DFRL's

Food Process & Technologies Brochure

DEFENCE FOOD RESEARCH LABORATORY

Defence Research & Development Oraganization (DRDO)

Ministry of Defence,

Siddarthanagar, Mysuru

Publisher
The Director
Defence Food Research Laboratory (DFRL)
Defence R & D Organization
Siddarthanagar, Mysore - 570 011
Karnataka, India

Tele : 91-821- 2473783
: 91-821- 2579601 / 600

Fax : 0821-2473468

Email : director@dfrl.drdo.in
head.tt@dfrl.drdo.in

Chief Editor :
Dr. ANIL DUTT SEMWAL, Director, DFRL, Mysuru

Editor :
Dr. M. Pal Murugan, Sc 'E' & Mr. S. Nagaraj, PS

Designing & Technical Assistance :
Mr. B.N. Ramesh, Tech 'C'

To Search 142 Technologies:
https://www.drdo.gov.in/drdo/English/index.jsp?pg=dfrl-tech.jsp

INNOVATIVE BUSINESS OPPORTUNITIES STATE-OF-THE ART FOOD PROCESS TECHNOLOGIES

Defence Food Research Laboratory
Siddarthanagar, Mysore - 570 011
Karnataka, India

"DFRL, IN THE SERVICE OF THE NATION"

VISION

To be a Technological Leader of Excellence in Food Research & Product Development

MISSION

Design, Develop & Evaluate;
Safe, Nutritious & Convenience Food to Meet the Needs of Services and Spin-off to Civil Application

CORE COMPETENCE

Development of Convenience & Ready-to-Eat Food Products and Implementation of Packaging systems & Processing Technologies for fresh & Processed Food, Testing & Evaluation of Food

FOREWORD

The Defence Food Research Laboratory (DFRL) was established in December 1961 under the aegis of Defence Research & Development Organization, DRDO, Ministry of Defence to cater to the strategic operational requirements of our services and to provide logistical support to the Armed Forces in the area of food supplies. DFRL has core competence in convenience foods, food packaging as well as food analysis and quality control.

DFRL has developed an array of food products/technologies to provide convenience, adequate nutrition and calories, apart from ensuring shelf-life and microbiological safety. Over the years, more than 567 Technology Transfers have been done to about 327 different entrepreneurs.

An effort has been made to compile the various Food Technologies & Products developed at DFRL till date. Many of these technologies have been transferred to various entrepreneurs successfully. It involved a tremendous effort on the part of various Heads of Departments and Team Members of the Technology Transfer Division to compile the same. I express my appreciation for the same and hope this effort will continue for future updating from time to time, to make the Brochure authentic and wholesome.

Dr. Anil Dutt Semwal
DIRECTOR

CATEGORY-A

MRE RATION TECHNOLOGY

The development of Pack Rations to Service Forces is very critical. Because, protecting food items from physical and chemical deterioration during packaging, storage, transport and handling is the most critical task amongst all. The packaging and any operational ration used during logistic period, should meet three considerations of

- Operational limitations on meals patterns;
- Operational limitations on weight and volume;
- Availability of materials in supply chain.

Defence Food Research Laboratory (DFRL), Mysore has developed Meals–Ready–to-Eat (MRE) Ration technology which comprises Retort pouch processed foods, Shelf stable no preservative chapaties/ Preserved & flavoured chapaties and Survival ration to meet the operational requirements of Armed Forces.

The retort pouch processed foods and shelf stable (no preservative) chapaties do not require any cooking since the contents are thermally processed and can be consumed as such or with warming, if required. Retort pouch processed Ready to Eat (RTE) foods are processed in a specially designed bulk sterilizer to ensure microbiological safety as well as commercial sterility.

The technology used is highly scientifically accepted at international level. The packaging material consists of multilayer structure of 12 micron Polyester / 9 micron Aluminum foil / 15 micron Nylon/70 micron cast Polypropylene designed to withstand high temperature and internal pressure during heating, cooling, storage and transport.

The preserved & flavoured chapaties are popular Indian wheat-based staple food developed by using certain preservatives and thermal treatment alongwith incorporation of stable flavours. The shelf-life of product is one year and suitable for use by troops during operational and combat situations as well as for various expeditions and mission undertaken on land and sea.

Survival Ration contains energy dense soft bar and delicious chikkis from groundnut with jaggery/sugar to meet the immediate nutritional requirements of Armed Forces during combat operations.

The Indian MRE compares very well with well-known international rations like MRE of USA and GP-24 of UK in nutritional quality and shelf-life. The shelf life of the ration is 12 months under ambient conditions. The total calorific value of the ration ranges from 2600 - 4600 kcal and meets the nutritional requirements as per the RDA requirements.

MRE - High Altitude

MRE - Jungle

MRE - Desert

MRE
Marine Commandos

MRE - Sailors

MRE - Tank Crew

MRE - Submarine Crew

CATEGORY-A

SURVIVAL RATION

DFRL, DRDO developed Survival Ration comprising energy dense soft bar and chikkis from groundnut with jaggery/sugar to meet immediate nutritional requirements of Armed Forces during operation.

The survival ration consists of soft bar 100 g x 2 Nos, Chikki (sugar based) 50 g x 3 Nos, Chikki (Jaggery based) 50 g x 3 Nos.

Rations are packed in Low Density Polyethylene (LDPE) of 125 micron thickness and hermetically sealed and vacuum packed. Chikkis are vacuum packed in laminated pouches to enhance the shelf life to more than one year without any sensory changes at ambient conditions.

Ration is designed to prevent thirst and is easily digestible. This provides around 2300 kcal of energy per pack of 500 gm with shelf life of one year under ambient condition.

EMERGENCY FLYING RATION

DFRL, DRDO developed energy dense soft bar to meet emergency operational requirement of Air Force. Pre-requisite for emergency flying ration is that protein and fat content should not be more than 5% to avoid thirstiness in emergency situations.

The shelf-life of emergency flying ration is 3 years at 55°C and packed in Polypropylene box of size 10.4 X 7.5 X 2.5 cm with weight of 165± 5gm. The bars are provided with indentation for easy breaking during consumption.

The developed soft bar provide energy of 660 kcal/pack and available in three different food flavors i.e. orange, pineapple and cardamom. The orange flavoured emergency flying ration is highly liked and part of emergency flying ration for Indian Airforce.

POTABLE STERILIZED WATER POUCHES

Potable sterilized water pouches, is one of the main component of Life Support Systems in Personal Survival Pack (PSP) of Indian Air Force. The potable water pouches are critical for the Indian Air Force to meet their operational requirements during sortie and strike operations.

Potable sterilized water is packed in multilayer pouches and thermally processed to achieve commercial sterility with the shelf life of 24 months under ambient conditions.

The technology has been developed to indigenous the process to reduce the cost and to develop indigenous manufactures/processors to supply potable sterilized water pouches to Indian Air Force. The technology is indigenous and cost effective. The potable sterilized water pouches are storable up to 24 months under ambient conditions.

In the civil sector, if any situation of emergency this technology can be adopted for the production of potable sterilized water in flexible pouches with longer shelf life. Hence, this technology is highly useful for critical mission and for other logistic operations. Potable water (pH: 6.5-7.5) is filled in multilayer packaging pouches which are sealed subsequently hermetically using high pressure pneumatically operated sealing machine.

Potable Sterilized water pouches is being regularly supplied to Indian Air Force.

CATEGORY-A

MOISTURE PROOF PACKAGING FOR SALT

Moisture proof salt packet is a part of Personal Survival Pack (PSP) of Air Force and the supply is limited to single source of supplier. From Foreign Countries DFRL undertook the indigenous development of moisture proof salt packet.

The Moisture proof salt packet is very critical for the Indian Air Force to meet their operational requirements during sortie and strike operations. Moisture proof salt packet is packed in controlled environment to achieve commercial sterility with the shelf life of 24 months under ambient conditions.

The technology has been developed to indigenous the packing technique to reduce the cost and to develop indigenous manufactures/processors to supply moisture proof salt packet to Indian Air Force.

Common salt is filled in multi layer packaging material and hermetically sealed as per the approved specifications/dimensions under controlled conditions such as controlled RH and room temperature. The item is being regularly supplied to Indian Air Force.

SEA DYE MARKER

The sea dye marker is a life saving item of Indian Air Force which is used to locate and rescue the air crew and other search vehicles during emergency.

The components of sea dye marker includes a fluorescent green dye, which spreads over water surface and creates a fluorescent green colour when it comes in contact with water.

The dye when dissolved in a liquid medium like sea water will fluoresce brilliantly to give a green colour, when illuminated with sun light or any other form of light of the appropriate wavelength in the range of visible light.

The bright fluorescent green colour increases the likelihood of being identified during day times and enhances the chances of rescuing a pilot or any other crew landed in the sea during an emergency.

Presently, Indian Air Force is importing the sea dye marker and the supply is limited due to a single source of supplier. Accordingly, DFRL undertook the indigenous development of sea dye marker. Fluorescent dye, which is a critical component of sea dye marker developed indigenously for making sea dye marker. Various packaging materials were screened and evaluated for the suitability to pack the sea dye marker and Polyurethane (PU) coated fabric was finalized.

DFRL, Mysore is regularly supplying sea dye marker to Indian Air Force.

****

CATEGORY-B

1.0 READY TO EAT (RTE) FOODS

1.1 PRESERVED & FLAVOURED CHAPATIES

The technological measures employed to preserve and stabilise this popular Indian wheat-based staple includes certain preservatives and thermal treatment alongwith incorporation of some stable flavour principle. The product is suitable for use by the troops during operational and combat situations as well as for various expeditions and missions undertaken on land and sea.

1.2 SPICED POTATO PARATHAS

Incorporation of spiced potato mix into the dough and, thermal as well as preservative regimes of stabilisation process are key to the development of this immensely popular nutritious and flavourful wheat staple. The product can be used during breakfast, lunch, dinner or on any other occasion as snack food.

1.3 GREEN LEAFY VEGETABLE CHAPATIES / PAROTHAS

Chapaties are regularly consumed and are the staple diet of Indians. Green leafy vegetables are rich source of vitamins, minerals and dietary fibre. DFRL has developed green leafy vegetable chapatti parothas/premix that require just mere addition of water for kneading and baking thus reducing the time of preparation of chapaties. The chapaties are stable for one year under ambient conditions and useful for packed meals rations.

1.4 SHORT-TERM PRESERVED CHAPATIES

Freshly baked chapaties have a shelf-life of twenty four to forty eight hours. To extend the shelf life of chapaties upto fifteen days by using permitted preservatives and packaging material, short term preserve chapaties were developed by DFRL.

The product is eminently suitable for use during long journeys and institutional feeding /catering programmes being undertaken by railways and certain canteens and restaurant chains in cosmopolitan centres.

1.5 SHELF-STABLE (NO PRESERVATIVE) CHAPATIES

Freshly prepared chapaties have very limited shelf-life. DFRL has developed preserved chapaties having a shelf-life of more than one year, and retort processing technology with multi layered packaging material were used to preserve the taste and after taste both.

