#### RESEARCH

DEVELOPMENT

INNOVATION



DELOSIONAS



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### Preface



In 2010, as the world economy recovered, the food and beverage industry of Taiwan reached an output of 547.3 billion NTD, a 6.19% increase from 2009 and the highest level in eight years. This was mainly due to the rise in international commodity prices, investment in new high-priced goods, and the development of new markets. Even though ECFA, signed by China and Taiwan in late June of 2010, excluded agricultural products (including processed foods), food manufacturers have been tested both by fierce competition within the local market and by globalization, and the Taiwanese food industry has demonstrated several competitive advantages in food safety, quality, and brand image, giving the industry a bright, stable, and sustainable future.

FIRDI utilizes core technologies through continuous funding from the government to aid food and biotech industries in the development of product name recognition and quality and meeting business and industry needs, for which it has been highly commended. Recently, research and development strategies have focused on value added foods for a healthy lifestyle that suit Taiwanese tastes, and development of products for specific health purposes, and these technologies have gradually been transferred to industrial application. For example, with the exclusive patent license for functional and nutritional peptide manufacturing

technology, vendors have set up factories in 2010 and are preparing to start up the emerging peptide production industry in the near future. We are also preparing to utilize twin-screw extrusion technology to develop new products such as resistant starch and modified food fiber, which will help vendors in technology transfer transform health-related valueadded businesses. Such industrial efficiency has helped FIRDI once again receive an outstanding prize for the project entitled "The Development of Functional Foods for the Prevention and the Improvement of Metabolic Syndrome" from the Ministry of Economic Affairs in 2010. This is the sixth time in a row that FIRDI won the award. FIRDI is also developing low-calorie food products high in dietary fiber that taste good and have good texture, which have been transferred to breakfast franchises for trials in hopes of providing more delicious options to consumers in the future.

In terms of bioresources, FIRDI has the most complete Bioresource Collection and Research Center in all of Asia, and has established a complete platform for microbial resource development. It is actively helping businesses develop biotechrelated health products and improve manufacturing process and quality, and is developing industrial application of local biological resources. Furthermore, it has received the "Value-Addition for Traditional Industries Award" from the Ministry of Economic Affairs Department of Industrial Technology in 2010 for its "Innovation, Value-Addition, Development and Application of Bioresources Project." Also, in order to provide convenient, effective and safe bioresource services to its customers, FIRDI launched a round-theclock commercial services platform starting in March of 2010, where customers may order and purchase bioresources online. In order to promote international visibility of Taiwan bioresources and the value of native Taiwan microbes, FIRDI has not only joined the Global Biodiversity Information Facility (GBIF) network and provided tens of thousands of strain information entries, but also has actively participated in international activities. In 2010, FIRDI was invited to participate in the Global Biological Resource Centre

Network (GBRCN) project meeting, where it actively participated and received high praise from several European, US, and Japanese Bioresource Centers.

For a long time, FIRDI has provided counseling, testing, and technical services to businesses on food sanitation and safety, which have been well-received. Currently, FIRDI provides over 400 chemical analysis items, nearly 50 microbiological tests, over 150 bioresource services, and has nearly 100 training courses. In 2010, FIRDI will continue to expand its service capacity, add tests for heavy metals in makeup, pesticide residues, and soil and water quality, and provide authentication services according to the ISO22000 food safety management system. FIRDI is not only the first microbial detection and chemical analysis laboratories recognized by the Department of Health, but is also recognized by the Japan Ministry of Health, Labor, and Welfare as the official analysis center for the detection of products exported. In order to ensure and raise the credibility of our inspection and analysis services, FIRDI is continuously to win Taiwan Accreditation Foundation (TAF) accreditation in the field of chemistry, biology and other tests. Currently, 139 items in chemical analysis, 18 items in microbiological testing (including makeup), 7 items in animal substances detection, and 9 items in strain testing and microbial gene mutation analysis have received accreditation. Also, 5 major aspects of bioresource services, 2 major aspects and 5 items in health food effectiveness and safety evaluation, and 1 item in GMP operations have all received ISO international accreditation and are routinely inspected to ensure perfection.

Recently, the government has vigorously promoted industrialization and value-added measures in technological resource and development results, and has increased counseling of local as well as small and medium enterprises. FIRDI established it's office in Southern Taiwan Innovation & Research Park in 2005, where we promote integration and innovation of food and biotechnology manufacturing processes not only to raise the technological capacity of the Taiwan food machinery industry but also to aid the dairy and processing industries in their production to comply with the operating standards of the Department of Health and GMP regulations for food. In order to integrate our technology into the international arena, FIRDI has signed an agreement with the European Hygienic Engineering & Design Group (EHEDG) on January of 2011 to become the Taiwan branch of this organization. The Ministry of Economic Affairs has nearly completed construction of their Chiayi Industry Innovation and Research Center in Chiayi City, and FIRDI was requested in charge of the operation of the Center, while the Center is set to begin formal operations in 2011. In the future, this center will work with other related research institutes to establish a near commercial technological service platform on a pilot-plant scale that takes regional service capacity into consideration as a way to implement industrial innovation concepts as quickly as possible. We hope this platform will be well utilized and supported by all.

FIRDI hopes to develop into an internationally recognized food and bioresource industry scientific research agency with a high capacity for creating industry value. In order to adapt to the diverse changes that will happen in the future food industry and market, FIRDI will actively move in the direction of change by: continuing to improve external service quality and expand the range of industrial services; utilizing our diverse talent pool to strengthen personnel training and form a flexible and experienced research team that will expand our research and development results and range of services; and increasing cross-domain integration and innovation to increase benefits from technological industrialization. We hope everyone will continue to cherish FIRDI as they always have and will continue to support and encourage us in the future.

Director General

Shu Kong Che

May 2011



# Organization & Human Resources

### I. Organization



### II. Human Resources



(2010.12)





### Technology Research & Development --Using Health Concepts to Add Value to Food Products

#### I. Functional Ingredients

#### 1. Application and development of functional oil products

Functional oils have been extensively used in foods to reduce energy uptake and to prevent obesity, gout and cardiovascular diseases. In this study, commercial immobilized lipases were used to produce 1,3-diacylglycerol (DAG) from glycerol and triglycerides by transesterification. High production rates of 1,3-DAG can be achieved under atmospheric pressure. With appropriate reaction temperature, time and molar ratio of glycerol to triglycerides, a yield of about 50% 1,3-DAG can be achieved. In addition to the physiological benefits, the functional oils (Fig.1) could be used to enhance thermal conduction in frying process to improve quality of food.

#### 2. Food with anti-thromboxane function

Atherosclerosis represents an important chronic inflammatory process associated with several pathophysiological reactions in vascular walls. A thrombus can be formed as a result of chronic inflammation, leading to fatal thrombosis in a



blood vessel. Due to its ability to inhibit cyclooxygenase activity in the biosynthesis of thromboxane, which leads to a decrease in thrombus formation, low-dos aspirin is usually used to prevent myocardial infarction. While there is no visible difference between acute inflammatory and normal tissue, the concentration of thromboxane in TPA-induced chronic inflammatory tissue is 10 times higher than that in normal tissue. Topical application of aspirin could inhibit TPA-induced inflammation. In the current study, several compounds and extracts from vegetables and fruits also showed bio-function. These include tea polyphenols, curcumin, and extracts of citrus fruits, sesame meal and green plum. Therefore, these have the potential to be developed as functional foods for cardiovascular protection (Fig.2-5).

## 3. Anti-inflammatory Chen-Pi (aged citrus peel)

Citrus ranks among the highest in annual fruit production in Taiwan. Among the various citrus fruits, orange has the largest share. Most of the oranges are consumed fresh, but some are processed into juice products. Even though orange peels are rich sources of polyphenolic compounds such as polymethoxyflavones (PMFs), they are largely discarded and buried as waste. The beneficial functions of PMFs, including anti-inflammatory, antitumor, and antioxidant properties, and inhibition of bacteria growth, clot formation, and atherosclerosis, have been intensely studied in recent years. Our study results revealed that acid treatment can further improve the biological activities of PMFs through the transformation of methoxy groups into hydroxy groups. In this study, the spent brine from pickling plums was used as the acidifying agent for the transformation of PMFs of oranges and Hirami lemons. The peels were then processed to make Chen-Pi (Fig.6). It was found that the efficiency of transformation of nobiletin into 5-demethylnobiletin was dependent on the acidity of the spent brine. Ethyl acetate extracts of the acidtreated orange peels showed better anti-inflammatory activity in a lipopolysaccharide (LPS)-induced inflammatory macrophage model. After processing, the PMFs contents of Chen-Pi were increased and showed significant anti-inflammatory effects. This study shows the utility of manufacturing Chen-Pi for its antiinflammatory activity and at the same time reducing food processing byproducts.

