolizable energy in the diet plus the weight equivalent in kilocalories (if weight loss occurs) is equal to the kilocalories required. Because most of the weight loss in the contingency periods was body water, the above techniques are not applicable. Therefore, the energy requirements were calculated from the insensible weight loss (IL), in grams, multiplied by 2.21 (37), where IL is equal to the insensible water loss (IW) plus the difference in the weight of the respiratory O_2 and CO_2. The IL is also equal to the initial body weight minus the final body weight plus the difference in the input weight of food and water and the output weight of urine and feces (37, p 14). Urinary nitrogen is a measure of protein oxidation from which the energy derived from protein metabolism may be calculated. If the fraction of the total energy derived from protein is known and can be extrapolated to some experimental situation, then total energy may be estimated.

TABLE IV

MENU OF METABOLIC DIETS

Meal A	Meal B	Meal C	Meal D
		Fresh food diet	
Canadian bacon	Roast beef sandwich	Sliced turkey	Ham and cheese sandwich
Bread and butter	Sliced peaches	Dinner rolls (2)	Red cherries
Applesauce	Peanut butter cookies (3)	Apricot halves	Brownie
Gingerbread	Grapefruit Tang	Pound cake	Orange Tang
Chocolate milk		Milk	
		Apollo nominal mission diet	
Cycle I			
Toasted oat cereal	Beef and gravy	Pea soup	Chicken sandwich
Sausage bites	Corn bar	Salmon salad	Chocolate pudding
Toasted bread cubes	Date fruitcake	Cinnamon toast	Peanut cubes
Orange drink	Toasted bread cubes	Fruit cocktail	Orange-grapefruit drink
	Tea and sugar	Orange drink	
Cycle II			
Apricot cereal cubes	Beef bites	Beef sandwich	Potato soup
Canadian bacon and applesauce	Potato salad	Chicken salad	Chicken and gravy
Toasted bread cubes	Pineapple fruitcake	Peach bar	Toasted bread cubes
Cocoa	Orange drink	Banana pudding	Peanut cubes
			Tea and sugar

TABLE IV, continued

Meal A	Meal B	Meal C	Meal D
		Apollo nominal mission diet	
Cycle III			
Sugar coated flakes	Tuna salad	Beef pot roast	Crab bites
Sausage patties	Cheese sandwich	Pea bar	Cinnamon toast
Cinnamon toast	Apricot pudding	Toasted bread cubes	Applesauce
Orange-grapefruit drink	Orange drink	Pineapple cubes	Brownie
		Tea and sugar	Grapefruit drink
Cycle IV			
Strawberry cereal cubes	Corn chowder	Shrimp cocktail	Beef and vegetables
Bacon squares	Beef sandwich	Chicken and vegetables	Spaghetti and meat sauce
Beef sandwich	Chocolate pudding	Toasted bread cubes	Cinnamon toast
Orange drink	Gingerbread	Butterscotch pudding	Apricot cubes
		Orange-grapefruit drink	Tea and sugar

TABLE V

REHYDRATION OF APOLLO NOMINAL MISSION DIET

Food item	Water of rehydration, ounces		
	Hot	Cold	Hot or cold
Toasted oat cereal		3	
Orange and other drinks		5	
Beef and gravy	3		
Pea and corn bars	3		
Tea and sugar			5
Potato and pea soups	5		
Salmon salad		3	
Fruit cocktail		3	
Chocolate pudding		2	
Canadian bacon and applesauce	2.5		
Cocoa			6
Potato salad		2.5	
Chicken salad		3	
Peach bar		3	
Banana pudding		3	
Chicken and gravy	3		
Sugar coated flakes		3	
Sausage patties	3		
Tuna salad		3	
Apricot pudding		3	
Beef pot roast	3		
Applesauce		5	
Corn chowder	5		
Shrimp cocktail		3	
Chicken and vegetables	3		
Butterscotch pudding		3	
Beef and vegetables	3		
Spaghetti and meat sauce	3		

TABLE VI

NUTRIENT COMPOSITION OF FRESH FOOD DIET*

Constituent	Units	Fresh food diet
Total weight	g	1690.0
Water	g	1164.2
Calories	cal	2504
Protein	g	100.7
Fat	g	88.4
Carbohydrate, total	g	326.4
Fiber	g	3.2
Ash	g	17.2
Calcium	mg	1112
Phosphorus	mg	1444
Iron	mg	14.1
Sodium	mg	4304
Potassium	mg	2508
Vitamin A**	I.U.	4970
Thiamin	mg	1.5
Riboflavin	mg	1.6
Niacin	mg	19.4
Vitamin C**	mg	17.0

* Composition calculated from Watt and Merrill (15).

** The grapefruit Tang served in meal B and orange Tang served in meal D were fortified with vitamins A and C, but the amount was not known.

TABLE VII

NUTRIENT COMPOSITION OF APOLLO NOMINAL MISSION DIET*

Constituent	Units	Cycle I	Cycle II	Cycle III	Cycle IV
Weight	g	544.50	543.10	541.20	545.45
Water	g	16.1	16.3	10.4	15.0
Calories	cal	2622	2650	2601	2637
Protein	g	102.9	112.7	109.7	107.1
Fat	g	118.8	125.6	111.5	122.5
Carbohydrate	g	287.2	269.5	289.9	290.3
Fiber	g	4.31	3.62	6.65	4.32
Ash	g	19.7	19.4	19.6	20.6
Calcium	mg	993	531	866	810
Phosphorus	mg	1618	1443	1381	1751
Iron	mg	11.4	10.6	9.7	11.1
Sodium	mg	4025	7076	4513	4833
Potassium	mg	2474	2411	2059	2208
Magnesium	mg	267.0	251.0	220.5	255.4
Chloride as NaCl	g	10.34	10.13	11.19	11.79

* Analysis of the Apollo nominal mission diet was supplied by the Food Division, U. S. Army Natick Laboratories, Natick, Massachusetts.

TABLE VIII

NUTRIENT COMPOSITION OF CONTINGENCY DIET*

Constituent	Units	Semisolid	Rods
Energy per unit	kcal	475.0	485.0
Weight per unit	g	140.0	110.0
Energy per gram of diet	kcal	3.4	4.4
Carbohydrate	g	65.3	72.1
Protein	g	11.9	10.0
Fat	g	18.5	17.5
Water (by difference)	g	44.0	10.0
Thiamine	mg	2.0	**
Niacin	mg	10.0	**
Vitamin B_6	mg	0.8	**
Riboflavin	mg	2.0	**
Calcium pantothenic acid	mg	3.0	**

* Analysis of the contingency diet was supplied by the Food Division, U.S. Army Natick Laboratories, Natick, Massachusetts.

** Vitamins are presumed to be present in the rod food in the same amounts as in the semisolid food.

SECTION III

RESULTS

Analyses of the different diets are shown in tables IX and X. The ANM diets which were supplied as two different batches show variations in composition well within the experimental error of analysis. These diets contained more solids, protein, fat, sodium, potassium, and chloride but less water and calcium than the fresh food diets. The effects of these differences will be discussed below. The contingency diets had fairly consistent compositions. The variations in water merely reflect the production problems. The tube pack had the lowest viscosity of the four, and therefore contained more water. The tube pack had more carbohydrate. The rods had considerably lower amounts of phosphorus, chloride, potassium, magnesium, and sodium than the foil and tube pack diets. The semisolid foil pack (A) and tube pack (C) had similar compositions except for water of composition. The rods had similar compositions. The high values for sodium and chloride for rods (B) were due to the sodium chloride which was added by the dietitian. The calculated compositions of the fresh food diet agree with the analyzed value except that the analyses show more sodium and potassium than the book values predicted. The ANM diets as analyzed are averages of all four cycles and these values agree with the averages of the analyses as shown in table VII, except that magnesium is lower in our analyzed diets as shown in table IX than in table VII. The data in table VII is per unit and the daily input was 2 units per day. It is seen that there is fairly good agreement between the analytical data in table VIII and table X.

The balance and digestibility of energy is shown in table XI for the test conditions and subject. The metabolizable calories and the coefficients of apparent digestibility are shown in the last two columns. At the end of the table the overall averages are shown for each diet. The overall digestibility of the fresh food diet of 95.9% is to be expected. The overall digestibility of the ANM diet of 95.4% is deceptive. Actually, ANM (A) shows digestibilities of 93% to 94% and it can be seen that the undigested energy in the feces is considerably higher on this diet than at any other time. Test VI was carried out in the chamber and the subjects were required to eat all the food. During tests IX and XI the subjects were preparing for the simulated Apollo contingency mission and they were not required to eat all the food and were not as restricted in their activities as they were in the other tests. It is likely that the increased activity as well as the elimination of some of the bite sized compressed food increased the digestibility of the ANM (B) diet. The digestibility of the contingency diets can be evaluated only when the subjects defecate. When no fecal or urine samples were obtained, the values in the table were placed in brackets ( ). In general, the digestibilities of the contingency diets were about

94%. The fresh food diet was designed to provide 2500 kcal per day, but actually provided only 2215 kcal per day. The use of factors for calculating caloric values is not always accurate. The ANM and contingency diets were to provide 2600 and 900 kcal per day, and the data show 2500 and 890 kcal per day; this is within experimental error for the contingency food only. In tests X and XII the subjects did not defecate while in the suit but only after they were out of the chamber. Subject 42 did not complete all phases of tests IX through XIII, and this data was omitted from these phases.

Food acceptability was determined by means of a 9-point hedonic scale. There were 3204 individual ratings of fresh food items (184 per item) and 712 overall meal ratings; these are summarized in table XII. There were 184 ratings of the contingency food which are summarized in table XII. There were 1313 individual ratings of ANM food items and 298 overall meal ratings which are summarized in table XII. It is of interest that the 1-day cycle menu of fresh foods did not become more monotonous; in fact it became more acceptable with time. Meal D was rated above 7 consistently; note the small standard deviation. Meal B was rated consistently lower than the other meals as it had 3 items of 4 that were disliked, especially the grapefruit Tang. The acceptabilities of the contingency diets are understandably lower than the fresh food diet. The foil pack (A) diet was disliked the most, mainly for its physical properties and probably because it was their first exposure to this type of food. The ratings for the rods improved with time. Even in the chamber and while in the pressure suits in test XII, two subjects rated the rods 5.3. The tube foods show inconsistent ratings apparently due to the variable physical properties of the diet from tube to tube. Note that in test VII, the ratings decreased with time. Also, subject 44 who rated the tube food at 6.5 while in the pressure suit in test X, rated it only 3.1 in test XII. Apparently the solids tended to separate out from the liquid phase and as a result a watery, buttery material would squeeze out at first, and then a more viscous material exuded which at times was so hard that the tubes broke when squeezed. In summary, of the contingency diets, the rods which were the most consistent in appearance, both in shape and form, and in taste were preferred most; in spite of a tackiness at times which made it difficult for the subjects to pass them through the aluminum tubes through the helmet port. The ratings of the ANM diet do not deserve more than a passing comment inasmuch as a new and more improved diet is available now. These ratings were predictable from previous studies (13). It is obvious that psychological effect and/or adaptation play a large role in these ratings; how else does one explain the fact that cycle I when repeated on the fifth day was consistently higher in tests VI and IX. The ratings in test XI are higher because the subjects did not have to eat all the food and such items as chicken and beef sandwiches and bites were consistently rejected. The main complaint with regard to the heavy waxy coating on the bite sized foods has been noted in other experiments; this waxy coating is probably the causative factor in the low digestibility attributed in the past to these diets.

Water balance data are summarized in table XIII. The water balance refers to the loss of water via skin and respiratory tract and is accurate when body weight does not change. During the contingency periods, the water of metabolism derived from body tissues was not measurable and it is estimated that 125 to 150 ml should be added to the data marked by the asterisk. The water balances in these tests are rather unusual or unique due to the effect of the contingency diets. The balances for the contingency diets are lower than for the other diets. This is due to the fact that the subjects lost weight on the 900-calorie diets and most of this weight was water excreted in the urine. The reverse occurs when the subjects returned to a complete diet; water is conserved by the body tissues and the water balance shows an apparent high water balance. These effects are seen dramatically in test periods VII and VIII. Of interest, with respect to the total water intake required, is the fact that there are 7 instances where less than 1500 ml per day of water was consumed by the subjects without adverse effects; especially, subject 45 who spent 100 hours in a pressure suit with an average daily consumption of 836 ml of water.

Body weight changes are summarized in table XIV and shown graphically in figure 1. All the subjects lost weight in the first test period while adjusting to the fresh food diet. Subsequently, there were relatively large weight losses during the contingency periods. In the recovery periods following the contingency periods, there were weight gains but the weight gains were modest on the fresh food diet. Two subjects rebounded on the ANM (A) diet which had 300 kcal per day more than the fresh food diet. Subject 41 lost 8 kg during the first 60 days. These weight changes are complicated by the shifts in body water as was discussed above. The patterns are the same in the second 30-day period. The weight loss in each contingency period is about the same and there were no differences due to the chamber or to wearing the pressure suits when unpressurized or pressurized.

The weight losses are referable to the energy required and the energy supplied in the diet. Thus, there is a linear relationship that exists between weight changes (+ gain, - loss) and the ($kcal_{met}/kg_{initial\ body\ weight}$). This is seen in figure 2 where a plot has been made of the weight lost by each subject versus ($kcal_{met}/kg_{initial\ body\ weight}$). The straight line when extrapolated to zero weight change occurs at 34 ($kcal_{met}/kg_{initial\ body\ weight}$). This means that 34 ($kcal_{met}/kg_{initial\ body\ weight}$) were required to maintain a subject at this initial body weight in the CAF for the first 15 days. Table XV is a summary of the energy requirements as computed by this method or the arithmetic method which are designated as $(kcal/kg)_o$. Note that in the third 5-day period of test I, $(kcal/kg)_o$ is equal to 30. The subjects have adjusted to the new diet in the first 10 days and are essentially in equilibrium. The data for the contingency periods cannot be calculated by these techniques and we assumed that the energy required is equal to that of the previous period; these are recorded and bracketed. The value of test III for the 15-day period is 28; this is due to the fact that the subjects are gaining weight. These mathematical analyses do not take into account any abnormal situation as the rebound from a 900-calorie diet. However, period 7 or the last 5-day period of test III shows a value of 31; again equilibrium has occurred. This pattern repeats itself at each cycle.

