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Defence Food Science in Australia

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Abstract. This paper briefly gives an account of the Defence Science and Technology Organisation (DSTO) and its research activities with special reference to the ongoing research programmes.

1. Introduction

The Armed Forces Food Science Establishment (AFFSE), Scottsdale an integral part of the Defence Science and Technology Organisation (DSTO) carries out research and development in food science. In accordance with the functions of DSTO the work at the Establishment is directed towards providing scientific and technical advice on Defence policy. AFFSE is tasked with the responsibility to supply scientific and technical advice to the Defence forces, on all matters relating to Defence feeding, procurement of foods and nutrition. It provides scientific and technical support to the Australian Defence Force by assisting in design and development and ultimately acquisition of prototype feeding equipment and feeding systems. Thus the basic charter of the Establishment is fulfilled.

A well equipped library, and engineering workshop supply necessary support to the Establishment.

2. Activities of the Section

2.1. *Food Technology and Experimental Processing*

The major portion of the Experimental Processing time is spent servicing the speciality requirements of the Australian Armed Forces. Major activities include production and packaging of freeze dried, composite meals and components, emergency rations and drinking water. Other special items are occasionally packed as required.

Food Technology has continued to study the freeze drying process, and in conjunction with Engineering has produced an increase in freeze dried yield averaging 45%

during the period 1974—1979. This is related to changes in formulation (particularly wet to dry ratio), loading densities and freeze drier operating parameters (e. g. platen temperatures). More recently, further increases in throughout have been achieved with rice by reanodising of freeze drier trays. This has permitted increased tray loading and an improved uniformity of spread. Experimentation is continuing to increase solids ratio on rice by lowering temperature and increasing cooking time.

A watching brief continues to be kept on the Australian Food Manufacturing Industry for any item suitable for inclusion in the operational ration packs. This applies particularly to the introduction of retort pouches and to possible replacements for the PVC emergency water pouches. Plastics readily available at present do not have the strength required to withstand ejection forces.

Meat texture work has continued. A study of accelerated ageing has shown that ageing at 60°C affects not only the myofibrillar proteins, but makes the connective tissue proteins much more susceptible to the effects of high temperature cooking. The effects of high temperature ageing on instrumental measures of freeze dried meat texture is being explored.

Preliminary work has been conducted on removal of unbound water from meat by centrifugation prior to freeze drying. However, centrifugal forces required for removal tend to lead to excessive breakdown of meat texture.

Preliminary work on the spray drying of instant gravies, and use of various modified starches and other thickening agents has commenced. It has been confirmed that most textural damage suffered by starch gels occurs at the freezing stage during freeze drying. Although chemical modification of the starches such as cross linking offers some protection, results obtained at the Establishment are at minor variance with the information supplied by the manufacturers. The effects of improved viscosity on the rate of meat rehydration have not yet been determined.

A feeding system based solely on the use of microwave ovens is being developed for use in Mine Hunter Catamarans (MHCAT). This may have spinoffs into other areas of Naval Feeding, particularly for heavy weather meals in other small craft. Factors that need to be considered are ease of preparation, and problems with lack of variety and boredom. Trial meals have been obtained from a hospital cook freeze catering system. These appear to have advantages over commercially available meals both from an organoleptic and microbiological aspect.

A new In-flight Ration Scale has been developed and is currently undergoing trial. The scale of issue for crews and passengers on transport aircraft has been finalised and work is continuing on a scale for strike aircraft crews. Both the In-flight Feeding Scale and MHCAT feeding systems are being undertaken by the combined Food Technology and Nutrition/Physiology sections.

A study has commenced on the corrosion characteristics of cans. Unlacquered cans will rust in as short a time as five days under adverse storage conditions.

Lacquering will retard this corrosion but only if the lacquer is continuous. Corrosion pit depth is currently undergoing assessment and the effects of tin plate thickness will be evaluated.