1.6 FIBRE RICH BISIBELEBHATH & FIBRE RICH VEGETABLE PULAV

The presence of dietary fibres in food have physiological benefits. They give relief from constipation and haemorrhoids. The constant use of recommended dietary fibre levels or dietary fibre rich products in diet have positive health benefits right from teeth, to control of normal levels of sugar, cholesterol, lipid metabolism, bile acid secretion to elimination of fecal waste.

CATEGORY-B

1.7 RETORT POUCH PROCESSED FOODS

Foods such as aloo choley, sooji halwa, fish curry, rice, dhal curry, vegetable and mutton pulav etc., are processed in retort amenable special kind of flexible polymeric films to achieve commercial sterility. The products are in a ready-to-eat form and can be eaten as such, straight out of the packs or, if facilities exist, can be warmed up by dipping the pack in hot water or keeping in hot air microwave before being consumed. Such foods have better consumer appeal and acceptability as compared to their canned counterparts. Convenience, ease of carrying and disposal after use are the special appealing features for the consumers.

1.8 READY-TO-EAT SOY CHUNKS

Pickles based on fruits and vegetables are presently available which contain no proteins. RTE soy chunks is the pickle prepared using texturised soy chunks for pickling. (The ready-to-eat soy chunks is the protein rich pickle.) This is a unique RTE product rich in protein that can be used as an adjunct along with chapati or rice.

1.9 READY-TO-EAT (RTE) & SHELF-STABLE FRIED CHICKEN LEG PIECES

Ready to eat non-vegetarian products are not available in remote areas. Moreover, the item could not be transported at ambient conditions for even a day or two. Thus, product innovation was made by DFRL to deliver a protein rich convenient RTE product for all age groups with good quality characteristics in terms of microbiological standards, chemical stability and sensory attributes which is stable under ambient, refrigerated and freezing temperature conditions.

1.10 READY-TO-EAT FROZEN PEAS 'N' CHICKEN PRODUCT

Freezing and frozen storage is one of the most important techniques for long-term preservation of meat and poultry products but some wastage still takes place. Nevertheless, freezing commonly damages muscle protein, induces protein denaturation and results in loss of protein functionality.

To prevent such changes, cryoprotectants such as glycerol were added to ensure maximum functionality of frozen poultry product.

The use of glycerol as cryoprotectant protected the muscle proteins from denaturation, improved the textural quality, reduced the freezing and thawing losses and damages caused due to crystal ice formation. Thus cryostabilization could be achieved by using glycerol to prevent actions taking place in frozen stored poultry products and it has been found to be very useful in the development of more stable and nutritive frozen poultry products.

CATEGORY-B

1.11 STABILIZED GREEN CHUTNEY

Green chutneys made up of green tomato, coriander leaves and spices are delicacies which have huge market potential in the defence and civil sectors. The chutney which is highly perishable and not suitable for long distance transportation was stabilized by hurdle concept for storage at ambient temperature. The process is based on combination of slight reduction in moisture, water activity, lowering of P^H and thermal treatment.

1.12 SOY SHRIKHAND

The Soy Shrikhand is based on soyabean and it is rich in soy-protein, cholesterol free fat as well as presence of bioactive components with anticancer & other functional properties. The product is cost effective & provides additional income to farmers through cottage industry. Usually the commercial shrikhand contains cholesterol to the level of 13mg/100g and has no dietary fibre but soy shirkhand is free from cholesterol. It is a rich source of bifideous micro flora, which is good for digestion and sound gut health.

1.13 HURDLE TECHNOLOGY PRESERVED FRUITS

Fruit slices are usually preserved by canning, dehydration or freezing process. These fruits undergo significant textural and taste losses during the processing and the technologies are as such capital intensive and difficult to be adopted in small scale/cottage industry.

Hurdle technology is a novel technique for the preservation of foods with emphasis on fruit slices and the low magnitude hurdles generated to minimize/avoid microbial proliferation resulting in shelf stable ready-to-eat fruit products with high moisture content.

The Hurdle technology preserved fruits retain their fresh appeal as that of fresh fruits. The product remains micro-biologically safe and has high acceptance. The process of preparing and processing these fruits is less energy intensive. These can be used in lieu of more expensive traditionally canned fruits. They can be consumed either as such or as part of various custard and porridge-like preparations.

1.14 HOLIBITE

DFRL has developed this instant energy giving health oriented ready to eat product for emergency use after exercises or for relaxation after exertion. This is an innovative product based on honey.

This is helpful in providing immediate energy to the body and provides 108 kcal per 30g capsule. Four to six capsules are good enough for managing emergency situations. A product containing 70% honey is yet to be heard of.

1.15 SWEETCORN PRODUCTS STABILIZED KERNELS & PASTE

Sweetcorn products have gained increased popularity over the years. The laboratory has developed a minimal process for extending the shelf-life of sweetcorn kernels for a period of forty five and sixty days at ambient and low temperatures respectively. Sweet or salty taste was also developed using hurdle process. The kernels in steamed and spiced form can be used for instant consumption as a snack food. The paste could be used as a sweetcorn spread and also can be used for other preparation i.e., dosa and other culinary preparations.

1.16 NATA-DE-COCO

Bacterial cellulose produced by *Acetobacter xylinum* at the air liquid interface of coconut water is known as Nata-de-coco. *A.xylinum* uses the nutrients in the coconut water medium and forms a thin slimy, transparent layer of cellulose on the surface of the medium which thickens with age, forming a thick whitish sheet after fifteen to twenty days. This sheet is cut into cubes, washed and boiled in water before cooking in sugar syrup. This unconventional product based on coconut water has immense potential because of the increasing awareness of the health benefits of fiber-rich products and the possibility of using a cheap, commonly wasted by product of the coconut industry to make a commercially value added product with export potential.

1.17 SHELF-STABLE, READY-TO-EAT MUTTON SANDWICH

Meat products are highly perishable. As of now there are not many RTE mutton based products available which are shelf-stable up to twelve months at room temperature. This product by DFRL has a longer shelf life, making RTE nutritious mutton based product much easily available at high altitudes as well.

1.18 CHANA NIBBLES

Bengal gram is a most popular and well accepted legume due to its taste and nutritional value. It is a good source of quality protein (21.3%), crude fibre (lignin 3.5%, cellulose 6.2 % & hemicellulose 4 .1%) and vitamins like folic acid, thiamine, riboflavin and niacin. However the cooking of chana takes long time & requires overnight soaking. Ready to eat chana nibble were developed, which can be used as snack at any time with long shelf-life under varied environments. It is a ready to eat spicy products can be used as such or with chapathi /rice.

1.19 VACUUM FRIED FRUIT & VEGETABLE CHIPS

Fruits and vegetables are rich source of important phyto-chemicals including vitamins which are destroyed during conventional deep fat frying process to a greater extent. Fruits also contain high amounts of sugars which get caramelized during atmospheric deep fat frying process yielding dark brown or black color unacceptable chips. Vacuum-frying is a deep-fat frying technique having advantages over traditional frying. In vacuum frying fruits and vegetables are fried at lower temperatures under vacuum conditions resulting in very good quality chips with lower oil absorption. Several fruits and vegetables chips have been developed using vacuum frying technology. These include apple, papaya, jackfruit, pears, bitter gourd, carrot, beetroot etc. The products have a shelf life of 3 months under ambient storage and packed conditions.

1.20 KATTI ROLLS (VEG & NON-VEG)

Katti roll is a katti Kabab wrapped in a layered parotha. Freshly prepared katti rolls are perishable & become unfit for consumption within 8-10 hrs. DFRL has developed shelf stable ready to eat Katti rolls with both veg & Non-veg stuffing by thermal processing. These katti rolls are convenient to use and can be consumed without any curry as an adjunct. Texture of katti rolls remains soft even after 12 months of storage at ambient temperature conditions. A large variety of katti rolls can be provided to break monotony. Katti rolls provides protein 16-19%; fat 9-12% and energy 260-300 kcals.

CATEGORY-B

1.21 OSMO DEHYDRATED FRUITS (MANGO, ORANGE, AMLA, PINEAPPLE, BANANA, PAPAYA, APPLE, GUAVA, Etc

Osmo-drying is an excellent dehydration technology used for dehydration of fruits. In this process, the fruit slices are dehydrated partially by putting them in concentrated sugar solution and partially by sun/hot air drying. The products retain their nutrition values to a greater extent in this process. The technology is highly suitable for several fruits including mango, papaya, pineapple, jackfruit, etc. The products have a shelf life of 6 months under ambient storage conditions.

1.22 JACKFRUIT PRODUCTS

Jackfruit bulbs can be stabilized by lowering their water activity (a_w) to a level insufficient to support bacterial growth by using combination processing treatments. The product range includes hurdle technology stabilized jackfruit bulbs, intermediate moisture jackfruit bulbs, osmo-processed jackfruit slices and dehydrated jackfruit slices. The products have shelf-life of 3-6 months under ambient storage conditions.

1.23 PALMYRAH PRODUCTS (HURDLE TECHNOLOGY)

Palmyra kernels have been stabilized using hurdle technology. The product is available in ready-to-eat form. The process retains the natural characteristics of the product. The product has a shelf life of 3 months under ambient storage conditions.

1.24 FOOD PRODUCTS WITH BACTERIAL CELLULOSE

Bacterial cellulose (nata) produced by *Gluconacetobacter xylinus* DFBT, is a polymer possessing unique properties such as renewability, high purity, biocompatibility, biodegradability, nanomorphology, amenable to chemical modifications and high water holding capacity. It is a tasteless, chewy and gelatinous soft material with an appealing translucent white appearance. Bacterial cellulose could be used in the development of novel fiber-rich foods and is widely applied in snack foods as it has a translucent white appearance, and is chewy and smooth. It can also be made into various shapes and is ideal for preparation of jellies, ice-creams and bacterial cellulose containing beverages. In addition, the bacterial cellulose can be made into pieces of ~1.0 cm^2, or homogenized and used as food additive. It is found to have high water retention capacity, low viscosity and is resistant to acid and heat

treatments. It is often used as an emulsifier, stabilizer, filler and texture modifier and is also useful as melt-resistant agent in ice cream preparation. Ice cream was prepared using ingredients such as Skimmed Milk powder, whipped soy cream, sugar, Vanilla essence, Strawberry, Pine-apple and Black Currant fruit juice concentrates with different cellulose concentrations.

1.25 PALMYRAH PRODUCTS (STEEP PRESERVATION TECHNOLOGY)


Steep Preserved Palmyrah Fruit

Palmyra kernels have been stabilized using steep preservation technology in sugar syrup packed in stand up pouches. The product shows excellent sensory attributes with a shelf life of 3 months under ambient storage conditions.

1.26 SHELF-STABLE READY TO EAT IDLIS & ITS VARIANTS WITH INSTANT COCONUT CHUTNEY MIX

Idli, is a popular South Indian fermented & steamed product, mainly consumed as a breakfast item by all segments of population of the country, but takes a long time for preparation. Idlis are made by the unique combination of cereals and legumes; providing substantial amounts of vitamins and proteins in the diet of people, apart from providing a fluffy/ spongy texture with characteristic flavour and aroma. Since, it is highly perishable, it should be consumed within the same day of preparation. A process for preservation of ready to eat idlis and its variants & instant chutney mix having shelf life of at least 90 days was developed. The preservation of shelf stable ready-to-eat (RTE) idlis was developed by thermal treatment without the addition of any preservative.

