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

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“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, 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 the 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 stability and microbiological safety. Over the years, more than 454 technology transfers have been done to about 261 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. Some of them are running 100% EOU industries. 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.

DIRECTOR
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 dt 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.

READY TO EAT (RTE) AND 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.
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.

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.
PRESERVED AND FLAVOURED CHAPATIES

The technological measures employed to preserve and stabilise this popular Indian wheat-based staple includes certain preservatives and thermal treatment along with 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 mission undertaken on land and sea.

PUFF AND 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.

GREEN LEAFY VEGETABLE CHAPATIES/PAROTHAS

Chapaties are regularly consumed and staple diet of Indians. Green leafy vegetables are rich source of vitamins, minerals and dietary fibre. DFRL has developed green leafy vegetable chapati 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.
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.

SPICED POTATO PARATHAS

Incorporation of spiced potato mix into the dough and, thermal as well as preservative regimes of stabilization process is the 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.

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.
FIBRE RICH BISIBELE BHATH AND FIBRE RICH VEGETABLE PULAV

The presence of dietary fibres in food have physiological benefits. They give relief from constipation and haemoloidate. 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.

HOLIBITE

DFRL has developed this instant energy 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 Kcals per 30g capsule. Four to six capsules are good enough for managing emergency situations. A product containing 70% honey is yet to be unheard of. It has also been proven in this product.

KARPURAVALLI MUNCH

Karpuravalli munch is a Ready-to-eat (RTE) appetizer based on spice combinations. It is sweet & sour in taste with Karpuravalli juice extract.

Karpurvalli which is having medicinal effect and distinct flavor helps in relieving the cough and cold. It helps in digestion & thereby improve the appetite with Shelf-life of 12 months.
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.

READY-TO-EAT PALAK DAL CURRY

The RTE Palak dhal curry which is stable at room temperature for one month was developed by inpack sterilization process. The process is simple and requires low capital investment of 10 – 15 lakh for 100 Kg/day production. The product is cost effective and useful for the government feeding programme. The product can be warmed in the pack or the content of the pack can be transferred to a vessel and warmed for the consumption. The product is rich in vitamins, minerals and protein as it is prepared by using green vegetable palak and pulses. The technology of the product has been given to the industry for Dhal-Roti project.

READY-TO-EAT WHOLE CHANNA MASALA

The Channa or Bengal gram is widely consumed pulse and rich in protein and minerals. The Channa curry is highly relished dish and consumed along with Chapati or rice. The shelf stable RTE Channa curry based on inpack sterilization process was developed which can be shelf stable for a month at room temperature. The product is highly liked by the consumer with respect to sensory characteristics. The process of RTE Channa curry is simple and cost effective. The technology of the product has been given to the industry for Dhal-roti project. The product can be prepared on small scale/cottage industry within 10 – 15 lakhs capital investment for 100 kg/day production. The product is rich in protein, vitamins and minerals.
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 microbiologically 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.

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.

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.
SOY SHIRKHAND

The Soya Shrikhand is based on soyabean and it is rich in soya-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 soya shrikhand is free from cholesterol. It is a rich source of bifideous micro flora, which is good for digestion and sound gut health.

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, stabilized by hurdle concept for storage at ambient temperature. The process is based on combination of slight reduction in moisture, water activity, lowering of PH and thermal treatment.

SWEETCORN PRODUCTS STABILIZED KERNELS AND 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 low temperature 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.
SWEETENED & FUNCTIONAL RAGI

It is a ready-to-eat & flavourful product based on Ragi. Ragi being a good source of iron & calcium, the product is very much useful in the improvement of blood (Haemoglobin) and calcium status for children & women who usually get anaemia/bone related disorders. This mix can be reconstituted in cold water and the shelf-life of the product is 6 months.

SPICED MILLET (RAGI)

This mix is rich in iron, calcium, fibre, minerals and vitamins. It is a cold water reconstituted product which is ready to eat. It is a nutritious food. Liked very much by children during acceptance trials. The Product has a shelf-life of 6 months under room temperature.

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 under go 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.
**ALBUMIN BAR**

An egg based snack bar which is rich in protein & dietary fibre was developed by DFRL to meet 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, 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 °C, 10 months at room temperature and 8 months under 37 °C.

**BARLEY BAR & FIBRE ENRICHED BAR**

Changes in life style 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.

**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.
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.

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.

