



RESEARCH

DEVELOPMENT

INNOVATION



FIRDI

FIRDI 2019 Annual Report



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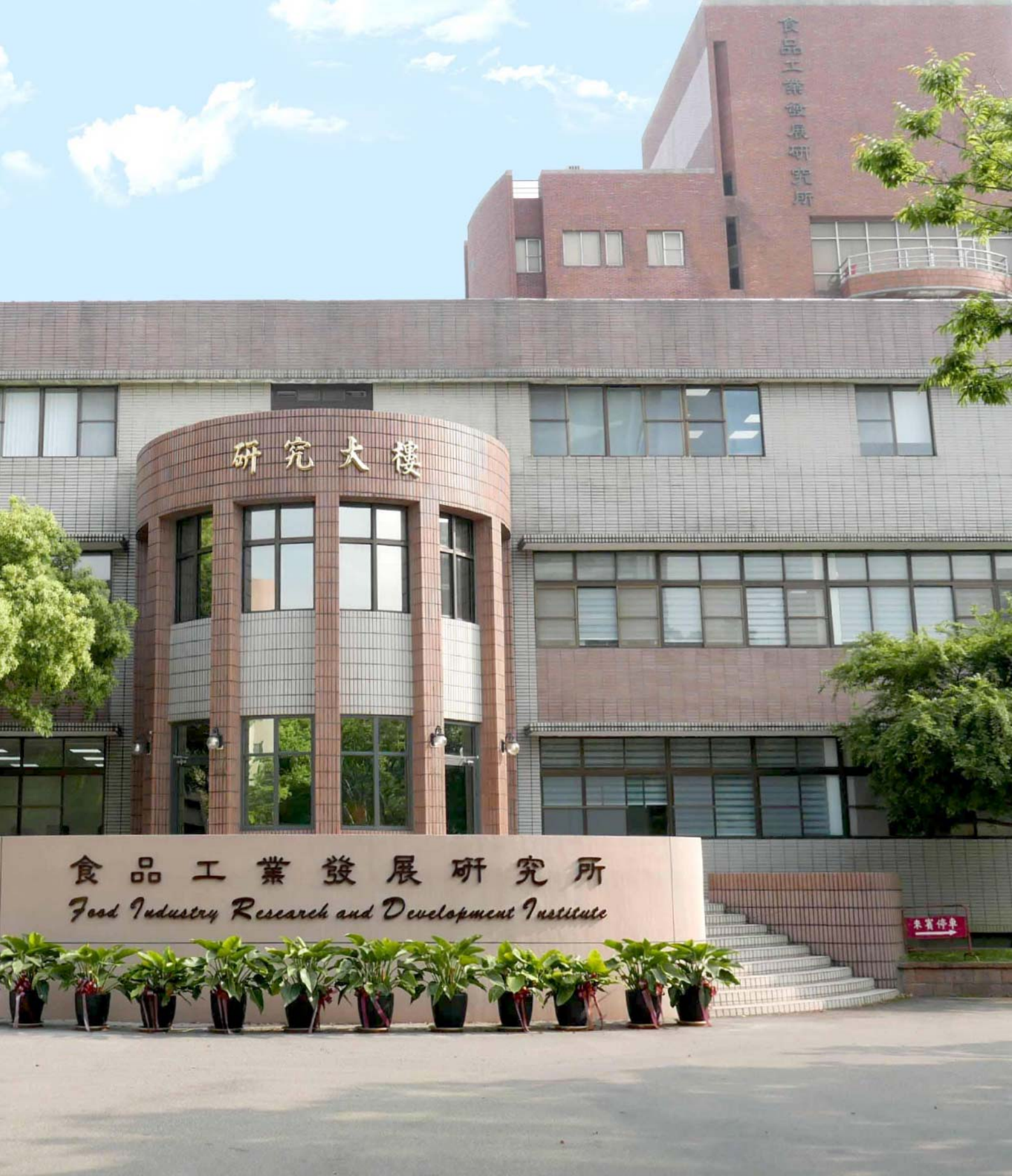
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2019 Annual Report

Food Industry Research & Development Institute

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Preface

The value of output of Taiwan's food industry (excluding tobacco manufacturing) in 2019 was 630.3 NTD billion, representing an increase of 2.44% compared with the previous year and accounting for 4.8% of the GDP of the manufacturing industry (ranked 7th). The ecology of the global food industry changes continuously and evolves along with the reconditioning of product value and active multidisciplinary integrations undertakings. Future business opportunities in terms of the plant-based alternative foods are now in the spotlight. Taiwan's food industry has already established a strong foundation of vegetarian meat manufacturing technology and has diversified products in the past. New business opportunities will be brought to the industry, if one could cross over to the niche market of the past and beyond the new flexitarian and vegetarian markets by connecting retail and catering channels in Europe, America and Asia.

In response to the foods market trends with regard to fineness, less additives, healthier choices and consumers' shopping conveniences, FIRDI continues to build food texture design technology platforms for the development of food structure controls via cohesions of software and hardware technologies; at the same time, to reduce the use of food additives, of which are accomplished by processing by-products from domestic commodities, such as soybeans, wheats and corns, to be used as substitutes for artificial additives, for utilization of developments of functional foods. Hence, industrial chains are linked together, of which facilitate the establishments of R&D alliances formed by complete supply chains of the pasta industry to develop and produce diversified innovative fine food products with less artificial additives that increases industrial competitiveness globally.

FIRDI has actively taken parts in encouraging cross-field cooperation, piloting transdisciplinary studies and establishing novel technologies, such as the novel type of protein fiber produced via food electrospinning technology, 3D printing platform that integrates traditional cookery and scaffold layered manufacturing for foods, and the introduction of an image sensing technique, which allows the digital management systems to be applied in real-time quality monitoring in the meat-packing industry. Moreover, industrial development and application of artificial intelligence (AI) have been arisen rapidly in 2019. FIRDI also took parts in initiation of comprehensive exploration and idea-generation for numerous AI technology applications in the food industry, at the same time, assisted improvements in smart production and manufacturing, as well as talent training in the food industry. Upon these researches and developments, it could be expected that the food industry in Taiwan is on the path to a promising and innovative future.

Since 2011, FIRDI has been assigned to operate the Chiayi Industry Innovation and Research Center by the Ministry of Economic Affairs. The Southern Taiwan Service Center and a pilot plant providing rapid trial production fields had been set up since then, specifically providing assistances for the southern region industry in terms of technical upgrades and production innovations. In 2019, the center had several achievements such as, guided the traditional food companies entering the high-value nutritious beverage market, as well as established smart cooking system to solve product surface softening problems for prepared frozen foods during reheating. On-site demonstrations would be executed by cooperation with convenience stores. Moreover, the center has assisted the establishment on cannery retort heat penetration testing technology that could shorten manufacturing management scheduling significantly for canneries. The concept of mechanical hygiene design was also promoted to strengthen the services of EHEDG hygienic design and testing laboratory technical services.

In terms of biological resource services and innovation, the Bioresource Collection and Research Center (BCRC) of FIRDI is not only the sole biological resource storage provider in Taiwan, but also serves as an important foundation for supporting the development of Taiwan's biotechnology industry. In 2019, international bonding between BCRC and other bioresource centers and academic institutes were active. Together with Academia Sinica, the world's first strictly anaerobic endolithic green sulfur bacteria from the coral skeletons of *Isopora palifera* was extracted, in 2019, meanwhile, a Memorandum of Understand (MOU) and Agreement were signed with the Japan National Institute of Technology and Evaluation (NITE), which enabled sharing of service capacities and information exchanges. Moreover, in response to the cell therapy project initiated by the Ministry of Health and Welfare, the "GTP Cell Processing Center" was set up at the end of 2019 for the promotion of cell and cellular therapy businesses. Companies were able to loan the laboratory spaces for preparation and production of all types of cells for such purposes, and consequently accelerated the implementation of commercialization of cell therapy R&D results.

Analysis Research and Service Center of FIRDI provides ISO 17025 authenticated inspection services. The center at the same time is also certified laboratory of the Taiwan Food and Drug Administration, Ministry of Health and Welfare, and Taiwan Accreditation Foundation. In 2019, Mutual Recognition Arrangement with ILAC-MRA and the center was signed, which ensured the quality of inspections were to meet international standards and specifications. An adulteration detection technique for "Dripped chicken essence" products was established in 2019, which involved with a rapid and sensitive fresh chicken materials detection method that provided further insurance as well as for efficiency of in-line chicken quality control and monitoring for the relevant industry. This, as consequence, reinforced the chicken related product quality controls.

As for certification services, for the quality assurance of food industry and in line with international standards to provide professional and impartial certification services that conform to the ISO standards (ISO and TAF standards) for the domestic food industry. Meanwhile, the unit was also an

internationally recognized certification organization certified by Australia's JAS-ANZ, the Food Safety System Certification 22000 (FSSC22000) and the GFSI- SQF (Safe Quality Food). We have assisted 10 domestic companies in passing SQF accreditation to ensure that the quality of products can meet international standards.

FIRDI continued to strengthen its capacity and service ranges, especially in, food safety and quality assurance counseling. In recent years, the Institute has established a food protection system that is in line with international standards to assist food factories in improving competitiveness with respect to exportation and global trading, based on risk prevention logics and actions, technical services and talents training were performed. Supports for small and medium-sized food companies were provided for the establishment of food safety management systems, product process control and optimization technology, of those which have enhanced the industrial promotion and service functions via initiating LINE@ group services. Real-time advisory services were offered by the Institute's technical expert team. Furthermore, FIRDI has been providing services for food and biotech enterprises located from counties and cities to offshore islands and other remote areas, which could efficiently, offered problem solving and quality improving solutions. The Institute has, again, been awarded the 6th "National Industrial Innovation Award – Model of Local Industry Innovation Award, MOEA" in 2019.

FIRDI, since its establishment, has been actively invested training programs for food and related industry professionals. Thus, the FIRDI Academy, was founded in 2015, for further we expansion of business and industrial talent cultivations and also acted as a knowledge exchange platform for the industries. The silver medal of the Ministry of Labor's Talent Development Quality Management System (TTQS) training organization had been awarded to the Academy in both 2017 and 2018, and it has become a qualified international SQF training center. The Academy has obtained the certification of the Integrated Competency and Application Platform (iCAP), competency-based courses initiated by the Workforce Development Agency, Ministry of Labor. The Academy, moreover, has spared no efforts in strengthening the industry-academia-research catalyst training mechanism through which customized competency-based courses were offered to improve the employability of cross-domain digital talents. FIRDI has thus been selected as the organization with excellent results in the study program and cultivations.

It is expected that FIRDI can become a food and bio-industry technology research institute with high-quality innovation capabilities with international reputations, and being the leader as well as the backing for sustainable development of the food industry. The word "Preface" is chosen to be the "2020 outlook word" for FIRDI. It is expected that the colleagues can continuously promote the progressive development of the food business. Optimistically, ongoing support and encouragement can be given by all sectors of the community to collectively make contributions to the development of Taiwan's food and biotechnology industry.



