A Field Test of Behavioral/Nutritional Effects of Prolonged Combat Rations [1,2,3]

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Introduction

The present experiment was designed to evaluate the effects of prolonged feeding the Meal, Ready to Eat (MRE) operational ration in troops engaged in an extended (34 days) field training exercise.

Current military scenarios call for US troops to subsist on operational rations for extended periods of time. It is currently not known whether this can be accomplished without compromising troop effectiveness. Current policy on duration of use of combat rations is contained in TEB MED 141 (1971); TM8-250 (1974), and TM8-501 (1961) which advise that the Meal Combat Individual (MCI) ration should not be used as the sole source of food for more than 10 consecutive days. There are reports indicating that the MRE ration is acceptable to troops over a 7-day period (Harmon: 1974) and that it is preferred to the MCI (Hiltz, 1974).

The MRE ration is formulated to meet the nutrient requirements of young adult males. It is composed of 30 food items, two beverages, a cream substitute, assorted candies, condiments and a gravy base. These components are divided into 12 menus with repetition of some items other than entrees across the 12 menus. The components are contained in a flexible retort pouch and can be eaten hot or cold. Seven of the food items are meant to be rehydrated, but they can be eaten without adding water. Three MRE pouches provide 3,600 calories and meet the known requirements for all nutrients.

The limited number of foods in the 12 meals in conjunction with the fact that on the average, each meal will be repeated every four days, raises the possibility that food monotony will develop when this ration is fed as the sole food source over an extended period of time. Some investigators have found that both food intake and food acceptability decline when limited menus are offered, (Hashim & Van Itallie, 1965; Kamen & Peryam, 1961; Schutz & Pilgrim, 1958; and Siegel & Pilgrim, 1958). In addition to food monotony, it is possible that some components of the MRE are not sufficiently palatable to the soldier and will not be consumed. The rejection of some components of the ration may lead to inadequate energy intake, consumption of a nutritionally imbalanced diet or inadequate vitamin and mineral intakes, due to the patterns of diet fortification and food selection.

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1 . The opinions expressed are the authors' and do not represent the positions of the US Department of the Army or the US Department of Defense.

2. Those seeking further information are referred to US Army Natick Research and Development Center Technical Report, "Effects of Prolonged Feeding Meal, Ready to Eat (MRE) Operational Rations."

3. This study was conducted following the human use procedures of the US Department of the Army.

Given the nutritional quality of the MRE and the possibility of food monotony developing, the acceptability and the consumption of the MRE were regarded as the primary measures. Accordingly, the most frequent and intensive measurements focused on these variables. In addition, a series of measures were taken to assess any possible harmful consequences of consuming this diet or of not eating sufficient amounts of it or of choosing foods from the ration in such a manner that inadequate amounts of specific vitamins or minerals were consumed. These secondary measures included: mood, morale, cognitive performance, psychomotor performance, physical symptoms, body weight, body fat "and nutritional status as indexed by the circulating levels of selected blood constituents. In addition, water intake and body fluid status were measured to provide a basis for evaluating whether thirst and/or dehydration contributed to or caused inadequate food intake if this outcome developed.

Another consideration in designing this experiment was that the MRE is designed to be used by troops engaged in combat. For this reason the test modelled as closely as possible the manner in which troops actually eat in the field. This consideration led us to allow the troops to trade items within the MRE menu, and it also led to the decision to provide the troops with hot sauce for their rations. Hot sauce is widely used by US troops in the field and by providing it to them, we hoped to prevent any other foods from being smuggled into the field. The actual availability of outside sources of food in the field was strictly controlled. The design of the field test was coordinated closely with the command group of the participating troops so as not to interfere with the actual training mission of the field exercise, and the testing schedule was set up around the training requirement.

Method

Design. Two combat support companies from the 2nd Brigade of the 25th Infantry Division participated in the test. The experimental company subsisted for 34 days on the MRE as their sole source of food. The control company ate both the MRE and freshly prepared meals which are called an A ration, specifically a hot A ration breakfast, an MRE lunch and a hot A ration dinner. The MRE company was issued three MRE meals at the beginning of each day and were free to consume the components during the course of the day as time permitted. The control company was fed its hot breakfast and dinner meals at scheduled times. The actual times for the control company varied from day to day. On some days the troops were fed the hot meals in the area of a mess tent whereas on other days the hot meal was brought in insulated food containers to the location in which the troops were training. On the days that the control company was training in the general vicinity of the mess tent, beverages including coffee, fruit juice and milk were available at non-meal times. The control company was given its MRE meal after breakfast and were free to consume it during the remainder of the day. In all other ways the two companies were equivalent and were tested in the same manner and at the same frequency.