In order to find a direct method for calculating the energy requirements for the simulated Apollo contingency mission, two techniques were used. The first technique used was based upon the assumption that the fraction of energy derived from protein, in test VI, the last 5 days of test IX, and test XI, would be applicable to tests VII, X, and XII, respectively. The (Pro Cal) were calculated from the urinary nitrogen of periods VII, X, and XII, as follows:

$$\text{Pro Cal} = \frac{\text{Energy derived from protein (urine, tests VII, X, and XII)}}{\text{Fraction of total energy due to protein (tests VI, IX, and XI)}}$$

The second technique used was based upon the assumption that under these test conditions, little or no sensible sweating occurred and therefore (IL x 2.21) will be an estimate of the energy required (37, p 14). These computations are shown in table XVI where they are compared with the energy calculated by use of 32 $(\text{kcal/kg})_o$ as discussed above, multiplied by the initial body weight. The values obtained with the use of 32 $(\text{kcal/kg})_o$ are higher in general than the other energy values. The Pro Cal data is in general lower than it should be. However, this is due to the fact that in the contingency period, the protein intake is reduced to about 25 g per day and there is a sparing action or conservation of protein. The urinary output therefore drops for two reasons; the sparing action and the decrease in energy requirements. The highest Pro Cal values of 2387, 2347, and 1944 were obtained from urinary nitrogen outputs that were 85, 78, and 73%, respectively, of that for the periods just preceding the corresponding contingency periods. The energy calculated from insensible water show no unusually high values indicating that ventilation rates were not unusually high and that sweating did not occur. The very low values in test VIII were caused by an unusually high diuresis for subjects 43 and 44 which is reflected in an unusually low water balance (see above). When all the data obtained by all the techniques shown in table XVI are summarized, it is seen that subject 41 had 5 of 6 values that ranged between 2321 and 2464 kcal/day, and subject 43 had 5 of 5 values that ranged between 1944 and 2340 kcal/day. However, subject 44 had 4 of 6 values that ranged between 1463 and 1618, and only 2 about 2200 kcal/day. Benedict (38) has shown that 28.3 kcal/kg is required in the first 24 hours of a starvation diet. Therefore, the absolute lower limit for subject 44 is 1970 kcal/day. In summary, the energy requirements during the simulated Apollo contingency mission are less than 32 kcal/kg and more likely to be in the order of 30 kcal/kg.

In the discussion of water balances it was shown that large shifts in body water occurred during the contingency periods. In order to obtain some estimate as to the relationship between total weight loss, tissue loss, and body water loss, we have made certain calculations as shown in table XVII. The data in each column represent the mean and standard deviation of 5 contingency tests. Required calories were calculated from the appropriate $(kcal/kg)_o$ and the initial body weight. Metabolizable calories in the diet are taken from the data on energy balances. Calories from tissue is the difference between column 1 and column 2. Tissue loss was calculated from column 3 by assuming 5 kcal/g of tissue. The last column is a ratio of calculated tissue loss to actual weight loss multiplied by 100. The calculated tissue loss is probably greater than it actually was because the 5 kcal/g of tissue is probably nearer 6 kcal/g of tissue under these metabolic conditions. However, the point to be made is that between 30% and 50% of the weight loss is water. Benedict's fasting man (38) lost 5.6 kg in the first week, of which 70% was water and 30% was tissue.

The data resulting from chemical analysis of food and waste products have been utilized in the determination of metabolic balances and digestibilities for the organic and inorganic constituents of the diets. Sweat losses have not been subtracted but are discussed separately below. The data have been normalized to grams per 24 hours and averaged according to test number and conditions. The coefficient of apparent digestibility is calculated as the percent net intake (intake minus output in feces) of the actual intake. These data are presented in tables XVIII through XXVII. The data in brackets are incomplete due to the fact that either a fecal or a urine sample was not obtained for the test.

The subjects were in positive balance for nitrogen (table XVIII) while on the fresh food diet (after test I) and ANM diet. This is the result of two factors; a high protein intake and a continual weight loss as seen above (figure 2). The negative balances shown for the contingency diets are an artifact. Normally, a negative balance would correspond to a weight gain, but the subjects were losing weight in this instance. Obviously, the subjects were utilizing tissue protein which is not included in the intake and the end products show up in the urine. The urinary nitrogen is slightly lower in the contingency periods than the other periods for two reasons as stated above; the sparing action or conservation of tissue protein while on this low protein regimen and the decreased caloric requirements due to the relative inactivity while on the 900-calorie diets. The urinary nitrogen patterns are not affected in any way in the chamber, or in the chamber in pressure suits over that seen in the CAF. The digestibility of nitrogen in the fresh food and ANM diets were above 90% which is to be expected. Digestibilities of the contingency diets were more difficult to ascertain due to the fact that reliable fecal samples were not readily obtained while on these diets. Digestibility of fat, ash, and fiber are shown in tables XIX through XXI. Digestibility of fat and ash are very high for all diets and show excellent absorption of these materials. Fiber digestibility is higher than one would expect. However, these apparent high digestibilities have been found in all studies accomplished to date but the reason for this is not known. Sodium digestiblity for all diets are around 99% (table XXII) which is to be expected. The subjects were in positive balance for sodium while on the fresh food and ANM diets with few exceptions. However, the subjects were in negative balance for sodium while on the contingency diets although the daily intake ranged from about 0.1 to 1.0 g/day. The urinary output of sodium is lower during the contingency periods than the preceding fresh food or ANM diets but always greater than the intake in the contingency diet. For these short periods, there is no physiological problem associated with these low intakes especially at the temperatures and low physical activity with these tests as there are adequate body stores. Potassium digestibilities (table XXIII) are high for all diets. However, it should be noted that there is relatively more potassium found in the feces than there is sodium. This has been seen in all our experiments. Whether this represents a lower abosrptivity of potassium or a greater turnover in the intestine is not known. It may represent a means for limiting the amount of this toxic material into the body. All the subjects were essentially in positive balance while on the fresh food and ANM diets. The subjects were all in negative balance while on the contingency diets. The amount of potassium excreted in the urine is not lowered to as great an extent as is sodium during the contingency tests. There is no tendency to conserve potassium. All the subjects were in positive balance for phosphorus while on the fresh food and ANM diets. The digestibilities of the diets are variable but in the range of values normally found for those diets. The subjects were in negative balance for phosphorus while on the contingency diets. The urinary output of phosphorus appears to be independent of the dietary phosphorus; there is little or no conservation of phosphorus. Calcium balance and digestibility are shown in table XXV. With the few exceptions which show digestibilities of zero, the data are in the range of values to be expected. All the subjects were in positive balance with the few exceptions, which are obviously due to the experimental error in fecal analysis, where a zero digestibility is shown. Magnesium digestibilities (table XXVI) show variations especially while the subjects were on the contingency diets, which are due to the error or limitation in measuring such low levels in the feces. In the fresh food diet with adequate levels of intake and expected digestibilities, the subjects were in positive balance. Measurements of fecal calcium and magnesium over short periods of time and at low levels of concentration are not very accurate. The chloride balance and digestibilities (table XXVII) are similar to those seen for sodium. Digestibilities of about 99% as seen are to be expected. The subjects were in positive balance while on the fresh food and ANM diets with one exception. The subjects were in negative balance while on the contingency diets because the urinary output of chloride in these periods, while reduced over that for the other diets, is still greater than the intake. There are adequate body stores for these short periods of reduced intake.

Sweat test data are summarized in table XXVIII where sweat rate, sweat concentration, and sweat loss are shown for each subject. The sweat rates for the two test periods are significantly different from each other ($P < 0.05$). The value of 35 g/hour is to be expected and is in line with other sweat test data. However, the value of 64 g/hour for the chamber period at altitude (380 mmHg) is nearly twice that at ambient pressure. In calculating the gross sweat, no correction is made for cutaneous insensible water loss which is very small at 25°C. In addition, the value for respiratory water loss is calculated from data in the literature obtained in a room at ambient pressure. The increase in the gross sweat rate at altitude may be due to an enhanced cutaneous insensible water loss or an increased ventilation rate over that expected for the ambient temperature in the chamber. There are no significant differences in the loss of calcium and nitrogen between the two tests. Neither are there any significant differences in the sweat concentrations between tests, although there are lower values at altitude from which one might conclude that there is an increase in cutaneous loss causing a deletion of the calcium and nitrogen. However, the limited amount of data does not permit one to draw any conclusions at this time.

Corrections of the nitrogen and calcium balances for sweat loss would obviously make the negative values more negative and the positive balances less positive, but would in no way make any of the positive balances negative. However, it should be noted that these data hold for the ambient temperature of these tests. At higher temperature, the sweat losses may be considerable and need to be taken into account in planning an adequate diet.

The urine of each subject was examined each day for protein, glucose, and acetone; The urine values were negative for these parameters. The result of the urine analyses of nocturnal voids are shown in table XXIV; these data are in the normal range of clinical values (39). Tables XXX is a summary of the 24-hour 17-hydroxycorticoids and creatinine. The mean and standard deviation are shown for the tests in which more than one daily sample was taken for analysis. The creatinine values are in the normal range of clinical values (39). The 17-hydroxycorticoid data is interesting. For this particular assay, the normal range is 5 to 10 mg/24 hours. Note that for each contingency period the value for each subject is lower than for the previous period. These lower than normal values reflect the reduced activity of the subjects during the contingency tests.

Blood chemistry and hematology data are summarized in tables XXXI through XXXIV. Table XXXI summarizes the concentration of inorganic elements in the serum which corresponds to those elements in the diets. There are no apparent changes in any of these tests and the mean and standard deviation are shown at the bottom of the table. All of the values are in the normal range of clinical values (39). Note that the test-to-test variations are greater than the variations between means among the subjects. Although the data for these elements do not show any changes, there is an apparent decrease in serum osmolality (tables XXXII). During the first 60-day experiment (tests I through VIII), the lowest value for each subject occurred at posttest VII with recovery at posttest VIII to the level found in pretest. In the second 30-day experiment, a similar effect is seen. Posttest XII, the last contingency test, shows the lowest values with their recovery in the posttest XIII although not to the pretest I or X levels. Thus, the rather low dietary intake of inorganic elements may have caused very small but real decreases in overall blood levels of these elements. Serum glucose, cholesterol, alkaline phosphatase, total protein, albumin, globulin, and A/G ratio were all in the normal range of clinical values in all tests (39). The mean values and the standard deviations are summarized at the bottom of table XXXIII. Hematological data (table XXXIV) are in the normal range of clinical values (39).

Physiological measurements are summarized in tables XXXV and XXXVI. Oral temperature, blood pressure, pulse rate, and respirations were in the normal range of clinical values (39). While in the pressure suit, the subjects took oral temperatures by means of thermistor probes; blood pressure and respirations were not taken and the suit worn by subject 44 did not have leads for monitoring pulse rate. Basal metabolism rates were taken only during the first 60-day experiment (table XXXVI). The values as shown and computed by the equipment are relative to a normal value based upon age, weight, height, and sex; +100 means a rate twice normal and -50 a rate one-half normal. In general, the basal metabolic rates for subjects 42, 43, and 44 were in the normal range; small fluctuations around zero are to be expected. However, subject 41 who lost the most weight and lost it continuously throughout this 60-day experiment, consistently shows values indicative of hypermetabolic activity. There were no significant alterations while on the contingency diets or in the chamber except that subject 41 shows the lowest of all his basal metabolic rates during tests VI and VIII.

Frequency, weight, moisture, and solids of fecal voids are summarized in table XXXVII titled waste management. The number of voids per day for the fresh food and ANM diets are about the same. As expected, the frequency on the contingency diet is reduced and while in the pressure suit, none of the subjects defecated; they waited until they were out of the suit to move their bowels. Fecal weight, moisture, and solids were larger on the ANM diet than the fresh food diet, and the lowest values are seen for the contingency diet as expected. There is a significantly larger weight of feces per man day on the ANM diet. This reflects in part the somewhat lower digestibility of this diet as seen before. The intake and output totals are not directly comparable as the weight of CO_2 given off and O_2 taken up have not been included in these calculations; neither has a correction been applied to account for the loss of weight incurred on the contingency diets. The insensible water loss for the fresh food diet is an artifact as shown above which comes about because of the large shifts in body water when the subjects changed from fresh food to contingency food and back to fresh food. Under the conditions of temperature, relative humidity, and activity of these tests, the value of 1000 per man day as seen for the ANM diet is probably more realistic.

TABLE IX

CHEMICAL ANALYSIS OF FRESH FOOD DIET AND ANM DIETS*

Constituents g/24 hr	Fresh food**	ANM (A)	ANM (B)
Dry solids	512	564	570
Water	1167	16	22
Protein	100	119	114
Fat	80	115	111
Carbohydrate (by difference)	312	304	322
Fiber	3	6	4
Ash	17	20	19
Calcium	1.19	0.88	0.77
Phosphorus	1.64	1.90	1.60
Sodium	3.77	4.95	4.50
Potassium	1.77	2.59	2.48
Chloride	5.21	6.80	6.80
Magnesium	0.18	0.19	0.16

* Analyzed by Wisconsin Alumni Research Foundation, Madison, Wisconsin.

** Average of 3 separate determinations.

TABLE X

CHEMICAL ANALYSIS OF CONTINGENCY DIETS*

Constituents /24 hr	Units	Foil pack (A)	Rods (B)**	Tube pack (C)	Rods (D)
Dry solids	g	202	196	221	191
Water	g	78	36	116	23
Protein	g	22	28	25	26
Fat	g	38	38	34	36
Carbohydrate (by difference)	g	137	127	159	127
Fiber	g	2	1	1	1
Ash	g	3	3	4	1
Calcium	mg	615	540	510	540
Phosphorus	mg	615	147	570	170
Sodium	mg	285	730	240	120
Potassium	mg	730	258	680	300
Chloride	mg	417	1620	480	370
Magnesium	mg	105	49	74	47

* Analyzed by Wisconsin Alumni Research Foundation, Madison, Wisconsin.

** 2.0 g of sodium chloride added.

TABLE XI

ENERGY BALANCE AND DIGESTIBILITY

Test period and condition	Subject	Intake	Undigested in feces	Digestible	Excreted in urine	Metabolizable	Coefficient of apparent digestibility
		kcal/24 hr					%
I, CAF	41	2401	76	2325	105	2220	96.8
Fresh food	42	2401	125	2227	102	2156	94.8
	43	2401	121	2280	112	2168	95.0
	44	2401	116	2285	88	2197	95.1
II, CAF	41	1032	39	993	81	912	96.2
Contingency	42	1032	86	946	75	871	91.7
Foil pack (A)	43	1032	55	977	75	902	94.7
	44	1032	90	942	79	863	91.3
III, CAF	41	2401	89	2312	88	2224	96.3
Fresh food	42	2401	103	2298	92	2206	95.7
	43	2401	81	2320	108	2212	96.6
	44	2401	112	2289	84	2205	95.7
IV, CAF	41	993	21	972	89	892	97.9
Rods (B)	42	993	45	948	59	889	95.5
	43	993	100	893	77	816	90.0
	44	993	39	954	60	894	96.1
V, CAF	41	2401	75	2326	97	2229	96.9
Fresh food	42	2401	112	2289	83	2206	95.3
	43	2401	39	2362	63	2299	98.4
	44	2401	105	2296	107	2189	95.6
VI, Chamber	41	2885	173	2712	99	2613	93.9
ANM (A)	42	2885	147	2738	104	2634	94.9
	43	2885	186	2699	109	2590	93.5
	44	2885	183	2702	86	2616	93.6

TABLE XI, continued

Test period and condition	Subject	Intake	Undigested in feces	Digestible	Excreted in urine	Metabolizable	Coefficient of apparent digestibility
		kcal/24 hr					%
VII, Chamber	41	993	19	974	65	909	98.0
Rods (B) and	42	993	104	889	66	823	89.5
Tube pack (C)	43	1105	*	(1105)	59	(1046)	(100.0)
	44	1105	86	1019	120	899	92.2
VIII, CAF	41	2401	90	2311	100	2211	96.3
Fresh food	42	2401	78	2323	66	2257	96.7
	43	2401	147	2254	82	2172	93.9
	44	2401	110	2291	41	2250	95.4
IX, CAF -	41	2762	130	2632	120	2512	95.3
Chamber	43	2762	85	2677	89	2588	96.9
ANM (B)	44	2731	102	2629	101	2528	96.3
X, Chamber	41	993	*	(993)	84	(909)	(100.0)
Rods (D) and	43	993	40	953	67	886	96.0
Tube pack (C)	44	954	*	(954)	57	(897)	(100.0)
XI, CAF	41	2717	81	2636	111	2525	97.0
ANM (B)	43	2172	50	2122	95	2027	97.7
	44	2493	78	2415	97	2318	96.9
XII, Chamber	41	993	*	(993)	65	(928)	(100.0)
Rods (D) and	43	923	50	873	*	(873)	94.6
Tube pack (C)	44	1105	38	1067	49	1018	96.6
XIII, CAF	41	2401	65	2336	100	2236	97.3
Fresh food	43	2401	38	2363	103	2260	98.4
	44	2401	59	2352	99	2243	97.5

* When no fecal or urine sample was obtained, the values are placed in brackets ().

