Synergy with Non-DRDO Agencies

LIFE SCIENCES

Glimpse of DRDO products emerging out of synergy with non-DRDO institutions
Clockwise: Drishti, salt-tolerant plant, and typhoid test kit
From the desk of Special Editors

The synergy between R&D organisation and academia and industries is essential for realising the second vision for the nation to transform India to a `Developed Nation'. DRDO is privileged to foster fruitful partnership with other S&T organisations, universities, and industries in many of our programmes. This has resulted in emergence of a large number of dual technologies with application not only for the Services but also for the Society.

We intend to bring out a series of Technology Focus issues highlighting some important indigenous technologies/products emerging out of such partnership. Some of these contributions in the area of Life Sciences are outstanding as they help to improve the quality of life on this planet. We are glad to note that the first issue in this series has been rightly devoted to the technologies resulted from the DRDO's partnership with other agencies in Life Sciences.

Dr W Selvamurthy  
Shri Vishal Chandra

Defence Research & Development Organisation (DRDO) during its four decades of service to the nation has developed a large number of technologies in many critical areas, including life sciences. Though these technologies are in the context of the needs of defence personnel, many of them have also contributed immensely to the medical science and to the society at large. Herein follows a brief description of various achievements in life sciences in partnership with academia, industry and other agencies. A large number of useful biomedical devices, products, technologies and pharmaceuticals have emerged out of this endeavour. Some important ones are highlighted in this issue.

Equipment/Products

Kalam-Raju Coronary Stent

The fusion of missile and medical technologies fructified in the form of fully indigenous international standard coronary stent aptly christened as Kalam-Raju stent. The stent is used for maintaining the coronary blood flow after the angioplasty. It is named after the architect of India’s guided missile programme, Bharat Ratna Dr APJ Abdul Kalam and Dr Soma Raju, the renowned cardiologist who performed the first balloon angioplasty in the country. Kalam-Raju stent is developed from delta-ferrite free matrix of austenitic stainless steel, largely used in missile components. The stent is fabricated by Andhra Biomedical Components Pvt. Ltd., Hyderabad, for Andhra Cardiology Associates Pvt. Ltd. The biological evaluation of the stent was carried out at Cardiovascular Technology Research Institute and clinically tested at CARE Hospital, Heart Institute, Hyderabad. The indigenous stent is affordable; the cost is nearly one-third of the imported one.

Cardiovascular Catheters

The catheters-based technique offers heart patients the choice of non-surgical treatment of defects within heart and blood vessels. Presently, the catheters are imported at high cost. Five types of indigenous catheters developed by DRDO under the aegis of Society for Biomedical Technology (SBMT) are used in coronary angiography and for removal of obstruction in blood vessels.
Biocompatible polymers, such as polyethylene (modified), polycarbonate and silicone elastomers were selected for manufacture of catheter components, viz., tubing, hub, sleeve and soft tip. Biocompatibility of these materials has been established. These catheters have been found to be satisfactory in angiography during clinical trials conducted at LPS Institute of Cardiology (GVSM Medical College), Kanpur. Technology has been transferred to Udhay Kunal Electronics Ltd., for manufacture.

**Drishti-1064**

An ophthalmic laser (Nd-Yag) photo disruptor known as Drishti-1064 has been developed under the aegis of SBMT. Drishti is used for capsulotomy and iridotomy. In the former, a cut is made in the membrane formed after cataract surgery to create a central opening thereby restoring vision. Iridotomy is a procedure wherein the same laser is used to create a hole in the iris creating an alternate pathway for the outflow of aqueous humor thereby reducing the intra-ocular pressure in cases of glaucoma. The prototype of Drishti-1064 was evaluated by LV Prasad Eye Institute, Hyderabad, by carrying out more than 100 posterior capsulotomy and iridotomy procedures in a span of 15 months.

The technology has been transferred to Bharat Electronics Ltd., Pune and SBMT for productionisation. First production prototype, PT-1, is undergoing clinical trials at Guru Nanak Eye Centre, Delhi. Significant technological expertise in the area of lasers for use in Defence technology has resulted in this high-tech equipment for the common man. The cost of this equipment is reduced to one-third as compared to the imported one.