#### 4. Study on ultrasonic extraction technique and anticoagulant activity of mushroom polysaccharides

The characteristics of ultrasound include high frequency, high intensity, short wavelength, strong transmission and special cavitation effects. The ultrasound technique is widely used in the food industry for cell disruption, extraction, freezing, drying and monitoring food quality. The purpose of this project was to study the extraction of polysaccharides from mushrooms using ultrasound. The results showed that with increasing temperature, frequency and time, the polysaccharides extracted from shiitake stipe at 500W rose accordingly. The polysaccharide content of the experimental group was 30% higher than the control group. We also assayed anti-coagulant activities of mushroom polysaccharides in vitro with an aggregometer. We found that the anti-coagulant activity of shiitake-stipe polysaccharide was 98.9%, 14% higher than the positive control (heparin 1760 U/ml). These results show that ultrasound processing technology can be used to develop functional foods with a high polysaccharide content.









#### Fig.1 Diacyl glyceral product

Fig.2-5 Low dosage aspirin (Fig.4) is usually used to prevent thrombus formation. Curcumin, tea polyphenols (Fig.3), and extracts of citrus fruits (Fig.2) are also showed the same biofunction as well. These have the potential to be developed as functional foods (Fig.5) for cardiovascular protection.

Fig.6 Chen-pi



### II. Health Concept Products

#### 1. Development of plant, animal, and seafood specialty functional food products

The purpose of this project was to develop specialty functional food products using domestic agricultural, seafood and animal materials. Eight products were developed, including (1) Braised pork sauce, (2) Cheese spread with vital fruit, (3) Mullet roe sauce,



(4) Sergestid shrimp paste, (5) Low-sugar candied kumquat, (6) Chen pi mei, (7) Probiotic-enriched dried mango, and (8) Red yeast rice wine soup (Monascus fermented germinated rice) (Fig.7). The recipes, processing parameters, and quality control for these products were also studied. These products will soon be licensed to local food manufacturers.

## 2. Processing technology for whole cabbage juice

Since fruits and vegetables contain a variety of vitamins, minerals, antioxidants and dietary fiber, USDA recommends eating 8 portions daily for good health. To maintain a product's smooth taste, pulp is usually removed in juice processing. We set out to develop a whole juice processing technique which produces juice that retains most of the fruit and vegetable fibers but has no unpleasant mouthfeel. Enzyme hydrolysis technology was used to hydrolyze fibers of domestic fruits and vegetables, such as radishes, cabbage and Chinese cabbage. Due to the presence of glucosinolate compounds, off-flavor is a common problem for cruciferous vegetables during process and storage. Blanching, enzymatic hydrolysis and sterilization processes were used to improve the flavor. Among various cruciferous vegetables tested, cabbage is the most suitable for mixed juice due to its bland flavor(fig.8). The flavor of mixed juice with cabbage remains constant after storage. In conclusion, the process developed allows for total utilization of whole fruits and vegetables, saves waste disposal cost, and increases the dietary fiber content of juice.

#### 3. Vegetarian bouillon

Bouillon plays an important role in Chinese food. However, it takes a long time to prepare, and there is a problem of disposal of the resulting residues. The purpose of this project was to develop vegetarian bouillon with micronization technology(Fig.9). This technology allows usage of whole vegetables and fruits, reduces residues, increases dietary fiber content, and meets consumer requirement. This bouillon is made of white cabbage, soybean sprouts, daikon, carrots, mushrooms, sweet corn, burdock, and kelp. The overall preference score of the above formulation was higher than two commercial products in a sensory evaluation test. Concentration, spray drying, and sterilization processing have little effect on the sensory quality of vegetarian bouillon. The major free amino acids and nucleotides in this bouillon were asparagine, L-glutamic acid, L-arginine, and 5'-CMP.



### III. Quality Control and Quality Inspection Techniques

We continued to study food quality control and food-processing technology. Food availability, shelf life and identification of food sources have progressively improved based on application of these technologies.

#### 1. Prevention of enzymatic browning of fresh cut vegetables and fruits by antibrowning agents

The effects of harvest season, water content, storage temperature and packaging on enzymatic browning of fresh cut fruits and vegetables were evaluated. Chemicals including 4-hexylresorcinol (4HR), N-acetylcysteine (NAC), citric acid (CA), ascorbic acid (AA),  $\beta$ -cyclodextrin and cysteine have well-established anti-enzymatic browning properties. The most efficiency combination for prevention of enzymatic browning under different local conditions was studied. Fresh cut fruits and vegetables treated with specific reagent combination, followed by optimum packaging and chilled storage could result in more than 3 times longer shelf life.

#### 2. Rice identification technology

#### (1) Rice variety identification technology

FIRDI has provided DNA identification service for rice cultivars since 2005. The service can be used to help the government and rice suppliers to manage rice quality. The rice cultivar is identified by molecular biology method based on simple sequence repeats (SSR) in some regions of the rice chromosomes. The simple sequence repeat number will affect the DNA size of the PCR product. The rice cultivar can be identified by comparing the DNA patterns of the PCR products obtained from multiple SSR primers with those previously established in the rice cultivar information bank. There were 232 cases in total of

Fig.7 Specialty functional food products

Fig.8 Mixed juice containing 30% whole cabbage juice

Fig.9 Vegetarian bouillon

DNA identification service of rice cultivars in 2010, including 41 cases of CAS rice cultivar certification program and 191 cases of industrial contract. DNA identification of the rice samples from CAS rice cultivar certification program indicated that the major rice cultivar was Tainang 11, followed by TK9 and Kaohsiung 139, whereas the major rice cultivar of the rice samples from industrial contract was TK9. followed by Tainang 11 and TK2.

#### (2) Inorganic elements as reaional indicator of rice

Inorganic element concentrations in domestic and imported rice were analyzed to establish a source indicator. Nine inorganic elements (Mo, Ni, Rb, Sr, Ca, Cu, Fe, Zn, Na) and their ratio to Ba (Mo/Ba, Rb/Ba, Sr/Ba, Ca/Ba, Cu/Ba, Fe/Ba, Mg/Ba, Mn/Ba, Zn/Ba) were analyzed. In order to obtain a clearer classification of domestic and imported rice, principal component analysis (PCA) was applied. Considering the eigenvalues, the first 4 principal components together explain 80.43% of the variance. Classification based on these inorganic elements would be able to separate rice from Taiwan, Thailand or Japan.

#### 3. Quality control technology

#### (1) Quality indicator of freshwater clam extract

Glycogen in clams is between 3000-4000mg/100g (edible part) and is stable during cooking and extraction. Furthermore, the percentage of free amino acids in clam extract included: glutamic acid (7.87-14.58%), glycine (1.95-4.31%), alanine (11.42-18.68%), leucine (3.32-5.92%), valine (3.69-5.10%) and ornithine (4.79-6.65%). These can be regarded as a fingerprint of clam extract composition. Our research indicated that both the glycogen and percentage

composition of amino acids can be used to determine the purity of clam extracts and can serve as quality indicators.

#### 4. Rapid screening technology

#### (1) Rapid simultaneous screen of food pathogen by biochip

The femA, mgtB, gyrB, gyrB, rfbE/fliC and plcA genes were designed as probes for detection of Staphylococcus aureus, Salmonella spp., Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli O157:H7 and Listeria monocytogenes, respectively. Each PCR product of a single pair primer was specifically hybridized with its probe in a biochip. There were no false positive results for this rapid screening technology. The detection sensitivity of the biochip was 3.0 log CFU/ml and the detection time was less than 48 hr.

#### (2) Simultaneous detection of food pathogen by real-time multiplex PCR

The virulence genes eamA and resE of Bacillus cereus and vacB, hylB, virC and hah of Vibrio parahaemolyticus were designed as multiplex PCR primers and probes for quantitative and simultaneous detection of these pathogens. There were no false positive results and good specificity was shown for all the designed primers and probes. The quantitation curves of both single and mixed pathogens were linear with a  $R^2$  of 0.99. The detection limits were 2 CFU/ml and 3 CFU/ml for mixed B. cereus and V. parahaemolyticus bacteria suspension, and were 60 CFU/ml and 27 CFU/ml for mixed B. cereus and V. parahaemolyticus in food.