TABLE XI, continued

Test period and condition	Subject	Intake	Undigested in feces	Digest-ible	Excreted in urine	Metabo-lizable	Coefficient of apparent digestibility
		kcal/24 hr					%
Fresh food diet	41	2401	82	2319	97	2222	96.6
	42	2401	104	2297	86	2211	95.7
	43	2401	97	2304	91	2213	96.0
	44	2401	111	2290	80	2210	95.4
Overall average		2401	98	2303	88	2215	95.9
Contingency diet	41	1006	23	983	75	908	97.7
	42	1006	78	928	67	861	92.2
	43	1043	77	966	70	896	92.6
	44	1043	72	971	86	885	93.1
Overall average		1024	62	962	74	888	93.9
ANM diet	41	2779	128	2651	110	2541	95.4
	42	2820	147	2673	83	2590	94.8
	43	2597	107	2490	97	2393	95.9
	44	2694	121	2573	92	2481	95.5
Overall average		2722	126	2596	95	2501	95.4

TABLE XII

ORGANOLEPTIC ACCEPTABILITY OF METABOLIC DIETS*

Test period and condition		Fresh food diet meal A	meal B	meal C	meal D	Average per 5-day test period
I, CAF	a.	6.6	6.0	6.7	7.0	6.6 ± 0.4
	b.	6.5	5.8	6.5	7.4	6.5 ± 0.6
	c.	6.4	5.7	6.7	7.3	6.5 ± 0.7
III, CAF	a.	7.0	5.6	6.4	7.6	6.6 ± 0.8
	b.	6.6	5.2	5.8	7.5	6.3 ± 1.0
	c.	6.6	5.6	5.9	7.5	6.4 ± 0.8
V, CAF		6.7	6.2	6.6	7.4	6.7 ± 0.5
VIII, CAF		7.2	6.8	7.0	7.5	7.1 ± 0.3
XIII, CAF		7.3	7.3	7.3	7.4	7.3 ± 0.06
Average per meal		6.8 ± 0.3	6.0 ± 0.6	6.5 ± 0.5	7.4 ± 0.2	

* Food acceptability was determined by means of a 9-point hedonic scale.

TABLE XII, continued

Test period and condition	Contingency diet					Average per 5-day test period
	day 1	day 2	day 3	day 4	day 5	
II, CAF Foil pack (A)	1.9	2.4	2.6	2.6	2.0	2.3 ± 0.4
IV, CAF Rods (B)	3.9	4.2	4.1	4.0	3.2	
VII, Chamber Rods (B)	4.2	5.8	5.8	6.0	5.0	
Tube pack (C)	6.0	5.0	4.8	4.3	4.3	

	Apollo nominal mission diet				
	cycle I	cycle II	cycle III	cycle IV	cycle I
VI, Chamber ANM (A)	5.6	6.4	6.5	5.8	6.5
IX, CAF - Chamber ANM (B)	5.6	5.9	6.2	6.2	6.3
	5.7	5.7	6.1	5.9	6.5
XI, CAF - Chamber ANM (B)	6.5	6.8	6.0	6.0	6.2

TABLE XIII

WATER BALANCE

Test period and condition	Subject No.	Intake, g/24 hr				Excretion, g/24 hr			Water balance
		Food	Ad lib	Meta-bolic	Total	Urine	Feces	Total	
I, CAF	41	1167	2154	314	3635	2114	36	2150	1485
Fresh food	42	1167	1188	314	2669	928	58	986	1683
	43	1167	970	314	2451	925	45	970	1481
	44	1167	1419	314	2900	1591	60	1651	1249
II, CAF	41	78	2815	132	3025	2191	17	2208	817*
Contingency	42	78	1133	132	1343	430	38	468	875*
	43	78	1508	132	1718	844	25	869	849*
	44	78	2206	132	2416	1916	38	1954	462*
III, CAF	41	1167	2329	314	3810	2284	39	2323	1487
Fresh food	42	1167	1180	314	2661	852	56	908	1753
	43	1167	1187	314	2668	1052	33	1085	1583
	44	1167	1666	314	3147	1690	62	1752	1395
IV, CAF	41	36	2000	128	2164	1716	9	1725	439*
Contingency	42	36	1246	128	1410	429	18	447	963*
	43	36	1694	128	1858	1216	57	1273	858*
	44	36	1879	128	2043	1526	12	1538	505*
V, CAF	41	1167	1994	314	3474	2199	28	2227	1247
Fresh food	42	1167	1375	314	2855	889	58	947	1908
	43	1167	993	314	2473	772	28	800	1673
	44	1167	1475	314	2955	1316	53	1369	1586
VI, Chamber	41	16	2544	354	2914	1734	68	1802	1112
ANM	42	16	1708	354	2078	768	55	823	1255
	43	16	1607	354	1977	885	82	967	1010
	44	16	1995	354	2365	1715	77	1792	573

* These values do not include water of metabolism derived from body stores, and it it estimated that 125 to 150 ml of water should be added.

** Subject wearing pressure suit.

TABLE XIII, continued

Test period and condition	Subject No.	Intake, g/24 hr Food	Ad lib	Meta-bolic	Total	Excretion, g/24 hr Urine	Feces	Total	Water balance
VII, Chamber	41	36	1693	128	1857	1217	7	1224	633*
Contingency	42	36	1055	128	1219	465	29	494	725*
	43	116	1938	141	2195	1980	0	1980	215*
	44	116	1415	141	1672	1552	25	1577	95*
VIII, CAF	41	1167	1777	314	3257	1720	26	1746	2511
Fresh food	42	1167	1482	314	2962	598	54	652	2310
	43	1167	1296	314	2776	1025	50	1075	1701
	44	1167	1038	314	2518	1000	65	1065	1453
IX, CAF -	41	22	2920	359	3301	2214	90	2304	997
Chamber	43	22	1440	359	1821	958	70	1028	793
ANM	44	22	1650	359	2031	958	78	1036	995
X, Chamber	41	36	1725	128	1889	1050	10	1060	829*
Contingency	43	36	1758	128	1922	1201	0	1201	721*
	44**	100	1058	122	1280	886	25	911	369*
XI, CAF -	41	22	2530	359	2911	1950	48	1998	913
Chamber	43	17	1584	282	1883	865	39	904	979
ANM	44	22	1995	359	2376	704	51	755	1621
XII, Chamber	41**	36	1307	128	1471	1036	0	1036	435*
Contingency	43**	33	684	119	836	†	47	†	†
	44	116	1155	141	1412	847	35	882	530*
XIII, CAF	41	1167	1853	314	3334	2430	40	2370	864
Fresh food	43	1167	939	314	2420	1206	34	1240	1180
	44	1167	716	314	2197	1091	61	1152	1045

† No urine sample.

TABLE XIV

BODY WEIGHT CHANGES

Test period and condition	Subject No.	Weight, kg		
		Initial	Final	Change
I, CAF	41	84.7	81.7	- 3.0
Fresh food	42	75.8	73.8	- 2.0
	43	77.6	75.2	- 2.4
	44	74.0	72.4	- 1.6
II, CAF	41	81.7	78.5	- 3.2
Contingency	42	73.8	71.2	- 2.6
	43	75.2	73.4	- 1.8
	44	72.4	69.5	- 2.9
III, CAF	41	78.5	79.0	0.5
Fresh food	42	71.2	72.0	0.8
	43	73.4	74.0	0.6
	44	69.5	71.3	1.8
IV, CAF	41	79.0	76.6	- 2.4
Contingency	42	72.0	69.5	- 2.5
	43	74.0	71.8	- 2.2
	44	71.3	69.1	- 2.2
V, CAF	41	76.6	77.2	0.6
Fresh food	42	69.5	70.9	1.4
	43	71.8	72.6	0.8
	44	69.1	70.0	0.9
VI, Chamber	41	77.2	77.9	0.7
ANM	42	70.9	70.7	(- 0.2)
	43	72.6	74.3	1.7
	44	70.0	72.5	2.5

* Subject wearing pressure suit, unpressurized.

** Subject wearing pressure suit, 3.7 psi.

† 4 days.

TABLE XIV, continued

Test period and condition	Subject No.	Weight, kg		
		Initial	Final	Change
VII, Chamber Contingency	41	77.9	76.3	- 1.6
	42*	70.7	69.0	- 1.7
	43*	74.3	71.9	- 2.4
	44	72.5	68.9	- 3.6
VIII, CAF Fresh food	41	76.3	76.1	- 0.2
	42	69.0	70.8	1.8
	43	71.9	72.5	0.6
	44	68.9	68.8	- 0.1
IX, CAF - Chamber ANM	41	80.5	77.0	- 3.5
	43	73.5	72.9	- 0.6
	44	70.9	70.8	- 0.1
X, Chamber Contingency	41	77.0	74.8	- 2.2
	43	72.9	70.9	- 2.0
	44**	70.8	68.1	- 2.7
XI, CAF - Chamber ANM	41	74.8	75.7	0.9
	43	70.9	72.1	1.2
	44	68.1	69.6	1.5
XII, Chamber+ Contingency	41**	75.7	74.4	- 1.3
	43**	72.1	69.8	- 2.3
	44	69.6	67.1	- 2.5
XIII, CAF Fresh food	41	74.4	75.4	0.1
	43	69.8	71.4	1.6
	44	67.1	67.6	0.5

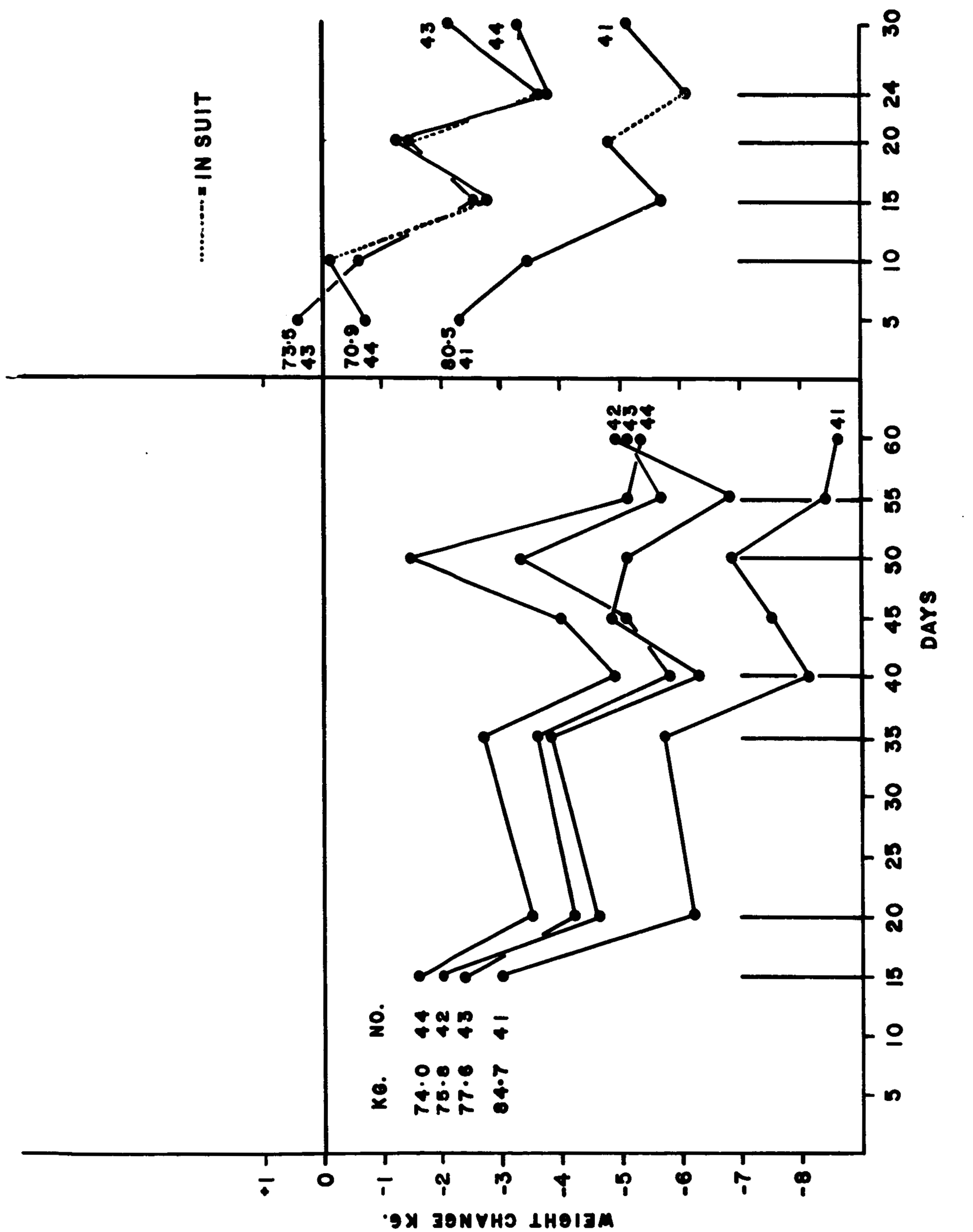

Figure 1. Cumulative weight changes as a function of time.

