

# FOODTECH INSIGHT FOR HEALTH

Technology Trend Analysis  
of Healthy Food



Intellectual Property Innovation  
Driven Enterprise Center (IP IDE Center)



กระทรวงพาณิชย์  
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## Table of Contents

Executive Summary .....	6
1. Data clean-up & Grouping.....	8
Objectives .....	8
Patent as an Indicators of research performance .....	8
Definition of Functional food Ingredient for Non-Communicable Disease (NCDs) patent.....	10
Identification of Functional Food Ingredient for Non-Communicable Disease (NCD) patent ...	11
Timeframe for analysis.....	11
Data extraction and analysis.....	12
2. The overall perspective of the Value Chain. ....	13
3. Innovation profile for each technology group.....	18
3.1 International Innovation Profile.....	19
3.2 Innovation profile in Thailand.....	23
4. Technology trend divided by a group of technology .....	26
4.1 Technology trend analysis in a global scale.....	26
4.2 Technology trend analysis in Thailand .....	28
5. Technology demand.....	31
6. Key players.....	33
6.1 International key players .....	33
6.2 Key players in Thailand.....	36
6.3 Innovation profiles of international companies.....	40
6.4 Principal technologies of international organizations .....	48
6.5 Principal technologies of organization filing patent applications in Thailand .....	50
6.6 Technology focus trend of international organizations.....	51

6.7 Patent applications classified by a group of technology of key players .....	52
7. Patent application filing countries or regions .....	55
8. Strengths and weaknesses, opportunities, and threat of technology .....	57
9. Technology trends related to industries.....	62
10. The potential technology analysis for development.....	64
10.1 Patent strength index strategy.....	64
10.2 Forward citation strategy .....	65
11. Suggestions for applying the analysis result .....	67
Reference .....	69

## Table of Tables

Table 1 Numbers of patent application classified by a group of technology of Jinshanmei Biotechnology Co., Ltd.....	52
Table 2 Numbers of patent application classified by a group of technology of University Kyunghee .....	52
Table 3 Numbers of patent classified by a group of technology of Nestle. ....	53
Table 4 Numbers of patent classified by a group of technology of Korea Food Research Institute .....	53
Table 5 Numbers of patent classified by a group of technology of Korea Institute of oriental medicine.....	54
Table 6 Numbers of patent filed in Thailand sorted by applicant types .....	59

## Table of Figures

Figure 1 Death rate resulted from Non-communicable diseases of the population ages ranges from 30-69 years old .....	13
Figure 2 Death rate resulted from Non-communicable diseases of the population ages range as of 70 years old.....	14
Figure 3 Supply chain of the Functional Food Ingredient.....	15
Figure 4 Numbers of international patent broken down by technology group.....	19
Figure 5 Proportions of international patent application by technology group .....	20
Figure 6 Numbers of Thai patents broken down by technology group .....	23
Figure 7 Timeline activity of patent filing categorised by types of functional food ingredients ..	26
Figure 8 Timeline activity of patent filing categorised by a group of non-communicable diseases .....	27
Figure 9 Timeline activity of patent filing categorised by a group of non-communicable diseases .....	28
Figure 10 International key players .....	33
Figure 11 Timeline activity of international key players.....	35
Figure 12 Numbers of invention of the key players .....	36
Figure 13 Timeline activity of Thai key players.....	37
Figure 14 Numbers of patent categorized by a group of technology of Jinshanmei Biotechnology Co., Lid. ....	40
Figure 15 Numbers of patent categorized by a group of technology of University Kyunghee.....	41
Figure 16 Numbers of patent categorized by a group of technology of Nestle .....	43
Figure 17 Numbers of patent categorized by a group of technology of Korea Food Research Institute .....	44
Figure 18 Numbers of patent categorized by a group of technology of Korea Institute of oriental medicine.....	46
Figure 19 Analysis of top patent assignees broken down by technology groups .....	48
Figure 20 Analysis of top patent assignees in Thailand broken down by technology groups.....	50
Figure 21 Analysis of top patent applicants broken down by filing locations .....	55

Figure 22 Compound Annual Growth/Decline Rate between 2012-2016 by first filing locations	55
Figure 23 Numbers of patent for top 10 first filing locations.....	57
Figure 24 Timelind of activity for top 10 first filing locations during 2007-2018.....	58
Figure 25 Aanlysis of overlap between tevhnology group.....	58
Figure 26 Numbers of patent application filed in Thailand divided by applicant types and a group of technologies .....	60
Figure 27 Numbers of patent application filed in Thailand sorted by a group of technologies..	61
Figure 28 Number of publications and numbers of inventions filed internationally during 2007-2018 .....	62
Figure 29 Number of patent applications filed in Thailand .....	63
Figure 30 Patent citation approaches .....	65

## Executive Summary

A study conducted of the international patent concerning to functional food ingredients for patient with Non-Communicable Diseases: NCDs have founded relevance inventions in total of 10,081 inventions in which most inventions have been invented and most patents have been filed mostly in Asia continent. The country that have the highest rates of inventions and patent filing is China and follow that would be Korea and Japan, respectively. China however, having the highest patent compound Annual Growth Rate: % CAGR at 51%, as for Korea which has the second highest total numbers of patents, however it's compound annual growth rate is down to -4%, as a result making Japan to have the patent compound annual growth rate at the second rank at 9%.

However, the study has found that technology concerning functional ingredient for patient with Non-Communicable Diseases, Asian Continent have the most concentrated patent activity. Further, United States of America and the European Union have the patent annual growth rate in this said technology filed reduction down to -22% and 6% respectively.

In analyzing the key players in this technology filed at the first rank is "Jinshanmei Biotechnology" which have an invention concerning vitamins, dietary mineral, protein, plant extract and dietary fiber for the treatment of Cardiovascular disease such as heart disease or hypertension. Follow with the second rank which is "University Kyunghee Industrial Cooperation" having most inventions concerning plant extract for the treatment of disease concerning the nervous system for which South Korea is one of the top key players that have filed for patent registration.

After conducting technology analyzing it shown that plant extract, vitamins and dietary minerals are functional food ingredient that have the highest rate for patent filing for the filed concerning Non-Communicable Diseases: NCDs in combination with Cardiovascular disease such as, heart disease or hypertension and nervous system disease such as Alzheimer's disease for example.

These group of diseases have the most registered patent for the treatment process for the functional food ingredient.

As for Thailand, the study has found 499 relevance patent applications which could be divided as follows: Patents application filed by foreign applicant 82.49%, Patent application filed by government sector/individual/company is only 17.51%. The patent application filing rate in Thailand have dropped continuously in the past 5 years because of the reduction in patent application filed by foreign applicant. From analyzing the foreign patent applications, the result shows that over 92.98% of the said applications is filed in the name of a company. As for Thai's company it is only 3.0%. The Thai's research institute and the Thai's education sector are the main applicants that file for patent application concerning Functional food ingredient which is 57% of all the total patent applications filed in Thailand as for the other 41% would be the business owner and Thai's researcher.

If comparing the world trend, it is found that inventions invented by a Thai's inventor that have the 3 highest patent application filing rate would be as follows: (1) The group concerning Cardiovascular Disease (2) Disease related to the nervous system and (3) Cancers. These shows that the Thai's government sector and Thai population have the patent application trend in accordance with the international patent trend direction.

After analyzing the main applicant categorized by from the technology filed we found that the group of disease concerning Cardiovascular disease and the disease related to the nervous system still have a low rate of patent application filing in Thailand, however these technology trend

is increasing globally. In the analyzer point of view, it seems that this is a great opportunity for the Thai's research institute/Thai's education sector as well as the Thai's company to further develop the research concerning this filed of technology in order to protect the country technologies and to go along with the global technology trend as well as increasing the chance of patent registration.



## 1. Data clean-up & Grouping

### Objectives

This analysis report presents the data regarding the analysis of the functional food ingredient for the treatment of patient with Non-Communicable Diseases: NCDs that have been filed as a Patent or Utility Model.

The objective of this report includes the presentation of the analysis result of the supply chain which is to present the overall perspective of the industrial process from start to the end process, in order to use this data to support the technology analysis by the use of the patent or Utility Model data according to this report.

### Patent as an Indicators of research performance

Patent can be used as an index indicator of the research and development (R&D) result (Griliches, 1998). Furthermore, the patent data and the patent reference ratio have a great impact on the market value (Hall, 2005) in which the patent is a certificate which certified that the product, method is novel, having an inventive step and is industrial applicable. Patent also give an exclusive right to the patent applicant to have the exclusive right to produce, use, sell, or import the product or product formed by the procedure in accordance with the patent for a certain time frame.

Patent also contains the useful information which is available for the public such as the International Patent Classification: IPC, applicant information, inventor information, the reference documents that is the foundation of the invention development (Background of the invention).

Therefore, the patent data analysis by using the credible researched data for analyzing the patent data such as the inventor, the technology group, the countries that have filed for patent protection, the countries that have a patent publication through a patent search engine along with the expert advice, these factors could help us have a perspective of the essential patent activity including the scope of the invention, the collaboration between the government sector and the company, and the numbers of the patent filed.

The publicized patent specification needs to be an information concerning innovations that is industrial applicable and is a tangible innovation. As for the intangible innovation, it is hardly founded such as a creative work concerning art and appreciation, computer program or business model (WIPO, 2018).

The patent data analysis is categorized by the group of industries which the vision that is clear and familiar is not usually could be done due to the restriction of the patent information as follows:

1. One innovation is a combination of different technologies, however, the patent data is categorized into group by the technology filed in the other we cannot search the innovation group that is compose of various technologies directly by using the International Patent Classification: IPC code for example in the cloud funding system or the distance learning system because in these innovation comprises of various technologies such as the network technology, the data input technology or the data display technology these depends on the inventors that what have they been developing the innovation in to which filed. For some instance, when the inventor solely develops the display technology for the long-distance medical technology, for this instance, this invention could be categorized in to the same group as the group concerning the broad casting for the gaming technology. For the above example, categorizing the display technologies is quite difficult.

2. The terms used in patent specification is the term that not a layman term that could be understood by most people, but it is a description of the feature or the uses for example when searching for an invention regarding “a chair” by using the search term “chair” all inventions relating to chairs would not show up due to the patent’s descriptions. The patent applicant or the patent agent will use a broad description for that certain patent, such “an instrument for sitting purpose” or “receiving plate” for example, in order to broaden the protection scope and to avoid being found by simple patent searching. For the mentioned reason making patent searching for analyzing purpose by using a search term only would not give sufficient and complete output data.

With this specific characteristic and limitation of patent as mentioned above making patent searching, technology grouping and patent data analyzing resulted in a different data results and different perspectives on the analysis report comparing to other technology analysis report, such as market analysis report and scientific experiments report for example, however this data still helps business entrepreneur or business executive to have some information to help making better decision and to have a better business strategy (T., 2015)

### **Definition of Functional food Ingredient for Non-Communicable Disease (NCDs) patent.**

This analysis has selected patents in the technology group relating to Functional food Ingredient for Non-Communicable Disease (NCDs) by using the keyword in combination with the International Patent Classification code (IPC Class) and the Derwent World Patent Index (DWPI) class as a main filter in order to search and categorized the data output.

Grouping the data by using the technology analysis as a main tool in combination with country main interest technology group that is saying that technology grouping by mainly using the patent data and dividing the technology topic by the patent description and considering the clarity of the said grouping.

The analyzer has categorized the industrial group into technology groups as follows:

Categorizing by the different type of functional food ingredient such as:

1. Vitamins & Minerals
2. Fatty acids
3. Protein
4. Hydrocolloids and dietary fiber
5. Plant extracts
6. Other functional food ingredients

Categorizing by the different type of the Non-Communicable Disease (NCDs) such as:

1. Metabolic disorders.
2. Cancer: Breast cancer such as Ovarian cancer, Skin cancer or Lung cancer.
3. Neurological disorders such as Alzheimer, memory declination or mental disorder.
4. Cardiovascular disease such as heart disease, Coronary artery disease or hypertension.
5. Respiratory disorders such as emphysema, pneumonia or asthma.
6. Other diseases/disorders such as overweight, chronic kidney disease, bone disease, kidney disease, liver disease, paralysis, paralyze or injury due to accident.

### **Identification of Functional Food Ingredient for Non-Communicable Disease (NCD) patent**

- Patent Search from the International patent database.

Patent search by using the keyword in combination with the International Patent Classification (IPC class) and the Derwent World Patent Index (DWPI) class by dividing these into the desire target study group of technology and then move on the searching and filtering the data.

- Patent search from the Thai Patent database.

Patent search from the Thai Patent database by using the keywords in combination with the International Patent Classification (IPC class), cited by using as the same search query as in the search from the international patent database by dividing these into the desire target study group of technology and then move on the searching and filtering the data.

### **Timeframe for analysis**

- Patent Search from the International patent database.

Creating a set of data in this report started by scoping patent filing time backward into 10 years, where were the patent filing filing between 2007 – 2018. However, the analysis result presents only from 2007 to 2016 because patent data in 2017-2018 were not published completely which may cause the whole analysis result of this report incomplete.

- Patent search from the Thai Patent database.

This set of data is not limited by the application filing date because the numbers of the relevant patents in Thailand is not a large number, therefore this make it possible to gather all the data and analyze it.

### **Data extraction and analysis**

This analysis report has arranged the invention and the analysis of the metrics by using the patent database as a foundation base and present the result in a table chart, graph or a graphic presentation which incorporate with the said patent data.

Data managing comprises of 4 steps as follows:

1<sup>st</sup> Step: Dividing the technology group in accordance with the International Patent Classification (IPC) or the Derwent World Patent Index (DWPI) Class.

2<sup>nd</sup> Step: Inputting the search query by using the relevant description of the IPC or DWPI class.

3<sup>rd</sup> Step: Filtering and cleaning up by selecting out the irrelevant data and then gathering the remaining data.

4<sup>th</sup> Step: Analyzing the data within the scope of the analysis objective by analyzing the data and present it in a report.

## 2. The overall perspective of the Value Chain.

The Non-communicable disease: NCDs is a disease that is not caused by infectious agents or is not transfer by a disease carrier and not contagious between person but is rather a disease that is caused by several factor within the human body from derived from the habit and daily living behaviour up to the symptom stage for instance, Metabolic disorders, Cancer, Neurological disorders, Cardiovascular disease, Respiratory disorders and other diseases/disorders such as overweight, chronic kidney disease, Bone diseases, injury due to accident, kidney disease, liver disease, paralysis and paralyze.

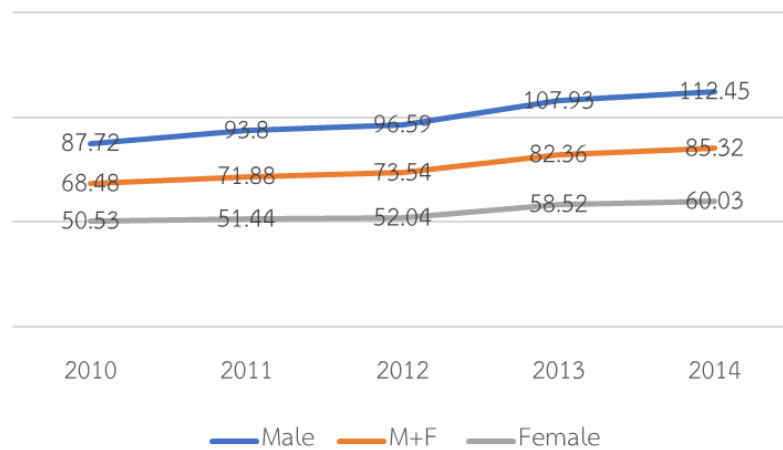


Figure 1 Death rate resulted from Non-communicable diseases of the population ages ranges from 30-69 years old

From Figure 1 which depicted the death rate resulted from Non-communicable diseases of the population ages ranges from 30-69 years old shows that the population ages ranges from 30-69 years old, all the group ages have an increasing death rate in from year to year, from year 2010-2014 (B.E. 2553-2557), the male population group having an increasing death rate as of 28.19%, the male and female population having an increasing death rate as of 24.59% and the female population having an increasing death rate as of 18.80% as a result it shows that the male population have a higher death rate of 9.39% more than the female population.

