พระบิดาแห่งเทคโนโลยีไทย

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รายงานประจำปี

สถาบันวิจัยวิทยาศาสตร์และเทคโนโลยีแห่งประเทศไทย (วว.)
Thailand Institute of Scientific and Technological Research (TISTR)

กระทรวงวิทยาศาสตร์และเทคโนโลยี (วท.)
Ministry Of Science and Technology (MOST)

Message from the Governor

Since an establishment in 1963, the Thailand Institute of Scientific and Technological Research (TISTR) has successfully fulfilled its mission through a long journey on the integration of science, technology, and innovation (STI) for the utmost benefits of the Thailand social and national development. All through 53 years, TISTR has been achieving in various dimensions of STI national agenda as could be seen from our outstanding research and development (R&D) projects that proudly won the towards in competitive occasions, namely, the 2nd runner-up award winning project in Food Innovation "Pro Fruit", and freeze dried fruits containing probiotics, which won the Food Innovation Award in the National Innovation Day. TISTR was also delighted to be honored of "the Outstanding Public Sector Organization" in energy and alternative energy conservation, winning Thailand Energy Award 2016 from the Alternative Energy Department and Efficiency (DEDE), Ministry of Energy. Moreover, more innovative research is still on the run such as development of H-FAME, high-quality alternative bio-diesel which was a Thailand-Japan collaborative project on "Science and Technology Research Partnership for Sustainable Development (SATREPS)". The objective of this mission was to obtain a technology that could increase fuel efficiency in terms of high quality, low production cost, and an environmentally friendly process. This could help confirm energy security that can uplift people's quality of life in all sectors.

Concerning industrial services, TISTR extended its service scope into: food safety testing, both in food and containers for food and drink particularly made of plastic; certification of biodegradable plastic quality, together with analysis and testing of quality and safety of the railway system. A concrete framework could be seen by a Memorandum of Understanding (MOU) that had been signed for mutual agreements with the State Railway of Thailand (SRT) and the Thailand Industrial Standards Institute in order to strengthen the railway system of Thailand and in the region,

TISTR put strong effort in leveraging Thai competitiveness with STIM (Science, Technology and Innovation Matching Program) policy, integrating science, technology, and innovation via the "OTOP Science Coupon" area-based project, which aimed to promote innovation among OTOP and SME entrepreneurs by adding highest values and expand market opportunities to their products and services. From our expertise and our success, TISTR is now moving towards the future with our mandates in research, development, technology transfer, and services that could accelerate the government policy in promoting these following industrial clusters: agriculture, biotechnology, food processing for the future, robotic and automation technology for industry, smart railway system, biofuel, medical equipment, and so on. TISTR deems it fitting to play a part in Food Innopolis project of the Ministry of Science and Technology (MOST) as we are excellently keen on and has been an expert in these issues for long, particularly functional food and food supplement form herbs, along with promotion strategies for community enterprises and SMEs.

In terms of internal process improvement, TISTR determines to move towards a smart and green office, placing more emphasis on utilization of information technology (IT) for ultimate goals of highest organizational efficiency and to implement the digital economy policy of the Government. In this regard, TISTR recently performed organizational restructuring in response to transformation into Thailand 4.0. We believe the success story is waiting ahead in 2017.

Dr.Luxsamee Plangsangmas
Governor

Gen. Tagerng karn Sri-am-pai
Board Chairman
(16 Apr 2015-Present)

Mrs. Hirunya Suchinai
Board Member
(6 Nov 2014 – Present)

Mr. Parametee Vimolsiri
Board Member
(1 Oct 2015- Present)

Miss Sukunya Theerakullert
Board Member
(1 Oct 2015 – 30 Sep 2016)

Mr. Chen Namchisiri
Board Member
(16 Apr 2015-Present)

Mr. Pasu Loharjun
Board Member
(16 Apr 2015-Present)

Mrs. Wannipa BhakdibutraBoard
Board Member
(16 Apr 2015-Present)

Board of TISTR

Asst.Prof.Dr. Chirapol Sintunawa
Board Member
(16 Apr 2015 -Present)

Prof.Dr. Bundhit Eua-arporn
Board Member
(10 Sep 2015-15 Aug 2016)

Mr. Somchai Saengratmaneedet
Board Member
(10 Sep 2015-Present)

Mrs. Chantara Phoonsiri
Board Member and Secretary
(28 Jul 2015-20 Dec 2015)

Dr. Luxsamei Plangsangmas
Board Member and Secretary
(21 Dec 2015-Present)

TISTR Executives

Dr. Luxsamei Plangsangmas
Governor

Mrs.Chantara Phoonsiri
Deputy Governor Research & Development for Bio-Industries

Dr.Aparat Mahakhant
Deputy Governor Research & Development for Sustainable Development

Mr.Wirach Chantra
Deputy Governor Industrial Services

Dr. Chutima Eamchotchawalit
Deputy Governor Administration

Mr. Yutthana Tantiwiwat
Chief Research Expert

Dr.Teerapatr Srinorakutara
Chief Research Expert

Mr.Anun Rungporntavewat
Chief Administrative Expert

Content

History of TISTR

The Thailand Institute of Scientific and Technological Research (TISTR) is a state enterprise of the Thai Government having the mandates to conduct scientific research and provide technical services. It was firstly established on 25th May 1963 as the Applied Scientific Research Corporation of Thailand (ASRCT) under the Office of the Prime Minister and was changed into "Thailand Institute of Scientific and Technological Research (TISTR)" in 1979 under the supervision of Ministry of Science and Technology. TISTR is financially funded by the Thai government to undertake activities as defined in the Thailand Institute of Scientific and Technological Research Act B.E. 2522. The objectives since its establishments are as follows:

1. To conduct research and provide scientific and technological services to the public and business sectors for the national economic and social development;

2. To conduct scientific and technological (S&T) research for the ultimate use of natural resources appropriate with economy, environment, healthcare, and people's welfare;

3. To improve national productivity according to the government's policy via the utilisation of scientific and technological research in the development of agricultural, industrial and commercial sectors;

4. To provide training to scientific researchers;

5. To provide testing, calibrating and other scientific - related services.

Vision/Missions/Key objectives/Strategies/ Organizational culture and shared values

Vision :

A leading organization in the integration of science, technology and innovation for the creation of a sustainable innovation-based society

Missions :

1. To conduct research and development (R&D) in science, technology and innovation for value adding of products and services, in order to enhance national competitiveness.
2. To provide services in analysis, testing, calibration, inspection, certification of quality management system, training and consultancy services, in order to enhance industrial competitiveness.
3. To transfer technology and innovation to industry and community enterprises, with a furtherance for economic, social and environmental utilizations.
4. To develop an effective organizational management system.

Key objectives :

1. To strengthen the capabilities in research and development and the effectiveness in S&T service provision to the Green Growth development of the country;
2. To play a key role in the ASEAN Economic Community (AEC) via the development of the networks related to R&D, innovation, and S&T services while harnessing TISTR's human resource for making the most of joining the AEC.
3. To enhance Thailand's competitiveness in scientific and technological infrastructure together with TISTR's competitive advantages in technology.
4. To develop the systems, equipment, marketing, rules and regulations, management systems, information, mechanisms, and the good governance supportive to the enhancement of science, technology, and innovation of TISTR and its capabilities in managing TISTR's S&T initiatives for the business sector and the public.

Strategies :

Strategy 1. Increasing TISTR's effectiveness in science, technology, and innovation for a comprehensive support of the knowledge-based society, responding to current life styles of Thai people.
Strategy 2. Increasing TISTR's competitive advantages in enhancing national economic growth.
Strategy 3. Increasing TISTR's capabilities in science, technology, and innovation for promoting energy and environmental security of the country.
Strategy 4. Increasing effectiveness in organizational management.

Organizational culture and shared values

Organizational culture: Managing organizational intelligence, creating innovation value

Shared values

SMART TISTR

T: Teamwork	- inclusive work environment
I : Innovation	- boosting creativity and innovation processes
S : Satisfaction	- customer's satisfaction
T: Trustworthy	- working with reliability and honesty
R : Responsibility	- doing duties at one's best

Statement of Direction (SOD)

The direction for organizational development of TISTR that corresponds with the national and organizational development strategies is "to add value and increase research and service expertise, to transfer research and development to commercial and social target customers, and to build stronger relationship and collaboration of research network locally and internationally."

Short-term plan

1. To conduct research and development and create innovations for national benefits in economic, social and environmental development under the scope of market demands.
2. To develop the administration system in compliance with international standards.
3. To strengthen the research networks by joining hands with other organizations in the governments and private sectors in the country and overseas.
4. To promote S&T services and the utilization of research for commercial and social purposes.

Long-term Plan

1. To build a sustainable network of S&T services locally and internationally.
2. To produce the value-added R&D products and innovation in order to increase social and economic values of the nation.

Type of Organization

The Thailand Institute of Scientific and Technological Research (TISTR) is a state-owned enterprise established to comply with government's special policy under the Ministry of Science and Technology (MOST). It was originally set up as the Applied Scientific Research Corporation of Thailand (ASRCT)" by the Applied Scientific Research Corporation of Thailand Act B.E. 2506 (1963). After the establishment of the Ministry of Science, Technology and Environment (MOSTE) on March 23, 1979, ASRCT Act was replaced by the Thailand Institute of Scientific and Technological Research Act B.E. 2522 (1979) up to present.

TISTR's core products and services include R&D products such as technology, knowledge, publication, patent, prototype machinery, product prototype, as well as scientific and technological services including analysis, testing, calibration, research service, consultation and training.

TISTR delivers its products to customers in various forms including technical presentation, research report, analytical report, calibration report, technology transfer, and training.

Contact

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Industry and Future Outlook

The 1st National Science, Technology and Innovation (STI) Policy and Plan (2012-2021) is focusing on the stability and quality of growth in national economy and the fair benefit distribution to society and communities. To meet its goal, there are requirements for effective STI development that would be a great facto in driving the socio-economic models of the knowledge-based society, enhancing the country's competitiveness, increasing quantitative and qualitative development of S&T personnel, reducing the reliance on imported technology, and setting ultimate goals of highest return to people by the R&D investment and utilization of STI to benefit their living.

Science, Technology and Innovation Policy Office finalized the development of S&T in 2016 showing that Thailand was ranked by IMD at the 28th from 61 countries. In 2015, the budget allocation from government for STI was 3.86 % by the whole country's budget allocation. The R&D investment of private to public sector was 54% to 46%. In 2013, Thailand increased its R&D investment at 0.48 % of its GDP, and the ratio of R&D personnel was 12.90 persons per 10,000 people.

The Office of the National Economic and Social Development Board (NESDB) expected the Thailand's economy in 2016 to grow up at 3.0-3.5% by the supportive factors i.e. (1) the raise to high level of public spending and investment (2) the driving measures by government to encourage economy (3) the number of tourists that increased continuously (4) the low level of oil price, and (5) the improvement of household incomes in the agricultural sector resulted by the production and the improvement of important agricultural commodity prices.

Similarly, the Kasikorn Research Center estimated that in 2016, Thailand's economy was likely to have a better direction and had its growth rate at 2.5 - 3.5% (median at 3.0%) compared to the rate in 2015 at 2.8% and investment was the core of this growth. With that, Government's investment remained as a key role in pushing money into the economic system and to support the confidence of the private sector. However, Thailand's economy still relied on and was driven by the expansion of the private sector in many groups to support additionally to the public investment and the growth of the tourism sector which was forecasted their lower rate or almost the same rate from the earlier years. The businesses that were expected to maintain growth, perhaps to have investment expansion after 2015 were the groups of construction, transportation, logistics, information technology, and healthcare. The businesses that may meet the challenges were the groups of food processing, modern retails, and car distribution in the country. Moreover, the business groups in value chain of agricultural products such as rice and rubber were forecasted to having faced the difficulty continuously in 2016 by drought that affected the yield of field crops. Whilst the rubber price was still low following the global oil price and purchase order from the major trading partners whose trend were not good by the slow rate of China's economy. Exported businesses that relied on labor productivity or labor-intensive i.e. textile, garment, leather, furniture and its parts, and electronic goods and appliances might be affected by the competitiveness in the global trading. This may lead the entrepreneurs and multinational companies to relocate their manufacture to the neighboring countries where have more cost advantages and tax incentives.

