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Comparative Field Evaluation of the In-service and Prototype Modular Mission Adaptive Combat Ration Packs

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ABSTRACT

Soldiers rarely consume all the food components issued in combat ration packs (CRP), compromising the adequacy of nutrient intake and the physical and cognitive performance of combatants. Mission adaptive (MA) nutrition—providing soldiers with optimal energy and nutrients when Army operates in contemporary environments and with changing demands—is thought to mitigate risk to performance. In a side-by-side comparison with in-service CRP, a nutrient optimised modular MA CRP design was fielded with dismounted infantry personnel to assess fitness-for-purpose and utilisation over a 6–day use period. Inadequate energy and nutrient intakes were identified as a result of the field trial. A detailed understanding of combatant energy expenditure, current and future risks to health and well-being and performance targets is required to optimise the design and provide a proof of concept. Further product development, potentially including formulated, energy-dense, and commercial-off-the-shelf components, is required to rectify the inadequate delivery of nutrients. Successful implementation of a MA CRP design will require training, education, policy and procedure, and interactive tools for verification of learning, validation of desirable behaviour and realisation of benefits. To provide a proof of concept, further trials are required to assess performance in various operational environments over longer use periods of up to 30 days.

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Executive Summary

Soldiers think and fight better when they are properly fed. However, they rarely consume all the food components issued in combat ration packs (CRP)—often as a result of 'field stripping' to mitigate for operational tempo and environmental constraints when deployed, or simply because they don't like the food. Due to the combined effects of soldiers discarding food components and the poor stability of some vitamins during storage, the adequacy of nutrient intake from CRP during operations can be compromised. Associated with inadequate nutrient intake is the risk of decreased physical and cognitive performance. This has raised concerns about the suitability of the current CRP in the expanded range of Australian Defence Force operations. It is suggested that the problems identified above are interrelated and may be ameliorated through improvements to the configuration of CRP.

The Army Modernisation Plan 2015 has identified the requirement for mission adaptive (MA) nutrition. Mission adaptive nutrition aims to provide soldiers with optimal energy and nutrients when Army operates in contemporary environments and with changing demands. The ability to tailor the rations carried by combatants has the potential to make a critical contribution to combatant performance. Under an Army Headquarters (AHQ) Trial Directive the Defence Science and Technology (DST) Group is conducting research to design, produce and evaluate the use of modular rations in Defence use environments. The end state will enable and support Army combatants and combat support personnel to out-think, outperform and outlast a lethal, agile and adaptable adversary—providing the best nutrition and supplementation for enhanced cognitive and physical performance throughout enduring operations in complex and ambiguous environments.

A modular MA CRP design has been developed that delivers to energy, nutrition and other fit–for–purpose requirements specified in the CRP User Requirement (CRP UR). The MA CRP could potentially replace both current one-person, one-day CRPs, i.e. the Combat Ration One Man (CR1M) and Patrol Ration One Man.

A field trial was conducted to evaluate a prototype MA CRP assembled solely from in-service components and delivering energy and nutrients commensurate with activity category (AC) 3 requirements (energy expenditure of 16 MJ/day). This study was conducted in a side-by-side comparison with the CR1M assembled in FY15/16. Energy and nutrient content requirements for both CRP designs were similar and as assembled met the majority of the AC 3 Military Recommended Dietary Intakes (MRDI). Further developmental work, potentially including formulated, energy-dense, and commercial-off-the-shelf (COTS) components, is required. COTS components including sport/energy gels, jerky, trail mix, high protein and/or carbohydrate bars could reduce the instance of inadequate nutrition being delivered. Future configurations need to provide less CHO with a commensurate increase in protein and fat. Small increases in dietary fibre should also be targeted.

Inadequate energy and nutrient intakes were identified as a result of the field trial. The average calculated daily energy expenditure (EE) of users during the trial (19±2 MJ/day) was above the level of energy provided by the CRP. The average energy intake for users of the MA CRP was 7.9 MJ/day during a 6–day period. Those consuming the CR1M averaged 8.7 MJ/day. Intakes of protein, carbohydrate, dietary fibre, vitamins A, B_6 and E, and minerals (calcium, copper, iodine, magnesium, manganese and potassium) were observed to be significantly inadequate. Additionally a significant excess of sodium intake was also identified.

Longer period studies are necessary to evaluate CRP acceptance and consumption patterns over enduring periods. Short-term studies of CRP use are limited in their ability to recognise and report patterns in consumer behaviour. These patterns may be influenced by mindsets such as 'it's only for a short period, I'll go without now, and feed-up when I return', ease of access to 'jack rations' and ability to swap with other combatants. Longer term studies are required to assess the potential exposure to nutrient inadequacies and inform the requirements for health, well-being and nutrition recovery programs.

Recommendations

To progress the modular MA CRP trials, DST Group recommends AHQ:

- review the reported EE for military tasks in 'ADF Nutrients for the 21st Century' for relevance to today's and future operational missions and tasks in contemporary environments. The review should include consideration of changes in load carriage, operational tempo, duration, location and climate
- conduct a comparative study applying doubly-labelled water and/or indirect calorimetry methods for EE with non-invasive techniques/unobtrusive devices that estimate EE during military-related activities. The aim being to make an informed decision on appropriate devices for field use applications and calculation of correction factors for such non-invasive techniques
- informed by the above, identify and specify the appropriate energy and nutrition required by combatants to adequately maintain health and well-being, and optimise their performance
- better understand and articulate the requirements of users in contemporary operational environments by conducting further field use trials that scope activities:
    - where combatants require energy and nutrients commensurate with AC 2 and AC 4
    - conducted in use environments other than hot climate
    - of longer duration (up to 30 days).
- consider the inclusion of the following additional outputs in the current Trial Directive and associated task documentation:
    - training and education packages for Commanding Officers, combatants and Combat Soldier Support personnel

  - policy and procedure for implementation, use, monitoring and control of MA CRP
  - interactive tools for verification of learning, validation of desirable behaviour and realisation of benefits.

  These outputs would enable the ADF to demonstrate appropriate CRP use, evaluate and where necessary change consumer behaviour through reinforcement of learning

- evaluate current field feeding practices in order to identify the hazards and mitigation strategies to reduce the risks to health when sustaining on CRP
- assess combatant's tolerance for CRP load burden, within the broader scope of the soldier combat ensemble load. Measure and compare the maximum, the actual and the desired CRP load burden users are prepared to carry during an expanded range of operations over enduring periods. This will confirm or refine the appropriateness of the current weight target of <1600 g
- include assessment of body weight and composition to understand the prevalence and significance of change to individuals' health status when subsisting on CRP for long periods
- better understand what function and level of performance food has in maintaining and potentially enhancing cognitive performance. Outcomes from this work should be used to influence CRP design in both product selection and eating behaviour.

In considering future configurations of the modular MA CRP, DST Group recommends:

- component selection focus on:
  - achieving functional and performance targets—include fortified components, offer variety and convenience (reduce impost on time, effort and equipment), hygienic in delivery
  - delivering adequate energy and nutrition
  - promoting high level consumption
  - reducing load burden—include energy dense and nutrient rich components (particularly those used in the meals modules). Product concepts including the combat food bar, COTS meal-in-a-bar and freeze dried products should be introduced to the MA CRP menu configuration
- well-consumed, highly accepted and nutritionally 'valuable' components be retained. Further, the weight of these popular items could be increased, and in doing so potentially increase the likelihood of improved nutrient intakes and a cost benefit—reducing the number of components required to ensure the MRDI requirements are met
- the value and continued use of unpopular, poorly consumed 'at risk' components (such as those more vulnerable to cross-contamination) be assessed. If continued use is justified, component improvement, COTS substitution and use of alternative

packaging are all strategies to improve utility of such components in military use environments

- removing rigid cans and aluminium tubes used to package CRP components
- introducing single use drink pouches for drink powders including sports drinks and 'protein shakes'
- introducing wet wipes and hand sanitiser in a potential field hygiene pack.

To improve the design and use of in-service CR1M, DST Group recommends:

- the energy content of CR1M be reduced to 16 MJ. This is 1.8 MJ lower than the current average energy content
- the energy and nutrient non–compliances identified in CR1M be addressed. This includes reducing saturated fat, CHO (particularly sugar) and sodium, while increasing micronutrient content, particularly vitamins B_2, B_6 and E and copper. Actions could include:
    - removing discretionary salt (reducing sodium by ~760 mg/day)
    - halving the salt content in those components currently contributing significant amounts to the daily provisioning (including retort meals, soup mixes and noodles condiments)
    - introducing low level (~20% MRDI) fortification of the suite of vitamins in key highly consumed CRP components including long life bread, wet (retort) meals, cheese, fruit, cereal and meat-based bars and drink powders
    - introducing product concepts, not currently included in CRP, which combatants are regularly using. This should include trail mixes, jerky and food bars.
- the 'brew kit' be re-configured with a focus on convenience and waste minimisation to justify continued inclusion. Coffee/sugar/milk or tea/sugar/milk could be consolidated as single serve, pre-mixed, hot drink sachets.

To further understand the ability of CRP to provide the required nutrients, evaluate compliance of the following:

- vitamins B_{12}, D, K, folate and pantothenic acid
- molybdenum.

Authors

Ms Tracey McLaughlin
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Tracey graduated from La Trobe University with a B.App.Sc. (Honours). Since joining Defence Science and Technology (DST) Group, Scottsdale in 1994 she has worked at the bench in food chemistry, food microbiology, sensory evaluation and food technology laboratories (for food and packaging T&E). Tracey has contributed to the development and evaluation of various current and prototype ration packs, investigating the nutritional content, product compliance and user acceptability.

Her current role is to advise on the food science and technology aspects of Defence combat feeding systems. In particular, in setting and reviewing specifications and standards for food and packaging, quality assurance of food and packaging and logistics of combat ration packs and their components.

Tracey's current research interests include investigating the design requirements (strategic, capability and operational) for future military ration packs and optimising the supply chain to deliver safe, palatable and serviceable combat rations.

Ms Jeanine De Diana
Land Division

Jeanine commenced work at DST Group Scottsdale in 2009 and has gained experience in physical and sensory analysis of food in the quality assurance program for shelf life assessment, verifying food safety and quality of CRP components. She has contributed in the drafting, reviewing and publishing of DEF(AUST) standards. Jeanine holds a Bachelor of Science (Food Technology) (Honours) from the University of Newcastle and is currently a Science Team Leader for the Quality Assurance program.

Mr Sean Bulmer
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Sean is an exercise scientist. During 2016 Sean worked as a Human Performance Science Research Assistant at DST Group Melbourne through The University of Wollongong. During this time Sean focused on developing Physical Performance Standards for The Royal Australian Air Force. Sean's research background has comprised field and laboratory data collection as well as use of psycho-physiological surveys. As of 2017 Sean is studying relationships between training load, hormones, sleep and psycho-physiology during Australian Army Basic Recruit Training as a topic for his PhD candidature. He will complete his candidature in early 2020.

Mr Angus Pike
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Angus is a Sports Scientist employed as a Research Assistant by the University of Wollongong (UOW), embedded at Defence Science and Technology (DST) Group, Melbourne. Since commencing with DST in 2016, Angus has primarily focused his efforts into developing Physical Employment Standards (PES) for the Australian Navy and Air Force; as well as investigating the physical performance of Australian soldiers. In conjunction with his involvement in the development of PES, Angus is undertaking an MPhil into quantifying physiological adaptations of training in Infantry soldiers.

Contents

Glossary

3RAR	Third Battalion, Royal Australian Regiment
AC	activity category
ADF	Australian Defence Force
AHQ	Army Headquarters
ARDR	Army research and development requirements
CHO	carbohydrate
CO	commanding officer
COTS	commercial–off–the–shelf
CRP	combat ration pack
CR1M	combat ration one man
DF	dietary fibre
DLW	doubly-labelled water technique
DST Group	Defence Science and Technology Group
EE	energy expenditure
FORCOMD	Forces Command
HP AMLE	human performance Army modernisation lines of effort
MA	mission adaptive
MRDI	military recommended dietary intakes
OA	overall acceptance
P:F:C ratio	percentage contribution of protein, fat and CHO to total energy
RNC	recommended nutritional criteria
RPP	ration packing program
SCE	soldier combat ensemble
SD	standard deviation
TFTA	Townsville Field Training Area
TRL	trial research leader
UR	user requirement
WBGT	wet bulb globe temperature

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1. Introduction

Soldiers think and fight better when they are properly fed. However they rarely consume all the food components issued in combat ration packs (CRP)—often as a result of 'field stripping' to mitigate for operational tempo and environmental constraints when deployed, or simply because they don't like the food. Due to the combined effects of soldiers discarding food components and the poor stability of some vitamins during storage, the adequacy of nutrient intake from CRP during operations can be compromised. Associated with inadequate nutrient intake is the risk of decreased physical and cognitive performance. This has raised concerns about the suitability of the current CRP in the expanded range of Australian Defence Force (ADF) operations. It is suggested that the problems identified above are inter-related and may be ameliorated through improvements to the configuration of CRP.

The Army Modernisation Plan 2015 [1] has identified the requirement for mission adaptive (MA) nutrition. MA nutrition aims to provide soldiers with optimal energy and nutrients when combatants operate in contemporary environments and with changing demands. The ability to tailor rations carried by combatants has the potential to make a critical contribution to their ability to perform. Under an Army Headquarters (AHQ) Trial Directive the Defence Science and Technology Group (DST Group) is conducting research to design, produce and evaluate the use of modular rations in Defence environments. The end state will enable and support combatants and combat support personnel to out-think, outperform and outlast a lethal, agile and adaptable adversary by providing the best nutrition and supplementation for enhanced cognitive and physical performance, throughout enduring operations in complex and ambiguous environments.

A three year Trial Program has been approved, requiring AHQ, DST Group, Forces Command (FORCOMD), Special Operations Headquarters and Capability Acquisition and Sustainment Group to work together, along with support and input from the functional commands, to see the modernised design fielded. A modular system is expected to be adaptive in delivering the mission specific energy and nutrition requirements established for the ADF [2]. The CRP User Requirement (UR) [2] has been updated to articulate the requirements of a 'mission adaptable' ration feeding capability.

CRP are mission-critical items, integral to the soldier combat system. Over the Trial Program, DST Group will develop a solution that delivers against the Human Performance Army Modernisation Lines of Effort (HP AMLE)—mind, body, tools and social—Army Research and Development Requirements (ARDRs) [1]. Table 1 details the desired outcomes, including relevant HP AMLE/ARDRs, and DST Group's proposed strategies to realise a MA CRP tool.[1]

[1] DST Group is concurrently evaluating the efficacy and safety of commonly used dietary supplements, and their effects on cognitive function. Outputs will be used to inform AHQ of substances that can be used and potentially shape policy and implementation for ADF personnel. Results of this work will inform augmentation strategies.

Table 1 Strategies toward realising HP AMLE/ARDRs through CRP

Desired outcome	Strategies toward realising an optimal tool
Physically prepare combatants	Enhance mobility by delivering a lighter, more compact CRP Exploit emerging food technologies and use of novel foods to deliver energy and nutrition fit-for-task Ensure CRP readily integrates with soldier combat ensemble Mitigate field feeding health and hygiene threats through design and controls
Augment physical and cognitive abilities (enhance cognitive and physical performance)	Exploit emerging knowledge and novel foods, to deliver safe, ethical and effective dietary supplements, ergogenic aids and stimulants such as caffeine
Ensure effective and efficient use of CRP	Improve eating behaviour through adapting education and training programs, practices and systems, to promote CRP 'worth' (including nutritive, health, and performance value)

The MA CRP trial program has two phases. Six stages have been identified for phase 1. This report covers the requirement of Stage 2 (of phase 1), with a focus on the HP AMLE/ARDR 'physical preparedness'. This report delivers to the following Trial Directive objectives:

- design an effective modular MA CRP and provide proof of concept
- characterise and fulfil the energy, nutritional and health requirements of combatants undertaking operations in the contemporary operating environment.

Stage 1 (of phase 1) developed a MA CRP framework aligned with the CRP UR, and delivered energy and nutrition optimal for combatants working to varying activity categories (AC). Appendix A illustrates the framework. This framework informed the assembly of a fit–for–purpose prototype MA CRP for evaluation during Stage 2. Augmentation was out of scope for the Stage 2 prototype as this design made sole use of in-service CRP components. This prototype was evaluated against the in-service Combat Ration One Man (CR1M). The trial also served to baseline the in-service CR1M in order to identify and justify beneficial change.

The MA CRP could potentially replace both current one-person, one-day CRPs, i.e. the CR1M and Patrol Ration One Man.

The key aims of Stage 2 were to:

- evaluate compliance of the MA CRP prototype against the CR UR

- measure acceptance and consumption/use of food and non-food items and packaging
- assess health and hygiene practices of combatants
- assess energy expenditure (EE)
- assess nutrient intake and adequacy in meeting military recommended energy and nutrition requirements
- assess user and issuer perceptions of the 'modular' concept
- assess jack ration use
- assess soldier wellness
- assess integration with the soldier combat ensemble (SCE)
- validate trial design and methodologies for subsequent MA CRP field use trials.

Other aims of Stage 2 were to:

- baseline the in-service CR1M
- evaluate compliance of the in-service CRP against the recommended nutritional criteria (RNC) for CRP
- assess the perceived worth of in-service CRP as a tool to support survival, performance and resilience through studying consumer behaviour in ration 'stripping'
- assess efficacy and convenience of individual components
- gather data to inform the development of derived requirements and/or resolve conflicting requirements within the CRP UR for a MA CRP.

2. Trial Design and Methodologies

Stage 2 of Phase 1 of the Trial Program involved pilot field testing of a MA CRP prototype with user unit/s (during the period 04 Apr–10 Apr 2016). A side-by-side comparison (no cross-over) of the in-service CR1M (2015–16 ration packing program (RPP)) and a modular MA CRP was conducted with dismounted combatants undertaking routine intensive field training activities at high range in a hot/humid environment (Townsville Field Training Area (TFTA), Queensland). The training activity was aimed at teaching standard operating procedures and training tactics and procedures for low level operations to new members to the company and re-confirming such for the remainder of alpha company. The average EE of trial participants was expected to be 16 MJ per man per day (equating to AC 3 Military Recommended Dietary Intakes (MRDI)) [3].

Ethical approval to conduct this study was provided by the DST Group low-risk human research ethics committee (DST Group Protocol LD06–16).

2.1 Participants and Study Groups

Participants were volunteers from 3rd Battalion, Royal Australian Regiment (3RAR). In a side–by–side comparison, 1st and half of 2nd Platoon (33 volunteers) were assigned the in-service CR1M, whilst 3rd platoon and the second half of 2nd Platoon (40 volunteers) were assigned the MA CRP. Herein the former group will be referred to as the 'control' group and the latter the 'modular' group. Each group was assumed to be undertaking similar activities.

Soldiers were briefed by the Commanding Officer (CO) and DST Group staff prior to the trial. Briefings detailing the study background, participant's roles and requirements, and the voluntary nature of their participation. Completed consent forms were collected from those who provided informed consent to participate. Participants were requested to keep all food packaging and uneaten items for collection and counting by the DST Trial Team.

2.2 Environmental (Climatic) Monitoring

Wet bulb globe temperature (WBGT) was logged using a 3M QUESTemp° heat stress monitor QT–34 (3M, Quest Technologies, Oconomowoc, WI, USA) for a record of environmental conditions. The WBGT equation for outdoor environments is defined as:

$$'WBGT = 0.7WB + 0.2G + 0.1DB \text{ [4]}$$

where WB = wet bulb temperature

G = globe temperature

DB = dry bulb temperature.

As it was impractical to have the device travel with soldiers, it was transported alongside company supplies and support equipment. The device was positioned outside in the vicinity of soldiers, logging temperature at 30 min intervals over the 6-day trial. WBGT data was imported to Microsoft Excel and an average across all days was calculated.

2.3 Rationing, Food Consumption and Energy and Nutrient Intake

The configuration and nutrient content of the rations issued to each of the study groups—'control' and 'modular'—differed. The CR1M was assembled to comply with the RNC for general purpose CRP [3], which includes energy, macronutrients and micronutrients (vitamins and minerals). The RNC are designed to ensure CRP provides the majority of the AC 3 MRDI for adult male consumers.

MA CRP performance criteria have not been established for energy, macronutrients and micronutrients, rather the CRP UR provided guidance on the suitable ranges for energy and macronutrients to suit a range of operations and/or use environments. As such, the Trial Team assembled MA CRP to provide AC 3 MRDI requirements for energy and nutrients.[2] This was expected to deliver the necessary nutrients to maintain combatant health and optimise their performance when used in the intended trial environment. To ensure that AC3 MRDIs were met at the time of consumption, the levels for labile vitamins (vitamins B_1, B_2, B_3, B_6, C) were set at three times that of the AC 3 MRDI. This was to account for potential losses between assembly and use.

Given the two ration designs were assembled to meet different nutritional requirements, the authors were aware that the criteria levels set for energy, protein, carbohydrate and dietary fibre were higher for the MA CRP design than for the CR1M.

Appendices B and C contain CRP configuration (menus), general information, ingredient listing and allergen identification for both the CR1M and MA CRP (respectively). Figure 1 illustrates the MA CRP prototype issued during this trial.

[2] The AC 3 MRDI reference value set for each nutrient was that corresponding to the user sub-group (adolescent male, adolescent female, adult male or adult female) with the greatest level requirement.

(a)

(b)

(c)

Figure 1 The MA CRP prototype; (a) meals module, (b) hot climate module, and (c) staples module

The control group were permitted to take additional food ('jack rations') into the use environment, while the modular group were requested not to. Each group was issued with a 3-day supply of CRP on day 1 of the trial and a re-supply on day 4. On each occasion, participants were issued one of each of the three menus made available. All components used in both the CR1M and MA CRP menus were approved CRP components. Both groups were permitted to take non-food items (including personal health and hygiene items) into the use environment.

Those in the control group were requested to go about business-as-usual. On day 1 they were permitted to strip rations as they typically would and surrender waste to the DST Group Trial Team. Those issued with modular rations were moderated in that they were asked to avoid 'stripping' when initially issued rations.