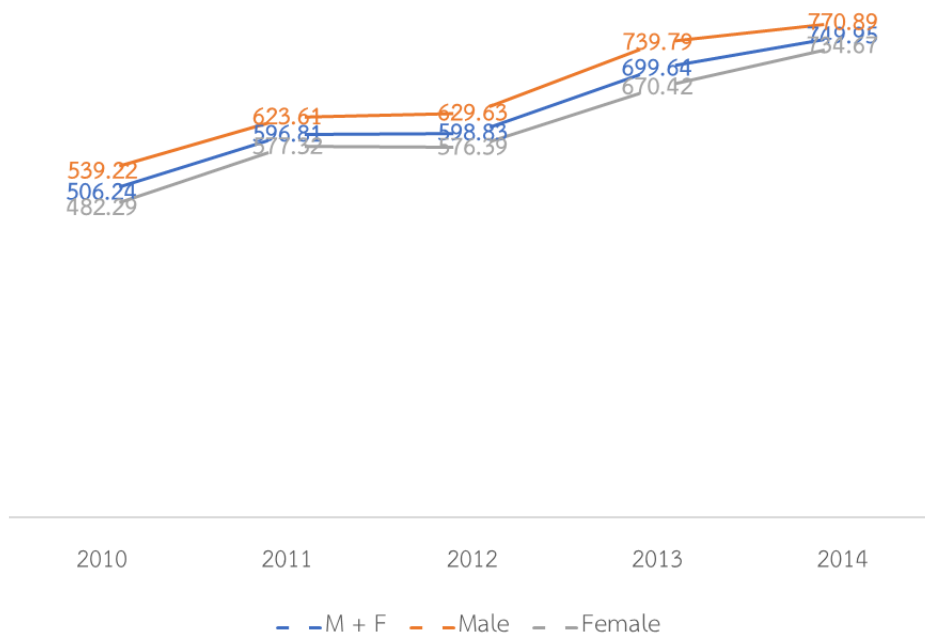


Figure 2 Death rate resulted from Non-communicable diseases of the population ages range as of 70 years old

From Figure 2 depicting the death rate resulted from Non-communicable diseases of the population ages range as of 70 years old. All group having an increasing death rate from year 2010-2014 (B.E. 2553-2557), the male population group having an increasing death rate as of 42.96%, the male and female population having an increasing death rate as of 48.14% and the female population having an increasing death rate as of 52.33% as a result it shows that the female population have a higher death rate of 9.37% more than the male population.

Functional food ingredient or Nutraceuticals ingredient which is the component used for enhancing food product in order for the food to have extra functions added on such as for curing disease and enhancing body strength.

Nowadays, they are numerous products that is categorized as functional food ingredient products in which it could be categorized in to groups as shown is this analysis report such as plant extract, Vitamins & Minerals, Fatty acids, Protein, Dietary fiber etc.

The overall view of the market for functional food ingredient at the present is expanding continuously due to the change in the eating behavior and the living style of the consumers that is more health conscious and the today society is turning toward the aging society as mentioned in the market analysis of “future market insights” under the topic “ Demand Growing on Account of Rising Awareness: APAC Industry Analysis and Opportunity Assessment, 2016-2026” which has revealed that the market for Functional food ingredient in the Asian Pacific is expected to increase 5.9% in the span of year 2016 to 2026 (B.E. 2559 - 2569) and is expected to have the total value as much as 5.04 billion dollar (USD) in the year 2026 (B.E. 2569).

The supply chain for the functional food ingredient industry consisted of the Upstream industry or business such as livestock and agriculture, the Midstream industry or business such as the food processing industry and Pharmaceutical and Medical supplies manufacturers, the Downstream industry or business such as the consumer. Theses could be categorized as the flow chart as follows:

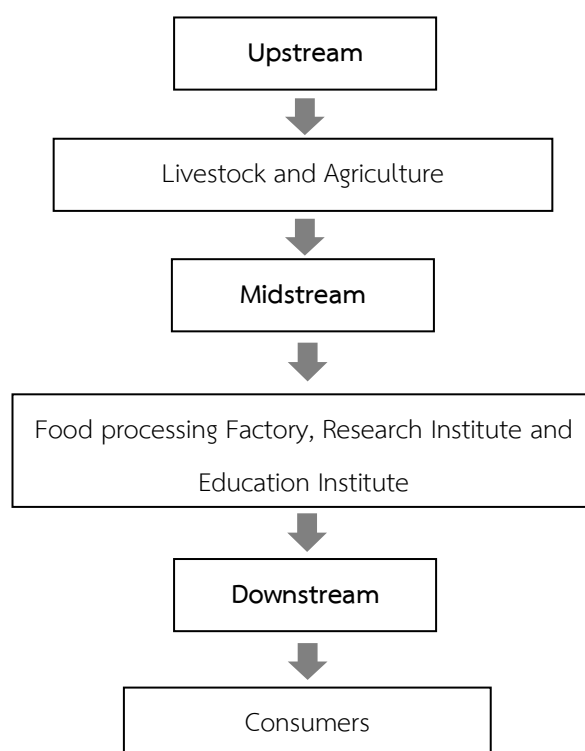


Figure 3 Supply chain of the Functional Food Ingredient



For the Functional Food Ingredient Industry, the Upstream Industry and Business such as the livestock and agriculture business group which includes animal farming up until the slaughterhouse industrial as for the agricultural segment which is agricultural relating to the agricultural products such as vegetable and fruits which start from the growing the vegetables and the fruits, maintenance, nourishing the agricultural products up until the plant harvesting which is a group of business that is very important because it is the group that produce the main ingredient for the demand of the consumer which is the downstream group of industry. The big and small business entity should make use of the up to dated technology to help managing the infrastructure of the organization for instance using a tracking system for farm animals for the convenient of compiling each animal data and the system could also be apply for the automatic animal feeding, as well as using the automatic light level setting system for a closed system animal farm in order to enhances the growth process of the animals, including a quality controlling of the animal farming to be more efficient and more organized. As for the agricultural sector it should make used of the technology in the semi-automatic form or to use to system to monitor the humidity in the soil or the air to have the data processor to be more systematic by being able to receive/send information for the growing area to the expert plant analyzer who have a suggestion to improving the plant growing quality, furthermore, giving educational knowledge for the farmer of the business owner is also a very important matter that should be emphasis. Including the use of the technology of maintaining the raw material that could be in a form of frozen meat or fresh agriculture product and the managing of the product in the warehouse to have better quality including the storing and transporting to the processing industry at the Midstream level.

Agricultural product both in the form of frozen meat, vegetable and fruit that is well maintained and having a rapid transport for the industry in the Upstream level by using the technology to keep the product fresh or the logistic system such as the form of transportation and the distribution of the product to the packaging factory of the raw material processing factory which these could be categorize as a Midstream industrial or the business group, in which this Midstream group is considered an industrial section that has an importance for the raw material

processing processes including meat, vegetable and fruit which was received for the Upstream industry and business group. These raw material processing plant should make use the extracting, quality standard, maintenance and food flavoring for consumer food product technologies. As for the functional food Ingredient processing industry it requires the know-how of a Health Care Professionals which in some case it would have a collaboration with a Government Health Sector Agencies or Universities in order to reduce the problem of hiring new workers. However, the cost of researching and developing is quite high and it also should have a sector that would be in charge with the coordinating and regulating the Regulatory Agencies because the important factor that should be the first in consideration for the business owner in the Midstream level would be the law and regulations due to the fact that not all of the functional food ingredients could be safely consume by human or animal.

Further, it also should have the managing system of the product in the warehouse and the distribution of such product to the sale point in order the make the product handling to the consumer at the downstream level to be more efficient.

The business at the downstream which is the Department store groups, convenient store, including the medical provider establishments for example, which received the product for the Midstream industry group that have a long term storage period or have an efficient storage time that could be used for consumption in many forms such as ready to eat process food, functional food, Dietary Supplements, Functional Beverages. Further, it should have think of new strategy to track the consumer buying or eating behaviors as well as conducting other marketing research by using the suitable technology throughout the whole supply chain which start form the studies of the consumer needs and behavior in the household sector this would improve the form of food distribution service in the midstream industry and the upstream industry level efficiently and this would resulted in producing a product that could answer the consumer needs at the downstream level.

### 3. Innovation profile for each technology group.

The study of the Innovation profile will study the overall perspective of the patented technology by categorizing the technology as follows

Categorizing by the component of the Functional Food Ingredient.

1. Vitamins & Minerals.
2. Fatty acids.
3. Protein.
4. Hydrocolloids/Dietary fiber.
5. Other functional ingredients.

Categorizing by the Non-Communicable Diseases: NCDs

1. Metabolic disorders
2. Cancer such as Breast cancer such as ovarian cancer, Skin cancer or Lung cancer.
3. Neurological disorders such as Alzheimer, memory declination or mental disorder.
4. Cardiovascular disease such as heart disease, Coronary artery disease or hypertension.
5. Respiratory disorders such as emphysema, pneumonia or asthma.
6. Other diseases/disorders such as overweight, chronic kidney disease, bone disease, kidney disease, liver disease, paralysis, paralyze or injury due to accident.

The Innovation profile according to this analysis report could be divided into 2 parts which is

- (1) The international innovation profile which would depict the overall perspective of international patents by categorizing the patents by the components of the Functional Food Ingredient and the Non-Communicable Disease and
- (2) The Thai innovation profile which would analyze the Thai patent database by categorizing in to one group which is the Non-Communicable Disease because the Thai Patent database is not fully complete making not capable to have the full detail on the Functional Food Ingredient category.

### 3.1 International Innovation Profile

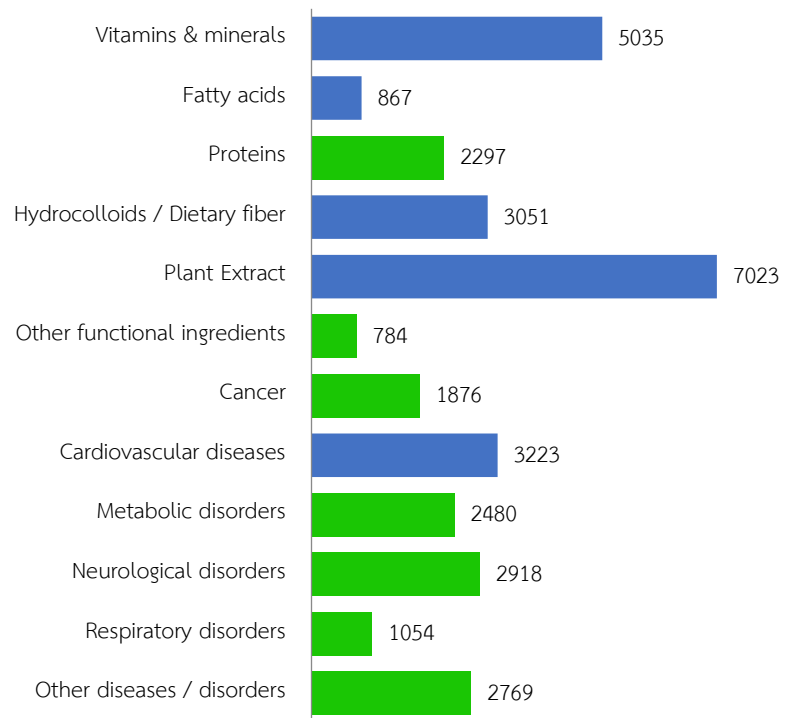


Figure 4 Numbers of international patent broken down by technology group

From the figure 4 which depicted the numbers of patent that was categorized by the technology group it was found that the plants extract, vitamins and minerals and dietary fiber are the top 3 rank groups of technology that was used as a component for the Functional Food Ingredient for Non-Communicable Disease in which the Plant extract was in 7,023 patents, Vitamins & Minerals was in 5,035 Patents and the Dietary fiber was in 3,051 patents, these shows that the plant extract was widely used as a component in Functional food Ingredient because the it is a raw material derived from nature that has been studied and used for a long period of time in each country and continent having plant and herb in the area to use as a medicine to cure disease and enhance the overall health in the form of traditional medicine and conventional medicine, especially in the Asian continent such as Thailand, China and Korea where these plants and herbs is easily find and have many medicinal properties which could be extracted from several parts such as the root, leaf and the trunk.

One example of the used of the Plant extract in the Functional food Ingredient such as Patent publication no. WO2010110640, Invention Title “Anti-diabetic nutraceutical composition

from palm leaf extract” application date 24 March 2009 which is an invention regarding the palm extract as a component of the Functional food Ingredient for Diabetic patient in which is extract could help reduce the blood sugar level and the stress condition that occurred form the oxidation of the diabetic patient.

Furthermore, the protein, fatty acid and other components were used as a component for the Functional Food Ingredient for Non-Communicable Disease (NCD) in which the protein that could be used for Functional Food Ingredient could be derived from plant and animal.

One example of the used of protein in Functional food Ingredient such as in Patent Publication no. WO2009144278, Invention Title “CONGLUTIN-GAMMA AS MEDICAMENT AND DIET SUPPLEMENT” ` application date 28 May 2009 for the innovation concerning the extracting of the conglutim –Y from Lupin seeds for the use as a Functional Food Ingredient , supplemental dietary for metabolic disorders especially Polycystic ovary syndrome, HIV (Lipodystrophy caused by HIV and Muscular dystrophy in which the conglutim-Y could increase the condensity of Flotillin-2 and caveolin-3 which is essential for the movement of the Insulin-regulated glucose tranporter (GLUT4) and the Muscle energy metabolism.

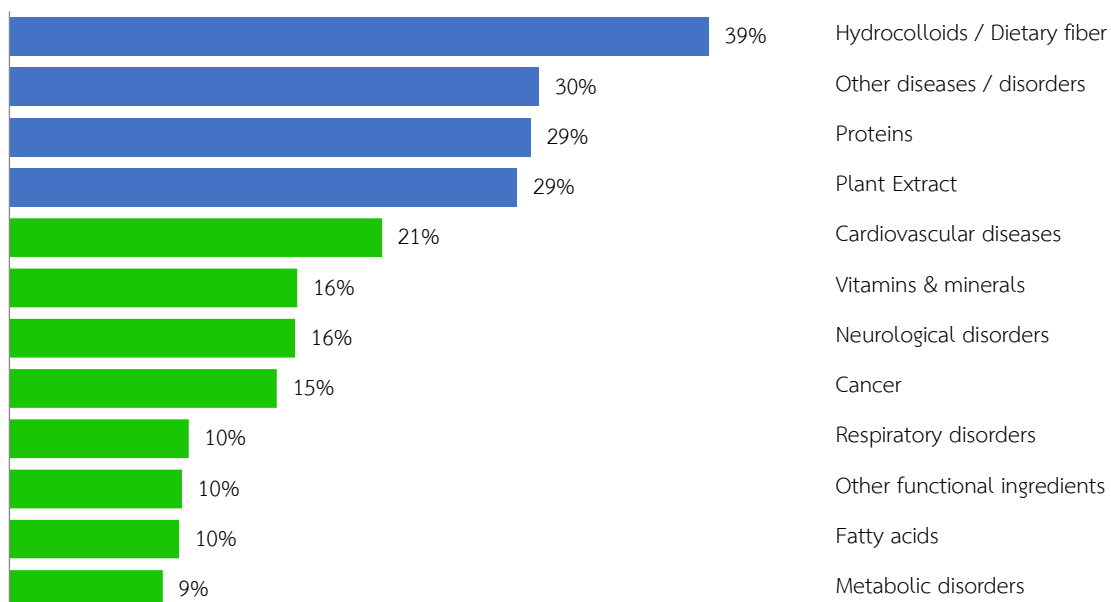


Figure 5 Proportions of international patent application by technology group

Considering the increasing numbers as of the last 10 years from year 2007 (B.E.2550) until year 2017 (B.E.2560) from the figure 5 depicting the patent application rate in each technology group it was founded that the dietary fiber was used in Functional Food Ingredient for Non-Communicable Disease (NCD) at the highest rate which is 39% follow by Protein and plant extract which is at 29%. Whereas the Non-Communicable Disease (NCD) is the main target for the development of the Functional Food Ingredient or the slowing down of the change of the diseases to occurred which are the cardiovascular diseases, neurological disorders and the metabolic disorders. The cardiovascular diseases were mentioned in 3,223 patents, neurological disorders were mentioned in 2,918 patents and the metabolic disorders were mentioned in 2,480 patents. Considering the increasing rate within the past 10 years from year 2007 (B.E.2550) until year 2017 (B.E.2560) from figure 5 which depict the patent application rate in each technology group it was found that the patent relating to the cardiovascular diseases have the highest growth rate of the top 3 rank which is 21% followed by the neurological disorders at 16% and cancer at 15% respectively, followed by the respiratory disorders and others disorder.