By the framework of the 12th National Economic and Social Development Plan which aimed to enhance the competitiveness and escape from the Middle Income Trap to higher income, the issue of STI development is focusing more on the change in production and living by giving priority to the disruptive technology that can improve products to be more user-friendly, cheaper price, small size, and also to use the digital technology to enhance and create value-added products and services to support the quality of life and people's occupation. The plan also guides the development of STI in R&D investment, human resource, infrastructure, management, including support and encouragement of entrepreneurs to play role in technology and innovation. Moreover, it is necessary to accelerate the use of R&D for more commercialized or socialized purposes under special focus on protection policy for intellectual properties.

Major Factors Affecting the Business.

In striving towards achievements of organizational missions and corporate goals, there are several factors that could affect the organization as follows:

- **Utilization of R&Ds including S&T services for both social and commercial benefits.**

TISTR has 3 key missions which are: firstly, to integrate R&D on innovative foods, healthy products, medical devices, renewable energy and environmental management for the social and commercial utilization; secondly, S&T services on analysis, testing, calibration, system certification, and consultation in compliance with the international standards; and thirdly, commercialization of research, innovations and services with the notion to satisfy the target customers both in manufacturing and service sectors. We aim to gear towards upgrading Thai industry into self-reliance both domestically and regionally by virtue of effective business management and strong marketing. Therefore, the research results of TISTR that cannot support society, or the S&T services that do not meet the needs of private sectors are the major factor affected the operation of TISTR.

TISTR formulates the technology roadmap to direct the technological development for the needs of society in the future. In formulating the roadmap, the input data must be primarily surveyed, particularly the needs of the private sector and society, of which this information obtained will be used for writing up the new project proposals. In terms of S&T services, TISTR has widened the scope of services to support customers' need in the future. This also optimizes the tasks that are likely to compete with other competitors.

- **The recognition of TISTR's achievements at ASEAN level.**

One of major goals of TISTR Master Plan during 2012 - 2021 is to utilize S&T in order to increase competitiveness of the private sector. One strategy is to encourage the private sector to participate in investments of R&D and S&T services. By the reasons, it is important to develop the processes in reaching the needs of target enterprises and providing support to those entrepreneurs in using S&T for increasing competitive advantage. In addition, there are other processes such as marketing development, management of intellectual property, and development of funding sources which all are important factors to increase those enterprises' competitiveness leading to the R&D investment respectively.

Trade liberalization under the ASEAN Economic Community (AEC) is not only an opportunity but issue that TISTR has to concern and prepare its readiness. For examples, the free manpower mobility in those scarce areas of the country and promotion of the international quality development are the important issue for industrial sectors to export their products to the countries that have imposed the Non-Tariff Barrier (NTB). With that, the liberalization affects both governmental and private R&D organizations from overseas to come to work in Thailand easier. Therefore, to increase the recognition at the ASEAN level, Thailand needs human resource development as the key principle to strive forward into ASEAN. TISTR then developed the collaboration with many organizations in the ASEAN countries to create network in this sub-region and also to strengthen its R&D and service capability respectively.

- **Increase target enterprises' competitiveness.**

The operation of TISTR has developed the tool to encourage R&D investment through the STIM (Science Technology and Innovation Matching Program), a system so called Science Coupon for OTOP. This system has been developed to support the development and competitiveness of enterprises by using STI to develop innovative products, packaging, processes and standards through business mentor mechanism and technology consultants. This operation also links with marketing services and finance through comprehensive and systematic operation.

• Capability building in innovation development through the development of new TISTR Expert Centers.

In order to promote the transfer of TISTR's R&D, technologies and innovations for the true benefits of the society, TISTR has focused on the strategy to encourage Thai enterprises in using R&D for accelerating national socio-economic and environmental developments. In implementing, TISTR has responsively established Expert Centers in various research fields, namely, agriculture and horticulture, medicinal plants, alternative energy, food processing, and rail system. However, for those Centers to be recognized internationally must be supported by collaborative networks, infrastructure to support R&D for commercialization and community, human resource development for specific talent, preparation for readiness of working space, laboratory, equipment, machinery, technology and sufficient tools that facilitate researchers in conducting their R&Ds that benefit the living of people.

• Update of laws and regulations in responsive to organizational development.

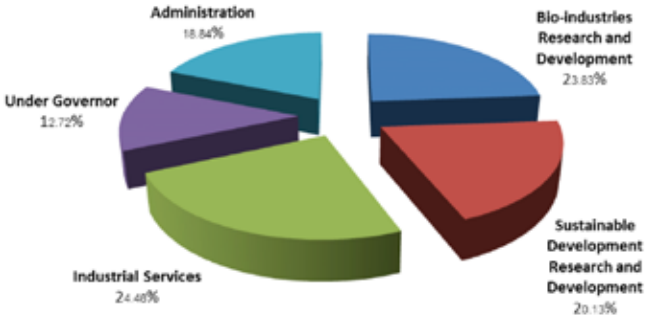
To implement the government policy, TISTR has been conducting many projects and missions of which have been initiated many years ago and some are newly launched in many areas involved with a number of stakeholders. In this regard, it is necessary for TISTR to amend or develop regulations and rules to accommodate the organizational development in the future so as to enable the organization with flexibility and effective.

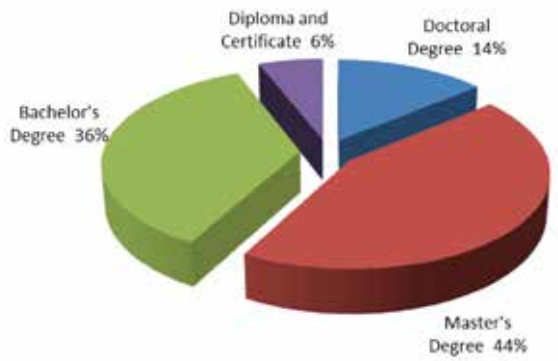
Human Resource

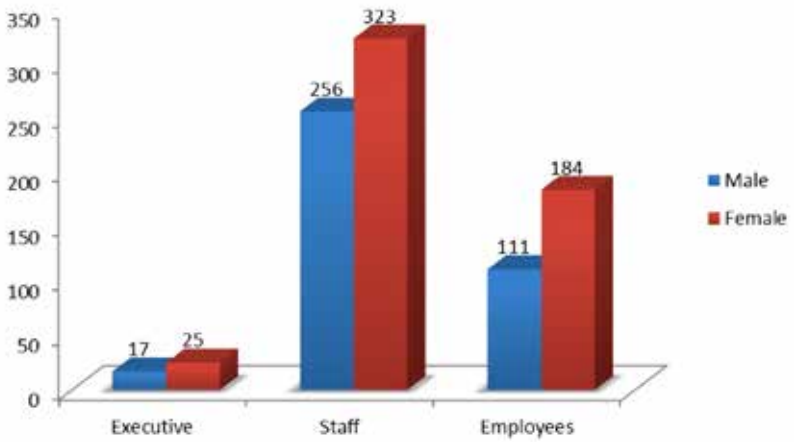
As of September 2016, there were totally 916 staffs comprising 621 permanent staffs and 295 employees: males 273 (43.96%), females 339 (56.04%). The total numbers of staff and employees could be categorized according to functional group, and educational degrees as follows:

Functional Group	Amount	Percentage
Bio-industries Research and Development	148	23.83 %
Sustainable Development Research and Development	125	20.13 %
Industrial Services	152	24.48 %
Under Governor	79	12.72 %
Administration	117	18.84 %
Total	**621**	**100** %

Proportion of TISTR's staff by educational degrees







Numbers of staff and employees

Highlights & Achievements in 2016

Research for Value addition to Agricultural Products

Research on Cosmeceutical Products from pigeon pea (*Cajanus Cajan*)

Operating under the research project 'R&D on cosmeceutical products from Thai indigenous beans', TISTR successfully developed liquid crystal serum with peptide extraction from pigeon pea. Its benefits are to increase collagen in skin cells and to reduce the amount of wrinkle at 72.7%, the depth of wrinkle at 70%, the length of wrinkle at 60%, and total of wrinkle area at 65%. Moreover, the product was capable of reducing blemish since the result showed significant difference that skin blemishes of the group applying the serum could be removed more successfully than those without applying it. At the trial stage of safety and efficiency evaluation, the product was applied 2 times per day (morning and evening) for 8 consecutive weeks by 20 Asian women between 35 - 65 year ranges and it revealed that the serum did not cause any allergy or irritation to their skin.

Research on Cosmeceutical Products from Indian gooseberry "EMsoftra®"

The successful products under the project of 'Cosmeceutical Products from Indian Gooseberry' (*Phyllanthus emblica*) were divided into 3 groups (for skin, hair, and oral cavity). The differential product advantage was from suitable ingredient proportion of Indian Gooseberry and Ma Kwan (*Zanthoxylum limonella* Alston) extracts that could increase bio-effect of the products, e.g. antioxidant, enzyme tyrosinase inhibiter in melanin pigmentation, anti-microbial treatment, and anti-inflammatory. This EMsoftra® serum was outstanding when compared to other products in the market and they fulfill the needs of customers concerning skin and hair treatment effects as well as anti-microbial and anti-inflammatory functions. Moreover, consumers can be ensured that the products are suitable for sensitive skin because they are made from natural herbal extraction.

Research on Product for Migraine Pain Relief from Herbal in Chrysanthemum '4GRAINE'

The products comprise of Chrysanthemum extract which helped to relieve migraine pain, and were produced in the forms of soluble powder with pleasing scent. Being different from other kinds of migraine treatment; '4GRAINE' had no side effect. According to the results from pharmaceutical studies, '4GRAINE' could stimulate serotonin receptor, similarly to the medicine categorized into "serotonin receptor agonist". The product passed safety evaluation by animal testing (acute and sub-chronic toxicities), and non-side effect evaluation by human testing (volunteers).

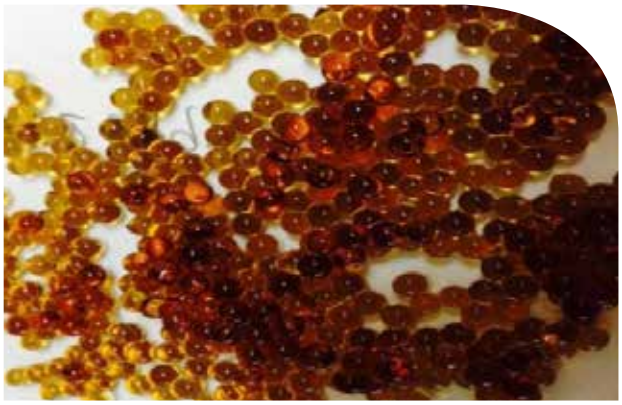
Dietary Supplement for Mental Relief

'Sirelax' is dietary supplement used for mental relief. The product consisted of Chrysanthemum extract which was capable of relieving mental stress and helping for better sleep. It passed efficacy and safety evaluation by animal testing.

Foods for Health

Research on Electrolyte Drinking (Sport Drinking) with Tamarind Extract for Sport Players "Tamarina Sport Drink"

The consumers can drink 'Tamarina', electrolyte drinking with tamarind extract, before or after sport workout, to replenish water and mineral losses, and prevent oxidative stress caused by excessive free radicals which occurred after a hard and long exercise. According to safety evaluation by cytotoxicity testing and animal testing (oral acute toxicity test), it did not cause any toxicity to the consumers when they applied it in high doses. More than 70% of consumers who had regular exercises were satisfied with electrolyte drinking from tamarind.