All food packages (unopened, opened and partly consumed, opened and fully consumed) were collected and counted to quantify the amount of food consumed by each trial participant. The percentage consumption of each food item was categorised as not consumed, partially consumed (25, 50 or 75%) or fully consumed (100%). Where no packaging was recovered from a participant, 'no response' was recorded. If a participant from either study group did not return at least 60% of the issued food items (unopened, opened and partly consumed, opened and fully consumed) they were excluded from the study.[3]

Analytical results obtained from DST Group Quality Assurance Programs of CRP food components (conducted between 2008/09 and 2015/16) were used to calculate the energy and nutrition made available and consumed. Where analytical data were not available, values reported in nutrition information panels for each food were used. When evaluating compliance of CRP configurations to their respective performance requirements, the following criteria (and shading) have been applied to results:

Status	Rule	Shading
Pass	Requirement is met	
Marginal	Result is within 5% of the requirement	
Fail	Result is 5% or more outside the requirement	

To assess the nutritional adequacy of participant diets, nutrient intakes were compared with the MRDI for AC 3 [3] and the measured EE. Results following 3-day and 6-day CRP use were compared using Microsoft Excel 2010 Data Analysis ToolPak for comparison and correlation analysis.

[3] A return rate of 60% was set to provide a level of assurance to the true eating behaviour. DST Group have not assumed a poor return rate means low consumption, only that there is poor visibility of eating behaviour.

2.4 Body Mass and Load Carriage Measurements

Weights with and without fitted-out SCE were recorded on three occasions for all participants—day 1, day 4 (during re-supply) and day 7 (end of trial)—to appreciate the likely weight combatants carry into an exercise, and the changes in overall load carriage as supplies are depleted and replenished over the duration of the exercise.

All weights without SCE were recorded with participants wearing boots and disruptive patterned camouflage uniform. Day 1 and day 4 weights were recorded at the TFTA. Day 7 weights were recorded following return to Lavarack Barrack and prior to accessing food sources. All weights were recorded mid to late morning.

2.5 Questionnaires: Demographics, Component Acceptability and Service Suitability

Questionnaires were administered to participants to collect demographic information (Appendix D), to assess discard habits and 'jack ration' use (Appendix E).

Acceptability of CR1M and MA CRP components was assessed through questionnaires administered on days 4 and 7 (Appendix F and G for CR1M and MA CRP questionnaires, respectively). For each ration component that participants used, overall acceptance (OA) was determined using a 5-point Likert scale (1=extremely poor, 2=poor, 3=fair, 4=good, 5=excellent). For this report OA was characterised as "high OA" – OA with a mean above 3.5 and "low OA" with a mean below 3.0. Consumption was characterised as "high" – a mean greater than 65% consumption and "low" – a mean below 50% consumption.

For each item that was not taken and/or used, participants were asked to provide reasons why the component was not used and how, if at all, it may be improved so as to increase use/consumption.

One intent of the acceptability questionnaire was to gain insights into what personal effects combatants took to address personal health and hygiene.[4] Questions also asked how much they took, how often they used it and what items they considered appropriate to include in an ADF issued hygiene pack. Additionally, questions were posed to gain insights into how combatants felt following field fielding.

Service suitability was determined through questioning related to mobility (ease of use and delivery systems), pack configuration, packaging, convenience (packet to mouth, component integration and interfaces (including water demand), compatibility with food/cooking utensils), water consumption and menu design. Finally, qualitative

[4] DST Group also considered visual observations and capturing imagery to articulate and interpret individuals' behaviours and patterns when preparing, eating and cleaning-up from consuming rations. Access to soldiers in the field environment was not conducive to this undertaking.

questioning investigated the preparation demands (including equipment, time and effort), processes and clean-up. Suitability of serving size (portions provided) was evaluated using a 3–point scale (1=too much, 2=enough, 3=not enough).

Lastly, a questionnaire to evaluate the acceptability, suitability and utility of the modular configuration/design concept (Appendix H) was presented to trial participants on day 7 of the study.

All questionnaires were administered to participants on iPads in offline mode using Qualtrics Surveys (Qualtrics LLC, Provo, USA). Means, modes, standard deviations (SD), standard errors of means and 95% confidence intervals were calculated in Qualtrics software as a measure of central tendency for all numeric data captured by the questionnaires. Outliers were assessed by inspection of box plots for values greater than 1.5 box–lengths from the edge of the box. Extreme outliers were those identified to be greater than 3 box–lengths away.

2.6 Energy Expenditure

EE data was collected using an activity monitoring device and a heart rate transmitter. On Day 1, ten participants (five from the Modular Group and five from the Control Group) representing all platoons and various roles within the company were each fitted with two light-weight devices attached externally to the body. They were fitted in public and posed little, if any, discomfort for participants. They were commercial-off-the-shelf (COTS) devices designed for use with humans. The activity monitoring device was worn on the wrist, just like a watch to monitor fine movements and body orientation. The ActiGraph accelerometer (Actigraph wGT3X–BT, Actigraph, Penscola, FL, USA) was an unobtrusive (4.6 cm x 3.3 cm x 1.5 cm, 19 g) tri-axial accelerometer, fastened immediately proximal to the non-dominant wrist joint using the Velcro strap supplied by ActiGraph. Velcro straps were comfortably tightened to prevent device movement independent of the fore-arm. Participants were instructed to tighten the strap should it became loose at any point. Participants confirmed that accelerometers did not influence their movements or behaviour during simulated operations. On day 4 a new set of accelerometers replaced the Day 1 assigned units to mitigate uncertainty regarding battery life and potential data loss, as there was potential for device damage or malfunction due to participant's activities. The heart rate transmitter was attached to the chest (Polar Team2, Polar electro, Finland), to monitor heart rate by detecting ventricular depolarization.

Prior to analysis each participant's data was divided into the maximum number of full 24-hr cycles captured (4 days), to ensure accurate 'per day' EE results. Data from the ActiGraph accelerometers was downloaded using the ActiLife program (ActiGraph, Penscola, FL, USA) for ActiGraph data management and analysis. A sample rate of 30 Hz using 60 sec epochs was analysed.

Accelerometer estimated EE was not able to account for load carriage (known to increase EE when compared to unloaded standing and ambulation) [5,6]. To overcome this limitation, an equation developed by Pandolf et al. (2005) [5], capable of utilising a load

carriage value, has been modified to use accelerometer EE as an input. EE was calculated via a modified Pandolf's equation with 'load carried' as '0'; where daily EE as recorded by accelerometer was used to solve for velocity. This velocity value was then used in a subsequent Pandolf equation, where 'load carried' was included. The difference in EE between these two equations is the estimated EE increase as a result of load carriage, if the participant were carrying the load for the entire 24 hours. This value was divided by 24, and the result multiplied by the number of hours the accelerometer suggested the participant was active (as opposed to inactive; determined by accelerometer readings of zero on multiple axis for extended periods of time), therefore only adding a load carriage EE estimate for appropriate lengths of time. EE results are presented as MJ/day.

2.7 Visual Observations and Informal Discussions

Visual observations, directly after CRP issue on day 1 and 4, were recorded (unstructured) in order to evaluate behaviour when breaking down CRP and integrating into the SCE. DST Group also planned to collate data on behaviour when preparing, consuming and cleaning up from consumption of CRP. This data was to inform the research of potential weaknesses in the health and/or personal hygiene practices of participants as a collective, however data capture was not possible given DST Group personnel did not have visibility of participants within the TFTA throughout the 6-day trial period.

On completion of the trial period, when participants returned to Lavarack Barracks, informal de-briefing sessions were conducted with two groups of 10 randomly selected participants who consumed the MA CRP. The sessions were semi-structured (and recorded). All individuals were encouraged to contribute, irrespective of rank, on their field use experience of MA CRP.

3. Results and Discussion

3.1 Participants

The target set for trial participants was 30 volunteers for each study group. The eventuating participants for each group were reduced as follows:

- Control group. Received informed consent from 30 volunteers. Two were subsequently removed as identified to be mechanised support (not dismounted infantry) and waste collected was incomplete. There were 4 medical evacuations during the trial period. A further 7 volunteers were removed (from consumption analysis) as waste collected was incomplete (<60% returned). This reduced the total study group for consumption analysis to 17 participants and the questionnaire sample size to 24.
- Modular group. Received informed consent from 31 volunteers. Seven were removed (from consumption analysis) as waste collected was incomplete (<60% returned) and one volunteer did not complete the questionnaire. The resultant sample size was 30 participants for questionnaire evaluation and 24 for consumption analysis.

All participants were male. Table 2 details the demographic profile for each study group with regards to both questionnaire and consumption analysis.

Table 2 Demographics of each study group for questionnaire and consumption analysis

		Questionnaire		Consumption	
		Control	Modular	Control	Modular
	n	24	30	17	24
Demographic profile	Response	% of total		% of total	
Age	16–17	0	0	0	0
	18–20	25	13	24	14
	21–25	63	63	71	62
	26–30	4	7	0	14
	31–35	8	3	6	0
	36–40	0	10	0	5
	41–45	0	0	0	0
	≥46	0	3	0	5
Role	Section Commander	17	10	18	13
	2nd in Command	17	10	18	13
	Rifleman	29	23	29	17
	Gunner	21	23	24	20
	Grenadier	8	13	0	17
	Other*	8	20	12	20
Years in ADF	≤1	17	13	12	14
	1–5	67	67	71	67
	6–10	13	7	12	10
	≥10	4	13	6	10
Deployments (past year)	1–5	13	30	12	29
	6–10	58	47	53	46
	11–15	17	13	18	13
	16–20	13	7	18	8
	21–25	0	3	0	4
Max days continuous CRP	1–5	4	3	0	4
	6–10	21	20	24	17
	11–15	13	10	12	8
	16–20	25	3	29	4
	≥20	38	63	35	67

*Other for CR1M: Platoon Commander, Platoon Sargent
*Other for MA CRP: Company commander, Company Sergeant Major, Platoon Sargent Commander, Platoon Sargent, Signaller

Table 2 illustrates that the modular group's age profile and years of service were skewed right of the control group. This was largely due to the interest of the more senior officers (company commander and platoon commander) wishing to trial the modular design. Senior officers aside, the user groups for each CRP configuration contained similar numbers of riflemen, grenadiers, gunners, section commanders and 2nd in command.

3.2 Environmental Conditions

In designing a suitable ration, the DST Group anticipated hot/humid conditions during the trial period. The average daily WBGT was 21.9±1.2 °C (Max. 31.5 °C, min. 16.3 °C). Such temperate conditions are not thought to influence EE [7,8] nor depress ration acceptability or consumption.

3.3 Configuration Compliance against Energy and Nutrient Requirements

3.3.1 Energy Content

Each menu of the CR1M provided an excess amount of energy (Table 3). DST Group has previously recommended a targeted approach when configuring CRP, particularly when delivering energy [9]. This recommendation aligns well with the proposed design framework for the MA CRP to deliver additional energy only to those that require it. Such an approach would be more cost-effective and less wasteful of resources than providing excess energy to all consumers. Tassone and Baker (2017) have observed that combat ration discards are relatively higher and consumption proportionately lower when total energy contained in CRP is increased beyond what soldiers have the ability to consume during missions [10]. This further supports the targeted approach to deliver only what is necessary for the individual combatant.

Table 3 Compliance of the menus of the MA CRP and CR1M to energy requirements

CRP design	Performance requirement (kJ)	Menu	Energy content of each module (kJ)				Total (kJ)
			Staples	Meals	Grab & go	Hot climate	
CR1M	16000	B	-	-	-	-	17810
		D	-	-	-	-	17720
		H	-	-	-	-	17750
Mean ± SD^							**17760±50**
MA CRP	16000–16500	1	7689	2796	3262	2187	15930
		2	7689	3420	3286	2016	16410
		3	7689	2915	3338	2183	16120
Mean ± SD							**16160±240**

^ SD; one standard deviation

On average, MA CRP menus provided energy levels commensurate with AC 3 MRDI. With marginally less energy provided by menu 1 for both the meals and Grab & Go packs, the overall energy content of menu 1 of the MA CRP was slightly lower. Table 3 provides a detailed breakdown of energy contribution from each menu of each module of the MA CRP.

3.3.2 Protein, Fat and Carbohydrate Content

On average the CR1M provided adequate protein and fat (Tables 4 and 5), even though two menus were marginally low for protein (Table 4). The CR1M however provided an excess amount of carbohydrate (CHO) and saturated fat (Table 6 and 7). The excess of CHO and fat being the underpinning reason for the excess energy levels achieved. Sugar was the major contributor (~60%) to total CHO.

The MA CRP, on average, provided adequate protein (Table 4) and fat (Table 5). While the CHO content remained marginally high (Table 6), the saturated fat was in excess (Table 7), improvement toward compliance for both was achieved. Here also, sugar was the major contributor (~65%) to total CHO.

3.3.3 Dietary Fibre Content

Both CRP designs contained similar dietary fibre (DF) content (Table 8). The CR1M, having a lower DF requirement than the MA CRP, was found to be compliant. The reported results (Table 8) carry a low bias as the analytical data set for DF in CRP components is incomplete. [Data is not available for many components.]

Table 4 Compliance of the menus of the MA CRP and CR1M to protein requirements

CRP design	Performance requirement (g)	Menu	Protein content of each module (g)				Total (g)
			Staples	**Meals**	**Grab & go**	**Hot climate**	
CR1M	122–150	B	-	-	-	-	138
		D	-	-	-	-	115
		H	-	-	-	-	119
Mean ± SD							**124±13**
MA CRP	126–169	1	45	56	16	20	137
		2	45	55	16	4	120
		3	45	48	27	20	140
Mean ± SD							**132±11**

Table 5 Compliance of the menus of the MA CRP and CR1M to fat requirements

CRP design	Performance requirement (g)	Menu	Fat (total) content of each module (g)				Total (g)
			Staples	**Meals**	**Grab & go**	**Hot climate**	
CR1M	108–143	B	-	-	-	-	126
		D	-	-	-	-	127
		H	-	-	-	-	127
Mean ± SD							**127±1**
MA CRP	108–143	1	56	24	11	10	104
		2	56	47	11	5	119
		3	56	36	6	10	107
Mean ± SD							**110±8**

Table 6 Compliance of the menus of the MA CRP and CR1M to CHO requirements

CRP design	Performance requirement (g)	Menu	CHO content of each module (g)				Total (g)
			Staples	Meals	Grab & go	Hot climate	
CR1M	565–590	B	-	-	-	-	613
		D	-	-	-	-	628
		H	-	-	-	-	640
Mean ± SD							**627±13**
MA CRP	557–590	1	323	20	144	86	574
		2	323	36	151	103	612
		3	323	33	152	86	594
Mean ± SD							**593±19**

Table 7 Compliance of the menus of the MA CRP and CR1M to sat-fat requirements

CRP design	Performance requirement (g)	Menu	Fat-sat content of each module (g)				Total (g)
			Staples	Meals	Grab & go	Hot climate	
CR1M	≤43	B	-	-	-	-	78
		D	-	-	-	-	78
		H	-	-	-	-	76
Mean ± SD							**77±1**
MA CRP	≤43	1	32	16	5	3	53
		2	32	27	5	2	66
		3	32	20	3	3	58
Mean ± SD							**59±7**

Table 8 Compliance of the menus of the MA CRP and CR1M to dietary fibre requirements

CRP design	Performance requirement (g)	Menu	Energy content of each module (g)				Total (g)
			Staples	Meals	Grab & go	Hot climate	
CR1M	24	B	-	-	-	-	25
		D	-	-	-	-	26
		H	-	-	-	-	26
Mean ± SD							**26±1**
MA CRP	30	1	16	0	9	1	26
		2	16	0	9	4	29
		3	16	0	6	1	23
Mean ± SD							**26±3**

3.3.4 P:F:C Ratio Compliance

Both configurations have the same requirements for recommended percentage contribution of protein, fat and CHO to total energy (P:F:C ratio). As shown in Table 9 the P:F:C ratio was not met by any of the menus of either CR1M or MA CRP.

The product selection for the MA CRP reduced the amount of fat provided by this design and increased the amount of protein. Both movements are favourable. Furthermore, adjustment through product choice is required to marginally reduce the CHO provided. This should be realised through marginal increases in fat.

Table 9 Compliance of the menus of the MA CRP and CR1M to the P:F:C ratio

CRP design	Performance requirement	Menu	Protein	Fat	CHO+DF*
CR1M	P: 13–18%	B	13.3	26.5	60.2 (59.1+1.1)
	F: 23–33%	D	11.1	26.8	62.0 (60.9+1.2)
	C*: 54–59%	H	11.3	26.4	62.3 (61.1+1.2)
Mean ± SD			**11.9±1.2**	**26.6±0.2**	**61.5±1.1**
MA CRP	P: 13–18%	1	14.5	23.8	61.8 (60.5+1.3)
	F: 23–33%	2	11.9	25.7	62.4 (61.0+1.4)
	C*: 54–59%	3	14.3	23.9	61.8 (60.7+1.1)
Mean ± SD			**13.5±1.4**	**24.5±1.1**	**62.0±0.3**

*this requirement includes both CHO and DF in contributing to total energy. Values in parentheses represent the breakdown.

3.3.5 Vitamin Content

Both CR1M and MA CRP met the requirement for vitamins A, B_1, B_3 and C (Table 10). Vitamin B_2 findings indicate both ration configurations provided substantially less than the requirement. The B_2 content in retort (wet) meals was variable (1–2.5 mg) and combinations (of two meals as a meal module) provided quite variable levels of B_2 (2–4.6 mg). The meal module provided on average 3.3 mg of B_2. Other substantial contributors (such as concentrated yeast extract and Sustagen®) are scarce. DST Group has previously identified B_2 as an 'at risk' vitamin due to the few number of components making available this vitamin in substantial amounts and recommended other stable sources of vitamin B_2 be introduced to CRP to mitigate the heavy reliance placed on a few current components [9].

Vitamin B_6 findings, while likely to carry a low bias due to incomplete data on levels in all CRP components, indicate both ration configurations provide significantly less than the requirement. DST Group has previously identified this inadequacy and recommended Army considers options to fortify with B_6 [3,9,11,12].

Table 10 Compliance of the menus of the MA CRP and CR1M to the vitamin requirements

	Vitamin	A	B_1	B_2	B_3 Equiv.	B_6	C	E
	RNC/AC 3 MRDI	900 µg	5.1 mg	7.5 mg	78 mg	7.5 mg	135 mg	10 mg
Design	Menu							
CR1M	B	1850	5.9	6.3	84.3	0.30	2010	6.9
	D	1850	6.3	6.5	90.5	0.30	2210	5.4
	H	2060	7.4	7.1	86.1	1.15	2190	10.8
	MEAN ± SD	**1920±120**	**6.5±0.8**	**6.6±0.4**	**86.9±3.2**	**0.58±0.49**	**2130±110**	**7.7±2.8**
MA CRP	1	1840	5.7	7.4	109.4	0.36	3990	10.9
	2	1840	6.7	4.8	63.6	0.31	3900	4.26
	3	2050	6.6	7.0	107.4	1.10	4080	11.9
	MEAN ± SD	**1910±120**	**6.3±0.5**	**6.4±1.4**	**93.5±25.9**	**0.59±0.44**	**3990±90**	**9.0±4.1**

Table 11 Compliance of the menus of the MA CRP and CR1M to the mineral requirements

	Mineral	Ca	Cr	Cu	I	Fe	Mg	Mn	P	K	Se	Na	Zn
	RNC/AC 3 MRDI	1300 mg	35 µg	1.7 mg	150 µg	18 mg	410 mg	5.5 mg	1250 mg	3800 mg	70 µg	920–2750 mg	14 mg
Design	Menu												
CR1M	B	1430	128	1.5	634	29	484	5.9	2250	4770	227	7760	32
	D	1450	121	1.5	633	28	475	6.1	2190	4790	221	7420	23
	H	1470	129	1.4	631	27	455	5.7	2200	5060	227	6980	23
	MEAN ± SD	**1450±20**	**126±4**	**1.5±0.1**	**633±1**	**28±1**	**471±15**	**5.9±0.2**	**2210±40**	**4870±160**	**225±4**	**7390±390**	**26±5**
MA CRP	1	1410	98	1.4	616	24	513	5.8	2300	4880	264	6430	26
	2	1440	89	1.5	625	25	495	5.9	2220	4880	228	6130	25
	3	1390	74	1.3	609	23	486	5.5	2130	4440	264	6450	21
	MEAN ± SD	**1410±30**	**87±12**	**1.4±0.1**	**617±8**	**24±1**	**498±14**	**5.7±0.2**	**2220±80**	**4730±260**	**252±21**	**6340±180**	**24±3**

Removal of the nut-based chocolate spread (previously the main contributor of Vitamin E in CRP [12]) has halved the vitamin E levels in CRP. Inclusion of a formulated drink powder in future CR1M will provide the necessary boost to CR1M. For the MA CRP menus, inclusion of both a formulated drink powder and tuna varieties in all menus will permit achievement of compliant levels.

The heavy reliance on a few CRP items to contribute substantial amounts of vitamins toward the recommended levels remains. DST Group has previously recommended that widespread fortification of the suite of vitamins in key CRP components be implemented [3,9,11,12]. DST Group further recommends low level (~20% MRDI) broad fortification be implemented in highly consumed components (including long life bread, wet (retort) meals, all-fruit bars, drink powders and cereal bars). [Refer section 3.4 below for discussion of consumption patterns.]

Vitamins B_{12}, D, K, folate and pantothenic acid have not been assessed due to limited availability of analytical data for these vitamins in all CRP components.

3.3.6 Mineral Content

With the exception of copper, all menus provided sufficient levels of each mineral. While copper is dispersed throughout CRP, with chocolate and cereal based products being substantial contributors, levels still need to be increased to support the RNC for copper.

While a reduction in sodium levels has been achieved in the MA CRP design, both CRP designs contain sodium levels significantly greater than the maximum level set. Inclusion of retort meals, noodles (in CR1M), yeast extract, soup mixes (in CR1M), processed cheese and discretionary salt remain the major sources of sodium in CRP. Removal of discretionary salt would reduce the level by ~760 mg. AHQ should also consider halving the salt levels in those products currently contributing significant amounts (these being retort meals, soup mixes and noodles condiments).

Molybdenum was not assessed due to non-availability of analytical data for this mineral in CRP components.

3.3.7 Weight Requirements and Compliance

The average weight of the in-service CR1M was 1785 g (Table 12). The average MA CRP (at 1646 g) reduced the daily load by over 130 g, although still not compliant with the CRP UR requirement (<1600 g). As shown in Table 12, menu 2 of MA CRP illustrates a weight below 1600 g is achievable.