The numbers of the Patents relating to Cardiovascular disease is increasing which is in accordance with the world condition having the death rate caused by cardiovascular disease is expected to increase in Thailand and globally, from the statistic of the World Health Organization in year 2012 (B.E.2555) which shown that the death rate caused by cardiovascular disease is in the total of 7.4 million person worldwide, whereas Thailand having an increasing death rate caused by cardiovascular disease, the group of people having high risk rate is the diabetic , high blood pressure, obesity, high blood cholesterol and people who smokes, from the Health department statistic form year 2012 (B.E.2555) up until year 2015 (B.E.2558 ) it found that the death rate caused by cardiovascular disease is approximately 2 deaths within one hour (TNN24, 2560) or approximately 28 death per 100,000 population and from the statistic of the Office of the National Economic and Social Development Board, the Health Department shows that the cost from the medical bills on average for the heart disease patient is around 7,000 million Baht per year (Bureau of Non Communicable Disease, Department of Disease Control, 2017) therefore it could be construe that the development of the innovation for cardiovascular disease is still

not sufficient in the Functional Food Ingredient industry which is in high demand in order to reduce the risk for cardiovascular disease and the concerning growing death rate.

### 3.2 Innovation profile in Thailand.

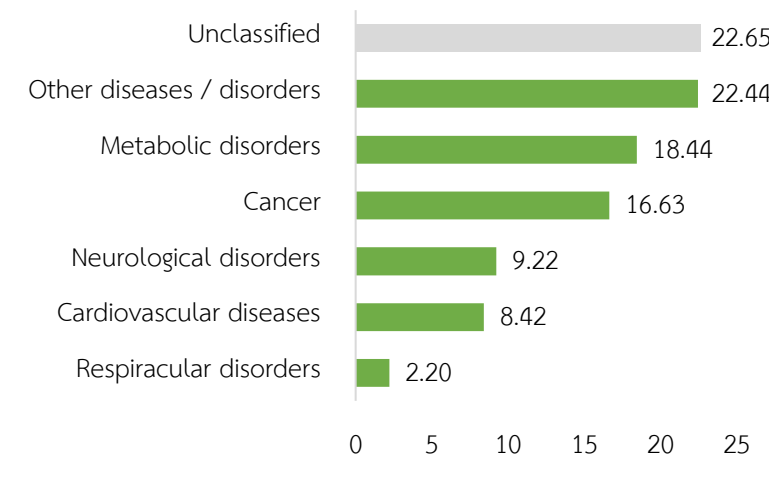


Figure 6 Numbers of Thai patents broken down by technology group

It shows the group that has the most patent applications which is unclassified due to the lack of relevant information that is concentrated in particular group of disease which is at 22%

Follow by the other diseases/disorders which have the numbers of patent applications at 22.44% which the highest rate comparing to the other Non-communicable diseases such as accident, obesity, bone disease, liver disease, kidney disease, making the compiling up into several patents. Obesity also have an increasing rate (nokdee, 2014) which is categorized as the other diseases/disorders making the development and the patent application relating to the other diseases increase as well.

The Third rank is the group of diabetic disease group which have the patent application rate at 18.44% which is a chronic disease caused by the living habit (pisitpaiboon, 2015) , in addition diabetic disease is one cause of the death rate for other group of non-communicable diseases and its rate is increasing continuously (Department of Disease Control, 2017) it make the sugar level and blood level non manageable which could make other organ failure such as eyes, nervous system, arteries wall, (Pholmanee, 2015), these make the Thai Patent application rate grows because of the importance of the food for the diabetic patient which is especially make to control the body sugar level.



The fourth rank which is the cancer group which have the patent application rate at 16.63% for Thailand cancer disease group is the main cause of death which is caused from the health habit (Thairath, 2016) having the patents relating to food or additive for cancer patient who have a low immune system and is prone to infection, therefore these patient needs to consume food enriched in nutritional and energy property in a moderate and sufficient amount such as food comprises with Whey protein, L-arginine, Omega 3, vitamins and minerals (Nestle, 2018) For the Thailand future trend of patent application having an increasing rate due to the fact that these food and additive is on demand to be used for the treatment of the patient and the care taker.

The fifth rank which is the neurological disorder having the patent application rate of 9.22% in Thailand as from year 2006 (B.E.2549) up until year 2012 (Health Information System Development Office, 2013) having a decreasing rate to 23.36% and is expected to decrease in the future. Whereas, most patent applications in Thailand is patents relating to psychoactive substance.

The next rank which is the cardiovascular disease having the most patent application at 8.42% which is similar to the neurological disorder group. The cardiovascular disease have an continuous increasing rate from year 2012 (B.E.2555) – 2015 (B.E.2558) (Phanmong, Chaiwan, และ Nutsada Saengsuwanto, 2016) which were caused from various reasons such as the abnormality of the heart structure, the abnormality of the heart arthritis, the abnormality of the heart electrical frequency, bad eating habit, smoking or lack of exercise for example. The Thailand future patent application relating to food of active substance expected to have an increasing rate due to the fact that certain food of active substance has a direct effect on the group of cardiovascular disease patient making it very essential for patient in directly controlling the sugar and the fat level of the patient.

The last rank would be the respiracular disorders which have the patent application rate at 2.20%, in which in Thailand this group of disorder is expected to have an increasing rate due

to human activities such as smoking, pollution from forest fire, constructions, toxic fumes from vehicles or industrial factory including the growing populations (Saenghirunvattana, 1999)

#### 4. Technology trend divided by a group of technology

Technology trend analysis by a group of technology performed by divided patent applications into different group of technology and illustrated as patent application numbers by year, so as to study and find a patent application in each technology which is likely to increasing file. The analysis in this report categorized technology trend analysis into 2 main topics:

1. Technology trend analysis in a global scale: illustrating patent application numbers a year, sorted by types of functional food ingredients and by a group of non-Communicable Diseases;
2. Technology trend analysis in Thailand: illustrating patent application numbers a year, sorted solely by a group of non-Communicable Diseases. However, owing to incompleteness of Thai patent database, this technology analysis according to this report cannot be completely sorted by types of functional food ingredients.

##### 4.1 Technology trend analysis in a global scale

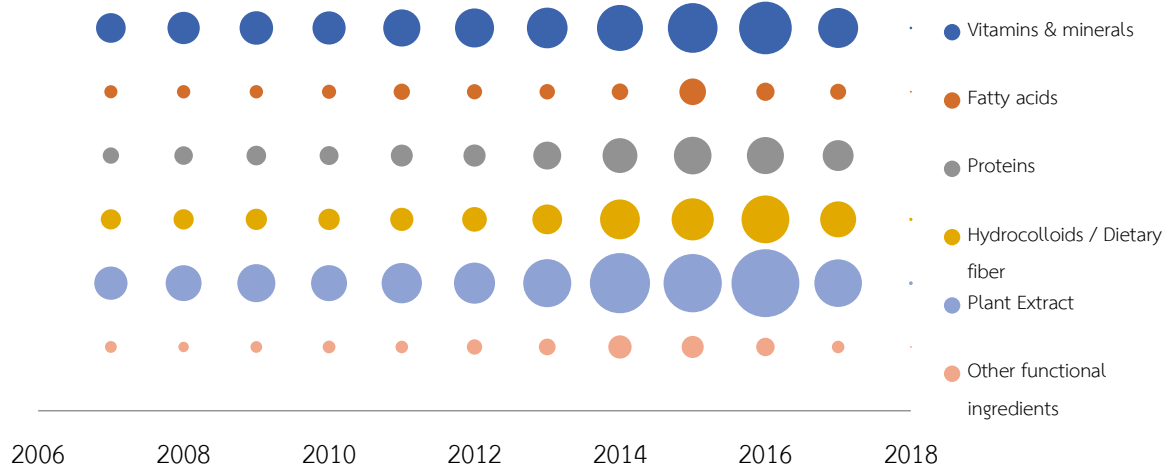


Figure 7 Timeline activity of patent filing categorised by types of functional food ingredients

Figure 7 illustrates patent application numbers a year sorted by types of functional food ingredients for NCDs from 2007 – 2018 (B.E. 2550 - 2561). It was found that plant extracts, vitamins and minerals, and dietary fiber were a group of technology used in the patents related to NCDs 3 as the top three functional food ingredients respectively: the dietary fiber was mostly continuously used with the growth filing rate between 2014 – 2016 (B. E. 2557 - 2559); the vitamins and minerals was mostly continuously used with the growth filing rate and reached its

peak in 2016 (B.E. 2559); the dietary fiber was started with increased filing rate in 2014 – present (B.E. 2557 – present). Moreover, fatty acids, proteins, and other functional ingredients were used in a lower rate than the mentioned functional food ingredients.

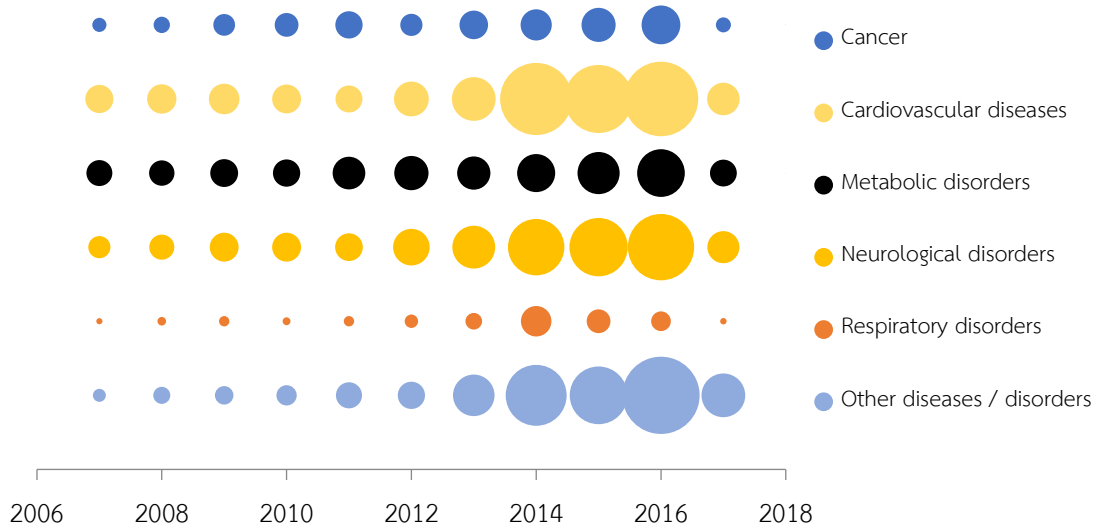


Figure 8 Timeline activity of patent filing categorised by a group of non-communicable diseases

Figure 8 illustrates the patent applications numbers a year sorted by a group of non-Communicable Diseases from 2007 – 2018 (B.E. 2550 – 2561). The figure shows that cardiovascular diseases, neurological disorders, and diabetes are a principal group of diseases for developing functional food ingredients for treating or alleviating the diseases as the top three functional food ingredients respectively. The numbers of patent applications related to treatment of cardiovascular diseases with functional food ingredients increased in 2014 (B.E. 2557).

## 4.2 Technology trend analysis in Thailand

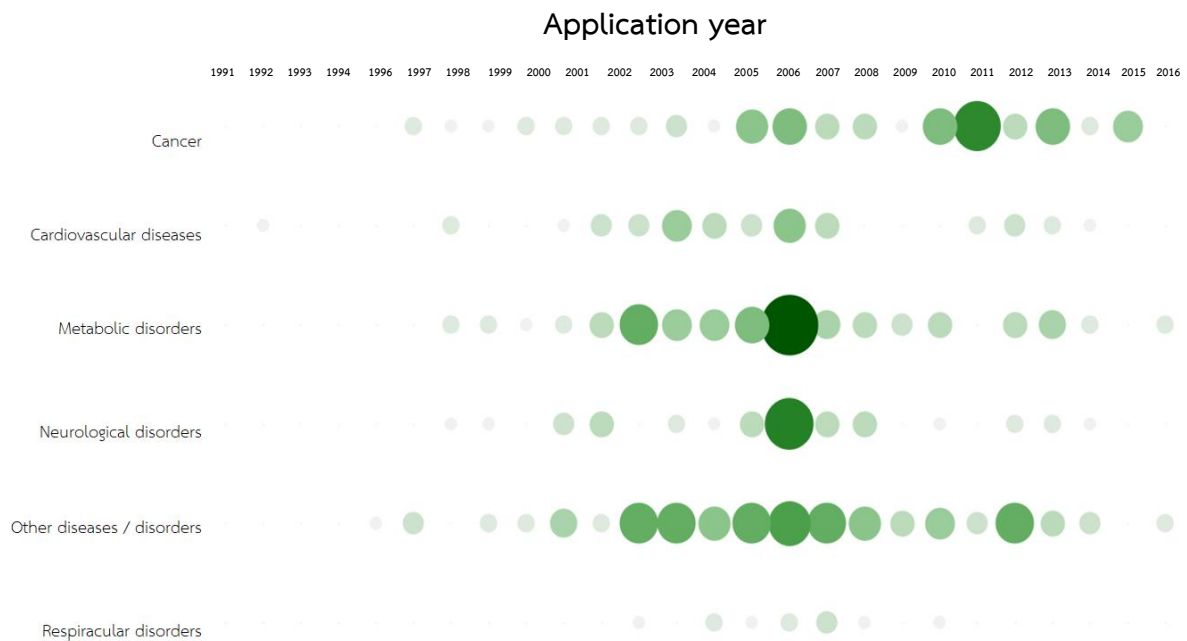


Figure 9 Timeline activity of patent filing categorised by a group of non-communicable diseases

The analysis depicts that between 1999 – 2006 (B.E. 2542 – 2549) had an increased patent application trend higher than that between 1991 – 1998 (B.E. 2534 – 2541), and the last five years or 2012 - 2016 (B.E. 2555 – 2559). At the beginning, patent application relate to cancer was filed between 2005 - 2006 (B.E. 2548 – 2549) by Ministry of Public Health, Thailand. As, the ministry started finding cervical and breast cancers in women at the age of 35, Thai people started pay attention to their own health, resulting in the increased patent applications from 2004 – 2006 (B.E. 2547 – 2549) (Ministry of Public Health, 2006). Then between 2009 – 2011 (B.E. 2552 – 2554), the symptom rate and dead rate of cancer patients were inclined to raised (Focal point ราชบุรุษ , 2013), causing increased patent application rate, especially the crest in 2011 (B.E. 2554), 15 applications. At the last five years, there were the higher rate of patent application than that in the period before 2004 (B.E. 2547).