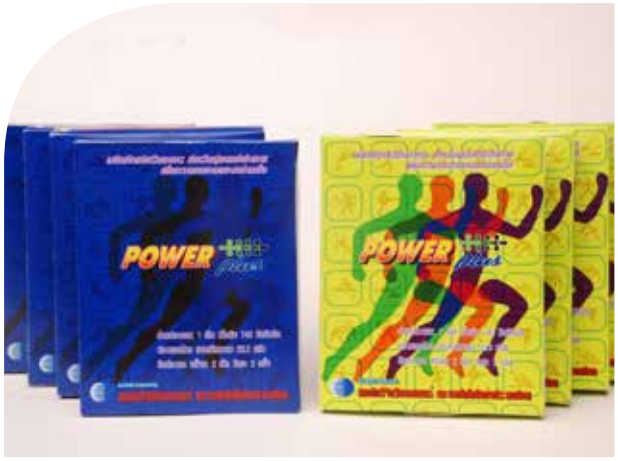


Product of Gel Beads from Tamarind Seed Extract for Food Industry, named 'IONTAM Encapsule'

IONTAM Encapsule, encapsulation technology for tamarind seed extract in sodium alginate gel beads, is a new technology used for storing essential substance (encapsulation) of tamarind seed extract to work more effectively and constantly. To prepare gel beads for the encapsulation technology, it needs to rely on principles of sequence and difference between sodium alginate (anions) and sodium chloride (cations), called 'Ionotropic gelation'. This technology passed safety evaluation in cell level and by animal test. It was found that it did not cause any toxicity in cells (cytotoxicity test), and acute toxicity when consuming orally (oral acute toxicity test). This invention was patented in 2015 and selected to be published in the international scientific journal 'Molecule' in 2016. It also can be applied in food and dietary supplement industries, as an ingredient in various food products, e.g. ice cream, sushi, drink, bread and so on.

Research on Dietary Supplement from Jamaican Cherry Extract

The product can be consumed as dietary supplement to reduce muscle exhaustion, and increase muscle strength and durability to move and work well. It is suitable for professional sport players, and people who start doing sport workout, in order to improve and develop their muscle strength and physical fitness.



Research on Dietary Supplement from Chickpea

The results of the production methods of protein isolate from Chickpea showed that this kind of protein isolate had mostly similar functional properties to that from soybean, and it can be used as an ingredient of food products, namely, meat dish, baked snack, and others. According to these findings, TISTR developed 3 products which were: 1) curd with protein extracted from Chickpea, 2) instant drink of 3 flavors with protein tablets extracted from Chickpea, and 3) soluble powder for drinking with protein extracted from Chickpea. 'Encapsulation Technology' is a key technology for enfolding protein extract in order to reduce bean smell and increase protein amount.

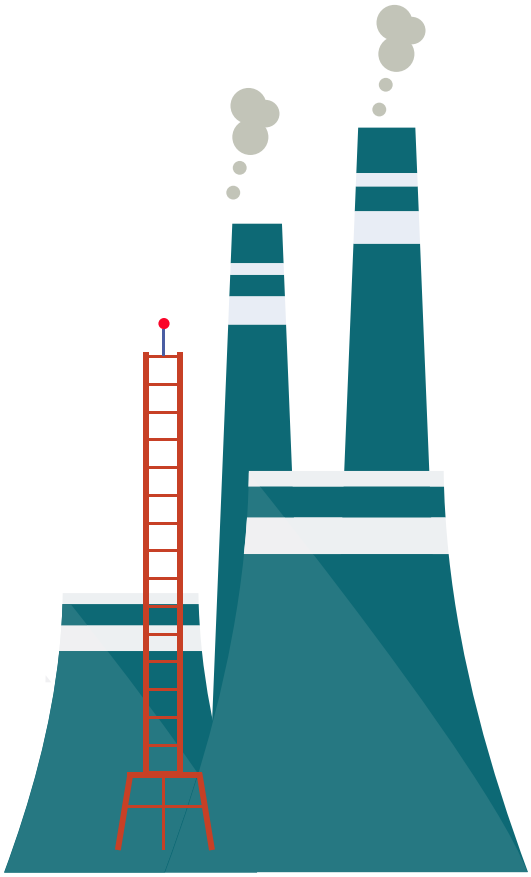
Research on Food Health Products from Indian Gooseberry

TISTR successfully developed 5 food products from Indian Gooseberry, which contained high nutrition and were suitable for consumers in every age range, including:
Osmotic dehydrated Indian gooseberry which had natural color, being tasty, not too sweet, and preservable for 3 – 4 months;
Indian gooseberry in syrup which had antioxidant effect, vitamin C, and could be preserved for 3 – 4 months at 4 ℃;
Indian gooseberry sheet which had antioxidant effect, vitamin C, and could be preserved for 3 months at room temperature;
Indian gooseberry gummy which had 30 – 36 milligrams/100 grams of Vitamin C, 65% – 70% antioxidant effect, and could be preserved for 3 – 4 months; and
Pasteurized drinking of Indian gooseberry cider which was tasty, not too sweet, having 68 milligrams/100 grams of Vitamin C, 55% – 57% antioxidant effect, and could be preserved for 1 month at 4 ℃.

Achievements in Energy Research

Bio-Methanol Production from Biogas Project

Energy Technology Department of TISTR successfully developed a prototype machine used for transforming biogas into bio-methanol at laboratory scale, with capacity of 100 milligram per day. The said process was done by an auto-thermal reforming method in a fixed-bed rector machine, and it was applied only 2 steps of controlled factors of catalyst, temperature and pressure. The first step turned biogas into synthetic gas by using a catalyst Ni/AL203, and then, turning synthetic gas into bio-methanol by a catalyst Cu/ZnO/Al205 at the second step. The results showed that there was more than 80% of the change of biogas at the primary stage, and product proportion of hydrogen gas and carbon monoxide gas was at 2 to 1, which could be used in the process of bio-methanol production with purity between 95 – 97%, and could fulfill that of a commercial standard. This achievement would be useful to industries that hold organic waste as potential raw material for biogas production. Not only reducing their workload in waste treatment, but it also generates multiple incomes from methanol production and its distribution to them. This also reduces the cost of methanol imported to Thailand and generates important opportunities to transfer research to commercialization to industrial sector onward.



Project to Upgrade Biogas into Bio-methane

Energy Technology Department of TISTR successfully conducted research and development on 'technologies for upgrading biogas into bio-methane'. The project aimed to develop novel technologies used for turning biogas into bio-methane, to study of efficiency of techniques to upgrade biogas into bio-methane production by the Pressure Swing Adsorption (PSA) system, and to study of the Compressed Bio-methane Gas (CBG) method used for the automotive industry. Most of the raw material used in the said biogas production system came from farming and anaerobic-industry activities. After the cleaning technologies of the scrubber system, the PSA system and the high gas compress system were processed, the bio-methane obtained composing of methane not lower than 90, and adsorbent carbon used in the PSA system with a capability of carbon dioxide removal at least 80%. This technology can be utilized in the areas where there are livestock-farming activities, anaerobic-wastewater management as well as highland communities in the northern part of Thailand where the gas pipeline system is difficult to install.

Science and Technology Services

Food Safety Testing

Industrial Metrology and Testing Service Center (MTC) of TISTR is ready to provide services on food safety testing by analyzing and detecting food contaminants and chemical residues in food production, including migration testing from food contact materials. MTC also provides testing services on food safety to food entrepreneurs/ providers who need to apply for food registration with the Food and Drug Administration (FDA) of Thailand. According to notification of the Ministry of Public Health of Thailand on food safely related to quality control on food products with consumer protection concerns, the products have to pass analysis and testing methods complying with international standards, and Thai Industrial Standard Institute (TIS)'s standard. For export food products, the products have to pass analysis and testing methods complying with Codex Alimentarius Commission (CAC)'s standard which have been accepted by the World trade Organization (WTO) according to the Agreement on Technical Barrier to Trade (TBT) and the Agreement on the Application of Sanitary and Phytosanitary Measure (PSP). MTC is ready to provide services on food safety of milk, milk products, ice cream, yogurt, drinking water, beverages in seal containers, dietary supplement, agricultural products e.g. vegetable and fruits, and Food Contact Materials (FCM) e.g. plastic packaging for food and drinking.

National Honorable Awards

An Honorary Doctorate in Science (Environmental Biology)

Mr. Taksin, the former Director of Sakaerat Environmental Research Station (SERS), received an Honorary Doctorate in Science (Environmental Biology) from Suranaree University of Technology, on 27 September 2015. Mr. Artchawakom worked as a major player in development of the SERS. With outstanding performance of the Station, SERS received the Excellent Ecotourism Award from the Tourism Authority of Thailand (TAT), under the Ministry of Tourism and Sports of Thailand.

The 2nd runner up of Innovative Design Award 2016 for Research on Pro-

Dr. Bhusita Wannissorn (a Senior Researcher of Bioscience Department), Dr. Panida Banjongsinsiri (a Senior Researcher of Food Technology Department), and researcher team, jointly developed food products 'Pro-fruits', which was dried fruits filled with probiotic. The product aims to create micro-organism balance in digestive tract system and to enhance food digestion and absorption abilities. This invention received the 2nd runner up of Innovative Design Award 2016 in the Food Design category, one of the National Innovation Award 2016, organized by the National Innovation Agency (NIA), under the Ministry of Science and Technology of Thailand, held on 5 October, 2016.

Excellent Award for Governmental Organization in Energy Conservation and Renewable Energy

TISTR received Thailand Energy Award 2016 in Energy Conservation and Renewable Energy category, sponsored by Department of Alternative Energy Development and Efficiency (DEDE), under the Ministry of Energy of Thailand.

Outstanding Poster Presentation Award


Certificate of Award

KRITTIYA THISAYAKORN

Effect of chrysanthemum flower extract on analgesia and serotonin levels associated with migraine symptoms in rats

Dr. Krittiya Thisayakorn, a Senior Researcher of Pharmaceutical and Natural Products Department, received the Outstanding Poster Presentation Award from her presentation performance on research topic of 'Effects of Chrysanthemum Flower Extract Analgesia and Serotonin Levels Associated with Migraine Symptoms in Rat', in the international conference 'The 32nd International Annual Meeting in Pharmaceutical Sciences', held at Chulalongkorn University, Bangkok, Thailand, on 10 – 11 March, 2016

1. Project on S&T for Extending Shelf Life of Longan for Export and Solving the Problem of Longan Oversupply in Markets

TISTR has received funding to operate the project since 2014 to present. The project aims to use S&T for extending shelf life of longan for export, solving the problem of longan oversupply in market, and enhancing longan farmers' capability of using suitable and effective S&T techniques to reduce the amount of spoiled longan, caused from its oversupply situation. TISTR set up the Technology Transfer Center for prolonging shelf life of longan for export through safe and standard scientific-applied methods. Pilot activities under the project were started in the areas of Lampoon province, namely:

Technology Transfer Center to Extend Shelf Life of Longan for Export

- TISTR set up a pilot center consisting of a fumigation room, storage room, and sulfur dioxide (SO_2) reduction room, before releasing into the environment, which complied with the industrial factory standards. The center has a production capacity of 9,000 ton per year and has product residues that do not exceed the required standards.

- Per year, TISTR set the target achievement that there were two cases of small-size fumigation centers which would be improved, and the problem of non-standard fumigation methods would be tackled. In 2016, TISTR achieved in providing scientific consultancy services to two clients, by improving their fumigation rooms, and supporting equipment and guidelines complying with required standards for longan export.

- TISTR applied information technology using QR code for product traceability in order to increase product reliability toward export of longan with standard fumigation. Three target groups in this project included fumigation center owners, farmers and entrepreneurs.

- TISTR organized the conservation and restoration activities together with utilization of community forest which was used as a buffer zone between sulfur dioxide (SO_2) fumigation cabinet and sensitive natural areas. These activities helped in promoting and reinforcing measures to reduce negative impact on the environment, as proposed in the Initial Environment Examination (IEE) report, and to enhance forest functional effectiveness in filtering and absorbing SO_2, dust and noise caused from fumigation activities.

Personnel Preparation

- To transfer suitable and effective technologies concerned to longan farmers, researchers, government technologists, students, who are in longan cultivation fields in various provinces in the Northern part of Thailand, namely Chiang Mai, Lamphun, Phayao, Nan, Chiang Rai and Tak. In each year, more than 300 interested local people were trained while 30 trainers from R&D personnel and government technologists could transfer technologies that met specific requirement of each local area.

- TISTR, in cooperation with Chiang Mai College of Agriculture and Technology and Lamphun College of Agriculture and Technology, developed academic curriculums in order to enhance abilities of R&D personnel and technologists in the techniques of technology transfer, and to prepare sustainable and effective local work force in order to support work tasks of current and future sulfur dioxide (SO_2) fumigation cabinets in local areas, so that they could control longan production and its distribution more effectively.

Fumigation Cabinet Management System for Local Farmers' Sustainability

- To provide guidelines of the fumigation cabinet management system in the form of agricultural cooperative to the farmers so that they can exploit its benefit extensively.