1.27 SOY PRODUCTS (MILK, FLAVOURED MILK, PANEER, CHIKKI, Etc)

Soybean is a rich source of various phyto-nutrients such as proteins, vitamins, isoflavones, etc. Value added products have been developed from soybeans in the form of soy milk, flavoured soy milk, soy paneer, soy chikki, etc. The processes for preparation of these products have been standardized so that the products are free from beany off-flavor. The developed products are high acceptable and possess excellent sensory attributes. The products can be easily commercialized by small scale or cottage scale industries.

CATEGORY-B

1.28 STABILIZED STUFFED VEGETABLES

Vegetables such as bitter gourd, brinjal, lady's finger, potato, parwal etc. were stuffed with spice mix formulation and shallow fried followed by thermal treatment for preservation purpose. The products are available in ready-to-eat form and can be eaten as such or with chapaties or rice preparations. The products are highly liked by consumers and have a shelf-life of 3 months under ambient storage conditions.

1.29 VEGETABALIZED BHUJIA

Snacks are popular throughout the world. Vegetable based snack has been developed using combination of vegetables using deep fat frying process. The product contains combination of several vegetables including potato, peas, cauliflower, carrot, etc., along with spices and salt. The product possesses excellent sensory attributes and is liked by a variety of consumers. The product is stable for a period of 3 months under ambient storage conditions.

1.30 STABILIZED READY TO EAT CHUTNEYS (FRUIT/VEGETABLES)

Chutneys are relished with a variety of food products. Chutneys are prepared from fruits or vegetables with addition of condiments, spices, salt, sugar, vinegar etc. Fruit and vegetable based chutneys have been developed from raw mango, pineapple, coriander, green chilli, mint, wood apple, carambola, etc. and the products have been stabilized using combination processing. The products are available in ready-to-eat form and have a shelf life of 3 months under ambient storage conditions.

****

CATEGORY-B

2.0 READY TO EAT BARS & BISCUITS

2.1 ALBUMIN BAR

An egg based snack bar which is rich in protein & dietary fibre was developed by DFRL to meet the changing needs of consumers. The Albumin bar has 10.3%, protein 23.5%, fat 1.2%, carbohydrate 62.90% and total ash 1.8%. It provides energy of 360 Kcal/100g. Bar was analyzed for amino acid profile and found rich in tryptophan (18.58mg, which acts as a precursor for the biosynthesis of serotonin, which is a contributor to feelings of well-being and happiness), aspartic acid (12.8mg), tyrosine (8.3mg) and threonine (8.25mg) per 100g of the product. Product comes as 25g packet servings and is stable up to 12 months under 5 ^{0}C, 10 months at room temperature and 8 months under 37 ^{0}C.

2.2 BARLEY BAR & FIBRE ENRICHED BAR

Changes in lifestyle and eating habits have considerably decreased the intake of fibre in everyday diet. DFRL has developed bars with soluble and insoluble fibres using barley grains as well as oat and wheat brans to provide high fibre content.

2.3 COCO-COCOA DELIGHT BAR

The highly liked chocolate bar has been prepared by DFRL using desiccated coconut and antioxidant rich substances like cocoa butter and cocoa powder, along with sugar and binder, to provide variety in operational ration packs. Cocoa butter and cocoa powder were used as they are rich sources of flavonoids.

2.4 ERGOGENIC BAR

The ergogenic bar was prepared using jaggery, walnut, cinnamon, pepper, ginger, turmeric powder, etc. for the use in high altitude regions. Ergogenic bar contains ingredients which warms up the body during extreme cold and enhances performance ability by boosting up the energy.

2.5 COMPOSITE CEREAL BAR

Composite cereal bar has been prepared using composition of different cereal ingredients. The bar contains soy, wheat, maize, barley etc., to provide balanced protein in the diet. This energy bar provides all essential amino acids in a balanced amount. The bar helps a lot in alleviating protein energy malnutrition, particularly in children as well as sports persons.

2.6 COMPOSITE TASTY BAR

Armed forces have to operate under various difficult circumstances. During emergency, survival situations and long route patrolling, troops need continuous supply of energy with adequate nutrition. Therefore, a protein rich nutritious energy bar was developed to cater to the requirement of armed forces.

This bar is rich in protein, light weight, easy to carry and provides sufficient energy during emergency and survival situations.

2.7 OMEGA-3-RICH BAR

Omega-3-rich bar has been developed by using walnut and flax seed as a source of omega-3- fatty acids. Generally in the market, omega- 3- fatty acid rich products are available based on non-vegetarian source of omega-3-fattyacids. The bar developed by DFRL is based on vegetable source. The bar can be used as a substitute for food containing non vegetarian source of fatty acids.

2.8 PROTEIN RICH MUTTON BAR

The protein rich mutton bar is a good source of protein (35.31 ± 0.36), carbohydrates (38.98 ± 0.15) and a moderate source of fat (10.14 ± 0.01) and provides 391 Kcal/100g. The product exhibited good microbiological safety throughout the storage periods at all temperatures. Mutton bar stored at 45^0C exhibited a shelf stability of 3 months in terms of physico-chemical and sensory attributes. Mineral analysis of the product revealed a good source of zinc (155.2 µg/g) and iron (46.2 µg/g).

2.9 NUTRI FOOD BAR

Due to the change in lifestyle and long working hours, there is a feeling of tiredness which necessiated the need of calorie dense foods. Nutri Food Bar developed by DFRL suited for these purposes and also there is a physiological feeling of fullness when eating these compressed bars.

This chewy calorie dense nutritionally rich compressed bar is prepared from readily assimilable and digestible sources of carbohydrates and proteins. This food bar serves as a meal substitute or supplement and forms a part of packed rations.

2.10 FLAXOAT TASTY BAR

Flaxoat tasty bar was prepared using flax seed and oat as a source of soluble fibre to provide a fibre rich diet to the consumers with better nutritional value. Flaxoat tasty bar provides both soluble and insoluble fibre in the diet for consumers.

2.11 HIGH ENERGY BAR

The convenient, 'ready-to-eat' High Energy Bar contains 9% protein, 10.5% fat, 70% carbohydrates and delivers energy of 400-410 K cal per 100g. The storage study (sensory, chemical and microbial) of the product was carried out and was found to be acceptable up to 9 months at 27±20^{0}C and 12 months at -18^{0}C respectively. Each bar weighs around 45-50 g packed in a suitable packaging material which can be easily carried or handled. The bar has been supplied to CRPF, Meghalaya Police & Assam Task Force.

2.12 SOY FORTIFIED OAT BAR

The different types of energy bar available in the market are usually prepared by partially roasted or unroasted ingredients which lack pleasant roasted aroma which is not suitable to the Indian palate.

The bar developed has a long shelf-life of fifteen months. The balanced amino acid present in soy and beta glucan fibre content of oat provides maximum health benefits to the consumers.

CATEGORY-B

2.13 SWEET & SOUR TASTY BAR

Generally energy bars are sweet in taste and part of various survival/energy rations. In order to provide change in taste, sweet and sour tasty bars have been developed which contain salt, chilli powder, sugar, different nuts and other ingredients of choice.

2.14 CHICKEN BAR

Bar is based on compression technology contain chicken solids and other ingredients. It is good source of micro & macro nutrients like vitamins, minerals, amino-acids and essential fatty acids in compact form. Provides 20.49% protein, 13.29% fat, 49.16% carbohydrates and 390 kcal/100g energy, shelf-life : 9 months.

2.15 GROUNDNUT BURFI

Groundnut burfi is a sweet product relished by all segments of population having a limited shelf-life. Groundnut burfi developed by DFRL is not only nutritious, but is calorie dense and has a shelf-life of more than five to six months.

2.16 EGG PROTEIN BISCUITS

Protein rich egg biscuits have been developed from real egg solids in three flavours viz., vanilla, pineapple and orange. The biscuits have 20% protein and deliver 475 Kcal/100g. These nutritious, flavoursome and tasty biscuits were highly accepted among the Armed Forces.

2.17 CHICKEN BISCUITS

Chicken is a good source of readily digestible protein and it contains all the essential amino acids and fatty acids as well as supplies vitamin B, minerals such as Cu, Zn, Na, K, Fe and P. Various type of biscuits are available in the market but with vegetarian ingredients only. Hence a high protein biscuit which can deliver essential amino acids, fatty acids and iron, chicken biscuits was developed at DFRL. It can cater to the needs of armed forces and civilian sectors and can also be used to rectify the protein calorie malnutrition in children as it is a high protein snack.

2.18 SEABUCKTHORN BASED BISCUITS

The first step towards the development of degenerative diseases in human is the onset of oxidative stress. The seabuckthorn based baked foods viz. biscuits, rusks, cakes, bread, etc. developed using seabuckthorn leaves extract reduce the oxidative stress as it is rich in antioxidants. The product is found to contain fibre, polyphenols and flavonoids. The shelf stability is found to be more than 8 months.

The baked foods developed by DFRL are unique as no other technology/product is available for baked food rich in antioxidants. The baked foods are antioxidative in nature and hence the consumption of these foods can reduce the incidence of chronic diseases.

2.19 MOONG DHAL BURFI

Burfi is one of the most popular traditional sweat dish relished all over India. Moong dhal is a rich and economic source of protein and other micro nutrients. Products based on Moong dhal such as Moong dhal burfi will be highly useful in alleviating the protein mal nutrition in under developed countries. As sweet item the product is highly liked by children. The product provides rich in calories and highly accepted by consumers. The shelf life of the products is nine months under ambient storage condition.

2.20 INTERMEDIATE MOISTURE COMPRESSED FRUIT & VEGETABLE BARS

Intermediate bars have been developed using osmo-processed fruits and vegetables. Fruits and vegetables pieces were osmo-dehydrated to optimum moisture content followed by compression to yield compressed bars. These include pineapple, apple, mango, amla, beetroot, carrot etc. and their combinations. The bars are available in ready-to-eat form and can be consumed as such. The products have excellent sensory attributes and have a shelf life of 3 months under ambient storage conditions.

2.21 FRUIT LEATHER

Fruit bars are relished by many consumers and they are stable for longer durations under ambient storage conditions. The fruits bars are available from mango, guava, jackfruit, papaya, mixed fruits etc. The fruit pulps are mixed with sugar and hydrocolloids and concentrated to optimum concentration levels by hot air dehydration. The products have a shelf life of 6 months under ambient storage conditions.

2.22 TYROSINE BAR

A ready-to-eat bar enriched with tyrosine was formulated by incorporating tyrosine and other binders. Tyrosine is a nonessential amino acid that body makes from another amino acid called phenylalanine. It is an essential component for the production of several important brain chemicals called neurotransmitters, including epinephrine, norepinephrine, and dopamine. Neurotransmitters help nerve cells communicate and influence mood. Under stress, the body isn't able to make enough tyrosine from phenylalanine. Supplementation of tyrosine helps to improve memory and performance under psychological stress. Hence Tyrosine supplemented food bars were developed to enhance the performance of troops in environmental extremes through performance enhancing food components. The nutraceutical food bar with tyrosine was developed by standardizing the ingredient combination and reducing the bulk by employing compression technology. This product has a good shelf stability of 1 year at room temperature. This bar can be employed in critical missions and during stressful conditions for improvement in cognitive and physical performance.

