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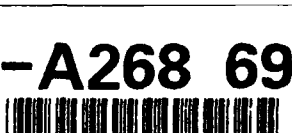

Cold Weather Field Evaluation of the 18-Man Arctic Tray Pack Ration Module, the Meal, Ready-to-Eat, and the Long Life Ration Packet

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The Army Field Feeding System was evaluated for its ability to provide adequate nutrition and hydration during a 10-day cold weather field exercise. Soldiers consumed the 18-Man Arctic Tray Pack Ration Module with either a wet-pack (Meal, Ready-to-Eat) or a dehydrated (Long Life Ration Packet) individual ration. Both feeding regimens were acceptable, meeting protein and micronutrients requirements. However, the soldiers consumed only 70% of their energy requirement, thus losing an average of 0.9% of body weight. This weight loss, although not excessive, underscores the importance of maintaining an adequate food intake during extended cold weather military field operations.

Introduction

The major problem of cold weather feeding during field operations is providing adequate quantities of water and warm palatable food to meet energy demands.[1] Various studies[2-5] have evaluated the nutritional and logistical suitability of using different individually packaged operational rations in a cold environment. These studies have shown that the rations tested (the Meal, Ready-to-Eat [MRE]; the Ration, Cold Weather [RCW]; or the Ration Lightweight [RLW]) are similar in maintaining nutritional status and body weight.

The purpose of this test was to assess the nutritional and hydration status of soldiers consuming a group feeding alternative (18-Man Arctic Tray Pack Ration Module [Arctic T]) with one of two individually packaged rations, a wet-pack (MRE) or a dehydrated (Long Life Ration Packet [LLRP]) ration, during a cold weather field training exercise.

Methods

Subjects

The test was conducted with 96 volunteer male soldiers from two batteries (A and B) from the 5/11th Field Artillery Battalion of the 6th Infantry Division (Light), for 10 days (January 28 to February 6, 1991), during the Arctic Warrior Field Training Exercise held at Fort Greely, Alaska. After receiving verbal and written explanation of the purpose of the test, the soldiers volunteered by signing a Volunteer Agreement Affidavit. The soldiers were housed in tents heated by "yukon" stoves and remained in the field for the duration of the test.

Rations

The MRE is the current standard operational ration. It is an individual meal containing mainly thermo-processed (wet-pack) food components which require no preparation except for reconstitution of beverages. There are 12 menus available, each containing an entree, crackers, a spread, cold beverage powder, a dessert, and an accessory packet. The average energy per menu is approximately 1,300 kilocalories. Each meal has an average gross weight of approximately 1.5 pounds.

The LLRP is an individual dehydrated/low moisture meal package. There are eight menus available, each containing an entree, a cereal bar, a cookie component, a candy component, an instant beverage, and an accessory packet. The entrees are pre-cooked, freeze-dehydrated, and can be reconstituted rapidly with either cold or hot water. The average energy provided is 1,400 kilocalories per meal for the commercial entree prototype. The LLRP is lightweight, weighing less than 1 pound.

The Arctic T is composed of a variety (10-day breakfast/dinner menu) of wet-packed entree, vegetable, dessert, and starch items that have been thermo-processed in flat, rectangular, multi-serving, half-size steam table metal cans, and are ready to heat and serve. This ration is supplemented with ultra high temperature-treated milk, cold cereal, and a calorie supplement module (pouched bread, cocoa beverage, M&M candy, oatmeal cookie bars, and dehydrated soup). The Arctic T ration provides approximately 2,200 kilocalories per meal.

Treatment Groups

The two batteries were located at different sites in the Fort Greely training area and consumed the rations being tested as their sole source of food. Both batteries received identical Arctic T (T) menus for breakfast and dinner meals, while the lunch meal consisted of an MRE for B Battery (T/MRE/T group, $n = 45$) and an LLRP for A Battery (T/LLRP/T group, $n = 51$).

Data Collection

Meteorological Data

Meteorological data were recorded daily by the Atmospheric Science Laboratory, Alaska Meteorological Team at Fort Greely.

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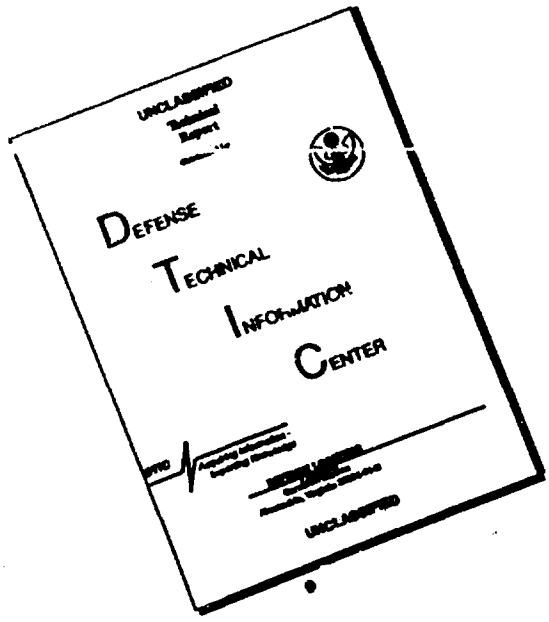

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Height

Height was measured prior to the test while the soldier stood, without shoes or hat, pressing his back and heels against a wall.