Further development of alternative menus for the meals module, taking into consideration energy dense and nutrient rich options, should be targeted to reduce CRP weight. Additionally the combat food bar and other meal-in-a-bar products should be included in the evaluation. Results from field use testing of in-service retort (wet) meals, including

their acceptability and consumption, will inform decisions on which retort meals should be retained in future configurations.

Table 12 Compliance of the menus of the MA CRP and CR1M to the weight requirement

CRP design	Performance requirement (g)	Menu	Weight of each module (g) Staples	Meals	Hot climate	Total (g)
CR1M	<1900	B	-	-	-	1817±4
		D	-	-	-	1827±5
		H	-	-	-	1741±6
MEAN ± SD						**1785±47**
MA CRP	<1600	1	916	527	213	1656±19
		2	901	530	160	1591±12
		3	942	528	212	1691±14
MEAN ± SD						**1646±51**

3.4 Perceived Worth Of CR1M

On commencement of day 1 the control group were permitted to break down their 3-day supply of CR1M, and surrender to DST Group any/all items they chose not to take with them for the next 3-day period. Long life bread and spaghetti bolognese were the only two components that 100% of participants made a choice to carry into the three day period. Table 13 provides a breakdown of the rate of stripping for each CR1M component when the rations were issued to the control group on Day 1. Other products to have a significant perceived worth (≥90% participants making a conscious choice to carry) included the wet (retort) meals, all-fruit bars, sports drinks, cereal bar and formulated drink powder.

Table 13 Discard rate for CR1M components during initial 'stripping'

Rate of discard		
0–10%	10–50%	50–90%
Long life bread	Chocolate candies	Chewing gum, sugar free
Spaghetti bolognese	Mi goreng instant noodles	Tomato ketchup
Plastic bag, self-closing	Paper toilet 10 sheets	Salt
Beef and pasta	Beef steak bar	Hard cream candy
Cereal bar, blueberry & apple	Instant mashed potato	Safety matches vial
All fruit bar, raspberry	Can opener, hand	Fruit jam, plum
Formulated drink powder, coffee	Natural muesli with fruit and seeds	Sweetened condensed milk
Sports drink, wild berry	Processed cheddar cheese	Instant coffee
Spoon, plastic	Rubber band, size 32	Non-dairy creamer
Beef, onion & gravy	Ration chocolate	Black pepper
Lamb korma	Soup, golden pumpkin	Tabasco sauce
Sports drink, orange	Fruit jam, strawberry	Scouring pad, soaped
Lamb casserole	Concentrated yeast extract	White sugar
Malay lamb curry	Soup, creamy mushroom	Tea bags
All fruit bar, mixed berry	Diced pears	Chocolate drink powder
	Diced two fruits	

The chocolate drink was the most discarded item (82%) of the issued CR1M. The contents of the 'brew kit' were also heavily discarded, as were the wet and dry condiments, the non-dairy creamer and hard cream candy. Predominantly, components were discarded during stripping because they:

- were not liked
- not needed for this particular exercise
- presented an unacceptable packaging burden, e.g. cans were too bulky/heavy
- were time consuming to prepare.

Section 3.5.1 discusses further the common reasons for the high discard rates.

3.5 CRP Utilisation

The first instruction given to participants when completing acceptability questionnaires was 'identify items not taken or used'. Subsequent to this, the questionnaire application tailored questionnaires to the individual. For those components they used, they were asked to rate acceptability. For those they didn't use (or take) they were asked 'why not?' and 'what, if any, suggestions could participants offer to improve the worth of these components?' The below discussion is framed around those components that were identified as used (consumed) and those not used.

3.5.1 Food Use Behaviour

3.5.1.1 Highly Consumed Components

Complete data for the OA and consumption rate of all CRP components is at Appendix I. Table 14 details those products that had high OA and high consumption by one or both groups.

Table 14 Highly consumed and highly accepted CRP components

Stage 2 CRP Products		
Long life bread	Tuna with dried tomato	Lamb korma
Mi goreng instant noodles	Beef & pasta	All fruit bar, raspberry
Processed cheddar cheese	Lamb casserole	Chocolate candies
Tuna with lime & black pepper	Spaghetti bolognese	Beef steak bar
Malay lamb curry		

With only CR1M menus B, D and H from RPP 2015/16 being made available for this trial, only lamb and beef varieties of wet meals were used and evaluated. Of the six wet meals made available, five were found to be highly consumed and well accepted (Table 14). The beef and onion gravy, whilst having high consumption, had a low OA.

DST Group recommends components with high OA and high consumption continue to be included in both CR1M and MA CRP configurations. DST Group further recommends the weight of popular items (such as these) be considered, and increased where there would be benefit in doing so. Increasing the serving size of popular components would increase the likelihood of improved nutrient intakes and potentially introduce a cost benefit—reducing the number of components required to ensure the MRDI requirements are met. Any application of this strategy should be reflected in net weight and nutritional requirements specified within DEF(AUST) specifications for CRP components.

Given this was a short duration trial, menu fatigue has not been assessed. The authors recommend more variety be offered to combatants, especially with main meals to minimise menu fatigue during extended use periods. Selection of main meal items should consider the introduction of freeze-dried components and COTS main meals.

3.5.1.2 Poorly Consumed Components

Table 15 summarises products from one or more groups that had high OA, and low consumption. Products included instant mashed potato (37% consumption; 3.7 OA), concentrated yeast extract (23% consumption; 3.7 OA), natural muesli with fruit and seeds (46% consumption; 3.5 OA) and wild berry sports drink (46% consumption; 4.1 OA).

Table 15 Poorly consumed CRP components with high acceptance

Stage 2 CRP Products		
Ration chocolate	Sports drink, wild berry	Natural muesli with fruit and seeds
Concentrated yeast extract	Fruit jam, plum	Sugar free chewing gum
Soup, creamy mushroom	Sweetened condensed milk	Hard candy, peppermint
Diced pears	Tabasco sauce	Hard candy, musk
Diced two fruits	Tomato ketchup	Hard cream candy
Soup, golden pumpkin	Salt	Tea bags
Instant mashed potato	White sugar	Chocolate drink powder
Sports drink, orange	Black pepper	Instant coffee

Another example of low consumption rate and high OA was the chocolate drink powder. This product had the highest discard rate (82%) from the control group. The consumption at days 1–3 was only 5% with a low initial OA of 2.8; however on days 4–6 consumption increased to 17%, as did the OA to 3.8. Additionally the modular group, who did not have the option to discard, had a consumption rate of 16% with an OA of 3.4 for days 1–3 and for days 4–6 the consumption rate was 26% and OA of 3.5.

Table 15 illustrates that OA is not sufficient to promote consumption; utility and appropriateness are also important to the delivery of required nutrition and sustenance. Other influences including “too bulky/heavy”, “package not easy to use”, “not needed”, “time and effort required to prepare” and “weather not favourable” were reported by combatants for not taking or consuming components.

The most frequent responses given for reasons that would encourage a consumer to change their mind (take the component) were, “nothing” or “completely different style of product”, other frequent responses were “different recipe” and “more convenient packaging".

On days 1–3 the main reasons why a component was not consumed included “don't like”, “wasn't hungry”, “too much effort” or “time to prepare”, “weather not favourable” and “bored with product”. At the completion of the trial participants once again were asked about products they had discarded/not consumed and why. The top reason for the majority of products not taken or used by the control group for days 4–6 were “don't like”, followed by “not needed”, “effort and time required to prepare” and “bored with product”.

Participants of the modular group had the following reasons when asked why products weren't consumed for days 4–6, for one or more of the items: “don't like”, followed by “package not user friendly” and “wasn't hungry”. “Time and effort” and “time required to prepare” were also frequently selected.

Products in Table 16 are those that were consistently low in OA and had low consumption by one or both groups. As a result of poor cons, the DST Group Trial Team recommends these components (Table 16) be substituted with high consumption rate/high OA equivalents and/or removal from CRP.

Table 16 Poorly consumed CRP components with low acceptance

Stage 2 CRP Products	
Natural muesli with fruit & seeds	Non-dairy creamer
Hard cream candy	Instant coffee
Chocolate drink powder	Tea bags

The OA for ancillary items—non-dairy creamer, instant coffee and tea bags (Table 16)—was based on scores from the control group. This group had the option to include 'jack rations'. Higher OA scores were observed for the modular group (Appendix I, Table I3). Whilst eliminating these items from CRP is not recommended, it is recommended these products be replaced with alternatives more acceptable to the combatant. Section 3.9 Jack ration use, identifies coffee sachets (with/without milk) as a regular supplement to the CRP, which could be sourced as alternatives for future MA CRP trials.

Additionally, natural muesli with fruit and seeds and the chocolate drink powder are major contributors to final energy calculations for the ration packs as a whole, whilst OA scores were higher for the modular group, consumption was below 50%. To increase consumption and total energy intake, it is recommended these products be replaced with more acceptable alternatives as a high priority. Alternatives could include Grab & go concept foods, whether this is a combination of breakfast bars and fruit in a squeezable tube, an energy dense breakfast bar or an energy dense prepared cereal in a squeezable tube. The addition of a chocolate flavoured formulated supplementary food/drink would be welcomed as indicated by the combatants.

The hard cream candy, whilst in theory contributes a large proportion of the carbohydrate requirement of the overall ration packs, had low OA and consumption by both groups. Participants indicated the main reasons for not taking or consuming the cream candy were: "didn't like", "not needed", "bored with product" and "wasn't hungry". It is recommended this product be replaced with an alternative product of similar nutritional profile or one with similar nutritional profile and has been fortified with essential vitamins and minerals, with improved OA; this would increase consumption and deliver the required nutrition.

The 'brew kit' provides little in the way of energy and nutrition. Product selection in configuring this element needs to focus on convenience and waste minimisation to justify continued inclusion. Coffee/sugar/milk or tea/sugar/milk could be consolidated as single serve, pre-mixed, hot drink sachets.

3.5.1.3 Pattern of Utilisation

Table 17 summarises products with an observed change in use as the trial progressed of more than 20%. Changes in OA responses are presented along-side consumption in order to identify patterns. This evaluation highlights changes in consumption and OA, which are potentially related to limited access over time to alternative sources of food including 'jack rations'. A limitation of this evaluation is the lack of complete visibility of components and their use within the first issue period, and later collected and counted in the second half of the trial period.

Further studies are needed to evaluate CRP acceptance and use over longer periods. Short-term studies of CRP use are limited in their ability to recognise and report patterns in eating behaviour. These patterns may be influenced by mindsets such as 'it's only for a short period, I'll go without now, and feed-up when I return', ease of access to 'jack rations' and ability to swap with other combatants. Longer period studies are necessary to understand CRP use over enduring periods. Certain operational situations result in limited access to jack rations and greater reliance on issued CRP. Longer term studies will identify the potential exposure to nutrient inadequacies and inform the requirements for health, well-being and nutrition recovery programs.

In addition to products in Table 17, it was observed ancillary items increased in usage once availability of alternatives became limited. These however were still below 50% consumption/usage, with the main reasons for not consuming/using these products being; "time & effort to prepare", "didn't like", "bored with product" and "wasn't hungry".

These observations indicate that as availability of alternative sources become limited, there were changes to OA and consumption for many products. That being said, improvement to initial quality and utility may go a long way to reducing discard rates, thus increasing OA and consumption.

Future MA CRP menus need to consider the work demand placed on the soldier and product compatibility in the various use environments in which soldiers are operating.

Table 17 Changes of more than 20% in consumption and overall acceptability

	Control Group		Modular Group	
Product	Consumption	Overall Acceptability	Consumption	Overall Acceptability
Chocolate drink powder	↑	↑	↑	↑
Tabasco sauce	↑	↑	↑	↑
White sugar	↑	↑	↑	↑
Hard candy, peppermint			↓	-
Black pepper	↑	↓	↓	↑
Tea bags	↑	↑	↑	↓
Sweetened condensed milk	↑	↑	↑	↓
Salt	↑	↓	↑	↓
Non-dairy creamer	↑	↑	↓	↑
Instant coffee	↑	↓	↑	↓
Tomato ketchup	↑	↑		
Chewing gum, sugar-free	↑	↓	↑	↓
Hard cream candy	↑	↑	↓	↑
Fruit jam, plum	↑	↑		
Concentrated yeast extract	↑	-	↓	↓
Soup, creamy mushroom	↑	↑		
Fruit jam, strawberry	↑	-		
Soup, golden pumpkin	↓	↑		
Sports drink, wild berry			↓	↓
Ration chocolate	↑	-	↑	↓
Sports drink, tropical		-	↓	↓
Sports drink, orange			↓	↓
Processed cheddar cheese	↑	↓		
Instant mashed potato	↑	↓	↑	↑
Mi goreng instant noodles	↑	-		
Formulated drink powder, coffee	↑	↑	↑	↓

3.5.2 Packaging, Convenience and Potential Cross-Contamination

CRP packaging should maximise packet to mouth eating behaviour, so as to reduce exposure to potentially compromising health and immune issues due to hand to food contact. This is best achieved through making available ready-to-consume (convenient) components. Both CRP configurations were designed to maximise opportunities for packet-to-mouth consumption through provision of dried fruit, meat and cereal-based bars.

Where preparation was necessary, such as that required for beverages, minimal impost on time, effort and equipment should be considered. The current supplemented protein drink powder, soup powders, and noodles require the use of re-useable equipment, and substantial amounts of time and effort to prepare. Optimal field feeding practices should reduce reliance on the need to clean re-useable food preparation and eating utensils.

Providing drink powders in a single use drink pouch, such as that in Figure 2, would reduce reliance on and need to clean re-useable equipment, thereby reducing the risk of microbiological contamination resulting from re-use of unclean equipment. The protein (dairy-based) drink powder poses the greatest risk and DST Group recommends Army consider providing this component in a single–use drink pouch. US military studies have shown the use of such a drink pouch has significantly increased the consumption rate of the enclosed product [13].

Products such as the cream candy and hard candy had multipart packaging that inevitably resulted in hand to food contact for consumption. Being of high sugar content, in a humid environment, these products were more susceptible to environmental contamination (such as dust and dirt sticking to food surfaces). DST Group recommends AHQ considers using confectionery components with less packaging and include those less vulnerable to environmental contamination.

Both the bread and the cracker biscuits also typically required some level of hand contact so as to consume with complementary products (such as tuna, spreads and cheese). Both products are dry so did not present the same risk as high sugar products if exposed to potential contaminants prior to consumption.

Figure 2 Meal-ready-to-eat drink pouch used by United States Military

While many of the food items contained within tubes and cans were well liked by combatants, the packaging form was criticised by its users as being 'too bulky' and 'not easy (quick and/or convenient) to use'. Continued inclusion of these food items in flexible packaging will potentially increase usage, and thus increase nutrient intake.

3.5.3 Non–Food Items

On commencement of day 1 the control group were permitted to break down their 3-day supply of CR1M, and surrender to DST Group any/all items they chose not to take with them for the next 3-day period. Scouring pad and safety matches (Table 18) were both highly discarded, indicating there was little product worth attached to either item. With low discard rates, the self-closing plastic bag (rubbish bag), spoon, toilet paper and can opener were all highly valued by participants. The main criticism for the majority of non-food items was that daily provisioning was excessive (Table 18). While the current design necessitated daily provisioning, moving toward a modular design has the potential to reduce wastage associated with over-provisioning of many CRP components. The introduction of a hygiene pack to support field feeding and personal care (one that is not a daily re-supply) could potentially be a cost-effective way of reducing the number of non-food items issued to users.

Table 18 Worth and use of non-food CRP items

Item	% stripping (day 1)^	Common reasons given for discarding	% unused during trial
Scouring pad, soaped	70	don't like, not needed, useless, took own	>70
Safety matches, vial	61	users took their own equivalent (some users considering issued item useless), too many issued for 3–day period	60–80
Rubber band, size 32	31	don't use	10–20
Can opener, hand	24	only one required for 3–day	20
Toilet paper, 10 pc	14	bring own, use wipes	50–60
Plastic spoon	6	don't need three for three days	<10
Plastic bag, self–closing	2	don't like	35–50

^ control group were allowed to discard on day 1

More than 50% of the scouring pads, safety matches and toilet paper taken on trial (both control and modular groups) were returned unused (Table 18). For the scouring pads and matches these results were similar to those observed during the stripping activity prior to trial commencement and illustrate that the products were neither highly used nor perceived useful in the field use environment. The toilet paper however carried a perceived worth but could be improved as a concept by inclusion of wipes in the CRP.

When asked how to improve the utility of poorly used and/or non–functional non–food items, participants seldom offered feedback, rather suggesting that nothing could be done.

3.5.4 Water Carriage, Consumption and Resupply

Both groups reported similar water consumption behaviour, with approximately one third consuming 1–3 L/day, while two–thirds consumed 4–6 L/day. Over 90% of participants felt they carried the right amount for their consumption behaviour. Almost all participants (> 95%) carried water in their water bottle/s, with almost 70% also reporting carrying water in a water bladder (such as a Camelbak).

Of concern to DST Group, was the number of participants (~20%) that regularly added sports drink powders (and other beverage bases) to their water bladder for consumption. Such a practice carries risk of bacterial growth; a risk that can be mitigated both through education and issue of single use drink pouch (such as that discussed in Section 3.5.2).

3.6 Adequacy of Food Intake

Nutrient intake results have been generated with the assumption that a component was not consumed if/when a participant's waste bag did not contain a package and its absence could not otherwise be explained. As such, there is potentially a low bias to the data presented.

Neither CRP configuration was adequately consumed to meet the daily nutrient requirements (Table 19). The energy intake of participants in both the control and modular groups was significantly less than the AC 3 MRDI of 16–16.5 MJ. Those using in-service CR1M (control group) consumed, on average, 54% of their requirement over the 6-day exercise (approximately 8.7 MJ per day). Participants consuming the modular design met only 49% of their AC 3 MRDI for energy, with an average energy intake of 7.9 MJ per day (Table 19). There was no significant (p<0.001) difference in energy intake between the two groups over the trial duration.

The protein intake for both groups was deficient by ~38% and CHO intake by more than 55% when considered against the AC 3 MRDI (Table 19). Inadequate consumption of dietary fibre was also observed. The low consumption rate for both CRP configurations assisted the intake of saturated fat to fall below the upper limit and sodium intake was borderline compliant with upper limits. Intake of dietary fibre, vitamins A, B_6 and E was inadequate and this was largely attributable to low provisions in both designs. Significant inadequacies were also observed for calcium, copper, iodine, magnesium, manganese and potassium for all users. Iron and phosphorous intakes, while low, were not significantly different from the requirement. For those consuming the MA CRP, their selenium intake was borderline compliant due to the inclusion of tuna, (a product not included in CR1M menus used in this trial). These findings provide a basis for incorporating further vitamin- and mineral-fortified products in CRP configurations. Fortified products may be provided by either in-service or COTS components and should focus on increasing the intake of vitamins B_6 and E and minerals (calcium, copper, iodine, magnesium, manganese and potassium).

*Table 19 Comparison of average daily energy and nutrient intake for each study group against AC3 MRDI^*

'Nutrient'	AC 3 MRDI	Control Group	Modular Group
		Mean ± standard deviation (SD)	
Energy (kJ)	16–16.5	8680±1930	7880±3010
Protein (g)	126–169	76±17	80±31
CHO (g)	557–590	266±67	248±104
Sugar (g)	–	140±41	138±59
Fat (g)	–	72±16	63±24
Fat–saturated (g)	<43	43±10	33±13
Dietary fibre (g)	30	13±4	13±6
Vitamin A (µg)	900	651±368	749±384
Vitamin B_1 (mg)	1.7	3.7±1.2	3.7±1.3
Vitamin B_2 (mg)	2.5	3.5±0.9	3.1±1.5
Vitamin B_3 (mg)	26	51±13	51±22
Vitamin B_6 (mg)	2.5	0.41±0.16	0.33±0.19
Vitamin C (mg)	45	1170±680	1630±1000
Vitamin E (mg)	10	4.9±1.2	5.8±2.5
Calcium (mg)	1300	450±147	544±249
Chromium (µg)	35	67±18	48±22
Copper (mg)	1.7	0.76±0.18	0.69±0.33
Iodine (µg)	150	112±50	123±90
Iron (mg)	18	15±3	13±6
Magnesium (mg)	410	222±59	233±106
Manganese (mg)	5.5	2.6±1.0	2.8±1.6
Phosphorous (mg)	1250	1050±260	1170±480
Potassium (mg)	3800	2400±620	2290±970
Selenium (µg)	70	43±18	69±30
Sodium (mg)	920–2750	3600±980	3200±1390
Zinc (mg)	14	16±4	14±6

^ results do not include consumption of 'jack rations' and non-issued CRP components

A significant difference in consumption of total fat (p<0.001), vitamin B_6 (p<0.03), chromium (p<0.001) and selenium (p<0.002) between the groups was identified. For all other nutrients, there was no significant difference in intake between the two consumer groups.

Infrequent use of 'jack rations' was identified in both groups, and provided little if any discernible contribution to overall average dietary intake. Table J1 at Appendix J contains summary data for both groups, illustrating the variability in consumption patterns between days 1–3, and days 4–6 and daily average. While there was no significant difference found between nutrients consumed during days 1–3 and days 4–6, a notable increase in nutrient intake was observed in the second half of the trial. The reason/s for such could not be ascertained however it may have been influenced by the retention of components and/or packaging from day 1–3 issue that were later surrendered and/or consumed, increasing the count for days 4–6. An increased desire to satiate hunger as the trial progressed and combatants fatigued is also likely to have influenced increased intake on days 4–6.

Table J1, Appendix J, also illustrates the variability in nutrient intakes when removing senior officers from the modular group. The demographic differences were discussed in Section 3.2. Senior officers (company commander and platoon commanders) taking part in this trial, all elected to be part of the modular group. Having roles and responsibilities likely to render them 'time poor' relative to junior ranks taking part, DST expected the consumption patterns of the modular group (on average) to be lower than the control group. Removal of these data sets and again comparing the two user groups did reduce the relative difference between the 2 groups. With senior officers removed, the only significant differences in intake between the 2 user groups were for saturated fat (p<0.05), vitamins C and E (p<0.03), chromium (p<0.005) and selenium (p<0.01), with the modular group consuming significantly more vitamins C and E and selenium, while consuming significantly less saturated fat and chromium. [The data presented in Table 19 is inclusive of senior staff in the modular group. As such, it carries a negative bias on the modular group, when comparing the two groups and assuming equivalence].