****

CATEGORY-B

3.0 READY TO EAT APPETIZERS, MUNCHES, & JAM

3.1 READY TO EAT APPETIZERS






Prolonged exposure to high altitude and certain pathological situtation leads to loss of appetite. To address this problem of appetite loss, spice based appetizers have been developed by DFRL. To provide convenience to consumers, these were developed in a ready-to-eat form with shelf- life of ten months. Active components present in the appetizer promotes secretion of juices from several glands and improves the appetite. The convenience of ready-to-eat product and longer shelf -life are added advantages. They can be consumed either as such or as part of various custard and porridge - like preparations.

3.2 TAMARIND JAM

A Low cost product to fight anemia problem was prepared from Tamarind & other easily available sources of minerals. The product is rich in vitamin C & iron content meets RDA requirements for iron. Consumption of tamarind jam 50g quantity used over two bread sandwiches meets about 45% RDA for adults. The product cost is Rs 28/100gm bottle & shelf-life of product is 6 months.

3.3 ANTI ULCERATIVE ALOE VERA BASED FRUIT SPREAD

Aloe vera gel (AG) is composed mainly of water as well as mono and polysaccharides (25% of the dry weight of the gel). The most prominent monosaccharide in AG is mannose-6-phosphate, and the most common polysaccharides are gluco-mannans.

Novel anti-inflammatory compound, C-glucosyl chromone, has been isolated from AG. Aloe gel also contains lignin, salicylic acid, saponins, sterols, and triterpenoids. The fresh gel contains proteolytic enzyme carboxypeptidase, glutathione peroxidase, as well as several isozymes of superoxide dismutase.

The gel also contains vitamins A, C, E,B12, thiamine, niacin and folic acid, as well as the minerals like sodium, potassium, calcium, magnesium, manganese, copper, zinc, chromium, and iron. Edible portion of Aloe vera plant has been used in the preparation of a fruit spread. The product is shelf-stable for more than 6 months, organoleptically acceptable.

The product has been evaluated for the anti-ulcerative effect in rats. In the experiment, gastric ulcer was created to rats by oral administration of acetic acid and the same has been reduced significantly by feeding the Aloe vera based fruit spread (Patent filed: No. 1493/DEL/2012 dtd 12 June 2012).

Aloe Vera gel is reported to possess antiviral and antitumor activity, protection from lung cancer, reduction of blood sugar in diabetes, wound healing, etc.

****

CATEGORY-B

4.0 INSTANTISED FOOD / MIXES

4.1 INSTANT SOOJI HALWA

Halwa made from sooji (Semolina) and sugar and further embellished with cashew kernels and flavours is a very popular dish of Indian dietary. Its rich roasted flavour and excellent taste endears it to young and old alike.

The convenient halwa mix developed by DFRL can be served within four minutes of simmering it in water and bringing the mix to boil with occasional stirring. The product scores very high on the consumer acceptability scale. The process of manufacture is fairly straight, simple and easily adaptable at commercial level.

4.2 INSTANT IDLI SAMBAR

Idlis are highly perishable traditional south Indian delicacy relished all over the country, should be consumed within the same day of preparation. Attempts were made to develop instant/RTE idlis capable of reconstituting by mere mixing with hot water within 3-5 mins. Efforts were also made to stabilize idlis in RTE form. Proximate composition, mineral content and Scanning Electron Microscopic studies were carried out. Evaluation of shelf-life of Idlis and sambar mix stored at ambient condition at 37^0C in polypropylene (PP) & metallized polyester (MP) pouches revealed that, the product was stable for more than 6 months for instant idlis, whereas, 40 days for RTE idlis.

4.3 INSTANT UPMA MIX

This semolina-made savoury preparation is relished at breakfast and as an item of snack at any other time. The mix is reconstituted by simmering in water and bringing the ingredients to a boil with occasional stirring. The product can be served hot within four minutes of its reconstitution and provide the consumer with all the characteristic taste and flavour that she/he looks forward to.

4.4 INSTANT COOKING RICE/VEGETABLE PULAV/KICHADI MIX

Cooking of rice/Vegetable Pulav/khichadi mix is a time consuming process and requires elaborate cooking facilities like pressure cooker, cooking vessels, gas etc. The preparation becomes much more difficult and requires a long time at high altitude areas where boiling point of water is less than 100^{0}C. The cooked rice has a limited shelf-life of 12 to 24 hrs at ambient condition.

DFRL has developed the instant cooking rice by pressure cooking & conditioning to particular moisture content, flaking to a specified thickness and drying in a through flow dryer such that it retains porous structure with low density which helps in faster rehydration during reconstitution. Instant rice does not require cooking. The rice can be prepared for consumption by just adding in hot water of about 80 - 90 ^{0}C within 5 to 10 minutes.

4.5 INSTANT WHEAT PORRIDGE MIX

Supply of fresh food to troops engaged in combat operations at inaccessible terrains is almost difficult. Hence troops have to survive on ready to eat foods or convenience foods which should be less in weight, with longer shelf-life and should provide adequate calories.

DFRL has developed instant wheat porridge dalia mix capable of reconstitution in four to five min in hot water as well as in cold water and provides 435 kcal/100g.

4.6 INSTANT COOKING PULSES & DAL FLAKES

The cooking of dal is a time consuming process & requires elaborate cooking facilities like pressure cooker, cooking vessels, gas, etc. The cooking of dal like red gram dal requires 45-60 minutes in open cooking or about 20-40 minutes in pressure cooking & subsequently requires seasoning time for the preparation of dal curries. Cooking of dal becomes much more difficult and requires longer time in high altitude areas where boiling point of water is less than 100^{0}C. The prepared dal curries have a limited shelf-life of twelve to twenty hours at ambient conditions.

The dal or pulses are naturally associated with hard to cook characteristics due to highly dense grainy structure & pectin, calcium, magnesium & phytin (PCMP) content. The cooking time of dal can be reduced by increasing the surface area of grain by flaking and breaking the PCMP complexes by cooking & drying in suitable dryer to less than 6 percent moisture content.

4.7 INSTANT COCONUT CHUTNEY MIX

Coconut chutney provides a definite tang to many of the traditional south Indian delicacies such as idli, dosa, urd dhal vada, bonda etc. Without the seasoning effect of coconut chutney, many of these products stand to lose their traditional appeal. The mix developed by the laboratory contains coconut gratings, tamarind, green chilli, coriander leaves, ginger, salt, spices and oil besides curry leaves and mustard seeds as essential ingredients. The product reconstitutes almost instantly on addition of water.

4.8 INSTANT DAL CURRIES BY FREEZE THAW DEHYDRATION PROCESS

The cooking of dal is a time consuming process and requires elaborate cooking facilities like pressure cooker, cooking vessels, gas etc. Also they have limited shelf life of twelve to twenty four hrs at ambient condition.

The cooking time of dal can be reduced by cooking the dal grains and drying in a suitable dryer to less than 6% moisture content. In the technology developed by DFRL, dal grains are cooked under pressure, conditioned to low temperature and dried under high air velocity through low dryer such that grains retains its shape and size of grains with porous structure and minimum density. These products when added to hot water gets reconstituted within two to three minutes.

The product has more than one year shelf life and forms complete meal along with rice, chapathi or parotha. It is useful during travelling, expeditions, institutional feeding and during odd times at home.

4.9 INSTA NUTRO CEREAL MIX - (BISIBELE BATH MIX)

DFRL has developed traditional south Indian spiced delicacy which is an admix of cooked cereals, pulses and vegetables. This calorie and protein rich product is especially liked and savoured for its rich blend of flavour and taste. It is a wholesome nutritious product liked by majority of the population. This product remains stable for one year and can be reconstituted in three to four minutes in boiling water.

4.10 INSTANT CARROT HALWA

'Gajar ka halwa' and 'Gajar pak' are extremely popular amongst a host of Indian and subcontinental consumers. Traditional carrot halwa and gajar pak preparations are very elaborate and far too cumbersome. Moreover the freshly prepared carrot halwa has limited shelf life of two to three days at room temperature and about one to two weeks in refrigerated condition. The development of Instant carrot halwa is intended to solve these problems.

The instant mix developed by DFRL reconstitutes within minutes of mixing with hot water and provides an ideal alternative besides meeting off-season demands for carrot. The innovated process is based on precooking and drying under controlled condtions which gives instant carrot halwa which can reconstitute by boiling in water within five minutes and has similar sensory quality as freshly prepared carrot halwa. The instant carrot halwa has got shelf life of more than twelve months at room temperature, and can be useful during traveling, expeditions, institutional feeding, food for natural disaster victims and for operational rations of armed forces.

4.11 INSTANT RAVA IDLI MIX

Rava idli mix are traditional products which are routinely consumed. These products have been developed by DFRL in convenient form of dry mixes which can be reconstituted or cooked in three to five minutes. Rava idlis are popular food items at breakfast as well as other times. The product is especially liked for its characteristic taste, besides its soft and fluffy texture. The product is prepared from Semolina with or without vegetables. Although its method of preparation is quite cumbersome, in order to provide convenience to consumers, DFRL has developed a ready-to-cook formulation which has all the essential ingredients akin to rava idlis. The product has excellent domestic as well as export potential.

4.12 INSTANT WHOLE PULSES & THEIR CURRIES

The cooking of dal is a time consuming process & requires elaborate cooking facilities like pressure cooker, cooking vessels, gas, etc. The cooking of dal like red gram dal requires 45-60 minutes in open cooking or about 20-40 minutes in pressure cooking & subsequently require seasoning time for the preparation of dal curries. Cooking of dal becomes much more difficult and requires longer time in high altitude areas where boiling point of water is less than 100^{0}C. The prepared dal curries have a limited shelf-life of twelve to twenty hours at ambient conditions.

The dal or pulses are naturally associated with hard to cook characteristics due to highly dense grainy structure & pectin, calcium, magnesium & phytin (PCMP) content. The cooking time of dal can be reduced by increasing the surface area of grain by flaking and breaking the PCMP complexes by cooking & drying in suitable dryer to less than 6 percent moisture content.

4.13 INSTANT VEGETABLE WADI MIX

Different types of wadi are available in the market that are made from urad dal, moong dal, etc. However, they take long time for cooking and instant vegetable based wadi are not available. DFRL has developed vegetables, potato, bottle gourd and carrot based wadi to provide better nutrition and ease of cooking.

CATEGORY-B

4.14 SOY FORTIFIED INSTANT SOOJI HALWA & UPMA MIX

Various instant food mixes are developed by DFRL which get reconstituted within four to five minutes with long shelf-life.

Instant mixes developed using soy bean or soy sooji which are very good sources of all essential amino acid and are known to improve the protein efficiency ratio.

4.15 INSTANT POHA

Ready-to-reconstitute instant Poha and Protein rich instant poha (beaten rice) was developed with six months shelf life. The protein content of the product was contributed by groundnut (*Arachis hypogia*) and moth beans (*Vigna aconitifolia*). The proximate composition of the final product was moisture-5.9%, fat-20.48%, protein-13.78%, ash-3.7% and crude fiber-7.5%. The process involves cleaning, blanching, dehydration, size reduction, pulverizing, blending, packing etc as the major steps. The instantisation process was standardized to achieve reconstitution within 3 minutes in boiling water. The shelf life of 6 months was established at room temperature in polypropylene and metalized polyester pouches. The product has high market potential as a quick breakfast / snack item.