Body Weight and Percent Body Fat

Pre- and post-test body weights (±0.05 kg) were taken before breakfast with soldiers dressed in undershorts and socks. Pre- and post-test percent body fats were estimated using circumference measurements at neck and abdomen.[6]

Food and Fluid Intakes

Daily food/fluid consumption from the breakfast and dinner meals was gathered by data collectors trained in the use of a validated modified visual estimation technique.[7,8] Each soldier received a standard food tray assembled in a central distribution tent. Upon completion of the meal, a data collector recorded the amount of uneaten food for each soldier. The soldiers self-reported on Diet Logs their lunch, snacks, and water/fluid intakes.

Ration Acceptability

Daily acceptability of ration food items was determined using a 9-point hedonic scale (9 = "like extremely"; 1 = "dislike extremely").

Urine Analysis

A first void, morning, midstream urine sample was collected daily and analyzed for specific gravity.

Human Factors

Human factor issues were assessed utilizing questionnaires (Soldier Science Directorate of the Natick, RD&E) completed by the soldiers on the last day.

Data Analysis

Repeated measures ANOVA (BMDP2V and SPSS-X MANOVA) was used to compare daily measures of nutritional and hydration status. Nutritional intake was compared with the Military Recommended Dietary Allowances (MRDA).[9] Pre- to post-test changes in body weight and body fat were assessed by paired *t* test. Group differences of ration acceptability and human factors were assessed by *t* test. The level of statistical significance was $p \leq 0.05$.

Results

Meteorological Data

Average temperature during the test was −19°F (median = −22°F), ranging from a maximum of +17°F to a minimum of −38°F. Average relative humidity was 64.5%, ranging from 59 to 73%, and there was no precipitation. Solar radiation ranged from 4 to 59 Langleys. There were approximately 7 hours of daylight per day.

Demographic and Anthropometric Data

The soldiers were homogeneous in respect to age, height, initial body weight, and initial percent body fat (Table I). Both groups lost similar amounts of body weight (mean ± SEM, −1.97 ± 0.36 kg and −1.06 ± 0.40 kg for T/MRE/T and T/LLRP/T, respectively). This weight loss was similar between groups, but it was significantly decreased for each group.

The body fat loss was significant within and between groups (mean ± SEM, −1.42 ± 0.13 and −0.69 ± 0.13 kg for T/MRE/T and T/LLRP/T, respectively) (Table I).

Nutrient Intake

The mean nutrient intakes presented were calculated from soldiers with complete data sets ($n = 37$ for T/MRE/T and $n = 32$ for T/LLRP/T) (Table II). Meals skipped are shown in Table III and are included in these data as zero intake.

Mean macronutrient intakes are shown in Table II, while mean daily energy intake is shown in Figure 1. The caloric distribution of the rations consumed by the T/MRE/T group was 46% carbohydrate, 16% protein, and 38% fat. The T/LLRP/T group consumed 50% carbohydrate, 15% protein, and 36% fat.

Skipped Meals

There was a modest negative correlation ($r = -0.44$; $p \leq 0.01$) between food intake and number of meals skipped. Although there was no difference in the number of skipped meals between groups, there was a distinct pattern for which meals were skipped more often within the groups (Table III). The reasons for the skipped meals were not acquired from the soldiers, but probably were due to unanticipated mission requirements and time constraints.

Ration Acceptability

Figure 2 contains summary ratings of overall acceptability, amount of food, variety, taste, and appearance of the rations. The LLRP was rated significantly higher than the MRE for all aspects. The contents of the MRE and the LLRP were divided into seven food categories, and the mean acceptability ratings are presented in Figure 3. Figure 4 shows a comparison between the food items sharing a common name in the two rations (MRE items were wet-pack, while the LLRP items were dehydrated).

The Arctic T acceptability ratings for breakfast, dinner, and supplement are shown in Figure 5.

TABLE I

SOLDIERS' DESCRIPTION

		Age			Weight			Body Fat		
	n	Median (years)	Range (years)	Height (cm)	Pre (kg)	Post (kg)	Δ (%)	Pre (%)	Post (%)	Δ (%)
T/MRE/T	51	24	18-39	174	78.4	77.5	-1.1	16.7	15.1	-10.6
T/LLRP/T	45	23	18-38	176	79.6	79.1	-0.6	17.2	16.5	-4.9[a]

[a] $p \leq 0.05$.