3.7 Energy Expenditure

The average daily EE for all participants was found to be 19.3±1.9 MJ/day (n = 20), F–Test and two tailed unpaired *t*–test revealed unequal variance and no significant difference between control and modular groups (p <0.05).

A review of military EE literature showed that operational EE averaged 19.3±2.7 MJ/day, with a range of 13.0–29.8 MJ/day [7]. EE during military activities can be highly variable, impacted by factors such as operational requirements (e.g. load carriage) and terrain [7]. This was highlighted in a study of US Army Rangers, who expended between 13.2 and 25.1 MJ/day across desert, mountain, jungle and forest operational training phases [15]. Australian soldiers have been studied in a similar climate to the present study during jungle combat training; including simulated bayonet fighting and 10–18 km treks in full combat attire, expending 19.9 MJ/day [15]. The North Atlantic Treaty Organisation reports

the EE of military personnel conducting 'normal' operations is approximately 15 MJ [16]. They also report the EE of soldiers performing sustained, dismounted, light-infantry or Special Forces operations to be approximately 20.5 MJ.

DST Group recommends AHQ reviews the reported EE for military tasks and considers whether the scope of activities as referred to in 'ADF Nutrients for the 21st Century' [3] is relevant and accurate for today's and future missions and tasks undertaken by the ADF [1]. The review should include consideration of changes in load carriage, operational tempo, duration and location. This is necessary to ensure this project remains relevant and targeted toward providing beneficial outcomes to ADF consumers operating in contemporary environments.

Given the focus of the field exercise was group tactics, manoeuvres and platoon cohesiveness, as opposed to physical preparedness involving physically arduous activities, DST Group did anticipate a comparatively lower EE than was found. The EE estimation method applied (as detailed in Section 2.6) has likely resulted in an overestimation of EE, even with attempts to account for load carriage.

An inherent limitation of the present method is that cases arise where the Pandolf equation cannot be solved for velocity. This occurs when daily accelerometer EE values are too low for the sum of Pandolf's remaining coefficients to equal a velocity greater than zero. Velocities lower than zero are outside the intended parameters of the equation [5], thus voiding its use. This resulted in 19 (out of 40) cases where EE calculation for a single day was unsolvable. Most of the unsolvable equations were for participants exhibiting longer amounts of 'inactive' time. Consequently, average EE of the study group is in reality lower than 19.3 MJ/day, although with current knowledge there is no way to confirm a more accurate result. There is potential for a correction factor or new coefficient to be developed, allowing for this method to be refined or a similar method to be developed, that would facilitate more accurate estimation of EE during military field activities involving load carriage. The British Military has been developing an accurate measure of EE using tri-axial accelerometers [17,18]. This work has identified the additional EE due to load carriage is a major hurdle to overcome in EE estimation [18].

The Doubly Labelled Water (DLW) technique is the gold standard for EE measurement in free-living conditions, such as military field exercises [19]. However, neither this technique nor indirect calorimetry (e.g. Metamax 3B, Cortex, Germany) was possible during the Stage 2 trial. In the absence of improved accelerometry-based estimations of EE, or other emerging technologies, DST recommend future CRP trials incorporate one or both of these established techniques to directly and accurately measure EE. These methods would also provide a valuable opportunity to directly compare measured EE against EE estimation methods (e.g. accelerometry). Correction factors or coefficients for load carriage could then be developed, to be used in an EE equation based on accelerometry.

The aim should be to collect all relevant data to inform the estimation of EE during military-related activities via non-invasive techniques/unobtrusive devices. The benefit of an unobtrusive device that accurately estimates EE to future nutrition-related studies is apparent. Other relevant data to capture should include direct observation of participant

activities/tasks, global positioning data on position, speed and time, heart rate and oxygen consumption data.

3.8 Health, Hygiene and Well-Being

3.8.1 Field Hygiene Practices

The CRP UR requires CRP to contain items to support maintenance of personal hygiene. CRP currently contains toilet paper and soaped scourers to support personal and field feeding hygiene practices. In addition, the CRP UR also requires inclusion of sanitiser, soap, hand towelette and feminine hygiene products [2]. None of which have been previously included in CRP.

As the Stage 2 trial did not introduce any new components (instead making use only of in-service components), DST Group sought to understand what and how well participants currently use hygiene effects to facilitate hygiene practices in a field environment. Questionnaires were used to assess what personal hygiene effects participants took into this trial period, what they regularly take on field exercises and what they would like to see included in a hygiene module for issue with CRP.

Participants would welcome the inclusion of wipes (86%) and hand sanitiser (77%) (Table 20). During the trial 85% of participants reported taking (their own) wet wipes and 94% reported regular use during field exercises.

Table 20 Personal hygiene items; use of and appropriateness for inclusion in CRP

Item	% Used during this trial			% Regular use^	% In favour of including		
	Control group	Modular group	Mean		Control group	Modular group	Mean
Wipes	89	81	85	94	93	80	86
Hand sanitizer	39	48	44	7	85	70	77
Shaving gear	96	100	98	46	59	50	54
Toothpaste/toothbrush	100	90	95	50	56	47	51
Mouthwash	18	23	20	0	44	43	44
Dental floss/picks	25	10	17	14	48	37	42
Deodorising products	14	6	10	7	22	27	25
Tissues	18	0	8	4			
Toilet paper (own supplied)	21	26	24	0	Product already included		
Other (Isocol, lip balm, sunscreen)	18	10	14	4			

^ only the control group were asked this question

Almost all participants took shaving gear and toothbrush/toothpaste. That said, they were not strongly in favour of including either in a potential hygiene pack as they were concerned with the potential quality and performance of Defence supplied effects. While it is true that ADF personnel have ready access to their own choice of personal effects prior to training activities, such access may be limited in an operational setting. AHQ will need to be informed by consumer requirements should such items be included in a hygiene pack to ensure that if supplied, there is a high likelihood of them being used.

When planning the Stage 2 trial, DST Group Trial Team intended to observe users interacting (preparing, eating and cleaning-up) with issued CRP. These observations were to inform cause and effect of field feeding related illness. In execution, this was not possible and as such this knowledge gap remains. Future trials need to pursue this opportunity, so as to inform design improvements.

On completion of the trial, DST Group requested 3RAR provide a brief on any field evacuations, potentially the result of feeding and/or personal hygiene practices. 3RAR reported no evacuations occurred for these reasons.

3.8.2 Load Carriage and Weight Change

DST Group found the average load burden at a supply/resupply event to be ~50 kg (including water, ammunition, weapons, food, communications, and protective equipment). Such a load burden warrants investigation with regards to EE (as discussed in Section 3.7). Over each a 3-day period the load burden was reduced (on average) by 20 kg, due largely to consumption of food, water and use of ammunition.

During this trial, the average energy intake (~8 MJ) fell well short of operational requirements. While some participants gained weight during the 6 days (as represented by a negative value in the ranges reported in Table 21), the average estimated weight loss was ~1 kg (1% of the initial body weight). This finding is consistent with that reported by Tassone and Baker (2017), where only negligible weight loss was observed over a short period (up to 8 days) of combat training. Statistically, there was no correlation between weight change and energy intake (R^2<0.04) over the 6-day period.

*Table 21 Weight loss of participants over the 6-day duration^*

Control group (n=24)		Modular group (n=30)	
Absolute (kg)	% of initial body weight	Absolute (kg)	% of initial body weight
0.9±1.4 (–3.4–3.6)	1.1±1.7 (–4.1– 4.0)	1.1±1.3 (–1.0–4.2)	1.2±1.4 (–1.3–4.0)

^ Results reported are mean ± standard deviation. In parentheses (range of participant group)

The authors remain concerned that combatants subsisting solely on CRP whilst engaged in training and military operations, and consistently consuming energy below their requirements for periods in excess of 8 days, will exhibit a decline in health and performance. Crowdy et al (1982) reported a substantial decrease of 3.9 kg (~5.5%) in mean body weight during a 12-day exercise with soldiers engaged in long foot patrols and

tactical exercises, and consumed on average 7.4 MJ/day [20]. DST Group recommends body weight and composition be introduced as routine measures during all future field use trials so as to understand the prevalence and significance of change to individuals health status when subsisting on CRP for long periods.

To better understand what the user is prepared to accept and to carry as a CRP load burden, DST Group recommends future studies measure the CRP load burden currently experienced by soldiers (taking account of stripping activities). Measurement of such should then be used to establish the threshold for CRP load burden that is acceptable to soldiers.

3.8.3 Wellness and Morale

DST Group was interested to understand whether participants felt satiated and energised as a result of eating. When asked whether CRP offered sufficient sustenance, the majority of users (70%) felt that the issued CRP (both designs) only partially delivered adequate sustenance. This is likely influenced by the poor consumption rates leading to a perceived inadequacy to satiate.

Further research is required to understand what function and level of impact food has in maintaining and potentially enhancing cognitive performance. Outcomes from this work should be used to influence CRP design in both product selection and eating behaviour.

3.9 'Jack Ration' Use

Fifty-three percent of the control group indicated they were taking 'jack rations' with them during this trial and 63% indicated they regularly took 'jack rations'. The modular group were requested not to take 'jack rations', however similar to the control group, reported regular high use (80%). The most frequently used 'jack rations' included tuna (44%), noodles (44%), jerky (28%), muesli bars (28%), protein bars (23%), trail mix (23%), protein bars (21%), confectionery (21%), coffee sachets (21%) and protein drink powder (21%).

Regular use of vitamin and mineral supplements (19%), pro/prebiotics (18%) and omega 3/6 (fish oil) supplements (18%) were also reported across both groups, although there was little evidence (in waste collected) to suggest that these were taken during this trial.

3.10 Ration Integration into SCE

During the trial, DST Group observed that no two people placed CRP in their SCE in a similar manner. In fact, no two SCE configurations were the same—each user had personalised the configuration to suit their needs. No less than 3 generations of SCEs were being used. DST Group questions whether it is plausible to design a CRP configuration for direct integration into SCE.

Even though modules provided packages smaller in size and weight than the in-service CRP, this compact delivery did not distract individuals from breaking down individual

packages to components and placing single items into various locations of an SCE. As each SCE was configured differently, there were no discernible patterns of behaviour for CRP integration. Integration was very much a personalised approach.

3.11 The 'Modular' Concept

Users indicated that all individual modules were somewhat palatable in a hot environment (the environment of this study), providing appropriate food choices and portions within each. Modules were considered to be suitably shaped, although users were not in favour of having separate modules, preferring to be issued with a single package. Extra layers of packaging increased the effort required to integrate components into the SCE. Modules were somewhat inconvenient, and given that users commonly break down CRP (even when delivered in modular form), sometimes down to individual components for integration into SCE, evaluating the performance of a modular design to 'integrate into SCE' would be futile.

Both the hot climate module and the 'Grab & go' pack (contained within the staples module) were reported to provide a necessary energy boost, and were considered to contain an appropriate combination of products. Users were also somewhat in agreement that the 'Grab & go' pack and the hot climate module encouraged users to drink more. While users were not keen to be issued separate modules they accepted the need to manage more packaging should these two modules be issued.

DST Group do not believe that a modular design will increase a combatant's choice to carry food, nor will it have any significant effect on integration, as the majority of combatants break down issued CRP to the component level before integration. In fact, modules were considered somewhat inconvenient as extra effort was required to break down CRP to individual components.

This was the first exposure of a modular design to a user group. Opportunities to educate users were limited to a pre-exercise briefing by the CO and a brief provided (immediately prior to issue) by the trial research leader (TRL). The CO brief sought to inform users that an alternative CRP was being evaluated while the (unrelated) training exercise was taking place. The TRL brief explained:

- the reasons for the research and potential outcomes, namely to:
    - increase consumption
    - improve energy and nutrition intake
    - reduce weight of load
    - improve field hygiene practices
    - sustain physical and cognitive performance.
- the user's role in the study, namely to:
    - use the CRP provided. Those in the control group were requested to go about business as usual. Those issued with modular rations were

moderated in that they were asked to avoid 'stripping' when initially issued rations
    - surrender all waste
    - complete questionnaires
    - be observed while interacting with the CRP
    - be measured for weight (with and without load), and EE (a sub-group only)
- the risks in participating
- security of information provided.

There was no education or training provided to users on the worth and benefit of CRP and its individual components. Based on anecdotal evidence, we understand that when CRP are issued COs instruct combatants to retain and consume the wet meals (above all else). This instruction legitimises the undesirable practice of CRP stripping. We also understand that recruitment training provides little in the way of CRP education. DST Group recommends that training and education, policy and procedure and interactive tools be identified as outputs within the current Trial Directive.[5] These outputs would enable the ADF to demonstrate appropriate CRP use, evaluate and where necessary change consumer behaviour through reinforcement of learning.

Training and education will likely improve the combatant's choice both to take (carry) food and to consume it. To realise the targeted outcomes, training and education (in documented and interactive forms) is also required for COs, and those responsible for ordering and supplying CRP commensurate with user needs. At present, there is a lot of scepticism from COs, users and combat soldier support entities. Questions to be answered include:

- How will COs know what demands (of modules) to raise?
- How will users know what CRP modules to collect?
- How will the supply system identify, management, monitor and control distribution, storage, availability and issue of modules?
- Will the provisioning of more entities in the supply system increase the risk of failure to deliver all necessary elements?

3.12 Future Considerations

3.12.1 Use of CRP Components

Well-consumed and nutritionally 'valuable' components including long life bread, mi goreng instant noodles, processed cheddar cheese, tuna varieties, wet main meals (beef & pasta, lamb casserole, Malay lamb curry and spaghetti bolognese), fruit snacks, and

[5] DST Group can provide costings and resource requirements to deliver these additional outputs, if requested by AHQ.

chocolate candies and steak bar should be retained. The 'worth' of components, including muesli, chocolate drink, the 'brew kit', non-dairy creamer, hard cream candy, soaped scouring pad and safety matches needs to be reviewed. If continued use is justified, component improvement and/or COTS substitution is required to increase the use in military environments.

While this trial was constrained to the use of in-service CRP components, (and particularly to those available in menus B, D and H of the 15/16 RPP build), design of future configurations should consider other CRP and COTS components. A number of in-service CRP components—such as instant noodles, soup powder, fruit spreads, tinned fruit, freeze-dried meals, chocolate candies, jam sandwich biscuit—were not included in the modular design. These require evaluation of worth in future design considerations.

Results from 'jack ration' use and suggested product inclusions and improvements need to be considered in future modular designs. COTS components will be of particular value in delivering convenient, packet–to–mouth (hygienic consumption behaviour), energy dense and nutrient rich (including supplementation) components.

3.12.2 Trial Design and Methodologies

Further field trials should measure and compare the maximum, the actual and the desired CRP load burden users are prepared to carry during an expanded range of operations over enduring periods. This will confirm or refine the appropriateness of the current weight target of <1600 g, based on the limits (expectations) of the user. [Note that this will be influenced by individual's desire to consume/use components taken into the field.]

The EE estimation methodology used in this study has likely resulted in an overestimation of EE. The focus of the present field exercise was group tactics, manoeuvres and platoon cohesiveness as opposed to physical preparedness involving arduous activities that would likely have expended ~19 MJ/day. EE during military activities can be highly variable, impacted by factors such as operational requirements (e.g. load carriage) and terrain. Further work is required to establish an accurate measurement of EE.

The provision of resources was found to be limiting for the conduct of the field trial. Additional manpower for data capture (and waste counting in particular) will be required for further field trials. Additional support from both DST Group and FORCOMD will be required to ensure success in further field trials.

To better understand and articulate the requirements of users in contemporary operational environments, further field use trials should include activities:

- where combatants require energy and nutrients commensurate with AC 2 and AC 4
- conducted in use environments other than hot climate
- of longer duration (up to 30 days).

4. Conclusions

Energy and nutrient content requirements for both CRP designs were similar in supporting the AC 3 requirements. The CR1M provided an energy excess of 1.8 MJ, while the MA CRP provided, on average, the daily requirement. Protein and total fat levels were adequate in both designs, however the CR1M provided a substantial excess of CHO and both designs contained excessive amounts of saturated fat and sodium. Sugar was the major source of CHO in both designs. Dietary fibre was low in MA CRP.

The P:F:C ratio was not met by either CR1M or MA CRP. CHO was in excess with protein contributing less than required. Future configurations need to provide less CHO with a commensurate increase in protein and fat. Small increases in dietary fibre should also be targeted.

Both CR1M and MA CRP met the requirements for vitamins A, B_1, B_3 and C and most minerals, however were inadequate in vitamins B_2, B_6 and E and copper. The heavy reliance on a few CRP items to contribute substantial amounts of vitamins remains a concern.

The average weight of the issued CR1M was 1785 g. The average MA CRP (at 1646 g) reduced the daily load by over 130 g. Further reduction is necessary to bring the weight down to a compliant level (<1600 g). Further field trials need to measure and compare the maximum, the actual and the desired CRP load burden users are prepared to carry during an expanded range of operations over enduring periods. This will confirm or refine the appropriateness of the current weight target of <1600 g, based on the limits (expectations) of the user.

Anecdotal advice suggested CRP 'stripping' is a legitimised culture within the user community. Training and education is required to improve the combatant's choice both to take (carry) food and to consume it.

Products found to have a significant perceived worth included the long life bread, wet (retort) meals, all-fruit bars, sports drinks, cereal bar, formulated drink powder, self-closing plastic bag (rubbish bag), spoon, toilet paper and can opener. The chocolate drink was the most discarded component. The contents of the 'brew kit' were also heavily discarded, as were the wet and dry condiments, the non-dairy creamer, hard cream candy, scouring pad and safety matches. Components were discarded because they were not liked, not needed for this particular exercise, presented an unacceptable burden, e.g. cans were too bulky/heavy, were time consuming to prepare or consumers were simply bored (fatigued) with the components.

Well-consumed and nutritionally 'valuable' components included bread, noodles, cheese, tuna, wet main meals (beef & pasta, lamb casserole, Malay lamb curry and spaghetti bolognese), fruit snacks, chocolate candies and steak bar.

Products found to be low in overall acceptability and poorly consumed included muesli, hard candy, chocolate drink powder, non-dairy creamer, coffee and tea. The continued inclusion of unpopular components needs to be reviewed. If continued use is justified, component improvement and/or COTS substitution is required to increase their use in military environments.

The main criticism of the majority of non-food items, particularly soaped scouring pad and safety matches, was that daily provisioning was excessive.

Longer period studies are necessary to evaluate CRP acceptance and consumption patterns over enduring periods. Short-term studies of CRP use are limited in their ability to recognise and report patterns in consumer behaviour. These patterns may be influenced by mindsets such as 'it's only for a short period, I'll go without now, and feed-up when I return', ease of access to 'jack rations' and ability to swap with other combatants. Longer term studies are required to assess the potential exposure to nutrient inadequacies and inform the requirements for health, well-being and nutrition recovery programs.

Use of 'jack-rations' was found to be common practice. The most frequently used 'jack rations' included tuna, noodles, jerky, muesli bars, protein bars, trail mix, protein bars, confectionery, coffee sachets and protein drink powder. Regular use of vitamin and mineral supplements, pro/prebiotics and omega 3/6 (fish oil) supplements were also reported.

A concerning number of participants (~20%) reported adding sports drink powders (and other beverage bases) to their water bladder for consumption. Such a practice carries undue risk and can easily be mitigated by use of a single use, drink pouch such as that included in US MREs.

A number of in-service CRP components not used in the MA CRP design—such as instant noodles, soup powder, fruit spreads, tinned fruit, freeze-dried meals, chocolate candies, jam sandwich biscuit—require evaluation of worth, acceptance and consumption.

The energy intake of participants consuming both the CR1M and MA CRP was significantly less (49–54%) than the AC 3 MRDI of 16–16.5 MJ. The protein intake was deficient by ~38% and CHO intake deficient by more than 55%. Widespread fortification of at-risk vitamin and minerals within CRP is required to address nutrient inadequacies in both CRP provisioning and nutrient intakes. Fortified products may be provided by either in-service or COTS components and should focus on increasing the levels of vitamins B_6 and E and minerals (calcium, copper, iodine, magnesium, manganese and potassium).

The average calculated (estimated) daily EE of participants during the trial (19±2 MJ/day) was above the level of energy provided. Given the EE estimation method applied, this is likely an overestimation.

The average combatant load burden at a supply/resupply event was found to be ~50 kg. The average estimated weight loss of combatants was 1% of the initial body weight.

Combatants that consistently consume a diet substantially inadequate in energy and nutrients for lengthy periods are likely to exhibit a decline in health and performance.

Combatants (~20% of participants) reported regular use of vitamin and mineral supplements, pro/prebiotics and omega 3/6 (fish oil) supplements.

Designing a CRP configuration for direct integration into SCE is not feasible. No two participants integrated CRP into their SCE in a similar manner. In fact, no two SCE configurations were the same—each user had personalised the configuration to suit their needs.

With regards to personal hygiene effects, high use rates were reported for shaving gear, toothpaste/toothbrush and wet wipes. Participants would welcome the inclusion of wipes and hand sanitiser in a CRP configuration. The introduction of a hygiene pack to support field feeding and personal care (one that is not a daily re-supply) could potentially be a cost-effective way of reducing the waste generated by daily provisioning of non-food items such as scourer, matches and toilet paper.

This was the first exposure of a modular design to a user group. There was no specific education or training provided to users on the worth and benefit of the MA CRP, its modules and its individual components. COs, users and combat soldier support entities are sceptical about the introduction of modular MA CRP. Questions to be answered include:

- how will COs know what demands (of modules) to raise?
- how will users know what CRP modules to collect?
- how will the supply system identify, management, monitor and control distribution, storage, availability and issue of modules?
- will the provisioning of more entities in the supply system increase the risk of failure to deliver all necessary elements?

Further socialisation, training and education should manage and control much of this scepticism.

Being issued 3 modules per day, rather than a single assembled CRP, was considered somewhat inconvenient given the extra effort required to breakdown CRP to individual components (for integration into CRP). There was also a perception of additional packaging being required to bundle modules and ultimately requiring disposal.

In order to provide proof of concept, further design development and field trials are required.