3. Nutrition/Physiology

The Ration Scale Committee has revised the Ration Scale. They have attempted to make alternatives more isocaloric than in the previous scale. This has resulted in a reduction in the spread of energy available from a range of 18, 600 kJ (8,770 to 27,360 kJ) to one of 10,900 kJ (11,200 to 22,120 kJ). The new scale, SUPMAN 4, was introduced into service in December 1982 and is titled the Australian Defence Force Ration Scale (ADFRS). Minor amendments have since been made to entitlements for cooking oil, increasing allowances for small messes and decreasing those for the large mess. This will allow control of fat useage without preventing the smaller mess from replacing its deep frying compound at regular intervals.

AFFSE is currently making submissions to the Ration Scale Committee with regard to reduction in the salt and instant coffee allowances and the items currently available under the Hot Weather Supplement.

Reductions in the salt content of the ration packs has been proposed and further work is proposed on the reduction of salt content on certain ration items.

A study on the food intake and energy expenditure of naval clearance divers has been completed. Energy and nutrient intakes were found to be sufficient and without excessive wastage. Energy expenditures were high, averaging 19,000 kJ per day. Any problems with the feeding system did not appear to be related to the quality of quantity of food, but there was a lack of time for eating meals and for resting or sleeping.

A study of more than 200 servicemen undergoing training is nearing completion, and has provided valuable information for the running of a more thorough study in the near future. There is a large variation in apparent energy available between units, with little apparent difference in energy expenditure. Even in cases where energy availability was low, it remains in excess of that required by the trainees. In addition all units average 3,300 kJ eaten outside the messing system, with little correlation between energy available inside and food consumption outside the system. A further study will be conducted early in the new period, involving kitchen and plate waste, a full survey of kitchen feeding and anthropometric details of the trainees. It is hoped that this trial will encompass the four year training period of officer cadets and will be conducted in conjunction with unit medical officers.

A major task is being undertaken for Navy to develop a feeding system for small vessels based on frozen foods. An industry wide survey of frozen foods has been undertaken and food consumption patterns aboard a Naval Patrol Boat have been

collected. Trials on specific foodstuffs including ease of preparation at sea are continuing.

4. Food Science

4.1. *Chemistry*

Ration pack analysis has continued on a regular basis, with results published annually as AFFSE reports. The last report included a detailed analysis of every item in the Combat Ration Ten Man and included a statistical analysis of the variation found between different packs of the same component. The variations found were attributable to the heterogeneous nature of the components and were considered acceptable. Fortified components were also evaluated for vitamin content. It was found that the concentration of vitamin varied in the order of half of the mean content of the component. This variation in initial content prevented a thorough examination of the decline in vitamin concentration in various fortified components during storage. A new trial has commenced with new methods of analysis and more extensive analysis to define the life of vitamins in fortified components during storage.

Analysis has commenced on a range of indigenous Australian foods. Proximate analysis of 90 of these foods has been reported. There are currently 130 of these foods being analysed for protein, fat, moisture, refractory ash, carbon, hydrogen, potassium sodium, calcium, magnesium, iron, copper, zinc, lead, cadmium, carbohydrate, ascorbic acid, thiamin and other vitamins, Most of the samples are very small which has limited the range of analyses which are possible.

4.2. *Proximate Analysis*

Protein determinations are now being done using an elemental analyser to determine nitrogen content. The elemental analyser in the same run determines carbon, hydrogen and nitrogen. It is possible to weigh the residual ash which provides a measure of refractory ash. This unit replaces the Kjel-Foss Analyser formerly used for automated protein determinations. The elemental analyser uses the gas phase. Pregel-Dumas catalysed oxidation followed by reduction to remove surplus oxygen. The efficient gases are measured using thermal conductivity. This procedure offers cost advantages with the determination of additional elements. It also offers the advantage of using small samples of 2 mg in size.

4.3. *Metal Analysis*

Analysis is nearing completion, using atomic absorption spectroscopy of Combat Ration One Man for the metals sodium, potassium, magnesium, calcium, iron, copper, zinc, cadmium and lead. The determinations are being undertaken on

dilutions of a single digestion procedure. The same method is being used to estimate these metals in survival foods.