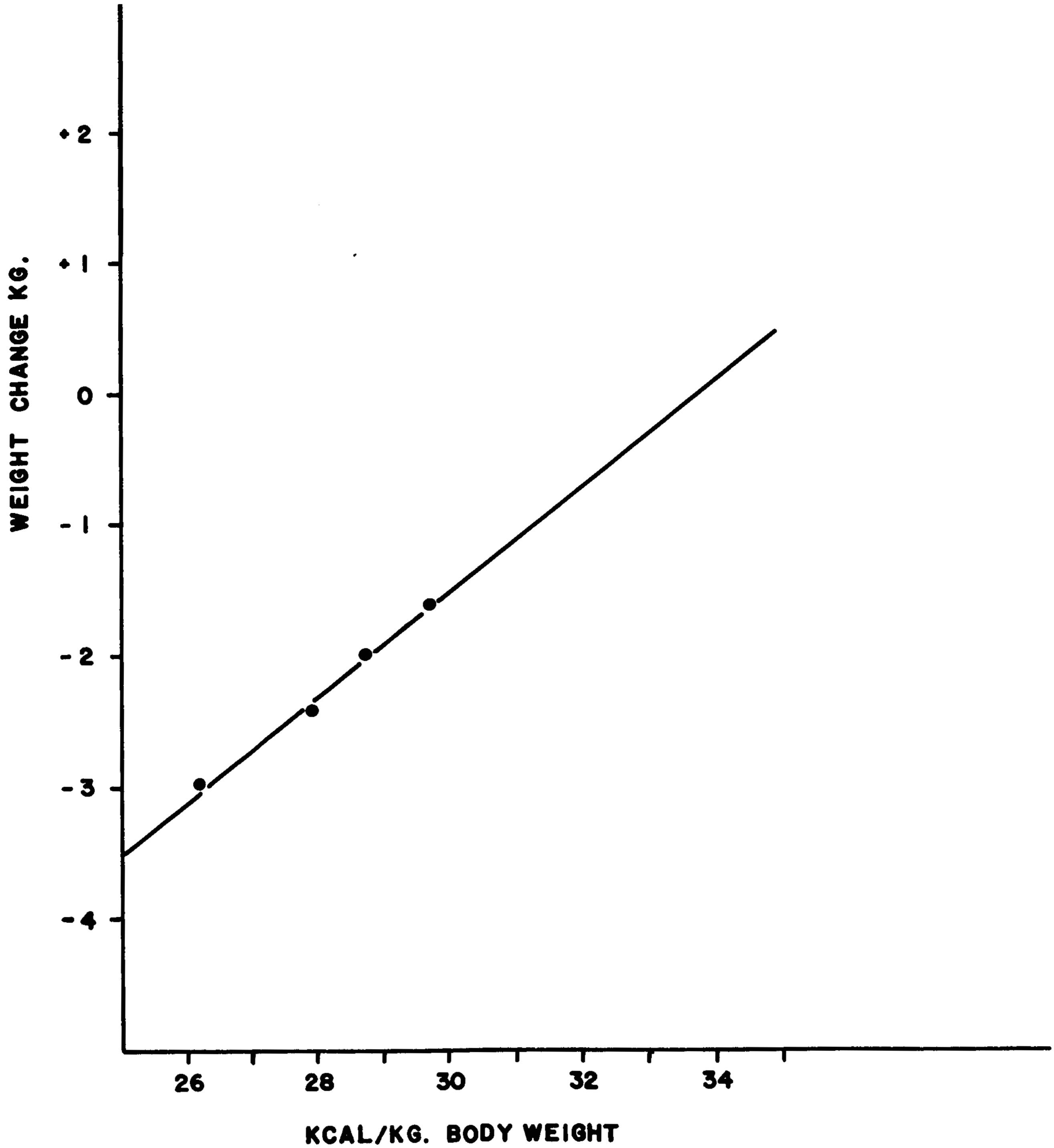

Figure 2.. Relationship between body weight changes and energy intake per per kilogram of body weight

TABLE XV

ENERGY REQUIREMENTS

Test	5-day periods	Conditions: Environment	Days	Diet	$(kcal/kg)_o$
I	1 - 3	CAF	15	Fresh food	34
	3	CAF	5	Fresh food	30
II	4	CAF	5	Contingnecy	(30)
III	5 - 7	CAF	15	Fresh food	28
	7	CAF	5	Fresh food	31
IV	8	CAF	5	Contingency	(31)
V	9	CAF	5	Fresh food	28
VI	10	Chamber	5	ANM	32
VII	11	Chamber	5	Contingency	(32)
VIII	12	CAF	5	Fresh food	29

TABLE XVI

SUMMARY OF ENERGY REQUIREMENTS IN THE CHAMBER ON CONTINGENCY DIETS

Test	Subject No.	Energy, kcal/day		
		32 kcal/kg	Pro Cal	(IL x 2.21)*
VII	41	2493	1562	1881
	43	2378	1440	738
	44	2320	1628	528
X	41	2464	2387	2321
	43	2333	1944	2108
	44**	2266	1530	1463
XII	41**	2422	2347	1430
	43**	2307		2340
	44†	2227	1618	1507

* IL = Insensible water + (CO_2 - O_2)

** Subject wearing pressure suit

† Subject serving as aide

TABLE XVII

SUMMARY OF CONTINGENCY EXPERIMENTS RELATIONSHIP BETWEEN CALCULATED TISSUE LOSS AND ACTUAL WEIGHT LOSS

Subject No.	Required calories	Metabolizable calories in diet	Calories from tissue	Calculated tissue loss g	Actual weight loss, g	% actual loss
41	2456 ± 26	910 ± 13	1546 ± 33	309 ± 7	441 ± 130	70
42	2236 ± 25	861 ± 34	1375 ± 55	275 ± 11	453 ± 98	61
43	2314 ± 45	891 ± 96	1411 ± 94	282 ± 19	451 ± 82	62
44	2239 ± 56	914 ± 78	1325 ± 79	265 ± 16	581 ± 103	46

TABLE XVIII

NITROGEN BALANCE AND DIGESTIBILITY

Test period and condition	Subject No.	Intake	Excretion Feces	Excretion Urine	Excretion Total	Balance	Coefficient of apparent digestibility
		g/24 hr					%
I, CAF	41	15.97	1.03	15.69	16.72	- 0.75	93.6
Fresh food	42	15.97	1.61	14.05	15.66	0.31	90.0
	43	15.97	1.20	14.77	15.97	0.00	92.5
	44	15.97	1.40	13.67	15.07	0.90	91.2
II, CAF	41	3.53	0.51	10.40	10.91	- 7.38	86.0
Contingency	42	3.53	1.08	8.91	9.99	- 6.46	69.4
Foil pack (A)	43	3.53	1.65	9.28	9.93	- 6.40	81.5
	44	3.53	1.14	9.14	10.29	- 6.76	67.4
III, CAF	41	15.97	1.10	13.37	14.47	1.50	93.0
Fresh food	42	15.97	1.28	12.12	13.40	2.57	92.0
	43	15.97	0.80	12.78	13.58	2.39	95.0
	44	15.97	1.63	12.12	13.75	2.22	89.8
IV, CAF	41	4.48	0.28	10.58	10.86	- 6.38	93.7
Contingency	42	4.48	0.60	8.40	9.00	- 4.52	86.6
Rods (B)	43	4.48	1.09	9.59	10.68	- 6.20	75.7
	44	4.48	0.30	8.26	8.56	- 4.08	93.3
V, CAF	41	15.97	0.88	13.02	13.90	2.07	94.5
Fresh food	42	15.97	1.42	11.12	12.54	3.47	91.1
	43	15.97	0.53	11.42	11.95	4.02	96.7
	44	15.97	1.44	10.29	11.73	4.24	91.0
VI, Chamber	41	19.00	1.58	16.81	18.39	0.61	91.7
ANM (A)	42	19.00	1.23	13.11	14.34	4.66	93.5
	43	19.00	1.79	14.28	16.07	2.93	90.6
	44	19.00	1.71	12.40	14.11	4.89	91.0

* When no fecal or urine sample was obtained, the values are placed in brackets ().

TABLE XVIII, continued

Test period and condition	Subject No.	Intake	Excretion Feces	Excretion Urine	Excretion Total	Balance	Coefficient of apparent digestibility
		g/24 hr					%
VII, Chamber Contingency Rods (B) and Tube pack (C)	41	4.48	0.16	10.61	10.77	- 6.29	96.4
	42	4.48	0.64	8.43	9.07	- 4.59	85.7
	43	4.00	*	8.82	(8.82)	(- 4.82)	(100.0)
	44	4.00	0.61	9.01	9.62	- 5.62	84.7
VIII, CAF Fresh food	41	15.97	0.61	13.29	13.09	2.07	96.2
	42	15.97	0.59	9.89	10.48	5.49	96.3
	43	15.97	1.16	10.54	11.61	4.36	92.7
	44	15.97	1.09	11.20	12.29	3.68	93.0
IX, CAF - Chamber ANM (B)	41	18.24	1.70	14.73	16.43	1.81	90.7
	43	18.24	1.16	12.28	13.44	4.80	93.6
	44	18.10	1.66	12.40	14.06	4.04	90.8
X, Chamber Contingency Rods (D) and Tube pack (C)	41	4.16	*	11.74	(11.74)	(- 7.58)	(100.0)
	43	4.16	0.23	9.03	9.26	- 5.10	94.5
	44	3.45	*	7.64	(7.64)	(- 4.19)	(100.0)
XI, CAF - Chamber ANM (B)	41	18.01	1.14	14.84	15.98	2.03	93.7
	43	15.23	0.71	11.89	12.60	2.63	95.3
	44	17.10	1.45	11.90	13.35	3.75	91.5
XII, Chamber Contingency Rods (D) and Tube pack (C)	41	4.16	*	11.54	(11.54)	(- 7.38)	(100.0)
	43	3.87	0.94	*	(0.94)	(2.93)	75.7
	44	4.00	0.71	8.08	8.79	- 4.79	82.2
XIII, CAF Fresh food	41	15.97	0.90	14.24	15.14	0.83	94.4
	43	15.97	0.81	10.69	11.50	4.47	94.9
	44	15.97	1.27	11.42	12.69	3.28	92.0

TABLE XIX

FAT DIGESTIBILITY

Test period and condition	Subject No.	Intake	Excretion in feces	Coefficient of apparent digestibility
		g/24 hr		%
I, CAF Fresh food	41	80	1.26	98.4
	42	80	1.27	98.4
	43	80	1.37	98.3
	44	80	0.79	99.3
II, CAF Contingency Foil pack (A)	41	38	0.36	99.0
	42	38	0.73	98.1
	43	38	1.09	97.1
	44	38	0.83	97.8
III, CAF Fresh food	41	80	1.02	98.7
	42	80	1.30	98.4
	43	80	1.23	98.5
	44	80	1.32	98.4
IV, CAF Contingency Rods (B)	41	38	0.37	99.0
	42	38	1.15	97.0
	43	38	2.45	93.5
	44	38	0.78	97.9
V, CAF Fresh food	41	80	1.80	97.7
	42	80	1.96	97.5
	43	80	0.72	99.1
	44	80	1.48	98.1
VI, Chamber ANM (A)	41	115	4.00	96.5
	42	115	4.15	96.4
	43	115	5.96	94.8
	44	115	4.07	96.5

* When no fecal sample was obtained, the values are placed in brackets ().

TABLE XIX, continued

Test period and condition	Subject No.	Intake	Excretion in feces	Coefficient of apparent digestibility
		g/24 hr		%
VII, Chamber Contingency Rods (B) and Tube pack (C)	41	38	1.09	97.1
	42	38	2.58	93.2
	43	34	*	(100.0)
	44	34	1.79	94.8
VIII, CAF Fresh food	41	80	2.17	97.3
	42	80	1.61	98.0
	43	80	3.27	95.9
	44	80	1.79	97.8
IX, CAF - Chamber ANM (B)	41	111	7.91	92.9
	43	111	4.21	96.2
	44	109	5.38	95.1
X, Chamber Contingency Rods (D) and Tube pack (C)	41	36	*	(100.0)
	43	36	0.91	97.5
	44	29	*	(100.0)
XI, CAF - Chamber ANM (B)	41	108	4.87	95.5
	43	76	2.46	96.8
	44	93	2.97	96.8
XII, Chamber Rods (D) and Tube pack (C)	41	36	*	(100.0)
	43	33	3.17	90.0
	44	34	1.64	95.2
XIII, CAF Fresh food	41	80	2.98	96.2
	43	80	2.04	97.5
	44	80	1.62	98.0

TABLE XX

ASH DIGESTIBILITY

Test period and condition	Subject No.	Intake	Excretion in feces	Coefficient of apparent digestibility
		g/24 hr		%
I, CAF Fresh food	41	17.0	0.31	98.2
	42	17.0	0.36	97.9
	43	17.0	0.36	97.9
	44	17.0	0.40	97.6
II, CAF Contingency Foil pack (A)	41	3.0	0.12	96.0
	42	3.0	0.11	96.3
	43	3.0	0.12	96.0
	44	3.0	0.24	92.0
III, CAF Fresh food	41	17.0	0.47	97.2
	42	17.0	0.30	98.2
	43	17.0	0.28	98.3
	44	17.0	0.39	97.7
IV, CAF Contingency Rods (B)	41	3.0	0.11	96.3
	42	3.0	0.13	95.7
	43	3.0	0.15	95.0
	44	3.0	0.10	96.6
V, CAF Fresh food	41	17.0	0.26	98.5
	42	17.0	0.33	98.0
	43	17.0	0.14	99.2
	44	17.0	0.30	98.2
VI, Chamber ANM (A)	41	20.0	0.40	98.0
	42	20.0	0.33	98.3
	43	20.0	0.46	97.7
	44	20.0	0.43	97.8

* When no fecal sample was obtained, the values are placed in brackets ( ).

TABLE XX, continued

Test period and condition	Subject No.	Intake	Excretion in feces	Coefficient of apparent digestibility
		g/24 hr		%
VII, Chamber	41	1.0	0.05	95.0
Contingency	42	1.0	0.18	82.0
Rods (B) and	43	4.0	*	(100.0)
Tube pack (C)	44	4.0	0.16	96.0
VIII, CAF	41	17.0	0.14	99.1
Fresh food	42	17.0	0.12	99.3
	43	17.0	0.26	98.5
	44	17.0	0.28	98.3
IX, CAF -	41	19.0	0.44	97.7
Chamber	43	19.0	0.30	98.4
ANM (B)	44	18.85	0.45	97.6
X, Chamber	41	1.0	*	(100.0)
Contingency Rods (D) and	43	1.0	0.07	93.0
Tube pack (C)	44	3.4	*	(100.0
XI, CAF -	41	18.7	0.30	98.3
Chamber	43	15.0	0.20	98.6
ANM (B)	44	17.7	0.30	98.3
XII, Chamber	41	1.0	*	(100.0)
Contingency Rods (D) and	43	0.93	0.21	77.0
Tube pack (C)	44	4.0	0.27	93.0
XIII, CAF	41	17.0	0.21	98.7
Fresh food	43	17.0	0.17	99.0
	44	17.0	0.30	98.2

TABLE XXI

FIBER DIGESTIBILITY

Test period and condition	Subject No.	Intake	Excretion in feces	Coefficient of apparent digestibility
		g/24 hr		%
I, CAF Fresh food	41	3.0	0.96	68
	42	3.0	2.54	15
	43	3.0	0.91	70
	44	3.0	2.22	26
II, CAF Contingency Foil pack (A)	41	2.0	0.41	80
	42	2.0	1.67	16
	43	2.0	0.34	83
	44	2.0	0.93	53
III, CAF Fresh food	41	3.0	0.78	74
	42	3.0	1.90	37
	43	3.0	0.51	83
	44	3.0	2.14	29
IV, CAF Contingency Rods (B)	41	1.0	0.17	83
	42	1.0	0.72	28
	43	1.0	0.92	8
	44	1.0	0.49	51
V, CAF Fresh food	41	3.0	0.43	86
	42	3.0	1.80	40
	43	3.0	0.36	88
	44	3.0	1.63	46
VI, Chamber ANM (A)	41	6.0	1.00	80
	42	6.0	2.32	61
	43	6.0	1.12	81
	44	6.0	2.57	57

* When no fecal sample was obtained, the values are placed in brackets ( ).