- To encourage the longan farmers to grow potential crops and mushroom in order to earn extra income.

2. Projects to Solve the Problems of Access to Food Processing Technology for SMEs in Local Areas to Enhance Food Industry up to the International Level.

As the Government's policy highlighted the importance of S&T infrastructure improvement and availability, it is necessary for TISTR to be well-equipped with these essential intellectual infrastructures that can be used for further steps in commercialization to the industrial sector, to get readiness, modernized and be accessible in various areas. The projects to solve the problems of lack of access to food processing technology for SMEs in local areas mainly aimed to facilitate SME owners in some part of the Northern part of Thailand to have more chance to access to advanced food processing technologies. These entrepreneurs faced problem at the preliminary-stage investment, including those who planned to expand into commercial production level with successful operation.

STI Basic Infrastructure in the Areas of Den Chai district, Phrae province

- To improve buildings used for the whole manufacturing process of value-added food products, to provide tools used for production assembly lines of instant drink and food products, and to establish laboratories complying with GMP standards to support R&D works used for new products and production line.

To Build Up Readiness and Competitiveness with S&T to Entrepreneurs

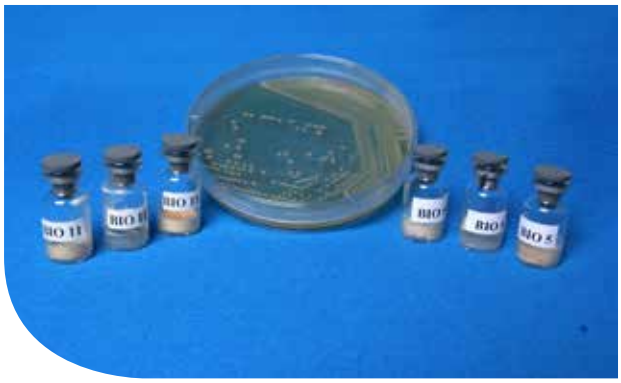
- To add value to products by improving its production processes to be in compliance with standards and promoting innovative products, especially the local ones of each area. It was expected that there were more than 10 entrepreneurs who were developed, and more than 10 products and production processes were improved each year.

- In cooperation with local partner agencies, TISTR transferred technologies to the local entrepreneurs by conducting training programs on product development with advanced technologies. Besides, TISTR joined hands with financial institutions to support those local entrepreneur concerning business analysis evaluation, and intensive consultancy services at actual production places in order to find solutions to the problems and draft development plans.

- In cooperation with educational institution networking, TISTR developed human capabilities of food science and technology to students and teachers in the areas near Technopolis through the learning activities of internship, real practices and/or workshop with R&D personnel or technologists working for industries, at STI basic infrastructure on food processing in local areas.

3. Projects on STI Utilization to Enhance OTOP Entrepreneurs' Competitiveness in Five Thai Regions.

TISTR supported OTOP entrepreneurs in 5 regions in Thailand by enhancing their ability to utilize STI knowledge for improving their productivity, innovation, packaging, standards, and advanced knowledge for productivity development, helping them to get readiness to sell their products in the ASEAN markets, and to relocate their products and services for concrete productivity development in many aspects. In 2016, TISTR conducted seminars on 'STI for OTOP Upgrade' in 12 provinces in Thailand, namely, Nakhon Phanom, Mukdahan, Sakon Nakhon, Chiang Rai, Ang Thong, Narathiwat, Trang, Surat Thani, Loei, Phathum Thani, Trat and Lampang. There were 997 entrepreneurs who came to attend in the seminars, and there were 222 entrepreneurs who passed the selection criteria (having been approved). Moreover, this project aimed to enhance the entrepreneurs' competence by leading them to the real business through supportive mechanisms, such as, funding sources or financial institutions (e.g. Krungthai Bank, Government Savings Bank, Thai Credit Guarantee Cooperation - TCG, Small and Medium Enterprise Development Bank of Thailand - SME Bank), and market channels developed by entrepreneurs' partner agencies (e.g. Thailand Post Co. Ltd., Department of International Trade Promotion, the Ministry of Commerce), with the purposes to expand their opportunities to become real business professionals, as well as, be able to provide service in target areas and develop the entrepreneurs completely.



4. Project on Establishment of Innovation Center on Effective Microorganisms for Industries

Innovation Center on Effective Microorganisms for Industries aimed to push R&D works for further development on food product and functional food produced by local communities or SMEs, to secure and enhance nation's opportunities and competitiveness in science, technology and innovation in biotechnology focusing on probiotic and prebiotic research. When Thailand entered into intense competition of the ASEAN intellectual property in this field. In 2016, our important achievement included the success of second phase of the establishment of Innovation Center on Effective Microorganisms for Industries. To continue the first phase of its establishment done in 2015, TISTR built laboratories and pilot plants for effective microorganisms and bio-substances productions, as well as, enhanced specialization of the innovative center staff according to capacity required in ISO/IEC 17025. Besides, the project promoted utilization of innovation of effective microorganism production to support community products from effective microorganism to be able to enter into the market. These were standards and quality improvement of the products provided by the groups of industries and entrepreneurs. After doing further development on research findings in laboratory scale, TISTR also developed new products branded 'Pro-fruits', which successfully received the Innovation Design Award 2016, bestowed by National Innovation Agency (NIA).

TISTR's Non-financial Performance in 2016

Research and Development Achieved in 2016

Thailand Institute of Scientific and Technological Research (TISTR) has conducted research and development (R&D) in science, technology, and innovation with an objective to promote the use of scientific knowledge gained from R&D projects in a broad range. In fiscal year 2016, fifty-eight R&D projects under government funding were finished and 2 technologies were transferred. The crucial achievements of R&D scope comprised 6 activities as follows:

Activity 1 R&D on agriculture for community
Activity 2 R&D on health food products
Activity 3 R&D on herbal medicine and neutraceuticals
Activity 4 R&D on renewable energy and environment
Activity 5 R&D on engineering design for small and medium enterprises (SMEs)
Activity 6 R&D on natural material innovation

Achievements of these following programs can be concluded as follows:

1. Health products from Indian gooseberry (*Phyllanthus emblica* Linn.)

Indian gooseberry is a local fruit having high anti-oxidants such as Vitamin C, tannin, polyphenol, flavonoid, and other bioactive compounds, thus having been used for a long time in drugs and food processing. Having high potential of economic and social values, Indian gooseberry has been studied in many of TISTR's R&D projects, namely, cultivation methods, selection of best varieties for processing into food products and neutraceuticals, technology transfer for commercial cultivation to farmers around Lam Takhong Research Station, Nakhon Ratchasima province. In order to add value to agricultural produce, the fruits of selected varieties were processed into snacks of high anti-oxidants. Besides, it has been developed into many kinds of neutraceuticals, for example, skin care, hair treatment, and oral care products. The R&D process also included testing of biosubstance, anti-inflammation, and skin irritation. TISTR is ready to transfer both knowledge and technology both commercially and socially.

2. Commercial utilization of Chinese angelica

Chinese angelica is a herb that is locally planted in Thailand under the Royal Initiative Project, at Doi Ang Khang Royal Agriculture Station, Amphoe Fang, and at Demonstration and Technology Transfer Station of Agriculture, Forestry and Environment, Ban Pak Saem, Amphoe Wiang Hang, Chiang Mai province. As Chinese angelica has been planted in Thailand without plan to promote, TISTR, therefore, conducted a research and development project for this plant. The result of R&D revealed the newly developed strain of Chinese angelica that had higher essential substance and active ingredients using induction of mutation technique in combination with new technology development for extending life-longer store of herb while nutritional and medicinal values could still be maintained. TISTR also discovered new technology for extending storage life of both fresh and dried fruits which could be done easily in a packing house. Besides, suitable packaging was developed for transportation that could reduce fruit transpiration in non-refrigerated trucks, together with packaging for dried fruits and shelf-ready packaging for modified Chinese angelica products. The cosmeceutical firming body cream from Chinese angelica was also developed and had passed the efficiency and product safety tests. This technology is ready for transferring to any interested entrepreneu

3. Conservation and value adding of local mushrooms in the north-east

• TISTR conducted a research and development project for the conservation and commercially value adding of local mushrooms in the north-east. The main objective was to conserve the local strains of northeastern mushrooms while utilizing the biodiversity. The research on conservation was to collect and classify genus and species of mushroom strains using morphology. A biodiversity central database was created and the nucleotide sequencing database of mushrooms was recorded in www.ddbj.nig.ac.jp. for 100 strains. These northeastern mushrooms were utilized and modified as ingredients in drug and food industries. The classification of mushrooms were conducted using the process and extraction technology of substances from mushrooms that were useful to health boosting such as prebiotic, triterpene, phenolic, and polysaccharide which could be used as ingredients in dietary supplement. In 2016, the developed products from mushrooms were, for example,

• Dietary supplement tablets full of polysaccharide and complex polysaccharide extracted from indigenous edible mushroom that help boost digestion and excretory system.

• Dietary supplement from local mushroom nourished with bifidobacteria good for health, promoting the growth of useful bacteria that helped maintain balance of gastrointestinal system and reduce enterocolitis.

• Dietary supplement concentrated drink and ready-to-drink for antimutagens and reducing cancer-risk.

TISTR developed mushroom cultivation technology for commercial purpose, motivating farmers to grow mushroom in flatland and avoid deforestation. Newly modified mushroom products were also developed and promoted for extra income earning.

4. Tablets from medicinal plant for a risk group of gout

ฝAgricultural Technology Department, TISTR and Faculty of Pharmacy, Ubon Ratchathani University collaboratively developed dietary supplement tablets from medicinal plants to reduce risk of gout attacks. The research and development processes began with raw material selection of potential mushrooms and herbs, extraction of active substances, and investigation of anti-inflammatory bioactive constituents for gouts. The quality of raw materials needed to be controlled in order to obtain highest bioactive compounds throughout the process. In this project, TISTR focused the study on mushroom growing that gave highest bioactive compounds, a technique in increasing fiber and beta-glucan that was bioactive compounds obtained. The cultivation of mushroom in a fermentation tank could reduce time and production cost when compared to in a greenhouse. The extract which was used as raw material for producing dietary supplement pills contained 0.16% beta-glucan (weight/weight) and also passed the pharmacopeial standards of tablet production.

5. Products for people with obesity and diabetes using micro-encapsulation technique

TISTR conducted research and development on food products for people especially the elderly with obesity and diabetes. The research projects included the extraction technique of natural active compounds for treating and preventing obesity and diabetes so as to use as an alternative to the imported substances and help minimize the cost of production machines. TISTR studied the preparation technique of encapsulated substances and innovative health products containing bioactive compounds for people having obesity and diabetes. The bioactive compounds were encapsulated using mixed protein and polysaccharide by a fluidized spray dryer. The powder of bioactive compounds was obtained and could be used as ingredients in food and beverages. TISTR's researchers further used this powder in developing many prototypes of functional food such as, beverages, snacks, and semi-liquid food that contained high nutritional values appropriate for people with obesity and diabetes.

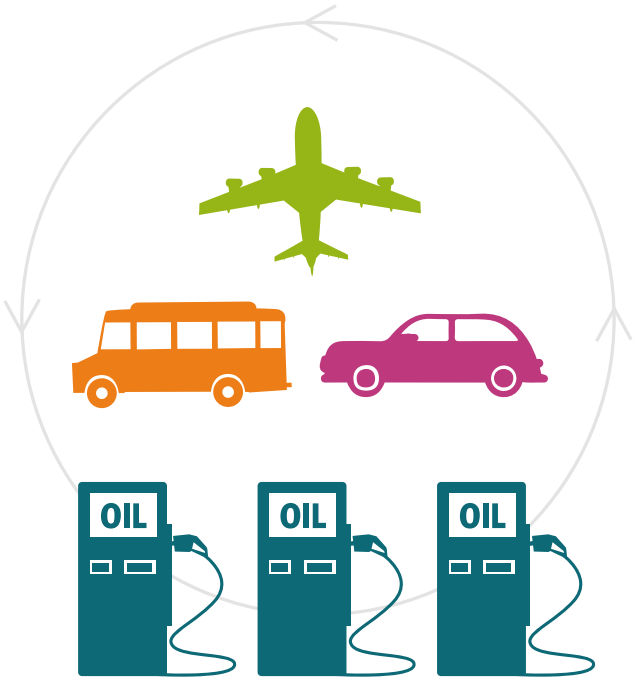
6. Improvement of bioflavonoids in vegetable and fruits to be used as ingredients for health food and drink products

Bioflavonoids are plant pigments for plant colouration comprising many types such as anthocyanin,

flavonol, etc. that have anti-oxidant activity preventing cancer, cardiovascular disorders and reducing risks of heart and blood vessel disease and coronary thrombosis. TISTR conducted a research project to study how to develop more of flavonoids in vegetable and fruits before harvesting such as mulberry, lime, Asiatic pennywort, Vietnamese coriander, Indian gooseberry, and black galingale, etc. using adaptation of a plant physiology process and plant growth regulators. A post-harvesting technology of these plants was studied as well as development of new technologies to extend longer storage life in terms of nutritional and medicinal values. New strains of these plants that gave higher rate of essential substances were also investigated, together with more value addition of raw material to be developed into health drink from high anti-oxidant vegetable and fruits, namely, Bio-flavonoid drink product from vegetable and fruit (extract from Asiatic pennywort), cosmeceutical product for skin cell shedding, and packaging development for transport and distribution.