5. Recommendations

To progress the modular MA CRP trials, DST Group recommends AHQ:

- review the reported EE for military tasks as referred to in 'ADF Nutrients for the 21st Century' for its relevance to today's and future operational missions and tasks and contemporary environments. The review should include consideration of changes in load carriage, operational tempo, duration, location and climate
- conduct a comparative study applying DLW and/or indirect calorimetry methods for EE with non-invasive techniques/unobtrusive devices that estimate EE during military-related activities. The aim of which is to make an informed decision on appropriate devices for field use applications and calculation of correction factors for such non-obtrusive techniques
- informed by the above, identify and specify the appropriate energy and nutrition required by combatants to adequately maintain health and well-being, and optimise their performance
- better understand and articulate the requirements of users in contemporary operational environments by conducting further field use trials that scope activities:
    - where combatants require energy and nutrients commensurate with AC 2 and AC 4
    - conducted in use environments other than hot climate
    - of longer duration (up to 30 days).
- consider the inclusion of the following additional outputs in the current Trial Directive and associated task documentation:
    - training and education packages for COs, combatants and Combat Soldier Support personnel
    - policy and procedure for implementation, use, monitoring and control of MA CRP
    - interactive tools for verification of learning, validation of desirable behaviour and realisation of benefits.

  These outputs would enable the ADF to demonstrate appropriate CRP use, evaluate and where necessary change consumer behaviour through reinforcement of learning.
- evaluate current field feeding practices in order to identify the hazards and mitigation strategies to reduce the risks to health when sustaining on CRP
- assess combatant's tolerance for CRP load burden, within the broader scope of SCE load. Measure and compare the maximum, the actual and the desired CRP load burden users are prepared to carry during an expanded range of operations over enduring periods. This will confirm or refine the appropriateness of the current weight target of <1600 g

- include assessment of body weight and composition to understand the prevalence and significance of change to individuals health status when subsisting on CRP for long periods
- better understand what function and level of performance food has in maintaining and potentially enhancing cognitive performance. Outcomes from this work should be used to influence CRP design in both product selection and eating behaviour.

In considering future configurations of the modular MA CRP, DST Group recommends:

- component selection focus on:
    - achieving functional and performance targets - include fortified components, offer variety and convenience (reduce impost on time, effort and equipment), hygienic in delivery
    - delivering adequate energy and nutrition
    - promoting high level consumption
    - reducing load burden - include energy dense and nutrient rich components (particularly those used in the meals modules). Product concepts including the combat food bar, COTS meal–in–a–bar type and freeze dried products should be introduced to the MA CRP menu configuration
- well-consumed, highly accepted and nutritionally 'valuable' components be retained. Further, the weight of these popular items could be increased, and in doing so potentially increase the likelihood of improved nutrient intakes and a cost benefit—reducing the number of components required to ensure the MRDI requirements are met
- the value and continued use of unpopular, poorly consumed 'at risk' components (such as those more vulnerable to cross-contamination) be assessed. If continued use is justified, component improvement, COTS substitution and use of alternate packaging are all strategies to improve utility of such components in military use environments
- removing rigid cans and aluminium tubes used to package CRP components
- introducing single use drink pouches for drink powders including sports drinks and 'protein shakes'
- introducing wet wipes and hand sanitiser in a potential field hygiene pack.

To improve the design and use of in-service CR1M, DST Group recommends:

- the energy content of CR1M be reduced to 16 MJ. This is 1.8 MJ lower than the current average energy content
- the energy and nutrient non–compliances identified in CR1M be addressed. This includes reducing saturated fat, CHO (particularly sugar) and sodium, while increasing micronutrient content, particularly vitamins B_2, B_6 and E and copper. Actions could include:

  - removing discretionary salt (reducing sodium by ~760 mg/day)
  - halving the salt content in those components currently contributing significant amounts to the daily provisioning (including retort meals, soup mixes and noodles condiments)
  - introducing low level (~20% MRDI) fortification of the suite of vitamins in key highly consumed CRP components including long life bread, wet (retort) meals, cheese, fruit, cereal and meat based–bars and drink powders
  - introducing product concepts, not currently included in CRP, that combatants are regularly using. This should include trail mixes, jerky and food bars.
- the 'brew kit' be re-configured with a focus on convenience and waste minimisation to justify continued inclusion. Coffee/sugar/milk or tea/sugar/milk could be consolidated as single serve, pre-mixed, hot drink sachets.

To further understand the adequacy of CRP to deliver the prescribed nutrients, evaluate compliance of the following:

- vitamins B_{12}, D, K, folate and pantothenic acid
- molybdenum.

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    - staff support to DST Group
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    - assembly of prototype packs
    - assistance during data analysis.
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Appendix A MA CRP Design Framework

*Table A1 Modular design: The load burden of modules issued when delivering to AC and MRDI**

	Energy (MJ)	*14 –14.5*	*16–16.5*	*19–19.5*
	P:F:C ratio	*14–19:24–34:52–57*	*13–18:23–33:54–59*	*12–17:22–32:56–61*
	Nutrients	*MRDI, AC 2*	*MRDI, AC 3*	*MRDI, AC 4*
			Module assembly	
Use (climatic) environment[1]	Temperate	Staples (880 g) + Meals (wet) (530 g) Total weight: 1410 g	Staples (880 g) + Meals (wet) (530 g)^ + Energy (140 g) Total weight: 1550 g	Staples (880 g) + Meals (dry) (270 g) + Energy (140 g) + Combat food bar (80 g) Total weight: 1370 g
	Hot	As above	Staples (880 g) + Meals (wet) (530 g)^ + Hot climate (185 g) Total weight: 1595 g	Staples (880 g) + Meals (dry) (270 g) + Hot climate (185 g) + Combat food bar (80 g) Total weight: 1415 g
	Cold	As above	Staples (880 g) + Meals (wet) (530 g)^ + Cold climate (155 g) Total weight: 1565 g	Staples (880 g) + Meals (dry) (270 g) + Cold climate (155 g) + Combat food bar (80 g) Total weight: 1380 g

* Weights do not take account of packaging required to bundle or documentation
^ The use of a hybrid meals module (refer section 2.2) could reduce the overall weight by ~180 g

Table A2 Modular design and module assembly for each level of energy and nutrient requirements

	Activity level	*AC 2*	*AC 3*	*AC 4*
	Energy (MJ)	*14–14.5*	*16–16.5*	*19–19.5*
	P:F:C ratio	*14–19:24–34:52–57*	*13–18:23–33:54–59*	*12–17:22–32:56–61*
	Nutrients	*MRDI, AC 2*	*MRDI, AC 3*	*MRDI, AC 4*
			Module assembly	
Use environment[1]	Temperate	Staples (11 MJ) + Meals (wet) (3–3.5 MJ)	Staples (11 MJ) + Meals (wet[2]) (3–3.5 MJ) + Energy (2 MJ)	Staples (11 MJ) + Meals (dry[3]) (5–5.5 MJ) + Energy (2 MJ) + Combat food bar (1 MJ)
	Hot	As above	Staples (11 MJ) + Meals (wet[2]) (3–3.5 MJ) + Hot climate (2 MJ)	Staples (11 MJ) + Meals (dry[3]) (5–5.5 MJ) + Hot climate (2 MJ) + Combat food bar (1 MJ)
	Cold	As above	Staples (11 MJ) + Meals (wet[2]) (3–3.5 MJ) + Cold climate (2 MJ)	Staples (11 MJ) + Meals (dry[3]) (5–5.5 MJ) + Cold climate (2 MJ) + Combat food bar (1 MJ)

1 A high altitude environment, while identified, is yet to be considered in the design
2 Wet is indicative of a retort meal
3 Dry is indicative of a light weight meal which may be dehydrated or intermediate moisture food bars

Table A3 Proposed Recommended Nutrition Criteria for MA CRP

Nutrient	Activity Category		
	2	3	4
Energy (MJ)	**14–14.5**	**16–16.5**	**19–19.5**
Protein (g)	**119–156**	**126–169**	**138–190**
CHO (g)	**471–499**	**557–590**	**683–724**
Dietary Fibre (g)	30	30	30
Vitamin A (µg)	900	900	900
Vitamin C (mg)	45	45	45
Vitamin E (mg)	10	10	10
Thiamine (mg	**1.5**	**1.7**	**2.0**
Riboflavin (mg)	**2.2**	**2.5**	**2.9**
Niacin (mg)	**23**	**26**	**31**
VitaminB_6 (mg)	**2.4**	**2.5**	**2.8**
Vitamin B_{12} (µg)	2.4	2.4	2.4
Folate (µg)	400	400	400
Pantothenic Acid (mg)	6	6	6
Biotin (µg)	30	30	30
Choline (mg)	550	550	550
Vitamin D (µg)	5	5	5
Vitamin K (µg)	70	70	70
Calcium (mg)	1300	1300	1300
Chromium (µg)	35	35	35
Copper (mg)	1.7	1.7	1.7
Iodine (µg)	150	150	150
Iron (mg)	18	18	18
Magnesium (mg)	410	410	410
Manganese (mg)	5.5	5.5	5.5
Molybdenum (µg)	45	45	45
Phosphorus (mg)	1250	1250	1250
Potassium (mg)	3800	3800	3800
Selenium (µg)	70	70	70
Sodium (mg)	**920–2500**	**920–2750**	**920–3000**
Zinc (mg)	14	14	14

[1] *Based on the 'ADF Nutritional Requirements in the 21st Century' [5] (amended to correct units for biotin, copper and manganese).*

Appendix B CR1M Menu and Instructions

AUSTRALIAN DEFENCE FORCE – COMBAT RATION ONE MAN (CR1M) **Packed 2015 / 2016**

INFORMATION FOR USERS

FOOD ALLERGIES

This ration pack has **NOT** been catered for consumers with any food allergy or special dietary requirements. You should read the **Information, Menu and Ingredients sheets** before consumption. If you have any doubt about the contents, you should not consume the ration pack.

GENERAL

The CR1M consists of two main meals, a number of light meal and snack components and sundry items. It is suggested that the two main components be used for breakfast and evening meals if the pack does not contain a breakfast cereal. The CR1M has been designed to ensure that you receive adequate nutritional sustenance for one day; therefore, it is desirable that all food in the pack is eaten.

To heat the retort pouch for consumption, place one unopened retort pouch into a cup canteen. Fill the cup canteen with water and place on your hexamine stove. Using two hexamine tablets, one at a time, boil the contents for 10–15 minutes. Carefully remove the pouch from the water and open up the pouch for consumption. The remaining water is safe to be used to prepare your beverages.

After a few months in a tropical climate the condensed milk may become thicker and brownish in appearance, but it is safe to eat and may be consumed without fear of any ill effect.

Chocolate may develop a light coloured film (fat bloom) on the surface. It is still safe to eat.

Due to unavoidable circumstances, items may be substituted; therefore may not correspond with the menu sheet.

The label on the packaging of each item contains detailed allergen information.

BEST BEFORE DATE (BBD)

Commercial–off–the–shelf (COTS) items have a best before date. Food that is labelled with a BBD signifies that although the date on the package may have passed, the product is still safe to consume as long as the packaging is not damaged and the sensory quality (colour, aroma, texture and flavour) is acceptable to the consumer. The BBD is used more to identify when the food may lose some of its qualities, rather than being unsafe to eat.

WATER STERILISATION

All water supplies must be regarded as contaminated unless medically cleared. If the water is dirty or cloudy, first filter using the Millbank Individual Filter. Once filtered, add the water sterilisation tablets and follow the directions on the tablets package. Wait 5 minutes and shake well, wait an additional 30 minutes so bacteria are killed before drinking or using to prepare food or beverage. Water may also be sterilised by boiling for a minimum of 5 minutes.

AVOID FOOD POISONING

Do not open more containers of food than are necessary for a meal. Any unconsumed portion of opened food that is wet or has been added with liquid must be disposed of (see disposal of litter paragraph).

AVOID DEHYDRATION

It is essential that you drink plenty of water. Heat and exercise cause dehydration and loss of thirst. You should drink plenty of water if you are sweating heavily, even if you don't feel thirsty. Drink enough water to keep your urine clear.

SALT INTAKE

Extra salt may be needed if working hard in hot environments / or during periods of heat acclimatisation when your salt losses are much greater. When required the extra salt should be taken dissolved in drinking water (not more than one (1) sachet for seven (7) litres of water), or sprinkled on food. Do not take extra salt unless you drink plenty of water. It is harmful to take extra salt without extra water.

DISPOSAL OF LITTER

There is packaging litter in each CR1M, which may give intelligence to the enemy if not discarded appropriately. Dispose all litter in a thoughtful manner with consideration for the environment.

IMPROVEMENTS

If you don't tell us then we cannot fix it. Any feedback or suggestion regarding improvements to ration packs should be directed to:

Combat Rations Section, Technical Cell, Health Systems Program Office, Defence Materiel Organisation

GPO BOX 519J, MELBOURNE VIC 3001 Or email to: crp.feedback@defence.gov.au

AUSTRALIAN DEFENCE FORCE – COMBAT RATION ONE MAN

MENU SHEET

FOOD ALLERGIES: This ration pack does **NOT** cater for consumers with any food allergy or special dietary requirements. You should read the **Menu, Information and Ingredients sheets** before consumption. If you have any doubt about the contents, you should not consume the ration pack.

MENU B		MENU D		MENU H	
Beef, onion & gravy	1 x 250g	Beef and pasta	1 x 250g	Lamb casserole	1 x 250g
Malay lamb curry	1 x 250g	Lamb korma	1 x 250g	Spaghetti bolognese	1 x 250g
Soup Golden Pumpkin	1 x 27.5g	Soup creamy mushroom	1 x 32.5g	Soup creamy mushroom	1 x 32.5g
Sports drink powder, orange	1 x 35g	Sports drink powder, wild berry	1 x 35g	Sports drink powder, wild berry	1 x 35g
All fruit bar, mixed fruit	2 x 20g	All fruit bar, mixed fruit	2 x 20g	All fruit bar, raspberry	2 x 20g
Fruit jam, strawberry	1 x 26g	Fruit jam, strawberry	1 x 26g	Fruit jam, plum	1 x 26g
Diced two fruits	1 x 140g	Diced pears	1 x 140g	Diced two fruits	1 x 140g
Cereal bar, apple & blueberry	1 x 50g	Cereal bar, apple & blueberry	1 x 50g	Cereal bar, apple & blueberry	1 x 50g
Instant mashed potato	1 x 60g	Instant mashed potato	1 x 60g	Instant mashed potato	1 x 60g
Hard cream candy	1 x 50g	Hard cream candy	1 x 50g	Hard cream candy	1 x 50g

ADDITIONAL ITEMS COMMON TO ALL MENUS

Chocolate Drink (Menu B &D)	1 x 40g	Salt	1 x 2g	Plastic bag, inner	1
Formulated drink powder, coffee (menu H)	1 x 60g	Sweetened condensed milk	1 x 85g	Plastic spoon	1
Instant coffee	2 x 3.5g	Chewing gum, sugar free	2 x Pkts	Scouring pad, soaped	1
Tea bags	2 x 2.5g	Long life bread	1 x 65g	Toilet paper, 10 sheets	1
White sugar	4 x 7g	Beef steak bar	1 x 25g	Menu sheet	1
Ration chocolate	1 x 50g	Tabasco sauce	1 x 3ml	Ingredient sheet	1
Chocolate candies	1 x 49g	Mi goreng instant noodles	1 x 55g	Information sheet	1
Processed cheddar cheese	1 x 56g	Natural muesli with fruits & seeds	1 x 90g	Rubber band, size 32	3
Concentrated yeast extract	1 x 15g	Non-dairy creamer	1 x 15g	Plastic bag, self-closure	1
Tomato ketchup	1 x 15g	Safety matches, vial	1	Can opener, hand	1
Black pepper	1 x 2g				

INGREDIENT LIST - COMBAT RATION ONE MAN - PACKED 2015 / 2016

FOOD ALLERGIES: This ration pack does **NOT** cater for consumers with any food allergy or special dietary requirements. You should read the **Information, Menu and Ingredients sheets** before consumption. Ingredients containing allergens are emboldened for ease of identification. If you have any doubt about the contents, you should not consume the ration pack. This Ingredient list is correct at the time of printing and may differ slightly from the ingredient list on the product label.

Beef, Onion & Gravy	**Malay lamb curry**	**Beef & pasta**	**Spaghetti bolognese**
Beef, Water, Onion, Tomato Paste, Corn Starch, Salt, Onion powder, Sugar, Vegetable Protein, Vitamins (Thiamine, Ascorbic Acid, Niacin, and Riboflavin), Garlic powder, White Pepper, Nutmeg, Colour (150c).	Lamb, Water, Vegetables (Potato, Onion, Spinach) Coconut **Milk**, Corn Starch, Curry powder, Garlic, Sugar, **Milk** powder, Salt, Ginger, Pepper, Tamarind Paste (Tamarind, Water, Sugar, Vinegar, Acid (260), Colour (150c)), Vitamins (Thiamine, Ascorbic Acid, Niacin, Riboflavin).	Beef, Water, Pasta (**Wheat**), Carrots, Onion, Corn Starch, Celery, Tomato Paste, Vegetable Protein (Vegetable Protein Extract, Rice Bran Oil), Curry powder, Salt, Onion powder, Vitamins (Ascorbic Acid, Niacin, Thiamine, Riboflavin), Garlic powder, Cayenne.	Beef, Tomato, Water, Spaghetti (**Durum Wheat**) Tomato Paste, Corn Starch, Sugar, Garlic, Salt Canola Oil, Vitamins (Thiamine, Ascorbic Acid, Niacin, Riboflavin), Pepper.
Lamb casserole	**Lamb korma**	**Natural muesli with fruits & seeds**	**Cereal bar, apple & blueberry**
Lamb, Stock (Water, Marine Salt, Sugar, Natural Vegetable Flavours, Rice Flour, Yeast Extract, Vegetable Protein Extract, Dehydrated Vegetables (Onion, Garlic, Chilli), **Soy Sauce** powder, Vegetable Oil (Canola) Flavour Enhancer, Caramel Colour, Vegetables (Carrot, Potato), Tomato Paste, Corn Starch, Garlic, Cumin, Paprika, Vitamins (Ascorbic Acid, Niacin, Riboflavin), Pepper.	Lamb, Korma Curry Paste (Water, **Soybean** Oil, Coriander, Garlic, Salt, Onion, Tomato Paste, Chilli, Turmeric, Black Pepper, Star Anise, Cumin, Herbs and Spices, Tamarind), Brown Rice Onion, Spinach, Coconut **Milk**, Tomato Paste, Corn Starch, Garlic, Sugar, Ginger, Vitamins (Thiamine, Ascorbic Acid, Niacin, Riboflavin).	**Rolled Oats** (67%), Dried Fruits (30%), Dried Papaya,[Papaya, Cane Sugar, Acidity Regulator (330), Preservative (**220**)], Dried Apricots [Apricots, Rice Flour (3%), Preservative (**223**)] Raisins [Raisins, Cotton Seed Oil], Dried Pineapple [Pineapple, Sugar, Acidity Regulator (330),Preservative (**223**)], Dried Cranberries [Cranberries, Sugar, Sunflower Oil],Dried Apples [Apples, Preservative (**220**)],Pumpkin Seeds (3%).	Cereal (Wheat Flour, Wheat Germ, Wheat Fibre, Wholemeal Flour), Sultanas, Apples, Blueberry Concentrate, Glycerine, Baking powder (450, 500), Potassium Sorbate (202), Sugar, Water, Milk solids, Skim Milk powder, Emulsifiers (322 from Soy, 471, 481), Palm Oil, Coconut Oil, Salt, Flavour, Butylated Hydroxyanisole (BHA), Glucose Syrup.
Chewing gum sugar free	**Beef steak bar**	**Soup golden pumpkin**	**Soup creamy mushroom**
<u>Lemon Lime</u> Maltitol, Sorbitol, Gum Base, Xylitol, Thickener (414), Mannitol, Humectant (422), Food Acids (330,296), Flavour, Emulsifier (322, from **Soy**), Colour (171), Sweeteners (951, 950), Calcium Phosphate, Glazing Agent (903), Antioxidant (321). <u>Peppermint</u> Maltitol, Sorbitol, Gum Base, Humectant (422), Thickener (414), Flavour, Mannitol, Emulsifier (322, from **Soy**), Sweeteners (951, 950), Sodium Bicarbonate, Colour (171), Glazing Agent (903), Antioxidant (321)	Beef, Sugar, **Soy** Sauce powder (**Wheat, Soybeans,** Salt), Salt, Flavourings (Onion powder, Garlic powder, Herbal Active and Spice Extracts of Rosemary), Spices (Black Pepper, Spice Extracts of Rosemary, Black Pepper and Paprika) Monosodium Glutamate (Flavour Enhancer (621)) **Hydrolysed Vegetable Protein** (Hydrolysed Corn Gluten), Sodium Erythorbate (Antioxidant (316, Potassium Sorbate (Preservative 202), Sodium Nitrite (Preservative 250) Smoke Flavour (Natural Wood Smoke).	Modified Potato Starch (1414), Pumpkin powder, (15.5%) Beverage Whitener [Glucose Syrup Solids, Vegetable Fat, Milk Protein, Mineral Salts (340,451,452) Emulsifiers (471,481,322)(from **Soy**) Anticaking Agent (551) Natural Flavour] Sugar, Croutons (12.5%)(**Wheat** Flour, Vegetable Oil, Salt, Yeast, Rosemary Extract) Maltodextrin, Salt Dehydrated Vegetables (Onion, Tomato) Natural Flavours, Mineral Salt (508), Yeast Extract, Vegetable Oil Garlic powder, Flavour Enhancer (635), Acidity Regulator (330), Natural Colour (160a)	Modified Potato Starch (1414) Beverage Whitener [Glucose Syrup Solids, Vegetable Fat, **Milk** Protein, Mineral Salts (340,451,452) Emulsifiers (471,481,322) (from **Soy**) Anticaking Agent (551) Natural Flavour] Maltodextrin, Croutons (15%) (**Wheat** Flour, Vegetable Oil ,Salt, Yeast, Rosemary Extract) Salt, Sugar, Mushroom Extract (3%) Natural Flavours, Onion powder, **Soy** Sauce powder, Mineral Salt (508),Yeast Extract, Chives, Vegetable Oil Flavour Enhancer (635), Natural Colour (150a), Malic Acid