TABLE XXI , continued

Test period and condition	Subject No.	Intake	Excretion in feces	Coefficient of apparent digestibility
		g/24 hr		%
VII, Chamber	41	1.0	0.23	77
Contingency	42	1.0	0.46	54
Rods (B) and	43	1.0	*	(100)
Tube pack (C)	44	1.0	0.39	61
VIII, CAF	41	3.0	1.16	61
Fresh food	42	3.0	0.81	73
	43	3.0	0.92	69
	44	3.0	1.38	54
IX, CAF -	41	4.0	1.20	70
Chamber	43	4.0	0.75	81
ANM (B)	44	3.96	2.00	50
X, Chamber	41	1.0	*	(100)
Contingency Rods (D) and	43	1.0	0.23	77
Tube pack (C)	44	0.86	*	(100)
XI, CAF -	41	4.0	0.70	82
Chamber	43	3.3	0.50	85
ANM (B)	44	3.8	1.00	74
XII, Chamber	41	1.0	*	(100)
Contingency Rods (D) and	43	0.93	0.76	18
Tubes (C)	44	1.0	0.43	57
XIII, CAF	41	3.0	0.62	79
Fresh food	43	3.0	0.60	80
	44	3.0	1.48	51

TABLE XXII

SODIUM BALANCE AND DIGESTIBILITY

Test period and condition	Subject No.	Intake	Excretion Feces	Urine	Total	Balance	Coefficient of apparent digestibility
		g/24 hr					%
I, CAF	41	3.77	0.03	3.73	3.76	0.01	99.2
Fresh food	42	3.77	0.02	3.31	3.33	0.44	99.5
	43	3.77	0.05	4.01	4.06	- 0.29	98.7
	44	3.77	0.02	3.34	3.46	0.41	99.5
II, CAF	41	0.29	0.01	1.03	1.04	- 0.75	96.5
Contingency	42	0.29	0.01	0.56	0.57	- 0.28	96.5
Foil pack (A)	43	0.29	0.04	1.18	1.22	- 0.93	86.2
	44	0.29	0.01	1.15	1.16	- 0.87	96.5
III, CAF	41	3.77	0.03	3.27	3.30	0.47	99.2
Fresh food	42	3.77	0.03	2.72	2.75	1.02	99.2
	43	3.77	0.03	3.20	3.23	0.54	99.2
	44	3.77	0.02	2.66	2.68	1.09	99.5
IV, CAF	41	0.73	0.01	1.13	1.14	- 0.41	98.6
Contingency	42	0.73	0.01	0.40	0.41	0.32	98.6
Rods (B)	43	0.73	0.08	1.22	1.30	- 0.57	89.0
	44	0.73	0.01	1.18	1.19	- 0.46	98.6
V, CAF	41	3.77	0.02	3.08	3.10	0.67	99.5
Fresh food	42	3.77	0.03	4.62	4.65	- 0.88	99.2
	43	3.77	0.04	2.39	2.43	1.34	98.9
	44	3.77	0.01	2.50	2.51	1.36	99.7
VI, Chamber	41	4.95	0.06	4.16	4.22	0.73	98.8
ANM (A)	42	4.95	0.05	3.30	3.35	1.60	99.0
	43	4.95	0.13	3.94	4.07	0.88	97.4
	44	4.95	0.02	3.60	3.63	1.32	99.4

* When no fecal or urine sample was obtained, the values are placed in brackets ( ).

TABLE XXII, continued

Test period and condition	Subject No.	Intake	Excretion Feces	Urine	Total	Balance	Coefficient of apparent digestibility %
			g/24 hr				
VII, Chamber	41	0.73	0.01	1.13	1.14	- 0.41	98.6
Contingency	42	0.73	0.01	0.70	0.71	0.02	98.6
Rods (B) and	43	1.01	*	1.64	(1.64)	(- 0.63)	(100.0)
Tube pack (C)	44	1.01	0.01	2.02	2.03	- 1.02	99.0
VIII, CAF	41	3.77	0.02	3.10	3.12	0.65	99.5
Fresh food	42	3.77	0.03	1.91	1.94	1.83	99.2
	43	3.77	0.03	2.56	2.59	1.18	99.2
	44	3.77	0.02	2.70	2.72	1.05	99.5
IX, CAF -	41	4.50	0.08	4.74	4.82	- 0.32	98.2
Chamber	43	4.50	0.05	3.28	3.33	1.17	98.9
ANM (B)	44	4.49	0.08	3.20	3.28	1.21	98.2
X, Chamber	41	0.12	*	0.84	(0.84)	(- 0.72)	(100.0)
Contingency Rods (D) and	43	0.12	0.01	0.84	0.85	- 0.73	91.7
Tube pack (C)	44	0.21	*	1.24	(1.24)	(- 1.03)	(100.0)
XI, CAF -	41	4.40	0.03	4.29	4.32	0.08	99.3
Chamber	43	3.64	0.03	2.86	2.89	0.75	99.2
ANM (B)	44	4.20	0.02	3.20	3.22	0.98	99.5
XII, Chamber	41	0.12	*	0.62	(0.62)	(- 0.50)	(100.0)
Contingency Rods (D) and	43	0.11	0.02	*	(0.02)	(0.09)	81.8
Tube pack (C)	44	0.24	0.02	1.10	1.12	- 0.88	91.7
XIII, CAF	41	3.77	0.03	3.64	3.67	0.10	99.2
Fresh food	43	3.77	0.01	2.89	2.90	0.87	99.7
	44	3.77	0.02	3.38	3.40	0.37	99.5

TABLE XXIII

POTASSIUM BALANCE AND DIGESTIBILITY

Test period and condition	Subject No.	Intake	Excretion Feces	Excretion Urine	Excretion Total	Balance	Coefficient of apparent digestibility
			g/24 hr				%
I, CAF Fresh food	41	1.77	0.38	0.93	1.31	0.46	78.5
	42	1.77	0.19	1.64	1.83	- 0.06	89.3
	43	1.77	0.41	1.42	1.83	- 0.06	76.8
	44	1.77	0.29	1.37	1.66	0.11	83.6
II, CAF Contingency Foil pack (A)	41	0.73	0.14	1.25	1.39	- 0.66	80.8
	42	0.73	0.10	1.42	1.52	- 0.79	86.3
	43	0.73	0.08	0.84	0.92	- 0.19	89.0
	44	0.73	0.08	0.38	0.46	0.27	89.0
III, CAF Fresh food	41	1.77	0.37	1.21	1.58	0.19	79.1
	42	1.77	0.31	1.41	1.72	0.05	82.5
	43	1.77	0.30	1.60	1.90	- 0.13	83.0
	44	1.77	0.42	1.02	1.44	0.33	76.3
IV, CAF Contingency Rods (B)	41	0.30	0.13	1.25	1.38	- 1.08	56.7
	42	0.30	0.13	0.99	1.12	- 0.82	56.7
	43	0.30	0.54	1.01	1.55	- 1.25	0.0
	44	0.30	0.14	0.72	0.86	- 0.56	53.3
V, CAF Fresh food	41	1.77	0.34	1.25	1.59	0.18	80.8
	42	1.77	0.36	0.89	1.25	0.52	79.7
	43	1.77	0.10	1.16	1.26	0.51	94.3
	44	1.77	0.41	0.96	1.37	0.40	76.8
VI, Chamber ANM (A)	41	2.59	0.68	1.91	2.59	0.00	73.7
	42	2.59	0.42	2.08	2.50	0.09	83.8
	43	2.59	0.57	1.59	2.16	0.43	78.0
	44	2.59	0.60	1.37	1.97	0.62	76.8

* When no fecal or urine sample was obtained, the values are placed in brackets ( ).

TABLE XXIII, continued

Test period and condition	Subject No.	Intake	Excretion Feces	Urine	Total	Balance	Coefficient of apparent digestibility %
			g/24 hr				
VII, Chamber Contingency Rods (B) and Tube pack (C)	41	0.30	0.06	0.79	0.85	- 0.55	80.0
	42	0.30	0.26	0.84	1.10	- 0.80	13.3
	43	0.68	*	0.79	(0.79)	(- 0.11)	(100.0)
	44	0.68	0.21	0.82	1.03	- 0.35	69.1
VIII, CAF Fresh food	41	1.77	0.20	0.98	1.18	0.59	88.7
	42	1.77	0.23	0.72	0.95	0.82	87.0
	43	1.77	0.43	1.33	1.76	0.01	75.7
	44	1.77	0.37	1.30	1.67	0.10	79.1
IX, CAF - Chamber ANM (B)	41	2.48	0.77	2.07	2.84	- 0.36	69.0
	43	2.48	0.42	1.49	1.91	0.47	83.1
	44	2.45	0.87	1.62	2.49	- 0.04	64.5
X, Chamber Contingency Rods (D) and Tube pack (C)	41	0.30	*	0.77	(0.77)	(- 0.47)	(100.0)
	43	0.30	0.09	2.88	2.97	- 2.67	70.0
	44	0.59	*	0.08	(0.08)	(0.51)	(100.0)
XI, CAF - Chamber ANM (B)	41	2.47	0.39	1.42	1.81	0.66	84.2
	43	2.03	0.26	1.38	1.64	0.39	87.2
	44	2.32	0.46	1.76	2.22	0.10	80.2
XII, Chamber Contingency Rods (D) and Tube pack (C)	41	0.30	*	1.24	(1.24)	(- 0.94)	(100.0)
	43	0.28	0.27	*	(0.27)	(0.01)	5.5
	44	0.68	0.36	0.63	0.99	- 0.31	47.1
XIII, CAF Fresh food	41	1.77	0.34	1.38	1.72	0.05	80.8
	43	1.77	0.26	1.33	1.59	0.18	85.3
	44	1.77	0.41	1.85	2.26	- 0.49	76.8

TABLE XXIV

PHOSPHORUS BALANCE AND DIGESTIBILITY

Test period and condition	Subject No.	Intake	Excretion			Balance	Coefficient of apparent digestibility
			Feces	Urine	Total		
		g/24 hr					%
I, CAF	41	1.64	0.48	0.89	1.37	0.27	70.7
Fresh food	42	1.64	0.41	0.80	1.21	0.43	75.0
	43	1.64	0.56	0.80	1.36	0.28	65.8
	44	1.64	0.49	0.71	1.20	0.44	70.1
II, CAF	41	0.62	0.21	0.81	1.02	- 0.40	66.1
Contingency	42	0.62	0.15	0.60	0.75	- 0.13	75.8
Foil pack (A)	43	0.62	0.15	0.62	0.77	- 0.15	75.8
	44	0.62	0.25	0.59	0.84	- 0.22	59.7
III, CAF	41	1.64	0.59	0.78	1.37	0.27	64.0
Fresh food	42	1.64	0.40	0.73	1.13	0.51	75.6
	43	1.64	0.41	0.80	1.21	0.43	75.0
	44	1.64	0.55	0.82	1.37	0.27	66.5
IV, CAF	41	0.15	0.09	0.61	0.70	- 0.55	40.0
Contingency	42	0.15	0.14	0.47	0.61	- 0.46	6.6
Rods (B)	43	0.15	0.40	0.36	0.76	- 0.61	0.0
	44	0.15	0.13	0.57	0.70	- 0.55	13.3
V, CAF	41	1.64	0.37	0.73	1.10	0.34	77.4
Fresh food	42	1.64	0.41	0.65	1.06	0.58	75.0
	43	1.64	0.14	0.67	0.81	0.83	91.5
	44	1.64	0.34	0.70	1.04	0.60	79.3
VI, Chamber	41	1.90	0.78	1.06	1.84	0.06	58.9
ANM (A)	42	1.90	0.32	0.92	1.24	0.66	83.1
	43	1.90	0.57	0.97	1.54	0.36	70.0
	44	1.90	0.47	1.08	1.55	0.36	73.3

* When no fecal or urine sample was obtained, the values are placed in brackets ( ).