**Titanium Bone Plates, Screws & Dental Implants**

Titanium bone plates and screws have been developed in association with Non-Ferrous Technology Development Centre (NFTDC), Hyderabad, for use in the surgical treatment of facial fractures. Multicentric clinical trials have been conducted on 130 patients at seven centres belonging to defence and civil sectors. These plates and screws have been found to be suitable for the rehabilitation of fractures of facial skeleton.

Similarly, titanium mesh of 0.3 mm has been developed for use in cases of jaw fracture and in post oral cancer reconstruction surgery. It is undergoing clinical trials at Raja Muthiah Dental College & Hospital, Annamalai University.

Yet another product of this association, the Titanium Dental Implants, has been successfully tested at different centres, viz., Institute of Nuclear Medicine & Allied Sciences, Delhi; King George Medical College, Lucknow and Government Dental College, Ahmedabad.

**Orthopaedic Implants & Devices**

**Total Hip Joint**

The total hip joint consisting of ball, stem and cup, has been developed in collaboration with the Central Glass & Ceramics Research Institute, Calcutta. The ball is made of alumina, the stem is made of Ti-6AL-4V alloy while the acetabular cap is made of orthopaedic grade ultra high molecular weight polyethylene. The trials are under way.

![Total hip joint showing acetabular ball and stem](image-url)
Artificial Limbs

The state-of-the-art, light-weight and cost-effective modular lower limb prosthesis has been designed and developed using carbon-carbon composites. The prototypes developed have been evaluated by Artificial Limb Centre, Pune and Mobility India, Bangalore. The modular design facilitates repair and replacement of individual components. By using various combinations of modular design, it is possible to fit an artificial limb to all amputees above and below knees. These are being produced by 515 Base Workshop, Bangalore. The indigenous artificial limb costs only 20 per cent of an imported one.

Bone Plates & Bone Screws for Long Bones

The dynamic compression bone plates (6 hole) and screws made of medical grade CP titanium, designed and developed by DRDO and manufactured by Bhavani Engineering Enterprise, Hyderabad, are undergoing multicentric clinical trials at ESI Hospital, Bangalore; Osmania Medical College and Kamineni Hospital, Hyderabad.

HAPO Bag

The high altitude pulmonary oedema (HAPO) is a crippling condition of collection of fluids in the lungs on acute induction to high mountains. It requires immediate treatment by providing low altitude environment. For this purpose, one-man portable HAPO bag has been developed by DRDO and productionised by Sagar Inflatables, Mumbai. This bag made of a coated fabric with low air permeability is able to hold a pressure of .130 mm Hg (compared to 100 mm Hg in imported bag) equivalent to lowering of altitude by 3000 m. Since this chamber is provided with a CO₂ absorbant canister, it requires pumping only after every 20 min as compared to the imported bags which require pumping every minute. An automatic pressure controller has been provided to monitor pressure. The HAPO bag is also provided with a higher output pump, an oxygen inlet, a urine bottle, and straps for restraining the patient.

Insect Repellent—DEPA

Diethyl phenyl acetamide (DEPA) is a newly developed broad spectrum insect repellant. It is highly effective against mosquitoes, flies, rat fleas and land leaches. It is non-toxic and safe to humans and animals. It is the only insect repellant covered by a separate ISI specification and is marketed by Alkylamines Chemical Ltd. Mumbai. While the Defence Services are using this product presently, it also has enormous market potential in India and abroad because of its effectiveness and low cost.

Slow Release Insecticidal Paint

A slow release insecticidal paint developed by DRDO adds a new dimension to the paint technology. In addition to decoration and preservation of wooden and metallic surfaces, this new paint keeps away mosquitoes, cockroaches and other
insects by slowly releasing the safe insecticide from the blended paint, achieved through a delicate balance of chemical formulation. It is a quick-drying paint with insecticidal activity for two years. One kg of paint covers an area of 5-7 sq m depending on the porosity of the surface. The paint is ideally suited for use in kitchens, restaurants, warehouses, hospitals, rail coaches, etc. The technology has been transferred to Sentinel Chemicals Industries, Jamshedpur.

Ratox—A Bait for Rat Control

Ratox is a single dose rodenticide bait used for commensal rat control. A rat prefers the bait over normal food available in the vicinity. The bait once consumed kills the rat instantaneously preventing it from reaching the burrows. This makes it easy to identify the dead rats and remove carcass. The efficacy of this product developed by DRDO has been confirmed by Central Arid Zone Research Institute, ICAR. The package is ready for technology transfer.