AJWAIN MUNCH

Ajwain munches influence the appetite by increasing the saliva secretion and digestible enzymes. It is based on ajwain, ginger & other essential ingredients. It secretes digestive juice, hence helps to consume food for children, adults and the soldiers who works at high altitude. It improves the gastric responses at the normal stimulation and also helps in relieving flatulence. The product Shelf-life is 12 months.
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.

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.

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.
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 fatty acids. 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.

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°C 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).

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 is ideally 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.
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.

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.

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 Kcal 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±2°C and 12 months at -18°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.
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.

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.

SWEET AND 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.
FLAX CHAPATI MIX

The convenience flax seed chapati mix can be made to dough by adding water for preparation of chapaties. The product is ready to serve. Rich in omega fatty acids. Promotes health. Provides soluble fibre that can help to lower cholesterol. The shelf-life of the product is 6 months.

INSTANT COOKING PULSES AND 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 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°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.
FLAX TAMRICE MIX

It is a ready to reconstitute, instant food product. The product is ready to serve by boiling the mix for 3-4 minutes. The shelf-life of the product is 8 months. Flax seed is rich in omega - 3 fatty acids. It gives a pleasant taste and flavor.

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.

FLAX SWEET MIX

It is a ready-eat product. Flax seed is rich in omega-3 fatty acids. This is one of the rare sweet products based on flax seed. The product is a good source of protein and essential fat. The mix is easily digestible and liked by all age groups, especially children. The shelf-life of the product is 6 months.
INSTANT COOKING RICE

Cooking of rice 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°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°C within 5 to 10 minutes.

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.

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.
INSTANT/ RTE 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°C 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.

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 traveling, expeditions, institutional feeding and during odd times at home.
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.

INSTANT WHOLE PULSES AND THEIR CURRIES

The cooking of whole legumes like kabuli channa, chickpea, green gram, rajmah is a time consuming process and requires elaborate cooking facilities.

The cooking time of whole legumes/pulses can be reduced by pressure cooking and drying grains in a suitable dryer to less than 6% moisture content. In this innovative process, the whole pulses are cooked under pressure, conditioned to low temperature and dried under high air velocity trough flow dryer such that grains retain their shape and size with porous structure and minimum density. These dehydrated products when added to hot water gets reconstituted within two to three minutes. The whole pulses curries like chole curry or rajmah curry can be prepared for the consumption by boiling in water within five to ten minutes. The product has more than one year shelf-life and forms complete meal along with rice or chapatti or paratha and useful during traveling, expeditions, institutional feeding and during odd times at home.

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.
INSTANT TAMRICE MIX & INSTANT 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 easily digestible. The shelf-life of the mixes is 12 months.

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.
FLAX COOKIES MIX

Flax seeds are a rich and the only source of omega fatty acids in plant origin and are good toxins 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 TSP/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.

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.

MILLET (RAGI) BEVERAGE MIX

This mix is rich in iron, calcium, fibre, minerals and vitamins. It is a cold water reconstituted product which is ready to eat. It is a nutritious food, liked very much by children during acceptance trials. Shelf-life of the product is 6 months.
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.

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 an 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.
APPETIZER BEVERAGE MIXES - SPICED DRINK MIX, SPICED TOMATO MIX AND 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.

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 as well as stomach upset. The curd based multifunctional product helps in brain soothing. 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.
FREEZE DRIED GRAPE JUICE POWDER WITH WHEY PROTEIN

Freeze dried High Protein grape juice powder was developed with incorporation of whey protein concentrate (WPC) as functional ingredient to cater to the increased protein requirements of soldiers in combat environment and to facilitate post exercise recovery. The freeze dried mix on reconstitution had a protein content of 6g per 100ml. The powder had anthocyanin content of 95 mg/100g and vitamin C content of 140 mg/100g and energy value of 83.6 Kcal/100ml.

The product is easily digestible and is a good source of branched chain amino acids. It is a unique combination of fruit based antioxidants & vitamins with dairy based protein in the form of a readily reconstitutable, refreshing, fresh tasting beverage mix with good color. Product is stable for a period of 10 months under ambient conditions and for 8 months at 37°C.

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 #61538-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 #6158-carotene which is necessary for the physiological and psychological well being of the troops located at high altitudes.
READY TO RECONSTITUTE FREEZE DRIED, SHELF STABLE RABRI POWDER

Many service locations are in far flung and high altitude areas where sweets are not available. To address the situation, DFRL developed freeze dried ready to reconstitute, shelf stable rabri powder having good quality characteristics in terms of microbiological, chemical and sensory attributes and stable under ambient temperature conditions.