4.16 THERMALLY STABLE WHOLE/SPLIT LEGUMES BASED READY TO EAT CURRY CONCENTRATE

Preparation of legume based delicacies begins with washing, soaking and then cooking with sub-constituents. Hydration/soaking of pulses before cooking usually extends the total processing/preparation time. Most of the thermally processed foods undergo excessive heating abuse which results in significant loss of the vital nutrients like vitamins, minerals, etc., resulting in less acceptable product with reduced keeping quality. Thus it would be desirable to devise a method for whole/split legumes based curry concentrate which is neither time not energy intensive.

DFRL has developed a ready to constitute thermally processed whole/split legumes concentrate with fat based spice mix. The process is exclusive and innovative in terms of delivering a product with enhanced uniform quality, better control during processing, energy efficiency and economically reasonable. The reason for the above said claim is that the entire recipe components are taken initially with minimal thermal pretreatment.

4.17 RICE BASED PRODUCTS (INSTANT TAMRICE & URD RICE MIX)

The mixes can be boiled in hot water for 3-4 minutes and the product is ready to serve. The products are very tasty. The instant tam rice mixes are based on unique blend of spices & technology. The mixes are having more useful minerals, vitamins, carbohydrates and relishes the hunger and are easily digestible. The shelf-life of the mixes is 12 months.

4.18 FLAX BASED PRODUCTS (FLAX CHAPATI MIX, FLAX SWEET MIX, FLAX COOKIES MIX, FLAX TAMRICE MIX)

Flax seeds are a rich and the only source of omega fatty acids in plant origin and are good for brain functioning. Flax seeds are also a rich source of dietary fibre and protein.

Flax seed based products provide vitamins and minerals besides fibre and omega fatty acids. Consumption of 2 teaspoon/day is good for health for all ages and is promising for improved brain functioning and cardiac health. Since the consumption of seeds is not feasible, many products using flax seeds have been developed by DFRL. The clinical studies have provided the support for scientific evidence of benefits.

4.19 FLAX BASED SPICE POWDERS

Flax seeds are rich source of omega fatty acids and also the only with plant origin. It is good for brain functioning and cardiac health. Flax powder development and their stability are yet to reach the consumers base. Thus, DFRL has developed flax spice powders for routine use, and supply of omega fatty acids, providing various health benefits. Also, it improves dietary fibre and protein profile of the products where these spice powders are used. The constant use of these will help in maintaining good health.

4.20 PUFF & SERVE CHAPATIES

These partially-baked chapaties are stabilised by incorporating certain antimycotic, antistaling and softening agents. Baking over a flame or a hot plate puffs them & makes it ready to be served as hot phulkas. The process is fairly simple and adaptable by any small scale entrepreneur. A paraphernalia of operations entailing traditional kitchen drudgery stand eliminated in the preparation of a phulkas, when making use of this kind of chapati. An ideal preparation for any housewife, short on time and energy.

4.21 NAAN PREMIX

Preparation of Naan is a tedious and time consuming process which requires at least ten to fourteen hours for fermentation.

Naan premix developed at DFRL requires just two to three hours for fermentation and it is fortified with necessary vitamins and minerals as per RDI requirements.

4.22 DEHYDRATED CURRY MIX CAULIFLOWER-POTATO-PEAS

Development of the curry mix involves different dehydration techniques and pre-treatments, inclusive of additive treated cauliflower for subsequent cabinet drying, colour fixed green peas for high temperature short time dehydration and diced potato processing by HTST/cabinet dehydration/ deep fat frying techniques. The spice mix is in stabilized form to facilitate preparation of wholesome curry and the reconstitution time is approximately ten minutes. When reconstituted with hot water, this preparation of Indian culinary gives characteristic aroma, taste and texture of freshly prepared curry.

CATEGORY-B

4.23 MILLET RAGI BASED PRODUCTS

Ragi based products developed by DFRL to provide high calcium and dietary fibre in the diet. The specific millet called finger millet (ragi) is a antidiabetic too. The product provides high convenience such as ready to eat or cold water reconstitution.

These products are good for skeletal health because of high 200-300 mg calcium content. Good for easing constipation problem, controlling lipid profile because of 20% dietary fibre content. Constant use helps diabetic patients in controlling their disease.

4.24 MILLET DHOKLA MIX & MILLET BHATURA MIX

There are no convenient mixes available for fermented and millet products. Hence DFRL has developed millet based fermented products such as dhokla and bhatura that are handy and convenient for consumers. The products, dhokla and bhatura need fermentation time of three to five hours for their preparation to begin. However the convenience mixes developed can be prepared within half an hour without fermentation.

4.25 READY TO RECONSTITUTE FREEZE DRIED SHELF-STABLE RABRI POWDER

Availability of sweets & desserts is difficult in many services locations, far flung areas & high altitudes.

DFRL developed freeze dried ready to reconstitute shelf stable rabri powder having good quality characteristic in terms of microbiological, chemical and sensory attributes and stable under ambient temperature condition.

4.26 VEGETABLE NOODLES

Vegetablized noodles have been developed using 60-70% vegetables in a cereal based matrix along with hydrocolloids, salt, spices and other ingredients. The vegetables include potato, cauliflower, peas, carrot, spinach etc. Addition of vegetables increases the phyto-nutrient content in the noodles making the product healthy in nature. The noodles are available with spice mix formulation. The product requires 3-4 min cooking time in boiling water. The product is stable for a period of 3 months under ambient storage conditions.

4.27 STABILIZED VEGETABLE GRAVY CONCENTRATE

Specific gravy concentrates are prepared for instant use to make different Indian culinary preparations and stabilized using combination processing technology. Variants of gravy concentrates have been developed such as potato-peas, potato-cauliflower, paneer-peas, etc. The concentrates can be used for preparation of curries. The products are available in ready-to-cook form and have a shelf life of 9 months under ambient storage conditions.

4.28 BREAKFAST CEREALS BASED ON MILLETS


RAGI FLAKES


PEARL MILLET FLAKES

The process of simple & user friendly way of making healthy and nutritious breakfast cereals (flakes) based on millets (Finger millet, sorghum, and pearl millet) was developed by DFRL which can be adopted by pilot scale or cottage industry entrepreneur. Breakfast cereals are Ready-To-Eat in nature and can be taken either as snacks or can be served with milk, nuts, and dried fruits like muesli. Reconstitution time: 2-3 min in hot water/milk .These are light in weight and are easy to digest. The products are devoid of cholesterol and are gluten free hence suitable for gluten sensitive population inclusive for kids and old age people. It is economic and have benefits of dietary fibre (12.2%), resistant starch, iron (3.7mg%), and calcium (288 mg%) which establish them as better source of breakfast cereals in comparison to the commercially available corn flakes and other similar products.

4.29 COMPRESSED CURRY CUBES


Potato Peas Compressed Bar


Aloo Methi Compressed Bar

Wholesome compressed curry cubes have been developed comprising of spices, oil, salt, vegetables etc in compact form. Several variants of curry cubes are available. Curry can be prepared from the cubes by boiling in water for 5-6 min. The products are highly suitable as light weight operational rations. The products have a shelf life of 1 year under ambient storage conditions.

4.30 JIFFY UPMA MIX

The semolina based savoury dish Upma is very common breakfast food. To ease the difficulties in preparation of upma, the Jiffy Upma mix was developed by DFRL. Jiffy Upma mix gets reconstituted within 2-3 minutes on addition of hot water in closed container. Ingredients used for the preparation of Jiffy upma are sooji rava, hydrogenated fat, urad dhal, chenna dhal, curry leaves, mustard, coriander leaves, dried green chilli, salt and citric acid. Products were stable chemically, microbiologically & sensorily up to 12 months in metalized polyester pouch. Consumer gets all characteristic taste and flavour of home made upma.

4.31 JIFFY HALWA MIX

Semolina based Jiffy Halwa mix under RTR category was developed with basic aim of rapid reconstitution upon addition of hot water. Instant mixes requires minimum 5 minutes per 100g for reconstitution on simmering, whereas Jiffy Halwa mix takes 1 - 2 minutes for reconstitution upon pouring hot water. Ingredients are chiroti rava, hydrogenated fat and refined sugar, dry fruits and cardamom. Products were chemically microbiologically & sensorily accepted up to 12 months in metalized polyester pouch. The product scores very high on consumer acceptability scale.

CATEGORY-B

4.32 TOMATO PRODUCTS

Sauce and ketchups are generally made from tomatoes. Tomato pulp is converted in to sauce and ketchup forms with addition of spices, salt, sugar etc. The products are shelf stable for a period of 6 months under ambient storage conditions. Various tomato based products such as sauce, ketchup, chutney, shambhar paste, rasam paste etc. have been developed by DFRL for the benefit of tomato growers and processors.

****

5.0 READY TO RECONSTITUTE SOUP/BEVERAGES/ JUICE POWDER MIXES

5.1 APPETIZER BEVERAGES MIXES - SPICED DRINK MIX, SPICED TOMATO MIX & CHAKOTHA SOUP MIX

The ready to reconstitute convenient appetizer mixes have been developed by DFRL to address the problem of loss of appetite. The pungent and active component present in these mixes, on reconstitution, generates pleasant aroma and their consumption leads to secretion of juices in digestive tract and glands which in turn improves appetite. Various spices responsible for appetite improvement have been incorporated in the product. The shelf-life of the products is 6 months.

5.2 APPETIZING MIX, READY TO RECONSTITUTE IN COLD WATER

Appetite loss is a general symptom at high altitude areas and under certain medical conditions. The product developed by DFRL is a convenient mix to tackle the problem of lack of appetite. Being a ready to reconstitute, it is an excellent and easy to use product.

The spices present in the product solve the problem of appetite loss as well as stomach upset. The curd based multifunctional product helps in brain soothening. The product is cold water reconstitutable and has a shelf-life of 6 months. The product consumption improves the appetite and has been proven in human clinical trials.

5.3 FREEZE DRIED BEVERAGES

Freeze drying is the best method of water removal with final products of highest quality compared to other conventional drying methods. Freeze drying is the removal of moisture by the sublimation of frozen water from the product at low temperature and pressure conditions. Due to the absence of liquid water and low temperatures required for the process, most of the deterioration and microbiological reactions are stopped which gives a final product of excellent quality. Freeze drying of foods decrease the water activity (aw) and thereby increase the shelf stability.

Various ready-to-reconstitute (RTR) and ready-to-serve (RTS) fruit juices and functional juice mixes were developed based on FD technology like mango juice powder, pineapple juice powder, grape juice powder, mango milk shake powder, carrot muskmelon juice powder, whey protein enriched grape juice powder, high protein pineapple lassi powder and probiotic pineapple lassi powder. The products are stable up to 1 year below 35.0 % relative humidity. Product can be reconstituted and prepared instantly by adding 150 ml of water to 30g of freeze dried juice powder/beverages.

5.4 FREEZE DRIED MANGO MILK SHAKE

Freeze dried fruit drinks serve as a natural source for delivering functional components. Techniques employed for processing fruit and vegetables often result in significant loss of colour, flavour and nutrients. Freeze drying technology eliminates the need for synthetic colouring and flavouring and also provides functional components.