TABLE XXIV, continued

Test period and condition	Subject No.	Intake	Excretion: Feces	Excretion: Urine	Excretion: Total	Balance	Coefficient of apparent digestibility
		g/24 hr					%
VII, Chamber	41	0.15	0.03	0.60	0.63	- 0.48	80.0
Contingency	42	0.15	0.17	0.56	0.73	- 0.58	0.0
Rods (B) and	43	0.57	*	0.79	(0.79)	(- 0.22)	(100.0)
Tube pack (C)	44	0.57	0.15	0.67	0.87	- 0.30	73.7
VIII, CAF	41	1.64	0.14	0.67	0.81	0.83	91.5
Fresh food	42	1.64	0.21	0.60	0.81	0.76	87.2
	43	1.64	0.39	0.72	1.11	0.53	76.2
	44	1.64	0.50	0.77	1.27	0.37	69.5
IX, CAF -	41	1.60	0.57	1.16	1.73	- 0.13	64.4
Chamber	43	1.60	0.31	0.86	1.17	0.43	80.1
ANM (B)	44	1.58	0.76	0.92	1.68	- 0.10	51.9
X, Chamber	41	0.17	*	0.73	(0.73)	(- 0.56)	(100.0)
Contingency Rods (D) and	43	0.17	0.07	0.48	0.55	- 0.38	58.8
Tube pack (C)	44	0.49	*	0.56	(0.56)	(- 0.07)	(100.0)
XI, CAF -	41	1.59	0.26	1.36	1.62	- 0.03	83.6
Chamber	43	1.32	0.21	0.86	1.07	0.25	84.0
ANM (B)	44	1.49	0.48	0.99	1.47	0.02	67.8
XII, Chamber	41	0.17	*	0.90	(0.90)	(- 0.73)	(100.0)
Contingency Rods (D) and	43	0.16	0.24	*	(0.24)	(- 0.08)	0.0
Tube pack (C)	44	0.57	0.39	0.31	0.70	- 0.13	31.6
XIII, CAF	41	1.64	0.28	0.80	1.08	0.56	82.9
Fresh food	43	1.64	0.28	0.69	0.97	0.67	82.9
	44	1.64	0.50	0.98	1.48	0.16	69.5

TABLE XXV

CALCIUM BALANCE AND DIGESTIBILITY

Test period and condition	Subject No.	Intake	Excretion Feces	Excretion Urine	Excretion Total	Balance	Coefficient of apparent digestibility %
			g/24 hr				
I, CAF	41	1.19	0.83	0.22	1.05	0.14	30.2
Fresh food	42	1.19	0.80	0.13	0.93	0.26	32.8
	43	1.19	0.92	0.24	1.16	0.03	22.7
	44	1.19	0.92	0.08	1.00	0.19	22.7
II, CAF	41	0.62	0.34	0.15	0.49	0.13	45.1
Contingency	42	0.62	0.34	0.09	0.43	0.19	45.1
Foil pack (A)	43	0.62	0.32	0.14	0.46	0.16	48.4
	44	0.62	0.51	0.08	0.59	0.03	17.7
III, CAF	41	1.19	0.76	0.21	0.97	0.22	36.1
Fresh food	42	1.19	0.69	0.16	0.85	0.34	42.0
	43	1.19	0.70	0.19	0.89	0.30	41.2
	44	1.19	0.91	0.11	1.02	0.17	23.5
IV, CAF	41	0.54	0.26	0.05	0.31	0.23	51.9
Contingency	42	0.54	0.23	0.04	0.27	0.27	57.4
Rods (B)	43	0.54	0.58	0.07	0.65	- 0.09	0.0
	44	0.54	0.18	0.00	0.18	0.36	66.7
V, CAF	41	1.19	0.44	0.20	0.64	0.52	62.1
Fresh food	42	1.19	0.70	0.16	0.86	0.30	40.0
	43	1.19	0.25	0.18	0.43	0.73	78.4
	44	1.19	0.65	0.08	0.64	0.52	51.7
VI, Chamber	41	0.88	1.02	0.17	1.19	- 0.31	0.0
ANM (A)	42	0.88	0.58	0.11	0.69	0.19	34.1
	43	0.88	0.94	0.18	1.12	- 0.24	0.0
	44	0.88	0.73	0.09	0.82	0.06	17.0

* When no fecal or urine sample was obtained, the values are placed in brackets ( ).

TABLE XXV, continued

Test period and condition	Subject No.	Intake	Excretion Feces	Urine	Total	Balance	Coefficient of apparent digestibility %
			g/24 hr				
VII, Chamber	41	0.54	0.10	0.10	0.20	0.34	81.5
Contingency	42	0.54	0.28	0.05	0.33	0.21	48.1
Rods (B) and	43	0.51	*	0.20	(0.20	(0.31)	(100.0)
Tube pack (C)	44	0.51	0.35	0.09	0.44	0.07	31.4
VIII, CAF	41	1.19	0.29	0.17	0.46	0.70	25.0
Fresh food	42	1.19	0.39	0.16	0.55	0.61	66.5
	43	1.19	0.69	0.20	0.89	0.27	40.5
	44	1.19	0.74	0.09	0.85	0.31	36.2
IX, CAF-	41	0.77	0.93	0.19	1.12	- 0.35	0.0
Chamber	43	0.77	0.68	0.15	0.83	- 0.06	11.7
ANM (B)	44	0.75	1.02	0.09	1.11	- 0.36	0.0
X, Chamber	41	0.54	*	0.10	(0.10)	(0.44)	(100.0)
Contingency Rods (D) and	43	0.54	0.16	0.07	0.23	0.31	70.4
Tube pack (C)	44	0.44	*	0.08	(0.08)	(0.36)	(100.0)
XI, CAF -	41	0.77	0.46	0.19	0.65	0.12	40.2
Chamber	43	0.64	0.38	0.16	0.54	0.10	40.6
ANM (B)	44	0.71	0.76	0.07	0.83	- 0.12	0.0
XII, Chamber	41	0.54	*	0.01	(0.01)	(0.44)	(100.0)
Contingency Rods (D) and	43	0.50	0.41	*	(0.41)	(0.09)	18.0
Tube pack (C)	44	0.51	0.58	0.07	0.65	- 0.14	0.0
XIII, CAF	41	1.19	0.51	0.22	0.73	0.46	57.1
Fresh food	43	1.19	0.44	0.14	0.58	0.61	63.0
	44	1.19	0.75	0.09	0.84	0.35	40.0

TABLE XXVI

MAGNESIUM BALANCE AND DIGESTIBILITY

Test period and condition	Subject No.	Intake	Excretion Feces	Excretion Urine	Excretion Total	Balance	Coefficient of apparent digestibility %
		g/24 hr					
I, CAF	41	0.18	0.12	0.10	0.22	- 0.04	33.3
Fresh food	42	0.18	0.11	0.10	0.21	- 0.03	38.8
	43	0.18	0.15	0.11	0.26	- 0.08	16.7
	44	0.18	0.13	0.09	0.22	- 0.04	27.8
II, CAF	41	0.11	0.04	0.09	0.13	- 0.02	63.6
Contingency	42	0.11	0.02	0.09	0.11	0.00	81.8
Foil pack (A)	43	0.11	0.02	0.08	0.10	0.10	81.8
	44	0.11	0.04	0.08	0.12	- 0.10	63.6
III, CAF	41	0.18	0.10	0.08	0.18	0.00	44.4
Fresh food	42	0.18	0.10	0.06	0.16	0.02	44.4
	43	0.18	0.07	0.08	0.15	0.03	61.1
	44	0.18	0.10	0.08	0.18	0.00	44.4
IV, CAF	41	0.05	0.03	0.03	0.06	- 0.01	40.0
Contingency	42	0.05	0.03	0.04	0.07	- 0.02	40.0
Rods (B)	43	0.05	0.07	0.09	0.16	- 0.11	0.0
	44	0.05	0.03	0.03	0.06	- 0.01	40.0
V, CAF	41	0.18	0.08	0.07	0.14	0.04	61.1
Fresh food	42	0.18	0.10	0.06	0.16	0.02	44.4
	43	0.18	0.03	0.07	0.10	0.08	83.3
	44	0.18	0.08	0.05	0.13	0.05	55.5
VI, Chamber	41	0.19	0.16	0.07	0.23	- 0.04	15.8
ANM (A)	42	0.19	0.11	0.09	0.20	- 0.01	42.1
	43	0.19	0.13	0.06	0.19	0.00	31.6
	44	0.19	0.11	0.05	0.16	0.03	42.1

* When no fecal or urine sample was obtained, the values are placed in brackets ().

TABLE XXVI, continued

Test period and condition	Subject No.	Intake	Excretion: Feces	Excretion: Urine	Excretion: Total	Balance	Coefficient of apparent digestibility
		g/24 hr	g/24 hr	g/24 hr	g/24 hr	g/24 hr	%
VII, Chamber	41	0.05	0.02	0.04	0.06	- 0.01	60.0
Contingency	42	0.05	0.07	0.04	0.11	- 0.06	0.0
Rods (B) and	43	0.07	*	0.08	(0.08)	(- 0.01)	(100.0)
Tube pack (C)	44	0.07	0.05	0.06	0.11	- 0.04	28.6
VIII, CAF	41	0.18	0.06	0.06	0.11	0.07	66.6
Fresh food	42	0.18	0.06	0.05	0.11	0.07	66.6
	43	0.18	0.09	0.06	0.15	0.03	50.0
	44	0.18	0.09	0.07	0.16	0.02	50.0
IX, CAF -	41	0.16	0.22	0.07	0.29	- 0.13	0.0
Chamber	43	0.16	0.14	0.08	0.22	- 0.06	12.5
AMN (B)	44	0.16	0.18	0.07	0.25	- 0.09	0.0
X, Chamber	41	0.05	*	0.04	(0.04)	(0.01)	(100.0)
Contingency Rods (D) and	43	0.05	0.03	0.04	0.07	- 0.02	40.0
Tube pack (C)	44	0.06	*	0.06	(0.06)	(0.00)	(100.0)
XI, CAF -	41	0.16	0.11	0.08	0.19	- 0.03	31.2
Chamber	43	0.12	0.06	0.09	0.15	- 0.03	50.0
ANM (B)	44	0.14	0.11	0.05	0.16	- 0.02	21.4
XII, Chamber	41	0.05	*	0.05	(0.05)	(0.00)	(100.0)
Contingency Rods (D) and	43	0.05	0.07	*	(0.07)	(- 0.02)	0.0
Tube pack (C)	44	0.07	0.11	0.06	0.17	- 0.10	0.0
XIII, CAF	41	0.18	0.10	0.07	0.17	0.01	44.4
Fresh food	43	0.18	0.06	0.06	0.12	0.06	66.6
	44	0.18	0.08	0.08	0.16	0.02	55.5

TABLE XXVII

CHLORIDE BALANCE AND DIGESTIBILITY

Test period and condition	Subject No.	Intake	Excretion Feces	Excretion Urine	Excretion Total	Balance	Coefficient of apparent digestibility
			g/24 hr				%
I, CAF Fresh food	41	5.21	0.02	5.80	5.82	- 0.61	99.6
	42	5.21	0.04	4.83	4.87	0.34	99.2
	43	5.21	0.02	5.85	5.87	- 0.66	99.6
	44	5.21	0.04	4.98	5.02	0.19	99.2
II, CAF Contingency Foil pack (A)	41	0.42	0.01	1.44	1.45	- 1.03	98.6
	42	0.42	0.01	0.92	0.93	- 0.51	97.6
	43	0.42	0.02	1.64	1.66	- 1.24	96.2
	44	0.42	0.01	2.08	2.09	- 1.67	97.6
III, CAF Fresh food	41	5.21	0.02	5.38	5.40	- 0.19	99.6
	42	5.21	0.02	4.16	4.18	1.03	99.6
	43	5.21	0.02	4.71	4.73	0.48	99.6
	44	5.21	0.03	4.50	4.53	0.68	99.4
IV, CAF Contingency Rods (B)	41	1.62	0.00	2.44	2.44	- 0.82	100.0
	42	1.62	0.01	2.08	2.09	- 0.47	99.4
	43	1.62	0.02	2.27	2.29	- 0.67	98.8
	44	1.62	0.01	2.20	2.21	- 0.59	99.4
V, CAF Fresh food	41	5.21	0.01	5.00	5.01	0.20	99.8
	42	5.21	0.02	3.07	3.09	2.12	99.1
	43	5.21	0.01	3.82	3.82	1.39	99.8
	44	5.21	0.02	3.74	3.76	1.45	99.6
VI, Chamber ANM (A)	41	6.80	0.01	4.68	4.69	2.11	99.8
	42	6.80	0.01	4.79	4.80	2.00	99.8
	43	6.80	0.01	5.70	5.70	1.09	99.8
	44	6.80	0.01	5.04	5.05	1.75	99.8

* When no fecal or urine sample was obtained, the values are placed in brackets ().

TABLE XXVII, continued

Test period and condition	Subject No.	Intake	Excretion: Feces	Excretion: Urine	Excretion: Total	Balance	Coefficient of apparent digestibility
		g/24 hr					%
VII, Chamber	41	1.62	0.00	1.98	1.98	- 0.36	100.0
Contingency	42	1.62	0.01	1.43	1.44	0.18	99.4
Rods (B) and	43	1.69	*	2.89	(2.89)	(- 1.20)	(100.0)
Tube pack (C)	44	1.69	0.01	3.10	3.11	- 1.42	99.4
VIII, CAF	41	5.21	0.01	4.49	4.50	0.71	99.8
Fresh food	42	5.21	0.01	2.62	2.63	2.58	99.8
	43	5.21	0.01	3.56	3.57	1.64	99.8
	44	5.21	0.01	4.04	4.05	1.16	99.8
IX, CAF -	41	6.80	0.02	8.07	8.09	- 1.29	99.7
Chamber	43	6.80	0.02	5.11	5.13	1.67	99.7
ANM (B)	44	6.75	0.04	7.10	7.15	- 0.40	99.4
X, Chamber	41	0.37	*	1.18	(1.18)	(- 0.81)	(100.0)
Contingency Rods (D) and	43	0.37	0.00	1.32	1.32	- 0.95	98.9
Tube pack (C)	44	0.41	*	1.38	(1.38)	(- 0.97)	(100.0)
XI, CAF -	41	6.68	0.01	5.49	6.50	0.18	99.8
Chamber	43	5.46	0.01	4.41	4.42	1.04	99.8
ANM (B)	44	6.39	0.02	3.36	3.38	3.01	99.7
XII, Chamber	41	0.37	*	1.25	(1.25)	(- 0.88)	(100.0)
Contingency Rods (D) and	43	0.34	0.00	*	(0.00)	(0.34)	99.1
Tube pack (C)	44	0.48	0.01	1.50	1.51	- 1.03	97.9
XIII, CAF	41	5.21	0.01	5.40	5.41	- 0.20	99.8
Fresh food	43	5.21	0.01	4.21	4.22	0.99	99.8
	44	5.21	0.02	5.36	5.38	- 0.17	99.6

TABLE XXVIII

SWEAT TEST SUMMARY

Test period and condition	Subject No.	Sweat Rate g/24 hr	Sweat concentration: Calcium mEq/l.	Sweat concentration: Nitrogen mg/l.	Sweat loss: Calcium mg/24 hr	Sweat loss: Nitrogen mg/24 hr
II, CAF	41	57	1.74	362	95	495
Contingency	42	36	2.17	278	75	240
Foil pack (A)	43	35	0.45	607	15	510
	44	14	1.49	964	20	320
Mean		35	1.46	553	51	391
Standard deviation		± 17	± 0.73	± 307	± 40	± 132
VI, Chamber	41	59	0.44	385	25	545
ANM (A)	42	68	0.46	392	30	640
380 mmHg	43	55	0.76	473	40	625
	44	76	0.82	291	60	530
Mean		64	0.62	385	39	585
Standard deviation		± 9	± 0.19	± 74	± 16	± 55

TABLE XXIX

URINE ANALYSES - NOCTURNAL VOID

Test period and condition	Subject No.	pH	Moisture g%	Solids g%	Specific gravity
I, CAF	41	5.8	97.2	4.5	1.019
Fresh food	42	5.2	96.6	5.5	1.022
	43	5.2	95.4	7.5	1.030
	44	5.2	96.8	5.1	1.021
II, CAF	41	5.3	97.2	4.4	1.018
Contingency	42	5.2	95.5	7.2	1.029
Foil pack (A)	43	5.2	95.3	7.6	1.031
	44	5.3	97.1	4.7	1.019
III, CAF	41	5.9	97.3	3.9	1.015
Fresh food	42	5.7	96.8	5.0	1.020
	43	5.7	95.5	7.3	1.029
	44	5.5	97.0	4.8	1.019
IV, CAF	41	5.6	97.1	4.7	1.019
Contingency	42	5.5	96.3	6.0	1.024
Rods (B)	43	5.6	96.6	5.4	1.022
	44	5.5	96.6	5.4	1.022
V, CAF	41	6.3	98.0	3.2	1.013
Fresh food	42	6.0	97.3	4.3	1.017
	43	5.8	95.6	7.1	1.029
	44	5.6	96.9	4.9	1.020
VI, Chamber	41	6.0	97.0	4.8	1.019
ANM (A)	42	6.0	96.0	6.3	1.026
	43	6.0	96.0	6.3	1.026
	44	5.0	98.4	2.5	1.010

* Nocturnal voids not collected.