### **Technology Research & Development** -Promoting the Application of Bioresources by Innovation and Value-addition

#### I. Collection and Preservation of **Bioresources**

#### 1. Collection of Bioresources

BCRC is constantly increasing the diversity of its bioresources by collecting strains from domestic and 2. Techniques for microbial identification foreign countries, and also by isolating microbes from To improve the accuracy, efficiency, and various unique environments in Taiwan. In this year, credibility of contracted identification service, BCRC a total of 3,798 strains were collected and could be makes efforts in developing molecular techniques for divided into two major categories. The first category microbial identification, especially sequence analysis is 626 public deposited strains, which consists of 188 of genes with higher resolution. Furthermore, the bacteria, 13 actinomycetes, 116 yeasts, 87 mushroom quality control and authentication of 100 important and 222 other filamentous fungal strains. These public microbial strains in food and industry, including lactic deposited strains included type strains for taxonomy acid bacteria, were executed by using sequence purpose, industrial strains for various applications analysis of nuclear ribosomal DNA and other and important local strains to enrich biodiversity. The differential genes. In addition, a total of 234 strains second category is 3,172 special collection strains, from 57 species belonging to genera Auricularia, which consists of 995 bacteria, 215 yeasts, 1090 fungal Tremella, Monascus, and Saccharomyces sensu stricto strains and 872 cell-lines. Special collections were have been examined. Through this study, a fungal focused on the collections of marine microbe and DNA barcode database comprising sequences and endophytic fungi in this year. The former produced 468 morphological characteristics was developed for strains which consists of 200 bacteria, 66 yeasts, 202 correct and quick identification to species level. hyphomycetes and 52 actinomycetes. The latter 690 endophytic fungal strains were isolated from endemic 3. Estasblishment of megakaryocyte plant of Taiwan, including Syzygium formosanu and cryopresevervation system Pourthiaea lucida. Besides the collection of living The production of platelets is directly dependent



Fig.1 Generation and cryopreservation procedures for megakaryocytes

culture resources, the genetic resources of 74,400 clones derived from a BAC library of Oryza nivara and two fosmid libraries from specific actinomycetes were constructed and preserved.

on the number of functional megakaryocytes, which in turn directly impacts blood coagulatin and thrombosis. In 2010, we have established and optimized a megakaryocyte cryopreservation system. In addition, with the aid of the previously established in-house hematopoietic stem cell and megakaryocyte proliferation protocols, we have also successfully generated a megakaryocyte induction system (Fig. 1). The megakaryocyte induction system is serumfree, thereby increasing its future potential for clinical applications.

#### II. Systematic Bioresource **Management and Services**

#### 1. Culture distribution and services

Of 4,755 batches of culture distributed, bacteria accounted for the major portion of sales, followed by cell lines, fungi, and yeast (Fig.2). There have been 1,194 cases of contracted tests completed, including EBV transfected lymphocytes, antifungal and antimicrobial tests, Legionella detection tests, ingredients analyses of Monascus products (monacolin K, citrinin,  $\gamma$  -aminobutyric acid, etc.), and analyses and quantization of microbial species present in commercial products. Services of cultivation of microorganisms and cell lines were also provided. Additionally, contract identification of 189 isolates from commercial products and microbial agents was completed.



Fig.2 Distribution of biological resources in 2010

#### 2. TAF accreditation and ISO 9001:2008

BCRC is a TAF-accredited test laboratory. It complies with the International Standard ISO/IEC 17025:2005 and is able to carry out Ames test in five testing fields, anti-microbial test (JIS Z2801) in three testing fields, and the detection of Legionella spp.. The testing reports issued by BCRC on these testing fields can be mutually accepted by international testing bodies to provide value-added services for industries. BCRC has received ISO Standard 9001 accreditation since 2001 and kept maintaining the quality assurance system without any nonconformity with regard to five practices: (1) Depository of patent-related biological materials; (2) Contract microbial identifications and tests; (3) Cultivation and preservation of animal cell lines; (4) Culture collection, preservation, and distribution; (5) Collection, preservation, and distribution of genomic and cDNA libraries.

#### 3. Biological material deposits for patent purposes

On April 21, 1994, FIRDI was entrusted by the MOEA as the designated national depository for biological materials related to patent application. "The Regulations and Rules of Biological Materials Deposits for Patent Purposes" was promulgated accordingly. To improve service satisfaction, the ISO 9001 quality management system has been adopted for this deposit service since 2000. As of December 2010,

Table 1: Types of deposited biological materials for patent purposes

Type of biological material	Percentage
Bacteria	28
Yeasts	4
Filamentous fungi	8
Plasmids	33
Hosts	-
Cell lines	23
Viruses and phages	3
Others	1
Total	100

(till the end of 2010)

a total of 1,792 biological materials have been deposited for patent purpose (Table 1). Viability tests are carried out according to a standard operation practice upon receipt of biological materials. To ensure safety and confidentiality of the deposited biological materials, the depository database and storeroom are operated under strict managerial regulations. In addition, the patented biological materials are offered for research purposes upon request after the patent is issued. Consultation is provided as necessary to time by FIRDI through various channels.

Biological safety cabinets (BSCs) are the most important primary protective devices in biological laboratory. Depending on the routine experiments carried out and their respective bio-safety level, each 4. Bioresources e-Commerce system BSC needs to be operated optimally in accordance to a strict set of standards. Currently, the US and EU Bioresources e-Commerce system, which have the highest standards on BSC safety, with the integrates BioResources Databank System, Customer former being the stricter. The BSCs can protect the Management System, Online Shopping Platform, worker, the specimen under study and the surrounding Professional Knowledgebase, and Internal Workflow environment from contamination of infectious agents System, has provided an efficient, multi-way payment, when the BSCs are functioning properly. To ensure and secure e-trade store to customers for bioresources the BSCs to be functioning properly, installation and distribution. This Bioresources e-Commerce system operation qualification are performed on each BSC also fulfills the government legislation in biosafety issue prior to leaving the factory, and field certification and biomaterial transfer agreement regarding benefit sharing issue. The concept of the system is shown in procedures are performed every year. At present, there is no standard BSC field certification in Taiwan. Figure 3. BCRC Bioresources e-Commerce system has We established the standard operation procedure been launched since 1 March, 2010. Customers can (SOP) of field certification on BSCs according to the pay their bills by the payment service online such as US National Sanitation Foundation (NSF) international credit card and ATM (Automatic Teller Machine) as standard NSF/ANSI 49-2009. This field certification



Fig.3 Concept of the BCRC Bioresources e-Commerce system

well as download e-form bill to pay later in the 24 hr convenient stores. Status of order can be monitored in the system. SSL data encryption technology was incorporated in this system so that customers can surf and shop conveniently without compromising the safety of personal information.

#### 5. Establishment of validation methods for biological safety cabinets

SOP includes downflow velocity, inflow velocity, airflow smoke patterns, HEPA filter leak, noise, lighting intensity and vibration test. Field testing of BSCs is shown in Fig.4 At present, we provide BSC's field certification services on site in hopes that through the implementation of bio-safety education and field certification, we can help promote the safety and security of biological/ microbial operators and the corresponding environments.



Fig.4 Field test of biological safety cabinets

### III. Value-Addition to Bioresources through Exploring Local Microbial Collections for Industrial Applicability

## 1. Development platform for microbial resources

To explore the application potential of the microbial resources and natural products, a selected portfolio of microorganisms were cultured, extracted and screened with multiple panels of biological assays. BCRC have been studying the unique microbial resources isolated from the biodiverse territories of Taiwan. In 2010,





Fig.5 Generation of erythroid progenitor cells

a special collection of over 400 species of extreme halophilic microorganisms was established, including bacteria, fungi, and actinomycetes. The halophilic microorganisms were cultured and their metabolites were collected for screening of biological functions. Several potential candidates were identified and will be subjected for further study. Cell-based reporter screening panels cover three distinctive areas of bioactivity were established in BCRC. By transfecting specific luminescent reporter genes into human cells expressing corresponding hormone receptors or transcription factors, the resulting luminescence of the cell correlates to the level of activation of the factor. New assays were continuously being added to our panel. In 2010, the assay for analyzing vitamin D receptor (VDR) was added to the screening panel. Currently we have established eight assays including sex hormone panel, metabolic hormone panel, and a cancer biomarker assay. All assays are conducted in microplates and samples in the forms of pure compounds, ferments, or crude extracts could be analyzed in our system. We have screened over 3,000 microbial extracts and identified more than a dozen of novel compounds. In addition to analyzing samples from BCRC, we also offer screening services to researchers and industries that are interested in aforementioned biological activities.

#### 2. Exploitation and application of cell resources – optimization of the serum-free culture system for HSC-derived erythroid progenitor cells

In 2010, we have developed a novel onestep, serum-free culture system for the induction of hematopoietic stem cells (HSC) into erythroid progenitor cells. We found that by combining the serum-free HSC expansion medium previously established in-house with the newly developed serumfree culture system, HSC can be robustly differentiated into erythroid progenitor cells at high efficiencies. This finding may have potential for clinical applications in the future (Fig.5).