Director General

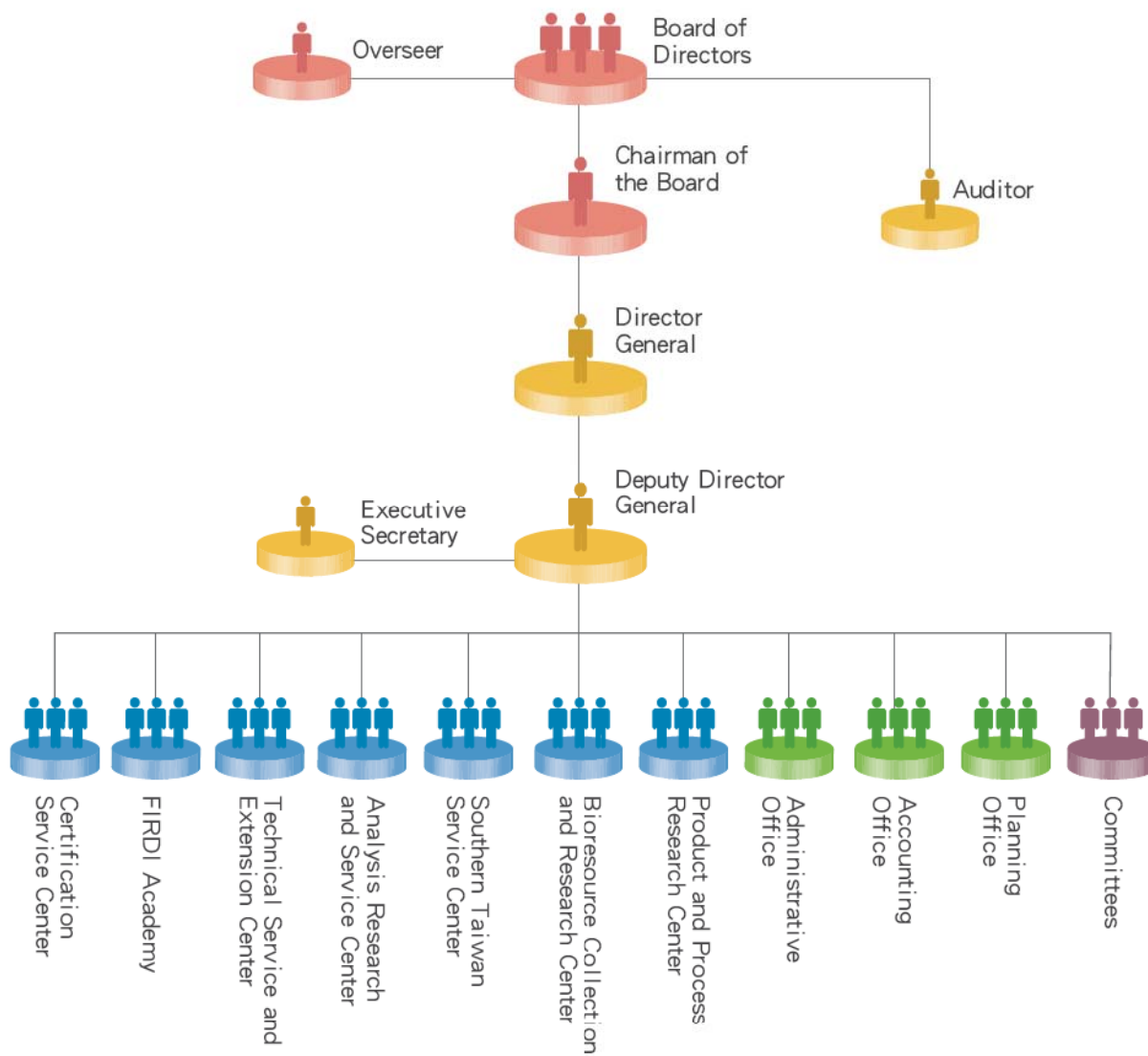
A handwritten signature in black ink, reading "Chii-Cherng Liao".

Dr. Chii-Cherng Liao
April, 2020

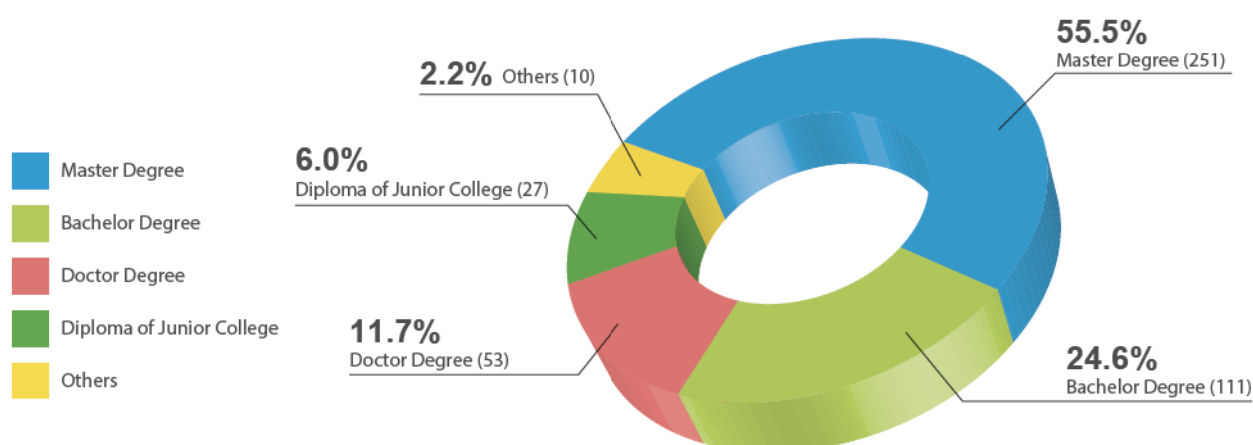


Organization and Human Resources

Organization



Human Resources



Number of employees : 452 (Dec. 2019)



Management team of FIRD



Technology Research and Development

Research and Development on Products and Processes

Commercialization and value-addition of agricultural and husbandry materials

Vegetable and fruit products for clean labeling concept: Banana starch containing resistant starch was developed via freeze-drying and grinding of bananas with different ratios of ripeness, of which, not only has better swelling power, but also with high barrier packaging materials that maintained stability of this powder as well as improved product quality and widened the raw material usages. In addition, a Citrus juice product that met CNS natural juice standards was developed by using the size reduction technology, part of the Tankan peels were added back to the Tankan (*Citrus tankan*) juice products. Moreover, jam products were developed without using pectin, artificial flavoring, colorants, syrups and preservatives. These products all fulfilled the concepts of whole-object utilization and clean

labeling, besides can be stored and distributed at room temperature.

Phosphate-free chicken sausage and restructured chicken burger products: Processing technology to replace phosphate with natural ingredients was established by applying natural ingredients such as liquid egg white or mushrooms to poultry processing products, as a consequence, chicken sausages and chicken burger products that complied with clean labeling with no phosphate addition were made. The product not only has good water retention, but also its texture hardness, adhesiveness, and mouth resistance have no significant differences from those of phosphate-added products.

Egg white gel manufactured foods: Manufactured products using sterilized liquid egg white as a raw material together with the gel technology was developed. These products could be stored and



Vegetable and fruit products for clean labeling concepts: banana powder (left), citrus juice and jam products (right)



Phosphate-free chicken sausage and restructured chicken burger products



Egg white gel prepared foods

distributed at room temperature and retained the nutrient of protein at the same time. In addition, the team helped industries to build up manufacturing processes and product specifications, of which these product qualities and textures were analyzed, protein-rich and low-cholesterol products were developed, which were meant to be easy to transport and distribute.

Technology of food texture design and products



Fermented wheat bran, whole grain flour with fermented wheat bran and high-fiber breads

High-fiber wheat bran baking products: Using wheat bran, a by-product via processing wheat, with solid fermentation and fiber hydrolysis process, the fermented wheat bran with good palatability and digestibility was developed. The processing properties of the mixture of flour and fermented wheat bran were improved. The fermented wheat bran stuffing in bread would be raised by 20-25%. Flour mills company, for example, would be benefited through this fermented wheat bran produced by food ingredient manufacturers by development of the whole wheat flour with fermented wheat bran. The fermented wheat bran also could be applied to high-fiber bun and toasts in bakery industry. A food industry & academia research alliance was established comprising a wheat flour mill, a bakery supplier and a bakery manufacturer.

Instant adzuki bean soup: The instant adzuki bean soup was manufactured via food texture design technology. This technology included pressure regulation, hot air dry with expansion and patented pneumatic dryer. Surface and internal microstructure of adzuki bean were modified via applying this technology, which then be transformed into instant adzuki bean. The instant adzuki beans could be ready to serve by adding water and using microwave for reheating. After rehydration, the adzuki beans had maintained their complete shape and flabbiness mouth feel. This technology had been transferred to manufacturers and diversified instant legume products were developed.



Instant adzuki beans

Modification of plant fiber: High temperature pressure processing and plasma activated water treatment were applied to improve water and oil holding capacity of plant fibers, such as okara, oat and corn fiber. The modified fiber could be used as clean label emulsifier and thickener.

Functional food ingredients: Polysaccharides and animal/plant protein ingredients were screened for evaluation of the emulsification and thickening characteristics. These functional ingredients were applied to creamy corn soup and fish sticks. It improved the oil-water separation of soups and still maintained a good texture, adhesiveness and crispness of fish sticks coatings.



Technology Research and Development



Coating with protein fibers using food electrospinning technology

Novel processing and application

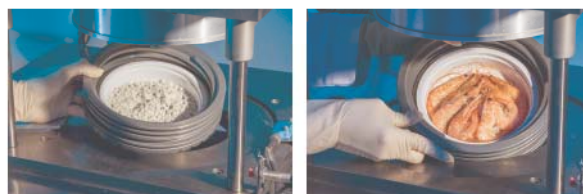
Construction of food electrospinning experimental platform and development on related processes: Food electrospinning is a novel technology for manufacturing fibers smaller than micron level diameters. Through organization and coating, product structure could be strengthened and functional properties could be improved. A food electrospinning experimental machine with a coaxial / blended function has been constructed to prepare protein fibers with a diameter ≤ 100 nm, a size similar to muscle fibers, giving the food a new texture structure. In addition, nutrients and flavors can be coated with the fibers, with high stability and coverage rate $\geq 90\%$, which improves the yield and product performance significantly.

Novel film coating for food safety improvement:

The DRD#2B empty can is made of TFS coated with novel film coating, consists of hydrophilic modified polyolefine. The major compositions of this modified polyolefine are polypropylene (PP) and polyethylene (PE) with the absence of bisphenol existence, which provided an alternative contact surface of can-food, for instance canned foods such as canned tuna in oil

and mackerel in tomato sauce are suitable to use this package.

Application of microwave assisted thermal sterilization in food pasteurization: The microwave assisted thermal sterilization technology (MATS) has the characteristics of energy conservation, volumetric heating, improved product quality, reduced time and operational cost, etc. MATS could be used in flavor powder pasteurization, which improved the heat transfer efficiency and reduced the numbers of pathogenic bacteria in a short time without flavor loss and quality deterioration. It was also used to pasteurize prepared foods, such as wine shrimp products, and the shelf-life could be extended from 10 days to 2 months at 4 °C. This technology could meet the consumption patterns of the unmanned economy in the future and open up new business models.