TABLE II

MILITARY RECOMMENDED DIETARY ALLOWANCES AND MEAN DAILY NUTRITIONAL INTAKE

Nutrient[a]	Unit	MRDA[b]	T/MRE/T (n = 37)	%MRDA	T/LLRP/T (n = 32)	%MRDA
Energy	kcal	4,500	3,271 ± 144	73	3,035 ± 106	67
Protein*	g	100	134.3 ± 5.0	134	110.6 ± 3.4	111
Carbohydrate	g	619[c]	375 ± 19	61	376 ± 16	61
Fat*	g	175[c]	138 ± 6	79	123 ± 4	70
Thiamin*	mg	1.6	3.79 ± 0.30	237	1.90 ± 0.10	119
Riboflavin*	mg	1.9	3.08 ± 0.10	162	2.50 ± 0.10	132
Niacin	mg NE	21	26.87 ± 0.86	128	27.60 ± 1.11	131
Vitamin B_6*	mg	2.2	2.13 ± 0.15	97	1.27 ± 0.06	58
Calcium	mg	800–1,200	1,445 ± 57	145	1,107 ± 53	111
Phosphorus*	mg	800–1,200	2,119 ± 79	212	1,787 ± 59	179
Magnesium	mg	350–400	374 ± 15	100	361 ± 14	96
Iron*	mg	10–18	18.71 ± 0.66	134	17.11 ± 0.54	122
Sodium	mg	5,500[d]	5,846 ± 286	106	5,651 ± 234	103

Values are mean ± SEM.

[a]Rows with an asterisk (*) indicate a statistically significant difference ($p \leq 0.05$) between groups.

[b]Military Recommended Dietary Allowance for males ≥ 17 years old, for a cold environment (< 57.2°F).[9]

[c]Military feeding guidelines suggest energy intake to be 50–55% from carbohydrate and 35–40% from fats.[9]

[d]Maximum amount allowed.

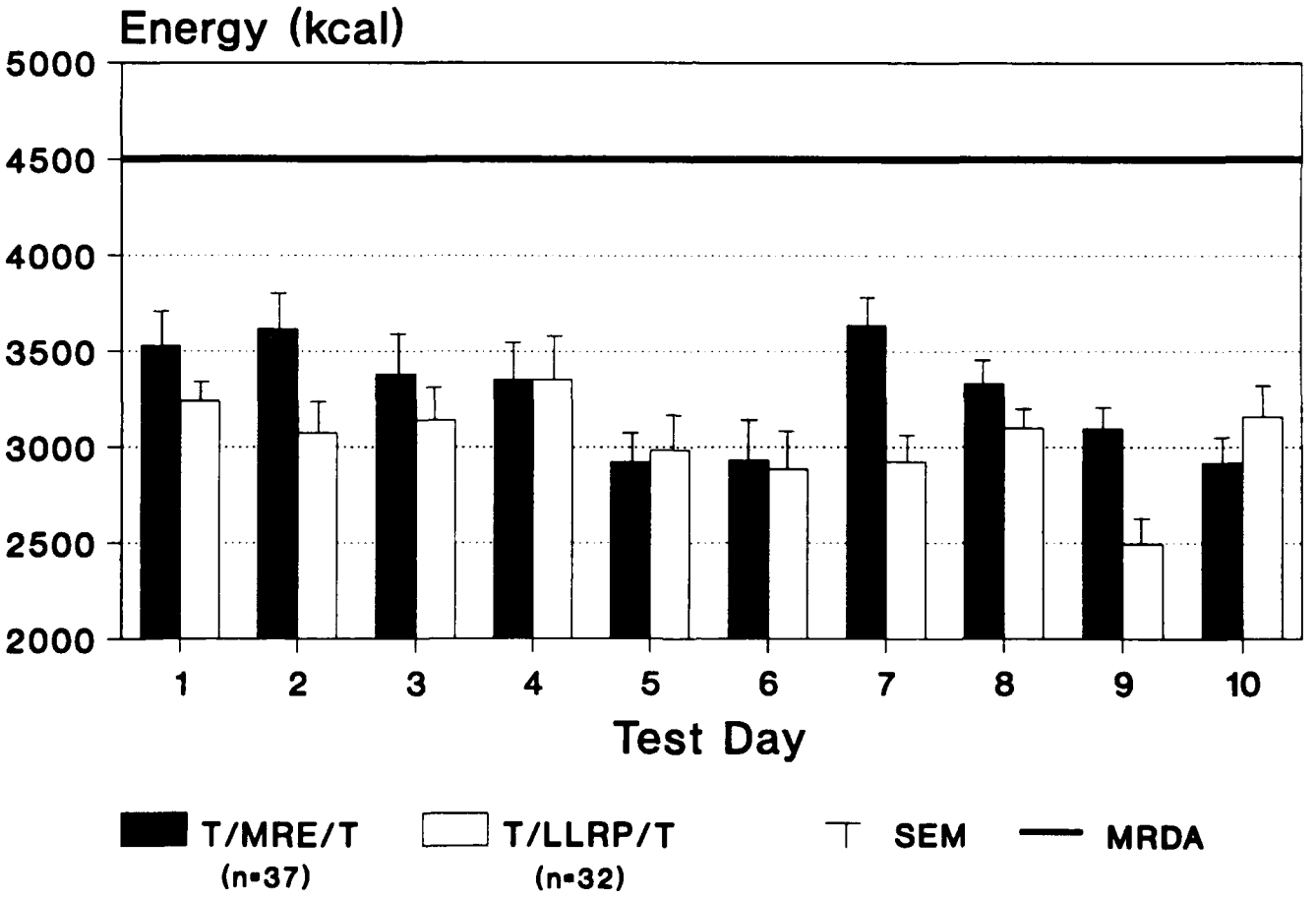


Fig. 1. Mean daily energy intake.