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### **Technology Research & Development** -Product Innovation in Peripheral Industries

#### I. Functional Products

#### 1. Anti-diabetic effects of fermented products on high fructose-induced hyperinsulinemic rats

There are more and more evidences indicating excess accumulation of reactive oxygen species within cells leads to increased oxidative stress and stress on the endoplasmic reticulum, which then damages cell membranes and activates various stress kinases. Skewed insulin signaling pathways contribute to the development of metabolic syndrome. Fermented products were screened against tertbutylhydroperoxide-induced oxidative damage in either HepG2 or HUVAC cells. Three fermented products including citrus peel fermented with yeast improved glucose tolerance and insulin resistance in high fructose-induced hyperinsulinemic Sprague-Dawley rats after 10-weeks of feeding (p < 0.05). The concentrations of liver TNF  $\alpha$ , IFN  $\gamma$ , IL-2 and IL-6 were significantly decreased in all three test groups.

> Activities of liver glutathione reductase and catalase were markedly higher in the fermented citrus peel group. These fermented products are able to improve glucose tolerance, decrease insulin resistance, and lower inflammation of the liver, when used as ingredients in the development of healthy food.

> > 2. Weight loss and angiotensin converting enzyme I/D polymorphism

Two polymorphic forms of the angiotensin converting enzyme (ACE) gene, alleles I and D, are found in humans. The frequency of the D/D genotype is markedly higher in patients with type 2 diabetes and myocardial infarction, and the D/D genotype is significantly associated with diabetic nephropathy. Moreover, during weight loss process, it is harder for the D/D genotype to lose body fat than either the I/ I or I/D genotype. Although genotype cannot be changed, activity of ACE can be decreased by consuming ACEi food. Overweight subjects (BMI>25) were recruited to follow a low calorie diet containing ACEi precursor peptides for 8 weeks. It was found that the reduction of body fat after weight loss was significantly greater in the ACE D/D genotype than in either I/I or I/D genotypes. Since it is widely known that many diseases are associated with obesity, such as high blood pressure, diabetes and heart disease, this ACEi precursor peptide product is especially useful to help those with the D/D genotype lose weight, and decrease the risk of metabolic syndrome.

#### 3. Development of resveratrol with high antioxidant activity

Resveratrol is a plant polyphenol with antibiotic activity for plants. With the functions of anti-aging, anti-oxidation, anti-inflammation, and vasodilation, it provides a very promising potential for healthy product application. Currently, most resveratrol was produced by plant extraction, plant cell cultivation, or recombinant microorganisms with the limitation of high cost and technology investment. In 2010, we focused on the production of resveratrol through fermentation technology, and the transformation of Polygonum cuspidatum to resveratrol was also investigated.



Fig.1 Development of a new-type of fungal product containing BC. (a) BC; (b) BC co-cultured with Ganoderma lucidum; (c) BC co-cultured with Coriolus versicolor; (d) BC co-cultured Phellinus linteus; (e) and (f) products after optimization of process parameters to increase the adsorption of the functional ingredients in BC.

#### 4. Development of a new-type of fungal product containing bacterial cellulose

Bacterial cellulose (BC) is an insoluble extracellular polysaccharide produced by Gluconacetobacter xylinus. Based on BC, we have developed a new-type of fungal product with chewy taste as shown in Fig. 1 instead of the traditional capsule form. Due to the dietary fiber introduced from BC, this kind of product could promote the digestive performance for edible application. Furthermore, we could introduce the functional ingredients produced by fungi into BC using co-cultivation. Through the optimization of process parameters, the adsorption amount of the functional ingredients was enhanced with apparently decrease of their loss after sterilization.

#### II. Modification and Formulation **Technology for Functional Material**

#### 1. Microemulsion techniques for lipophilic functional ingredients

It is known that omega-3 in fish oil contributes to both visual and brain development of infants, and reduces the risk of inflammation-related diseases.

Besides its fishy smell, the long-chain polyunsaturated fatty acids of fish oil are easily destroyed by oxygen, heat, and light, rendering processing and storage difficult and limiting their applications. In this study, a microemulsion system was developed for masking the unpleasant flavor of fish oil. The optimal masking formula was found from the ternary phase diagram, based on a composite of fish oil, emulsifier, and coemulsifier. The microemulsified fish oil (Fig.2) does not give off a fishy smell, and is thermally stable and



Fig.2 Micro-emulsion of the masking fish oil Fig.3 Orange juice contained micro-emulsion of the masking fish oil

transparent. The droplet size remained less than 100 nm during storage. When added to orange juice (0.03% DHA)(Fig.3), there is no significant difference between the fortified and original juice in sensory evaluation scores or color after one month at 4°C.

#### 2. Novel formulations for functional inaredients

The emulsions of coenzyme  $Q_{10}$  after high pressure homogenization were quite well and the average particle size could reach 166 nm. The formulation was safe with apparently improved absorption in pharmacokinetic performance as demonstrated by animal studies.

#### 3. Enzyme treatment processing technology for preparation of resistant starch

An enzymatic process was developed to produce starch with resistant starch content higher than 10% and less than 100 units of glucose with a designed reactor (Fig.4). This technique

> can be applied to the processing of most starch sources. The resultant resistant starch is suitable for addition to foods with a high starch content to improve the colonic physiology and to increase the value of to rice and flour staple foods. Resistant starches were introduced into kernel-type multigrain products, rice vermicelli and rice cake, and the glycemic index of each of these products was lower than that of white bread in healthy human subjects. A cooperative research project was signed



Fig.4 Enzyme treatment reactor for preparation of resistant starch

Fig.5 Modified/stabilized rice bran and related instant drink products

between a local food factory and FIRDI to develop the technology. A government supported project (SBIR) was granted to the company with the assistance of FIRDI. It is expected that the development and production of products with high resistant starch content will continue and they will be on the market soon.

#### 4. Reactive extrusion for modification of physicochemical properties of fiber from agricultural byproducts

Dietary fiber provides many health benefits for humans. The physiological effects and customer acceptance of dietary fiber are closely related to its physicochemical properties. The goal of this project was to increase the utility of agricultural byproducts by developing fiber modification technology. Increased cellulose degradation and property modification are achieved by combining additives and external fixture to enhance the effects of micronization and extrusion.

(a) original BC



Fig.6 Contact angle change of BC membrane after chemical modification. (a) The water contact angle is 35° before chemical modification; (b) the water contact angle is 92° after chemical modification

Rice bran, wheat bran, mushroom stalk and okra were m2-day. Furthermore, the water contact angle kept tested this year. Our data showed reactive extrusion constant at room temperature after 90 days with no can increase the ratio of soluble to total dietary fiber aging (Fig.6). by up to 20% and improve physical properties, such as water-holding/swelling capacity and solubility. 6. Development of probiotic functional foods and nutraceuticals Up to 10% dietary fiber produced in this way can be added to a fried shredded pork product without Lactic acid bacteria (LAB) mediate many positive affecting sensory properties. This technology has been effects on human health and are used as probiotics. In transferred to a local company for manufacturing this project, we aimed to screen the LAB strains having of stabilized organic rice bran. At 50kg/hr processing anti-cancer activity and high exo-polysaccharide speed, the rice bran product has good flavor and produced ability, and also to develop the processes taste. Instant drinks containing this rice bran are using fruits materials for probiotic food development. also being developed (Fig.5). In conclusion, this For nutraceutical research, biotransformation unique green process can adjust dietary fiber ratio catalysed by LAB using the natural ingredients and improve the solubility and taste of food fiber as substrates was performed to produce active of agricultural byproducts. The technique can be metabolites for anti-cancer properties. Moreover, applied to different food fiber sources to produce some LAB strains have high exopolysaccharides commercially feasible fiber ingredients. (EPS) production, and these EPS fulfill variety of diverse functions including the immunoregulation, 5. Modification of bacterial cellulose and its stimulating the immune system of host and improving application host immune defense. We have established the EPS BC with its unique properties, such as ultrafine production process, and the results showed that EPS induced cytokines production. We also used the local fruits as materials for making the snacks containing the LAB strains. "Spread cheese with vital fruit" and "Probiotic-enriched dried mango" are two kinds of specimen. The diversity of functions in the probiotic product development is through the use of agro-natural ingredients to provide a more diverse market of lactic acid bacteria products.

reticulated structure with diameter of 30-50 nm, high purity, high crystallinity, high water-retention, and good biological compatibility, has great potential in novel biomaterial market. After chemical modification, the characteristic of its surface was changed from hydrophilic to hydrophobic side. The water contact angles of BC were above 70°, even up to 100°, and the permeability reached around 6800 g/



Fig.7 Customer communication interface and documents

#### III. Healthy Foodservice System

#### 1. Identifying customer needs by service experience engineering method

After analyzing consumer behavior data using service experience engineering method, 22 highfiber healthy meals were designed. Seven of the 22 high-fiber healthy meals were chosen for trial with 1,400 persons with of a breakfast franchise. Besides the meals themselves, criteria included in the trial are manufacturing process for high-fiber semi-finished products, marketing plans (including design examples for the customer communication interface), and sales and service (Fig.7). The data collected from this trial will help future participants to develop innovative products and to create new business opportunities and marketing strategies.