Test Subjects. All troops from both companies participated in the test including the NCO's and the officers. Within each company a sub-sample of 30 men volunteered to undergo more intensive testing (urine and blood analyses, food and water intake, cognitive and psychomotor performance testing)

The daily level of physical activity of a typical soldier in a combat support company is best characterized as moderate. The majority of troops in a combat support company spend their day in a vehicle and typically do not engage in extended running or movement on foot.

Test Site. Baseline testing took place at Schofield Barracks, Oahu, where the 25th Infantry Division is stationed. The field test took place at the Pohakuloa Training Area (PTA), Hawaii during August/September 1983. The elevation at PTA is approximately 6,000 feet. The terrain is rugged, dry and dusty except for heavy morning mist at elevations higher than base camp. The climate is warm (70-85°F) during the day and cool at night (40-60°F). The site is remote from towns, thereby minimizing the availability of outside sources of food. All subjects remained in the field exercise area except for the three mornings when the volunteers in each company came to the base camp. On these mornings physiological and psychological data were collected.

Procedure. Ten days prior to the start of the field test the following data were gathered from all men in both companies: (1) food preferences (g-point hedonic scale), (2) US Surgeon General's Environmental Symptoms Questionnaire of 67 items, (3) Profile of Mood States (POMS), (4) Leadership Evaluation and Analysis Program Interaction Inventory Adjunct Numbers 1,2 and (5) body weight. These measures, with the exception of body weight, were repeated three times during the field test at approximately equal intervals (T_1 = days 11/12, T_2 = days 23/24 and T_3 = days 33/34) with the two companies tested on successive days. In addition, on these same days, the volunteers within each company underwent additional testing and on these individuals the following measures were taken: (6) body weight, (7) skinfold thickness at several sites, (8) nutritional status blood levels of Vitamin C, retinol, pyridoxal phosphate, folate, total protein, plasma albumin), (9.) body fluid status (urine volume, urine osmolality, hematocrit, and hemoglobin, (10) cognitive tests (Sternberg Memory Scanning Task, Baddeley Grammatical Reasoning, Wechsler Digit Span, Digit Symbol Substitution Task, Simple Mental Addition, Mental Addition with Coding) and (11) psychomotor tests (Ball-pipe Test, Atari video game, and Spoke Test). Height was also measured in the volunteers prior to the study so that percent body fat could be computed from the height, weight and skinfold thickness measures using the standard AMEDD procedure.

Food intake, water intake and food acceptability were measured in the thirty volunteers in each company during four test periods. The four test periods consisted of days 8-9-10 (Period A), 15-16-17 (Period B), 21-22-23 (Period C) and 31-32 (Period D). Food acceptability data were also collected from another 15-30 men in each company at each meal on the days that consumption and acceptability data were collected from the volunteers. Table 1 shows the testing schedule for both the entire group and for the thirty volunteers who were studied more intensively.

Results

The MRE items that were consumed were very well received by the troops in both companies with average acceptability scores of 7.05 for the MRE group and 6.48 for the control group on a g-point hedonic scale. The MRE group also rated the MRE higher than the control group rated comparable hot A ration meals. There was no indication of a decline in the acceptability of the MRE over the 34 days of the field test. The MRE was rated higher for lunch and dinner than it was for breakfast.

Although these high ratings indicate that the items consumed by an individual were highly acceptable to him, an examination of the consumption data for each of the foods classes reveals that of the item distributed, the following percentages were actually eaten by the troops: entrees - 68%, starch items - 60%, spreads - 47%, fruits - 51%, desserts - 50%, beverages - 27% and condiments and candies'- 26%.

The final questionnaire about the MRE was consistent with the acceptability data. It revealed that the troops were generally satisfied with the ration's taste, appearance, variety and ease of preparation. Their ratings of the amount of food it provided were in the neutral range and more detailed questions indicated that they felt that the portion sizes of some components were too small. Responses to the questionnaire also revealed four potential areas in which the ration could be improved: (1) the troops indicated that the entree and the dehydrated fruit portion sizes were too small. (2) The MRE group indicated that they liked the ration better for lunch and dinner than for breakfast. (3) The troops overwhelmingly indicated that they wanted more variety in the beverages that were included in the ration. (4) The MRE group indicated that they did not consume the ration at designated meal times.

Despite its high acceptability and the troops' satisfaction with the ration, the MRE was not consumed in sufficient quantity. Daily caloric intake averaged 2,251 calories for the MRE group and 2,957 for the control group. Both values are considerably below the recommended level of 3,600 calories for operational rations. The MRE group showed a decline in daily caloric intake over the course of the field test, whereas daily caloric intake tended to remain stable in the control group.