All fruit bar, mixed fruit	Long life bread	Sports drink powder, wild berry	Sports drink powder, orange
Fruit (Concentrated Apple Puree, Concentrated Apple Juice, Blackcurrant Puree, strawberry Puree, Blueberry Puree), Bulking Agent (Polydextrose), **Wheat** Fibre, Gelling Agent (Pectin), Flavours (Natural), Acidity Regulator (Citric Acid) Fruit & Vegetable concentrates (black carrot, blackcurrant),	**Flour,** Water, Sugar, Vegetable Oil, Yeast, Iodised Salt, Bread Improver (emulsifier (481),**wheat flour, soya flour,** free flow agent (170),vegetable fat, flour improver (300), enzymes), Vegetable Fat (water, vegetable oil, sugar, emulsifier (475)) Hydrocolloid Gum, Enzyme (1100), and Vitamins (Folic Acid, Thiamine).	Caster Sugar, Dextrose Monohydrate, Ascorbic Acid (Vitamin C) Artificial Flavour, Sodium Chloride, Citric Acid, Amino Acid Blend (Magnesium Chelate, L–Glutamine, L–Leucine, L–Isoleucine, L–Valine), Potassium Chloride, Sucralose, Artificial Colour (123).	Caster Sugar, Dextrose Monohydrate, Ascorbic Acid (Vitamin C) Artificial Flavour, Sodium Chloride, Citric Acid, Amino Acid Blend (Magnesium Chelate, L–Glutamine, L–Leucine, L–Isoleucine, L–Valine), Potassium Chloride, Sucralose, Artificial Colour (110).
Mi goreng instant noodles	**Ration chocolate**	**All fruit bar, raspberry**	**Instant mashed potato**
Noodles [Wheat flour, Palm oil, Salt, Stabilizers (450, 412) Emulsifier (322) (Contains Soy), Raising agents (501,500)] Seasoning powder [Sugar, Flavour enhancers (621, 627, 631) Spices, Salt, Chicken flavour (contains Egg, Sesame, Soy), Caramel colour (150d) hydrolysed vegetable protein (Contains Soy), Anti–caking agent (551)], Seasoning Sauce (Palm oil, Fried onion, Fried garlic), Sweet Soy Sauce [Sugar, Water, Salt, Soy Bean, Wheat, Preservative (211)], Chilli Sauce [Chilli, Water, Sugar, Salt, Spices, Acidity regulator (330, 260), Garlic Flavour, Preservative (211, 223)], Fried Shallot (Shallot, Palm Oil).	Cocoa Butter, **Dextrose,** Sugar, **Milk** Solids, Cocoa Mass, Emulsifier **(Soy** Lecithin**),** Vitamin Premix (Ascorbic Acid, Retinol (Vitamin A Acetate, Cornstarch, Thickener (414), Corn Oil), Thiamine Hydrochloride)	Fruit (Concentrated Apple Puree, Apple Juice, raspberry Puree, Citrus Fibre), Pectin, Fruit & Vegetable concentrates (black carrot, blackcurrant), Flavours (Natural).	Dried Potatoes (Potato, Emulsifier (471), Stabilizers (450i), Citric Acid (330), Antioxidants (**223**, 320), Canola Oil (Canola Oil, Antifoam (900)), **Milk** powder (**Milk** Solids, **Soy** Lecithin), Salt, Sugar, Chives.
	Chocolate candies	**Concentrated yeast extract**	**Non–dairy creamer (NDC)**
	Milk Chocolate (Sugar, Milk Solids, Cocoa Mass, Cocoa Butter, Vegetable Fat, Emulsifier (Soy Lecithin), Salt, Flavour), Sugar, Starch (Include Wheat), Glucose Syrup (Include Wheat), Vegetable Gum (414), Colours (17, 129, 133, 110, 102), Thickener (Dextrin), Glazing Agent (903).	Yeast extract (From Yeast grown on **Barley**), Salt, Mineral Salt (506), **Malt** Extract (from **Barley**), Natural Colour (150c), Preservative **(220**), Vegetable Flavours, Niacin, Thiamine, Riboflavin, Folate	Glucose Syrup, Hydrogenated Palm Kernel Oil, Dipotassium Phosphate (340ii), Emulsifier (471) **Sodium Caseinate**, Anticaking (551), Natural Colour (160b), Flavour
	Fruit jam, strawberry	**Hard cream candy**	**Chocolate drink powder**
	Sugar , Strawberries, Apple Juice Concentrate, Pectin, Citric Acid (330).	**Butter**, **Cream**, Salt, Flavour, Emulsifier, **Soy** Lecithin	Cane Sugar, Cocoa, Emulsifier (322) (**Soy** Lecithin)), Spice (Cinnamon).
Processed cheddar cheese	**Tomato ketchup**	**Fruit jam, plum**	**Diced two fruits**
Cheddar Cheese (Pasteurised **Milk**, Salt, Culture, Rennet), Water, Food Acids (330, 331), **Butter**, Salt, Preservative (234).	Water, Tomato Paste (20%), Sugar, Food Acid (260), Thickeners (1442, 415), Salt, Spices, Preservatives (202,211), Natural Flavour.	Sugar, plums Puree, Apple Juice Concentrate, Pectin, Sodium Citrate (331), Citric Acid (330).	Diced Pears, Diced Peaches, Water, Sugar.
Diced pears	**Black pepper**	**Sweetened condensed milk**	**Instant coffee**
Diced Pear, Water, Sugar.	Ground Black Pepper	**Milk**, sugar	Coffee Robusta.
White sugar	**Salt**	**Tea bags**	**Tabasco Sauce**
Cane Sugar.	Salt; Anti–caking Agent	Small Leaf Tea.	Distilled vinegar, red

Appendix C Mission Adaptive CRP Menu and Instructions

MEALS MODULE **Packed 2015 / 2016**

INFORMATION FOR USERS

FOOD ALLERGIES

This ration pack module has **NOT** been catered for consumers with any food allergy or special dietary requirements. You should read the **Information for users, Menu sheet and Ingredients list** before consumption. If you have any doubt about the contents, you should not consume the ration pack.

GENERAL

The MA CRP meals module consists of two main meals. The MA CRP has been designed to ensure that you receive adequate nutritional sustenance for one day; therefore, it is desirable that all food in this and other issued modules is eaten.

The MA CRP meals module shall be issued with a MA CRP staples module, containing food hygiene effects and eating utensils.

To heat the retort pouch for consumption, place one unopened retort pouch into a cup canteen. Fill the cup canteen with water and place on your hexamine stove. Using two hexamine tablets, one at a time, boil the contents for 10–15 minutes. Carefully remove the pouch from the water and open up the pouch for consumption. The remaining water is safe to be used to prepare your beverages**.**

Due to unavoidable circumstances, items may be substituted; therefore may not correspond with the menu sheet.

The label on the packaging of each item contains detailed allergen information.

BEST BEFORE DATE (BBD)

Commercial–off–the–shelf (COTS) items have a best before date. Food that is labelled with a BBD signifies that although the date on the package may have passed, the product is still safe to consume as long as the packaging is not damaged and the sensory quality (colour, aroma, texture and flavour) is acceptable to the consumer. The BBD is used more to identify when the food may lose some of its qualities, rather than being unsafe to eat.

AVOID FOOD POISONING

Do not open more containers of food than are necessary for a meal. Any unconsumed portion of opened food that is wet or has been added with liquid must be disposed of (see disposal of litter paragraph).

AVOID DEHYDRATION

It is essential that you drink plenty of water. Heat and exercise cause dehydration and loss of thirst. You should drink plenty of water if you are sweating heavily, even if you don't feel thirsty. Drink enough water to keep your urine clear.

SALT INTAKE

Extra salt may be needed if working hard in hot environments / or during periods of heat acclimatisation when your salt losses are much greater. When required extra salt (provided in the Staples module) should be taken dissolved in drinking water (not more than one (1) sachet for seven (7) litres of water), or sprinkled on food. Do not take extra salt unless you drink plenty of water. It is harmful to take extra salt without extra water.

DISPOSAL OF LITTER

There is packaging litter in each module of the MA CRP, which may give intelligence to the enemy if not discarded appropriately. Dispose all litter in a thoughtful manner with consideration for the environment.

MEALS MODULE – MENU SHEET AND INGREDIENT LIST

FOOD ALLERGIES: This meals module does **NOT** cater for consumers with any food allergy or special dietary requirements. You should read the **Information for users, Menu sheet and Ingredients list** before consumption. Ingredients containing allergens are emboldened for ease of identification. If you have any doubt about the contents, you should not consume the meals module. This Ingredient list is correct at the time of printing and may differ slightly from the ingredient list on the product label.

MENU 1		MENU 2		MENU 3	
Beef, onion & gravy	1 x 250g	Malay lamb curry	1 x 250g	Beef & pasta	1 x 250g
Lamb casserole	1 x 250g	Spaghetti bolognese	1 x 250g	Lamb korma	1 x 250g

Items Common to ALL meals modules

Menu sheet & Ingredient List	1
Information For Users	1

INGREDIENT LIST		
Beef, onion & gravy	**Malay lamb curry**	**Beef & pasta**
Beef (65%), Water, Onion, Tomato Paste, Corn Starch, Salt, Onion powder, Sugar, Vegetable Protein, Vitamins (Ascorbic Acid, Niacin, Thiamine, and Riboflavin), Garlic powder, White Pepper, Nutmeg, Colour (150c).	Lamb (40%), Water, Vegetables (Potato, Onion, Spinach) Coconut **Milk**, Corn Starch, Curry powder, Garlic, Sugar, **Milk** powder, Salt, Ginger, Pepper, Tamarind Paste (Water, Tamarind, Sugar, Salt, Vinegar, Acid (260), Colour (150c)), Vitamins (Ascorbic Acid, Niacin, Thiamine, Riboflavin).	Beef (41%), Water, Pasta (7%) (**Durum Wheat**), Carrots, Onion, Corn Starch, Celery, Tomato Paste, Vegetable Protein (Vegetable Protein Extract, Rice Bran Oil), Curry powder, Salt, Onion powder, Vitamins (Ascorbic Acid, Niacin, Thiamine, Riboflavin), Garlic powder, Cayenne Pepper.
Lamb casserole	**Spaghetti bolognese**	**Lamb korma**
Lamb (40%), Stock (Water, Marine Salt, Sugar, Natural Vegetable Flavours, Rice Flour, Yeast Extract, Vegetable Protein Extract, Dehydrated Vegetables (Onion, Garlic, Chilli), **Soy Sauce** powder, Vegetable Oil (Canola) Flavour Enhancer (627, 631), Caramel Colour (150a), Vegetables (Carrot, Potato), Tomato Paste, Corn Starch, Garlic, Cumin, Paprika, Vitamins (Ascorbic Acid, Niacin, Thiamine, Riboflavin), Pepper.	Beef (44%), Tomato, Water, Spaghetti (10%) (**Durum Wheat**) Tomato Paste, Corn Starch, Sugar, Garlic, Salt Canola Oil, Vitamins (Ascorbic Acid, Niacin, Thiamine, Riboflavin), Pepper.	Lamb (40%), Korma Curry Paste (38%) (Water, **Soybean** Oil, Coriander, Garlic, Salt, Onion, Tomato Paste, Chilli, Turmeric, Black Pepper, Star Anise, Cumin, Herbs and Spices, Tamarind), Brown Rice, Onion, Spinach, Coconut **Milk**, Tomato Paste, Corn Starch, Garlic, Sugar, Ginger, Vitamins (Ascorbic Acid, Niacin, Thiamine, Riboflavin).

STAPLES MODULE **Packed 2015 / 2016**

INFORMATION FOR USERS

FOOD ALLERGIES

This ration pack module has **NOT** been catered for consumers with any food allergy or special dietary requirements. You should read the **Information for users, Menu sheet and Ingredients list** before consumption. If you have any doubt about the contents, you should not consume the ration pack.

GENERAL

The MA CRP staples module consists of a number of light meal and snack components and sundry items. The MA CRP has been designed to ensure that you receive adequate nutritional sustenance for one day; therefore, it is desirable that all food in this and other issued modules is eaten.

After a few months in a tropical climate the condensed milk may become thicker and brownish in appearance, but it is safe to eat and may be consumed without fear of any ill effect.

Chocolate may develop a light coloured film (fat bloom) on the surface. It is still safe to eat.

Due to unavoidable circumstances, items may be substituted; therefore may not correspond with the menu sheet.

The label on the packaging of each item contains detailed allergen information.

BEST BEFORE DATE (BBD)

Commercial–off–the–shelf (COTS) items have a best before date. Food that is labelled with a BBD signifies that although the date on the package may have passed, the product is still safe to consume as long as the packaging is not damaged and the sensory quality (colour, aroma, texture and flavour) is acceptable to the consumer. The BBD is used more to identify when the food may lose some of its qualities, rather than being unsafe to eat.

WATER STERILISATION

All water supplies must be regarded as contaminated unless medically cleared. If the water is dirty or cloudy, first filter using the Millbank Individual Filter. Once filtered, add the water sterilisation tablets and follow the directions on the tablets package. Wait 5 minutes and shake well, wait an additional 30 minutes so bacteria are killed before drinking or using to prepare food or beverage. Water may also be sterilised by boiling for a minimum of 5 minutes.

AVOID FOOD POISONING

Do not open more containers of food than are necessary for a meal. Any unconsumed portion of opened food that is wet or has been added with liquid must be disposed of (see disposal of litter paragraph).

AVOID DEHYDRATION

It is essential that you drink plenty of water. Heat and exercise cause dehydration and loss of thirst. You should drink plenty of water if you are sweating heavily, even if you don't feel thirsty. Drink enough water to keep your urine clear.

SALT INTAKE

Extra salt may be needed if working hard in hot environments / or during periods of heat acclimatisation when your salt losses are much greater. When required the extra salt should be taken dissolved in drinking water (not more than one (1) sachet for seven (7) litres of water), or sprinkled on food. Do not take extra salt unless you drink plenty of water. It is harmful to take extra salt without extra water.

DISPOSAL OF LITTER

There is packaging litter in each CR1M, which may give intelligence to the enemy if not discarded appropriately. Dispose all litter in a thoughtful manner with consideration for the environment.

STAPLES MODULE – MENU SHEET AND INGREDIENT LIST

FOOD ALLERGIES: This meals module does **NOT** cater for consumers with any food allergy or special dietary requirements. You should read the **Information for users, Menu sheet and Ingredients list** before consumption. Ingredients containing allergens are emboldened for ease of identification. If you have any doubt about the contents, you should not consume the meals module. This Ingredient list is correct at the time of printing and may differ slightly from the ingredient list on the product label.

Items Common to ALL Staples Modules

Natural muesli with fruits & seeds	1 x 90g	Sweetened condensed milk	1 x 85g	Safety matches, vial	1
Non–dairy creamer	1 x 15g	Instant coffee	2 x 3.5g	Plastic bag, inner	1
Long life bread	1 x 50g	Tea bags	2 x 2.5g	Plastic spoon	1
Chocolate drink powder (Menu 1 and 2 only)	1 x 40g	Sugar, white	2 x 7g	Menu sheet & Ingred. list	1
Hard cream candy	1 x 50g	Tabasco sauce	1 x 3ml	Information for users	1
Ration chocolate	1 x 50g	Salt	1 x 2g	Rubber band, size 32	3
Processed cheddar cheese	1 x 56g	Black pepper	1 x 2g	Plastic bag, self–closure	1
Concentrated yeast extract	1 x 15g	Scouring pad, soaped	1	Can opener, hand	1
Instant mashed potato	1 x 60g	Toilet paper, 10 sheets	1		

Grab & Go Pack within Staples Module

MENU 1		MENU 2		MENU 3	
All fruit bar, mixed fruit	2 x 20g	All fruit bar, raspberry	2 x 20g	All fruit bar, mixed fruit	2 x 20g
Cereal bar, apricot	1 x 50g	Cereal bar, apricot	1 x 50g	Formulated drink powder, coffee	1 x 60g
Sports drink powder, orange	1 x 35g	Sports drink powder, wild berry	1 x 35g	Sports drink powder, wild berry	1 x 35g
Beef steak bar	1 x 25g	Beef steak bar	1 x 25g	Beef steak bar	1 x 25g
Cereal bar, apple & blueberry	1 x 50g	Cereal bar, apple & blueberry	1 x 50g	Cereal bar, apple & blueberry	1 x 50g
Chewing gum, sugar–free	2 x Pkt	Chewing gum, sugar–free	2 x Pkt	Chewing gum, sugar–free	2 x Pkt

INGREDIENT LIST		
Natural muesli with fruits and seeds	**Cereal bar, blueberry & apple**	**Cereal bar, apricot**
Rolled Oats (67%), Dried Fruits (30%), Dried Papaya,[Papaya, Cane Sugar, Acidity Regulator (330), Preservative (**220**)], Dried Apricots [Apricots, Rice Flour (3%), Preservative (**223**)] Raisins [Raisins, Cotton Seed Oil], Dried Pineapple [Pineapple, Sugar, Acidity Regulator (330),Preservative (**223**)], Dried Cranberries [Cranberries, Sugar, Sunflower Oil],Dried Apples [Apples, Preservative (**220**)],Pumpkin Seeds (3%).	Wheat Flour, Stoneground Wholemeal Flour, Sugar, Sultanas, Margarine (Vegetable Oils (Palm and Coconut), Water, Salt, Emulsifiers (471, 322 from Soy Lecithin), Flavour, Colour (160a)), Glucose syrup, Dried Apple (5%), Skim Milk powder, Glycerol, Blueberry Concentrate (0.4%) Invert Sugar Syrup, Baking powder, Flavour, Potassium Sorbate.	Wheat Flour, Wheat Germ, Wheat Fibre, Wholemeal Flour, Sultanas, Dried Apricots, Glycerol (450, 500), Baking powder (450, 500), Carrot Concentrate, Potassium Sorbate (202), Sugar, Water, Milk solids, Skim Milk powder, Emulsifiers (322 from Soy, 471, 481), Palm Oil, Coconut Oil, Salt, Flavour, Butylated Hydroxyanisole (BHA), Glucose Syrup, Invert Sugar Syrup.

All fruit bar, mixed fruit	**Chewing Gum Sugar Free, Peppermint**	**Beef steak bar**
Fruit (Concentrated Apple Puree (49%), Concentrated Apple Juice (32%), Blackcurrant Puree (8%), strawberry Puree (7%), Blueberry Puree (4&%)), Citrus fibre, Gelling Agent (Pectin, 440), Flavours (Natural), Fruit & Vegetable concentrates (black carrot, blackcurrant).	Maltitol, Sorbitol, Gum Base, Humectant (422), Thickener (414), Flavour, Mannitol, Emulsifier (322, from **Soy**), Sweeteners (951, 950), Sodium Bicarbonate, Colour (171), Glazing Agent (903), Antioxidant (321).	Beef, Sugar, **Soy** Sauce (Water, **Wheat, Soybeans,** Salt), Salt, Flavourings, Spices, Pepper (0.3%), **Maltodextrin**, **Hydrolysed Vegetable Protein**, Flavour enhancer (E621), Antioxidant (E316), , Smoke Flavour , Preservative (E250).
Sports drink powder, wild berry	**Sports drink powder, orange**	**Instant mashed potato**
Caster Sugar, Dextrose Monohydrate, Ascorbic Acid (Vitamin C) Artificial Flavour, Sodium Chloride, Citric Acid, Amino Acid Blend (Magnesium Chelate, L–Glutamine, L–Leucine, L–Isoleucine, L–Valine), Potassium Chloride, Sucralose, Artificial Colour (123).	Caster Sugar, Dextrose Monohydrate, Ascorbic Acid (Vitamin C) Artificial Flavour, Sodium Chloride, Citric Acid, Amino Acid Blend (Magnesium Chelate, L–Glutamine, L–Leucine, L–Isoleucine, L–Valine), Potassium Chloride, Sucralose, Artificial Colour (110).	Dried Potatoes (Potato, Emulsifier (471), Stabilizers (450i), Citric Acid (330), Antioxidants (**223**, 320), Canola Oil (Canola Oil, Antifoam (900)), **Milk** powder (**Milk** Solids, **Soy** Lecithin), Salt, Sugar, Chives.
Cheese, Processed Cheddar	**Chocolate Drink powder**	**Hard Cream Candy**
Cheddar Cheese (Pasteurised **Milk**, Salt, Culture, Rennet), Water, Emulsifier (331), **Butter** (contains **Milk)**, Salt, Acidity regulator (330, 339), Preservative (234).	Cane Sugar, Cocoa (18%), Emulsifier (322) (**Soy** Lecithin)), Spice (Cinnamon).	Sugar, Glucose Syrup (from **Wheat),** Cream (7%) (from **Milk)**, Condensed **Whey**, **Butter (4.5%)**, Cane Sugar Syrup, Salt, **Butterfat**, Emulsifier (322), (**Soy** Lecithin), Flavour.
Concentrated yeast extract	**All fruit bar, raspberry**	**Non Dairy Creamer (NDC)**
Yeast extract (min 75%) (From Yeast grown on **Barley** and **Wheat**), Salt, Mineral Salt (508), **Mal**t Extract (from **Barley**), Colour (150c), Flavours, Niacin, Thiamine, Riboflavin, Folate.	Fruit (Concentrated Apple Puree (45%), Concentrated Apple Juice (30%), raspberry Puree (22%)), Citrus Fibre, Gelling agent (Pectin, 440), Fruit & Vegetable concentrates (black carrot, blackcurrant), Flavours (Natural).	Glucose Syrup, Hydrogenated Palm Kernel Oil, Dipotassium Phosphate (340ii), Emulsifier (471) **Sodium Caseinate**, Anticaking (551), Natural Colour (160b), Flavour
Long life bread	**Formulated drink powder, Coffee**	**Ration chocolate**
Flour, Water, Sugar, Vegetable Oil, Yeast, Iodised Salt, Bread Improver (emulsifier (481),**wheat flour, soya flour,** free flow agent (170),vegetable fat, flour improver (300), enzymes), Vegetable Fat (water, vegetable oil, sugar, emulsifier (475)) Hydrocolloid Gum, Enzyme (1100), and Vitamins (Folic Acid, Thiamine).	Non–fat **Milk** Solids, Corn Syrup Solids, Whole **Milk** powder, Sugar, Coffee powder, Minerals (Magnesium Hydrogen Phosphate, Ferric Pyrophospate, Zinc Gluconate, Copper Gluconate, Manganese Sulphate, Sodium Molybdate, Chromium Trichloride, Sodium Selenite), Stabiliser (414), Vitamins (C,E, Niancinamide, A, D3, B6, B1, B2, Folic Acid, K1, B12), Flavour	Sugar, Dextrose (Corn), **Milk** Solids (19%), Cocoa Butter, Cocoa Mass (min 20%), Vegetable Fat (309), Emulsifier **(Soy** Lecithin 476**),** Vitamin Premix (Ascorbic Acid, Retinol (Vitamin A Acetate, Cornstarch, Thickener (414), Corn Oil, Sugar), Maltodextrin, Thiamine Hydrochloride), Flavour.
Tabasco Sauce	**Instant coffee**	**Sweetened condensed milk**
Distilled vinegar, red peppers, salt	Granulated coffee	**Milk**, Sugar, lactose
Salt	**Tea Bags**	**Sugar, White**
Salt; Anti–caking Agent (535).	Black Tea.	Cane Sugar.
Pepper, Black		
Ground Black Pepper		

HOT CLIMATE MODULE

INFORMATION FOR USERS

FOOD ALLERGIES

This ration pack module has **NOT** been catered for consumers with any food allergy or special dietary requirements. You should read the **Information for users, Menu sheet and Ingredients list** before consumption. If you have any doubt about the contents, you should not consume the ration pack.