Considering these, DFRL developed ready-to-reconstitute freeze dried mango milk shakes which can deliver the RDA level of ascorbic acid and & Beta-carotene.

This fruit and milk based product provides the micro and macro nutrients which are essential for troops deployed at high altitudes. It provides ascorbic acid and & Beta - carotene which is necessary for the physiological and psychological well being of the troops located at high altitudes.

5.5 BEET ROOT JUICE POWDER

The vegetable juices are good source of minor nutrients and functional properties with higher assimilation into the body. The color of the beet root juice is very native and it has a good flavour. But the juice as such shows colour degradation, while in dehydrated form the colour remains stable for twelve months. It is a cold water reconstituted product. The improved grade of haemoglobin in human subjects has been proved through clinical trials.

CATEGORY-B

5.6 MORINGA PRODUCTS SOUP MIXES & BEVERAGES

Moringa is popularly known as 'drumstick' and the leaves and pods are extremely nutritious in terms of vital nutrients and minerals. The commodity has potential health benefits and therefore are very popular as a delicacy besides the health benefits. The technology involves processing of leaves and pods and formulation of a soup mix with suitable thickening agents and spicing. The reconstitution is instant in warm water and the product is shelf stable for a period of six months under ambient conditions.

5.7 SEABUCKTHORN BASED SPICED SQUASH

Oxidative stress is the initialisation of the onset of many degenerative diseases. The seabuckthorn based spiced squash developed by DFRL which is capable of reducing incidents of oxidative stress. The squash is shelf-stable for more than eight months and rich in vitamin C and minor amounts of spice principle and other antioxidants.

The seabuckthorn based spiced squash is spiced with locally available spices. The squash is unique in nature as it is enriched with ascorbic acid and phenols. Hence, it is good in tackling the problem associated with stressful situations.

5.8 SEABUCKTHORN BASED HERBAL TEA

Daily intake of fried foods, high fat foods, environmental and physical stress leads to the development of oxidative stress. Oxidative stress is an initial step towards the development of many degenerative diseases. The herbal tea developed using seabuckthorn leaves and locally available herbs and spices reduces the onset of oxidative stress as evidenced by experiments conducted in rats.

The tea is rich in polyphenols, flavonids, spices and other natural antioxidants. The tea is refreshing, stimulating and stress relieving apart from being a thirst quencher.

5.9 SPRAY DRIED FRUIT/BEGETABLE JUICE POWDER

Fruit and vegetable based instant juice powder mix developed are light weight in nature and can be easily reconstituted in water to yield a refreshing beverage. The juice powders have excellent sensory attributes as well as reconstitution characteristics. The products include orange, pineapple, mango, papaya, grapes beetroot, carrot, etc. The products offer admirable convenience and are stable for a period of 1 year under ambient storage conditions.

5.10 READY TO RECONSTITUTE COFFEE MIX

Instant coffee mix was developed by optimal blending of coffee powder, sugar, non-nutritive sweetener, milk powder etc. Specific blends of coffee extracts, sugar, milk powder, non-nutritive sweetener, herbal extracts, etc. are made and the product is standardized as per the requirement of specific consumer group. The product offers convenience and can be reconstituted with in a min in hot water to yield superb coffee ready for drinking. The product has a shelf life of 3 months under ambient storage conditions.

****

CATEGORY-B

6.0 READY TO DRINK JUICE & BEVERAGES

6.1 ALOE PASSION DRINK

Anxiety is debilitating state of mind. It has emerged to be a common psychiatric manifestation of modern day lifestyle. Herbal anxiolyte as curative agents promise to alleviate anxiety and other pscychiatric disorders with minimal adverse side effects. *Passiflora edulis var flavicarpa* commonly called passion fruit is relished for its taste throughout the world and has been attributed as good food for health. The aloe passion drink developed by DFRL has anxiolytic and sedative properties.

6.2 BRAHMI DRINK

"Brahmi herbal drink" (BHD), an anti-fatigue and neuroprotective was developed from the herb *Bacopa monniera*. The major active components present in the drink are bacosides. Pre-clinical studies conducted showed the ergogenic efficacy of BHD is due to adaptogenic and antioxidant potency of bacosides. The drink facilitates learning, improves consolidation of learned behaviour and cognitive-enhancing propensity by modulating the expression of acetylcholine esterase activity, brain derived neurotropic factor and muscarnic M1 receptors.

6.3 ALOE VERA JUICE

Natural antidiabetics without toxicity and less cost are necessary to reduce side effects of allopathic drugs. Low calorie aloe juice reduces blood sugar, enhances nutrient absorption, heals wounds very fast, is anti-inflammatory and antimicrobial in nature.

The juice has many complex polysaccharides that reduces blood sugar and has many bioactive compounds and amino acids that inhibit arthritis problems, enhances wound healing, stimulates blood circulation, induces sleep and reduces urination at nights.

6.4 NONI - BASED RTS BEVERAGE

Noni *Morinda citrifolic* is a non conventional, under utilized, non-table fruit which is very rich in various polyphenolic, antioxidant and neutraceutical principals. However, ripe Noni fruit has a typical butyric offensive odour which restricts its usage as table fruit despite its numerous health benefiting and restorative properties. The utilization of Noni fruit; thus, demanded innovating a process that could effectively mask the unacceptable odour of ripe Noni fruit in order to develop consumer acceptable value added products from it.

6.5 BETEL LEAF JUICE

Betel leaves have digestive property and are a good source of carotenoids, vitamins and minerals. However, constant chewing of leaves can have certain undesirable effects in the mouth and therefore juice form serves as a good alternative. The product is a ready to serve juice, which helps in regular digestion of food, particularly after a heavy meal. It has a shelf life of four months and can also be commercialized in sachets.

6.6 PERFORMANCE ENHANCEMENT DRINK

Aloe vera is known since ages for its health benefits. It is known to increase the blood circulation, helping supply of nutrients to cells, and thus enhancing the nutrient absorption across the endothelial cells to blood stream. These two properties have been utilized for developing Aloe vera-based pomegranate/pineapple drink to enhance the physical performance. The product has been tested for its performance enhancing properties in rats, which were allowed to swim until exhaustion, and has been found to reduce lactic acid accumulation in muscle, thereby reducing the muscle 'Catch' during heavy exercise.

CATEGORY-B

6.7 VEGETABLE JUICES - ASH GOURD JUICE, ASH GOURD PUDINA JUICE, CUCUMBER JUICE, BOTTLE GOURD JUICE


Cucumber Juice


Ashgourd Pudina Juice


Bottlegourd Pudina Juice

The vegetable juices are rich in variety of nutrients. The vegetable juice consumption provides the vital nutrients and fibre to the body apart from energy, thus helping in health maintainance by fulfilling the bodily requirement of micronutrients.

Ash gourd juice is rich in B-series vitamins and souble fibre. Ash gourd juice consumption has proved the benefits of mineral balance, antigastric through clinical trials. Cucumber juice provides both soluble fibre and digestiveness.

6.8 FERMENTED VEGETABLE BEVERAGES - ASHGOURD FERMENTED BEVERAGE, CUCUMBER FERMENTED BEVERAGE, CUCUMBER MINT FERMENTED BEVERAGE


Ashgourd Fermented Beverage


Cucumber Fermented Beverage


Cucumber Mint Fermented Beverage

Vegetable juices are susceptible to spoilage, thus to preserve them controlled fermentation and stabilization is required. Fermentation is an age old method of preservation. Fermentation improves digestibility, nutrient content, and functional properties in terms of increase in anti- oxidants and phenolics. However, there is a need for optimization of the process. By using the fermentation techniques DFRL developed shelf stable fermented vegetable juices based on ashgourd, cucumber, mint etc., with less than 5% alcohol.

6.9 GINGER BEVERAGE, AJWAIN BEVERAGE & KARPURAVALLI BEVERAGE

Loss of appetite is one of the major problems faced at high altitudes. In addition the problem of nausea and flatulence is also persistant. In order to overcome above said problems, DFRL has developed these products that are refreshing and have a shelf life of six months. At high altitudes, liquid form of carbohydrate based drinks are preferred. These products serve as beverage, and also satisfy appetite.

6.10 FRUIT JUICE BLENDED TENDER COCONUT WATER

Tender coconut water RTS in fruit flavours

Fruit juice blended tender coconut water is a delicious health drink and can be highly useful for prophylactic purposes and also as a hospital based beverage besides catering to the requirements of sports including rallies and expeditions. Optimal blending of tender coconut water and different fruit juices is based on sensory attributes and also process requirements. Tender coconut water was blended with different fruit juices, i.e. lemon, mango, pineapple, blue grapes, apple, pomegranate, etc. to increase the palatability as plain tender coconut water has bland taste. The process in the form of controlled thermal treatment works in a manner which is suitable for beverages with specific pH values and soluble solids. The blending is based on selection of commodities with vital nutrients which can be stabilized in the modulated biochemical profile of the beverage concerned. The products are highly acceptable with a shelf-life of 9 months under packed conditions at ambient temperature.

CATEGORY-B

6.11 NATA IN FRUIT VEGETABLE JUICE

Bacterial cellulose obtained from *Gluconactobacter xylinus* is a dietary fiber and used as food additives in developed countries in various forms. A bioprocess technology has been developed for cost-effective product of bacterial cellulose and have been used in fruit juices and beverages. The bacterial cellulose in the form of cellulose cubes is mixed with beverages and fruit juices and consumed as nata. Addition of bacterial cellulose pulp upto 50 percent on wet weight basis does not affect the flavour and taste of the product but improves its texture. The cellulose containing fruit juices are stable up to 6 months at ambient temperature.

6.12 FRUIT BLENDED NONI RTS BEVERAGES (AMLA & PINEAPPLE, ETC)

Noni based ready-to-serve (RTS) beverages have been developed. Various fruit juices have been blended in optimal quantities to mask the off-flavour of noni along with TSS and pH adjustments to give good quality product. The products have a shelf life of 6 months under ambient storage conditions.

6.13 PRESERVED SUGARCANE JUICE

Sugarcane juice has been preserved in ready-to-drink form in stand-up pouches/polymeric bottles and polymeric bottles and stabilized using thermal processing technology. Sugarcane juice has been blended with optimal levels of fruit juices/herbal extracts/condiment extracts followed by addition of chemical additives. The product was stabilized using thermal processing technology. The technology is simple and low cost in nature and is suitable for small scale entrepreneurs. The product has a shelf life of 30 days under ambient storage conditions.

6.14 FRUIT BEVERAGES (WATERMELON, MELONS, PAPAYA, MANGO, LEMON, GRAPES, POMEGRANATE, PINEAPPLE)

Fruits beverages are relished due to their refreshing and nutritional properties. Several fruit juices such as watermelon, melons, papaya, mango, lemon, pineapple, grapes, pomegranate, etc. have been developed and stabilised using pasteurization treatment. The products are highly acceptable and possess excellent sensory attributes. The beverages are also available with suspended pulp/fruit pieces to give the mouthfeel of the actual fruit. The products have shelf life of 6 months under ambient storage conditions.