7. Production of bio-fuel for aircrafts

The research projects in this research and development program aimed to produce and improve quality of bio-fuel up to the same standards as that used for aircrafts that had higher heat value by using a catalyst. A production process of bio-fuel was also developed for higher efficiency using pyrolysis and gasification technologies. Biogas was considered as an alternative for renewable energy by transforming the biogas into bio-methane that could be utilized as a substitute for LPG and NGV or CBG. Achievements of this project was a prototype technology of bio-fuel production for aircraft at semi-pilot scale, a prototype of a reactor for bio-methanol at laboratory scale, a reactor for bio-jet using the chain auto reforming process at laboratory scale, and a catalyst for a production process of aircraft fuel from dimethyl ether and alcohol. These research and development projects have high potential to be transferred commercially to any interested entrepreneur.



8. High quality biodiesel at community level using various kinds of raw materials with clean technology

This research project aimed to develop the production processes in the industry of bio-energy and alternative energy, particularly the bio-diesel production processes from various kinds of raw material. The production processes focused on bio-diesel production from household waste and industrial food waste. Production process development were as follows: improvement of raw materials in parallel with production process, for example, bio-diesel production for high acid oil, adjustment of raw material oil to feed into the production process of multi-feedstock bio-diesel, upgrading oil quality with hydrogenation process, and synthesis of catalysts in bio-diesel production process. Moreover, the project included design and development of a prototype for bio-diesel production at community level and the process that could reduce water pollution from the production process. The essential output of this project was the knowledge obtained from bio-diesel production process using oil from wastewater pond of coconut milk and palm oil industries, development of equipment sets used in the process of raw material adjustment, hydrogen production technology from wastewater in bio-diesel production process, and a prototype for bio-diesel production at 200 liters per day.

Patents and Petty Patents, as registered with Department of Intellectual Property in Fiscal Year 2016

In fiscal year 2016, TISTR filed 44 R&D products for patents and 2 for petty patents as follows:

Patents

1. Formula and process for fruit coating film from konjac (*Amorphophallus konjac*)
2. Reversible double screw blade and folded channel of mixer impellers
3. Aquaculture in the aquaponic close system
4. Method for flowering stimulation of mulberry tree using defoliation chemicals
5. Open heating system attached with electrical coil and a controlling handle
6. Fixed bed reactor with one heat pipe and easy changing of a catalyst
7. Recipe and process for production of dried cube fermented fish (Jeow Bong)
8. Formula and process for production of anti-bacterial dental resin composite
9. Distributer of chemical fertilizer pellets and water irrigation system
10. Third type of designed bottle
11. Formula and process for production of herbal candy for reducing cigarette cravings
12. Formula of serum and extraction method of peptide from *Cajananus cajan* (L) Mill. sp.
13. Production process of hydrogel pad for pressure sore prevention
14. Robotic arms for a sprayer and cutting tool of high tree pruning
15. Energy saving system for membrane filtering
16. Fabric coating method using rubber
17. Nano-siica mixed cement composite as dental adhesive
18. Mixture and encapsulation techniques for aroma and bio-active compounds of angelica extract
19. Production technology of rice sausage for vegetarians
20. Sulfur dioxide fumigation equipment using continuous control of gas release
21. Extraction process of asthaxanthin from Phaffia rhodozyma yeast
22. Production of Sodium-A zeolite from paddy stubble
23. Pipe of heat generator using plasma step
24. Formula and process for production of cheese for vegetarians
25. Method for drying yeasts with adhesive
26. Process for ethanol production including methods of digestion, toxic reduction and fermentation
27. Automated machine – clamp tools – automated arms
28. Production process and formula for acid soil adjustment using ash and saw dust from hardwoods
29. Production process of mushroom fiber in food
30. Formula and production process of products from *Mucuna gigantea* extract for relieving neurological symptoms
31. Formula and process of cellophane noodle from jackfruit starch
32. Rotating mixer propeller
33. Two steps of fermentation in ethanol production process
34. Mixer propeller of basket shape containing a catalyst that controls flow direction
35. Formula and production process of foot odor spray from Indian gooseberry extract
36. Box with insulator lining for fresh produce having low ethylene production
37. Energy saving process of algae biomass production
38. Formula of culture media and techniques for cultivating microalgae in biofuel production
39. Formula and production process of anti-depression products from chrysanthemum
40. Formula and production process of protein drink mix from peas and herbal liquid or fruit juice
41. Production process of extracted products from onion coated with ginger or green tea extracts
42. Extraction process of Polypore mushroom (*Trametes versicolor* (L.: Fr.) Que'l. having anti-bacteria function
43. Formula and production process of herbal drink mixed with onion extract
44. Stage distribution baffle system for increasing vertical flow in algal pond

Petty Patents

1. Formula and production process of gummy Indian gooseberry
2. Formula and production process of low-calorie soursop jam

National and International Publications

International publications

No.	Journal	Paper Title
1	J. Chromatogr. Sci.	Determination of γ-Aminobutyric Acid (GABA) in rambutan fruit cv. Rongrian by HPLC-ELSD and separation of GABA from rambutan fruit using Dowex 50W-X8 Column.
2	Molecules	Physicochemical Properties of Defatted Rambutan (*Nephelium lappaceum*) Seed Flour after Alkaline Treatment.
3	Molecules	Development of wax-Incorporated emulsion gel beads for the encapsulation and intragastic floating delivery of the active antioxidant from *Tamarindus indica L.*
4	Int J. Syst Evol Microbiol.	*Flavobacterium tistrianum* sp. nov., a gliding bacterium isolated from soil at Sakaerat Biosphere Reserve, Thailand.
5	Systematic Botany	Phylogenetic analyses of molecular data and reconstruction of morphological character evolution in Asian impatiens section Semeiocardium (Balsaminaceae).
6	Comptes Rendus Chimie	Upgrading of palm biodiesel fuel over supported palladium catalysts.
7	Journal of analytical and applied pyrolysis	Evalution of Ni-based catalysts for the catalytic fast pyrolysis of jatropha residues.
8	Key Engineering Materials	The effect of β-Sic nanowires on the properties of Al_2O_3 composites.
9	Key Engineering Materials	Influence of silane couping agent and nano-filler on the properties of dental resin composite cements.
10	Key Engineering Materials	Comparison of milling techniques to figure of merit of 0.98PZT-0.02BYF piezoelectric ceramic energy harvester.
11	Key Engineering Materials	Effect of milling time on the properties of BYF doped PZT energy harvesting ceramics by high-energy ball milling.
12	Key Engineering Materials	Chemical crosslinking of silk fibroin , chitosan, and gelatin blend nanofiber Mats.
13	Research Journal of Pharmaceutical, Biological and Chemical Sciences	Investigation of DPPH radical scavenging, antioxidant and melanogenesis stimulating activities of various pigment extracts from Thai herbal plants.
14	Agriculture and Natural Resources	Selection of macrocybe crass mushroom for commercial production.

No.	Journal	Paper Title
15	The Thailand Natural History Museum Journal	*Zingiber sirindhorniae*, a remarkable new species in Zingiber section dymczewiczia (Zingiberaceae) from Thailand.
16	Zootaxa	Contribution to the taxonomy of scaly crickets (Orthoptera : Mogoplistidae: Mogoplistinae) from Southeast Asia.
17	International Journal of Pharmacy and Pharmaceutical Sciences	Molecular, histological,and anti-oxidant evaluation of colistis induction in rats by different concentration of dextran sodium sulfate (5 KDA).
18	CyTA-Journal of Food	Evaluation of factors that influence the L-glutamic and ^-aminobutyric acid production during *Hericium erinaceus* fermentation by lactic acid bacteria.
19	International Journal Systematic and Evolutionary Microbiology	*Paenibacillus cathormii* sp. nov., isolated from tree bark
20	Journal of Microbiology and Biotechnology	Microbial community of healthy Thai vegetarians and non-vegetarians, their core gut microbiota and pathogens risk.
21	International Food Research Journal	Effect of spray drying conditions on physical characteristics of coconut sugar powder.

National Publications

No.	Journal	Paper Title
1	Khon Kaen Agricultural Journal	Quantitation of organic acid, sugar, total phenolic contents, and free radical scavenging activity of Ceylon oak (Nephelium hypoleucum Kurz)
2	Agricultural Sci.J	Free radical scavenging capacity, ascorbic acid content and total phenol content in ethanolic extract of Indian gooseberry fruit after storage in different conditions
3	Agricultural Sci.J	Genetic relationships in the bamboo inferred from the ITS2 and psbA-trnH sequences region
4	Agricultural Sci.J	Correlation between RAPD markers and beta-asarone in Acorus calamus
5	Agricultural Sci.J	Isolated chickpea protein and its applications in functional protein drinks
6	Agricultural Sci.J	Effect of packaging materials and sodium metabisulfite on prolonging storage life and browning symptom in Litchi (Litchi chinensis Sonn. cv. Hong Huay)
7	Agricultural Sci.J	Effect of packaging and temperature on quality changes and essential compounds of Chinese angelica
8	Agricultural Sci.J	Effect of 1-Methylcyclopropene on extending the storage life of thermo-tolerance Shiitake mushroom
9	Agricultural Sci.J	Change in fat content of Rambutan seeds during extraction with supercritical carbon dioxide, pasting properties of Rambutan seed flour and its use as a wheat flour substitute in biscuits
10	Agricultural Sci.J	Effect of spraying urea, NAA, ethephon and leaf removal on flowering fruit quality and yield of mulberry fruit
11	Thai Journal of Pharmaceutical Sciences (TJPS)	Effect of chrysanthemum flower extract on analgesia and serotonin levels associated with migraine symptom in rats

No.	Journal	Paper Title
12	Thai Journal of Pharmaceutical Sciences (TJPS)	Cytotoxic and cyto-protective activities of four Thai indigenous Russula mushroom extracts on Raw 264.7 cell
13	Thai Journal of Pharmaceutical Sciences (TJPS)	Development and validation of HPLC method for 6-Gingerol and 6-Shogaol in ginger capsules for the treatment of chemotherapy -induced nausea and vomiting
14	Thai Journal of Pharmaceutical	Anti-oxidant activities and poly phenolic compounds of Longan (Dimocarpus longan Lour) peel and seed extracts
15	Sciences (TJPS) Thai Journal of	Radical scavenging antioxidant and melanogenesis stimulating activities of different spices of rice (Oryza sativa L.) extracts for hair treatment formulation
16	Pharmaceutical Sciences (TJPS)	Apoptotic activity of ethanolic extract of Thai indigenous mushroom Russula alboareolate against L929, HeLa and HepG2 cell by MMP assay
17	Thai Journal of Pharmaceutical Sciences (TJPS)	Effect of total phenolic content on free radical scavenging activities of Boletus mushroom extract
18	Food and Applied Bioscience	Production of mushroom protein hydrolysates by enzymatic hydrolysis and their physicochemical properties
19	Applied Environmental Research	Application of rice stubble synthesized zeolite for greenhouse gas reduction

National and International Proceedings

No	Conference/Meeting	Paper Title
1	The 6 th International Conference on Natural Product Health and Beauty (NATPRO6)	Cytotoxicity activity and phytochemical studies of some iridoids isolated from the rhizomes of *Thunbergia laurifolia* Lindl.
2	The 6 th International Conference on Natural Product Health and Beauty (NATPRO6)	Extraction and characterization of Tammarind seeds polysaccharides (TSP) as drug delivery from Tamarindus *indica* L.
3	The 6 th International Conference on Natural Product Health and Beauty (NATPRO6)	Antioxidant and melanogenesis stimulating activities of different pigment extracts for grey hair treatment.
4	The 6 th International Conference on Natural Product Health and Beauty (NATPRO6)	*In Vitro* stimulant activity study on dermal fibroblast collagen synthesis of peptides isolated from pigeon peas, chick peas and soya beans.
5	The 6 th International Conference on Natural product health and Beauty (NATPRO6)	Bioactivity assessments of *Vitis vinifera* cv.Ribier (Pok Dum) seeds prepared by supercritical CO_2 and ethanol extraction method.
6	The 6 th International Conference on Natural Product Health and Beauty (NATPRO6)	Cytotoxic, cyto-protective and apoptotic activities of ethanolic extract of Thai indigenous mushroom *Russula alboarelata.*
7	The 6 th International Conference on Natural product health and Beauty (NATPRO6)	The development of *Phyllanthus emblica* and *Zanthoxylum limonella* feminine hygiene wash.