Cardiovascular diseases-related patents, between 2001 – 2007 (B.E. 2544 – 2550), had a tendency to file continuously, 31 applications, according to a statistical database from the strategy and planning division, Ministry of Public Health, 1992 – 2008 (B.E. 2535 – 2551) showing rapidly increasing cardiovascular disease patients (Health Information System Development

Office, 2012). For this reason, Thai people paid more attention to food and health, in terms of lifestyle and patent application numbers, which reached its highest point in 2003 (B.E. 2546) and 2006 (B.E. 2549) with 6 and 7 applications respectively. After that period, numbers of patent applications were decreased in (B.E. 2551 - 2559).

Diabetes-related patents, between 2003 – 2006 (B.E. 2546 – 2549), were more likely to filed. According to the statistical information of Health information system development shew the increasing symptoms and death rate of diabetic patients between 1988 - 2012 (B.E. 2531 - 2555) (Health Information System Development Office, 2012), including a group of diabetic patients who do not know they are developing diabetes. For this reason, the diabetic patients had been continuously increased resuting from their genes and foods consumed a day. It had evidence that the diabetes was early developed at 35 years old, and reached its incidence rate at 60 year of age and above (Thassanawin, 2007), inconformity with patent filing numbers in 2006 (B.E. 2549) at 22 applications and declined between 2013 – 2016 (B.E. 2556 – 2559).

Neurological disorders-related patents, between 2004 – 2006 (B.E. 2547 – 2549), were likely to filed 16 applications, and the peak in 2006 (B.E. 2549), comforming to the patient numbers increased between 1993 – 2013 (B.E. 2536 – 2556) (Health Information System Development Office, 2014). However, the patent application numbers were dropped between 2011 – 2016 (B.E. 2554 - 2559).

Other diseases-related patens, between 1998 – 2014 (B.E. 2541 – 2557), gained a proclivity to continuously file, 106 applications, according to the rate of accidents and death rate which were risen between 1993 – 2009 (B.E. 2536 – 2552) (Health Information System Development Office, 2008), and declined between 2013 – 2016 (B.E. 2556 – 2559).

Respiratory diseases-related patents, between 2004 – 2007 (B.E. 2547 – 2550), were more likely to file, 9 applications, and declined in 2008 (B.E. 2551) and after.

From the information above, at the last three years, patents-related to all diseases were declined, according to the decreased whole picture of patent filing rate in Thailand because

international organizations were less likely to file patents in Thailand. In the other hand, with this incident, Thai people and Thai organizations had gained a good opportunity to file related patent applications. Additionally, it was found that technologies related to diabetes were little less likely to be filed because international organizations were still interested in.

Cancer-related patents were rapidly filed in the last five years in compatible with those filed in the past because Thai research institutes and academic institutes had more patent activities in that technology. In other words, the patent activities that Thai institute did had an impact on the whole picture of the country vividly.

## 5. Technology demand

At the present, food selection of consumers has considerably changed from that in the past that they have more focused on food nutritions because a matter of aging society and healthy food society. For these reasons, the food industries have developed the food processes which more serve human health-related desires by conducting research and developing on food production having food ingredients or nutrients beneficial to the human body, or slowing down diseases, which is the begning of a functional food ingredient industry and functional food ingredients.

The functional food industry has continuously developed and tent to be the crucial industry of the future, according to the functional food market information in 2017 that functional food maket generates income over 299 million United State Dollar (US), or 6.,6 Billion Thai Baht (THB) (Bureau of Non Communicble Disease, Department of Disease Control, 2017).

Literraly, Japan is the largest functional food market in Asia because its government supports a production and consuming healthy food helping decrease the risk of diseases or protect disease delelopment. The Japanese government issued a special law for functional food and launched the food standard label “Food for Specified Health Uses” (FOSHU) (N. , 2012) for functional foods distributed in Japan in order for consumers to assure the food quality and benefits to comsumers. Additionally, the food products labeled FOSHU had to be validated by Ministry of Health, Labour, and Welfare of Japan (Ministry of Health, Labour and Welfare, MHLW) (Ministry of Health, Labour and Welfare, 2018). For these reasons, there were functional foods placed in Japanese markets more than 1,700 products in 1995-2005 (Zasshi., 2007 Mar)

The functional food market in Thailand generated more than 96,000 million Thai Baht (THB) and had continuously grown with 6% a year from 2014 – 2016. This growth rate was driven by food producers and entrepreneurs 29 companiees in 2016, resulting from the trend of food awareness, quality-food selection, and benefits to health of the consumer as well as aging people numbers which have conruluously been increasing. Furthermore, from the food company database in Thailand, there are only 6 functional food companies, or 3% of all food companies,



while there are 123 supplementary food companies, or 51% of all food companies, 82 herbal product companies, or 34% of all food companies, and there are 28 other food companies, or 12% of all food companies in Thailand. Furthermore, from the food data depicts that functional food products in Thailand comprise the products for improving brain functions, for beauty and anti-aging matter, for health, and for weight control.

## 6. Key players

Key players are applicants owning a high number of patent applications. In this report, there are applicant rankings in an International scale and Thailand as follows:

### 6.1 International key players

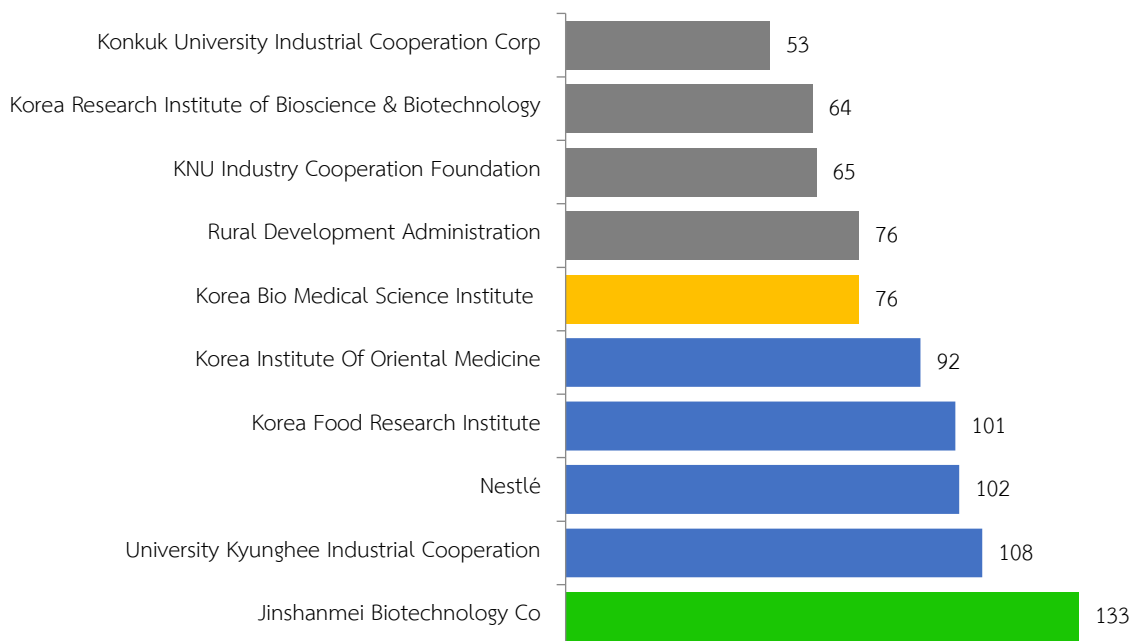


Figure 10 International key players

Figure 10 illustrating key players filing patents. It is found that an applicant filing the largest number of patents involved in functional food ingredients for curing or preventing non-Communicable diseases (NCDs) is Jinshanmei Biotechnology Co., Ltd, 133 applications, University Kyung Hee Industrial Cooperation or in the name of Office of Research and University-Industry Cooperation of Kyung Hee University playing a role in supporting research and development activities in the university and collaborating with external public and private sectors. The Office of Research and University-Industry Cooperation filed the 108 patent applications related to functional food ingredients for curing or preventing non-Communicable diseases (NCDs) which is the highest patent application numbers in the Republic of South Korea (ROK). The second rank organization filing the patent applications is Nestlé, 102 applications. In overall picture from the first tenth key players filing the patent applications in the mentioned technology, there are eight south Korean organizations, namely Kyung Hee University, Korea Food Research Institute, Korea

Institute of Oriental Medicine, Korea Bio Medical Science Institute, Rural Development Administration, KNU Industrial Cooperation Foundation (Kyungpook National University), Korea Research Institute of Bioscience and Biotechnology and Konkuk University Industrial Cooperation Corp.

1. Jinshanmei Biotechnology Co., Ltd, or Jinshanmei Food Co., Ltd. is the company expertising in Nutritional food and Healthy food, and adept in providing consultation and conducting biological product research.
2. University Kyunghee Industrial Cooperation, or in the nomination of the Office of Research and University-Industry Cooperation of the Kyung Hee University, the institute supporting research and development activities within the university as well as playing a role in a principal institute of the university for research and development cooperations with external public and private sectors.

The Kyung Hee University is a private university having several compuses in the republic od South Korea such as in Seoul, Yongin, Hongneung, and Gwangneung (Research and Business Foundation , 2018) where provides various disciplines in Science and management, the university conducts research in various fields like medical research, aerospace research, especially the research related to an Antiviral agent from natural extraction for controlling AIDS (Office of Research and University-Industry Cooperation (Seoul), 2018).

3. Nestlé is the company underscoring nutritional and healthy topics and having a head office in Vevey, Switzerland, produces and distributes several types of foods and beverages serving consumers' needs in a global scale (Nestle, 2018).
4. Korea Food Research Institute (KFRI) is the research institute highlighting nutrition and health research, located in Jeollabuk-do, South Korea. The institute has major research units namely, Strategic Food Technology, Food Functionality, and Industrial Support for developing food innovations, particularly food processing, safety food, and functional food materials (Korea Food Research Institute, 2018)

5. Korea Institute of Oriental Medicine (KIOM) is the institute adept in health and medicine research, especially in diagnosis by the Korean traditional medicine underscoring the uplift the quality of the Korean traditional medicine to be equal to or beyond the conventional medicine (KIOM, 2018).

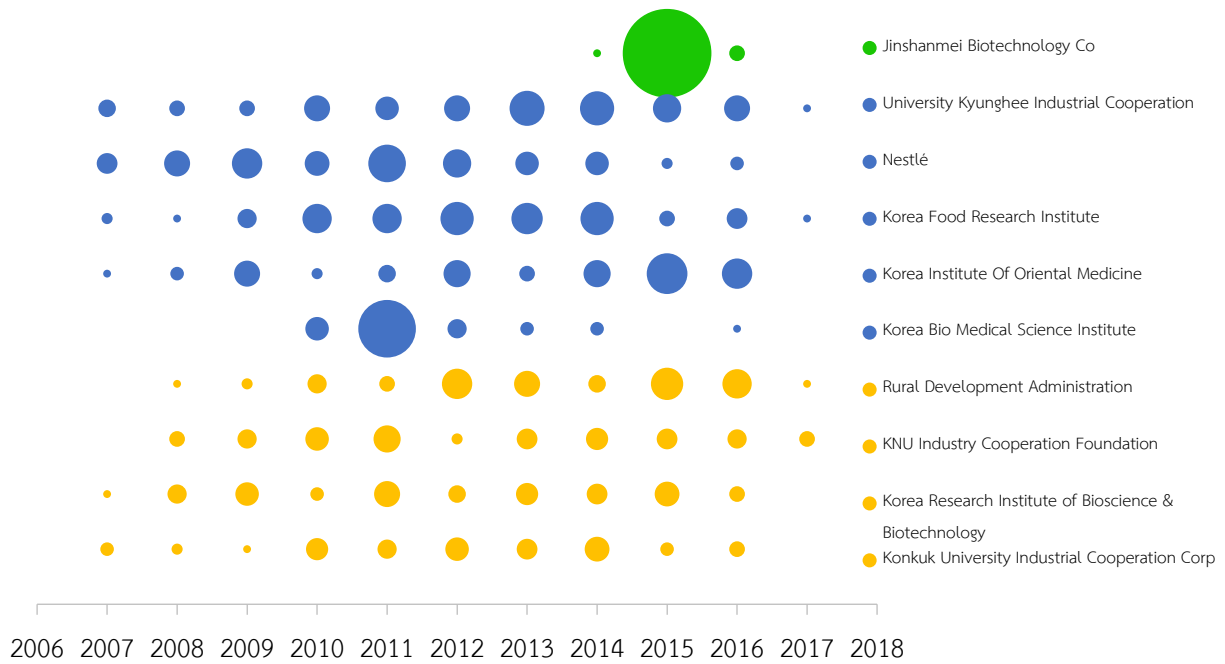


Figure 11 Timeline activity of international key players

From the figure 11, It is found that Jinshanmei Biotechnology Co., Ltd has begun filing patent applications associated with the application of functional food ingredients for curing or preventing non-Communicable diseases from 2014 (B.E. 2557). It is evidently increasing in patent application numbers in 2015 (B.E. 2558). While other institutes have filed close patent application numbers in each year, Nestlé, the Korea Food Research Institute, and Korea Bio Medical Science Institute have decreased patent application numbers in this field.

## 6.2 Key players in Thailand

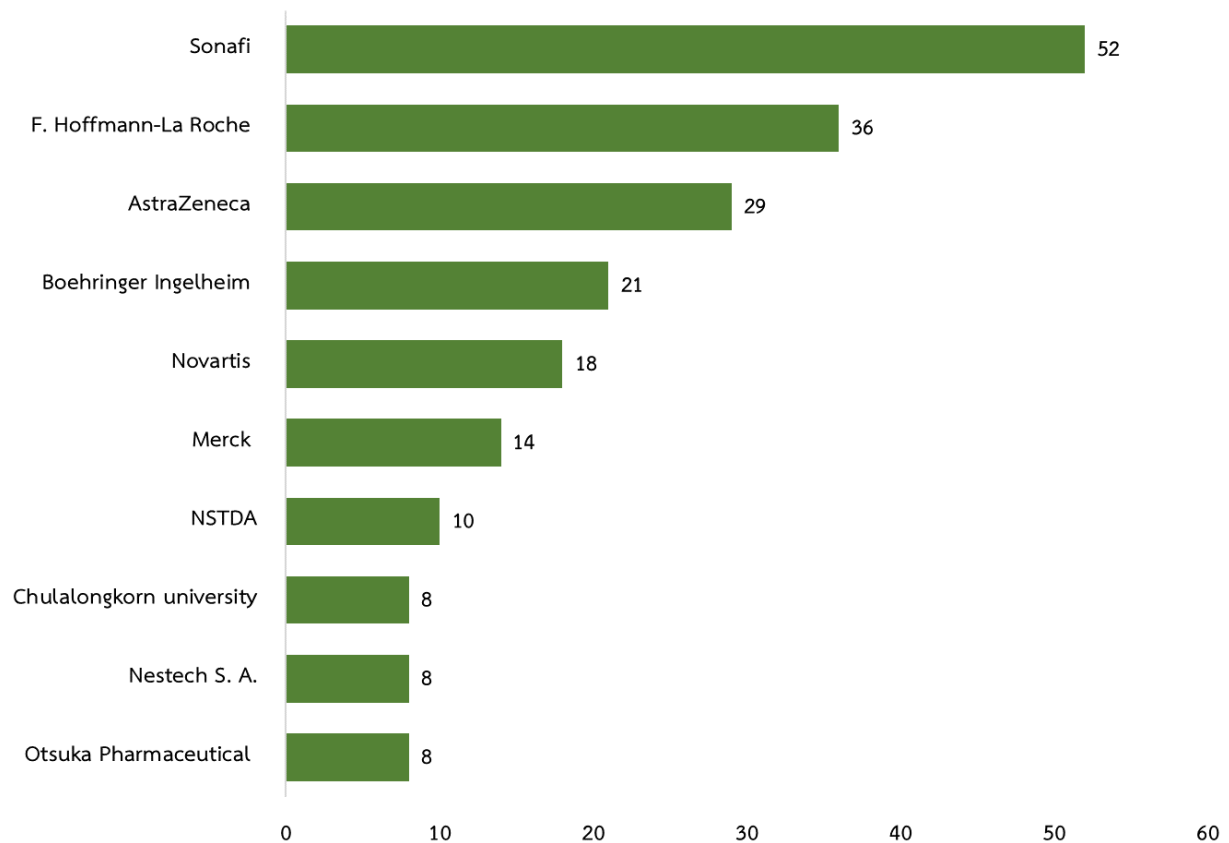


Figure 12 Numbers of invention of the key players

Figure 12 illustrates the first 10 key players in Thailand filing functional food ingredients' patent applications namely National Science and Technology Development Agency (NSTDA) filing 10 patent applications, or 4.90% of overall related patent applications, and Chulalongkorn university filing 8 patent applications, or 3.92% of overall related patent applications, While other key players are international organizations who file the patent applications in Thailand, or 91.18% of overall related patent applications. From the information above, the latter has much more patent applications than that of the former organizations from Thailand. Figure 12 depict the international organizations give priority to patent filing than that of Thai organizations.