6.15 HIGH PRESSURED PROCESSED JUICES

High pressure processing is a novel non-thermal processing technique used for preservation of food products. The advantage of high pressure processing over conventional thermal processing is retention of natural characteristics such as colour, aroma etc. of the commodity including nutritional attributes. Several fruit juices such as pineapple, apple, mango, pomegranate, grapes etc. including coconut water have been stabilized using high pressure technology. The products have a shelf life of 2-3 months under low storage temperature conditions.

****

CATEGORY-B

7.0 FOOD PRESERVATIVES

7.1 KEEP FRESH SALT

The peroxidation of lipid/fat in processed food is the main cause for the development of off flavour which is the limiting factor in determining the shelf life of the products, though the nutritive value remains same, to the acceptable level. Addition of permitted synthetic antioxidants delays the onset of rancidity but their efficacy depends on frying temperature, duration, volatility and their carry over properties. At high temperature of processing, antioxidant loss takes place due to degradation leads to the onset of rancidity.

DFRL has developed this salt, coated with antioxidant which could be used at 2% level which is sufficient to take care of the onset of rancidity.

7.2 PRESERVATIVE MIXTURE

Chapaties are perishable and get spoiled within 24-48 hours due to mirobiological spoilage. Thus, DFRL has developed preservative mixture, formulated with permitted preservatives. By using these preservatives chapaties shelf-life can be extended for 10 to 15 days.

7.3 BIOPRESERVATIVE FOR EXTENDING SHELF-LIFE OF FRESH MUTTON AT ROOM TEMPERATURE

At present, no technology is available for preservation of fresh mutton without the use of chemical preservative.

DFRL has addressed the problem by identifying and applying an edible preservative viz. pomegranate peel extract which enhances the shelf-life of fresh mutton up to four days at ambient conditions.

This biopreservative, thus increases the shelf-life of mutton beyond twenty hours. The technology is highly useful for meat industry for improving the shelf-life of fresh mutton without chilling.

****

CATEGORY-B

8.0 DETECTION KITS

8.1 MEAT TESTING KIT FOR DETECTION OF COLD SLAUGHTERED MEAT & MICROBIAL QUALITY

Simple test based on the colour reaction between haemoglobin and malachite green was standardized and a field test kit was developed to detect cold slaughtered meat within 5 minutes. The test kit contains the dye coated strips, screw capped bottle/tubes, small knife and forceps. One dye coated strip is added in to the bottle containing about 10 ml of potable water and a small piece of meat to be tested (approx 1-2g) and shaken well. In 2 minutes colour of water changes from blue to olive-green (dirty green) which changes to colorless and finally pink when kept for long period, if the meat is from dead or dying animal due to some infection or disease. This test could be performed under field conditions requiring no lab facility and skilled/trained worker.

8.2 MILK TESTING KIT FOR DETECTION OF ADULTERATION & MICROBIAL QUALITY

Strip based testing kit to detect the presence of added adulterants like urea, boric acid, pulverized soap, detergents, hydrogen peroxide, starch and neutralizers. It also provides strips to detect the microbial freshness of milk to screen spoilage index. Use of the test strip is very handy and never raises the problem of spilling of chemical or reagents on the users. It has the ease of application from house hold to field level use of services. Test results are easily distinguishable by observing the color change in the samples. Most of the test strips can detect an adulteration level at less than 1.0% and are stable up to one year at room temperature conditions.

8.3 FROZEN/CHILLED MUTTON/CHICKEN TESTING KIT

Meat being highly nutritious consists of protein, fat, vitamins, minerals with relatively high moisture content. It is prone to various chemical changes resulting in deterioration of meat quality. It also provides an excellent platform for growth of various micro organisms resulting in spoilage. To assess the Microbiological spoilage of meat or any other food stuff, the widely used index is the Standard Plate Count (SPC). It provides a means of measuring the composite microbial population in foods. The conventional method of counting colonies (SPC) on solid medium requires 24-48 hours. It is not useful in determining the microbial quality of frozen meat since it consumes more time. There is a wide choice of new procedures available for the rapid determination of microbial numbers. These techniques require sophisticated and sensitive instrumentation, considerable support facilities and skilled/trained staff.

To assess and screen the microbiological quality of frozen/chilled mutton/chicken chemically treated paper based test strips were developed based on principle of dye reduction. The results are easy to interpret within 30 minute. The test is simple, does not require sophisticated laboratory facilities and can be performed by unskilled persons under field conditions. The test is inexpensive compared to conventional methods and other modern techniques. The developed strips are stable for more than nine months. The test kit has been validated by NABL accredited laboratory.

8.4 SALMONELLA TESTING KIT

Rapid, reliable and low cost identification for important enterobacteriaceae organisms, namely, *Salmonella, Shigella, E. coli and Proteus* species.

Involves specific monoclonal antibodies and a few easy to do biochemical tests. The kit has been independently evaluated in three different medical colleges located in various parts of Karnataka with satisfactory reports.

The test cab be conducted within 3 hrs instead of 3-5 days by the conventional procedures. It is Highly economical, and cost per test – Rs. 25/- and no skilled man power is required to perform the test.

8.5 SHIGELLA SPS, ESCHERICHIA COLI DETECTION KIT

The Enterobacteriaceae are a large family of bacteria, including highly potent pathogens, such as *Salmonella, Shigella, Escherichia coli* and *Proteus* having the capacity to cause serious diseases. Conventional methodologies for identifying these pathogens are tedious and would need five days to achieve the results. Commercial kits available for detection are highly expensive, needs to be imported and these kits can detect only one organism at a time. The test kit developed at DFRL, detects Shigella genus, entire *E. coli* group along with Proteus spp. simultaneously, employing monoclonal antibody based simple dot ELISA and a set of four biochemical tests namely, Indole, Urease production, KOH string and Oxidase test. It is reliable, simple, takes three hours to produce results and is relatively inexpensive. This test system has been tested with number of reference strains, isolates and clinical samples. Third party evaluation of this kit was done at three medical colleges of Karnataka with satisfactory reports.

CATEGORY-B

9.0 PROCESS / OTHER TECHNOLOGIES

9.1 MINIMALLY PROCESSED VEGETABLES IN PRECUT & PACKAGED FORM

Minimally Processed Vegetables in Precut and Packaged Form

Minimal processing protocols for fourteen types of vegetables i.e., carrot, cauliflower, cabbage, potato, radish, capsicum etc., are included in the technical package. The additive based technology, with nil to minimal use of heat processing, yields fresh-like products with a shelf-life of two weeks under ambient and six to eight weeks under low temperature conditions. The products minimise kitchen drudgery besides reducing the packaging and transportation costs due to the elimination of incredible portions. The products, as a result of inbuilt ability to withstand ambient temperatures, offer marketing flexibility, under varied temperature conditions at the retail outlets. The energy saving technology is suitable for small scale/rural industry.

9.2 STANDARDIZATION OF PROCESS FOR MAKING MILK PANEER & ENHANCEMENT OF ITS SHELF-LIFE

This process has been developed to enhance the shelf life of paneer with respect to standardization of paneer preparation and to study the physico-chemical, microbiological and sensory attributes and raw material treatment with different hurdle treatments.

Different treatments were given to paneer, like addition of preservatives, salt and sorbic acid, surface drying, vaccum packing and inpack pasteurization. In most of the treatments a combination of all the above were given to establish the shelf-life enhancement.

9.3 SHELLAC COATING

India produces and exports a large quantity of shellac. However, there is no commercial shellac based surface coating available for the purpose of coating of fruits and vegetables for extending their shelf life. The waxol based coatings have number of disadvantages such as non-uniform nature, incidence of anaerobiosis within the fruits, long drying times etc.

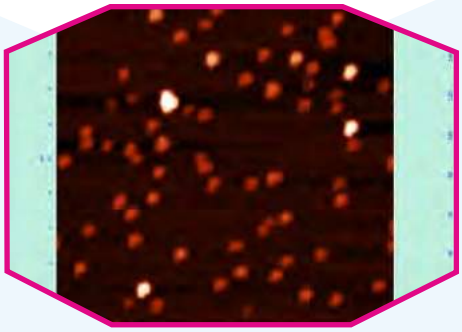
Shellac is soluble in specific solvents at specific pH and temperature conditions. Stock solution in aqueous form is prepared at higher concentrations and diluted to the required level depending on the commodity for application as a surface coating. The formulation also consists of hydrocolloid suspension, emulsifying and thickening agents for use as a surface coating.

9.4 STACK ENCAPSULATION TECHNIQUE

Sugar and salt are highly hygroscopic in nature, and if not packed or preserved properly absorb moisture and start drifting/dripping especially in coastal/high humid region. Similarly cereals and pulses, if not stored in proper way, absorb moisture and get infested leading to tremendous loss and becomes unacceptable.

A simple innovative stack encapsulation technique has been developed by using polyethylene film 400-700 guage with permitted fumigants which completely prevents moisture ingress and infestation. This technique can be used with and without fumigation of products.

9.5 PROCESS FOR BACTERIAL CELLULOSE PRODUCTION



Bacterial cellulose is produced by *Acetobacter xylinum*. The microorganisms can utilize a wide range of carbon and nitrogen sources for cellulose production. The cellulose thus produced is purer and structurally different from the cellulose of plant origin. Due to their biological origin they are invariably biodegradable, very much sought after to substitute the current recalcitrant and xenobiotic materials prepared from petrochemicals.This biopolymer has several practical implications in biotechnology and other fields of biomedical sciences. The production of bacterial cellulose has been carried out up to the volume of 500 liters using plastic containers in a repeated manner. Preparation of cost effective media for the production of bacterial cellulose has been studied without using commercially available yeast extract. Soft cellulose (Nata) was used as beverage additive. Furthermore, the bacterial cellulose is produced in soft form in substantial quantities in five litre bottles for use as nata in combination with various fruit juices.

9.6 PRODUCTION OF LACTIC ACID BACTERIUM AS β - GALACTOSIDASE SOURCES

Lactic acid bacteria are predominantly used as probiotic bacteria to improve the intestinal health of human beings and some farm animals woldwide. The bacteria are also widely used for the producion of beta-galactosidase (lactase) for the hydrolysis of lactose, a disaccharide, in milk. Beta-galactosidase is an enzyme which can convert lactose into glucose and galactose moieties. Hydrolysis of lactose is essential from medical, environmental and food technological angles. Many adults and children can not digest milk sugar and therefore develop complications generally known as lactose intolerance. Extraction and use of this enzyme from lactic acid bacteria can give a solution to the problem. The process for the growth of β- galactosidase producing lactic acid bacteria, extraction of enzyme and its immobilization for lactose hydrolysis in milk has been demonstrated. Therefore the reproducible growth of lactic acid bacteria in a culture medium is essential from biotechnology point of view. Practically, the growth of lactic acid bacteria is affected by viral infections and the quantity of bacterial biomass obtained varies from batch to batch. Moreover the media ingredients used for the growh of lactic acid bacteria mainly comprise of beef extract and peptone which are not acceptable to the Indian population.