BEET ROOT JUICE POWDER MIX

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.

MORINGA PRODUCTS SOUP MIXES AND 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.
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, flavonoids, spices and other natural antioxidants. The tea is refreshing, stimulating and stress relieving apart from being a thirst quencher.

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.
DEHYDRATED CURRY MIX CAULIFLOWER-POTATO/PEAS/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.

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. The product remains stable for one year and can be reconstituted in three to four minutes in boiling water.

VERMICELLI KHEER MIX

This convenient mix contains good quality vermicelli, milk solids, sugar & flavours to suit Indian palate. Roasting, pre-cooking of vermicelli and hor-air dehydration are intrinsic to processing of this kheer mix. The product requires to be simmered in hot water for 5-6 minutes with occasional stirring to yield tasty vermicelli kheer.
READY TO DRINK JUICES & BEVERAGES

ALOE PASSION DRINK

Anxiety is debilitating state of mind. It has emerged to be a common psychiatric manifestation of modern day lifestyle. Herbal anxiolytes as curative agents promise to alleviate anxiety and other psychiatric 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.

ANTIFATIGUE & NURO PROTECTIVE 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.

BEETEL LEAF JUICE

Beetel 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.
FERMENTED VEGETABLE BEVERAGES - 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.

GINGER BEVERAGE, AJWAIN BEVERAGE AND KARPURVALLI BEVERAGE

Loss of appetite is one of the major problems faced at high altitudes. In addition the problem of nausea and flatulence is also persistent. 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.

The active components present in the beverages will act on the digestive juices, thus helping in improvement of appetite. These are complete preservative chemical beverages with six months stability.
TETRA PACK PRODUCTS -
SPICED DRINK APPETIZER, CURD CEREAL DRINK, ASHGOURD PUDINA JUICE, TENDER COCONUT WATER, APPLE ELECTROLYTE, ORANGE ELECTROLYTE, MANGO ELECTROLYTE

The tetra pack products are processed in a way that causes least possible nutrient damage to food. To reduce thermal damage and to promote concept of vegetable juice, or ready to drink appetizer, these products were developed. The curd cereal drink is a first of its kind particulate food product in tetrapack and has an excellent shelf-life.

The products processed in tetrapack retain its nutrients and flavor properties almost like a fresh product. The shelf life of six to ten months and ready to eat form makes it an exceptional product. The innovative ingredient compositions are responsible for their functional properties.

LOW CALORIE 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.
TENDER COCONUT WATER PRESERVATION TECHNOLOGY

Tender coconut water is much valued for its delicate taste, aroma & flavour apart from the minerals & other nutrients that it delivers. The laboratory has developed an innovative state-of-the-art technology to preserve and stabilise tender coconut water in flexible polymeric pouches and aluminium cans. The technology enables retention of all the natural goodness and delicate flavour of tender coconut water and has been developed in collaboration with Coconut Development Board (CDB) Kochi. The product has a shelf-life of 6 months in standiplastic packs and aluminium cans under ambient conditions. The Shelf-life can be further extended by 3 more months under refrigerated storage. The use of mild heat treatment and a biopreservative are key to this promising technology, ideal for domestic as well as export markets.

TENDER COCONUT WATER BLENDED WITH FRUIT JUICES

Tender coconut water 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 products were found highly acceptable with a shelf-life of 9 months under packed conditions at ambient temperature. The products have gained a national status and has tremendous commercial potential.

TENDER & MATURE COCONUT WATER BEVERAGE WITH SUSPENDED KERNELS (LEMON FLAVOURED)

Tender/mature coconut water beverage with and without suspended kernels were developed. The levels of lemon juice and TSS (Total Soluble Solids) were optimized. The product was found to be stable for 6 months under ambient storage conditions. The beverage was packed in stand up pouches as well as in bottles. The kernels was treated to remain in suspended form as well as to avoid discoloration in the coconut water.
VEGETABLE JUICES - ASHGOURD JUICE, ASHGOURD PUDINA JUICE, CUCUMBER JUICE, BOTTLEGOURD 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 maintenance by fulfilling the bodily requirement of micronutrients.

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

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.
**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 to 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 to take care of the onset of rancidity and volatility which results in batch to batch variation in the concentration of antioxidant.