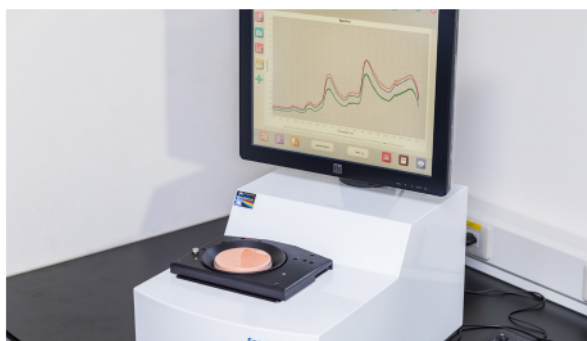
Application of MATS in flavor powder and wine shrimp prepared foods pasteurization

Construction of food 3D printing platform and development on related processes:

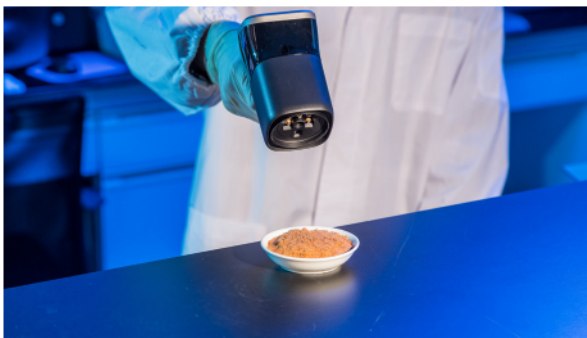
Food 3D printing is a novel technology that combined traditional food cookery and scaffold layered additive manufacturing. Based on the existing experimental machine with extrusion / molding temperature control function, double nozzles and spot spray functions were added this year. Combined with structural design and food material database among with new functions, the printer could prepare imitation meat slices with a variety of food materials (protein, polysaccharides and lipids), which could solve the problems of inadequate printable materials, 3D product styles, low product accuracy and yield problems.

Applications of sensing technology in food processing

Real-time optical monitoring systems for meat qualities: FIRDI combined transdisciplinary talents to form a food optical sensing system



Non-destructive near-infrared spectroscopy equipment



Hand-held color meter



Trial production of plant protein products using food 3D printing technology

development team. A hand-held color meter and a portable food composition analyzer were established for checking the end point of roast processing and predicting the basic composition of meat slurry. These devices have already applied to products like pork floss and hot dog. This technique has improved the stability of product quality by standardized data evaluations, which replaced naked-eye judgment and conventional time-consuming chemical analysis. In addition, it increased the efficiency of formula controls and manufacturing processes meeting regulations.

Multiple sensing systems for fruit quality evaluation:

FIRDI have established optical (near-infrared spectroscopy and imaging system) and physical (hardness) detection systems for fruit quality evaluation objectively. The quality parameters such as sugar content, total soluble solid, appearance color and hardness were analyzed and digitized by corresponding systems. Moreover, these values of quality parameters and data collected using sensory evaluation systems were analyzed via multiple logistic regression analysis, for the establishment of the fruits quality predicting models. The quality predicting models of muskmelon and kiwifruit were established. This technology was expected to be a potential tool for marking levels and determining processing conditions in the food industry.



Technology Research and Development

Integrations in Processes and Equipment

Development of key equipment and processing technology for particulates contained beverage

Development of the key equipment for particle-contained beverages: Establishment of parallel sterile storage tank and pipeline control technology, which can be used as high-temperature sterilization back pressure device for beverages containing particles, was achieved. This allowed the reduction of the breakage rate of particles in the beverage and is already in used

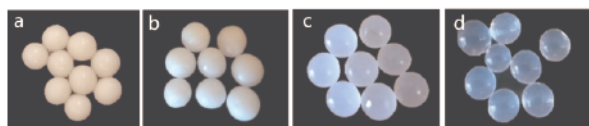
on market. The sterile storage tank hardware conforms to the principles of hygienic design and could be effectively clean-in-place (CIP), i.e. the equipment was sterilized by high-temperature steam, sterile air and steam barriers, which could effectively be used to protect the beverage from microbial contamination during production. It could also be connected with aseptic filling equipment for particular beverages for packaging operations, so that it could maintain the best integrity and flavor.



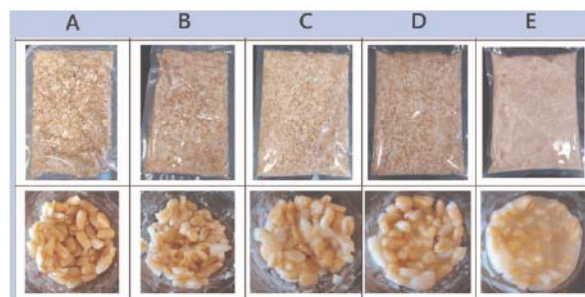
The development of the key equipment for particle-contained beverage sterilization system

Aseptic processing and packaging pilot test of particle-contained beverage: Particle heat resistance and fluidity were evaluated through ultra-high-temperature processing platform. The liquid food production equipment and process optimization technology were combined to provide customized process design and product storage stability assessment based on the

manufacturing equipment of the industry. This process allowed customized pilot test of particle-contained beverage services, which shortened product development durations.



Grain matured process technology



Heat-resistance particle formulation and process technology

Smart cooking system and quality predication technology for prepared foods

The integration of cookary system and smart components: A Smart Reheating System consists of different energy reheating technologies was developed. This system involved a barcode reading device and temperature feedback programs, which comprised with microwave, infrared and hot air for conditioning food reheating process. The combination of energy reheating technologies and smart cooking machine allowed the reheating qualities of pre-baked prepared foods improved significantly. This research allowed the establishment of the qualities database of temperature, color, texture and sensory for future evaluation references.

Combination of energy reheating and quality adjustment techniques for prepared food: Database of temperature, color, texture and sensory evaluation for smart cooking system used specifically for automatic re-heating prepared food process was set up by the establishment of complex energy re-heating technology standard testing platform. The reheating processing for prepared foods in convenience stores, food & beverage chain industries, could be significantly improved in terms of reheating qualities. All the results could be used as the foundations for the development of smarter reheating process in food industry.



High temperature resistant container



Smart Cooking System



Frozen chicken nuggets reheating by Smart Cooking System

Oven-safe package material for prepared food:

The oven-safe and microwaveable material used for making transparent containers was developed. This container was composited of paper-plastic complex. By combining precisely designed air-circulation and microwave penetrations, the temperature distribution problems caused by container materials for frozen food during reheating were resolved. The lamination strength of the containers was increasing by double layer coating that overcame the delamination of containers during high-temperature cooking over 200°C, thus this material, in combination with previous re-heating smart cooking technologies, could be used for prepared food product packaging directly in microwave smart cooking combination system.



Technology Research and Development

Services and Value-addition of Bioresources

Quality improvement of BCRC operation

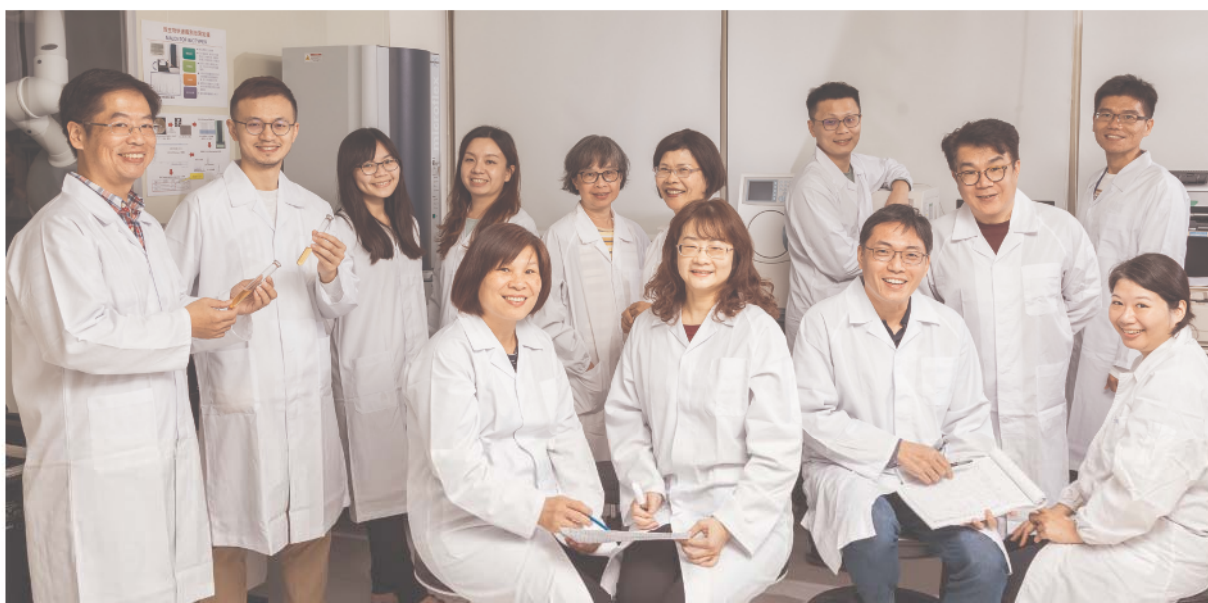
BCRC obtained multiple quality management certifications: BCRC of FIRDI is the only bioresource repository facility in Taiwan. It aims to continuously improve and maintain a world-class bioresource banking facility and provide diversified services to the industry, as well as participate in the development of the bio-economic industry actively. In 2019, BCRC passed annual authentication of ISO 9001:2015, ISO 17025:2017 and ISO 17034:2016 certifications, which ensure continuous delivery of high quality testing technique and services.

In this year, BCRC received a total of 92 deposition requests of biomaterials, and assisted over 30 local companies and 4 overseas universities (from Japan, Italy, Australia and India) to preserve a total of 498 important biomaterials. This shows that the preservation and management quality of BCRC has been recognized by the scientific

communities all over the world. BCRC actively assisting the development of the bio-industry, the center provided a total of 4,637 batches of biological resources, and completed 1,217 cases of commissioned testing and identification services in 2019.

Promotions of the exploration and value development of novel marine bacteria resources:

Metabolites of halotolerant microorganisms (such as marine bacteria) could be used as highly effective moisturizing beauty products, special flavor additives and natural antibacterial agents. However, the special ion and osmotic pressure requirements made it difficult to culture and hindered its industrial application. The cultivation technology of fastidious microorganisms with the expertise in microbial identification was combined for promotion of the exploration and value-addition of novel marine bacteria by industry, academia and research party.



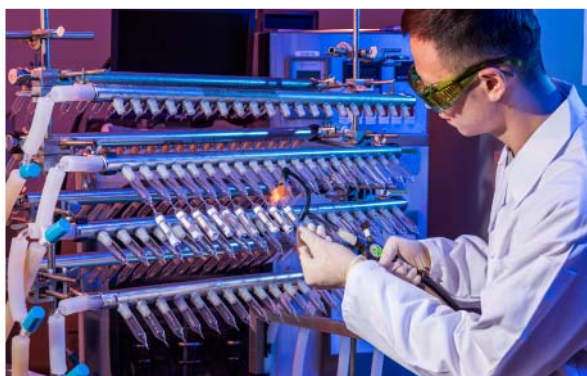
Microbial Identification Technology Team



Strictly anaerobic operation platform

In 2019, a halotolerant marine microbial culture technology platform was established, and 400 strains of marine bacteria isolated from seawater and marine sediments in the offshore southwestern Taiwan were collected. This special collection covered a total of 50 genera and 96 different species, which could be provided to the public for further functional screening and development of their market-value.

Together with Biodiversity Research Center, Academia Sinica, this team has been the first successful case in the world to isolate and culture the strictly anaerobic endolithic green sulfur



Preparation of microbial freeze-drying vial for preservation

bacteria from the coral skeletons of *Isopora palifera* and published in the scientific journal, *Microbiome*. Cooperation with the Institute of Oceanography, National Taiwan University was also there to isolate and identify a new marine bacterium, *Dongshaea marina* BCRC 81069^T belonged to a new genus and published in the journal, *IJSEM*.