TABLE III

NUMBER OF SKIPPED MEALS

	Breakfast	Lunch	Dinner	Total
T/MRE/T	5	40	7	52
T/LLRP/T	17	17	23	57

Values = number of soldiers who skipped the specified meal during the test period.

The frequency of frozen rations may have affected ration acceptability (Table IV). Damage to the ration packets was not identified as a problem by either group.

Fluid Intake and Hydration Status

There were no significant differences between the groups' reports on difficulty of obtaining water. Both groups found it "slightly easy" to obtain water and "almost always" obtained enough. The most frequent reason given for not drinking enough was that their water was frozen, 23.5 and 50% reported this in the T/MRE/T and T/LLRP/T groups, respectively.

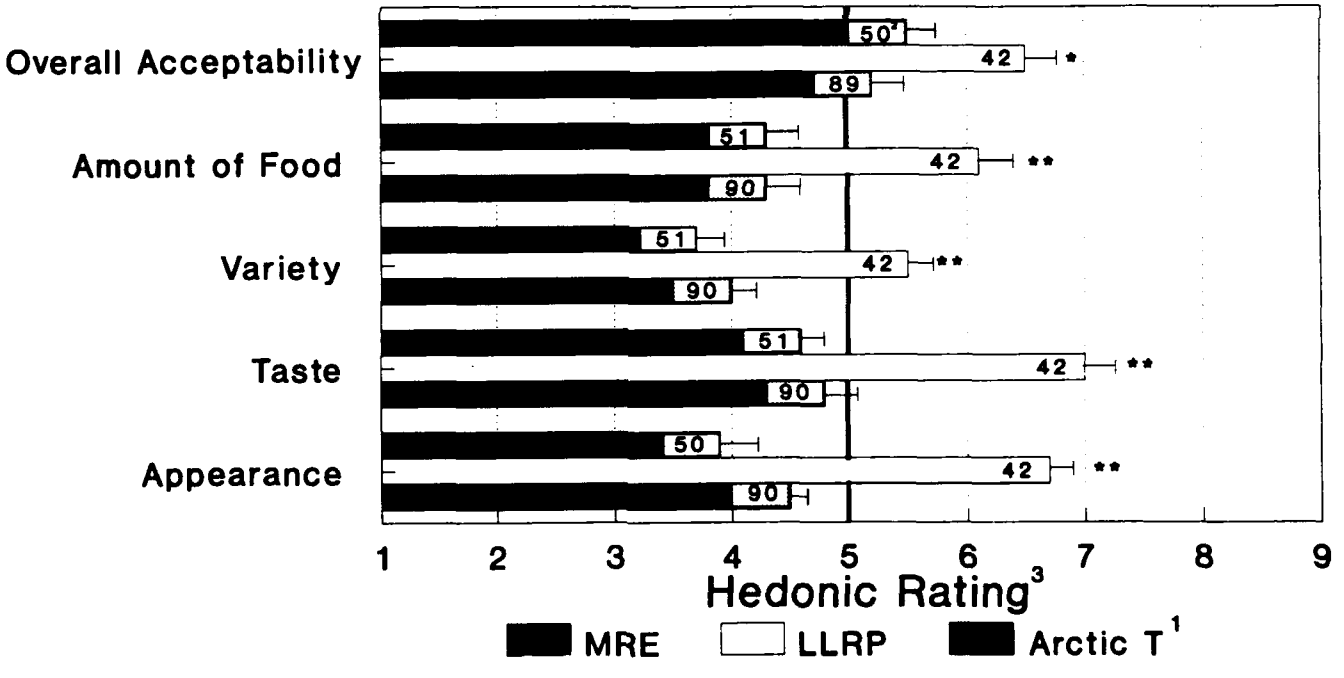
Mean total fluid intake (includes water from canteen, rehydration of foods, and wet-pack food items) and urine specific gravity are presented in Figure 6. Overall, total fluid intake and hydration status between groups were not significantly different, although they varied from one day to the next.

Discussion

The U.S. Army has recommended that a minimum of 4,500 kcal per day be made available for soldiers working in the cold.[9] Soldiers garrisoned in cold weather regions, if adequately clothed, require approximately the same amount of calories as soldiers engaged in similar temperate garrison activities. Energy requirements increase in proportion to the amount of time spent patrolling on foot, snowshoes, or on skis.[10] Small unit movements in the cold requiring packing and moving equipment; and breaking-down, moving, and re-establishing bivouacs, result in high levels of energy expenditure. Thus, energy requirements for cold weather field operations are quite variable and difficult to estimate. Energy expenditure measurements for this test are reported elsewhere[11] and were close to the military recommendations (mean ± SEM, 4,253 ± 151 kcal).