No	Conference/Meeting	Paper Title
8	The 6th International Conference on Natural Product Health and Beauty (NATPRO6)	The development of *Phyllanthus emblica* and *Zanthoxylum limonella* facial mark powder.
9	The 6th International Conference on Natural Product Health and Beauty (NATPRO6)	Development of tamarind (*Tamarindus indica* L.) seed extracts loaded wax-incorporated alginate-based emulsion gel beads using a modified ionotropic gelation.
10	The 6th International Conference on Natural Product Health and Beauty (NATPRO6)	Microemusion and biological activity of Indian gooseberry extract.
11	The 6th International Conference on Natural Product Health and Beauty (NATPRO6)	The development of *Phyllanthus emblica* and *Zanthoxylum limonella* mouthwash.
12	The 6th International Conference on Natural Product Health and Beauty (NATPRO6)	The development of *Phyllanthus emblica* and *Zanthoxylum limonella* mouth spray.
13	The 6th International Conference on Natural Product Health and Beauty (NATPRO6)	The development of *Phyllanthus emblica* and *Zanthoxylum limonella* toothpaste
14	The 6th International Conference on Natural Product Health and Beauty (NATPRO6)	The development of *Phyllanthus emblica* and *Zanthoxylum limonella* toothpowder.
15	2015 International Conference on Alternative Energy in Developing Countries and Emerging Economies	Biodiesel production from refined palm oil using supercritical ethyl acetate in a microreactor.
16	2015 International Conference on Alternative Energy in Developing Countries and Emerging Economies	Bioethanol production from oil palm frond by simultaneous saccarification and fermentation.
17	The 2016 Pure and Applied Chemistry International Conference (PACCON 2016)	Non-catalytic biodiesel synthesis in continuous miniaturized reactor.
18	The 2016 Pure and Applied Chemistry International Conference (PACCON 2016)	Influence of crosslink monomer on the formation of copolymer microcapsules encapsulated heat storage material.
19	The 2016 Pure and Applied Chemistry International Conference (PACCON 2016)	A study of pilot plant for production of bio-oil using fluidized bed reactors.
20	The 27 th Annual Meeting of the Thai Society for Biotechnology and International Conference	Magnetic nanobead-based immunoassay for rapid detection of CEA tumor biomarker.
21	The 27 th Annual Meeting of the Thai Society for Biotechnology and International Conference	Evalution of prebiotic property in edible mushroom.

No	Conference/Meeting	Paper Title
22	The 27th Annual Meeting of the Thai Society for Biotechnology and International Conference	Exopolysaccharide production by submerged culture of wild mushroom, *Lentinus* sp.
23	The 27th Annual Meeting of the Thai Society for Biotechnology and International Conference	Screening and characterization of exopolysaccharide from EPS producing Lactic acid isolated from fermented foods.
24	The 5th International Biochemistry and Molecular Biology Conference 2016	Biological activities of chickpea protien hydrosate.
25	The 5th International Biochemistry and Molecular Biology Conference 2016 PETROMAT PPC Symposium 2016	Morphological and molecular identification of Hed-Taen-Red (*Macrocybe crassa*) native strains from Thailand.
26	The 18th Food Innovation Asia Conference 2016	Preparation of poly (vinyl alcohol) nanofiber mats loaded ampicillin for antibacterial purpose.
27	The 18th Food Innovation Asia Conference 2016	Shelf life of pasteurized soursop (*Annona muricata* L.) leaf tea products.
28	The 5 Burapha University International Conference 2016	Effect of modified atmospheric (MA) conditions and packaging films on quality of butter cakes.
29	The 5 burapha university international conference 2016	Plant growth promoting traits of lactic acid bacterium isolate from rice Rhizosphere and its effect on rice growth.
30	The 9th SWU International Conference	Reduction of greenhouse gas emission by rice farming using zeolites
31	Thailand Welding and Inspection Technology 2015 (KMUTT and MU)	Fatigue damage evaluation of friction stir spot welded AISI 1012 cold rolled-steel under random force amplitudes.
32	Thailand Welding and Inspection Technology 2015 (KMUTT and MU)	3-Dimension observation of the interior fatigue fracture mechanism on friction stir spot welded AISI 1012 Cold Rolled-steel.
33	Thailand Welding and Inspection Technology 2015 (KMUTT and MU) 12th Conference on Energy Network of Thailand	3-Dimension observation of the interior Fatigue Fracture mechanism on friction stir spot welded AISI 1012 Cold Rolled-steel
34	12th Conference on Energy Network of Thailand	Bio-oil production from biomass by using pyrolysis method - pyrolysis gas chromatography and pyrolysis prototype
35	12th Conference on Energy Network of Thailand	Synthesis of liquid hydrocarbons by Fischer-Tropsch process using fixed bed reactor (mm)
36	12th Conference on Energy Network of Thailand	Hydrogen production by stream reforming process

Technology transfer: Technology for social and commercial utilization

Technology transfer to society

The results of research and development projects undertaken by TISTR including the knowledge gained could be utilized throughout the nation and yielded benefits to the upgrade of quality of life of Thai people and the communities. Transfer of science, technology and knowledge was performed via knowledge transfer activities such as workshops and training courses under TISTR Technology Transfer projects in the region organized by Lam Takhong Research Station, Sakaerat Environmental Research Station and Northern Agricultural Research Station in cooperation with organizations, agencies, networks. The key activities in the regions are as follows:

Northern region

The activities were carried out by the Northern Agricultural Research Station (Doi Pui), Chiang Mai province regarding the project on shelf life extension of fresh longan to meet quality and export standards in Lamphun province and Ceramic Industries Development Center in cooperation with:

- Pa Miang Royal Project Development Center to organize a training course on production standards and postharvest management : Shiitake mushroom
- Royal Development Project Administration Center to organize a training course on mushroom cultivation.
- Vocational colleges in the areas of Chiang Mai and Lamphun provinces for knowledge transfer of shelf life extension technology of fresh longan for export.
- Production process and quality control of ceramic products, Lampang province.

Central and Eastern regions

The activities were carried out by TISTR at Technopolis in cooperation with provincial agencies such as:

- Production of infected mushroom loaf and product processing of roasted chili paste with bolete mushroom and bolete mushroom in cooking sauce, Phra Nakorn Si Ayutthaya province.
- Use of paddy rice dryer for small-scale farmers, Phra Nakorn Si Ayutthaya province.
- Upstream waste segregation/organic waste management and organic fertilizer production, Phichit province.
- Competency enhancement for dairy farming officers in the livestock area, district 7, Phetchaburi province.
- Processing and value addition to pineapple products, Prachuap Khiri Khan province
- Formula and production process of ready-to-drink Longkong juice, Chanthaburi province.

Northeastern region

The activities were carried out by Lamtakong Research Station and Sakaerat Environmental Research Station, Nakorn Ratchasima province.

- Study visits at Lamtakong Research Station on interlocking block production, organic vegetable system, and organic fertilizer production.
- Propagation of sour tamarind plant and product processing by preserving in syrup, and drying.
- Pruning of Melientha suavis and planting of moonflower for commercialization.
- Preparation of latex compound for rubber coated fabric gloves and fabrication of rubber coated fabric glove products, Udon Thani province.
- Product development from Hom-Mali rice flour, Udon Thani province.

Southern region

Technology transfer activities were carried out by TISTR at Technopolis in cooperation with the Southern Border Provinces Administration Center, Provincial

Agriculture Offices in 5 provinces, Royal Initiative Farm Project, Provincial Industry Office, Agriculture and Cooperatives Office, and Isalamic Bank.

- Use of biological extracts for increasing agricultural productivity and production of organic fertilizer production and fermented bio-extract for agricultural applications, in Yala and Pattani provinces.
- Integrated value addition of Longkong fruit in Songkhla, Satun, Yala, Narathiwat and Pattani provinces.
- Food processing from agricultural produce for career promotion of community enterprise groups in the Southern region in Chumphon and Songkhla provinces.
- Fabrication of rubber coated fabric gloves in Songkhla, Trang and Satun provinces
- Fabrication of rubber foam in Surat Thani province.
- Preparation of latex compound for rubber coated fabric gloves, Narathiwat province.
- Production of "Serene" fish rice crackers, Pattani province.
- Production process of ceramics and energy saving, Songkhla province.

Commercial technology transfer

A variety of TISTR products that entrepreneurs are interested in customizing the commercial production were as follows:

• **Technology transfer of ready-to-serve Cavendish banana-based drink product** to Pride Fruit Co., Ltd. The product was developed from over-ripe Cavendish banana to be processed into ready-to-serve drink that had full nutrition such as potassium, calcium, iron, vitamin B6 and vitamin B12. The drink product had natural looking color with an odor of Cavendish banana, with good taste even without adding artificial color and preservative.

• **Technology transfer on production of VITISTRA nano-cosmeceutical creams day & night formulato Cosceutic Innovation Laboratories Co., Ltd. A Pilot development of cosmeceutical products from Thai grape seed extract was conducted using nano-emulsion technology, in which the emulsion consisted of small particles, for encapsulating the grape seed extract that contained high amounts of pharmacologically active constituents, thus suitable for use in cosmeceutical products.**

• **Technology transfer on development of ready-to-drink lemon juice and ready-made lemon juice** to Central Food Intertrade, Co., Ltd. The products were developed with a special technique, having the control of sweetness and acidity levels, as well as pasteurization at optimum temperature and pressure to kill microorganisms and prevent spoilage. A commercial production process was also developed to make a lemon juice drink having good taste and is easy to drink just like a fresh lemon juice as the lemon flavor was also preserved. The lemon juice is beneficial for health as a health drink and thirst quenching.

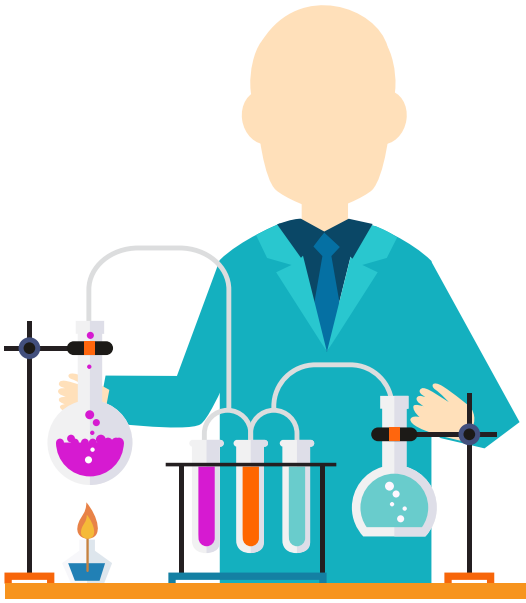
• **Development of a vacuum sealer and gas injection for SMEs** to Mr. Somnuk Rianrakwong. The developed machine was designed to make product packaging more convenient, faster and compatible with industrial use in packaging with nitrogen. In working, it combined all functions in one machine i.e. a seal type and packaging materials such as aluminum foil bags, thick/thin plastic bags with a width in the range 10-40 cm and a thickness of 80-200 microns that could provide more convenience, reduce the costs of production and enhancethe productive potentiality of machinery products by Thai engineers.