GENERAL

The MA CRP hot climate module consists of a light meal, carbohydrate supplement and sports beverage powder. The MA CRP has been designed to ensure that you receive adequate nutritional sustenance for one day; therefore, it is desirable that all food in this and other issued modules is eaten.

The MA CRP hot climate module shall be issued with a MA CRP staples module, containing food hygiene effects and eating utensils. Due to unavoidable circumstances, items may be substituted; therefore may not correspond with the menu sheet.

The label on the packaging of each item contains detailed allergen information.

BEST BEFORE DATE (BBD)

Commercial–off–the–shelf (COTS) items have a best before date. Food that is labelled with a BBD signifies that although the date on the package may have passed, the product is still safe to consume as long as the packaging is not damaged and the sensory quality (colour, aroma, texture and flavour) is acceptable to the consumer. The BBD is used more to identify when the food may lose some of its qualities, rather than being unsafe to eat.

WATER STERILISATION

All water supplies must be regarded as contaminated unless medically cleared. If the water is dirty or cloudy, first filter using the Millbank Individual Filter. Once filtered, add the water sterilisation tablets and follow the directions on the tablets package. Wait 5 minutes and shake well, wait an additional 30 minutes so bacteria are killed before drinking or using to prepare food or beverage. Water may also be sterilised by boiling for a minimum of 5 minutes.

AVOID FOOD POISONING

Do not open more containers of food than are necessary for a meal. Any unconsumed portion of opened food that is wet or has been added with liquid must be disposed of (see disposal of litter paragraph).

AVOID DEHYDRATION

It is essential that you drink plenty of water. Heat and exercise cause dehydration and loss of thirst. You should drink plenty of water if you are sweating heavily, even if you don't feel thirsty. Drink enough water to keep your urine clear.

SALT INTAKE

Extra salt may be needed if working hard in hot environments / or during periods of heat acclimatisation when your salt losses are much greater. When required the extra salt (provided in the Staples Module) should be taken dissolved in drinking water (not more than one (1) sachet for seven (7) litres of water), or sprinkled on food. Do not take extra salt unless you drink plenty of water. It is harmful to take extra salt without extra water.

DISPOSAL OF LITTER

There is packaging litter in each CR1M, which may give intelligence to the enemy if not discarded appropriately. Dispose all litter in a thoughtful manner with consideration for the environment.

HOT CLIMATE MODULE – MENU SHEET AND INGREDIENT LIST

FOOD ALLERGIES: This meals module does **NOT** cater for consumers with any food allergy or special dietary requirements. You should read the **Information for users, Menu sheet and Ingredients list** before consumption. Ingredients containing allergens are emboldened for ease of identification. If you have any doubt about the contents, you should not consume the meals module. This Ingredient list is correct at the time of printing and may differ slightly from the ingredient list on the product label.

MENU 1		MENU 2		MENU 3	
Tuna with dried tomato & herb dressing	1 x 85g	Tuna with lime & black pepper dressing	1 x 85g	Tuna with lime & black pepper dressing	1 x 85g
Cream cracker biscuit	1 x 35g	Cream cracker biscuit	1 x 35g	Cream cracker biscuit	1 x 35g
Sports drink powder, tropical	1 x 35g	Sports drink powder, tropical	1 x 35g	Sports drink powder, tropical	1 x 35g
Hard candy, peppermint	1 x 34g	Hard candy, peppermint	1 x 34g	Hard candy, musk	1 x 34g

Items Common to ALL hot climate modules

Menu sheet & Ingredient List	1
Information For Users	1

INGREDIENT LIST		
Tuna with Lime and Black Pepper Dressing	**Tuna with Dried Tomato & Herb Dressing**	**Biscuits, Cream Cracker**
Tuna (65%), Water, Vegetable Oil, Vinegar, Sugar, Tapioca, Thickener (14420, Lime Juice, Salt, Black pepper, Garlic, Mustard powder, Vegetable gum (415), Natural Lime Flavour, Lime Zest.	Tuna (65%), Water, Vegetable Oil, Spirit Oven Dried Tomatoes (5%), Vinegar, Sugar, Herbs (1.4%), Garlic, Spring Onions, Tapioca, Thickener (1442), Onion, Salt, Mustard powder, Vegetable gum (415), Spice.	**Wheat** Flour, Vegetable fat, (Antioxidant (306 **Soy**) Emulsifiers (**Soy** Lecithin,471, 481)), Invert Syrup, Salt, **Malt** Extract (from Barley), Yeast, Rising Agent (Baking Soda), **Milk** Solids.
Sports drink powder, tropical	**Hard Candy, Musk**	**Hard Candy, Pep–o–mint**
Caster Sugar, Dextrose Monohydrate, Ascorbic Acid (Vitamin C) Artificial Flavour, Sodium Chloride, Citric Acid, Amino Acid Blend (Magnesium Chelate, L–Glutamine, L–Leucine, L–Isoleucine, L–Valine), Potassium Chloride, Sucralose, Artificial Colour (110)	Sugar, **Glucose** Syrup (from **Wheat),** Tapioca Starch, Stabilizer (1401), **Maltodextrin**, Flavour, Colour (122, 123, 124)	Sugar, **Glucose** Syrup (from **Wheat**), Tapioca Starch, Modified Starch (1401) Maize, Australian Peppermint Oil

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Appendix D Demographic Questionnaire

The following information was gathered to provide us with some general information on the user group.

Q1 Please select your age as of your last birthday.

- ❍ 16–17
- ❍ 18–20
- ❍ 21–25
- ❍ 26–30
- ❍ 31–35
- ❍ 36–40
- ❍ 41–45
- ❍ >46

Q2 What is your main role within the platoon?

- ❍ Section Commander
- ❍ 2IC
- ❍ Rifleman
- ❍ Gunner
- ❍ Grenadier
- ❍ Other (Please specify) _____

Q3 How long have you been in the ADF (Years)?

- ❍ ≤1
- ❍ 1–5
- ❍ 6–10
- ❍ ≥10

Q4 How many times have you deployed field in the last 12 months?

- ❍ 1–5
- ❍ 6–10
- ❍ 11–15
- ❍ 16–20
- ❍ 21–25

Q5 What is the maximum number of days you have continuously used CRP?

- ❍ 1–5
- ❍ 6–10
- ❍ 11–15
- ❍ 16–20
- ❍ ≥20

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Appendix E Discards Questionnaire

MACR1M Stage 2 Discard

Q1 Thank you for participating in our study. To understand better the behaviour of ADF personnel stripping rations and using 'jack rations', please provide us with the below information

Please specify your Unique Identifier # [ ]

Q2 Did you discard any items from your ration packs today?

- ❍ Yes
- ❍ No

If No Is Selected, the respondent will Skip To; Are you taking any jack rations and/or personal hygiene products with you during this exercise?

If Yes Is selected, the respondent will be sent to Q3

Q3 Please select from the matrix below the items you discarded

	Discarded (624)
Beef onion & gravy	❑
Malay lamb curry	❑
Beef & pasta	❑
Lamb korma	❑
Lamb casserole	❑
Spaghetti bolognese	❑
Mi goring instant noodles	❑
Soup, golden pumpkin	❑
Soup, creamy mushroom	❑
Chocolate drink powder	❑
Sports drink powder, orange	❑
Sports drink powder, wild berry	❑
Formulated drink powder, coffee	❑
All fruit bar, mixed berry	❑
Beef steak bar	❑
Cereal bar, apple & blueberry	❑
All fruit bar, raspberry	❑
Ration chocolate	❑
Chocolate candies	❑
Hard cream candy	❑
Chewing gum, sugar free	❑
Natural Muesli with fruit & seeds	❑
Non–dairy creamer	❑
Instant mashed potato	❑
Long life bread	❑
Processed cheddar cheese	❑
Concentrated yeast extract	❑
Fruit jam, strawberry	❑
Fruit jam, plum	❑
Diced two fruits	❑
Diced pears	❑
Sweetened condensed milk	❑
Instant coffee	❑
Tea bags	❑
White sugar	❑
Tabasco sauce	❑
Tomato ketchup	❑
Salt	❑
Black pepper	❑

The following questions have logic added; the initial column is filled based components selected from the previous question and/or the question is visible when "other" is chosen.

Q4 Please select from below why you discarded those ration items. More than one answer may be selected.

	Don't Like (625)	Not likely to eat during exercise (626)	Took Jack Ration equivalent (645)	Takes too long to prepare (627)	Takes too long to eat (636)	Too bulky/ heavy (628)	Product not compatible with conditions (hot/cold) (630)	Package not user friendly (632)	Provides little Energy (633)	Doesn't agree with me (634)	Other (644)

Q5 If you answered other for one or more items.

	Please expand here

Q6 Consider for a moment the items you didn't take;
Would any of the following contribute to reversing your decision? More than one answer may be selected.

	Completely different style of product (1)	Different recipe (2)	More convenient packaging (3)	Packaging less visible signature (4)	Edible in climate/ environment (5)	More energy – calorie content (6)	Nothing (7)	Other (8)	Serve size – too large (9)	Serve Size – too small (10)

Q7 if you answered other for one or more items.

	Please expand here

Q8 Please select from the matrix below the items you discarded

	Discarded (624)
Safety matches (vial) (40)	❑
Hand can opener (FRED) (42)	❑
Rubber band (size 32) (43)	❑
Soaped Scouring pads (44)	❑
Toilet paper (10 sheets) (45)	❑
Plastic bag (inner) (46)	❑
Self closing plastic bag (23)	❑
Plastic Spoon (13)	❑

The following questions have logic added; the initial column is filled based components selected from the previous question and/or the question is visible when "other" is chosen.

Q9 If you discarded any non food items, please select from below why you discarded those items.–More than one answer may be selected.

	Not Liked (625)	Took equivalent (own) (626)	Inadequate (627)	Insufficient amount (636)	Doesn't work (628)	Useless (629)	Other (635)

Q10 If you answered other for one or more items.

	Please expand here

Q11 Consider for a moment the items you didn't take; would any of the following contribute to reversing your decision? More than one answer may be selected.

	Completely different product (1)	Greater utility (2)	More robust product (5)	Nothing (7)	Other (8)	Size – provide more (9)	Size – provide less (10)

Q12 If you answered other for one or more items.

	Please expand here

Q13 Are you taking any jack rations and/or personal hygiene products with you during this exercise?

- ❍ Yes (1)
- ❍ No (2)

If No is Selected, Then Skip To End of Block

Q14 If Yes please select one or more of the styles for the products below?

	Yes (1)
Muesli bar/s (1)	❑
Energy bar (2)	❑
Protein bar (3)	❑
Energy drink powder (4)	❑
Protein drink powder (5)	❑
"Coffee Sachet (with/without milk powder)" (6)	❑
Energy Gel/s (7)	❑
Traditional Jerky (8)	❑
Bar – Jerky style (9)	❑
Gum (10)	❑
Chocolate based confectionery (11)	❑
Sugar based confectionery (12)	❑
Tuna (13)	❑
Noodles (14)	❑
Savoury biscuits (15)	❑
Soy/Rice Crisps (16)	❑
Trail mix (18)	❑
Vitamin/Mineral supplements (26)	❑
Pro/Pre biotic supplements (27)	❑
Omega 3/6 – Fish oil supplements (28)	❑
Herbal supplements (29)	❑
Other (30)	❑

Q15 Please select the personal hygiene products you regularly take with you?

	Yes (1)
Hand sanitiser (31)	❑
Hand Wipes (32)	❑
Shaving gear (33)	❑
Other	❑
Toothpaste/toothbrush	❑
Mouthwash	❑
Dental floss/picks	❑
Other	❑
Deodorising Products	❑
Body Wipes	❑
Tissues	❑
Toilet Paper	❑
Other	❑

Appendix F Ration Acceptability Questionnaire (Control Group)

MACR1M Control Group Day 3 Questionnaire

Q1 Thank you for participating in our study. We would like you to answer the questions below, this will assist us gain some insight and understanding on how ration packs are used in the field. We are not only interested in your likes and dislikes of individual items but value your opinion on the serviceability and convenience of the packs provided.

Q2 Please specify your Unique Identifier #

Q3 For the items taken but not used from below please select the relevant answer. If item was taken and used leave blank....

	Item not taken	Item not used
Beef, onion & gravy	❑	❑
Malay lamb curry	❑	❑
Beef & pasta	❑	❑
Lamb korma	❑	❑
Lamb casserole	❑	❑
Spaghetti bolognese	❑	❑
Natural muesli with fruit & seeds	❑	❑
Mi goreng noodles	❑	❑
Soup, golden pumpkin	❑	❑
Soup, creamy mushroom	❑	❑
Instant coffee	❑	❑
Tea bags	❑	❑
Chocolate drink powder	❑	❑
Sports drink, orange	❑	❑
Sports drink, wild berry	❑	❑
Formulated drink powder, coffee	❑	❑
All fruit bar, mixed berry	❑	❑
All fruit bar, raspberry	❑	❑
Beef steak bar	❑	❑
Cereal bar, apple & blueberry	❑	❑
Ration chocolate	❑	❑
Chocolates candies	❑	❑
Hard cream candy	❑	❑
Chewing gum, sugar free	❑	❑
Non–dairy creamer	❑	❑
Instant mashed potato	❑	❑
Processed cheddar cheese	❑	❑
Concentrated yeast extract	❑	❑
Fruit jam, strawberry	❑	❑

	Item not taken	Item not used
Fruit jam, plum	❑	❑
Diced two fruit	❑	❑
Diced pears	❑	❑
Long life bread	❑	❑
Sweetened condensed milk	❑	❑
White sugar	❑	❑
Tabasco sauce	❑	❑
Tomato ketchup	❑	❑
Salt	❑	❑
Black pepper	❑	❑
Safety matches, vial	❑	❑
Plastic spoon	❑	❑
Can opener, hand	❑	❑
Rubber band, size 32	❑	❑
Scouring pad, soaped	❑	❑
Toilet paper, 10 sheets	❑	❑
Plastic bag, self closing	❑	❑

The following questions have logic added; the initial column is filled based components selected from the previous question and/or the question is visible when "other" is chosen.

Q4 Please indicate which response best describes your overall acceptance of the items you used (all or part of). Please consider usefulness, convenience, packaging suitability and how well you like it.

	Extremely Poor	Poor	Fair	Good	Excellent

Q5 For the items that you did use (all or part of), please indicate whether the amount supplied was enough or not.

	Not Enough	Enough	Too Much

Q6 For the items taken but not used (all or part of); please indicate why. More than one response may be selected.

	Didn't Like	Package not easy to use	Wasn't Hungry	Weather not favourable to eat/use	Too much	Bored with product	Limited by preparation demands			Not fit for purpose
							Time	Effort	Equipment	

"Package not easy to open", was replaced with "Not needed" for Day 6.

Q7 Do you have problems with the packaging of any individual ration item, e.g. cans, tubes, sachets?

- ❍ Yes
- ❍ No
- ❍ Unsure

If No Is Selected, Then Skip To Click to write the question text

Q8 If yes/unsure please expand below.

	Please expand here

Q9 Is there too much packaging used in the current in service CRP.

- ❍ Yes
- ❍ No
- ❍ Unsure

If No Is Selected, Then Skip To Did you take any of the following per...

Q10 If yes/unsure please expand below.

	Please expand here

Q11 Did you take any of the following personal hygiene items with you during this exercise?

	Yes	No
Hand sanitizer	❍	❍
Wipes	❍	❍
Shaving gear	❍	❍
Toothpaste/toothbrush	❍	❍
Mouthwash	❍	❍
Dental floss/picks	❍	❍
Deodorising products	❍	❍
Tissues	❍	❍
Toilet paper	❍	❍
Other	❍	❍

Answer If Did you take any of the following personal hygiene items with you during this exercise? Other – Yes Is Selected

Q12 You chose other in the previous question, please expand here.

	Please expand here

Q13 Please answer the following question on how you feel.

	Not at all	Only a little	Some	A lot
To what extent do you feel the ration pack offered you sufficient sustenance?	❍	❍	❍	❍

Appendix G Ration Acceptability Questionnaire (Modular MA CRP Group)

Q1 Thank you for participating in our study. We would like you to answer the questions below, this will assist us gain some insight and understanding on how ration packs are used in the field. We are not only interested in your likes and dislikes of individual items but value your opinion on the serviceability and convenience of the packs provided.

Q2 Please specify your Unique Identifier #

Q3 For the items taken but not used from below please select the relevant answer. If item was taken and used leave blank....

	Item not used
Beef, onion & gravy	❑
Lamb casserole	❑
Malay lamb curry	❑
Spaghetti bolognese	❑
Beef & pasta	❑
Lamb korma	❑
Tuna with dried tomato	❑
Tuna with lime & black pepper	❑
Cream cracker biscuits	❑
Sports drink, tropical	❑
All fruit bar, mixed berry	❑
All fruit bar, raspberry	❑
Cereal bar, apricot	❑
Beef steak bar	❑
Cereal Bar, apple & blueberry	❑
Sports drink, orange	❑
Sports drink, wild berry	❑
Formulated drink powder, coffee	❑
Chewing gum, sugar free	❑
Hard candy, peppermint	❑
Hard candy, musk	❑
Natural muesli with fruit & seeds	❑
Non-dairy creamer	❑
Long life bread	❑
Chocolate drink powder	❑
Hard cream candy	❑
Ration chocolate	❑
Processed cheddar cheese	❑
Concentrated yeast extract	❑

	Item not used
Instant mashed potato	❑
Sweetened condensed milk	❑
Instant coffee	❑
Tea bags	❑
White sugar	❑
Tabasco sauce	❑
Salt	❑
Black pepper	❑
Scouring pad, soaped	❑
Toilet paper, 10 sheets	❑
Safety matches, vial	❑
Plastic spoon	❑
Can opener, hand	❑
Rubber band, size 32	❑
Plastic bag, self-closure	❑

The following questions have logic added; the initial column is filled based components selected from the previous question and/or the question is visible when "other" is chosen.

Q4 Please indicate which response best describes your overall acceptance of the items you used (all or part of). Please consider usefulness, convenience, packaging suitability and how well you like it.

	Extremely Poor	Poor	Fair	Good	Excellent

Q5 For the items that you did use (all or part of), please indicate whether the amount supplied was enough or not.

	Not Enough	Enough	Too Much

Q6 For the items taken but not used (all or part of); please indicate why. More than one response may be selected.

	Didn't Like	Package not easy to use	Wasn't Hungry	Weather not favourable to eat/use	Too much	Bored with product	Limited by preparation demands			Not fit for purpose
							Time	Effort	Equipment	

"Package not easy to open", was replaced with "Not needed" for Day 6.

Q7 Do you have problems with the packaging of any individual ration item, e.g. cans, tubes, sachets?

- ❍ Yes
- ❍ No
- ❍ Unsure

If No Is Selected, Then Skip To Click to write the question text

Q8 If yes/unsure please expand below.

	Please expand here

Q9 Is there too much packaging used in the current in service CRP.

- ❍ Yes
- ❍ No
- ❍ Unsure

If No Is Selected, Then Skip To Did you take any of the following per...

Q10 If yes/unsure please expand below.

	Please expand here

Q11 Did you take any of the following personal hygiene items with you during this exercise?

	Yes	No
Hand sanitizer	❍	❍
Wipes	❍	❍
Shaving gear	❍	❍
Toothpaste/toothbrush	❍	❍
Mouthwash	❍	❍
Dental floss/picks	❍	❍
Deodorising products	❍	❍
Tissues	❍	❍
Toilet paper	❍	❍
Other	❍	❍

Answer If Did you take any of the following personal hygiene items with you during this exercise? Other - Yes Is Selected

Q12 You chose other in the previous question, please expand here.

	Please expand here

Q13 Please answer the following question on how you feel.

	Not at all	Only a little	Some	A lot
To what extent do you feel the ration pack offered you sufficient sustenance?	❍	❍	❍	❍

The following questions were asked on Day 6 in addition to the Ration Acceptability Questionnaire, for both groups.

Q14 Which of the below health/hygiene items would you like to see included in a pack?

	Yes	No	No preference
Hand sanitiser	❍	❍	❍
Wipes	❍	❍	❍
Shaving gear	❍	❍	❍
Toothpaste/toothbrush	❍	❍	❍
Mouthwash	❍	❍	❍
Dental floss/picks	❍	❍	❍
Deodorising products	❍	❍	❍

Q15 What was your average daily water consumption (Litres) during this exercise?

- ❍ <1
- ❍ 1–3
- ❍ 4–6
- ❍ 7–9
- ❍ 10 or more

Q16 Do you feel you carried enough water during this exercise?

- ❍ Yes
- ❍ No

Q17 What do you use to carry/contain the water taken? More than one response may be entered

- ❑ Water bottle
- ❑ Water bladder
- ❑ Other

Answer If What do you use to carry/contain the water taken? Other Is Selected

Q18 You chose other could you please expand here.

Q19 Do you regularly add your sports powders or other beverage bases to your camelback (water bladder)?

- ❍ Yes
- ❍ No

Q20 Do you regularly take Jack rations?

- ❍ Yes
- ❍ No

If No Is Selected, Then Skip To End of Survey

Q21 Which of the following do you regularly take as Jack rations?

Muesli bar/s	❍
Energy bar	❍
Protein bar	❍
Energy beverage powder	❍
Protein beverage powder	❍
Coffee sachet (with/without milk powder)	❍
Energy gel/s	❍
Traditional Jerky	❍
Bar – Jerky style	❍
Gum	❍
Chocolate based confectionery	❍
Sugar based confectionery	❍
Tuna	❍
Noodles	❍
Savoury biscuits	❍
Soy/rice crisps	❍
Trail mix	❍
Vitamin/Mineral supplements	❍
Pro/Pre biotic supplements	❍
Omega 3/6 – Fish oil supplements	❍
Herbal supplements	❍

Appendix H Modular Design Concept Questionnaire

Thank you for participating in our study.