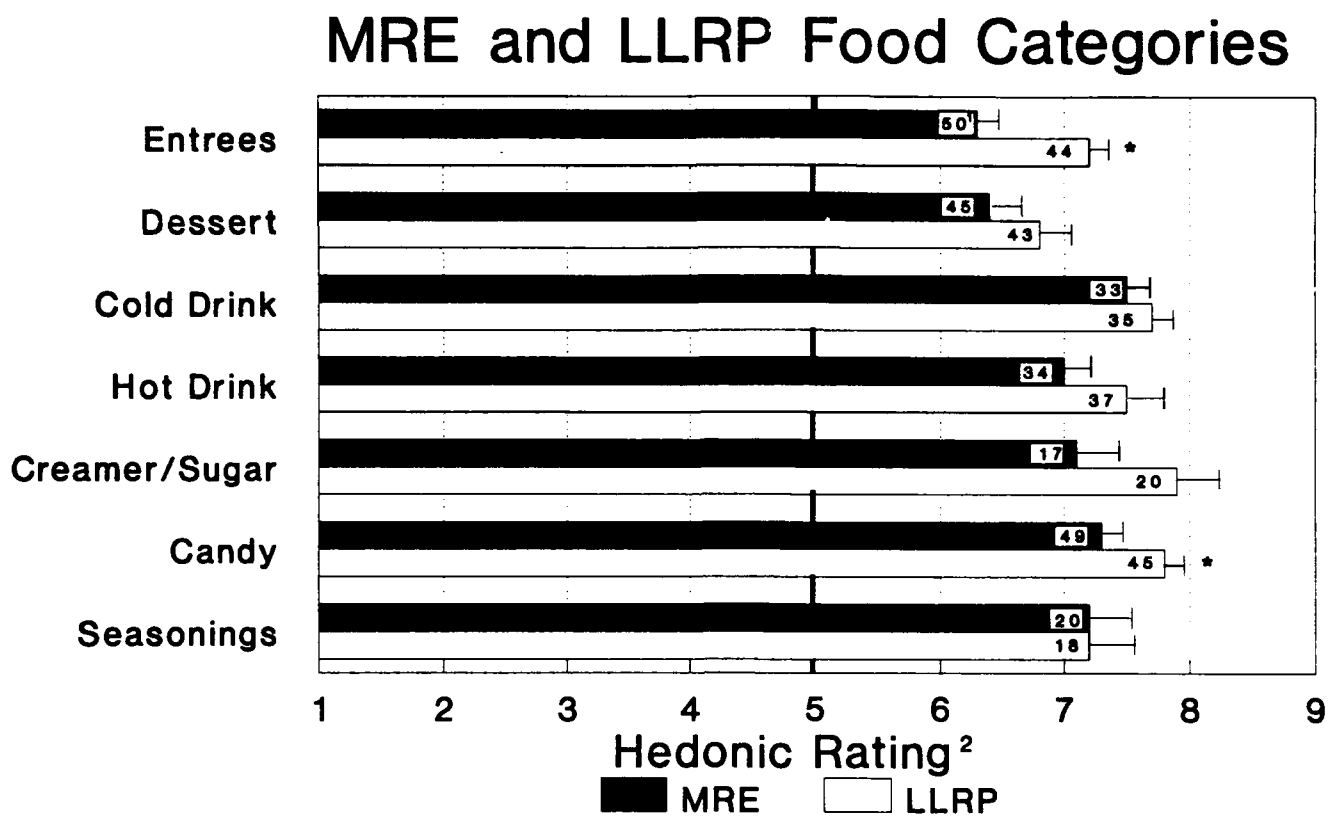
Although the soldiers in this test were provided with more than an adequate supply of rations (approximately 6,500 kcal), they did not consume enough food (mean intake approximately 3,100 kcal) to meet energy expenditures. Several factors are known to influence field ration consumption: customary food intake including food frequency and preference,[12] ration acceptability, ease of preparation,[13] availability of water,[14,15] hypohydration, ration temperature, monotony,[16,17] and palatability.[16]

Overall, water consumption and hydration status were similar for both groups, and hydration probably played a minor role



[1] Combined Arctic T Rating (T/MRE/T and T/LLRP/T groups).
[2] Mean rating and SEM (—|) from the number of soldiers consuming the ration.
[3] Nine-point hedonic scale (9=extremely satisfied, 5=neutral, 1=extremely dissatisfied).
* $p \leq 0.05$; ** $p \leq 0.01$

Fig. 2. Comparison of MRE, LLRP, and Arctic T rations.