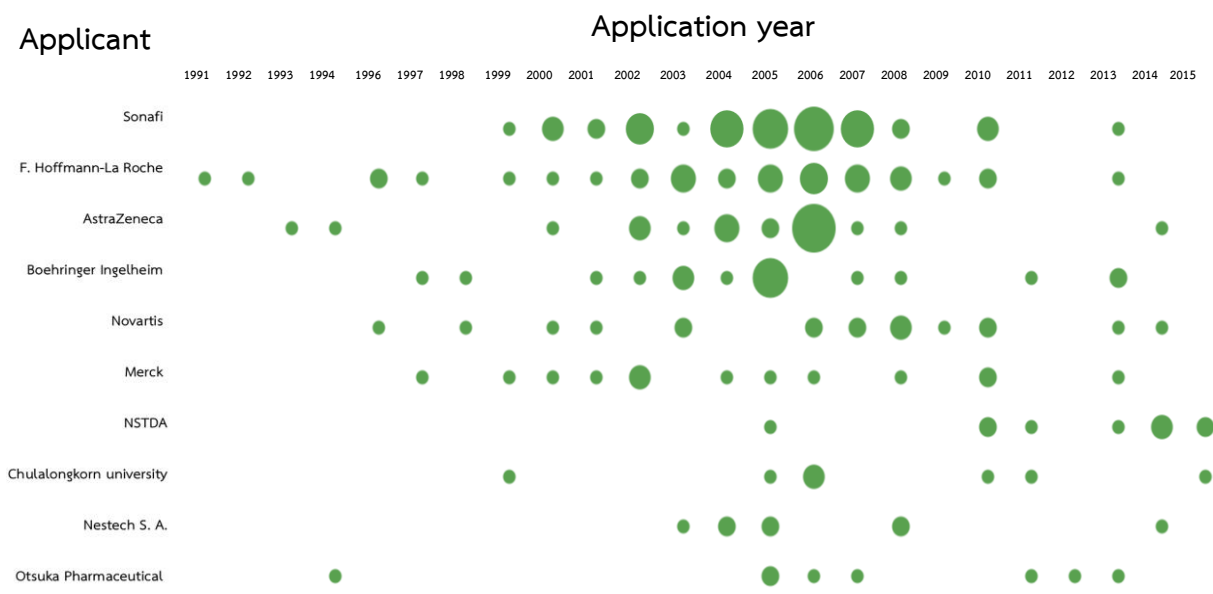


Figure 13 Timeline activity of Thai key players

From the figure13, Sanofi Co., Ltd. is the first company conducting research and developing and filing Pharmaceutical patent applications, particularly in heart and cardiovascular diseases, Thrombosis, Cancer, Central Neurological disorders, diabetes, internal diseases, and vaccines.

Sanofi Co., Ltd. started filing patent applications in Thailand from 1999 – 2013 (B.E. 2542 – 2556), the highest in 2006 (B.E. 2549), where is the year a majority of key players filed patent applications.

The second rank is F. Hoffmann-La Roche Co., Ltd., one of the companies conducting research and developing drugs and medical supplies, especially Vitamins, Acne medications, Endocrine system diseases, and Diabetes. The company was established in 1996 (B.E. 2539) and was the company filing patent applications continuously from 1991 – 2013 (B.E. 2534 – 2556).

The third rank is AstraZeneca Co., Ltd, a British-Swedish company running a drug and bio-pharmaceutical business, was established in 1999 (B.E. 2542). The company began filing patent applications in Thailand 1993 (B.E. 2536), the highest in 2006 (B.E. 2549), AstraZeneca has developed a drug for treating a Rheumatoid arthritis called the Humira.

Furthermore, the company tookover Cambridge Antibody technology Group Plc, a British biotechnology company resulting in booting AstraZeneca's patent application numbers. In 2007 (B.E. 2550), AstraZeneca launched a co-campaine with Medimmune, an affiliated corporation of the company tookover in the same year. Then, in 2012 (B.E. 2556), Astrazeneca tookover Amylin Pharmaceuticals, an American biopharmaceurical company. From the mentioned activities, Astrazeneca was unlikely to file patent applications in the last 10 years, which may result from changing patent applicants, or alternating the company's technology focus.

The fourth rank is Boehringer Ingelheim Co., Ltd., a Pharmaceutical and Biomedical company, was established in 1885 (B.E. 2428). The company has focus on developing heart and cardiovascular diseases, Respiratory disorders, Neurological disorders, Diabetes, Viral diseases, and Tumors. The Boehringer Ingelheim had patent application between 1997 – 2013 (B.E. 2540 – 2556), the highest in 2005 (B.E. 2548).

The fifth rank is Novartis Co., Ltd., having conducted research and developed medical supplies, and biotechnologies. The company filed the first patent application in 1996 (B.E. 2539), having increasing patent application trend between 1996 – 2014 (B.E. 2539 – 2557) because Novartis developed Vaccines, Human growth hormones, a Blood test unit, and biomaterials as well as co-invested with the Chinese vaccines company, Zhejiang Tianyuan Bio-Pharmarceutical Co., Ltd. as a major shareholder. Thanks to the activities mentioned above, the patent application numbers of Novartis had rapidly increased in that period. However, Novartis's patent application numbers declined in seven years after that period, which may result from changing patent applicants, or alternating the company's technology focus.

The sixth rank is Merck Co., Ltd., focusing upon chemicals especially Vaccines and antibiotic drug, Hepatitis-C Virus, HIV, Diabetes, Immune system, and cancer. Merck was established in 1891 (B.E. 2434) and its patent applications was filed continuously between 1997 – 2013 (B.E. 2540 - 2556).

The seventh rank is National Science and Technology Development Agency (NSTDA), filing patent applications between 2005 – 2015 (B.E. 2548 – 2558). However, the patent

application numbers of NSTDA is much fewer than those of international companies, particularly in 1999 – 2006 (B.E. 2542 – 2549). In other words, NSTDA has increasingly filed patent applications in 2010 – 2015 (B.E. 2553 – 2558)

The eighth rank is Chulalongkorn university, filing patent applications between 1999 – 2015 (B.E 2542 – 2558). Between 1999 – 2006, the university had a high rate of patent applications according to the rate of international companies.

The ninth is Nestech S. A., conducting research and developing on food products. Nestech filed patent applications between 2003 – 2014 (B.E. 2546 – 2557).

The tenth rank is Otsuka Pharmaceutical Co., Ltd., conducting research and developing on Pharmaceuticals, Tumors, and Central nervous system. Otsuka filed patent applications between 1994 – 2013 (B.E. 2537 - 2556).



### 6.3 Innovation profiles of international companies

The Innovation profiles of the first fifth international companies filing patent applications are (1) Jinshanmei Biotechnology Co., Ltd. (2) University kyunghee industrial Cooperation (3) Nestle (4) Korea Food Research Institute, and (5) Korea Institute of oriental medicine. There is categorization of patent applications according to the companies' Portfolio by a group of technology in order to know the interests and strengths of them as follows.

#### 1. Jinshanmei Biotechnology Co., Lid.

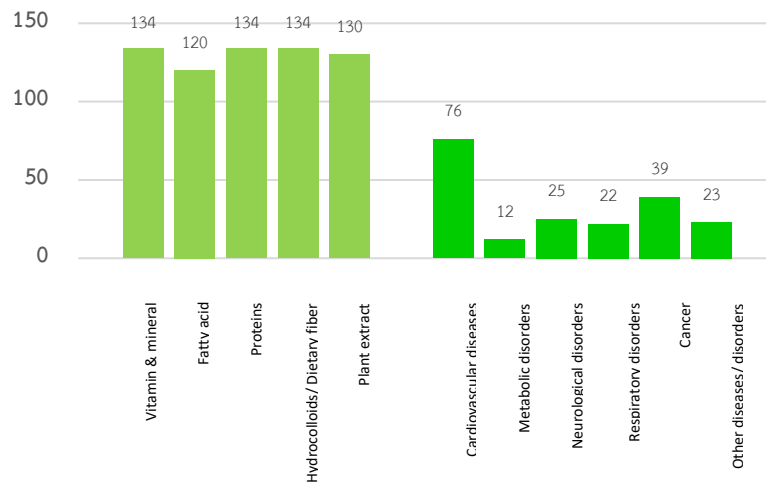


Figure 14 Numbers of patent categorized by a group of technology of Jinshanmei Biotechnology Co., Lid.

Jinshanmei Biotechnology Co., Lid., is the number one key player filing the highest numbers of patent applications. The company concentrated on the inventions related to heart and cardiovascular diseases treatment by using various functional food ingredients.

#### Invention examples:

1. Patent publication No.: CN107549813A

Title: Fully-nutritive formula food for patients suffering from hernia of intestines

This patent disclosed food composition, for curing Hernia, containing licorice, microencapsulated Bifidobacterium, L-glutamine, gamma-aminobutyric acid, complex amino acids and mineral premix.

2. Patent publication No.: CN105852101A

Title: Medical formula food for treating coronary heart disease

This patent disclosed food composition, for treating Coronary Artery Disease (CAD), comprising Ganoderma lucidum spore powder, Cordyceps sinensis, Ginkgo, Codonopsis, Astragalus, Schisandra, Sichuan dome, safflower, Angelica and Citrus aurantium.

3. Patent publication No.: CN105852100A

Title: Medical formula food for atherosclerosis

This patent disclosed food composition, for treating Atherosclerosis, Dendrobium candidum and Ganoderma lucidum.

## 2. University Kyunghee

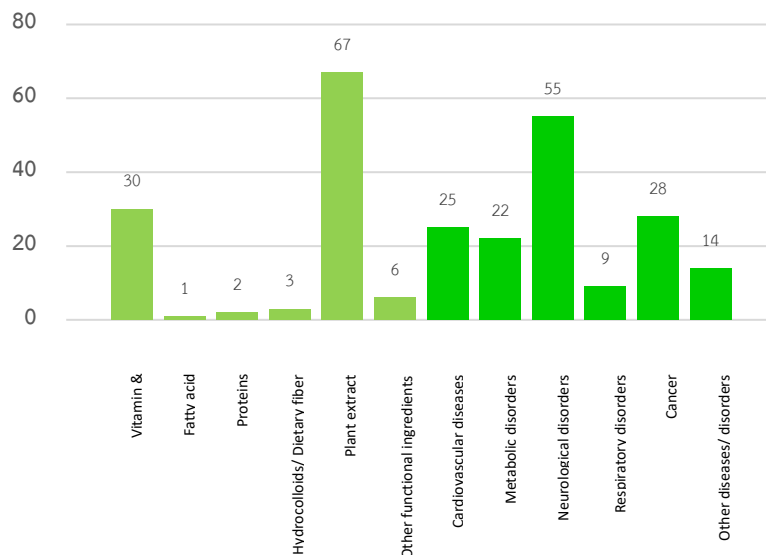


Figure 15 Numbers of patent categorized by a group of technology of University Kyunghee

Kyunghee university launched the inventions involved in plant extracts for treating Neurological disorders.

## **Invention examples**

1. Patent publication No.: WO2013081419A1

Title: PHARMACEUTICAL COMPOSITION FOR PREVENTION OR TREATMENT OF COGNITIVE FUNCTION DISORDERS COMPRISING SPINOSYNE

This patent disclosed Pharmaceutical compositions, for treating Cognitive function disorders like Amnesia, Dementia, comprising Spinosyn or Spinosyn extract extracted from Ziziphus jujube.

2. Patent publication No.: WO2014200261A1

Title: ANTICANCER COMPOSITION CONTAINING MIXED HERBAL MEDICINE EXTRACT AS ACTIVE INGREDIENT

This patent disclosed Pharmaceutical compositions for curing cancer such as Gastric cancer and Breast cancer, comprising the extract from Milkvetch root, from Snake gourd root, and from Angelica gigas.

3. Patent publication No.: WO2015053561A1

Title: COMPOSITION FOR PREVENTING OR TREATING CEREBRAL APOPLEXY OR NEURODEGENERATIVE DISEASES, CONTAINING EXTRACT COMPLEX OF PUERARIA THUNBERGIANA AND SCUTELLARIA BAICALENSIS GEORGI AS ACTIVE INGREDIENT

This patent disclosed Pharmaceutical compositions for treating Stroke and Alzheimer's disease, comprising Radix puerariae extract and Radix scutellariae extract.

### 3. Nestle

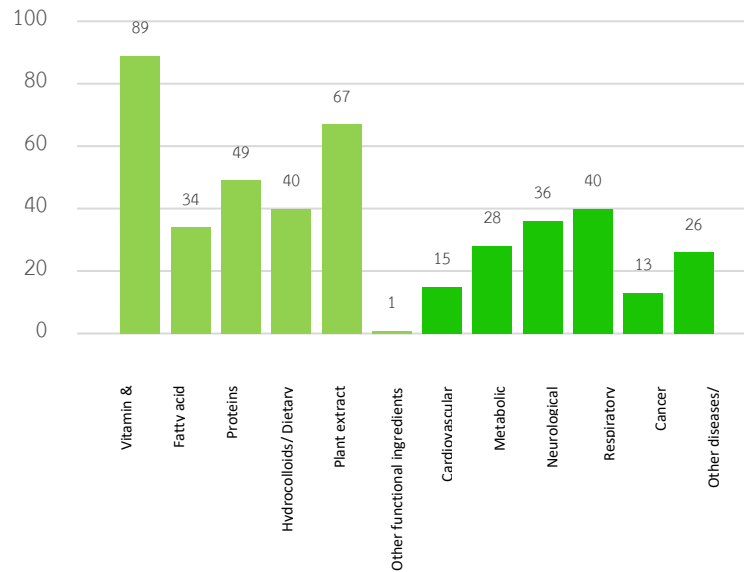


Figure 16 Numbers of patent categorized by a group of technology of Nestle

Nestle had inventions concerned with various functional food ingredients, especially Vitamin and Minerals, and Plant extracts as the top and the second patent application topics that Nestle filed. Objectives of developing functional food ingredients for treating non-Communicable diseases are various. However, At the present, the patent portfolio of Nestle spotlights on respiratory diseases.

#### Invention examples

1. Patent publication No.: WO2015104390A1

Title: MATERIAL VITAMIN B6 ADMINISTRATION FOR THE PREVENTION OF INCREASED ADIPOSITY, OVERWEIGHT OR OBESITY IN THE OFFSPRING”

This invention disclosed the application of Vitamin B6 for preventing obesity and excessive fat.

2. Patent publication No.: EP2561767A1

Title: Epicatechin for alleviating symptoms of allergy

This invention disclosed the application of epicatechin for reducing allergy in digestive system, Diarrhea, Vomiting, and skin irritation from allergy like food allergy.