Promotion of product development via increasing the diversity of lactic acid bacteria collection:

In gut microbiome research, people noticed that microbiota directed foods (MDF) regulate microbiota in human gut for health benefits. FIRDI has cooperated with other institutions to collect lactic acid bacteria from breast milk, infant stool, and old dough in recent years to enrich diversity of bifidobacteria, lactobacillus, and lactococcus species. Technology was also established, which could rapidly analyze the cell counts and growth of lactic acid bacteria by flow cytometers. This new technique would accelerate the development of novel MDF and fermented food products in the future.



Technology Research and Development



FIRDI - NITE bilateral MOU and Agreement Signing Ceremony in Tokyo, Japan.

The extension and investigation on the diversified fungal resources in Taiwan:

In 2019 a total of 80 versatile fungal strains belonging to mushroom, entomogenous fungi or *Trichoderma* species were collected and well preserved. In order to encourage the efficient and sustainable usage of these bioresources, the antagonistic activity against plant pathogens and the immunomodulation properties of medicinal mushroom were evaluated. In the other hand, the relative techniques of bioflavour-synthesis products derived from the microorganisms and the technique and processing in dry-aged meat products was established. The useful bioresource and professional service has been provided to the agricultural or biotech industries.

Development of alternatives to animal testing:

The global trends of alternatives to animal testing have been emphasized in recent years. Following the OECD 442E guidelines, BCRC established the platform of skin sensitization compliance to international standards by using human monocyte cell line to provide the testing services for cosmetics and medical devices.

FIRDI-NITE Bilateral MOU: In 21st of January, 2019, NITE (National Institute of Technology and Evaluation), Japan, and FIRDI signed a bilateral Memorandum of Understand (MOU) and Agreement to enhance the cooperation with respect to bioresource collections, identifications, distributions, usage of bioresources, as well as biosecurity issues in both technical and information sharing. Deputy Director General of FIRDI, Prof. Tony, J. Fang and Director of BCRC, Dr. Gwo-Fang Yuan represented FIRDI in the signing ceremony in Tokyo, Japan. This bilateral MOU and Agreement will not only prompt the services but also enhance the reputation as well as visibilities for both parties



Detection and analysis of microbial biochemical characteristics

Industrial applications of biological resources

Product development and business expansion in mushroom industry: To increase the output values of the mushroom industry, the value-addition applications for the byproducts were developed this year. Development of mushroom seasonings and conditioning foods by fermentation technology, enzyme-assisted extractions, and ingredients as well as formula technology were supported using BCRC knowhow to the industrial community. Moreover, the spent mushroom substrate (SMS) has serious impacts on the environments. For the sustainable agricultural and mushroom industry, several products such as biofertilizer, microbial pesticides, and probiotic feeds were developed from the spent mushroom substrate and mushroom stump.

Development and industrialization of the baking yeast: Microflora of old dough was analyzed and more than one hundred local yeast strains from old dough, fruits and flowers of Taiwan were collected. Furthermore, the database about fermented characteristic of these collected baking yeasts was set up. Based on the analytical results using this database, 15 baking yeasts that have potential to apply in commercial were developed, which could help to increase the diversity of local yeast starter collection.

Development and industrialization of Craft Beer: Along with the abundant bioresource of BCRC, a key platform for upgrading the local brewing industry, especially for the craft beer manufacturers were built. Via screening of potential yeasts with specific aromatic flavors, these yeasts were also examined with a quite representative practice on the purine and ethanol behaviors. In aiming the exploration of craft beer involving low purine, low ethanol as well as special aromas in Taiwan, the design of

beer starter to foster the competitiveness and diversification of craft beer were focused.

Application and value-addition of biotransformation on the processing of red quinoa: To improve the benefit of red quinoa in Taiwan, a key platform for the removal of sugar residues using different strains was established. This platform has exhibited pretty promising results for value enhancement via biotransformation. Taking various sugar residues into consideration, the objective strains with over 95% of saponin reduction were selected, which led to a more nutritious and highly edible red quinoa after biotransformation.



Combination of craft beer development with local agricultural products in Taiwan



Yeast starter with special aroma for beer production



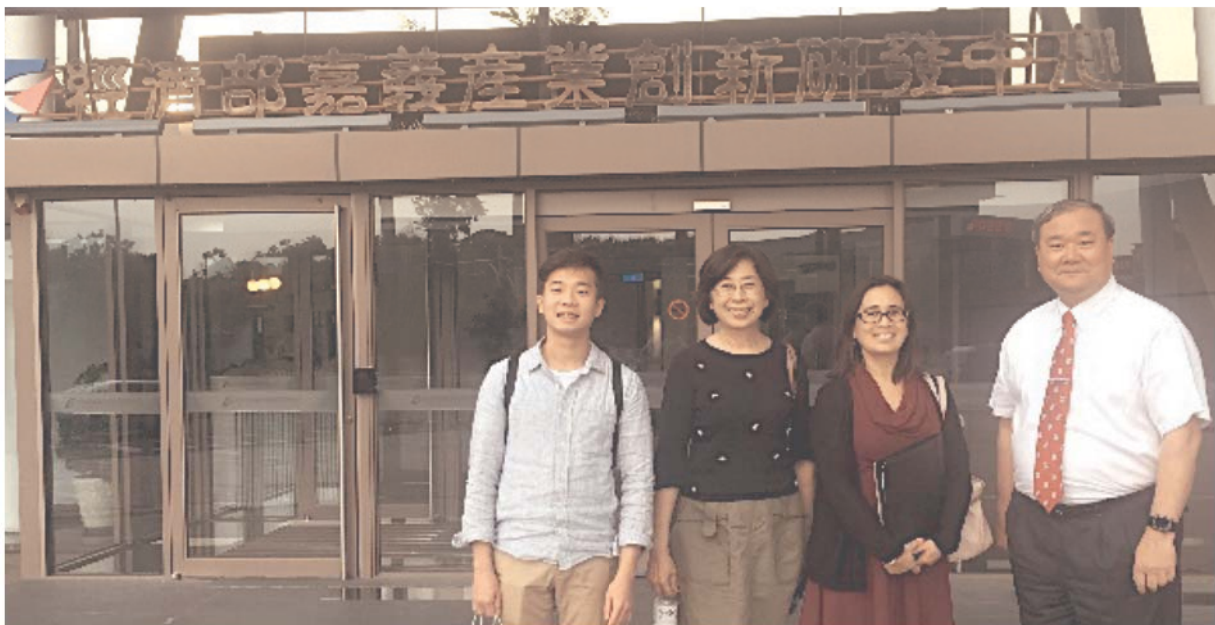
Red quinoa and its samples with biotransformation



Industrial Services

Operating Chiayi Industry Innovation and Research Center(CIIC), MOEA

FIRDI has assigned by the Ministry of Economic Affairs (MOEA) to operate the administration and research functions of CIIC since 2011. FIRDI has been continuously working on the promotion of CIIC, as the benchmark for innovation and as a health-oriented technology transfer and application center through integrating resources of industries, government, academia and research institutes in Southern Taiwan.



AIT Kaohsiung Deputy Branch Chief, Suzanne Wong, visited CIIC in May, 2019.

Integration of service capacity to assist local industry in innovative research: In 2019, 104 firms were visited for R&D problem-solving services, 46 conferences and training courses were held within total of 1,578 attendees sharing and further training in professional knowledge. Since the establishment of the Food Safety Inspection Center in 2011, 316 firms had served, in addition, a more convenient and faster testing service for the local food industry were provided. Moreover, in 2019, the 9 research communities set up by the research institutes stationed in CIIC have held 13 forums on specific topics, expecting to stimulate innovative ideas and cooperative opportunities

within these knowledge-sharing platforms.

Integration of institutional resources and promotion on innovation of industrial technology: The "Demand-planning of Local Specialty Industries" program, which has integrated the capabilities of CIIC's four research legal parties, provided technology service model for pilot production implementation, real-life experiences, and product commercialization to assist technology-upgrading of local industry. In 2019, 13 firms had worked with research institutes in CIIC as business tenants and 54 pilot plant services were provided correspondingly. CIIC,



Participantes del Curso de Relaciones Exteriores, MOFA, visited CIIC in June, 2019.

in 2019, has assisted 13 cases/firms obtaining central/local governmental sponsorships in R&D subsidies with 8,410,000 NTD in total.

Facilitate the cooperation between academic and research institutes to serve local industry:

CIIC has constructed and operated the Research Resource Integration and Service Network (RRISN) website by integrating resources of the academia and research institutes in Chiayi/Yunlin.

To date, 4 research institutes and 8 colleges in Chiayi/Yunlin have been uploading their service information and R&D outcomes to this website. Registered website members of RRISN platform would receive monthly newsletters with updated information, which hopefully could lead to knowledge sharing and higher page view counts for the website. There are already 125,000 views accumulated since the website had launched.

| Supervision on Rural and Offshore Islands Industry

Offshore islands industry consultation:

Counseling local businesses in Kinmen with researching and developing of new types of souvenirs and gifts processed using local agricultural specialties and related products were performed. Hurdle technology, filling and binding technology, package and formula design key process technologies were introduced for the development of two series of shelf-stable beef products, i.e. beef sauce prepared food and

phosphate-free beef jerky. As a consequence, the problems of sluggish sales of beef caused by the use of a single beef cut in the Kinmen area were solved. Companies from Penghu were assisted in fields of product R&D, mechanical semi-automation design as well as health and safety consultations. Innovative products such as cactus chocolate, oyster crispy snacks, preservative-free neritic squid snacks and Matsu "red vinasse meat sauce" were successfully developed as a result.



Industrial Services

Rural industry consultation: Businesses in Dongshi Township, Chiayi, regarding "prepared vegetarian mushroom foods" and Qingliang Agriculture Farm in Taitung regarding organic plum extract chewing candy products with market differentiation characteristics were assisted, respectively. Advices were given to companies in Taitung that use fresh turmeric preservation technology for the production of turmeric sesame oil chicken soup products, of which specialty raw materials of the Taitung region were used as ingredients. Cross-fields investments, such as electronics industries together with the biotechnology industry were made with the linkage and consultation of FIRDI. Investment from the electronic industries were introduced to Taitung for founding local factories regarding the development of new products such as fruit and vegetable vinegar and red oolong

Kombucha, which have, as an initial purpose of, boosted the local economy and promoting industrial development.



Assisting businesses in Taitung for the development of fruit and vegetable vinegar

Supervision on Upgrading of Food Industry

Facilitation on process innovation and upgrades of prepared foods industry:

Advanced technology were applied for prepared food processing to overcome mutual problems of food processing, so that product optimization and rapid commercialization could be achieved. In 2019, a total of 15 cases were completed in terms of assisting in the development of: high-purity sesame lignin, red quinoa/carrot high-fiber baking product, nice flavor and function chicken essence using special feed or novel air-cooled chicken ingredients, freezing-resistance fish ball products, and new safe food packaging, etc.

Pushing the smart manufacturing in the food industry:

In 2019, FIRDI has provided consultancy services of process and equipment automation and digitalization for 35 food companies. 4 cases were successfully accomplished via integration of the smart manufacturing and process automation technique and improvement in product quality and reduction the labor costs were achieved. Exhibitions, matchmaking for SI suppliers & food companies, and project cooperation matchings were also held by FIRDI, which has led to a 300 million NTD investment in smart manufacturing food industries. . In addition, FIRDI has conducted training courses for managers in food industry to learn the key to smart manufacturing.

| Food Quality Assurance Services

Implement of Food Protection System to food

factories: In response to the global food safety management trend considering the impact of FSMA and other international standards upgrades, the group had gradually enhanced the functions of the on-line Food Protection Plan Builder (FPPB), which included the new off-line templates and updated the technical contents. FIRDI had supported 51 factories out of 262 factory reach-outs via FPPB which had successfully introduced the Food Protection System in line. Educational workshops and 2 international conferences had been held to expand besides strengthen the industry's horizon and capability on Food Protection

Promotion and improvement of catering industry implementing HACCP System:

131 catering businesses, with the help of the group in 2019, had voluntarily implemented HACCP system, at the same time, auditor's consensus meetings, caterers seminar briefing and food safety conference were also held. Based on analyses of past audit reports and results from unannounced on-site audits, catering business, with implementation of HACCP system, had no food poisoning report for six consecutive years.