TABLE XXIX, continued

Test period and condition	Subject No.	*p*H	Moisture g%	Solids g%	Specific gravity
VII, Chamber	41	5.8	97.4	4.1	1.019
Contingency	42	5.8	96.7	5.2	1.021
Rods (B) and	43	6.0	97.5	3.9	1.012
Tube pack (C)	44	5.7	97.7	3.6	1.013
VIII, CAF	41	6.3	97.1	4.8	1.017
Fresh food	42	5.9	96.2	6.2	1.024
	43	6.7	97.0	4.8	1.021
	44	5.8	96.7	5.3	1.021
IX, CAF -	41	5.6	97.7	3.6	1.014
Chamber	43	5.3	96.3	6.0	1.024
ANM (B)	44	5.4	95.8	6.7	1.027
X, Chamber *	41				
Contingency Rods (D) and	43				
Tube pack (C)	44				
XI, CAF -	41	5.7	96.8	5.1	1.020
Chamber	43	5.8	95.7	6.9	1.027
ANM (B)	44	5.3	95.9	6.5	1.020
XII, Chamber *	41				
Contingency Rods (D) and	43				
Tube pack (C)	44				
XIII, CAF	41	6.0	97.3	4.2	1.017
Fresh food	43	6.5	96.0	6.5	1.026
	44	5.5	95.7	7.0	1.028

TABLE XXX

URINARY STEROIDS AND CREATININE

Test period and condition	Subject No.	17-Hydroxycorticoids mg/24 hr	Creatinine g/24 hr
I, CAF	41	9.6 ± 1.2	2.41 ± 0.10
Fresh food	42	7.7 ± 1.0	2.12 ± 0.08
	43	8.8 ± 0.8	2.04 ± 0.04
	44	5.5 ± 0.9	2.35 ± 0.04
II, CAF	41	4.6	2.15
Contingency	42	3.3	1.93
Foil pack (A)	43	5.1	1.89
	44	2.5	2.36
III, CAF	41	9.1 ± 0.3	2.36 ± 0.22
Fresh food	42	8.8 ± 1.2	2.00 ± 0.18
	43	8.0 ± 0.0	2.09 ± 0.12
	44	5.4 ± 0.0	2.29 ± 0.19
IV, CAF	41	6.2	1.83
Contingency	42	5.3	1.83
Rods (B)	43	6.0	1.59
	44	3.9	1.86
V, CAF	41	9.3	1.99
Fresh food	42	8.1	1.88
	43	7.2	1.85
	44	4.9	1.97
VI, Chamber	41	7.8	2.29
ANM (A)	42	9.3	2.15
	43	8.0	2.19
	44	4.9	2.30

* Twenty-four hours after chamber run.

** No sample.

TABLE XXX, continued

Test period and condition	Subject No.	17-Hydroxycorticoids mg/24 hr	Creatinine g/24 hr
VII, Chamber	41	2.3	1.70
Contingency	42	4.0	2.20
Rods (B) and	43	5.3	1.60
Tube pack (C)	44	3.8	2.08
VIII, CAF	41	5.2	1.89
Fresh food	42	3.0	1.67
	43	5.2	1.81
	44	4.4	2.20
IX, CAF -	41	9.2 ± 0.14	2.02 ± 0.32
Chamber	43	6.4 ± 0.1	1.69 ± 0.02
ANM (B)	44	5.8 ± 0.8	2.16 ± 0.06
X, Chamber	41	5.9	2.19
Contingency Rods (D) and	43	4.0	1.78
Tube pack (C)	44	3.5	2.30
XI, CAF -	41	6.3	1.87
Chamber	43	5.0	1.85
ANM (B)	44	3.1	1.91
XII, Chamber	41	7.6*	1.58
Contingency Rods (D) and	43	2.9*	**
Tube pack (C)	44	2.9*	1.93

TABLE XXXI

INORGANIC CONSTITUENTS IN BLOOD SERUM

Test period and condition	Subject No.	Mg	Cl	K	Na	Ca	P
		mEq/liter					
Pretest I	41	1.7	110	4.2	135	5.0	4.4
	42	2.3	105	5.0	142	4.8	4.9
	43	1.8	105	4.3	139	4.8	4.7
	44	1.9	110	4.0	139	5.0	4.4
Posttest II Post contingency CAF	41	1.2	97	4.4	135	4.8	4.2
	42	1.5	105	3.9	135	4.6	4.2
	43	1.3	105	4.2	135	4.6	4.2
	44	1.2	94	4.1	132	4.8	4.2
Posttest IV Post contingency CAF	41	*	104	4.7	145	5.0	4.3
	42	1.7	108	4.7	142	5.0	4.0
	43	1.7	107	3.9	139	4.9	4.0
	44	1.8	108	4.0	132	4.7	3.5
Posttest VII Post contingency Chamber	41	2.3	103	6.9**	139	5.1	4.0
	42	2.3	105	6.8**	142	5.0	4.3
	43	1.9	101	6.7**	142	5.0	3.8
	44	2.1	100	6.9**	139	5.3	3.7
Posttest VIII CAF	41	2.3	99	4.2	142	5.2	4.3
	42	2.3	107	4.2	142	5.0	4.6
	43	1.9	101	4.0	139	5.0	4.2
	44	2.1	96	4.2	139	5.2	3.9
Pretest IX CAF	41	2.3	105	4.5	142	4.8	4.9
	42	2.3	105	4.8	145	5.0	4.9
	43	2.3	105	4.1	145	5.2	4.6
	44	1.9	107	4.3	148	5.1	4.4

* No sample.

** Hemolyzed sample.

TABLE XXXI, continued

Test period and condition	Subject No.	Mg	Cl	K	Na	Ca	P
		mEq/liter					
Pretest X	41	1.7	105	4.5	139	5.2	4.7
CAF - Chamber	43	1.8	108	4.2	142	4.9	4.7
	44	1.4	108	4.4	139	4.7	4.0
Posttest X	41	1.9	103	4.8	139	5.6	3.8
Post contingency	43	1.7	99	3.8	142	5.2	4.2
Chamber	44	1.5	99	4.0	145	5.1	3.8
Pretest XII	41	1.9	110	4.8	148	5.0	4.4
CAF-Chamber	43	1.7	110	4.3	148	5.2	4.2
	44	1.7	110	4.1	145	4.9	4.2
Posttest XII	41	1.7	102	4.3	142	4.3	3.7
Post contingency	43	1.6	104	4.2	135	4.2	3.7
Chamber	44	1.5	106	4.3	139	3.9	3.9
Posttest XIII	41	2.2	106	4.5	135	5.2	4.3
CAF	43	1.9	107	4.2	135	5.2	3.7
	44	1.6	106	4.2	142	5.1	3.8
Subject mean and standard deviation							
	41	1.9 ± 0.35	103 ± 3.5	4.4 ± 0.21	139 ± 3.5	5.0 ± 0.34	4.3 ± 0.37
	42	2.1 ± 0.37	106 ± 1.3	4.5 ± 0.46	141 ± 3.3	4.9 ± 0.17	4.5 ± 0.34
	43	1.8 ± 0.25	104 ± 3.0	4.1 ± 0.17	139 ± 3.5	4.9 ± 0.30	4.2 ± 0.39
	44	1.7 ± 0.34	103 ± 5.6	4.2 ± 0.15	139 ± 5.0	4.9 ± 0.40	4.0 ± 0.29

TABLE XXXII

SERUM OSMOLALITY

Test period and condition	Subject No. 41	42	43	44
Pretest I	290	297	292	292
Posttest II Post contingency CAF	290	289	295	288
Posttest IV Post contingency CAF	287	291	285	279
Posttest VII Post contingency Chamber	276	277	274	277
Posttest VIII CAF	295	298	294	294
Pretest IX CAF	294	294	287	294
Pretest X CAF - Chamber	296	293	290	290
Posttest X Post contingency Chamber	281	282	269	274*
Pretest XII CAF - Chamber	281	276	268	278
Posttest XII Post contingency Chamber	266*	**	257*	259
Posttest XIII CAF	285	**	281	283

* Subject wearing pressure suit.

** No sample.

TABLE XXXIII

ORGANIC CONSTITUENTS IN BLOOD SERUM

Test period and condition	Subject No.	Glucose mg %	Cholesterol mg %	Alkaline Phosphatase*	Total Protein g %	Albumen g %	Globulin g %	A/G Ratio
Pretest I	41	79	145	1.4	6.6	4.6	2.0	2.3
	42	84	164	2.7	7.6	5.1	2.5	2.1
	43	73	207	2.1	7.6	5.1	2.5	2.1
	44	84	245	2.0	7.1	4.6	2.5	1.8
Posttest II	41	63	145	1.0	6.8	4.6	2.2	2.1
Post contingency	42	65	149	2.0	6.1	4.2	1.9	2.2
CAF	43	71	164	1.6	5.6	4.6	2.0	2.3
	44	73	272	1.4	7.3	4.8	2.5	1.9
Posttest IV	41	77	135	1.0	7.8	5.6	2.2	2.5
Post contingency	42	84	130	2.1	6.6	4.8	1.8	2.7
CAF	43	78	145	1.0	6.8	4.8	2.0	2.4
	44	84	225	1.1	7.1	4.5	2.5	1.7
Posttest VII	41	58**	145	1.6	7.1	5.1	2.0	2.5
Post contingency	42	56**	145	2.5	7.1	5.1	2.0	2.5
Chamber	43	53**	164	2.0	7.6	5.2	2.4	2.1
	44	56**	231	1.7	7.6	5.1	2.5	2.0
Posttest VIII	41	75	140	0.7	6.7	4.9	1.8	2.7
CAF	42	79	142	2.4	6.8	4.6	2.2	2.1
	43	79	159	1.6	6.8	4.5	2.3	2.0
	44	85	265	1.3	7.2	4.6	2.6	1.8
Pretest IX	41	75	130	1.1	6.4	4.6	1.8	2.6
	42	85	145	2.9	6.6	4.8	1.8	2.7
	43	80	179	2.0	7.0	4.8	2.2	2.2

* Bodansky units.

** Blood glucose not analyzed immediately (20 to 24 mg too low).

† Insufficient sample.

TABLE XXXIII, continued

Test period and condition	Subject No.	Glucose mg %	Cholesterol mg %	Alkaline Phosphatase*	Total Protein g %	Albumen g %	Globulin g %	A/G Ratio
Pretest X	41	73	169	1.4	7.6	5.2	2.4	2.2
	43	84	179	1.4	7.1	4.9	2.2	2.2
	44	89	225	1.6	6.9	4.3	2.5	1.7
Posttest X	41	82	169	1.6	8.2	6.0	2.2	2.7
Post contingency	43	71	219	2.2	7.8	5.6	2.2	2.5
Chamber	44	71	287	1.6	8.2	5.4	2.9	1.9
Pretest XII	41	55	145	1.5	7.3	†	†	†
	43	63	185	1.8	7.1	†	†	†
	44	67	231	2.0	6.9	†	†	†
Posttest XII	41	63	135	2.3	5.2	†	†	†
Post contingency	43	79	159	1.8	5.1	†	†	†
Chamber	44	91	200	2.1	5.5	†	†	†
Posttest XIII	41	40**	149	1.6	7.1	5.1	2.0	2.6
CAF	43	40**	140	2.3	6.9	4.9	2.0	2.5
	44	50**	265	2.3	7.3	4.8	2.5	1.9
		Subject mean and standard deviation						
	41	73	146	1.4	7.1	5.1	2.1	2.5
		± 7.0	± 13	± 0.4	± 0.6	± 0.5	± 0.2	± 0.3
	42	79	146	2.4	6.8	4.8	2.0	2.4
		± 8.4	± 11	± 0.3	± 0.5	± 0.3	± 0.3	± 0.3
	43	77	171	1.8	7.1	4.9	2.2	2.2
		± 4.7	± 24	± 0.4	± 0.4	± 0.3	± 0.2	± 0.3
	44	83	252	1.6	7.2	4.8	2.5	1.9
		± 7.3	± 31	± 0.4	± 0.5	± 0.3	± 0.3	± 0.3

TABLE XXXIV

HEMATOLOGY

Test period and condition	Subject No.	White blood cells mm^3	Hemoglobin g/100	Hematocrit %	Eosinophils %	PMN Segs. %	Lymphocytes %
Pretest I	41	8800	15.6	48	1	58	41
	42	9200	16.6	52	1	71	28
	43	6200	15.7	48	2	53	45
	44	7200	15.7	49	1	59	40
Posttest II Post contingency CAF	41	6300	14.7	44	1	60	39
	42	5600	14.4	44	1	58	41
	43	6200	15.4	48	2	59	39
	44	7200	15.6	49	2	56	42
Posttest IV Post contingency CAF	41	9100	15.4	48	1	55	44
	42	9700	13.8	43	2	63	35
	43	7800	14.8	46	2	59	39
	44	7700	15.4	48	4	53	43
Posttest VII Post contingency Chamber	41	8600	13.8	43	3	60	37
	42	9800	13.8	43	2	66	32
	43	8000	13.8	45	3	59	38
	44	8200	12.5	40	2	56	42
Posttest VIII CAF	41	7400	13.8	44	2	64	33
	42	7800	13.8	43	2	35	63
	43	8100	14.3	45	1	60	39
	44	8200	13.5	43	4	60	36
Pretest IX CAF	41	8500	15.0	43	2	68	30
	42	9900	16.2	45	1	58	41
	43	6700	15.5	46	2	50	48
	44	6100	16.2	45	1	38	61

TABLE XXXIV, continued

Test period and condition	Subject No.	White blood cells mm^3	Hemo-globin g/100	Hemato-crit %	Eosino-phils %	PMN Segs. %	Lympho-cytes %
Pretest X	41	6800	15.5	43	1	39	60
CAF - Chamber	43	8000	14.3	40	4	70	26
	44	7600	15.0	42	1	60	39
Postest X	41	6700	15.5	43	3	50	47
Post contingency	43	8600	15.0	42	0	43	57
Chamber	44	9500	14.3	40	3	60	37
Pretest XII	41	7500	15.5	43	0	51	49
CAF - Chamber	43	8200	15.5	43	1	50	49
	44	8400	15.5	43	4	53	43
Posttest XII	41	8500	14.8	41	1	59	40
Post contingency	43	8200	15.5	43	1	66	33
	44	8100	15.5	44	2	57	41
Posttest XIII	41	6700	15.5	43	0	56	44
CAF	43	8600	15.5	43	2	56	42
	44	8400	15.5	43	1	60	39
		Subject mean and standard deviation					
	41	7700	15.0	44	1	56	42
		± 1000	± 0.7	± 2.6	± 1.0	± 7.8	± 8.0
	42	8700	14.8	45	1	58	40
		± 1600	± 1.3	± 3.5	± 0.8	± 12.0	± 12.0
	43	7700	15.0	44	2	57	41
		± 900	± 0.6	± 2.5	± 1.1	± 7.6	± 8.3
	44	7900	15.0	44	2	56	42
		± 860	± 1.1	± 3.2	± 1.3	± 6.4	± 6.6

TABLE XXXV

PHYSIOLOGICAL MEASUREMENTS

Test period and condition	Subject No.	Body temperature oral, °F	Blood pressure systolic/diastolic	Pulse rate beats/min.	Respirations /min.
I, CAF	41	97.4	105/64	76	17
Fresh food	42	97.9	113/71	70	18
	43	97.5	119/80	70	15
	44	97.3	118/77	71	18
II, CAF	41	97.3	96/64	77	16
Contingency	42	97.9	102/70	70	16
Foil pack (A)	43	97.8	113/86	68	13
	44	97.3	115/97	74	18
III, CAF	41	97.3	96/65	70	16
Fresh food	42	98.1	103/72	73	16
	43	97.4	113/78	64	14
	44	97.3	117/77	75	16
IV, CAF	41	97.0	96/61	68	15
Contingency	42	98.1	102/71	75	15
Rods (B)	43	97.2	113/80	64	13
	44	97.4	117/82	69	17
V, CAF	41	97.1	103/66	68	15
Fresh food	42	98.0	108/92	72	15
	43	97.4	116/82	56	14
	44	97.3	117/75	63	16
VI, Chamber	41	97.4	108/67	71	15
ANM (A)	42	98.2	111/72	73	14
	43	97.3	117/82	69	13
	44	96.9	119/77	69	15

* Subject wearing pressure suit, unpressurized.