#### 2. Development of high-fiber, low-calorie foods using food modification techniques

Various techniques were used to develop both high-fiber/low-calorie and high-calcium/high-iron meals. These include five semi-finished products, such as fish tofu, and five sauces, such as Thai-style seafood sauce. The related techniques can be transferred to operators of food processing or dining service systems. The use of healthy materials can create a diversity of unique dining products.

### IV. Process Integration and Consulting **Services for Food Processing** Machinery

#### 1. Research and design of small volume aseptic filling system

Taiwan biotechnological products have become important R & D projects for restructuring and adding value to the food industry over the past decade. Functional health drinks can currently only be bottled by acidification and heat processing, but this processing technology affects product quality and severely limits product items. Therefore, FIRDI is actively involved in research and design of a small-volume aseptic filling system that can be integrated with food processing technology. It would then be more useful to the functional health drink industry by reducing the loss or destruction of functional ingredients during manufacturing, filling and sales. The aseptic filling system was developed for maintenance of high quality and retention of the high-value functional health component.

FIRDI therefore invited the domestic food machinery and functional health drink manufacturers to hold a forum on small-volume aseptic filling systems. Regarding product development of functional health drinks, we achieved a consensus on what research is necessary to develop small-volume aseptic filling systems (Fig.8) to meet market trends and the needs of manufacturers. The various modules are illustrated as follows:

#### (1) Aseptic cavity airflow distribution module

This module mainly provided an aseptic space for the filling system using class 100 (ISO class 5) aseptic positive air pressure to separate the liquid food from outside non-aseptic air to avoid contamination. This module must match the chamber's internal structural design, the system architectural design and spatial configuration.

#### (2) Packaging material transport module

To achieve clean or sterile conditions, the design of the mechanism for gripping and delivering packaging materials (container and cap) and the material selected must be integrated with hygienic design concepts.

#### (3) Cleaning and sterilization module

The design of this module involves development of sterilization capacity to effectively kill heat-



Fig.8 Research and design of small volume aseptic filling system

resistant spores of microorganisms in components of the packaging material, bottle cavity and internal structure of the packaging device. Post-contamination can then be avoided by cleaning and sterilization during pre-production or production procedures.

#### (4) 30-100ml quantitative aseptic filling module

Depending on the nature of the product (such as viscosity, etc.), a suitable quantitative filling module should be chosen to apply aseptic airflow to drive the liquid food. Using the quantitative filling module, the liquid can be filled accurately (with an error of about 2%) and the filling rate matched to the container, so bubbling is rare.

#### (5) Container sealing module

The main purpose of the container sealing module is to separate the aseptic products in the container from exterior factors that can cause deterioration or decay of the products. It needs to match the container type and meet the manufacturer's marketing need for selling the products. It is better to choose covers with a suitable structural design and materials to allow for tolerance and cleaning efficiency.





#### (6) Process control point monitoring and process control module

The controlling module joins the hardware components, sterile air, fungicides and other piping in an integrated mechatronic control module to achieve the purpose of monitoring and process control.

The filling system can be quickly applied to liquid food by developing and integrating techniques for each of the key components of the modules mentioned above to match the level achieved by foreign manufacturer's liquid food equipment design and development. The design techniques can be extended to aseptic filling systems for large-volume (> 100ml) bottles. This enhances the capabilities of design, development and analysis of key components of the domestic liquid food machinery industries. It also enhances hygienic safety and self-brand value, effectively reduces the defect rate of products and maintains product quality, and meets the needs of the food industry.

#### 2. Technology transfer and counseling services for food machinery industry

In order to enhance the technical capacity of the domestic food machinery industry and benefit the dairy and beverage processing industries, FIRDI has for the past 7 years geared its aseptic research direction toward hygienic design of filling systems for liquid foods. In work on applications of aseptic processing and packaging technology to the hygienic design of filling systems for liquid foods, FIRDI has not only assisted food machinery manufacturers in fabricating to hygienic design standards and developing quality control technology for the filling machine, but also developed basic techniques for aseptic filling system design for food machinery manufacturers.

The "Hygienic Design of Food Machinery and Related Microbiological Verification Technology" developed by the Southern Taiwan Service Center has transferred to 5 vendors in 2010. This technique helped the industry assess the aseptic technology base and confirm the hygienic and safety design basis with microbiological testing of the production system. It consequently maintained a reasonable product defect rate of the production system, led to R & D investment and equipment investment of 500 million NT dollars with an output product value of 400 million NT dollars. The direct benefits of the technology transfer are helping manufacturers to establish the hygienic design techniques of key components, confirm the production line with "good hygienic practices of canned food" and the operating standards of the certification of food GMP (Good Manufacturing Practices) of the Department of Health.

"Research and design of small-capacity aseptic filling systems - mechanical design of key module, integration of process control procedures and verification technology of aseptic performance" is the preliminary project of Technology Development Program of the Southern Taiwan Service Center in 2010. Based on the experience of machinery hygienic design, sterile air flow field analysis, aseptic system validation technology and the design verification equipment, microbiological validation laboratory, FIRDI jointly developed a mechanical aseptic filling system with one domestic manufacturer. The technologies of hygienic machinery design and sterile air flow field analysis brought in enhancement of the operating efficiency, health security and commercial added value of the developed facilities.

The second project, "Design of Microwave-assisted Vacuum-Drying Performance Certification," which was first developed by the Southern Taiwan Service Center and domestic factories in 2010, has assisted a domestic manufacturer in developing batch microwave freeze-drying equipment into an integrated process to reduce cost and wasted drying time, shortening the drying time by more than half.

Through technology transfer of "Development and certification of a microwave-assisted heating system," a domestic manufacturer developed microwave assisted hot air convective dehydration for fish products, which could not only lower the water content, reducing frying time, but also slow the



Fig.9 Microwave-assisted deep-frying system Fig.10 Microve-assisted infrared rays system

deterioration of frying oils, thereby increasing quality and improving efficiency. The same technique can be applied to drying farm produce of high value.

In the area of patent applications, the southern Taiwan Service Center has obtained a patent for "A method and device for ohmic heating in thermal processing." This technique was applied to rapid heating of daikon cake by the authorized manufacturer, and fast food restaurants will benefit by providing this customized daikon cake product. Consumers will also enjoy more diverse products and customized services.

With regard to our consulting service, the Southern Taiwan Service Center assists domestic manufacturers in certification of and consulting about sterilization equipment of the beverage production line including the quality of welds, so they conform to the canned food good hygiene practice regulations, by certifying that the piping weld quality and equipment conform



to the health and safety standards. Furthermore, the "continuous microwave heating module design and certification technology" not only assists manufacturers in the design of continuous microwave module systems, but also in testing the equipment and certification of the system. In the future, this technique may be patented and the related device will be protected by the Intellectual Property Rights so it is not easy to copy and counterfeit, to promote strong competiveness. Moreover, the Southern Taiwan Service Center assists manufacturers in organizing technical conferences, preparation of contract proposals for the testing of beverage production lines and evaluation of sterilization efficiency in order to reduce the rate of defective products and ensure food safety.



### Technology Research & Development —Using Innovative R&D to Help Upgrade Local Industries

#### 1. Pre-operational phase of the Chiayi Industry Innovation and Research Center

Chiayi Industry Innovation and Research Center (hereinafter referred to as Chiayi Innovation Center) was established in Chiayi City by the Ministry of Economic Affairs to integrate the research capabilities of industrial, academic and research communities in Chiayi, promote the upgrading of local industry and support the development of existing industrial areas in Chiayi and the central and southern Taiwan science parks. Beginning in 2011, the Food Industry Research and Development Institute will be stationed in and operate the Chiayi Innovation Center. Other corporate bodies in the center include the Metal Industries Research & Development Center, Precision Machinery Research Development Center, and Cycling & Health Tech Industry R&D Center.