Hygiene management and consultation for canned foods:

A total of 5 expert meetings on the relevant provisions and management improvement measures of thermally processed foods packaged in hermetically sealed containers manufacturing industry were held in 2019. Moreover, 2 basic and advanced training courses of food hygiene unit staff were held, respectively. Likewise, 3 symposiums on status of thermally processed foods packaged in hermetically sealed containers, 5 industry briefing sessions, 1 symposium with international experts on

thermally processed foods in hermetically sealed containers management were held. At the same time, Chinese translations of the regulations of 3 countries (organizations) on thermally processed foods packaged in hermetically sealed containers, as well as the Q & A manual for canned food manufacturing management was compiled and printed.

Furthermore, the production and management time of canned food were meant to be shortened. The "Professional Technical Training Course for Measuring Canned Food Sterilizing Value (first course)" was held to assist the industry for establishment of their own expertise in retort thermal distribution test and product heat penetration test. Two companies, meanwhile, had completed FIRDI's qualification evaluation of self-established sterilization conditions and were approved by expert committee of FIRDI with qualified reports issued, of which measurement on the heat distribution of sterilization equipment, evaluation the sterilization conditions and sterilizing values of various products could be executed independently.

Establishment of the quality index and best before date of processed frozen agricultural vegetable products:

The preservation of bulk frozen agricultural vegetables (onion, leek, broccoli, corn, potato, bitter melon, cauliflower, sweet potato, cowpea) were evaluated, and the feasibility of frozen preservation of leafy vegetables (cabbage, Brassica napus, bok choy and kale) were tested. These results assisted frozen vegetable processing industry to optimize process and enhanced self-management, at the same time, established reference basis for the best before date of frozen vegetable preservation, on which, could be used as a connection and diversified application for the development of frozen vegetable supply chain.



Industrial Services



Food industry upgrade and transformation counselor workshop

Food factory Good Hygienic Practice guidance: Food Good Hygienic Practices (GHP) and technical consultation, diagnosis, and counseling have been completed upon 352 factory visits in 2019, in which, 36 factories have completed industry upgrade and transformation, including newly built factories, additional production lines, faulty product problem-solving and prevention, as well as the hygiene and

safety of local characteristic industries, etc. 14 management seminars and food factory technical training classes, in addition, had been conducted to assist the food enterprises in setting up along with implementing GHP standards and process management, which, as a consequence, enhanced industrial quality assurance capabilities.

| Analysis and Knowledge Services in Food Industry

Provide dynamic analysis and industrial knowledge services for food industry

Information regarding policies and regulations that affect domestic and export sales of local food products, new products and new technologies, as well as food product consumption and market development trends was collected. News on market trends were updated monthly, and total

number entry was over 1,000 through this year. The food industry knowledge base and the theme community's information on market development trends and analyses were also continuously updated. All information was disseminated and shared to external parties via publications, online articles, emails, seminars, sharing sessions, and conferences. Food industry knowledge bases, theme community membership system, and the

ITIS Intelligence Network are also continuously promoted to provide members and communities with first-hand information and trends.

Various seminars, such as "Future Business Opportunities - 2019 Taiwan Elder-Friendly Food Industry Chain Development", "2019 Global Food Industry Trends - Sharing of ITIS Concept by Food Industry Research and Development Institute", "Business Opportunities of Changing Plant-Based Foods and Lifestyles", and "Food Value Creation in the C2B Era" were held. Regular conferences for food industry marketing enhancement alliances, free presentation services for trade unions, and customized presentation services for enterprises were organized for assisting the government and manufacturers in promptly grasping changes in the environment. And Launch the "Eatender label" for encouraging the development of elderly-friendly foods, and strongly suggested manufacturers to apply on products to utilize the "Eatender label" on product packaging and marketing.

Publication of the Food Industry Survey and Annual Reports

Publication of the 2019 Food Industry Annual which provides a comprehensive overview of the industry in various regions including the United States, Europe, Japan, China, and Southeast Asia. It also analyzed foods and related industries in Taiwan as well as global trending topics, including the 2030 forecasts, news in food productions and machine collaborations, insights on food microbiology, and cutting-edge innovations. It was presented mainly through graphs and tables, which provide a read-ease keynote presentation. New topics covered in the 2019 edition, broadened scopes of the Annual, including analyses of the Middle East, Australia and New

Zealand, as well as vegetarian foods, casual snacks, etc. Developmental in Food industry of Taiwan has been recorded in detail that provided future directions for the industry.

The local industry research topics, including dairy products, meat products, beverages and other related industries, were conducted and published. Labeling issues of agricultural products also analyzed. Similarly, food and meal consumption analysis via food consumption surveys, industry business outlook and demand surveys of Taiwanese were investigated based on current local eating lifestyles. Online surveys and qualitative research on food demand of Indonesia, Vietnam, and other South-bound countries were also performed, constantly. Publications included forward-looking analysis reports e.g. a blueprint for 2030 food trends, artificial intelligence (AI), foods of the future, plant-based Ecosystem, virtual food distribution channels, social media revolution etc. Digital and multidisciplinary researches were also conducted in collaboration with the Market Intelligence & Consulting Institute (MIC) of the Institute for Information Industry (III) and Taiwan Textile Industry Research Institute.

Customized market research, including studies on the applications of AI within the food industry, social media trend tracking, and the ASEAN food industry, were conducted to meet the needs of the industry. In addition, multiple analyses, forums, and industry chain summits (including those between Taiwan and Thailand and Taiwan and Malaysia) regarding the international export environment and international business opportunities were completed. This is beneficial to the expansion of collaboration and business opportunities between Taiwan and ASEAN countries.



Food Inspection and Safety Evaluation

The Analysis Research and Service Center (ARSC) of FIRDI was an ISO 17025:2017 accredited food testing laboratory that provides inspection services which complies with the requirements of international standard. ARSC has been granted 584 accredited testing items from the Taiwan Food and Drug Administration (TFDA) and 972 accreditations from the Taiwan Accreditation Foundation (TAF).

Optimization of Service Quality

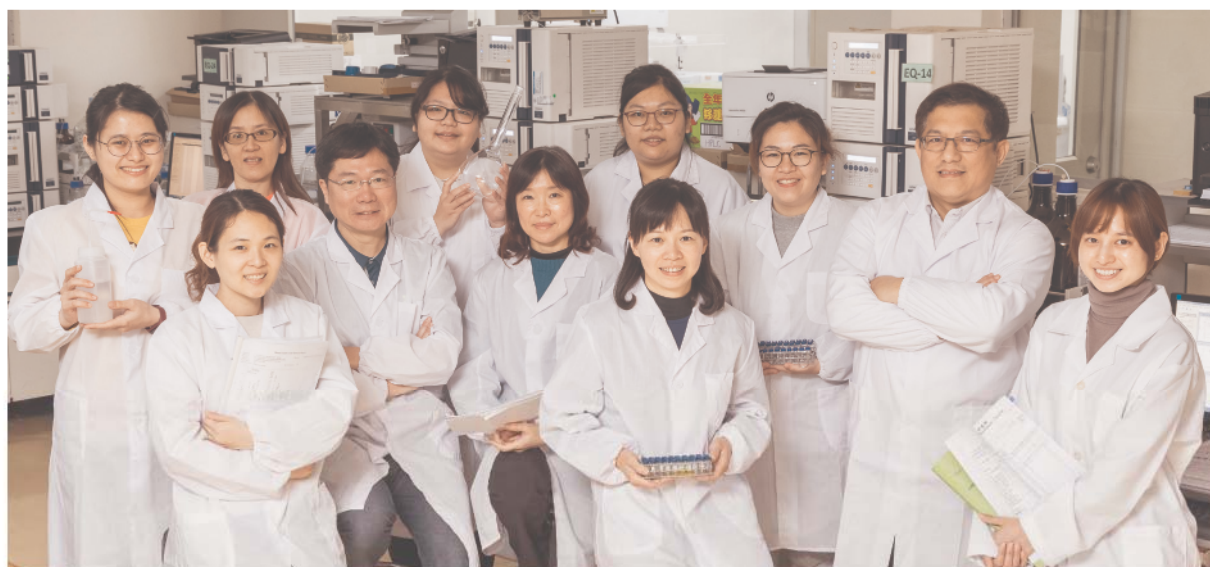
International accredited and registered testing laboratory:

To expand product exportation, FIRDI has actively strived to become an accredited testing laboratory registered in several countries. The Institute currently holds accreditations from various countries and regions: the Export Public Inspection System certificate for 584 items issued by Japan's Ministry of Health, Labor and Welfare; fishery product inspection certificate for 17 items issued by the European Union; drink, vinegar, and wine inspection certificate for 21 items issued by Brazil; fresh crop import (including fruits, vegetables, grains, nuts, and tea) inspection certificate for 184 items issued by the Indonesian Agency for Agriculture Research and Development; maleic acid (anhydride) inspection certificate issued by Singapore; and the National Treasury Agency

certificate on plasticizers inspection in alcohol exports for 9 items.

Consultation on laboratory accreditation:

To serve and assist the industry in adhering to the Act Governing Food Safety and Sanitation as well as the Three-tier Quality Assurance System for Food Safety, FIRDI has been providing consultation services, such as hardware planning and personnel training, for companies interested in establishing their self-management laboratories of the first-tier quality assurance that meet international standards. For companies who would like to set up their own accredited contract testing laboratories that meet the standard ISO 17025: 2017, FIRDI had assisted hard and strive for them to become a qualified contract testing laboratory of the industry.



Food adulteration identification team

Expansion in Scopes of Technical Researches

Establishments in adulteration identification

techniques: Food adulteration identification, such as purity of fruit juice, Bird's nest, Honey (corn fructose, sucrose) and rice grade inspection services, e.g. Pure Rice Vermicelli and Pure Rice Flour (Corn Starch), of FIRDI are unique in Taiwan. By integrating equipment such as Gas Chromatograph Ion Mobility Spectrometer (GC-IMS) and Gas Chromatography Mass Spectrometry (GC-MS), novel high-value food testing services regarding differentiations in spectral profiles with respect to volatile components in food products could be identified. Databases of volatile flavor compounds, inorganic elements, and free amino acids with multiple eigenvectors for dripped chicken essence products was established via the combination of the above techniques, which has led to an adulteration detection model to be constructed. This technology has obtained the patent of the Republic of China, in addition to the ability to identify commercial chicken essence products with substantial accuracy and could also assist the industry to optimize product quality management.

Assessments on product quality and

specifications: This assessment technique can monitor and evaluate the quality specifications of the specific products. By using statistical analysis techniques, the main component database was established to identify the differences between samples. This procedure could help the industries quickly assess product qualities and enhance the production efficiency. In addition, the quality assessment service of food product has been continuously deepened. The assessment system combines with the GC-IMS, the chemical analysis technique and the sensory evaluation were in place to establish the volatile composition

fingerprints database for product quality monitoring, which allowed the manufacturers to identify the product deterioration factors, of which to be the basis of development in terms of product quality improvement and production time and cost deductions.