• **Research and development of a garlic and onion fryer machine** to Mr. Somnuk Rianrakwong, the factory owner of Por Ubon (Mahachai Warin), for the processing of instant garlic and onion for distribution to micro enterprises. With the R&D, the fryer was used to replace human labor with the precise control of temperature and time and to yield consistent color and good quality products, saving time and reducing losses. The developed machine can process at a maximum of 2 kg and is powered by LPG gas. Its external structure is made of food grade stainless steel 304

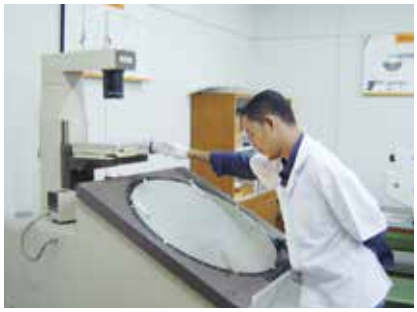
• **Development of paddy rice dryer for using in the rice seed production** to Songkit Civil Ltd. Part. The machine used for reducing the moisture content of

paddy rice during the rainy season or the locations where rice drying are limited. By applying principles of energy saving design, the developed dryer is highly efficient while yielding quality paddy rice complied with purchase standards.

- **Development of ultrasonic fruit and vegetable washing machine for market trails Model UC56041** to Miss Patchara Thipchanyawat and Mrs. Phuttharaksa Komolsiripakdee. The developed machine is efficient at the household scale in washing chemical residue and microorganisms left on the leaves of vegetables and the outer surface of fruits using the ultrasonic vibration system.
- **Development of semi-automatic rice making machine** to Mrs. Worapannee Noijaiboon. The developed machine for semi-automatically filling liquid rice paste and controlling the filling time with the temperature control unit.
- **Development of instant paste filling machine (semi-dried paste)** to P.P.N Foods Co. Ltd. The developed machine for filling instant chili paste can be used with dried and semi-dried products.
- **Productivity development of potato washing and polishing machine** to Mrs. Araya Kulthanyarat. The developed machine was efficient in washing and polishing the skins of potatoes continuously within the whole machine, fast for use while energy saving, reducing working hours and having no contamination as no chemicals used in the process. This machine also helped reduce the production cost of potato peeling with the weight loss of potatoes by 6% when compared to other methods with the loss of only 20%
- **Licensing agreement of production technology of concentrated extracts from Thai medicinal plants equivalent to herbal balls for sprain and pain** to Chiang Mai University and Well Med, Co., Ltd.
- **Lemon squeezer** to Thai Hachiban Co., Ltd., Sparklink Hour and Dee Prom restaurant. The development of a lemon squeezer capable of squeezing lemons and oranges with a high speed of 4,000 fruits per hour. The developed machine was made from food grade stainless steel and had changeable squeezing rollers for a suitable use.



Scientific and Technological Services






Thailand Institute of Scientific and Technological Research (TISTR) is one of Thai state enterprises providing integrated services of science and technology (S&T) that can be certified according to the International Standards, namely, ISO/IEC 17020, ISO/IEC 17021, and ISO/IEC 17025. The types of services are as follows:

1. Analysis and testing of materials and products to follow standards, laws, and regulations Of Thailand and internationally
2. Calibration in all fields of industrial metrology of which services can be provided both in-house and on-site.
3. Inspection of the operating conditions and failure analysis of materials, equipment, machines in industries.
4. Quality system assessment and accreditation according to International Standards such as ISO 9001, ISO 14001, TIS/OHSAS 18001, ISO 22000, GMP, HACCP, and Thailand Tourism Standard.
5. Certification of products such as products made from biodegradable materials.
6. Inspection body service for boilers, liquefied petroleum gas tank, and pressure gauge.
7. Analysis and testing services
8. Training/Consultation of laboratory quality management system according to ISO/IEC 17025 and related disciplines such as the quality management system, analysis techniques, testing, calibration, failure analysis, and risk assessment.

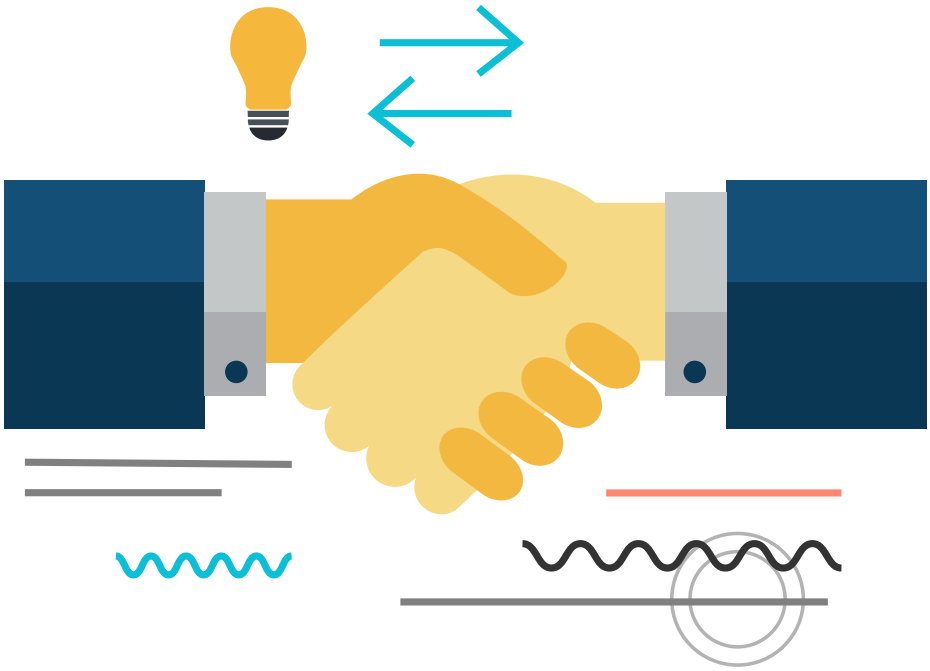
In fiscal year 2016, TISTR provided S&T services to customers as follows:

- 138,455 items from analysis, testing, and calibration.
- 50 training courses.
- Total customers 2,140 .

Types of products which are ready for food safety testing

- Food and food products, for example, milk and milk products, ice cream, yoghurt, drinking water, beverages in closed containers, supplementary products.
- Agricultural products such as vegetables and fruits
- Food contact materials, for instance, plastic packaging for food and beverages

Testing list: Antibiotics, Melamine and derivatives, Beta-agonists, Pesticide residues, Preservatives, Antioxidants, Sweetener, Mycotoxin, Microbiological analysis, Heavy metals, GMO, Food allergen etc. including Food adulteration, Migration testing from food contact materials such as Microbiological analysis, BPA, Heavy metals etc.



Beyond the Boundaries of International Cooperation on STI in AEC

International cooperation in science, technology and innovation has played an important role in driving development and prosperity of the nation and region. Particularly the international cooperation among ASEAN member countries, Thailand has maintained long proximity to the neighboring countries for a long time, related in many aspects of geographical-, politic-, economic-, trade relations and so on.

The Thai Government realized the importance of ASEAN community. According to the statement of Prime Minister Gen. Prayuth Chan-ocha given to the National Legislative Assembly on September 12, 2014, it is necessary to promote roles and opportunities of Thailand in the ASEAN community in many aspects, such as, to promote strong linkage of economic, trade and investment collaborations within ASEAN region, to expand economic collaboration with our neighboring countries, to improve competitiveness of Thai entrepreneurs at all levels, especially the group of SMEs, to develop workforce quality and capability in industrial sector, to accelerate the development of transportation linkage and logistic system, including logistic routes from production sources to local communities source of product processing, and to develop Special Economic Zone, starting from cross-border-trade gates. Moreover, the strategies of the Ministry of Science and Technology (MOST) of Thailand in 2016 addressed the establishment of STI collaboration with ASEAN community, by designating its subordinate agencies to establish international partnership through project implementation.

Based on the Thai Government's vision, policies and strategies mentioned above, TISTR set practical approaches to work in the areas of international relations and cooperation, especially with ASEAN member countries, as follows:

1.) To strengthen STI cooperation and enhance STI competency in needed fields of TISTR, in order to develop research work and advancement, develop new

and further technologies, and expand knowledge networking in STI.

2.) To use STI collaborative activities to create atmosphere conducive to the development of international relation and collaboration, to expand market and improve organization and images of the nation. With the goals to help other countries in terms of STI based on mutual interest of the both sides, TISTR sent experts to provide scientific knowledge and consultation, conducted training courses, and offered service on standard testing and analysis for the products.

3.) To gain recognition within the region and be acknowledged as an organization playing key role in STI creation in international forums, TISTR's staff involved in technical presentation in academic community since these activities could help elevate nation's competitiveness. Not only innovative R&D was introduced in international conferences, for instance to the ASEAN member countries, but also a chance that TISTR's staff could exchange STI knowledge.

4.) To publicize STI advancement of TISTR to the foreign countries in order to raise awareness in TISTR's roles and TISTR's international collaborative activities since it was a part to help in the development of the nation and the integration of the cooperative activities.

TISTR has categorised 2 groups of countries-based and issues-based discussion to establish bilateral collaboration with the ASEAN countries:

1.) Group One - Neighboring countries that prefer to gain knowledge from TISTR and conduct R&D collaboration with TISTR.

1.1 Lao PDR – Botany, Agricultural Technology, Technology for local communities, Development of organic fertilizer production, and Biomass energy

1.2 Vietnam – Biotechnology, Standard testing and analysis

1.3 Myanmar – Technology transfer on organic agriculture technology

2.) Group Two – Neighbouring countries that have scientific expertise and scientific need in equal.

2.1 Malaysia – Biotechnology, Testing and analysis on food and medical products

2.2 Indonesia – Landslide warning machine

2.3 The Philippines – Organic agriculture technology

TISTR also established STI Collaboration with ASEAN's dialogue partners, namely ASEAN+3 (China, Korea and Japan), and ASEAN+6 (China, Korea, Japan, Australia, New Zealand, and India), such as, cooperation between TISTR and China/Japan on railways system technology, environment and renewable energy, biotechnology and agriculture, biotechnology, medical products and herbal products; cooperation between TISTR and Korea on material technology and biotechnology; cooperation between TISTR and Australia/ New Zealand on food technology and functional food; and cooperation between TISTR and India on food technology, laboratory development with eco-toxicology principles and material testing and analysis.

Moreover, TISTR held many important events to promote and enhance international collaboration with ASEAN member countries, such as:

1.) Regional Workshop on "Overcoming Critical Bottlenecks to Accelerate Renewable Energy Deployment in ASEAN+6 Countries", during June 14 – 15, 2016, at Rama Garden Hotel, Bangkok, with financial support by the Ministry of Science and Technology (MOST) of Thailand, operated in the framework of ASEAN+6 for Energy and Biomass Energy Networking

2.) International Conference 'ASEAN+6 Organic Agricultural Forum 2016: Sustainable Agriculture', during June 28 – 29, 2016, at Imperial Mea Ping Hotel, Chiang Mai province, as a platform for learning and sharing knowledge and experience where many invited foreign speakers/experts in the areas of organic agriculture technology from ASEAN+6 member countries were gathered in a forum to discuss the topics and problems on organic agriculture approaches, organic agriculture export and sustainable development in organic agriculture.

3.) International Conference 'Innovation Trends in Functional Foods and Dietary Supplement', during July 28 – 29, 2016, at Centara Grand at Central Plaza Ladprao Hotel, Bangkok, with the objectives to share knowledge and experience as well as to create collaboration and relation between private sector and academic researchers from both inside and outside countries, especially researchers from ASEAN Economic Community (AEC) in order to promote the conduct of further research for commercialization.

4.) International Conference 'the 3rd Asian Fermented Food on Probiotic-Prebiotic: Bioactive Ingredients for Functional Products', during July 28 – 29, 2016, at Centara Grand at Central Plaza Ladprao Hotel, Bangkok, with the objectives to share knowledge and experience among interested participants and invited speakers from ASEAN member countries, Asia, and Europe, on biotechnology, microorganism, probiotic - prebiotic for food products and alternative products.