3. Patent publication No.: WO2013190068A1

Title: PROBIOTIC AND POLYPHENOL AGAINST NEURODEGENERATION

This invention disclosed the composition of substances for supplementing food and for treating Alzheimer's disease, Parkinson disease, Creutzfeldt-Jakob disease, and Insomnia, by *Lactobacillus johnsonii* CNCM 1-1225 and polyphenol composition such as Rosmarinic acid.

#### 4. Korea Food Research Institute

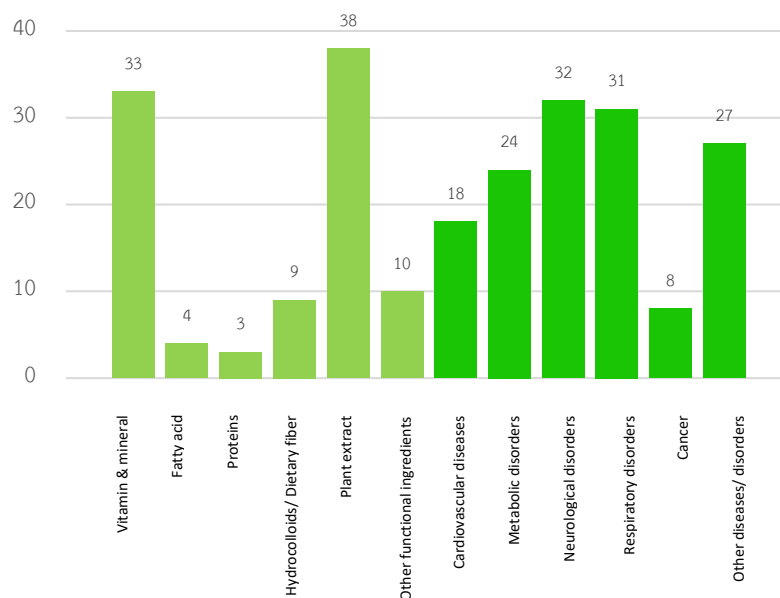


Figure 17 Numbers of patent categorized by a group of technology of Korea Food Research Institute

Korea Food Research Institute patent portfolio was almost similar to that of Nestle, containing functional food ingredients, particularly Plant extracts, Vitamins and Minerals respectively. Objectives of the institute's invention is to treat non-Communicable diseases. However, the institute had few patent applications related to cancer.

## Invention examples

1. Patent publication No.: WO2014104570A1

Title: PHARMACEUTICAL OR FOOD COMPOSITION COMPRISING OLDENLANDIA BRACHYPODA, SPERGULARIA MARINA, DISPORUM SMILACINUM, PERSICARIA POSUMBU, OR GEUM ALEPPICUM

This invention disclosed the compositions related to Pharmaceuticals or foods for diabetic and obese patients, comprising Oldenlandia brachypoda extract, Spargularia marina extract, Disporum smilacinum extract, and Geum aleppicum extract.

2. Patent publication No.: CN103153323B

Title: Composition for promoting memory and learning ability

This invention disclosed the compositions of Pharmaceuticals or foods, helping inhibit neuronal cell damage, comprising Artemisia apiacea extract, Illicium verum extract, and Lepidium apetalum extract.

3. Patent publication No.: WO2012150747A1

Title: METHOD FOR MANUFACTURING GARLIC OIL AND BUTTER CONTAINING AJOENE

This invention disclosed a method for preparing Cheese comprising Ajoene substance, which is the combination of a Garlic extract, "Allicin", milk, and fat, and heating the combination.

## 5. Korea Institute of oriental medicine

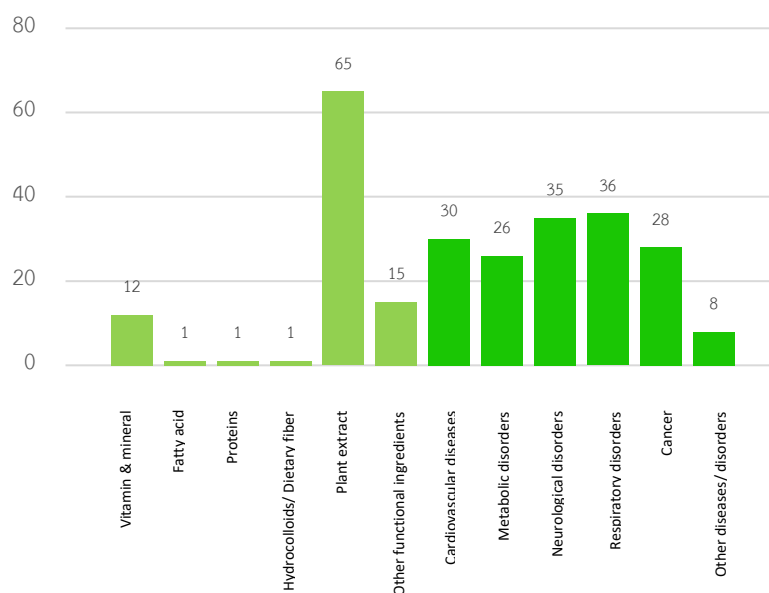


Figure 18 Numbers of patent categorized by a group of technology of Korea Institute of oriental medicine

From the figure 18, it is shown that Korea Institute of oriental medicine centered on developing plant extracts, while other functional food ingredients were fewly filed. The Korea Institute of oriental medicine invented patent applications for treating various NCDs.

### Invention examples

1. Patent publication No.: WO2014109587A1

Title: PHARMACEUTICAL COMPOSITION AND FUNCTIONAL FOOD COMPRISING NATURAL EXTRACTS FOR PREVENTING OR TREATING DIABETIC COMPLICATIONS OR ANGIOEDEMA

This invention disclosed Pharmaceutical compositions, for treating diabetes and Angioedema, comprising Rhizoma coptidis and Ivy leave extracts.

2. Patent publication No.: US9737583B2

Title: Composition for prevention or treatment of acute renal failure including herbal extract or fraction thereof as active ingredient

This invention disclosed Pharmaceutical composition for treating Renal failure caused from cancer drugs, comprising Fructus amomi rotundus extract.

3. Patent publication No.: WO2011055869A1

Title: COMPOSITIONS FOR TREATMENT AND PREVENTION OF DIABETIC COMPLICATIONS USING OSTEOMELES SCHWERINAE

This invention disclosed Pharmaceutical composition for treating diabetes, Senility, and Cancer, comprising Osteomeles schwerinae extract which contains 2-O-acetyl vitexin, Hyperoside, and Quercetin.



## 6.4 Principal technologies of international organizations

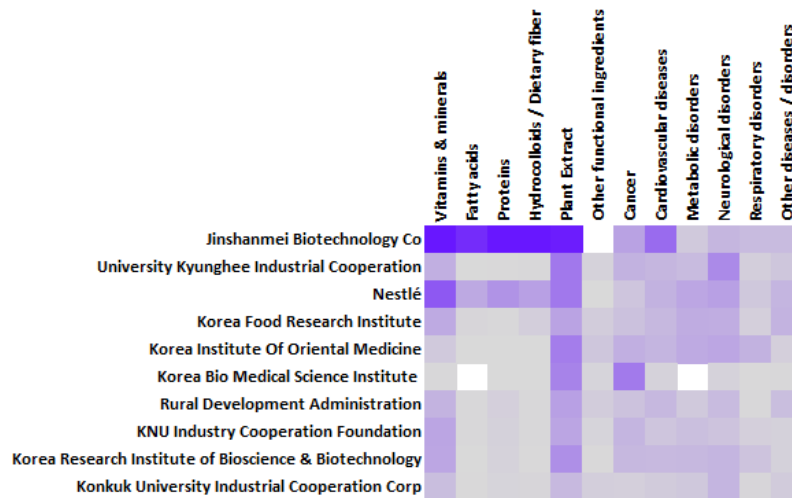


Figure 19 Analysis of top patent assignees broken down by technology groups

From the figure 19, it is found that Jinshanmei Biotechnology Co. Ltd., filed patent applications using Vitamins and Minerals, Proteins, dietary fiber, plant extracts, and fatty acids as Function food ingredients for treating NCDs, particularly Coronary disease as the top disease, and Cancer, Neurological disorders, Respiratory diseases, and other diseases respectively.

Kyung Hee University filed patent applications related to plant extracts, and vitamins and minerals as Functional food ingredients for treating NCDs, especially Neurological disorders as the top disease, cancer, coronary disease, and metabolic disorders respectively.

Nestlé filed the patent applications applying vitamins and minerals, and plant extracts as functional food ingredients and proteins, fatty acid, and dietary fiber respectively, for NCDs especially metabolic disorders and Neurological disorders.

Korea Food Research Institute filed patent applications applying plant extracts, and vitamins and minerals as functional food ingredients for NCDs especially metabolic disorders and Neurological disorders.

Korea Institute of Oriental Medicine filed patent applications applying plant extracts as functional food ingredients for NCDs especially metabolic disorders and Neurological disorders.

Korea Bio Medical Science Institute, Rural Development Administration filed patent applications applying plant extracts as functional food ingredients for NCDs especially cancer.

KNU Industrial Cooperation Foundation (Kyungpook National University) filed patent applications applying plant extracts, and vitamins and minerals as functional food ingredients for NCDs especially cancer and metabolic disorders.

Korea Research Institute of Bioscience and Biotechnology filed patent applications applying plant extracts, and vitamins and minerals as functional food ingredients for NCDs, especially Neurological disorders as the top disease, cancer, cardiovascular disease, and metabolic disorders respectively.

Konkuk University Industrial Cooperation Corp. filed patent applications applying plant extracts, and vitamins and minerals as functional food ingredients for NCDs, especially Neurological disorders.

## 6.5 Principal technologies of organization filing patent applications in Thailand

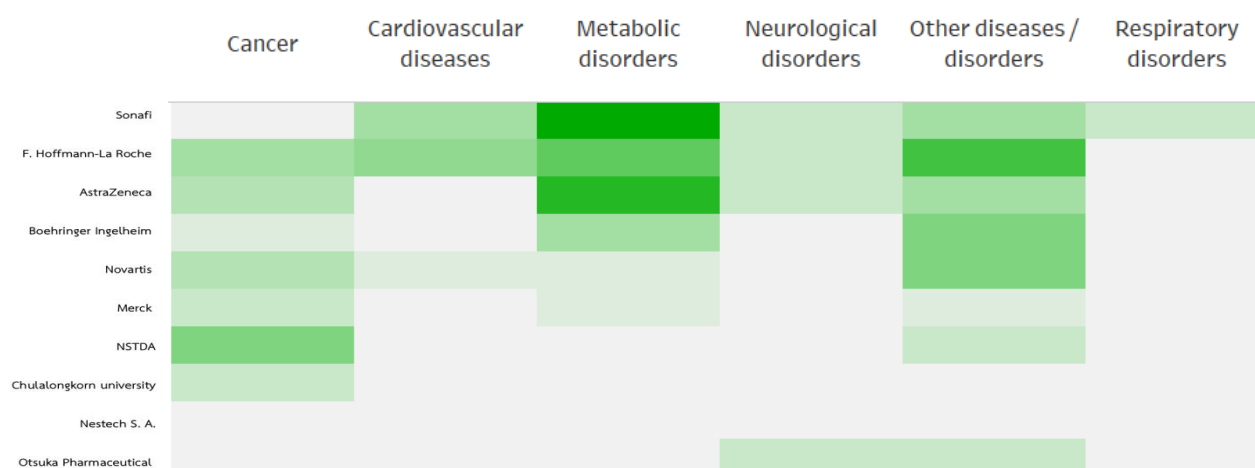


Figure 20 Analysis of top patent assignees in Thailand broken down by technology groups

The interests of the first 3 key players are diabetes, other diseases, and cancer. Patent applications related to diabetes was the top topic to file patent applications, 48 applications, and the top applicants for diabetes are Sonafi Co., Ltd., 16 applications, and Astrazeneca Co., Ltd., 13 applications. Other diseases patent applications as the top second topic to file patent applications, 44 applications. The top applicants for the diseases are F. Hoffmann-La Roche Co., Ltd., 11 applications, and Boehringer Ingelheim Co., Ltd., and Novartis, 7 and 7 applications respectively. The top third topic for filing was cancer, 31 applications. The key players for this topic are National Science and Technology Development Agency (NSTDA) and F. Hoffmann-La Roche Co., Ltd., 7 and 5 applications respectively.

From the information mentioned above, National Science and Technology Development Agency ( NSTDA) focused upon cancer, 7 applications, other diseases, 3 applications. Chulalongkorn university though was not on the list of top key players, interested in cancer because Thai people have developed and died from this disease in a high rate. Therefore, Thai researchers, in NSTDA and Chulalongkorn university, have mainly concentrated on cancer.

The above analysis of patent filing trend of international organizations is different from the trend of Thai organizations focusing upon other diseases, diabetes, and cancer respectively. The patent applications numbers on Cardiovascular diseases and neurological disorders are quite

small. Therefore, there are still opportunities for entrepreneur, research institutes, academic institutions, and Thai private organizations inventing and filing the related patents inconsistent with the global patent application trend.

## **6.6 Technology focus trend of international organizations**

### **1. Jinshanmei Biotechnology Co., Ltd.**

Jinshanmei Biotechnology having increasing patent activities in the past three years shows the company has just started developing related innovations. However, its interest is not intent focusing on a specific functional food ingredient, because its patent applications falls in various topics equally.

### **2. University Kyunghee Industrial Cooperation**

Kyunghee university tends to file patents related to plant extracts and neurological disorders' drugs.

### **3. Nestle**

Nestle is unlikely to file patents involved in functional food ingredients. The company used to file various functional food ingredients reaching the peak in 2011 (B.E. 2554) and falling in each year orderly.

### **4. Korea Food Research Institute**

The patent filing trend of Korea Food Research Institute is quite diversified. However, the patent applications related to plant extracts have been filed in each year regularly, 3 – 8 applications a year.

### **5. Korea Institute of oriental medicine**

Korea Institute of oriental medicine have heavily centered on the inventions related to plant extracts in the past five years, together with a few numbers of vitamins and minerals. In terms of treatment objectives, the institute patents are diversified with no focus on a specific topic.

## 6.7 Patent applications classified by a group of technology of key players

### 1. Jinshanmei Biotechnology Co Ltd.

Table 1 Numbers of patent application classified by a group of technology of Jinshanmei Biotechnology Co., Ltd.

Technology\Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Vitamins & minerals								1	128	4
Fatty acids									115	4
Proteins								1	128	4
Hydrocolloids / Dietary fiber								1	128	4
Plant Extract								1	124	4
Other functional ingredients										
Cancer									39	
Cardiovascular diseases									72	4
Metabolic disorders									10	2
Neurological disorders									24	1
Respiratory disorders									21	1
Other diseases / disorders								1	21	

### 2. University Kyunghee Industrial Cooperation

Table 2 Numbers of patent application classified by a group of technology of University Kyunghee

Technology\Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Vitamins & minerals	3	1			2	3	7	7	5	2
Fatty acids	1									
Proteins					1				1	
Hydrocolloids / Dietary fiber								1	2	
Plant Extract	3	3	1	5	4	7	10	12	12	9
Other functional ingredients				1	1			3		1
Cancer		2	1	5	2	2	4	5		7
Cardiovascular diseases	2			2	1	1	5	6	6	2
Metabolic disorders	1		2	1	4		3	3	5	3
Neurological disorders	4	1		8	4	7	11	10	8	1
Respiratory disorders					2	2	1	3		1
Other diseases / disorders		1	1	2	1		4	2	2	1

### 3. Nestle

Table 3 Numbers of patent classified by a group of technology of Nestle.