Food additive specifications inspection

The inspection service for food additive specifications:

Continuing the developments and verifying testing methods of food additives, confirmation on the applicability and specifications of food additive were accomplished. Complied food additive specifications and food additives inspections themselves, examination performance were speed up. Thus, the safe use of food additives and its managements could be further secured. In 2019, food additive inspection methods for β -cyclodextrin and boric acid have been developed and verified. Applicabilities for the inspection of food additives in 9 major categories of foods including salad dressing were assessed, of which 156 sample items were inspected and verified; 126 legal/illegal food additives and adulteration in foods had, at the same time, been inspected. 3 expert review meetings were organized to complete the revision and formulation of inspection methods.



Food Inspection and Safety Evaluation

Monitoring anomalous substances in commercial Chinese herbal medicines:

In order to survey the anomalous substances in Chinese herbal medicines in Taiwan, the herbs containing anomalous substances such as heavy metals, sulfur dioxide and aflatoxins were chosen in this project, of which the background levels of anomalous substances in the herbs were determined. Apart from the evaluation of the

coincidence rates about the current norms, the results could also be used as the basis for judging the preliminary screening of high-risk Chinese herbal medicines. According to the monitoring results, various suggestions of anomalous substances have been compiled to provide a reference for the competent authority to manage the health and safety of Chinese herbal medicines in the future.

Inspection Capacity Deepening

Food Composition Database and the Edible Oil Database in Taiwan:

The establishment of a food composition database not only helped the research of the dietary habits and characteristics of Taiwanese people, but also provided consumers with appropriate food composition information, which is the basis of the food nutrition labeling system. Maintenance and establishment, in 2019, for the "Taiwan Food Composition Database" has been continued, of which also assisted the maintenance and upgrade of the TFDA online database, user opinions, and computer programs.

Food adulteration data collection and corresponding database construction:

An information platform of food adulteration has been continuously updated. In 2019, a new section, "Drug Abuse", has been launched. This database, in the future, would be available to the public, thus the understanding of the possible fraudulent situation of food could be further educated. The future goal would be aiming for international information exchanges and alerts in real-time.

Evaluation of the freshness of raw chicken meat using GC-IMS with chemometrics:

A pattern recognition analysis based on volatile components was established and applied for determination on the freshness of raw chicken

meat. The new method was faster than traditional microorganism detection methods as well as chemical analysis methods and was much more environmental friendly. On the basis of huge amount of data, the database could support an online automated chicken meat quality determination and grading system.



Sample pretreatment for pesticide and veterinary drug residues testing



Certification Services

Various types of certification services do FIRDI provide including CAS Taiwan Premium Agricultural Products Certification, Second-level Quality Management Certification, Taiwan Quality Food Certification, FSSC 22000 Certification, SQF Certification, in which, all, are in compliance with ISO standards. In order to expand ranges of services, FIRDI has obtained accreditation for international schemes, such as accreditation by JAS-ANZ for SQF scheme and FSSC 22000 scheme.



Dr. Liao, Director General of FIRDI, and Mr. Bill McBride, SQFI Representative, were co-hosting the Certification Ceremony of SQF Version 8.0

■ The Promotion of Governmental Certification Programs

CAS Taiwan Premium Agricultural Products Certification: The outcomes of 2019 key projects were summarized as follow: 85 cases on implementation on surveillance audits and 257 cases on sample testing for CAS certified products, 2 factories were serviced for products and processes improvement assistance. Other issues involving on-site inspections, projects meeting, strengthen certification management consistency, discussion on the industry development were also investigated for the requirements and future direction of CAS.

Promotion of seafood quality certification system: For the accreditation of premium seafood products, FIRDI has conducted surveillance factory inspections in total of 20 cases, with follow-up inspections up to 46 cases and sample testing for 74 cases. Contributions, moreover, in the renewal of raw material acceptance hygiene standard along with facilities and manufacturing process improvement and product risk control were also made. At the same time, FIRDI, meanwhile, had held the food safety regulation seminars for seafood industries to increase the public knowledge and awareness on food safety and hygiene regulation, as a consequence could enhance the legal compliance of each product.



Certification Services

The expansion of accreditation and certification system regulations for agricultural products:

TGAP standard for seven new categories of brewed soy sauce, tofu, fermented tofu, fermented bean paste, edible ice, chilled beverages, etc. were drafted. Guidelines, furthermore, for improving agricultural and grain industries were compiled after many visits to local industries as well as expert meeting discussion, finally a version of agricultural processing reference for the farmers was edited and published.

The promotion for agricultural primary production farm management system:

FIRDI has assisted in the edition and publication of "Administrative Measures for Primary Production Farms of Agricultural Products", in the meanwhile, promoted the industrial management strategies and policy communications. A total of 25 agricultural and grain product processing sites were visited, whereas 16 processing sites have completed the infrastructure planning, and improved the management system consistency from agricultural products production to primary processing.

Second-level quality management certification:

FIRDI has gained the recognition as an eligible certification body for second-level quality management certification since June, 2016. It was a mandatory certification scheme based on the Act Governing Food Safety and Sanitation, which is established by the Ministry of Health. FIRDI has accredited more than 500 facilities till the end of 2019.

The alcohol quality certification system: In 2019, on behalf of National Treasury Administration, FIRDI has conducted on-site assessment, factories consultation, new products review for a total of 44 production lines and 249 alcoholic beverage products. Followed-up inspections and random sampling for post-marketing monitoring plans were completed in a total number of 189 and 120 cases, respectively. Additionally, revision of the alcohol quality certification assessment standard for public regulation and held training classes regarding technology and process for wine inspection and other related issues were executed.



Seminar and educational training for the raw material seafood process risk control and analysis

Independent Certification Schemes

FSSC 22000 Certification: In 2018, FIRDI has applied for the recognition as FSSC certification body, and at the end of year, the accreditation from Australian accreditation body JAS-ANZ had been successfully achieved. 7 companies, since then, had been certified with the FSSC 22000. FSSC 22000 schemes was developed for the food manufacturing companies, it was managed according to ISO 22000 and ISO 22002-1 standards and now covered up to all food manufacturing related industry.

SQF Certification: FIRDI has obtained the international licensed as the SQF certification body. In this globalization era, SQF as one of the GFSI recognized scheme, was an important option for the local food industry to expand their business range to the international market as well as ensuring their quality assurance system in track with the international standard. Till the end of 2019, there have been a total of 10 certified SQF sites.

Taiwan Quality Food Certification (TQF): FIRDI has been certified by Taiwan Accreditation Foundation accreditation for the ISO 17065 standard and Taiwan Quality Food certification scheme. FIRDI could provide certification services, based on the scheme requirements, to several food sector categories. Currently, 161 companies and 189 production lines had passed the certification. This scheme, moreover, has aligned with the international standards, and FIRDI would actively cooperate with TQF for the harmonization between international certifications in order to assist local food industry to reduce any exportation barriers.

ISO 22000 certification: Since 2010, FIRDI has obtained accreditation from TAF as food safety management system certification body. Currently, the certification scope covers a large portion of food manufacturers and will continually expand to those manufacturing and processing enterprises in the food supply chain. This year, ISO 22000 has published its new version and a seminar regarding this topic was held by FIRDI in order to make the local industry understand the key differences in the updated version.



Office assessment of FIRDI conducted by JAS-ANZ

SQF Certification Ceremony: The SQF certification ceremony was held on June 20, which was attended by the SQFI Asia-Pacific representative Mr. Bill McBride to award 5 the most current SQF certified sites. These 5 certified sites are Flavor Full, Standard Dairy Products, Chen Hsiang Foods, Huaciang Industry, and Lien Hwa Milling Corporation. These industries not only have committed to the maintenance of food safety but have also obtained the highest level of SQF quality certification. FIRDI certification center is the only Taiwanese independent institution to achieve acknowledgement as SQF certification body and, since then, FIRDI has certified 10 sites for this SQF food safety and quality certification.



Industrial Personnel Training



Symposium for Qualification Assessment for Food Industry Talents

Profession Training and Education

Since its establishment, FIRDI has devoted itself to food-related professional training and has grown to be the largest food industry professional training institution in Taiwan. FIRDI Academy was established in 2015, for the development of cross-disciplinary innovative courses, cultivate diverse talents, and held qualification assessments. To improve the quality of training services, FIRDI Academy introduced and implemented Taiwan Talent Quality-management System (TTQS), and was awarded the Silver Medal for TTQS Training Organization Version in 2017 and 2019. FIRDI Academy has also become an international SQF training center that provided internationalized training courses. FIRDI was, in addition, committed to the integration of curriculum and occupational competency development. The "Basic Principles of HACCP" and "Principles of HACCP (Advanced)" courses had been accredited the iCAP (Integrated Competency and Application) logo by the Workforce Development Agency, Ministry of Labor. FIRDI Academy was, moreover, committed to the cultivation of interdisciplinary digital talents to improve the employability of food industry professionals, and therefore, was selected as an institute with excellent performance in training professional talents in 2019. To summarize, a total of 215 classes were offered this year, 6,866 people were trained and 6 qualification assessments were held with 6,582 applicants.

Training for industry in self-management and food protection: FIRDI offered 15 training courses of source-management/self-management system of the food industry and had trained 412 trainees, in 2019. In response to new trends in US FSMA and international food safety management, FIRDI also offered 14 classes of key technologies

in food protection and food safety program series with 264 trainees; hosted 3 international conferences that focused on the key strategies for the development of European and American Markets as well as troubleshooting for US custom detention.



Training for sensory evaluation methods

Food hygiene auditing training: With the purpose of strengthen the professional capability of the food hygiene inspectors from local health bureaus across the country, training courses of food regulations, HACCP, food poisoning investigation, and field simulation inspection were offered. This year, a total number of 24 classes were offered to 1,120 trainees.

Internationalized training program: International accreditation programs were introduced and offered publicly to the food industry, which allowed the food industry to stay in line with global management systems and be well prepared for the impact of changes in international laws and regulations. As the SQF training center, the lecturers of the Institute had obtained the qualifications of professional training instructors accredited by the Safe Quality Food Institute (SQFI) and the Food Safety Preventive Controls Alliance (FSPCA). In 2019, a total number of 2 "Introduction of SQF System" courses, 3 "Preventive Controls Qualified Individual (PCQI)" courses, 1 "SQF Auditor Training" course, and 1 "Implementing The SQF Quality Code Ed 8.0" course, were offered.

Food safety and regulation training: FIRDI has been offering HACCP courses, related personnel continuing education and training courses, and domestic food regulation courses for years. In addition, the Institute has taken root in food safety education by hosting food safety summer camps for senior high school students. The Institute also offered series of international food regulation and market trend courses specifically for the export industry, including FSMA practices, Halal certification and quality assurance, ASEAN food safety regulations and export practices, and product design strategies. FIRDI has held 20 training courses on "Management System of Primary Agricultural Products Processing Plant" and trained 1,206 trainees, in 2019, to improve farmers' knowledge of food safety management, and to assist them to obtain certificates for primary processing plants for agricultural products.