The goal of the Chiayi Innovation Center is to construct a service platform to develop industrial technologies to promote the upgrading of local industry, provide a R&D test platform for production and commercialization of health food, and promote innovative technology and services in the health and



Fig.1 Outlook of Chiayi Industry Innovation and Research Center



Fig.2 Building sketch of Chiayi Industry Innovation and Research Center

green energy industries. During the pre-operation phase, the Chiayi Innovation Center gathered information on the research capability of industrial, academic and research communities in Chiayi by holding various activities to prepare to promote the upgrading and restructuring of local industry and anticipate the development of industry clustering.

Chiayi Innovation Center is located at the intersection of Po-ai Road and Shixian Road in Chiayi City with a land area of 1 hectare and building area of 17,200 m<sup>2</sup>. It is a candidate for the Diamond award as a green building, including a research building, service building, and pilot plant. The pilot plant can provide relevant trial production and commercialization services to accelerate the commercialization of new products.

## 2. Assist in the innovation and upgrading of off-shore industries

## (1) Establishment of retort pouch processing technique in Kinmen

Due to its distant and isolated geographic location, the skill level of Kinmen food manufacturers lags behind that of Taiwanese. With tension easing



between the two sides of the Taiwan Strait, Kinmen food manufacturers face fierce low-cost, low-labor competition from mainland China manufacturers. FIRDI has being working with Kinmen food manufacturers over the last two years to increase their competitiveness. One of the techniques developed is retort pouch processing.

The distinctive marketing feature of Kinmen beef is that its cows are raised on sorghum distillery residues. In this study, the texture of beef products with different processing parameters was evaluated to establish optimum processing conditions for Kinmen beef retort pouch products (Fig.3), including tenderization, precooking, filling, sealing and sterilization. Thermo penetration has been carried out and the sterilizing value ( $F_0$ ) must be above 6 to assure that the product can be stored at room temperature. Sensory analysis results showed that the texture and overall acceptability of beef retort pouch products were rated highly. With this technology, more diversified and convenient specialty Kinmen products have

#### been developed.

#### (2) Establishment of "R&D Alliance for Matsu Local Specialty Fermented Foods"

BCRC in coordination with the policy of the Ministry of Economic Affairs is responsible for planning and organizing the offshore area industry R&D alliance so as to help the industrial and commercial development in Matsu and balance the gap between homeland and offshore islands. In 2010, we helped the members of Matsu Local Specialty Industry R&D Alliance funded in last year by 3 small and medium makers in Matsu carry out the R&D on Red Mold Rice (RMR), white Koji and Acetobacterium. For scale-up of RMR and white Koji production processes and development





Fig.3 Beef retort pourch product Fig.4 The local specialty products of Matsu Alliance Fig.5 DIY tour for Matsu old wine

of new products, such as Matsu old wine vinegar, develop new products, while helping members of the Hong-Zao sauce and Hong-Zao pickle, we further off-shore food industry in Kinmen, Matsu and Penghu promoted the establishment of **FR&D** Alliance for gradually establish a R&D alliance for 5 local specialty Matsu Local Specialty Fermented Foods] . The project products. In 2010, we assisted companies with 149 has successfully improved the product quality and applications for government funding and project quantity by the new technologies and concept, and guidance, which helped companies to improve developed novel local specialties. It is noteworthy manufacturing processes and produce new products. that two products of Matsu Alliance, Hong-Zao lilac This led to over 900 million NT dollars in investment fish and XO Spicy radish, have obtained the award of from manufacturers, an increase of over 1.9 NT billion Taiwan Best 100 Specialty. The award demonstrated dollars in output value, and overall affirmation the the quality of local specialties was widely accepted effectiveness of the service by manufacturers. by consumers. Moreover, Matsu Alliance simplified the manufacture process of Matsu old wine as a DIY tour. The new idea not only received great success but also facilitated the transformation of members of Matsu Alliance from food processing industry into cultural tourism business (Fig.4-5).

#### 3. Establishment of a consulting group for upgrading food processing technology

In order to promote innovation and upgrading of traditional industries, in 2009 FIRDI established the "Consulting group for upgrading food processing technology" in accordance with government policies. Its primary responsibility is consulting in the agricultural counties of Yunlin, Taichung, Changhua, Nantou and Chiayi to improve manufacturing processes and



# **Industry Service**



## Industry Service —Safety and Quality Consultation

### I. Promotion of Food Quality Management System

The Food Industry Research and Development Institute has actively cooperated with government agencies to promote quality management systems including the following.

#### 1. Promotion of CAS food system

A total of 11 categories of CAS products were promoted by FIRDI. In 2010, 20 food manufactures of 151 food products were newly approved as users of the CAS mark, and 98.1% of sampled products passed the quality inspection. Those with unsatisfactory products were immediately informed and follow-up inspections were performed until these producers were found compliant. The CAS certification system has had a progressive benefit in the promotion of domestic food processing industries. This system has gradually gained acceptance in both China and Asia and is trusted by consumers.

#### 2. Food GMP accreditation system

FIRDI assists the Government in promotion of food ISO 22000 is an international certification certification systems, and ongoing maintenance of the standard that defines requirements of the food GMP food accreditation system to enhance integrity safety management (HACCP) system. To encourage and credibility, in response to the needs of the industry the domestic food industry to follow the ISO 22000 to amply the range of products accredited (food management system, in 2010 FIRDI was approved as additives, food packaging materials, functional foods) the certification body for the food safety management and to develop relevant specifications. Furthermore, system (ISO 22000) by the Taiwan Accreditation we have also been sought out by food processors to Foundation (TAF). Currently certification is only available assist with the process of technological innovation. for the frozen meat processing industry, but we will We also provide consultation and diagnostic services actively seek to increase the scope to include other to help introduce the quality assurance system, and items (dairy, soy processing, general food, beverage, strengthen self-management through regular external canned food industry). For relevant application audits, in order to enhance the quality of the food information, refer to our web site at http://osweb.firdi. industry. There are currently 360 domestic food factory org.tw/isogmp/Bulletin.asp "Food Safety Management lines and 2,997 certified products. System (ISO 22000) certification services."

#### 3. Certification of liquor products

To ensure the safety and quality of alcoholic products in the market, a certification system, the Fancy Liquor Logo, was established by the National Treasury Agency in 2003. A total of 219 alcoholic products manufactured by 28 establishments were granted the right to use the "Fancy Liquor" logo. The certified products include sorghum liquor, rice wine, grape wine and fruit wine. Four conferences were run in 2010 to promote the certification system.



Fig.1 The on-site inspection for Fancy Liquor factories

#### 4. ISO 22000 certification services

## 5. HACCP in lunchbox plants and foodservice establishments

In 2010, 235 prepared lunchbox plants and foodservice establishments passed the HACCP based hygiene accreditation and were certified to use the new HACCP logo approved by the Department of Health. This application has significantly increased the proportion of hotel catering, showing the importance attached to consumer food safety and support of the international food safety system to enhance competitiveness.

#### 6. Food safety management system for canned food

Adequate commercial sterilization is the key point in the process to ensure the safety of canned foods. Before low acid canned food (LACF) products reach market, an approved process must be established by FIRDI. Market surveillance and on-site audits have also been done to ensure the safety and quality of locally canned food. A consultation service was provided for local LACF manufacturers to correct non-conformance found from surveillance and audits. A conference was held in 2010 in the hope of highlighting the importance of risk control for canned foods.



#### 7. Food safety management system for dairy products

In 2010 the Department of Health (DOH) announced processes used with milk products must comply with the HACCP system, so FIRDI conducted a series of events to help complete the intended measure this year. Of 69 milk establishments identified, 74 product lines were chosen for audit by local DOH officials following an audit manual prepared by FIRDI. Nonconformance results and CCP control measures were collected and recorded in a database. After the audits, 6 conferences were held to communicate the roadmap to achieving the standards set by HACCP.

#### 8. Food traceability system

Food safety has become the primary concern for food suppliers, raising the importance of preventing unsafe products from reaching sales racks and the recall of unsafe products. In order to reach this goal, companies rely on product authentication and tracking. In order to ensure that processed foods and commercial products are traceable and maintain accountability for certain events in order to facilitate recall, the Department of Health of the Executive Yuan set up a food traceability system in order to monitor the flow of unsafe products and reduce the impact of unsafe products on society.

After establishing methods for planning and implementing techniques in dairy processing and water and beverage (tea and coffee) packaging, we also completed a module on production process planning, for use in tracking food products involving more complex processes. Due to the frequency of safety concerns with imported raw materials and foods, a new raw materials registration and management system is being added to the current food traceability system to better control the source of raw materials used at food processing plants.