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.

**PRESERVATIVE MIXTURE**

Chapaties are perishable and get spoiled within 24-48 hours due to microbiological 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.
Detection Kits

MEAT TESTING KIT FOR DETECTION OF COLD SLAUGHTERED MEAT AND 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.

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.
MICROBIAL DETECTION KIT FOR SALMONELLA SPECIES, SHIGELLA SPICES, ESCHERICHIA COLI GROUP & PROTEUS SPECIES

- Rapid, reliable and low cost identification of important enterobacteriaceae organisms, namely, *Salmonella*, *Shigella*, *E. coli* and *Proteus species*.
- Involves specific monoclonal antibodies and a few easy to do biochemical tests.
- Independently evaluated in three different medical colleges located in various parts of Karnataka with satisfactory reports.
- Time taken is 3 hrs instead of 3-5 days by the conventional procedures.
- Highly economical, cost per test – Rs. 25/-
- Skilled man power not required.

Potential users:
- Microbiology departments of all medical and veterinary colleges and institutions.
- Diagnostic medical and veterinary laboratories.
- Analytical and quality control food laboratories.
- CFLs of armed forces.
- Food export inspection agencies.
- Disease control/outbreak investigation institutions and their peripheral units.
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.

CONTINUOUS BLANCHING SYSTEM

Blanching is a pre-heat process for vegetable dehydration which inactivates enzymes, decreases microbial population and expels cellular gases. The two blanching methods commonly used are boiling in hot water and steam blanching. At industrial levels, steam blanching is the most widely used practical method. Steam blanching is more efficient because of the lower loss of nutrients and shorter period of exposure to heat. Blancher for commercial processing of vegetables is generally designed to suit the utility of the industries. Compared to the advancement of product technologies for quality improvement, the advancement in food processing machines is lagging behind. Thus the existing blanchers are suited for batch process or semi-continuous process and are not economical.
DFRL has developed a continuous blanching system suitable for various vegetables, such as carrot, potato, curry leaves, beans etc., based on a controlled feeder, conveyor and steam injection. Also in our country the development of food processing is slow paced because of lack of suitable machineries for up-gradation. DFRL, thus keeping in view the food processing operations, economics of the process and routine requirement of machines for automation, has designed this continuous blancher for vegetables. The invented continuous blanching system for vegetables has a capacity of 500 kgs per hour and is fully power packed. It is suitable for continuous and speedy processing of vegetables. The conditions such as feed rate, conveyor movement and steam flow can be optimized depending on the vegetable to be blanched. The operating system reduces the labour requirement and cost of processing.

**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°C or 35°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.

DESIGN FOR RETORT/STERILISER PROCESSING OF LIQUID, SEMI-SOLID AND 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°C is about 15 psig 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.
NOVEL MOULD DESIGN FOR RETORT PROCESSING OF LIQUID, SEMI-SOLID AND 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 buildup internal pressure of pouch during retort processing.

ON-LINE CONDITIONING SYSTEM
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.

**Process / Other Technologies**

**BREATHTABLE FILMS FOR PACKING FRESH PRODUCES – ENHANCING MECHANICAL PROPERTIES**

Traditionally, the quality and shelf life of fresh produces were enhanced by enclosing them in films that modified or controlled the atmosphere surrounding the product. The use of MAP/CAP for fresh produce was a natural progression once packaging technology had advanced to include the “breathable” materials. This technology will help food industry which is currently facing constraints like non-availability of adequate critical infrastructural facilities like cold chains and packaging.

DFRL has developed breathable films keeping in view the need for such films which are cost effective in production and have good mechanical properties. The primary function of the breathable film is to provide barrier properties, being tough with high tensile and tear strength. A significant advantage of this approach is that the strengthened/breathable films can be used as packing materials.
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, very serious waste accumulation problems have arisen. Considering the wide use of LDPE films and the magnitude of the environmental problem caused by such materials, there is a urgent need for environmentally degradable LDPE film 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.

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.
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.

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.
PRODUCTION OF LACTIC ACID BACTERIUM AS β-GALACTO-SIDASE SOURCES

Lactic acid bacteria are predominantly used as probiotic bacteria to improve the intestinal health of human beings and some farm animals worldwide. The bacteria are also widely used for the production 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 cannot 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 growth 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.
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.

STANDARDIZATION OF PROCESS FOR MAKING MILK PANEER AND 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.
......army marches on its stomach

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