Group practice for seal integrity inspection



Industrial Personnel Training



Practice audition for HACCP of meat industry



Food factory visits for Food Safety Summer Camp High School Students

Qualification Assessment for Food Industry Talents

FIRDI held qualification assessment of "Food Quality Assurance Engineer" and "Health Food Engineers" for food industry talents. The former certification was issued by the Ministry of Economic Affairs (MOEA), and the latter was issued jointly by FIRDI and the Health Food Society of Taiwan. The assessment was approved by the iPAS program of the Industrial Development Bureau of MOEA. In 2019, 6 assessments were held in 92 test rooms on 46 examination sites across the country with 6,582 applicants. In total, 372 "MOEA Certified Food Quality Assurance Associate", 54 "MOEA Certified Food Quality Assurance Specialist", 409 Professional Health Food Engineer-Entry Level, and 10 "Professional Health Food Engineer-Intermediate Level" were certified. Throughout the year, FIRDI has conferred 806 certificates in total.

Recognition and supports by enterprises and schools: In order to promote the qualification assessment, FIRDI had signed recognition agreement with 275 companies which priority would be given to the certified applicants for interviews or hiring, and rewarded employees who passed the qualification assessment. FIRDI hosted two sessions of "Qualification Assessment of Food Industry Talents Symposium" for the industries, of which had invited companies for witnesses, high-level endorsements and rewarding employees who signed for the assessment to share their experiences. FIRDI, in addition, had also promoted campus cooperation schemes for qualification assessment by setting up test sites especially for students who registered for the assessment in groups. Supports from many universities were revealed by inclusion of the assessment certification as one of the

graduation requirements, or as an award program for student with professional licenses.

Follow-up surveys on the certificate holders:

In order to track the beneficial effects of the program, follow-up surveys were conducted on 1,671 certificate holders this year. 30 % of the certified employees got pay raise or received praise and open encouragement for higher performance rating. Also, 90% of the certified students were successfully employed when seeking for the first job, with a median salary of 28,981 NTD for bachelor's degree holders and 39,200 NTD for master's degree holders. Online services of corporate recognition and talent pool were added this year to provide information on job openings in the recognized companies, industry experts were invited to share endorsements and experiences, and network had been built with other certificate holders.



Special Reports

The "Offshore Island Industry Innovation and Consulting Team" of FIRDI has been awarded the 6th "National Industrial Innovation Award – Model of Local Industry Innovation Award, MOEA"

Since 2018, FIRDI has enthusiastically assisted local food industries in offshore islands like Kinmen, Matsu and Penghu to upgrade their businesses by using the energy of technology development programs and won the 2nd "National Industrial Innovation Award – Model of Local Industry Innovation Award, Ministry of Economic Affairs" in 2012 for outstanding performance. Since then, FIRDI has been providing this counseling service, continuously. "Offshore Islands Food Industry Innovation and Upgrading Consulting Team" has utilized the Project of Offshore Islands Guidance supported by the Industrial Development Bureau to assimilate central, corporate and local resources and keenly promoted industry innovation and development of offshore islands since 2016. Substantial achievement of the team, the 6th "National Industrial Innovation Award – Model of Local Industry Innovation Award, Ministry of Economic Affairs", again was awarded in 2019. Specific topics include:



Group photo taken after "Offshore Islands Food Industry Innovation and Upgrading Consulting Team" award presentation

Resolve the problems of industrial land and processing on offshore islands and development of innovative products: Step-by-step guidance, advices together with proposals regarding the rural planning made by county governments and companies for land development in the industrial parks on offshore islands were provided to assist the firms to fulfill the health and safety regulations and other standards. Semi-automatic equipment has been introduced to cope with aging

population and man power shortage issues, and to improve the quality of manufacturing processes. Businesses of outlying islands have obtained a total of 25.3 million NTDs from government subsidy programs since 2015, of which had developed 30 kinds of new products, promoted further investment of 48.76 million NTDs and increased output value to at least 50 million NTDs with the supervision of the team. The affected output value has exceeded 350 million NTDs.



Special Reports

Activating the offshore islands industrial chain and leading the development of Local Characteristic Industry with benchmark enterprise:

According to the features of each island, FIRDI has strengthened their industrial chain, such as "sorghum distillery residue and beef industrial chain" in Kinmen, "red vinasse and old wine industrial chain" in Matsu and "cactus fruit and scallop sauce industrial chain" in Penghu, and extended their application to cosmetics and tourism. FIRDI had, also, assisted Liang-Jin-Farm (sorghum distillery residue beef processing foods; Kinmen), Lin-Yi-he-Factory (red vinasse and old wine products; Matsu) and KueiShan International Ltd. (scallop sauce and aquatic processing food; Penghu) in becoming the benchmark manufacturer who led the development of industrial innovation.

Talent training and industrial innovation through cooperation of industry- government-university:

Collaborated with National Quemoy University and National Penghu University of Science and Technology, the "offshore islands industrial development consulting service platform" was set up to assist local businesses in providing real-time services. Local corporate

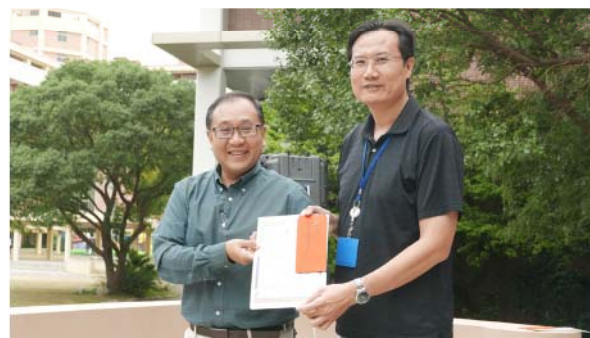
manpower and resources were strengthened, together with lectures and hands-on workshops held through the cooperation of local health promotion divisions, the design of blended courses, and micro courses based on GFSI international channel purchasing platform standards were introduced. More than 500 persons had attended the training courses.

Marketing of offshore islands specialty products and expansion of domestic and overseas sales channels:

Activities and events were organized to promote, exhibit and trade the agricultural and local products of offshore islands, these, at the same time, helped local companies in compliance to relevant regulations. Liang Jin beef hot pot has become the leading brand in Taiwan's supermarkets; whereas Matsu distillery has successfully entered the RT-MART shelves. Collaborations with local governments and Taiwan External Trade Development Council, international procurement meetings were held to match and procure global buyers. These events assisted Liang Jin and Lin Yihe Factory expanded their sales chain into the Chinese market. KueiShan International Ltd. has already entered the Japanese and Hong Kong markets.

| Initiation of AI Application in Food Industry

Besides the promotion and assistance in the food industry in terms of smart manufacturing and experts trainings, FIRDI formed a technological team in the food spectrum sensing system in 2018 to assist the meat-packing industry introducing a quality real-time spectrum monitoring system for the modern digital management process. This was achieved through collaboration with the graduate institute and undergraduate program of the Electro-optical Engineering Department



AI innovative competition proposal award presented by Mr. Mark Hsieh, Chairman of the Board of FIRDI



Initiate the mission of AI applications to the food industry in new era

at National Taiwan Normal University and optoelectronics companies for allowing the food industry to get ready for the rapid advancements of artificial intelligence.

This year, FIRDI launched comprehensive exploration and brainstorming of AI applications in various areas of the domestic food industry. New capacities have been introduced through phased implementations, which included building the consensus of advancement by means of AI workshops, organizing a "FIRDI preparatory planning group for AI applications", creating a database inventory that could establish, optimize, or be applied both outside and inside the Institute, to integrate the four major aspects of AI applications in Taiwan's food industry (R&D helpers, process efficiency, documented monitoring and modern services), and drawing up value memorandums for 19 case studies in the hope of leading the food industry of our country towards a promising future. Innovative competition in "AI applications in the food industry" aimed at the three major aspects:

"precise and efficient manufacturing processes", "R&D flip and acceleration", and "smart and effort-saving supervision" was held based on the value memorandum stated above, to fellow colleagues were invited to make proposals that would be subsequently appraised by experts from both inside and outside the institute. The proposals that were selected thereby were the priorities to be included in the execution of the innovative and forward-looking program to enable the fulfillment of future imaginations and the performance of new motivation and influence that will drive industrial innovation.

Furthermore, scholars and experts from National Cheng Kung University, National Chung Hsing University, National Taiwan Normal University and Chung-Hua Institution for Economic Research were invited to share topics of AI application and development in industry of food and biotechnology to expand the depth and breadth of practical applications by fellow colleagues in the AI industry.



Special Reports



Group photo of Mr. Ta-Sheng Lo (2nd from the left), General Director of Department of Industrial Technology, with domestic industry delegates at the press conference held by the Ministry of Economic Affairs

| Innovation and Application of Plant Protein-based Meat Products

The up growth of global vegetarian market looks promising. By 2020, the vegetarian population has been estimated to reach 30% around the world, and the vegetarian population in the United States, the United Kingdom and Portugal would increase by 3-6 times. The vegan population in Taiwan has also reached up to 12%. The flexitarian consumers concerning animal welfare, indulgence, and health have been ever more expanding. It was estimated that the global vegetarian market would grow exponentially in the next five years.

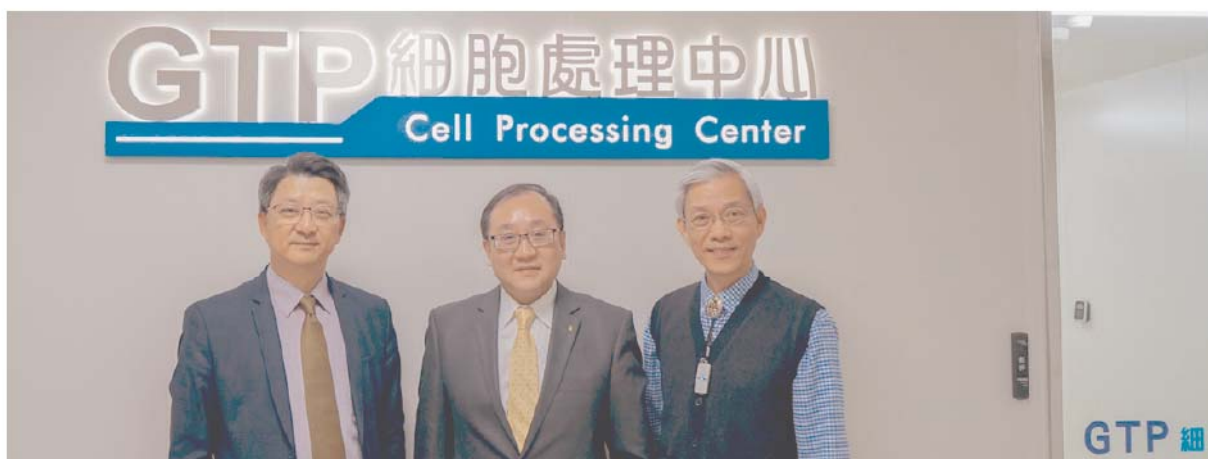
FIRDI began to investigate plant-based meat technology in the 1990s, and had developed the first-generation texturized vegetable protein (TVP) and the second-generation wet-type TVP products since then. Numbers of patented process and devices were obtained, that helped local vegetarian food manufacturers becoming the main TVP and processing product exporters globally. Nowadays, the export value of such products is nearly 670 million USDs annually. In 2019, FIRDI integrated advantages of food extruder and low shear devices for the

innovative development of the third-generation plant protein-based meats with fiber structure resembling as real meats. They can be directly prepared for consumption without secondary processes. It also met the consumer trends of less additives, eating healthy and animal alternatives.

FIRDI has cooperated with a number of domestic vegetarian food manufacturers for upgrading plant-based meat processes innovatively. FIRDI would, at the same time, provide services in alliance with the domestic industry chain to help them grasping the global plant-based meat market, which valued over 4 billion USDs.