¹Mean rating and SEM (—|—) from the number of different soldiers consuming the ration.
²Nine-point hedonic scale (9=like extremely, 5=neutral, 1=dislike extremely).
* $p \leq 0.05$

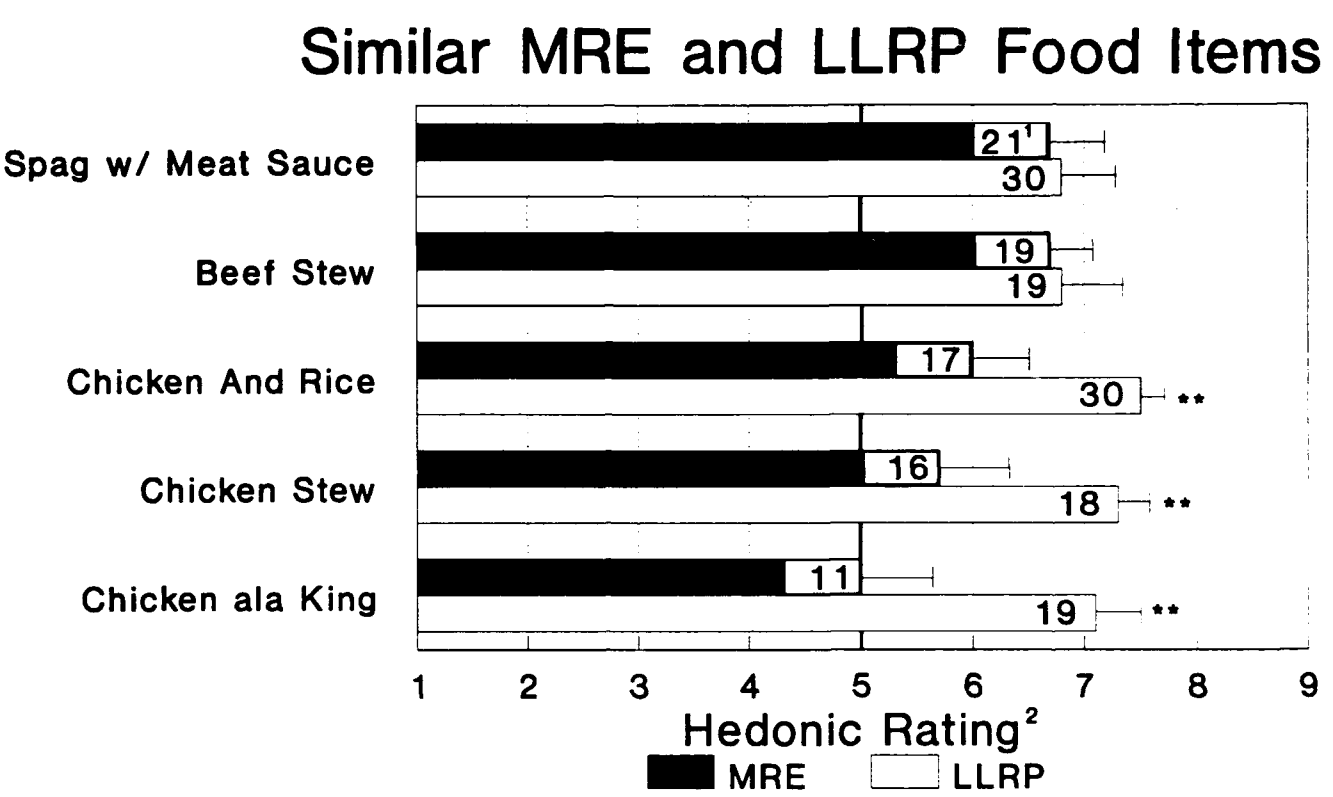
Fig. 3. Comparison of MRE and LLRP food categories.

in differences between the two feeding regimens. The nutritional intakes observed in this test were similar to those of a previous military field study,[5] suggesting that the cold weather military feeding regimen customarily results in generally adequate micro-nutrient intakes but less than adequate energy intakes.

While the T/LLRP/T group gave the dehydrated LLRP higher ratings than the T/MRE/T group gave the MRE, the amount consumed of the two rations did not differ. The T/LLRP/T group may have been giving higher ratings because of the novelty of the new ration (the LLRP was packaged in a colorful commercial packaging) or they were comparing it to the MRE, which most had eaten before. In fact, the T/LLRP/T gave significantly higher ratings for the candies which were similar to the MRE candies. They also rated several of the Arctic T food groups significantly higher than the T/MRE/T group did, even though both groups had the same items. This difference may have been caused by a "halo effect" of the novel ration.

The T/LLRP/T group rated the LLRP as being easier to use than the T/MRE/T group rated the MRE. Although most foods in the MRE are convenient to use (ready-to-eat), they are bulkier and heavier than the dehydrated rations. Further, their water content makes them susceptible to freezing, requiring thaw-out time. The LLRP, on the other hand, is too dry to freeze. However, it requires additional water to adequately utilize most of the food components in it. Further, the logistical problem of procuring an adequate supply of unfrozen water increases under arctic conditions. In this test, however, the problem of dehydrated rations was not apparent because water was readily available, and the dehydrated rations were consumed only once a day.