Technologies

Preservation of Tender Coconut water

Tender coconut water, a delicious common drink with a characteristic flavour. It is rich in minerals and is used in hospitals as an infant drink for treatment of dehydration. A method for the preservation of tender coconut water with natural flavour and uniform taste has been developed under a project sponsored by Coconut Development Board, Kochi, under the Ministry of Agriculture, Government of India. The process involves short-period pasteurisation along with the addition of natural biopreservatives and sweetners. Adoption of this technology will improve the economy of the coconut growing farmers. This technology which will bring down the transportation cost and increase shelf life (3 months under ambient conditions and 6 months under refrigeration) of tender coconut water, has been transferred to potential entrepreneurs.

Salt-Tolerant Plants

Water is scarce in Rajasthan with the endemic problem of high salinity in ground water. Under the Rajiv Gandhi National Water Mission known as Sujalam, DRDO has set up electrodialysis plants for providing safe drinking water to problem villages in Barmer district of Rajasthan. The water left out after treatment through electrodialysis contains high levels of solids, and the same has been utilised for growing plants resistant to high salt content in water. For this, the plants/trees resistant to high salt contents have been identified (Albizia acculeata, Azadirachta indica, Acacia tortilis, Perkinsonia acculeata, Leucania lucocephala, Cassia samia, Acacia salicina and Tamarix articulata). With these, an ecofriendly agroforestry has emerged making the desert green. Certain species of vegetables and edible plants have also been identified which will be beneficial for the villagers. These include: radish, spinach, cabbage, bottle gourd, brinjal, and bitter gourd.

Enzyme Technology for Fruit Juice Processing

Efficient use of enzymes is a crucial step in fruit juice processing. It helps in improving production and quality by increasing soluble solid contents, colour, aroma, taste, mouthfeel and also nutritional components. Under a project funded by Department of Biotechnology, using this method, technology for processing of papaya, guava, plum, mango, pineapple and orange has been developed using a commercially available blend of enzymes, viz., Rohament PL and Rohapect D5L (1:1 ratio at the same protein level)
at a concentration of 0.5 per cent volume by weight.

The enzyme treatment increases the sugar content, brings down the pH to acidic side thereby enhancing the shelf life of the product. India being the second largest producer of fruits, adoption of this technology will enable India to use the opportunities to enhance export of fruit beverages, pulps and concentrates.

Pisciculture in Central Himalayas

The technology has been successfully developed for breeding four varieties of fishes, i.e., common carp, silver carp, grey carp and golden carp using circular hatchery for induced breeding as well as synthetic hormone ovaprim for artificial breeding. This technology increases the yield even in extreme winter conditions. Besides, culture technology for Mahseer, an endangered species is also being developed. Towards this effort, Indian Council of Agricultural Research is collaborating.

Services

Water Desalination

With the technology for converting brackish water into potable water, DRDO in collaboration with Rajiv Gandhi National Drinking Water Mission under Ministry of Rural Development has installed 115 desalination plants using electrodialysis method. The Public Health Engineering Department and Water Development Department of Rajasthan, Regional Remote Sensing Service Centre, Department of Space and Bhabha Atomic Research Centre are partners in this programme. The installed plants are continuously maintained and monitored by DRDO for ensuring the availability of safe drinking water to the villagers.

Two-Phase Selection System

The selection systems for screening of candidates for entry into armed forces have been updated in association with Directorate of Recruitment, Army HQrs. For this purpose, DRDO has framed a two-phase selection system for evaluation of candidates. The preliminary phase of assessment includes intelligence and personality tests, which help to screen out candidates who do not possess required attributes.

The second phase consists of detailed assessment using the three-pronged personality testing through interviews, group testing and psychological techniques. In this system, 40-50 per cent of the candidates who do not possess the required attributes are eliminated after the preliminary assessment thereby reducing the workload of the assessors making them more effective and bringing more objectivity in assessments. This also results in significant savings to the exchequer.

Psychoneuro-Immunological Study of Breast Cancer

DRDO undertook a collaborative study with the Bangalore Cancer Research Foundation, and the Centre for Cellular and Molecular Biology, Hyderabad, on psychoneuro-immunological aspects of breast cancer. Perceived stress of the patients and the emotional support received by them from the spouses and care givers are seen to influence the immune profile through the neuro-hormonal system.
Multiple regression analysis reveals a good correlation of psychological profile with specific immune responses. These findings indicate that immunological status could be altered through psychological interventions using coping strategies, thereby improving the prognosis.