** Subject wearing pressure suit, 3.7 psi.

TABLE XXXV, continued

Test period and condition	Subject No.	Body temperature oral, °F	Blood pressure systolic/diastolic	Pulse rate beats/min.	Respirations /min.
VII, Chamber	41	96.8	99/66	69	14
Contingency	42	98.1	*	72	14
Rods (B) and	43	98.6	*	56	11
Tube pack (C)	44	97.0	120/86	65	17
VIII, CAF	41	97.0	104/67	72	14
Fresh food	42	98.2	106/72	71	14
	43	97.3	121/84	71	12
	44	97.6	111/75	66	16
IX, CAF -	41	97.3	109/70	79	15
Chamber	42	98.1	104/72	77	15
ANM (B)	43	97.2	119/82	65	11
	44	97.4	117/83	70	16
X, Chamber	41	97.1	111/78	82	14
Contingency	42**	97.4	**	55	**
Rods (D) and	43	97.2	120/81	78	12
Tube pack (C)	44**	97.3	**	**	**
XI, CAF -	41	97.0	104/70	72	14
Chamber	43	97.2	112/76	60	11
ANM (B)	44	97.3	115/82	73	15
XII, Chamber	41**	96.8	**	70	**
Contingency Rods (D) and	43**	96.2	**	65	**
Tube pack (C)	44	97.1	114/83	73	16
XIII, CAF	41	96.9	104/59	68	13
Fresh food	43	96.9	111/77	65	11
	44	96.6	112/82	69	16

TABLE XXXVI

BASAL METABOLIC RATES

Test period and condition	Day	Subject No. 41	42	43	44
I, CAF	1	+ 94		- 8	
Fresh food	2		+ 12		+ 5
	3	+ 80		- 13	
	4		+ 35		- 21
	5	+ 100		- 11	
	6		+ 5		+ 7
	7	+ 90		- 16	
	8		- 3		+ 9
	9	+ 100		+ 35	
	10		+ 30		+ 5
	11	+ 100		- 14	
	12		+ 3		+ 5
	13	+ 100		- 27	
	14		+ 24		+ 15
	15	+ 100		+ 20	
II, CAF	16		0		- 26
Contingency	17	+ 55		- 3	
Foil pack (A)	18		+ 6		+ 82
	19	+ 100		- 38	
	20		- 12		+ 15
	21	+ 100		- 22	
	22		- 15		+ 33
	23	+ 100		+ 11	
	24		+ 17		- 14
	25	+ 100		+ 45	
	26		+ 2		+ 10
	27	+ 100		- 14	
	28		- 10		- 16
	29	+ 45		- 27	
	30		- 5		- 19
	31	+ 44		- 15	
	32		- 2		- 16
	33	+ 50		- 15	
	34		- 3		- 12
	35	+ 100		- 25	

TABLE XXXVI, continued

Test period and condition	Day	Subject No. 41	42	43	44
IV, CAF	36		- 7		- 16
Contingency	37	+ 75		+ 70	
Rods (B)	38		+ 29		- 12
	39	+ 55		+ 21	
	40		+ 6		- 15
V, CAF	41	+ 100		- 30	
Fresh food	42		+ 15		- 14
	43	+ 90		- 29	
	44		- 11		- 12
	45	+ 70		+ 61	
VI, Chamber	46				
ANM (A)	47				
	48	+ 44	+ 8	- 5	- 23
	49	+ 33	- 7	- 3	+ 4
	50	+ 40	+ 15	+ 2	- 15
VII, Chamber	51	- 5	- 7	- 2	- 10
Contingency	52	+ 12	+ 12	- 10	- 14
Rods (B) and	53	- 6	- 9	+ 54	- 13
Tube pack (C)	54	+ 90	- 4	+ 100	- 3
	55	+ 50	+ 70	- 20	+ 50
VIII, CAF	56	+ 100	- 20		
Fresh food	57			+ 60	- 20
	58	- 20	- 5		
	59			+ 12	+ 5
	60	+ 100	- 10		

TABLE XXXVII

FECAL VOIDS

Test period and condition	Subject No.	Frequency /24 hr	Weight g/24 hr	Moisture g/24 hr	Solids g/24 hr
I, CAF	41	0.73	51.8	36.3	15.5
Fresh food	42	1.13	83.1	57.9	15.2
	43	1.00	68.5	45.5	23.0
	44	0.87	84.1	60.0	24.1
II, CAF	41	0.80	24.4	17.1	7.3
Contingency	42	0.80	52.8	37.8	15.0
Foil pack (A)	43	0.60	33.8	23.9	8.9
	44	1.00	53.8	38.3	15.5
III, CAF	41	0.87	56.8	38.8	18.0
Fresh food	42	1.13	80.1	55.9	24.2
	43	0.87	48.7	33.1	15.6
	44	0.93	83.7	61.9	21.8
IV, CAF	41	0.40	13.0	8.6	4.4
Contingency	42	0.40	27.6	18.0	9.6
Rods (B)	43	0.80	75.6	56.8	18.8
	44	0.40	18.8	11.7	7.1
V, CAF	41	0.40	42.2	28.2	14.0
Fresh food	42	1.00	79.2	57.2	21.6
	43	0.60	36.4	28.4	8.0
	44	0.80	82.8	53.0	19.8
VI, Chamber	41	1.00	97.4	68.4	29.0
ANM (A)	42	1.40	79.2	55.1	24.1
	43	1.20	116.2	81.8	34.4
	44	0.80	107.6	77.2	30.4

* Values corrected for food not consumed.

TABLE XXXVII, continued

Test period and condition	Subject No.	Frequency /24 hr	Weight g/24 hr	Moisture g/24 hr	Solids g/24 hr
VII, Chamber Contingency Rods (B) and Tube pack (C)	41	0.40	11.0	7.0	4.0
	42	0.40	44.2	28.8	15.4
	43	0.00	00.0	00.0	00.0
	44	0.20	37.2	24.8	12.4
VIII, CAF Fresh food	41	0.50	41.7	26.1	15.6
	42	0.50	71.5	54.2	17.3
	43	1.00	79.2	50.4	27.8
	44	0.75	95.2	65.1	20.1
IX, CAF - Chamber ANM (B)	41	0.90	108.9	89.5	19.4
	43*	0.70	84.8	70.4	14.4
	44	0.70	91.2	77.5	13.7
X, Chamber Contingency Rods (D) and Tube pack (C)	41	0.20	11.6	9.5	2.1
	43	0.00	00.0	00.0	00.0
	44	0.20	30.2	25.3	4.9
XI, CAF - Chamber ANM (B)	41	0.40	57.4	47.5	9.9
	43	0.60	48.4	39.0	9.4
	44	0.60	60.6	59.8	9.8
XII, Chamber Contingency Rods (D) and Tube pack (C)	41	0.00	00.0	00.0	00.0
	43	0.25	54.7	46.8	7.9
	44	0.25	42.0	35.0	7.0
XIII, CAF Fresh food	41	0.40	49.8	39.8	10.0
	43	0.40	41.0	33.0	7.1
	44	0.60	71.2	60.5	10.7

TABLE XXXVIII

WASTE MANAGEMENT

	Fresh food	Apollo nominal mission food	Contingency food
	Intake, g/24 hr		
Dietary solids	512	568	202
Dietary water	1167	20	89
Ad libitum water	1400 ± 417	2000 ± 182	1500 ± 311
Metabolic water	314	357	134*
	3400	2900	1900
	Excretion, g/24 hr		
Urine	1300 ± 590	1300 ± 580	1100 ± 465
Feces	65 ± 17	86 ± 2.5	32 ± 12
Insensible water	1500 ± 274	1000 ± 68	600 ± 189*
	2900	2400	1700

* Does not include water of metabolism from body stores.

SECTION IV

DISCUSSION

During this experiment, the subjects ate 900-calorie contingency diets during 5 tests, one of which was in the chamber at altitude in a 50-50, O_2-N_2 gas environment, and two in the chamber during which time 2 subjects wore pressure suits. Three types of contingency diets were eaten and the rods were rated highest on the 9-point hedonic scale. The rods were the most consistent in appearance and taste. However, the tube pack diet offered the most simplicity with respect to the manipulative operations necessary for the subject to get food through the helmet and into his mouth.

The water consumed during these contingency tests varied from about 700 ml per day to about 2000 ml per day. The lowest values for each subject were obtained when the subject wore the pressure suit; the values ranged from between 700 ml per day and 1300 ml per day.

The subjects lost weight while in the contingency periods. However, most of the weight loss was water; it was calculated that 30% to 54% of the weight loss was water. Energy requirements in the contingency and simulated aerospace environments are lower than one might expect from published data on nutritional requirements. According to the recommendations of the Food and Nutrition Board of the National Research Council (36, p 354), 34 kcal/kg are required for sedentary adults; the requirements during sleep are 23 kcal/kg (36, p352). In the chamber, we have calculated the requirements to be about 32 kcal/kg while on a regular diet and about 30 to 31 kcal/kg while on the contingency diets. These caloric requirements are equivalent to 8 hours of sleep and 16 hours of sitting quietly (36, p 354). This was about the level of activity as seen visually and this low level of activity is confirmed by the decrease in 17-hydroxycorticoids during the contingency periods. During the contingency periods, the subjects had available in their diets, on the average of about 22 g of metabolizable protein. From the urinary outputs, it is calculated that on the average of about 60 g per day were metabolized. Therefore, about 40 g per day of protein that was metabolized was derived from body tissues; this probably comes mostly from the liver which appears to have the only significant reserves of protein available for rapid utilization (37, p 649). Thus, in addition to the 900 kcal provided by the diet, about 160 kcal were derived from tissue protein and the additional 1100 to 1200 kcal needed were probably derived entirely from body fat depots. There is very little reserve carbohydrate; this may be estimated from Benedict's data as about 150 to 200 g (38). It is apparent that the contingency diet contained enough carbohydrate to provide a metabolic mixture of protein, fat, and carbohydrate that did not induce ketosis. There never was any indication of the formation of ketone bodies in the urine of the subjects.

Of the mineral elements in the contingency diet, only calcium was provided in an amount that maintained the subjects in positive balance. The subjects were in negative balance for sodium, potassium, phosphorus, chloride, and magnesium. However, normal blood levels of the inorganic constituents were maintained throughout, there was a slight but definite decrease in serum osmolality during the contingency tests. It can be inferred from all the data that normal kidney function was maintained and that adrenocortical and thyroid hormones were secreted in normal (17-hydroxycorticoids in less than normal) amounts during the contingency periods.

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Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Department of Research Miami Valley Hospital Dayton, Ohio 45409	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP N/A

3. REPORT TITLE
THE BIOCHEMICAL, PHYSIOLOGICAL, AND METABOLIC EFFECTS OF APOLLO NOMINAL MISSION AND CONTINGENCY DIETS ON HUMAN SUBJECTS WHILE ON A SIMULATED APOLLO MISSION

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Final Report, February 1966 - June 1966

5. AUTHOR(S) *(First name, middle initial, last name)*
Bernard J. Katchman, PhD
James P. F. Murphy
Vickie R. Must
Ellis Patrick, MD

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
December 1967	83	39

8a. CONTRACT OR GRANT NO. AF 33(657)-11716	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. 7164	
c. Task No. 716405	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)* AMRL-TR-67-164
d.	

10. DISTRIBUTION STATEMENT
Distribution of this document is unlimited. It may be released to the Clearinghouse, Department of Commerce, for sale to the general public.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Aerospace Medical Research Laboratories Aerospace Medical Div., Air Force Systems Command, Wright-Patterson AFB, OH 45433

13. ABSTRACT
Four human male subjects participated in a 90-day experiment consisting of 60-day and 30-day confinement periods with a 5-day break between. The subjects were confined either to the controlled activity facility of the chamber of the Life Support Systems Evaluator at altitude wearing pressure suits unpressurized and pressurized at 3.7 psi. The subjects ate a fresh food diet, an Apollo nominal mission diet, or an Apollo contingency diet that provided 2200, 2500, and 900 kcal/day, respectively. The rod form of the contingency diet was the most acceptable from an organoleptic standpoint. The tube form was more easily handled from a functional standpoint, although the formulation of the tube food as well as the tube itself needs to be improved to make it operationally more effective than at present. The subjects lost about 500 g/day of body weight while on the contingency diet of which about 50% is estimated to be water. About 40 g/day of body weight was lost because of protein catabolism. Blood levels of sodium, potassium, phosphorus, chloride, calcium, and magnesium were maintained in the normal range of clinical values. Physiologic measurements all were in the normal range of clinical values. However, the 17-hydroxycorticoids of the urine decreased to low normal and below normal ranges of clinical values. Three of the four subjects completed a simulated Apollo emergency mission wearing a pressure suit pressurized at 3.7 psi and on a 900-calorie contingency diet. There were no adverse effects upon their health and no evidence that their capacity to function in a normal manner was in any way impaired.

DD FORM 1 NOV 65 1473

Security Classification

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Aerospace nutrition						
Biochemical Evaluation						
Physiological Evaluation						
Metabolic Evaluation						
Diets						
Confinement						
Contingency Conditions						
Precooked foods						
Dehydrated foods						
Bite size foods						
Space system contingency foods						
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Security Classification