Group feeding rations are used to relieve the monotony of individual packaged rations when centralized feeding is possible. Historically, when the T ration (Arctic T ration without the calorie supplement module) was being used in cold climates, it was supplemented with warming beverages at the unit level. This practice not only enhanced soldiers' morale, but it increased the caloric content of the ration, which otherwise did not meet the MRDA for energy.[9] The Arctic T ration calorie supplement was tailored after the supplements developed by the 6th Infantry Division, based upon their experience in Alaska. This group feeding alternative was well received in this test. Other than the fact that the fruit and milk were often frozen, there were few problems reported with the temperature of the Arctic T ration items. The soldiers reported usually getting the heated items either hot or warm. This was due to the efficient serving method and the insulating styrofoam clam shell food container of the Arctic T ration.



[1] Mean rating and SEM(—|) from the number of different soldiers consuming the ration.
[2] Nine-point hedonic scale (9=like extremely, 5=neutral, 1=dislike extremely).
** $p \leq 0.01$

Fig. 4. Comparison of similar MRE and LLRP food items.

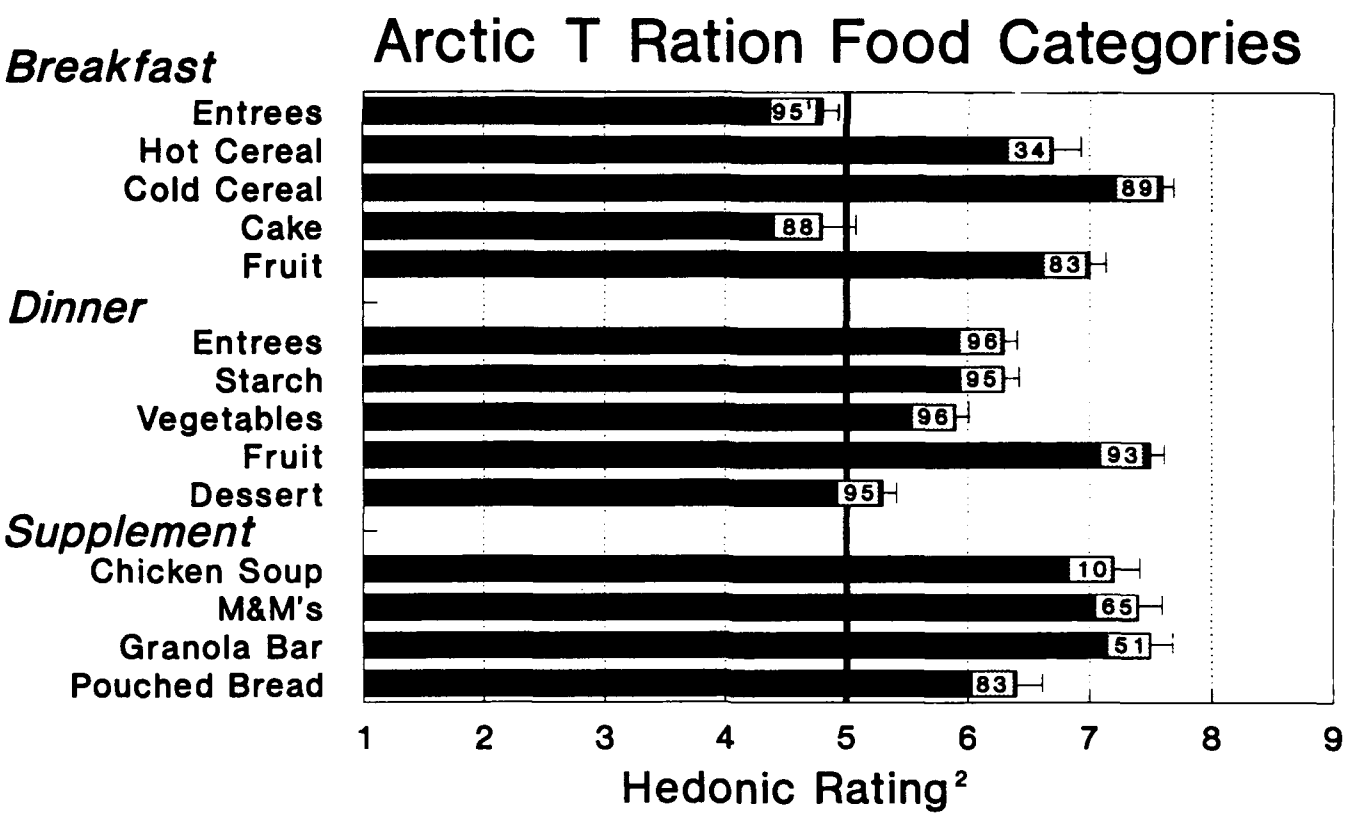
Monotony is a major contributor to decreased ration acceptability and dietary intake.[17] The soldiers in this 10-day test had access to 12 MRE menus or 8 LLRP menus, and they were offered 6 breakfast and 7 dinner menus from the Arctic T ration. Nevertheless, menu variety was not obvious, with six of the breakfast meals having sausage links, and eight of the breakfast meals having "egg squares" (both scrambled eggs and omelets were served in squares). It would be expected that in a short test like this one, monotony would not be an issue. Further, when monotony is the problem, food intake tends to decrease over time. Figure 1 shows a fairly constant intake over time, suggesting that, in this test, monotony was not necessarily a confining factor. This is not to say that the soldiers may have been tired with some of the rations because of their previous field training exercises[2-5] and therefore the decline in food consumption over time was not as evident.