4.4. *Vitamin Methods*

Major emphasis has been placed on new methods of analysis. High pressure liquid chromatography methods (HPLC) are being developed for ascorbic acid and B group vitamins and is now being used with ration pack components and survival foods. It has been found that the method correlates well with the dichlorophenolinophenol method for most foods. However, a few foods gave substantially differing results by the two methods, and gave additional peaks responding to the HPLC detector. It has been concluded that the old dichlorophenolindophenol method will overestimate ascorbic acid in, for example, coffee by a factor of two. Current development is directed to finding a means of using the method to determine both ascorbic acid and dehydroascorbic acid.

A HPLC method is being used to determine thiamin as the fluorophore thiachrome.

Development work towards a method for niacin, pyridoxin, riboflavin, thiamin and homologues in foods is still on. A reliable chromatographic separation has been achieved, however, the detector is a factor of a hundred too low in sensitivity. Experiments towards more sensitive detector systems and concentration of the vitamins for analysis are in progress.

In order to validate HPLC vitamin assays, microbiological methods for the analysis of the B group vitamins are currently being developed. Methods are now operational for niacin and riboflavin and is planned to evaluate these vitamins in the combat ration for 10 men.

4.5 *Dietary Fibre and Available Carbohydrate*

The method of Englyst is being implemented with some modification. The method is intended to provide information on the proportions of carbohydrate available to humans and the classes of dietary fibre components in a food. It determines the fractious separated by hydrolysis techniques as the monomeric sugar alditol acetates using an automated gas chromatograph. Uronic acids are determined using a programmable UV-visible spectrophotometer. Lignin/cutin is estimated gravimetrically and nitrogen content estimated using an Elemental Analyser. The data generated provides details of free available sugars, available starch, resistant (heat damaged) starch, water soluble hemicelluloses, water insoluble hemicelluloses, water soluble proteins, water insoluble pectins, cellulose, and the lignin/cutin fraction.

The various components are considered to have differing effects of interest in human nutrition. The available sugars are used by the body for energy. The cellulose and lignin/cutin passes through the body and may assist in the removal of

bile acids, reducing the cholesterol load. The hemicellulose fraction normally passes through the body, however, long residence time in the lower colon can allow bacterial degradation releasing some energy as low molecular weight fatty acids. These fatty acids can be absorbed from the lower colon. The pectins can also pass through and also may be degraded in the lower colon, but at a different rate. The pectins are considered to reduce the availability of metals such as iron, zinc and calcium.

4.6. *Microbiology*

Regular testing of products produced at the AFFSE are performed to ensure compliance to the Australian Defence Force Food Specifications (ADFFS). Batches are tested using a five subsample, three class attribute plan.

Storage trials on freeze dried (F.D.) meals have shown a reduction in Standard Plate Count (S.P.C.) over a two years period. The greatest reduction in S.P.C. during storage was in F.D. rice. The F.D. meat meals would appear to afford a greater degree of protection to the micro-organisms during storage.

4.7. *Water Sterilizing Tablets*

Research activity has been directed towards the assessment of the efficiency of water sterilizing tablets. A range of tablets has been assessed in both pure water and simulated contaminated water at different temperature and pH values. Of special interest has been the requirement of one of the tablets—Afses, to remain quiescent during the initial five minute contact to ensure maximum release of iodine. Laboratory trials incorporating continual agitation have been conducted to assess the tablets. More recently trials in canteens have been conducted to verify that the results incorporating agitation can be reproduced in vivo.

4.8. *Yeast and Mould Media Trials*

An evaluation has been made on a number of media which are used for enumerating yeasts and moulds. Based on the results of these trials the AFFSE now routinely uses Dichloran rose-bengal chlortetracycline agar (D.R.B.C.) (King, et al. 1979)*. This medium is preferred since it enumerated at least equivalent numbers of fungi c/w the other media, and in some instances significantly (< 0.05) more. D.R.B.C. has the advantage over non rose-bengal based media of the colonies being easier to count. This is because the dye is taken up by the colonies, making them stand out. The inclusion of dichloran significantly reduces the size of the mould colonies.

* King, JR. A. D., Hocking, A. D. & Pitt, J. I. 1979. Dichloran rose-bengal medium for enumeration and isolation of moulds from foods. APP & Environmental Micr., 37 (5), 959-964.

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