This year, we are actively promoting this system to the food industry, and have held industry seminars in



Fig.2 Food traceability system

Northern, Central, and Southern Taiwan to introduce food safety regulations in the food traceability system, the use of information carriers, and the structure and network of the food traceability system. This has helped us promote the food traceability system even more broadly with less effort. We are also expanding the promotion of the food traceability system to processed grain food products, processed meat food products and the fat and oil industries.

### II. Support and Promotion of Food Safety and Quality Systems

#### 1. Promotion of the labeling of food nutrition

Food nutrition labeling may enhance consumer awareness and understanding the contents of nutritional ingredients in food. A total of 6479 food nutrition labeling data were collected. Suitable labeling type per service for different food categories were referenced to international formulation. The analytical method and allowable variation of dietary fiber, carbohydrates, cholesterol and trans fat have been compiled and recommended. Consensus meetings were held for the officers and food manufactories to help advocate the policy and assist in correct labeling.

## 2. Integration and development of the food nutrient composition database

A food nutrient composition database is important not only for research on diet and health, but also as a source of nutrition information for consumers. The contents of the food composition database were expanded and revised. Eighty food items were analyzed for approximate composition, minerals, vitamins, amino acids, fatty acids, cholesterol, dietary fiber and sugars. A fish and shellfish product database was published as a reference book and disc.

#### 3. Evaluation of analysis method and market monitoring of nutrients in infant formula and follow-up infant formula

Methodologies for the analysis of 7 nutrients including vitamin B6, biotin, folic acid, copper, manganese, potassium and magnesium were collected and evaluated. The summarized information and analytical data were fully discussed in committee meetings. Finally, a total of 11 analysis methods for these 7 nutrients and values for allowed deviation between the labeled and measured amount were suggested. The finalized information could then be used by the Department of Health as a reference guide for further policy making.

#### 4. Database on risk assessment for food safety

A database on risk assessment for food safety is important for both the government and consumer to understand and manage the risk of chemical hazards and food pathogens to public health. In 2010, reports on 180 chemical/microbial hazards of food were revised and 80 hazards newly completed, including 25 pesticides, 21 food additives, 10 viruses, 3 biotoxins, 2 environmental hormones, 3 GMOs, 7 allergens, 4 irradiation foods, 3 toxic mushrooms and 2 others. Both professional and general versions of the database exist.

#### 5. Management of vacuum packed foods

In order to do risk assessment for locally vacuum packed food, a surveillance project was sponsored by DOH. 51 soybean vacuum packed foods and 80 non-soybean vacuum packed food were sampled to analyze Aw (water activity), pH, preservatives, salt content and package structure and to check the labeling. The recommended results were summarized and provided to DOH according to the vacuum packed food good hygiene practice promulgated on October 14, 2010.

#### 6. High-quality raw materials management counseling for food factories

To strengthen the raw material management system in food factories, FIRDI produced a reference for food businesses in Taiwan, providing benchmarks for raw materials management system development and implementation to track the current situation in domestic and foreign food plants, develop suitable management systems for domestic raw materials, and set acceptable storage criteria for four raw materials (soybeans, wheat flour, tea, milk powder). We also consulted with the industry to establish and implement a high-quality food factory materials management system, and held a seminar to promote value-added products and improve the safety of raw materials to enhance the level of processing technology in the food industry, and promote the international competitiveness of domestically processed foods.

## Industry Service -Technical Service and Training

#### 1. Pesticide residue testing services

FIRDI offers pesticide residue testing services, in accordance with food notice #0991900925 issued on April 6, 2010 and notice #0991904819 issued on December 31, 2010 by the Food and Drug Administration (FDA), which is under the Department of Health of the Executive Yuan. We provide the most accurate, professional, diligent, and speedy service in the industrial community.

#### 2. Free technical consulting service

Technical Service and Extension Center (TSEC) plays as the contact window and as the linking bridge between the Institute and industry to provide various technical services. The service scope is designed to meet the need of food industry in terms of technology advancement and regulation revision. All technical service projects and application procedures are set out on our web site at http://www.firdi.org.tw/4/4. htm "Technical Service Manual." The Center provides free consulting services, the aim being for relevant experts to propose effective solutions in processing, packaging, storing, and about the quality of their products, etc., through the judgment on the quality of raw materials and current products, on the spot state photograph, personnel's education background and sanitation of equipment etc. Companies are welcome to make use of the resources provided by FIRDI.

#### 3. Analysis and services

This year, food adulteration detection by PCR; total plate count for detection of Escherichia coli, Staphylococcus aureus and Pseudomonas aeruginosa in cosmetics and Enterobacteriaceae and E. sakazakii detection in food have been accredited by TAF. Additional new services offered include measurement



of functional ingredients, including polysaccharides, collagen,  $\beta$ -glucan, arabinogalactan, dietary fiber, glycogen, fructan, adenosine, hesperidin, total monomeric anthocyanin pigment content, triterpenoids qualitative pattern analysis and organic germanium levels in Ganoderma lucidum.

#### 4. Technical training

Our training group offers two categories of industry training. The first category is on-site customized training projects conducted for general food factories. Content of the training is designed specifically according to the project proposal and the requirements of each food factory. The



second category of training courses is non-projectbased professional training, which are in the form of training courses that draw on our accumulated research achievements and share information and technologies from past service activities. These training courses can not only satisfy clients' knowledge, technology, and information needs, but also facilitate the advancement of the food industry. In addition, we have also undertaken governmentfunded projects, mainly personnel training projects for the Industrial Development Bureau and projects with the Department of Health of the Executive Yuan. In particular, this year (2010) we conducted a Personnel Training Program on Inspection Procedures of Imported Foods in coordination with the re-structuring of the Department of Health. The targeted customers for this training program were future inspectors of local health centers around the country, who will either deal with border management matters or support inspection processes for imported foods. The goal of this training program was to reinforce management of imported and domestic foods and to implement management of food traceability.

This year (2010), we conducted a total of 119 classes with 2707 trainees. Major training courses included food safety management systems (Hazard Analysis and Critical Control Points, HACCP), and food hygiene management and inspection (Department of Health). All the trainees felt that the training received was highly beneficial and they warmly recommend the training programs offered by our training group.



#### 1. Dynamic analysis of food industry development

With the support of projects sponsored by the Ministry of Economic Affairs and the Council of Agriculture, we have completed several surveys and dynamic analyses of the development of the food industry, and communicated the results and provided appropriate services in various ways. The main achievements included the following.

Publication of "Food Market Information," 12 issues including 1,198 papers/abstracts, and 1,011 figures or tables, in the field of food policy and regulation, new products and new techniques, food consumption, and trends of market development, that may affect the sales of our food products. Hopefully, the provision of the information will help the government and industries plan for future development and guide research strategies for research and development.

Publication of "Almanac of the Food Industry, 2010," which covers information on the foreign food industry and major food industries in Taiwan, including non-alcoholic beverages, frozen food, instant noodles, edible oils, health food, fresh deli food, animal feed, seasonings, food packaging and machinery, and foodservices, with information on the market situation, trends for development, changes of policy, and business dynamics.

Publication of "Almanac of Food Consumption Survey, 2010," which includes basic data of consumers surveyed, consumer choice of food channels, personal eating habits, and demand for various foods. The almanac provides information including consumption characteristics and consumer behaviors for various agricultural products and

#### processed foods.

We have established a platform for food product information analysis, which collects global information about grain production and trends of materials used in food processing, and provides future price information for raw materials.

We also extended our information services and sharing, including various industry surveys and research information disseminated through book publication, web presentation, e-mailing, workshops, sharing meetings, and seminars, to share information and communicate with others. In addition to the activities of the food information interest group, we have also developed interest groups in specific fields, including non-alcoholic beverages, to provide members with first-hand information and business dynamics.

#### 2. Customized knowledge service for food industries

We completed customized market research for several food industries, including co-competition among firms, industrial value-chain structure, new products, new packaging, new techniques, new equipment, food show information, firm and market dynamics, production, sales and trade data, consumption trends, and Taiwan and global market development. Market research reports covered topics on beverages, dairy products, soy milk and dairy milk, the health industry, and food machinery. The information service may help enterprises reduce time and manpower in collection of information, disseminating new and whole industry information, and thus immediately clarify global and domestic market changes and development trends, effectively taking the pulse of the market (giving

insight into market trends), to assist with research and development and planning of marketing strategies.

#### 3. Survey and research on food industry in Taiwan and Mainland China

We have completed five publications particularly related to Taiwan and Mainland China, including: Research on models for operation and cooperation between Taiwan and Mainland China in food and related industries, Research on industrialization and cooperative development of Chinese-style health foods, Analysis of the value chain in the deli food industry in Mainland China, Analysis of the health food value chain in Mainland China, and Analysis of the food machinery value chain in Mainland China. Meanwhile, we have disseminated the

information through rapid reports to industry, and an industrial analysis report to instantly provide industry with insightful information. In addition, we have systematically analyzed food sanitary and safety laws and regulation and related workflow in Taiwan and Mainland China to help firms clearly distinguish the laws of the two countries.