Management of Coronary Artery Disease

The coronary artery disease (CAD) is fast becoming a major public health problem. The younger generation in the productive age group of 20-40 years is increasingly affected. The first attack is usually massive and 54 per cent Indians have all three coronary arteries involved.

DRDO in collaboration with Global Hospital and Research Centre, Mount Abu; All India Institute of Medical Sciences, New Delhi and Central Research Institute of Yoga, New Delhi, has undertaken a project funded by Ministry of Health and Family Welfare to study the curative effect of life style changes in the management of CAD. The life style changes include a low fat, high fibre vegetarian diet and moderate aerobic exercise. The stress management is through Rajayoga meditation. Patients of CAD with angiographically documented single, double or triple vessel disease (SVD, DVD or TVD) were registered for the programme.

A marked improvement in cardiac function was observed after a week and after six months improvement in terms of left ventricular ejection fraction and exercise tolerance was noted. Systolic and diastolic blood pressure decreased significantly and a 10 to 20 per cent decline in total cholesterol, low density lipoprotein and triglycerides levels besides increasing high density lipoprotein levels was observed. The fasting insulin, glycosylated haemoglobin and glucose levels showed a significant decrease suggesting a better glycemic control.

Pharmaceuticals/Diagnostic Kits

Rapid Detection of Insecticide-Resistant Mosquitoes

A quick and easy method of detection of insecticide-resistant mosquitoes has been developed. This method requires only a single larva or mosquito, and is based on biochemical mechanism which takes only 15-30 min in comparison to the conventional bioassay which takes 24 hr. The technique can be used even by a semi-skilled individual in the field and costs only Rs 5 for each test. The efficacy of the technique has been established in field trials conducted by Malaria Research Centre, Delhi; Vector Control Research Centre, Pondicherry, and Centre for Research in Medical Entomology, Madurai.

Antibody Detection Kit for Brucellosis

A simple, rapid and inexpensive dot-ELISA kit has been developed.
for detection of antibodies of *Brucella*, an organism primarily afflicting cattle and other domestic animals. It also affects human beings, causing pyrexia of unknown origin and low back pain. The animal kit has undergone field trials by the Department of Animal Husbandry, Government of Andhra Pradesh, Hyderabad; Disease Investigation Section, Government of Maharashtra, Pune; Farah Institute for Research on Goats, Mathura, and Central Military Veterinary Laboratory, Meerut. The utility of human brucellosis test kit has been established by trials at Veterinary Biological Research Institute, Nizam Institute of Medical Sciences, and Shree Medical Centre, Hyderabad.

The test can be performed in serum, whole blood, or milk at ambient temperature with minor modifications. The cost per test is only Rs 5.

**Typhoid Test Kit**

This test kit is useful to detect the typhoid organism at an early stage as compared to Widal test. It is quick, requiring only 8-10 hr in contrast to the conventional blood culture method which requires 2-3 days to get the result. The kit has 95 per cent sensitivity and 100 per cent specificity. The test system is based on rapid growth of the organism in a specially developed medium and only 3 ml of blood is required as compared to 10 ml required for conventional blood culture. The added advantage of this test is that no special equipment or specially trained staff is required.

**Neem-Based Vaginal Contraceptive**

The neem-based vaginal contraceptive (*Concept*), containing NIM-76 as the active spermicidal component derived from neem oil, has been found to be effective in controlling fertility in experimental animals and it is free from any toxicity. The active component was isolated from neem oil in collaboration with Indian Agriculture Research Institute, New Delhi. The process has been patented in India, and the patents filed in USA and EPO are under examination. In addition, the active components in NIM-76 are found to cure vaginal infections.

**Adaptogens for High Altitude Acclimatisation & Stress Management**

The extreme cold and low oxygen pressure conditions at high altitude are detrimental to the physical and mental performance of human beings. The problem is acute for the natives of the plains/low altitudes. Several studies have been conducted to assess the magnitude of loss of performance and on ways and means to arrest or reverse it. In collaboration with Himalaya Drug Company and Lupin India Ltd., two composite herbal preparations have been formulated which are found to arrest the deterioration in performance and enhance acclimatisation. These are undergoing extensive field trials in high altitude areas and in insurgency locations.