Technology\Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Vitamins & minerals	4	11	12	10	20	12	8	9	2	1
Fatty acids	2		4	1	16	2	2	5	2	
Proteins	3	5	8	3	14	3	4	6	2	1
Hydrocolloids / Dietary fiber	5	7	3	5	12	3	3	1		1
Plant Extract	5	7	8	8	17	8	7	5	1	1
Other functional ingredients			1							
Cancer	1	4	1	5	3	1				
Cardiovascular diseases	4	2	4	4	4	6	1	2		1
Metabolic disorders	4	3	3	6	7	4	1	6	1	1
Neurological disorders	2	6	7	2	8	5	4	4	2	
Respiratory disorders			5	1	3	2		2		
Other diseases / disorders	1	1	4	2	6	5	4	1		2

### 4. Korea Food Research Institute

Table 4 Numbers of patent classified by a group of technology of Korea Food Research Institute

Technology\Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Vitamins & minerals			2	4	9	7	2	1	1	6
Fatty acids	1					2	1			
Proteins						2				1
Hydrocolloids / Dietary fiber	1		3	1	3			1		
Plant Extract			2	7	3	8	5	4	3	5
Other functional ingredients	1	1		1	3	2	1	1		
Cancer					2	3	3	3	2	4
Cardiovascular diseases		1	2	7	2	6	3	1	1	1
Metabolic disorders	1		3	4	3	12	5	3	1	
Neurological disorders		1	2	9	4	3	6	3		3
Respiratory disorders						3	1	1	1	2
Other diseases / disorders	1				4	4	6	10	1	1

## 6. Korea Institute of oriental medicine

Table 5 Numbers of patent classified by a group of technology of Korea Institute of oriental medicine

Technology\Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Vitamins & minerals			2				1	2	4	3
Fatty acids								1		
Proteins										1
Hydrocolloids / Dietary fiber								1		
Plant Extract	1	4	4	1	2	8	3	9	20	13
Other functional ingredients		1	3	1	2			1	7	
Cancer		1	5			4	3	7	5	5
Cardiovascular diseases			2	1	3	10	3	3	1	3
Metabolic disorders	1	3	6		1	10	3	6	3	2
Neurological disorders	1	3	4	1	1	8	3	3	6	6
Respiratory disorders		2	1		1			2	20	2
Other diseases / disorders			2	1	1			1	1	2

### 7. Patent application filing countries or regions

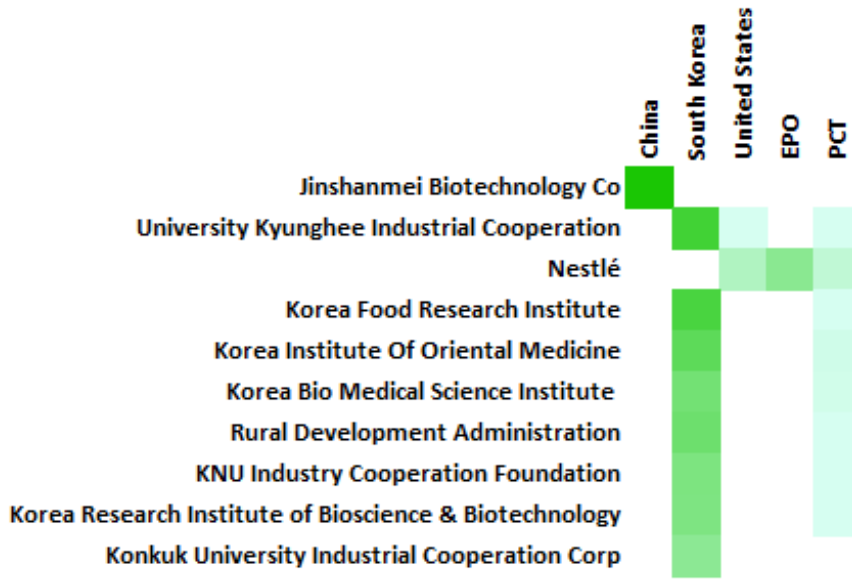


Figure 21 Analysis of top patent applicants broken down by filing locations

From the figure 21 showing a majority of key players filing patent applications in South Korea and PCT application because they are Korean organizations located in South Korea, except Netle mostly filing patents in Europe and the U.S.

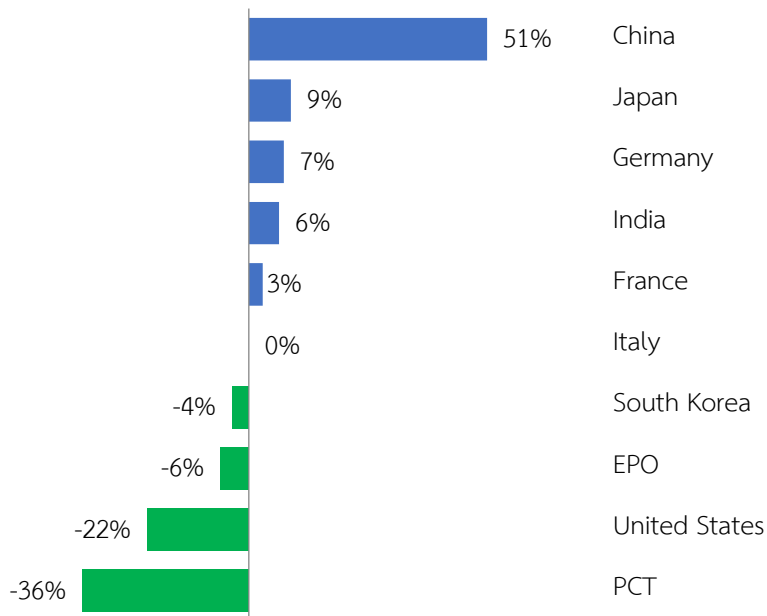


Figure 22 Compound Annual Growth/Decline Rate between 2012-2016 by first filing locations



With regards to the previous information, the top key player is a Chinese company, Jinshanmei Biotechnology Co., Ltd., but the majority of key players organizations filing patent are from South Korea. However, in accordance with FIG. 7.2, the filing rate in South Korea is declined.

## 8. Stregnths and weaknesses, opportunities, and threat of technology

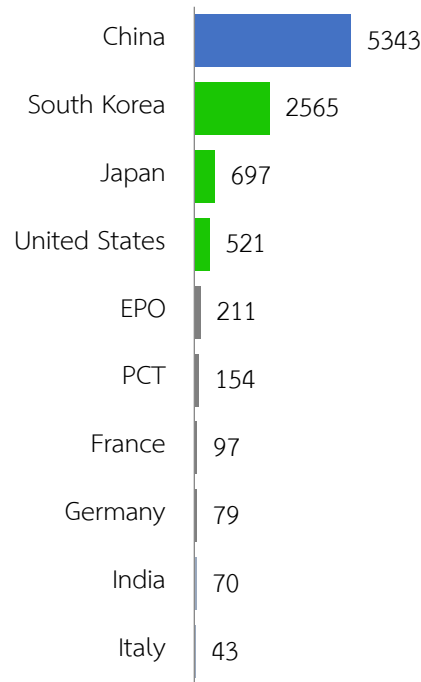


Figure 23 Numbers of patent for top 10 first filing locations

According to figure 23, patents related to functional food ingredients for non-Communicable diseases: NCDs are mostly filed in China, South Korrea, and Japan respectively. Furthermore, the topmost patent applicants who file patent applications in the past 10 years, according to figure 23, are from China, Japan with 51% and 9% respectively.

As, China gives priority to a number of patent applications, patents filed by Chinese applicants might be quite unorganized drafted in some patent applications when we are considered in descriptions of patent applications. For this reason, China is one of the top regions having a good opportunity for protecting inventions.

Additionally, India has a growth patent filing rate as the fourth at 6 %, while its accumulative patent numbers is in the ninth. In consideration, India has a lot of raw materials to be managed like Thailand, Thailand's patent application rate is not on the top 10 list. It depicts Thai patent applications are small quantity which may cause the poor innovation protection and being troublesome to do business independently owing to having no right to own technology.

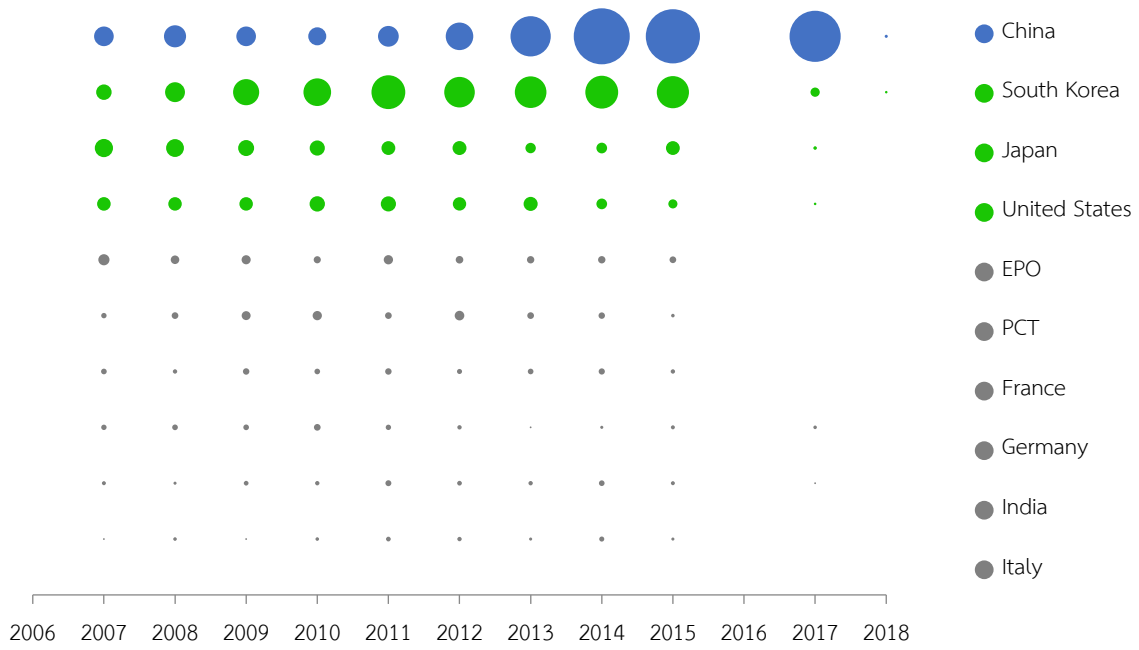


Figure 24 Timelind of activity for top 10 first filing locations during 2007-2018

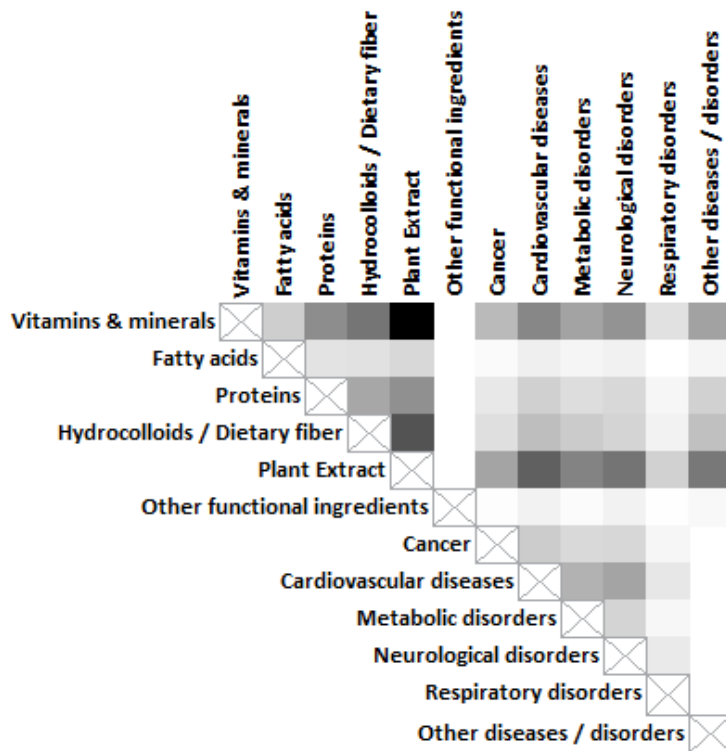


Figure 25 Aanalysis of overlap between tevhnology group

Figure 25 depicts the cross of one technology and another technology in terms of technology name and density. It shows patent applications related to plant extracts are co-invented with vitamins and minerals, and Hydrocolloids and Dietary fiber respectively.

From the figure 25 Plant extract patent applications are the most diversified for alleviating NCDs, and the second is the vitamins and minerals patent applications.

Moreover, the analyst team has retrieved Thai patent database and filtered and re-sorted in order to research and display strengths and weaknesses of Inventions filed in Thailand as shown in Table 6.

Table 6 Numbers of patent filed in Thailand sorted by applicant types

	Domestic	International
academy	27.00%	0.85%
company	3.00%	92.98%
Institute	29.00%	0.43%
Person	41.00%	5.74%

When we consider applicant types, a majority of patent applications were filed by international companies, 92.98%, while domestic companies filed only 3.00%. On the contrary, the top domestic applicants filed patent applications are persons, institutes, and academies with 41.00%, 29.00%, and 27.00% respectively.

With low rate of patent applications filed by domestic companies, may lead to adverse impact on doing business of them, because of a lack of technology management right for production and distribution processes. From the above information, there is the competition among Thai academic institutions, research institutes and persons and international companies.

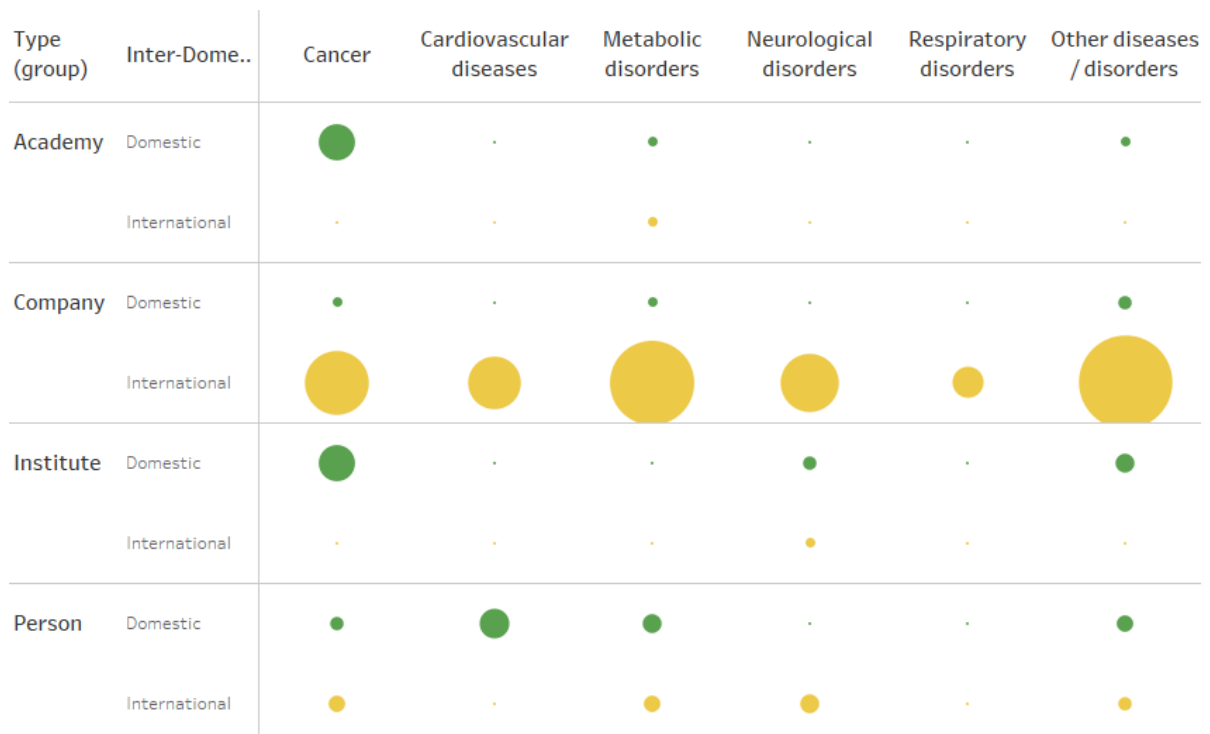


Figure 26 Numbers of patent application filed in Thailand divided by applicant types and a group of technologies

Figure 26 indicates that the majority of international company interest in the inventions related to diabetes and other diseases treatments, while Thai academic and research institutes interest in inventions involved in cancer treatment, and Thai persons have an interest in cardiovascular diseases. It indicates that the interest of Thai organizations and persons are quite different from that of international organizations. However, when we consider the global trend if filing patents, Thai organizations are on the tract of innovation global trend namely the inventions involved in cardiovascular diseases and cancer, which is advantageous to develop and focus on raising the expertise in those issues in Thailand, one of the developing countries.