Fig.1 Signed conference consensus paper and took group photo in the Cross-strait Food Industry Cooperation and Interaction Conference

#### 1. The Second Cross-Strait Food Industry Cooperation and Interaction Conference, held in Beijing, China

In order to promote long-term cross-strait industrial cooperation and Interaction, FIRDI and the Chinese Institute of Food Science and Technology (CIFST) cohosted the Cross-Strait Food Industry Cooperation and Interaction Conference. After a successful first conference held in December, 2009 in Taipei, Taiwan, the second conference was held on August 5-6, 2010 in Beijing, China.

Many Taiwanese food manufacturers paid great attention to and actively participated in this conference. Ministry of Economic Affairs, Department of Industrial Technology Deputy Director General Lin Chuan-Neng and FIRDI Director General Chen Shu-Kong led a delegation of 57 people from food manufacturers such as Taisun Enterprises, Wei-Chuan Foods, Heysong, Standard Foods, Royal chef, and TOMAX, health food manufacturers such as Kang Jian, Toong Yeuan, TCI, Allied, Lytone, the Sinphar Group, and Grape King, peripheral manufacturers such as UPCC, the Sinew Consulting Group, and

TÜV Rheinland, and associations such as the Taiwan Frozen Food Processors Association, the Taiwan Association for Lactic Acid Bacteria, the Taiwan Association for Food Science and Technology, the Health Food Society of Taiwan, the Taiwan Food GMP Development Association, and the Taiwan Premium Agricultural Products Development Institute.

The conference centered on discussion of fluidity across interaction platforms and in communication channels, cross-strait value chain interactions, and food safety and standards mechanisms. During the conference, the two sides also signed two letters of intent and one conference consensus paper in hopes that industries from the two sides would complement each other while together driving cross-strait food industrialization and seizing the opportunities presented by globalization (Fig.1).

#### 2. Aid in carrying out the cross-strait food and logistics pilot project

In accordance with the Ministry of Economic Affairs bridge building project, FIRDI established the Cross-Strait Food and Logistics Pilot Project. In 2010, we helped to host four Taiwan Food and Logistics Pilot Project working group meetings while planning and executing the China Food and Logistics Pilot Project working group's visit on December 19-24. During this time, we held the Cross-Strait Food and Logistics Pilot Project working group meeting and discussed the work of the project, the cities in which it would be held, and the items involved (Fig.2).

### 2010 Awards







Dr. Jinn-Tsyy Lai, Senior Research Scientist of FIRDI, was awarded the Superior Guidance Service Personnel Awards from Small and Medium Enterprise Administration, Ministry of Economic Affairs, R.O.C.



Dr. Shiang-Tang Jane, Research Scientist of FIRDI, was awarded Management Achievement Award from Taiwan Association for Food Science and Technology (Fig.5). Ms. Hui-Shwu Chang, Technologist of FIRDI and Mr. Pei-Yang Tsai, Administrator of FIRDI, were both awarded Extension and Service Achievement Award from Taiwan Association for Food Science and Technology (Fig.6-7).



Fig.2 Cross-strait Food and Logistics Pilot Project working group meeting

FIRDI efforts recognized in 2010 MOEA R&D Programs Awards, include: "Development of Functional Foods for the Prevention and the Improvement of Metabolic Syndrome Project (1/4)" was awarded an Excellent Award (Fig.1), "Innovation, Value-Addition, Development and Application of Bioresources Project (3/4)" was awarded the Value-Addition for Traditional Industries Award (Fig.2), and Dr. Gwo-Fang Yuan, Director of Bioresources Collection and Research Center, was awarded the Technology Heroine Award (Fig.3).





Global Vegetarian Foods Consumer Trends Report was awarded an outstanding prize of Industry & Technology Intelligence Service Project 2010, which was written by Ms. Li-Ting Chen, Research Scientist of FIRDI, and Dr. Shiang-Tang Jane, Director of Planning Office, FIRDI.

### 2010 Activities





#### January

Jan. 26 Held Join Research Project Signing Ceremony with Corning Incorporated, Dr. Shu-Kong Chen, Director General of FIRDI and Dr. Ronald A. Fairs, Director of Cell Biology, Corning Incorporated, signed the contract.

#### March

- Mcr. 17 Dr. Chao-Chou Kang, Director-General of Food and Drug Administration, Department of Health, Executive Yuan, R.O.C., visited FIRDI.
- Mar. 22 Mr. Su-Yi Wang, Secretary of Bayannaoer Committee of the CPC, and Mr. Te-Feng Tsao chairman of standard Foods Co., visted FIRDI.
- Mar. 24 Mr. Ming-Tsai Hsu, Mayor of Hsinchu city, led a team of 8 to visit FIRDI.

- Mar. 25 Announcement meeting of FIRDI's research achievements in 2010 and initiation of cooperation projects among industries and FIRDI was held in Hsinchu and Tainan.
- Mar. 29 Mr. Tou-Hsiung Yang, Chairman of Vedan Group, led a team of 8 to visit FIRDI.

#### April

Apr. 15 Dr. Olivier Ballevre, Head of Nestle' Research and Development Centre Beijing, visited FIRDI.

#### May

- May. 4 Dr. Juraj Koudelka, Representative of Czech Economics and Cultural Office Taipei, visited FIRDI.
- May. 12 Dr. Shu-Kong Chen, Director General of FIRDI and Dr. Ming-Jen Lee, President of National Chiayi Univ., signed a cooperation agreement memorandum in Chiayi Univ..



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#### June

- June 2 The R & D Alliance of the Development of Carotenoid and its Products was established in Hsinchu. After the ceremony, the alliance members, Dr. Shu-Kong Chen, Director General of FIRDI, Mr. Wen-Sheng Liu, General Manager of Asia-Pacific Biotech, Mr. James Liu, Director of Yenchen Machinery and Mr. Chen-Kang Liu, General Manager of Whole-Grain Biotech, co-signed a memorandum of understanding to link a close relationship.
- Jun. 4 Held a technology transfer signing ceremony, Dr. Shu-Kong Chen, Director General of FIRDI and Mr. His-Yuan Lai, General Manager of Leezen Corp., signed a technology transfer contract.
- **Jun. 23** FIRDI joined the 20<sup>th</sup> Taipei International Food Show in Taipei World Trade Center.
- Jun. 24 The "2010 Innovation and Research Matching Forum of Starting Chiayi Industry Innovation and Research Center up" was held in Chiayi.

Jun. 25 A tea party was held for the retirement of Dr. Ming-Sai Chien, Director of Food Analysis Research and Service Center.

#### July

Jul. 22 FIRDI joined the Taiwan International Biotech Exhibition 2010 in Taipei World Trade Center.

#### August

Aug. 5 Held "The Second Cross-Strait Food Industry Cooperation and Interaction Conference" in Beijing, China.

#### September

Sept. 26 Dr. Chii-Cherng Liao, Deputy Director General of FIRDI and Dr. Gwo-Fang Yuan, Director of Bioresources Collection and Research Center of FIRDI attended the International Conference on Culture Collection, ICCC-12 Conference 2010 in Brazil and gave a speech.





- Sept .28 Food safety specialists of P.R. China visited FIRDI.
- Sept. 30 FIRDI joined the Taipei International Invention Show & Technomart held in Taipei World Trade Center.

#### October

- Oct. 15 Mr. Yin-Pao Pin, Deputy Director of Municipal People's Congress of Xin-Yang City Henan Province, China, led a team of 10 to visit FIRDI.
- Oct. 19 Mr. Hans Fortuin, Representative of Netherlands Trade & Investment Office and Mr. Jan Fongers, Asia Manager of Wageningen International, Wageningen University & Research Centre, visited FIRDI.
- Oct. 30 In celebrating FIRDI's 43<sup>rd</sup> Anniversary, series of activities were held.

#### November

Nov. 22 Ms. Kuei-Lan Sung, Deputy Secretary-General of China National Accreditation Service for Conformity Assessment and Mr. Shou-Yun Huang, Deputy Director of Certification and Accreditation Administration of the People's of Republic China, led a team of 12 to visit FIRDI.

#### December

Dec. 2 Dr. Darunee Edwards, President of Food Science Technology Association of Thailand, visited FIRDI.

> Health food specialists of P.R. China visited FIRDI.

Dec. 13 Dr. Hisao Ohtake, Prof. Of Osaka University, Japan, visited FIRDI and held round table discussions.









### 2010 Annual Report

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