In view of these problems a growth medium for lactic acid bacteria production has been developed comprising of soypeptone and soybean meal for food applications as well as for probiotic use in human consumption. Moreover the growth media has been modified to reduce phage (virus) infection to obtain reproducible amounts of lactic acid bacteria biomass, since the bacteria was grown using plant based ingredients the enzyme extracted is suitable for Indian population. The technology mentioned is useful for the production of probiotic bacteria as well as the enzyme beta-galactosidase in a cost effective acceptable manner. Using this technology it is possible to obtain a substantial amount of bacterial biomass for probiotic use and for enzyme extraction.

CATEGORY-B

9.7 ETHYLENE ABSORBING FORMULATIONS FOR SHELF-LIFE EXTENSION OF FRUITS & VEGETABLES

Extending the shelf life of fresh fruits and vegetables requires a multi-facet approach in which generation of ethylene free atmosphere is of high importance. Sealed pouches and air-tight containers containing bulk stored fruits and vegetables tend to accumulate ethylene and ethylene being a ripening hormone promotes the ripening of fruits and senescence of vegetables. In order to make the storage atmosphere free from ethylene, suitable chemical formulation is required. Electronic gadgets which are imported can be used for scavenging of ethylene but they require continuous power supply and they can not be used in smaller containers and pouches. Potassium permanganate is a highly reactive substance and it requires impregnation in suitable inorganic matrix for its ethylene scavenging ability. The pH of the matrix shall be ideal for ethylene trapping and subsequent oxidation. Another feature as a requirement of the matrix is to have sufficient porosity within the granules to allow optimal trapping and oxidation of ethylene. The matrix shall also be firm enough to avoid powdering and to keep the active principle permanganate in diffused state without crystallization for utilization in the oxidation process of ethylene. The solution necessarily incorporates all the above features and the formulation could be fabricated further in the form of filter blankets and sachets for use in reefer containers and prepackaged pouches respectively.

9.8 PRESERVATION TECHNOLOGY FOR GINGER PASTE, GARLIC PASTE & COMBINATION THEREOF

Ginger and garlic are the basic ingredients of Indian kitchens/ culinary houses routine basis. These are used in the form of pastes of different particle size and blends depending upon the end product. The process involves the cleaning, sorting, de-skinning, pulverizing, blending, pasteurization and packing. The products have a shelf life of 3-6 months based on the blending and packing methodology. The standardized process retains the characteristic flavor of the product. The advantages of these products are it's readily availability in the cooking area and removal of kitchen drudgery for processing of specific dishes which saves time in defence as well as civilian kitchens. The product can be packed in PP bottles/jars and flexible pouches.

9.9 PRESERVATION TECHNOLOGY OF TAMARIND CHUTNEY

Tamarind chutney is a shelf stable ready-to use convenient product. The tamarind chutney is consumed as adjunct with many popular Indian snacks such as samosa, Kachori, Pani-puri, Dhokla etc. The chutney preparation is a simple process with jaggery and spice and is stabilized using thermal processing. The chutney recipe can be altered to suit the compatibility with the product with which is being served.The technological steps involved are cleaning, grinding /blending, packing, and pasteurization. The product can be packed in PP bottles/jars and flexible pouches with a shelf life varying from 4-6 months. The chutney holds high marketing potential due to its versatile applications.

9.10 EDIBLE CUTLERY

Edible cutlery has been developed in the form spoons, fork soup spoons using food materials such as Starch and fibers. Edible cutlery can be made to impart taste & texture using different flavour and colour with food ingredients of plants origin. Edible cutlery can be made with varied composition and are biodegradable and environment friendly. The edible cutlery can with stand moisture up to 30-40 minutes. The products are shelf stable for a period of 12 months and can be used in all climatic condition.

9.11 STABILIZED CONDIMENT PASTES

Ginger Paste

Garlic Paste

Several condiments such as ginger, garlic, onion, coriander, chilli, etc. have been stabilized in ready-to-use form. The products are available as such or in combination. The products have been stabilized using combination processing technique and they offer excellent convenience in culinary preparations. The products have a shelf life of 3 months under ambient storage conditions.

9.12 ENVIRONMENTALLY DEGRADABLE FILMS

Low-density polyethylene (LDPE) is one of the most commonly used commodity plastic for food packaging applications. Biodegradability of this material is quite limited and due to its ever increasing use, accumulation & pollution occurring on earth at alarming levels. Considering the wide use of LDPE films and the magnitude of the environmental problem caused by such materials, need for environmentally degradable LDPE film is extremely important to avoid the serious threat of environmental pollution.

DFRL developed a LDPE based environmentally degradable packaging materials by incorporating a combination of biodegradable and photodegradable additives into LDPE. The addition of biodegradable additives into LDPE enables the microorganisms in the environment to degrade a portion of the additive, while the photodegradable additives results in chemical oxidation of the polymer chains triggered by UV irradiation or heat exposure. The combined effect of these additives lead to fragmentation and subsequent conversion of visible plastic contaminants into very small fragments, which reduces the environmental waste problems.

****

CATEGORY-B

10.0 DESIGNS & MACHINERY

10.1 BIOSYNTHESIS REACTOR

India's agricultural production base is quite strong but at the same time wastage of agricultural produce is massive. If the industry can adopt better/improved packaging techniques at farm level, the transportation losses could be reduced and at the same time, freshness of the products can be maintained. Presently, synthetic imported films are being used to control the respiration in Modified Atmosphere Packing (MAP). Traditionally fruits and vegetables were coated with wax and shellac containing pesticides which are not eco-friendly.

DFRL has invented a biosynthesis reactor to develop different emulsion formulations of biopolymers and bio-preservatives for packing, and coating to enhance shelf life of fresh produce. The capacity of reactor is upto 25 litres and has an automatic power pack. The parameters such as temperature, pressure, torque, agitation speed, feed rate & rotation with inert atmosphere can be optimized depending on the biopolymers to be synthesized. The operating system is portable, reduces labour requirement and the cost of processing. The system is suitable and provides opportunities for adding value to agricultural biopolymers which are abundantly available in nature as proteins of plant/animal or as by-products of the food processing industry thereby significantly reducing the environmental impact of synthetic film and health hazards. This biosynthesis reactor has been developed in order to develop and process different formulations of biopolymers and bio preservatives for applications in food technology.

10.2 DESIGN FOR RETORT/STERILISER PROCESSING OF LIQUID, SEMI-SOLID & SOLID FOOD PRODUCTS

Thermal processing of foods in rigid, semi-rigid and flexible packaging system is the most acceptable form of food preservation. It represents a unique combination of packaging, process and product technologies with potential functional, quality and economic benefits. The increasing consumer awareness and unwillingness to accept other methods of food preservation like chemical preservation, irradiation, etc., has offered a vast scope for thermal processing of foods.

In this retort, the pressure at 120^{0}C is about 15 P_{sig} pounds per square inch gauge and over pressure during processing is required to maintain the integrity of pouches and counterbalance the buildup of pressure inside the pouch due to limited resistance of internal pressure inside these packages.

In order to evaluate the process efficiency of the newly developed retort, products such as potable water, sooji halwa, vegetable pulav and potato-peas curry were packed in multilayer flexible packaging material processed as per method prescribed by American Society for Testing and Materials (ASTM). The microbiological quality tests of the products packed both in flexible pouches and aluminium cans confirmed the commercial sterility of the products. The sensory analysis had substantiated the overall acceptability attributes of the products. Hence, it is evident that the newly designed retort is effective in processing of various food products and has various advantages.

CATEGORY-B

10.3 DESIGN FOR IMMOBILIZED ENZYME REACTOR SYSTEM

The hydrolysis of lactose is desirable to overcome the problem of its moderate solubility in concentrated milk products and to ensure its easy digestion for cases of lactose intolerant infants and adults. DFRL has designed and fabricated a bioreactor to make the hydrolysis of the lactose a cost effective, novel and simple to operate method either in batch or continuous mode. The biocatalyst, if reused for several times, can contribute in improving the cost-benefit ratio. The lactose hydrolysis is carried out either at 5-15^{0}C or 35^{0}C to drastically reduce the microbial contamination in the bioreactor developed. The bioreactor can hold immobilized enzyme/whole cell catalysts at high density and varying operational temperatures.

This bioreactor is able to retain immobilized biocatalysts prepared in form of granules, blocks, or fibrous materials. The instrument can provide long term mechanical and biochemical stability to immobilized enzyme preparations and effective hydrolysis of lactose in closed loop. The system achieved hydrolysis purity of 98% in milk. The economy and process efficiency of lactose hydrolysis in milk improved using this continuous flow bioreactor. The technology is economical and microbiologically safe.

10.4 NOVEL MOULD DESIGN FOR RETORT PROCESSING OF LIQUID, SEMI-SOLID & SOLID FOOD PRODUCTS

Retort processing is the most acceptable form of food preservation for ready to eat food products. It represents a unique combination of package, process and product technologies with potential, functional, quality and economic benefits. It requires just warming in a microwave oven or water bath before eating. It can be classified as light weight, flexible laminated food package that maintains shelf-life, texture and nutritive value of food. A significant advantage of this invention is that it provides an easy-open aluminum mould for flexi-pouches to maintain excellent structural integrity of individual pouches, better heat transfer, stackability to counterbalance the builtup internal pressure of pouch during retort processing.

10.5 FRESH CURD MAKER

The army personnel deployed in high altitudes and extreme altitude environments are not getting fresh wholesome curd in their regular menu. At high altitudes where the temperatures are sub-zero, curdling of milk at low temperatures are impossible. Therefore DFRL-DRDO has developed a system for making fresh curd working at very low electrical energy successfully at high altitudes and at sub-zero temperature. The equipment prepares fresh curd of 5 to 10 litre capacity within four hours at operational voltage of 220 V AC +/- 10% , 3A , single phase.

10.6 DIGITALIZED HOT PLATES FOR SHIP GALLEYS

DFRL-DRDO has developed an industrial compliance EMF cooking system wherein EMF is induced to stainless steel vessel without heating the environment. The system designed reduces ambient heat of the cookhouse/ship galley and restricts to the place where the utensil kept for cooking. The system reduces fatigue of the galley staff and occupational hazards significantly. This system faster cooking of heterogeneous food products with heating area of heating area of 12 inches X 12 inches (capacity / size as per requirement).

10.7 ON-LINE CONDITIONING SYSTEM

On-Line Conditioner (Isometric View)

In the development of processed foods, the on-line conditioner has its place in conditioning of dal and rice prior to flaking, and vegetables prior to frying. Also with the adjustable air flow and temperature management, it can also be used for drying of vegetables or cereals to overcome thermal abuse during conventional dehydration. It is also a very convenient method for drying heat sensitive food materials as it prevents their overheating due to mixing. From energy and environmental viewpoints as well as the global requirement to feed the growing population, it is very important to improve the conditioning techniques to reduce spoilage and enhance the keeping quality of the product.

At present conditioning of the products is a manual operation and automation will quicken the process and make it more economical. Hence, an effort has been made to design 750Kg/hr capacity on-line conditioning equipment for agro-products. This operator friendly equipment has been engineered with controlled temperature, air velocity, product movement and an auto loading and delivery system.

****

DEFENCE FOOD RESEARCH LABORATORY

Defence Research & Development Oraganization (DRDO)
Ministry of Defence, Siddarthanagar, Mysuru - 570 011
Ph : 0821 - 2473783, 2579601, 2579600, Fax : 0821-2473468
email : director@dfrl.drdo.in
head.tt@dfrl.drdo.in