	DOMESTIC	INTERNATIONAL
Cancer	39.76%	60.24%
Cardiovascular diseases	23.81%	76.19%
Metabolic disorders	6.52%	93.48%
Neurological disorders	4.35%	95.65%
Respiratory disorders	0.00%	100%
Other diseases / disorders	8.85%	91.15%

Figure 27 Numbers of patent application filed in Thailand sorted by a group of technologies

According to figure 27, Patent applications filed by the domestic persons are less than those filed by the international persons in all topics.

## 9. Technology trends related to industries

Patent application trend in the global scale has been increasing, but the trend in Thailand has decreased instead, although almost 80% of patent applications filed in Thailand are international applications. The reasons of the application decrease in Thailand are unspecified because of a vast of involved factors. However, the analyst considers that one of causes is a functional food ingredient technology for some NCDs are not approved by the Food and Drug Administration of Thailand, causing institutes and companies in that circle are not doing business unboundedly. For this reason, there are few patent applications in Thailand

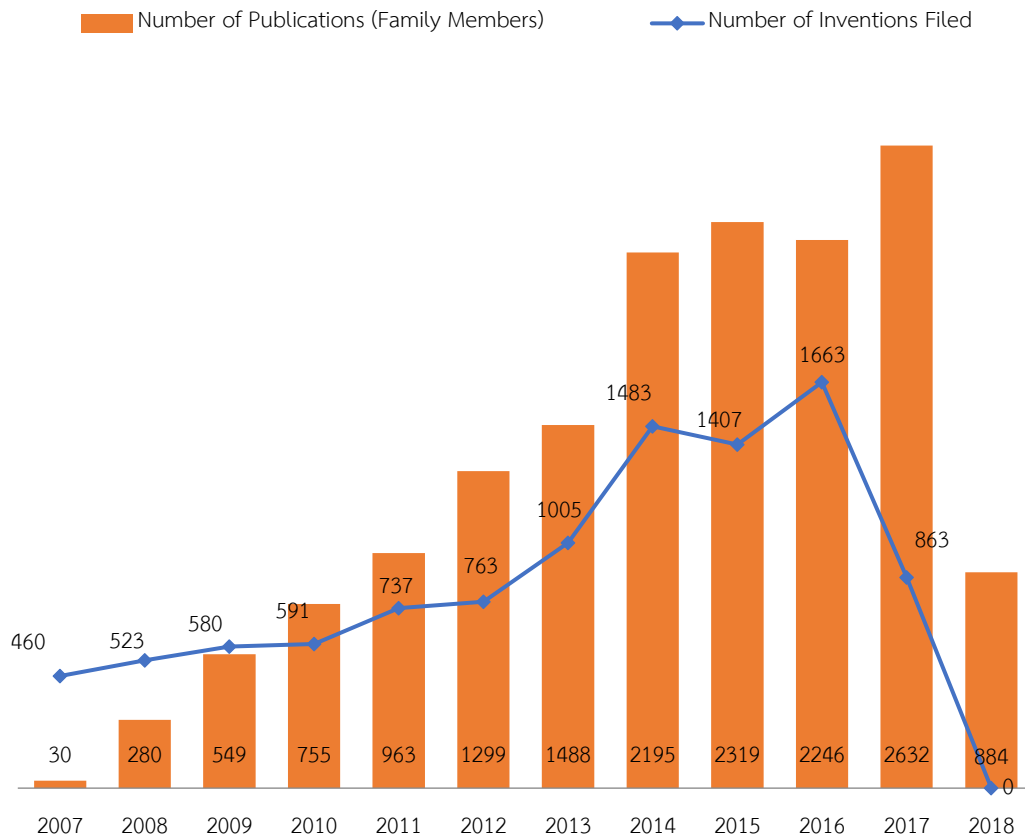


Figure 28 Number of publications and numbers of inventions filed internationally during 2007-2018

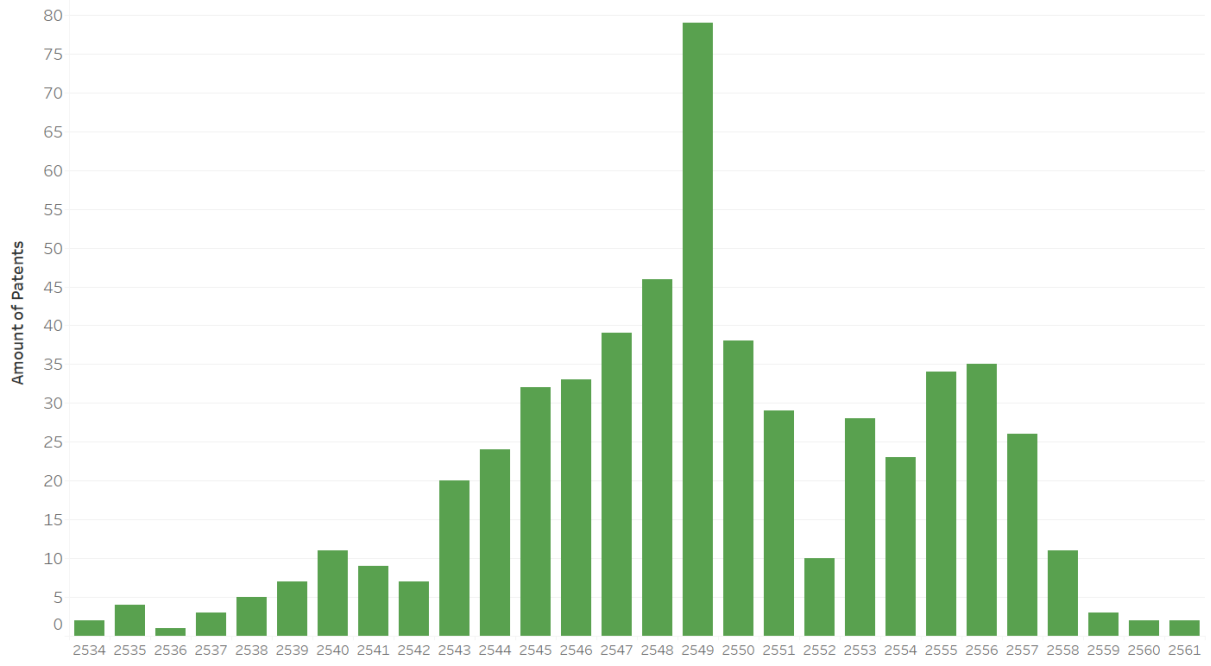


Figure 29 Number of patent applications filed in Thailand



## 10. The potential technology analysis for development

The analysis for taking potential technologies consists of 2 approaches namely (1) Patent strength Index, and (2) Forward Citation:

### 10.1 Patent strength index strategy

The strength index analysis performed by Clarivate analytics, by Clarivate Analytics Invention Strength Index consisting of four indexes:

1. Frequency of citation by downstream patent applications: this index used “a Forward citation frequency” instead of counting numbers of citations, helping decrease biases to old-patents having high citation times.
2. Geographic filing breadth: this index counts numbers of countries or Legal jurisdictions where a patent files, which the numbers show the countries or legal jurisdictions, and value of each patent as well as a strategy to produce and distribute the patent of each applicant.
3. Technical breadth: this index is used to measure technology diversity of each patent application by “Derwent World Patents Index™ Classification”, which is a technology classification by technology experts of the Clarivate analytic. The more diversified technical breadth is, the opportunities to apply in various fields of technologies appear, leading to high value of patents.
4. Age of the patent: this index measures the remained patent term of each patent, which the longer patent term is, the higher technology utility, leading to high patent value.
5. Overall strength: this index brings the previous indexes to do a statistical calculation in order to calculate overall strength of each patent application.

The highest Strength index patent is patent publication No.: WO2013185184A2;

Title: “Production of long chain polyunsaturated fatty acids in plant cells”

It disclosed synthesizing method for Long-chain polyunsaturated fatty acids in recombinant cell of plants such as Docosahexaenoic acid.

Furthermore, this invention relates to functional food ingredients - vitamins and minerals, fatty acid, and plant extract for treating non-Communicable Diseases (NCDs) namely cancer, cardiovascular diseases, diabetes, neurological disorders, and respiratory disorder. From the information above, it is shown that this invention has a broad property covering various types of technology analyzed.

## 10.2 Forward citation strategy

Patent citation consists of two approaches: Forward citation and Backward citation

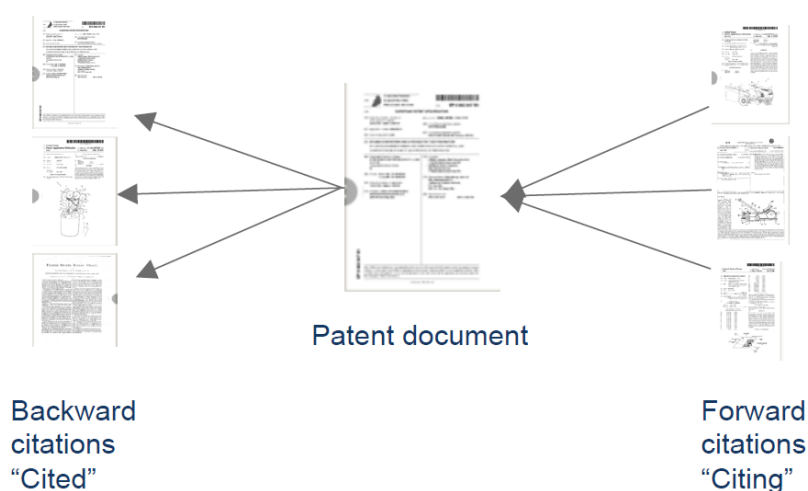


Figure 30 Patent citation approaches

Forward citation mentions patents citing our patent, or in other words, the higher number of patent forward citation is, the higher impact of that patent application to industry is, because that patent application is used to be an upstream of another people's technology.

This analysis report retrieved patent applications highly cited with the Forward citation as follows:

1. Patent publication No.: WO2009033071A2

Title: Novel fungal enzymes

This invention disclosed novel enzyme and the use of the enzyme. The enzyme was synthesized from a genetic-engineering process of fungi in order to use to turn Lignocellulose to sugar, including enzyme use in other processes such as washing process, cleaning process, bleaching paper out, or waste water treatment.

2. Patent publication No. CN102669658A

Title: Preparation method of plant enzyme food

This invention disclosed preparing methode of plant enzyme used in food processes, which helps boosting a body immune system and metabolism

## 11. Suggestions for applying the analysis result

This analysis report: functional food ingredients for non-Communicable diseases (NCDs) by using patent database contains key patent applicants filing the patents in related topics in global scale, including their patent applications. The report may guide Thai entrepreneurs to catch the developing trend of related technologies, and raise potential patents selected by the analyst team as the followings:

1) Synthesizing method of unsaturated long-chain fatty acid for treating non-Communicable Diseases – cancer, cardiovascular diseases, diabetes, neurological disorders, and respiratory diseases;

2) Novel enzyme, synthesized from a genetic-engineering process of fungi, uses to turn Lignocellulose to sugar; and

3) Enzyme preparation method from plant helps boost body immune system

The analyst team has considered the three mentioned patents the most potential patents being able to develop and actualize the potential inventions.

Furthermore, from the analysis strengths and weaknesses of patents filed in Thailand, the domestic inventions involved in using functional food ingredients for treating neurological disorders and cardiovascular diseases are quite small numbers, including the patents filed by Thai people and foreigners, while the inventions in the two mentioned technologies have a higher rate in a global scale. The analysis result indicates that the two technologies are interested in the world. However, the analyst team considers that with a few numbers of patent applications, there are a great opportunity for Thai entrepreneurs, or Thai institutes and organizations developing and filing related patents in order to play a principal role in satisfying the technological gaps as potential key players.

In conclusion, total number of domestic patents in Thailand are small compatible with those in a global scale. Additionally, there are decreasing patent filing numbers according to “the critique of the analysis report: Tech Insight” arranged by Department of Intellectual Property,

Thailand, which invited experts in a variety of perspectives to discuss on the topic of this report. The discussion depicts that the one of root causes of decreased patent applications is regulations of patent use from functional food ingredients of Food and Drug Administration (FDA) of Thailand, which may be rigid in order for consumers to be protected. For these reasons, the functional food ingredients not having an enough laboratory test, may not be part of raw materials, implemented, distributed leading to the decreased patent applications. In other words, the inventions related to functional food ingredients for NCDs has many factors beyond patent filing, but regulations of Food and Drug Administration, Thailand.

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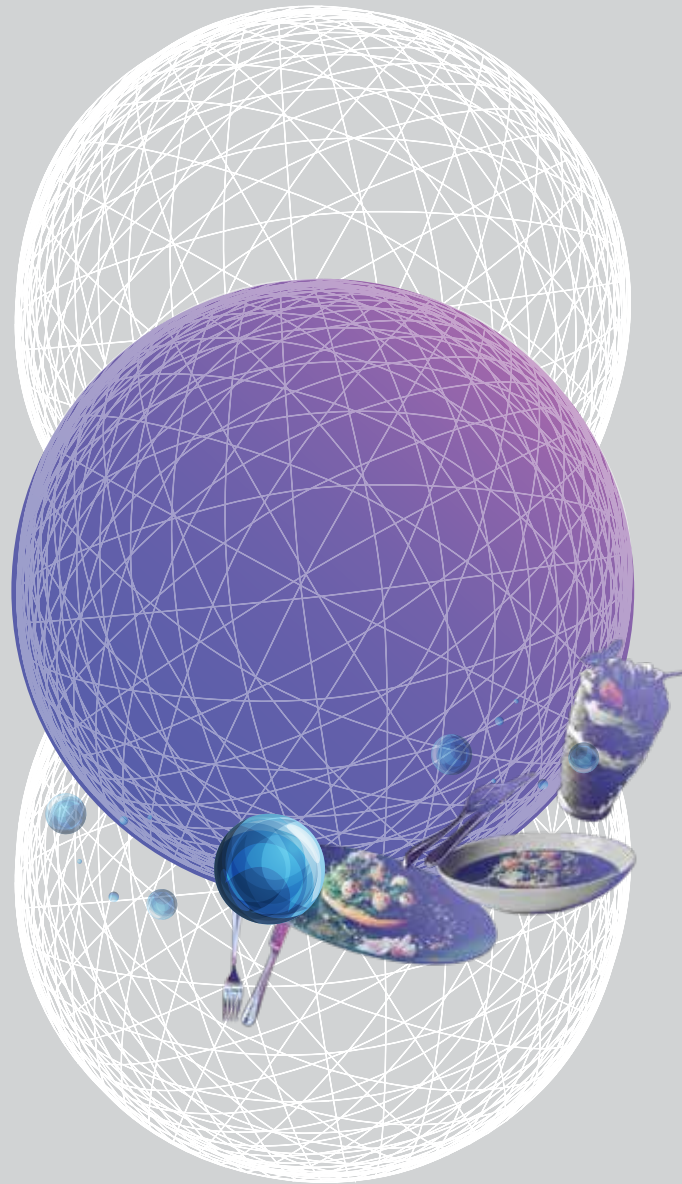
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