The low energy intake (67 and 73% of energy MRDA for T/MRE/T and T/LLRP/T, respectively) was due to the amount of carbohydrates and fat consumed. Provision of greater quantities of carbohydrates in warming beverages would address both the low energy intake and the marginal carbohydrate intake. It is interesting to note that, in spite of the energy deficit, the subjects in the current test consumed adequate levels of vitamins and minerals, except for vitamin B_6 in the T/LLRP/T group.

Both groups had similar levels of physical activity as indicated by actigraph monitors, activity diaries, and questionnaires, as reported elsewhere.[11] Thus, the similar body weight loss indicates that one ration regimen was not favored over the other. Although the body weight loss was significant for both groups, it was within the guidelines of 3% weight loss for operational rations. Since the soldiers were well hydrated (Fig. 6), energy deficit (Fig. 1) was probably responsible for the weight loss observed. The majority of the body weight loss appeared to have come from the body fat compartment, as indicated by the changes in percent body fat. Weight losses of this magnitude are not serious; however, this rate of weight loss would be of concern during extended military field operations lasting longer than 10 days.

Conclusion

The rations provided in this test (18-Man Arctic Tray Pack Ration Module; Meal, Ready-to-Eat; and Long Life Ration Packet) were acceptable to the soldiers when they could be consumed warm or hot. Since neither feeding regimen, T/MRE/T or T/LLRP/T, was better than the other in preventing body weight loss or maintaining nutritional and hydration status, it was concluded that the choice of a ration combination depends



[1]Mean rating and SEM (—|) from the number of different soldiers consuming the ration.
[2]Nine-point hedonic scale (9-like extremely, 5-neutral, 1-dislike extremely).

Fig. 5. Arctic T ration acceptability ratings.

upon the environmental conditions and mission parameters of soldiers operating in an arctic environment. The final decision should be made very carefully to optimize the performance of the soldiers and may depend upon availability of water and the capability of soldiers to heat it. In some cases, it may be advisable to issue a combination of both the MRE and the LLRP so the soldiers could cope better with a variety of conditions.

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TABLE IV

FREQUENCY OF FROZEN RATIONS

	MRE (%)	LLRP (%)	Arctic T T/MRE/T (%)	Arctic T T/LLRP/T (%)
More than once a day	27.1	0	6.3	4.9
Daily	43.8	14.6	4.2	4.9
About every other day	8.3	2.4	4.2	14.6
A few times	8.3	7.3	25.0	17.1
Once	2.1	4.9	20.8	7.3
Never	10.4	70.7	39.6	51.2

Percentages are from those soldiers who answered the question.

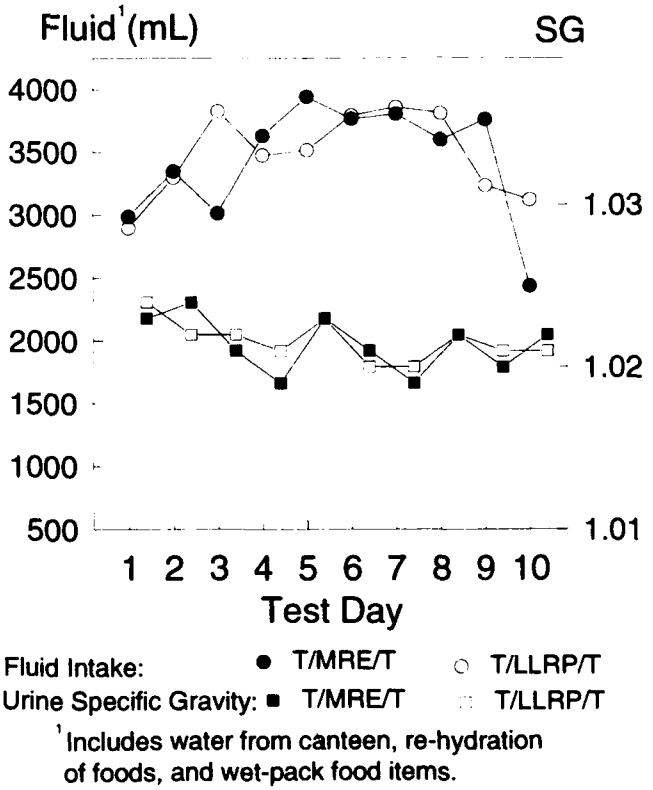

Fig. 6. Mean daily fluid intake and urine specific gravity.

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