Keeping in mind the importance of meeting daily nutritional requirements, you have been issued a number of modules during this exercise. These modules represent one concept for a new modular ration pack. In total these modules provided the nutrition required to support the level of physical activity demanded by this exercise. Field feeding is set to change, we would like you to contribute, by sharing your understanding and experience of operational feeding to guide this research and play a vital role in the process. We would like to ask you some questions regarding your thoughts and opinions not only on your likes and dislikes of components, but also on the design of the Modular ration pack and the individual modules contained within that you were issued.

Q1 The meals module is a core module, which provides two main meals. For this trial, it is two wet meals. Please indicate your thoughts regarding the following statements for the meals module;

The meals module:

Q2 The staples module is a core module that was designed to contain common items, a brew kit and a grab & go module. Please indicate the extent to which you agree or disagree with the following statements for the staples module as a complete unit;

The staples module:

Q3 The grab & pack was designed as a part day pack that could be accessed quickly and used during a forward movement activity. This was intended to provide energy dense eat–on–the–go and an addition drink powder to promote hydration. Please indicate the extent to which you agree or disagree with the following statements;

The grab & go pack:

Q4 The hot climate module was an energy supplement module intended for issue when soldiers are engaged in vigorous activity in a hot environment. The module provided additional energy and nutrition to support the operational tempo and promote hydration in a hot environment. In large, it provided additional carbohydrates that were palatable in a hot environment. Please indicate the extent to which you agree or disagree with the following statements;
The hot climate module:

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
was easy to integrate in SCE?	❍	❍	❍	❍	❍	❍	❍
was palatable in a hot environment?	❍	❍	❍	❍	❍	❍	❍
was packaged appropriately?	❍	❍	❍	❍	❍	❍	❍
was appropriate to be a separate module?	❍	❍	❍	❍	❍	❍	❍
provided appropriate food choices?	❍	❍	❍	❍	❍	❍	❍
provided	❍	❍	❍	❍	❍	❍	❍

appropriate food portions?							
was convenient?	❍	❍	❍	❍	❍	❍	❍
adequately sized?	❍	❍	❍	❍	❍	❍	❍
adequately shaped?	❍	❍	❍	❍	❍	❍	❍

Q5 In order to have a grab & go pack, additional packaging is required. Will this be manageable?

- ❍ Yes
- ❍ Unsure
- ❍ No

Q6 In order to have a hot climate module, additional packaging is required. Will this be manageable?

- ❍ Yes
- ❍ Unsure
- ❍ No

Q7 Would you like to see the hot climate module made available, when the operational situation determines it is appropriate?

- ❍ Yes
- ❍ Unsure
- ❍ No

Appendix I Ration Component Worth, Acceptability and Consumption Results

Table I1 Control group use behaviour with CR1M menus B, D and H; percent discarded, mean overall acceptability and percent consumption rates

Component	Discarded	Component	Consumed (Day 1–3)	Overall Acceptance	Consumed* (Day 4–6)	Overall Acceptance
MENU B						
Beef, onion & gravy	**5%**	Beef, onion & gravy	74%	3.0	65%	3.2
Malay lamb curry	**5%**	Malay lamb curry	89%	3.6	89%	3.7
Soup, golden pumpkin	**32%**	Soup, golden pumpkin	28%	3.5	22%	3.9
Sports drink, orange	**9%**	Sports drink, orange	50%	3.6	42%	3.7
All fruit bar, mixed berry	**5%**	All fruit bar, mixed berry	76%	4.0	81%	3.7
Fruit jam, strawberry	**39%**	Fruit jam, strawberry	24%	3.5	44%	3.5
Diced two fruits	**24%**	Diced two fruits	50%	3.7	44%	3.5
Cereal bar, apple & blueberry	**2%**	Cereal bar, apple & blueberry	72%	3.6	71%	3.3
Instant mashed potato	**20%**	Instant mashed potato	56%	4.1	73%	3.9
Hard cream candy	**58%**	Hard cream candy	2%	3.0	4%	3.2
MENU D						
Beef & pasta	**0%**	Beef & pasta	82%	3.7	71%	3.6
Lamb korma	**0%**	Lamb korma	79%	3.6	64%	3.6
Soup, creamy mushroom	**41%**	Soup, creamy mushroom	18%	3.9	39%	3.8
Sports drink, wild berry	**7%**	Sports drink, wild berry	61%	3.6	60%	3.7
All fruit bar, mixed berry	**5%**	All fruit bar, mixed berry	76%	4.0	81%	3.7
Fruit jam, strawberry	**39%**	Fruit jam, strawberry	24%	3.5	44%	3.5
Diced pears	**36%**	Diced pears	47%	3.5	55%	3.3
Cereal bar, apple & blueberry	**2%**	Cereal bar, apple & blueberry	72%	3.6	71%	3.3
Instant mashed potato	**20%**	Instant mashed potato	56%	4.1	73%	3.9
Hard cream candy	**58%**	Hard cream candy	2%	3.0	4%	3.2

** will be influenced by potential carry over from day 1–3*

Table I1 cont.d. Control group use behaviour with CR1M menus B, D and H; percent discarded, mean overall acceptability and percent consumption rates

Component	Discarded	Component	Consumed (Day 1–3)	Overall Acceptance	Consumed* (Day 4–6)	Overall Acceptance
MENU H						
Lamb casserole	**5%**	Lamb casserole	89%	3.5	73%	3.5
Spaghetti bolognese	**0%**	Spaghetti bolognese	94%	4.0	88%	3.9
Soup, creamy mushroom	**41%**	Soup, creamy mushroom	18%	3.9	39%	3.8
Sports drink, wild berry	**7%**	Sports drink, wild berry	61%	3.6	60%	3.7
All fruit bar, raspberry	**7%**	All fruit bar, raspberry	85%	4.0	78%	3.8
Fruit jam, plum	**50%**	Fruit jam, plum	24%	3.3	42%	3.5
Diced two fruits	**24%**	Diced two fruits	50%	3.7	44%	3.5
Cereal bar, apple & blueberry	**2%**	Cereal bar, apple & blueberry	72%	3.6	71%	3.3
Instant mashed potato	**20%**	Instant mashed potato	56%	4.1	73%	3.9
Hard cream candy	**58%**	Hard cream candy	2%	3.0	4%	3.2
Formulated drink powder, coffee (Menu H only)	**5%**	Formulated drink powder, coffee (Menu H only)	75%	3.4	92%	3.7
Common Menu Items						
Chocolate drink (Menu B & D)	**82%**	Chocolate drink (Menu B & D)	5%	2.8	17%	3.8
Instant coffee	**63%**	Instant coffee	4%	3.0	24%	2.9
Tea bags	**72%**	Tea bags	2%	3.0	8%	3.3
White sugar	**73%**	White sugar	2%	3.3	16%	3.4
Ration chocolate	**27%**	Ration chocolate	37%	3.5	57%	3.5
Chocolate candies	**12%**	Chocolate candies	76%	4.0	87%	3.7
Processed cheddar cheese	**27%**	Processed cheddar cheese	54%	3.8	73%	3.7
Concentrated yeast extract	**42%**	Concentrated yeast extract	5%	3.4	10%	3.4
Tomato ketchup	**61%**	Tomato ketchup	4%	3.2	24%	3.4
Black pepper	**73%**	Black pepper	3%	3.6	24%	3.4
Salt	**64%**	Salt	5%	3.7	20%	3.5
Sweetened condensed milk	**67%**	Sweetened condensed milk	10%	3.1	27%	3.3
Chewing gum, sugar free	**61%**	Chewing gum, sugar free	8%	3.3	17%	3.1
Long life bread	**0%**	Long life bread	92%	4.2	98%	4.1
Beef steak bar	**11%**	Beef steak bar	67%	3.8	55%	3.4
Tabasco sauce	**76%**	Tabasco sauce	2%	3.2	6%	3.5
Mi goreng instant noodles	**12%**	Mi goreng instant noodles	65%	4.1	78%	4.1
Natural Muesli with fruit & seeds	**35%**	Natural Muesli with fruit & seeds	27%	2.5	27%	2.9
Non–dairy creamer	**64%**	Non–dairy creamer	5%	2.5	13%	3.4

** will be influenced by potential carry over from day 1–3*

Table I2 Modular group use behaviour with meals and hot climate modules; mean overall acceptability and percent consumption rates

Component	Consumed (Day 1–3)	Overall acceptance	Consumed (Day 4–6)*	Overall acceptance
Meals module				
Menu 1				
Beef, onion & gravy	71%	3.0	68%	3.3
Lamb casserole	81%	3.4	68%	3.4
Menu 2				
Malay lamb curry	60%	3.6	65%	3.7
Spaghetti bolognese	86%	3.9	78%	3.9
Menu 3				
Beef & pasta	65%	3.2	59%	3.3
Lamb korma	70%	3.4	63%	3.5
Hot climate module				
Menu 1				
Tuna with dried tomato	92%	3.8	83%	3.9
Cream cracker biscuit	66%	3.5	72%	3.6
Sports drink powder, tropical	57%	4.0	37%	3.7
Hard candy, peppermint	11%	3.2	5%	3.2
Menu 2				
Tuna with lime & black pepper dressing	82%	4.1	85%	4.1
Cream cracker biscuit	66%	3.5	72%	3.6
Sports drink powder, tropical	57%	4.0	37%	3.7
Hard candy, peppermint	11%	3.2	5%	3.2
Menu 3				
Tuna with lime & black pepper dressing	82%	4.1	85%	4.1
Cream cracker biscuit	66%	3.5	72%	3.6
Sports drink powder, tropical	57%	4.0	37%	3.7
Hard candy, musk	29%	3.6	32%	3.6

** will be influenced by potential carry over from day 1–3*

Table I3 Modular group use behaviour with staples and grab & go modules; mean overall acceptability and percent consumption rates

Component	Consumed (Day 1–3)	Overall Acceptance	Consumed (Day 4–6)*	Overall Acceptance
STAPLES MODULE				
Items Common to ALL staples modules				
Natural muesli with fruits & seeds	42%	3.5	49%	3.6
Non–dairy creamer	34%	3.0	32%	3.5
Long life bread	84%	4.4	93%	4.2
Chocolate drink powder	16%	3.4	26%	3.5
Hard cream candy	14%	3.3	10%	3.7
Ration chocolate	52%	3.9	72%	3.7
Processed cheddar cheese	75%	4.1	82%	3.9
Concentrated yeast extract	23%	3.7	21%	3.3
Instant mashed potato	37%	3.7	60%	3.9
Sweetened condensed milk	26%	4.2	46%	3.7
Instant coffee	14%	4.1	31%	3.8
Tea bags	2%	4.5	6%	4.1
White sugar	24%	3.8	38%	3.9
Tabasco sauce	17%	4.2	27%	3.9
Salt	13%	4.3	16%	3.8
Black pepper	9%	3.7	8%	3.9
Grab & go pack (within staples module)				
MENU 1				
All fruit bar, mixed fruit	64%	4.1	72%	3.9
Cereal bar, apricot	69%	3.7	68%	3.6
Sports drink powder, orange	63%	4.0	50%	3.7
Beef steak bar	70%	3.9	74%	3.8
Cereal bar, apple & blueberry	62%	3.9	63%	3.8
Chewing gum, sugar–free	17%	3.8	21%	3.4
MENU 2				
All fruit bar, raspberry	70%	4.1	74%	3.9
Cereal bar, apricot	69%	3.7	68%	3.6
Sports drink powder, wild berry	46%	4.1	34%	3.7
Beef steak bar	70%	3.9	74%	3.8
Cereal bar, apple & blueberry	62%	3.9	63%	3.8
Chewing gum, sugar–free	17%	3.8	21%	3.4
MENU 3				
All fruit bar, mixed fruit	64%	4.1	72%	3.9
Formulated drink powder, coffee	61%	4.0	78%	3.9
Sports drink powder, wild berry	46%	4.1	34%	3.7
Beef steak bar	70%	3.9	74%	3.8
Cereal bar, apple & blueberry	62%	3.9	63%	3.8
Chewing Gum, Sugar–free	17%	3.8	21%	3.4

** will be influenced by potential carry over from day 1–3*

Appendix J Nutrient Intake Comparison

Table J1 Nutrient intake comparison. Control group –vs– modular group over various consumption periods, with and without inclusion of 'jack rations' consumption#

Nutrient	Control group						Modular group						Modular group (minus SOs)					
	Day 1-3		Day 4-6		Average		Day 1-3		Day 4-6		Average		Day 1-3		Day 4-6		Average	
	Issued	Issued +JR	Issued	Issued +JR	Issued	Issued +JR	Issued	Issued +JR	Issued	Issued +JR	Issued	Issued +JR	Issued	Issued +JR	Issued	Issued +JR	Issued	Issued +JR
Energy (kJ)	8130 ± 2120	8310 ± 2140	9230 ± 2710	9310 ± 2770	8680 ± 1930	8810 ± 1970	7060 ± 3060	7070 ± 3060	8700 ± 3510	8800 ± 3440	7880 ± 3010	7930 ± 2970	7630 ± 2840	7630 ± 2830	8980 ± 3560	9090 ± 3480	8300 ± 2930	8360 ± 2880
Fat (g)	69 ± 19	70 ± 19	75 ± 23	75 ± 23	72 ± 16	73 ± 17	55 ± 25	55 ± 25	71 ± 30	71 ± 30	63 ± 24	63 ± 24	60 ± 22	60 ± 22	74 ± 31	74 ± 30	67 ± 23	67 ± 22
Fat-sat (g)	40 ± 12	41 ± 12	45 ± 14	45 ± 14	43 ± 10	43 ± 10	29 ± 13	29 ± 13	37 ± 17	38 ± 17	33 ± 13	33 ± 13	31 ± 12	31 ± 12	39 ± 17	39 ± 17	35 ± 12	35 ± 12
Protein (g)	77 ± 20	79 ± 20	75 ± 22	75 ± 23	76 ± 17	77 ± 18	73 ± 32	73 ± 32	87 ± 40	87 ± 40	80 ± 31	80 ± 30	78 ± 29	78 ± 29	91 ± 39	91 ± 39	85 ± 28	85 ± 28
CHO (g)	240 ± 69	243 ± 67	292 ± 96	295 ± 98	266 ± 67	269 ± 68	219 ± 103	219 ± 103	278 ± 120	282 ± 117	248 ± 104	251 ± 102	236 ± 99	236 ± 99	285 ± 124	290 ± 121	260 ± 105	263 ± 103
Sugar (g)	123 ± 43	124 ± 40	157 ± 60	158 ± 61	140 ± 41	141 ± 41	122 ± 62	122 ± 62	153 ± 66	157 ± 64	138 ± 59	140 ± 58	131 ± 62	131 ± 62	156 ± 69	160 ± 67	143 ± 61	146 ± 60
Dietary fibre (g)	12 ± 4	13 ± 6	15 ± 6	15 ± 6	13 ± 4	14 ± 5	11 ± 6	11 ± 6	15 ± 7	15 ± 7	13 ± 6	13 ± 6	12 ± 6	12 ± 6	15 ± 7	15 ± 7	14 ± 6	14 ± 6
Vitamin A (µg)	478 ± 397		823 ± 484		651 ± 368		555 ± 511		943 ± 464		749 ± 384		603 ± 527		962 ± 485		783 ± 397	
Vitamin B_1 (mg)	3.4 ± 1.2		4.1 ± 1.8		3.7 ± 1.2		3.0 ± 1.6		4.3 ± 1.6		3.7 ± 1.3		3.3 ± 1.4		4.4 ± 1.7		3.9 ± 1.2	
Vitamin B_2 (mg)	3.6 ± 1.1		3.4 ± 1.1		3.5 ± 0.9		2.9 ± 1.6		3.4 ± 1.9		3.1 ± 1.5		3.2 ± 1.5		3.6 ± 1.9		3.4 ± 1.4	
Vitamin B_3 (mg)	53 ± 16		49 ± 15		51 ± 13		47 ± 24		55 ± 29		51 ± 22		52 ± 22		58 ± 28		55 ± 20	
Vitamin B_6 (mg)	0.34 ± 0.16		0.49 ± 0.35		0.41 ± 0.16		0.28 ± 0.17		0.39 ± 0.24		0.33 ± 0.19		0.29 ± 0.18		0.41 ± 0.23		0.35 ± 0.19	
Vitamin C (mg)	1010 ± 740		1320 ± 850		1170 ± 680		1990 ± 1190		1260 ± 1070		1630 ± 1000		2200 ± 1100		1350 ± 1110		1780 ± 960	
Vitamin E (mg)	4.4 ± 1.6		5.3 ± 2.2		4.9 ± 1.2		5.4 ± 2.2		6.3 ± 3.3		5.8 ± 2.5		5.7 ± 2.2		6.8 ± 3.0		6.2 ± 2.4	
Sodium (mg)	3410 ± 1160	3410 ± 1160	3780 ± 1190	3800 ± 1200	3600 ± 980	3610 ± 980	2940 ± 1390	2940 ± 1390	3460 ± 1860	3490 ± 1860	3200 ± 1390	3210 ± 1390	3200 ± 1280	3200 ± 1280	3670 ± 1840	3700 ± 1830	3431 ± 1297	3448 ± 1285
Iodine (µg)	87 ± 53	87 ± 53	138 ± 68	138 ± 68	112 ± 50	113 ± 50	99 ± 80	99 ± 80	147 ± 153	147 ± 153	123 ± 90	123 ± 90	99 ± 82	99 ± 82	150 ± 164	151 ± 163	125 ± 95	125 ± 95
Magnesium (mg)	212 ± 58	212 ± 58	232 ± 75	234 ± 76	222 ± 59	223 ± 59	215 ± 104	215 ± 104	250 ± 120	250 ± 120	233 ± 106	234 ± 105	235 ± 94	235 ± 94	262 ± 124	265 ± 122	249 ± 103	250 ± 102
Potassium (mg)	2290 ± 680	2290 ± 680	2500 ± 770	2510 ± 790	2400 ± 620	2400 ± 620	2020 ± 950	2020 ± 950	2560 ± 1250	2580 ± 1240	2290 ± 970	2300 ± 970	2200 ± 860	2210 ± 860	2660 ± 1280	2690 ± 1270	2433 ± 943	2445 ± 934
Iron (mg)	15 ± 4	15 ± 4	15 ± 5	15 ± 5	15 ± 3	15 ± 3	12 ± 6	12 ± 6	15 ± 7	15 ± 7	13 ± 6	13 ± 6	13 ± 5	13 ± 5	15 ± 7	15 ± 7	14 ± 6	14 ± 6
Calcium (mg)	400 ± 150	400 ± 150	500 ± 220	503 ± 225	450 ± 150	450 ± 150	440 ± 220	440 ± 220	650 ± 360	649 ± 356	540 ± 250	550 ± 250	470 ± 220	470 ± 220	670 ± 380	670 ± 370	568 ± 256	569 ± 255
Copper (mg)	0.75 ± 0.20	0.75 ± 0.20	0.78 ± 0.23	0.78 ± 0.24	0.76 ± 0.18	0.77 ± 0.18	0.61 ± 0.31	0.61 ± 0.31	0.76 ± 0.39	0.77 ± 0.38	0.69 ± 0.33	0.69 ± 0.33	0.67 ± 0.29	0.67 ± 0.29	0.80 ± 0.39	0.81 ± 0.38	0.73 ± 0.32	0.74 ± 0.32
Manganese (mg)	2.6 ± 1.1	2.6 ± 1.1	2.7 ± 1.3	2.7 ± 1.3	2.6 ± 1.0	2.6 ± 1.0	2.5 ± 1.5	2.5 ± 1.5	3.1 ± 1.9	3.1 ± 1.9	2.8 ± 1.6	2.8 ± 1.6	2.7 ± 1.4	2.7 ± 1.4	3.2 ± 1.9	3.2 ± 1.9	3.97 ± 1.63	2.99 ± 1.62
Phosphorous (mg)	1020 ± 270	1020 ± 270	1070 ± 350	1080 ± 360	1050 ± 260	1050 ± 260	1030 ± 460	1030 ± 460	1320 ± 610	1320 ± 600	1170 ± 480	1170 ± 480	1110 ± 430	1110 ± 430	1370 ± 610	1370 ± 610	1240 ± 467	1240 ± 460
Chromium (µg)	65 ± 16	65 ± 16	68 ± 25	68 ± 25	67 ± 18	67 ± 18	46 ± 30	46 ± 30	50 ± 21	52 ± 20	48 ± 22	49 ± 21	44 ± 17	44 ± 17	52 ± 20	55 ± 19	48 ± 17	50 ± 16
Selenium (µg)	37 ± 17	37 ± 17	48 ± 27	48 ± 27	43 ± 18	43 ± 18	64 ± 33	64 ± 33	75 ± 49	75 ± 49	69 ± 30	69 ± 30	62 ± 27	62 ± 27	79 ± 50	80 ± 50	71 ± 30	71 ± 30
Zinc (mg)	17 ± 4	17 ± 4	15 ± 5	15 ± 5	16 ± 4	16 ± 4	13 ± 7	13 ± 7	15 ± 8	15 ± 8	14 ± 6	14 ± 6	14 ± 6	14 ± 6	16 ± 8	16 ± 8	15 ± 6	15 ± 6

Results reported as average ± standard deviation

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19. ABSTRACT

Soldiers rarely consume all the food components issued in combat ration packs (CRP), compromising the adequacy of nutrient intake and the physical and cognitive performance of combatants. Mission adaptive (MA) nutrition—providing soldiers with optimal energy and nutrients when Army operates in contemporary environments and with changing demands—is thought to mitigate risk to performance. In a side-by-side comparison with in-service CRP, a nutrient optimised modular MA CRP design was fielded with dismounted infantry personnel to assess fitness-for-purpose and utilisation over a 6–day use period. Inadequate energy and nutrient intakes were identified as a result of the field trial. A detailed understanding of combatant energy expenditure, current and future risks to health and well-being and performance targets is required to optimise the design and provide a proof of concept. Further product development, potentially including formulated, energy-dense, and commercial-off-the-shelf components, is required to rectify the inadequate delivery of nutrients. Successful implementation of a MA CRP design will require training, education, policy and procedure, and interactive tools for verification of learning, validation of desirable behaviour and realisation of benefits. To provide a proof of concept, further trials are required to assess performance in various operational environments over longer use periods of up to 30 days.