Even though each ASEAN member country holds different levels of R&D skill and STI capability which particularly respond to their nation need, STI collaboration among ASEAN member countries can bring sustainable development which improves quality of life of ASEAN people and enhances competence in many aspects of ASEAN countries. Therefore, TISTR paid attention to establish concrete collaboration with foreign countries, especially with ASEAN counties, for mutual utilization and together development in STI which led to sustainable development in ASEAN region onward.

International Cooperation

In fiscal year 2016, TISTR conducted 35 projects of international cooperation as follows:

Bilateral cooperation: 34 projects

- Cooperation with ASEAN Member States (AMS), which are Malaysia, Indonesia, Laos, and Vietnam : 6 projects
- Cooperation with ASEAN+6 Member States (China, Japan, South Korea, India, Australia, and New Zealand) : 16 projects
- Cooperation with the other countries such as France, United Kingdom, Fiji, and Canada : 12 projects

Multilateral Cooperation: 1 project under the framework of The Asia-Pacific Metrology Programme (APMP)

Highlights of International Activities

Cooperation with ASEAN Member States (AMS)

Institute ofMaterial Science (IMS), Vietnam

TISTR organized the Symposium on Failure Analysis and Inspection for Materials and Products in ASEAN Countries during 25th- 26th August 2016 at Chaophya Park Hotel, Bangkok, Thailand and had COMFA/IMS officers as the guest speakers.

Pha Tad Ke Botanical Garden, Laos

TISTR researchers attended the 3rd Symposium of Flora of Cambodia, Laos, and Vietnam "Botanical Research in Tropical Asia" at Vientiane, Laos to stimulate the collaboration among Laos and Indochina in the study of the tropical floral.

Northern Agriculture and Forestry College (NAFC), Laos

TISTR researchers provided training to lecturers of the Northern Agriculture and Forestry College (NAFC) and the Souphanouvong University during 23rd– 27th December 2016 in Laos under the topics of :

1. Intention of GMP Certification for ASEAN Community
2. Production of Cash Crop Vegetable (Phak Wan Pa)
3. Mushroom Cultivation in Mushroom House

Cooperation with ASEAN+6 Member States

Council of Scientific and Industrial Research (CSIR), India

TISTR researchers attended the training workshop on "The Advanced Food Technology, Food Analysis, Function Food Particularly on Testing and Analysis of Coffee" during 19th- 25th June 2016 at CSIR - Central Food Technological Research Institute (CSIR - CFTRI), Mysore, India.



National Institute of Advanced Industrial Science and Technology (AIST), Japan

Based on the cooperation between TISTR and AIST on water purification, AIST contacted Techno Morioka Co., Ltd. for the support on the TOC meter to demonstrate and monitor water purification in Thailand and TISTR contacted Metropolitan Waterworks Authority (Thailand) for support on the project.

Based on the cooperation on food analysis, TISTR, in cooperation with the National Metrology Institute of Japan (NMIJ/ AIST), and the National Institute of Metrology – Thailand (NIMT), co - organized the event of NMIJ – TISTR – NIMT Chemistry Metrology Seminar "the 2nd Proficiency Testing in Thailand : Trace Elemental Analysis in Polished Rice Flour", on 28th March 2016 at Century Park Hotel, Bangkok, Thailand to sum up comparative results of trace elemental analysis in polished rice flour between Thailand and Japan laboratories.




Yunnan Academy of Science and Technology Development (YASTD), China

TISTR researchers had a study visit and training on "Improving Chrysanthemum Breeding by Seedling Production" during 8th – 14th March 2016 at YASTD, Yunnan, China.

Meijo University, Japan

The brainstorming meeting at International Research Center for Natural Environmental Science on "The 2nd Achievement in Outdoor Microalgae Cultivation and R&D at TISTR AEC" during 27th January – 2nd February 2016" at Meijo University, Nagoya, Japan.

Research collaboration on Transgenic Microalgae

"The 4th Symposium on Perspective Innovation and Achievement of Algal Biofuel R&D (4th PIAB)" on 8th August 2016 at TISTR Technopolis.




Korea Institute of Materials Science (KIMS), South Korea

TISTR representatives attended the "International Union of Materials Research Societies - International Conference on Advanced Materials (IUMRS-ICAM 2015)" during 25th – 29th October 2015 at Jeju, South Korea.

TISTR organized the "KIMS-ASEAN Symposium 2016" during 26th – 29th January 2016 at TISTR, Technopolis, Thailand.


DIN CERTCO Gesellschaft für Konformitätsbewertung mbH, Germany

In order to promote and support DIN CERTCO customers on certification of bio-plastics products in Thailand;

- TISTR hosted a meeting to exchange information on compostable and bio-based plastics products and further proposed a product certification service with Din Certco working group.

- TISTR publicized the product certification service with Din Certco and expanded the bio-based plastics certification service especially for TBIA members at TBIA annual meeting on 16th December 2015.



UniServices on behalf of Department of Nutrition, University of Auckland, New Zealand

Dr. Thanchanok Muangman conducted a short term research fellowship on Effect of Plants Extract on Immunomodulatory during 28th March – 30th April 2016 at University of Auckland, New Zealand.


Massey University, New Zealand

Mr. Parkpoom Siriarchavatana attended a training workshop at Massey University, New Zealand during 29th February – 1st April 2016 including:

- Study visit at food laboratories, cytological and immunity, physiology, animal research and veterinary pathology laboratories.
- Training on laboratory animals surgery for hormone and bone research study.
- Training on bone disease laboratory testing related to osteoblast - chondrocyte interactions.

Dr. Supaporn conducted a short term research fellowship on “Encapsulation Technique by Using Spray Dryer” at Massey University during 28th March – 6th April 2016

International Conference

In fiscal year 2016, TISTR hosted many international conferences and invited experts and scientists from current alliances and renowned institutes to join the conferences to provide learning and exchange of views and experiences on R&D, S&T services and organizational management.

1. WAITRO Networking Conference themed "STI to Strengthen SMEs and Communities" was held on 29th October 2015 at Anantara Riverside Resort & Spa, Bangkok, Thailand in conjunction with the 75th WAITRO Board Meeting and 16th WAITRO Regional Representatives and Regional Focal Point Meeting, which the Governor was nominated as a WAITRO's board member for Regional Representative for Asia and the Pacific. The conference aimed to provide a stage for knowledge and experiences sharing among speakers and participants in exploring the ideas of technology transfer and how STI could facilitate the advancement of those SMEs and communities.

2. The 2nd International Advisory Committee (IAC) Meeting held on 27th November 2015. There were the IAC members from USA, Sweden and New Zealand attending the meeting as follows:

1) Dr.Richard B. Dasher, Director of US-Asia Technology Management Center, US-ATMC, Stanford University, USA (Chairman of the Meeting)
2) Dr.Kjell-Hakan Narfelt, Chief Strategy Officer, VINNOVA – Swedish Governmental Agency for Innovation Systems, Sweden
3) Prof. Richard Archer, Institute of Food Nutrition and Human Health – IFNHH, College of Health, Massey University, New Zealand

The meeting discussed and listened to suggestions from the IAC committee for TISTR's operations in 2015, especially on the establishment of biological diversity and expert centers at Technopolis, and highlight projects.

3. Regional Workshop on Overcoming Critical Bottlenecks to Accelerate Renewable Energy Deployment in ASEAN+6 Countries was held during 14th- 15th June 2016 at Rama Gardens Hotel, Bangkok, Thailand with the financial support of the Ministry of Science and Technology (MOST), Thailand and operated under ASEAN energy framework and ASEAN+6 biomass energy networking.

4. International Conference on "ASEAN+6 Organic Agriculture Forum 2016 : Sustainable Agriculture" was held during 28th-29th June 2016 at the Imperial Mae Ping Hotel, Chiang Mai province, Thailand to provide a stage for knowledge and experiences sharing among agricultural technology experts from ASEAN+6 member states to discuss organic farming and export problems and develop sustainable organic agriculture.

5. International Conference on "Innovative Trends in Functional Foods and Dietary Supplement" was held during 28th – 29th July 2016 at Centara Grand at Central Plaza Ladphrao, Bangkok, Thailand to exchange information and experiences regarding research and development in functional foods and dietary supplements and create collaborative networking between researchers and business sectors in AEC members to encourage product commercialization.

6. International Conference on "The 3rd Asian Fermented Food on Probiotic-prebiotic : Bioactive Ingredients for Functional Products" was held during 28th – 29th July 2016 at Centara Grand at Central Plaza Ladphrao, Bangkok, Thailand to provide a place for knowledge and experiences sharing among international participants on biotechnology, microorganism and prebiotic for food and functional products.

Gallery of Highlight Activities

H.E. General Prayut Chan-ocha, Prime Minister of Thailand visited the showcase of TISTR's research outputs and innovation machineries at "Innovation and Technology of Thailand for SMEs" during 3rd- 9th October 2015 at Khlong Phadung Krung Kasem market near the Royal Thai Government House.

Dr. Pichet Durongkaveroj, Minister of Science and Technology, was a chairman in the opening ceremony of "Knowledge Transfer....Learning the Achievements for Sustainable Forest Preservation", which was held during 22nd- 23rd January 2016 at Sakaerat Environmental Research Station (SERS), Nakhon Ratchasima province.

TISTR held a press conference for the launch of new products on 26thJanuary 2016 at Grand Ballroom C, Centara Grand at Central Plaza Ladprao, Bangkok. Dr. Luxsamee Plangsangmas, the Governor of TISTR, announced that TISTR was ready to launch brand new products including medicine and cosmetic from Thai herbal extracts and rubber value added technologies.

TISTR held the green station activity “mosquito repellent oil” on the Children’s Day 2016 during 7th- 9th January 2016 at the Ministry of Science and Technology.

TISTR in coordination with the National Institute of Metrology Thailand (NIMT) and Thailand Institute of Nuclear Technology (TINT) held a press conference to announce the industry services under the NQI/MSTQ project on 24th May 2016 at TISTR HQ, Technopolis, Pathum Thani.

TISTR co-organized the STARTUP THAILAND 2016, which was held during 28thApril – 1st May 2016 at Queen Sirikit National Convention Center (QSNCC), Bangkok.

TISTR organized an international conference on organic farming in the topic “ASEAN+6 Organic Agriculture Forum 2016: Sustainable Agriculture” during 28th- 30th June 2016 at the Imperial MaeP ing Hotel, Chiang Mai province.

TISTR jointly signed a cooperation agreement on “the Civil States Project on STI for OTOP Upgrade” between Ministry of Science and Technology (MOST) and the other 35 STI agencies for OTOP upgrade on 5th July 2016 at Innovation Park building, Ministry of Science and Technology.

TISTR organized the 53rd anniversary of TISTR science and technology in the theme “Food for the Future” during 28th- 29th July 2016 at Centara Grand at Central Plaza Ladprao, Bangkok.

TISTR organized the Mitrephora Sirikitiae planting for the queen event to mark the auspicious occasion of Her Majesty Queen Sirikit’s seventh cycle or 84th birthday anniversary on 8th August 2016 at Lamtakhong Research Station, Pak Chong District, Nakhon Ratchasrima province.

TISTR joined in the exhibition, showing the development OTOP/SMEs products, of Thailand Research Expo 2016 during 17th- 21st August 2016 at Centara Grand at Central World, Bangkok.

TISTR joined in organizing "Science @ Cuisine"event in the National Science and Technology Fair 2016 during 18th- 29th August 2016 at IMPACT Muang Thong Thani, Bangkok.

Mr. Arkom Termpittayapaisith - Minister of Transport, Dr.Pichet Durongkaveroj - Minister of Science and Technology, and Mr. Pornchai Tarkulwaranont - Vice Minister of the Ministry of Industry jointly signed a cooperation agreement and participated in a dialogue on the country's railway system development strategy between State Railway of Thailand (SRT), Thai Industrial Standards Institute (TISI), and Thailand Institute of Scientific and Technological Research (TISTR) to support the expanding of Thai railway development in the future on 7th September 2016 at the Club and Meeting Hall Building, Ministry of Transport.

TISTR organized the TISTR and Friends 2016 on the theme of "Innovation for the Enhancement of Thai Products to the International Market" during 20th- 22nd September 2016 at Zone B, 1st floor, Central Plaza Ladprao, Bangkok.

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