The low food intake did not appear to be due to dissatisfaction with the sensory properties of the ration (taste, smell, appearance) or to thirst-induced anorexia. Water intake of the MRE group was somewhat lower than that of the control group (2,678 ml/day vs. 3,128 ml/day), but was not low enough to produce increased reports of thirst or significant changes in the monitored indices of body fluid status (urine osmolality, hematocrit and hemoglobin). Rather, the low food intake in the MRE group appears to result from several factors including: loss of appetite, absence of scheduled meals, small portion size of highly rated and consumed entree items, lack of breakfast items in the ration, and the limited variety of beverages in the ration.

The major consequences of the low food intakes were body weight loss and some vitamin and mineral intakes that were below recommended levels. The majority of troops in both companies lost weight during the 34 day field test (69 of 71 in the MRE company and 57 or 68 in the control company), but the men in the MRE company lost significantly more weight than those in the control company (8.2 pounds vs. 4.6 pounds). Both groups had intakes of niacin and magnesium that were below the recommended levels and the MRE group had intakes of riboflavin, calcium and iron that were below recommended levels.

The other measures that were taken to evaluate any effects of prolonged feeding the MRE or any possible effects of nutritional deficiencies that developed did not reveal any major differences between the two companies. The questionnaire data on the incidence of physical symptoms showed that the two groups showed similar profiles of complaints and discomforts during the field test, but of the 67 possible symptoms on the questionnaire, the two symptoms reported at the highest frequency were: "I feel good" and "I feel alert." There were, however, two important food-related symptoms that were reported at a higher frequency by the MRE group. The MRE company reported that they had lost their appetite and that they experienced gas pressure more frequently

than the control group. The MRE company did not differ from the control company on any of the six mood scales, and both companies showed an improvement which might be a test artifact, In a similar manner, the two companies did not differ from one another on measures of morale and perceptions of leadership, which were positive and stable over the four data collection points.

The performance of the troops in the two companies did not differ on a test battery of cognitive and psychomotor tasks. The test battery measured hand-eye coordination, speed of gross arm movements, accuracy and speed of aiming at stationary and moving targets, reaction time, memory scanning rate, short term memory capacity, speed and accuracy of coding digits into symbols, grammatical reasoning,and the speed and accuracy of arithmetic problem solving. Within the MRE company, the performance of the individuals who lost the most weight (greater than 7% body weight loss) did not differ from the performance of those who lost the least amount of weight during the field test.

Despite the low levels of food intake, nutritional status as indexed by measures of hemoglobin, hematocrit, plasma albumin, plasma total protein, serum Vitamin C, serum folate, plasma pyridoxal phosphate, serum retinol and serum zinc did not reveal significant differences between the two companies or values that were outside the normal range. Plasma albumin and total protein were consistent with adequate protein status. Values for serum Vitamin C were normal throughout the field trial. Values for retinol were at the upper range of normal levels. Serum folate values fell during the field test in both companies, but not below normal limits. Plasma pyridoxal phosphate concentrations remained unchanged during the field test in the control company, but rose above normal levels in the MRE company. Serum zinc remained within normal limits in both companies. Thus, the data on selected blood constituents indicate nutritional status was not compromised by subsistence on the MRE for 34 days.

In summary, feeding an operational ration to troops as the sole source of food for 34 days did not appear to negatively affect food acceptability, nutritional status, or cognitive and psychomotor performance. The troops, however, did lose more weight than those fed a more conventional and more varied diet. By redesigning the Meal, Ready to Eat ration based on these findings, it is predicted that increased consumption can be realized. Such redesign and retesting is now underway. This study also raises important basic questions about the mechanism of food monotony and the importance of scheduled meal times for inducing higher food consumption.

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Table 1

Testing Schedule for Prolonged Feeding of Meal, Ready to Eat (MRE) Rations

MEASURES	FREQUENCY	WHEN	SAMPLE
1 - Food-related Measures			
a. Food Preference	4x	Baseline, T_1, T_2, T_3	100%
b. Food Acceptability	11 days	Periods A,B,C,D	100%
c. Food and Water Consumption	11 days	Periods A,B,C,D	Volunteers
2 - Nutritional Status			
a. Body Weight	4x	Baseline, T_1, T_2, T_3	Volunteers
	2x	Baseline, T_3	Non-volunteers
b. Anthropometry height, skinfold thickness	2x	Baseline, T_3	Volunteers
c. Body Fluid Status	4x	Baseline, T_1, T_2, T_3	Volunteers
d. Blood Constituents	4x	Baseline, T_1, T_2, T_3	Volunteers
3 - Clinical Symptoms			
a. Symptoms Checklist	4x	Baseline, T_1, T_2, T_3	100%
b. Weekly Availability of Physician			
4 - Psychological Tests			
a. Cognitive & Psychomotor Performance	4x	Baseline, T_1, T_2, T_3	Volunteers
b. Mood	4x	Baseline, T_1, T_2, T_3	100%
c. Morale & Perceptions of Leadership	4x	Baseline, T_1, T_2, T_3	100%

PROCEEDINGS

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