"Innovative plant protein-based meat products", the show booth from FIRDI in Industrial Technology Focus Exhibition 2019, Taipei



The Chairman Mr. Mark Hsieh unveiling the "GTP Cell Processing Center"

Operation of GTP Cell Processing Center

Cell therapy plays a key role for development of new drugs in regenerative medicine. The basic requirements for manufacturing cell-based product were that the regulations of Good Tissue Practice (GTP) must be complied, in Taiwan. From 2013, BCRC provided the high quality GTP compliant facility and instruments to help the cooperated companies bridge the technical gap from business idea to startup.

In response to the urgent needs industry for GTP facility, FIRDI established the "GTP cell processing center" in 2019, providing 4 independent operating rooms and be suitable for producing various types of cells. Additionally, the management

system and quality control testing would support the cooperated companies, which may improve product development and manufacture processes. These services would foster the commercialization of R&D results and create values for cell therapy companies in the future.



Cell operating room in "GTP Cell Processing Center"

Advancement the Development of the Elder-friendly Food Industry

FIRDI has hosted elderly-friendly food appraise and elect events since 2016 to create awareness of food demands of the elderly among all industries, as well as to establish various technical and service platforms, thereby engaging in active efforts to promote the development of the elder-friendly food industry.

Establishment of common platform for development of elder-friendly foods: 133 products from 54 companies were selected based on product quality, nutritional value, texture, characteristics, packaging design, and portion

size plus meal preparation. Events to exhibit and support such products were also held to create important platforms and opportunities for the development of elder-friendly foods by domestic businesses.



Special Reports



Group photo of Dr. Liao, Director General of FIRDI, and Senior Specialist Fang-Chi Cheng from the Council of Agriculture with representatives of food businesses that obtained Eatender

Establishment for product R&D and consumption

insight service platform: Four texture levels were set after establishing preliminary procedures for solid and semi-solid foods, texture analysis and sensory evaluation methods, which allowed pioneering development of a tongue mashable product line in Taiwan. According to the characteristics of different ingredients and product packaging, furthermore, process of packaging foods at room temperature for elder-friendly was established, and technical services were provided to industry for development of new products. It could address the daily needs of home-dwelling elders or serve as back-office support for the food distribution system of nursing homes. Likewise, assistances were

provided to businesses for developing 6 products with different texture level, as well as new products and services through workshops for the design of elder-friendly meals and services.

Establishment of industrial chain and promotion platform:

The elder-friendly food label "Eatender" and texture level labels were designed, and 20 manufacturers have already filed applications for 44 products. In addition, elder-friendly meal tests and sensory assessments were carried out jointly by hospitals and food businesses to assist the latter in understanding product specifications and quality demand. Elder-friendly food counters were also set in sales channels to increase awareness by consumers towards the channels and the Eatender label.



Diversified product development of convenience foods appropriate for the elderly



Eatender was launched in 2019



Meaning behind Eatender



Official website of Eatender

■ Promotion of Overseas Cooperation and Exchanges

Thailand-Taiwan Industrial Collaboration Summit in Bangkok, Thailand: Led by the national federation of industries of both sides, the 3rd "Thailand-Taiwan Industrial Collaboration Summit" was jointly held by FIRDI and the National Food Institute (NFI) of Thailand on August 20th, 2019 in Thailand. About 480 industrial representatives who paid close attention to the four major aspects of food biotechnology, textile, smart city and automation from both countries converged on the site to carry out communications and business matchmaking talks before signing 7 letters of intent for cooperation, among which two MOUs were signed between FIRDI and the food manufacturers, food materials suppliers and food machinery traders from Thailand in the hope of maintaining focus on the issues deepening and increasing the industrial value of the forum cooperation platform.

Indonesia-Taiwan Industrial Collaboration Forum and Taiwan-Malaysia Industrial Collaboration Summit in Taipei: The 3rd "2019 Taiwan-Malaysia Industrial Collaboration Summit," the business conference and food, drug and cosmetic sub forum which was co-organized by FIRDI, took place in Taipei on October 3, 2019. To assist the domestic food industry in linking up quickly with the halal ecosphere, FIRDI signed a memorandum

of understanding that would help the industrial chains on both sides to jointly expand halal business opportunities in the future with Halal Industry Development Corp. in Malaise at the HDC venue. The 3rd "Indonesia-Taiwan Industrial Collaboration Forum" whose food biotechnology sub forum was co-organized by FIRDI was held in December of the same year in Taipei. Three items for future collaboration were majorly discussed, together with business communications and matchmaking talks carried out by industrial representatives from Taiwan and Indonesia.



Organizing the "2019 Indonesia-Taiwan Industrial Collaboration Forum – sub forum of food biotechnology"



Organizing the "2019 Taiwan-Malaysia Industrial Collaboration Summit – food, drug and cosmetic sub forum"



Planning and organizing the "2019 Thailand-Taiwan Industrial Collaboration Summit"



Special Reports

Awards Obtained in 2019

- The "Offshore Island Industry Innovation and Consulting Team" of FIRDI has been awarded the 6th "National Industrial Innovation Award – Model of Local Industry Innovation Award, MOEA". Dr. Liao Chii-Cherng, Director General of FIRDI, represented the team at the Ministry of Economic Affairs Joint Award Presentation Ceremony held on April 10 in Taipei.
- The "Acceleration of product development and technology transfer of functional food through microencapsulation domain", derived from BCRC's research achievements, was awarded the honor of silver medal of Taipei Biotech Awards, 2019.
- The awards given to the excellent researchers in the institute from the Taiwan Association for Food Science and Technology was listed as followed: Research Scientist Yo-Ji Zheng obtained the "Food Science and Technology R&D Achievement Award", Associate Research Scientist Bao-Hong Huang obtained "Mr. Zhang Tong Commemorative Patent Invention Award," Research Scientist Jun-Ren Lin and Zhi-Jia Yang obtained "Extension and Service Achievement Award." The awards were granted and recognized at the annual general meeting held on November 29, Taichung.
- "Activation of future preservation technology of agricultural products," the smart agriculture project plan of the Ministry of Science and Technology executed by our institute was granted the "2019 Futuristic Breakthrough Technology Award" and selected to be the exhibit highlight technology which partook in "2019 Future Tech (FUTEX), Leading Your Life" held by the Ministry of Science and Technology at Taipei from December 5th to 8th, 2019.
- Offshore Island Industry Innovation and Consulting Team and Eatender (age-friendly meal) Promotion Team of FIRDI was presented the "2019 Mr. Hsieh Cheng-Yuan Special Contribution Award" and "Mr. Hsieh Chung-Pi Innovation Award" by Mr. Hsieh Cheng-Yuan Food Technology Development Foundation, respectively.



The Food Industry Innovation Consulting Group for Taiwan's Offshore Island of FIRDI has been awarded the 6th "National Industrial Innovation Award – Model of Local Industry Innovation Award, MOEA".



The project team of "Activation of future preservation technology of agricultural products" has received the "2019 Futuristic Breakthrough Technology Award" from Ministry of Science and Technology, Taiwan.



Major Events in 2019

1

01/09

Visited by Mr. Prasert Pinpathomrat, President, Rajamangala University of Technology Thanyaburi (RMUTT), Thailand in a delegate group of 10 persons.



01/10

Held a signing ceremony for the memorandum of understanding concerning cooperation between FIRDI and Rajamangala University of Technology Thanyaburi (RMUTT), Thailand.



01/21

Bioresource Collection and Research Center (BCRC) signed a bilateral Memorandum of Understand and Agreement with National Institute of Technology and Evaluation (NITE) in Tokyo, Japan.



2

02/27

Held a retirement tea party for Dr. Gwo-Fang Yuan, the director of the Bioresource Collection and Research Center.



3

03/01

Dr. Gwo-Fang Yuan, the director of the Bioresource Collection and Research Center retired from her post on February 28. The position was taken over by Dr. Wen-Shen Chu starting March 1.

03/12

Visit paid by José Isaías Barahona Herrera, Deputy Minister of Foreign Affairs of Honduras.





Major Events in 2019

03/26

"The Conference to announce FIRDI's research achievements of 2019 and initiation of cooperation projects between industries and FIRDI" was held respectively in Hsinchu and Chiayi. (March 26 and March 28)



04/10

The Offshore Island Industry Innovation and Consulting team of our institute received the 6th "National Industrial Innovation Award – Model of Local Industry Innovation Award, MOEA".



04/17

Visited by supervisors and directors of the Food Industry Intelligent Automation Association Taiwan in a group of 20 people.



5

05/02

Visited by Prof. Yanyun Zhao, Food Science Department, Oregon State University, U.S.A. as part of a delegate group of 5 persons.



05/07

Visited by Jin-Pu Zheng, Deputy Inspector, Beijing Municipal Health Commission as part of a delegate group of 13 persons.



6

06/04

Visited by Mr. Sukoso and Mr. Amega Furi Masta, director-general and sales division chief of Badan Penyelenggara Jaminan Produk Halal, Halal Product Assurance Organizing Agency, Indonesia.



06/05

Organized press conference to present the results of the food technology development program at the Ministry of Economic Affairs.



06/20

Annual certification ceremony for SQF Version 8.0 was held in Hsinchu.



7

07/25

Visit paid by Mr. Indra Darmawan, Director of Regional Promotion Facilitation-Indonesia Investment Coordinating Board, Indonesia, as part of a delegate group of 11 persons.



07/25

Partook in the "2019 Bio Asia Taiwan International Conference and Exhibition" held in Taipei. (July 25 to July 28)



07/26

The R&D achievements of "acceleration of product development of technology transfer of functional food through microencapsulation" by the BCRC of our institution received the "2019 Taipei Biotech Awards Technology Transfer Siler Medal Award" and exhibited at the "Bio Asia Taiwan International Conference and Exhibition" held in Taipei.



8

08/05

Visited by Hui-Song Hong, section director of the Consumers' Goods and Chemical Industries Division, Industrial Development Bureau.





Major Events in 2019

9

09/10

Participated in "Do It Today – Precision Medicine and Lifestyles of Health and Sustainability Session" held by the Department of Industrial Technology, Ministry of Economic Affairs in Taipei. (September 10 to September 11)



10/04

Visited by Young Entrepreneur Chamber of Commerce, YEC, Thailand, in a group of 88 people.



11

09/24

Visited by Ms. Pemikar Lusananon, director of economic division, Thailand Trade and Economic Office (Taipei) in a group of five persons.



11/01

Visited by Mr. Yong Bao, president of National Health Industry Research Institute at Shanghai Jiao Tong University.



10

10/02

Visited by Mr. Eizaz Azha, the representative of the Halal Industry Development Corporation, HDC in a group of two and Dr. Nik Ismail Nik Daud, halal inspection expert and Former President of Malaysian Institute of Food Technology (MIFT).



11/02

Held the 52nd anniversary celebrations and events of FIRDI.



11/08

Visited by Dr. Ruth Petran, vice chairman of Food Safety Department at ECOLAB in a group of 5 persons.



11/26

Visited by Mr. Bosco de la Vega Valladolid, chapter president of CAN, Mexico, and consultant Mr. Francisco de Rosenzweig Mendialdua.



12/10

Visit paid by Ms. Siti Rohmah Siregar and Dr. Hendra Wijaya, director and research fellow of the Center for Agriculture and Biosciences (CABI), Indonesia, as part of a group of 14.



12/19

Establishment of the GTP Cell Processing Center.

12/31

Held a retirement tea party for Ms. Yan-Hwa Chu, the director of Product and Process Research Center.



12/05

Participated in the "2019 Taiwan Healthcare Expo" held in Taipei. (from December 5 to December 8)



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FIRDI 2019



財團法人

食品工業發展研究所

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