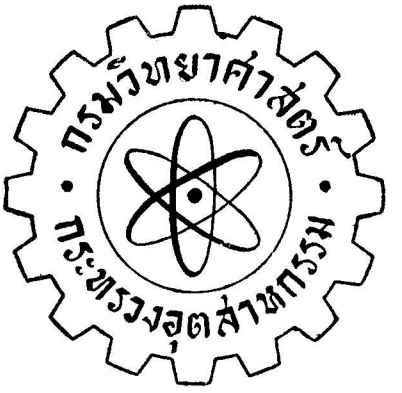


REPORT UPON THE WORK

OF THE

DEPARTMENT OF SCIENCE

Ministry of Industry

Bangkok, Thailand

No. 19

FOR THE YEAR 1956 (B.E. 2499)

FOREWORD

This 19th report covers the work of the Department of Science, Ministry of Industry during the year 1956. Some of the more interesting topics of research and analysis are briefly discussed.

The Department of Science is a non-profit-making organization rendering its services on all scientific and technical problems to the public as well as to other governmental organizations. Further details may be obtained from the Department of Science, Rama VI Road, Bangkok, during office hours.

Charng Ratanarat
Dr. phil. nat. (magna cum laude), Dip. Chem.
Director-General

Department of Science
Ministry of Industry

STAFF
1956

Position	Grade	Number of Positions	Vacant Positions
Director - General	Special	1	–
Deputy Director - General	Special	1	–
Director of Division	Special	1	–
Principal Scientific Officer	Special	1	–
Senior Scientific Officer, Chief of Division	First	3	–
Senior Scientific Officer	First	3	2
Chief of the Division of Analytical Chemistry Training	First	1	–
Secretary	First	1	–
Scientific Officer, Chief of Section	Second	13	2
Scientific Officer	Second	13	–
Chief of Section	Second	4	–
Assistant Scientific Officer	Third	29	5
Assistant Technician	Third	15	4
Section Staff	Third	5	–
Assistant Technician	Fourth	1	–
Section Staff	Fourth	1	–
Laboratory Assistant	Fourth	16	4
Clerk	Fourth	7	–
Non - commissioned Official	–	42	2
Employee	–	20	–
	Total	178	19

REVISION OF A REGULATION OF THE CIVIL SERVICE COMMISSION

A Regulation on the appointment of a graduate from the Department's School of Analytical Chemistry Training, to a position of not higher than First Order, Third Grade Civil Servant, and at a starting basic salary of 90 bahts, originally applicable within the Department of Science, was extended to apply in all other governmental departments. A graduate can also be appointed as a Third Grade Assistant Technician or as Third Grade Teacher.

CERTIFICATION OF LOCALLY MANUFACTURED PRODUCTS

Of the total of 23 products requested to be certified, 18 were approved.

Merchandise	Kind	Certified	Not Certified
Cosmetics	7	6	1
Food	4	1	3
Distilled Water	2	2	–
Acid	1	–	1
Fire Extinguisher	2	2	–
Dry Cell	7	7	–
Total	23	18	5

BROADCAST AND PUBLICATION OF SCIENTIFIC ARTICLES

Seventeen articles were broadcasted in thirteen "Science for the People" programme. They were sent through the Ministry of Industry to be published in various magazines.

"The Work of the Department of Science" was also broadcasted every month. In addition, five special articles on various topics were prepared and read by our staffmembers on different occasions. The Department, with the cooperation of the Thai Atomic Energy for Peace Commission had arranged a six-month lecture course on Radiochemistry and its Application to be given at the Department's Auditorium by Dr. Pradisth Cheosakul, our Principal Scientific Officer.

The Department of Science issued annually the "Report upon the Work of the Department of Science" in Thai and English editions. "The Department of Science News" were quarterly published in January, April, July and October. Apart from those mentioned above, a special document in Thai on "Natural Springs in Thailand" was also published.

AID FROM THE FOOD AND AGRICULTURE ORGANIZATION

Through the aid from the Food and Agriculture Organization (FAO), the Department of Science was fortunate to have Dr. M. van Eekelen, a food specialist, as the expert attached to the Department for a period of one year. Staff of the Division of Biological Sceince was assigned to be his local counterpart during his stay, from 10th September 1955 to 20th August 1956.

Dr. van Eekelen's services were planned as follows:

1) to conduct a survey of existing surplus of foodstuffs in Thailand,

2) to carry out a study of existing food industries in the country in order to recommend the types of food industries to be developed,

3) to prepare a programme of research and investigation in the field of food preservation and processing, and

4) to train Thai technicians in various aspects of the food industry.

Dr. van Eekelen was the Director of the Central Institute for Nutrition Research, a branch of the Netherland's National Council for Applied Scientific Research. Though this was his first visit to this country, Dr. van Eekelen was well known among many scientists here; some of them had their training under his directorship at the Central Institute for Nutrition Research.

After his arrival in Thailand, Dr. van Eekelen, accompanied by the Director of the Division of Biological Science, paid many visits to food producers in various parts of the country. He also conferred with officials from the Ministry of Agriculture, the Ministry of Public Health, and the Ministry of Industry, and also from various organizations of the United Nations.

As for research, Dr. van Eekelen acted as a consultant and on many occasions took part in the study of various problems in cooperation with the staff of the Division of Biological Science, in the study of products from fish with the staff of the Department of Fishery, and in the study of animal fodder with the staff of the Department of Liverstock Development.

In addition, Dr. van Eekelen had given his support in the arrangement to obtain funds for two officials of the Division of Biological Science to have their study and training abroad, one on Food Microbiology and the other on Food Technology. Also through his assistance, the Department of Science received some equipment from the Food and Agriculture Organization.

During his stay at the Department of Science, Dr. van Eekelen proved himself to be one of the most able scientists, well liked and highly respected by every one. His knowledge and experience, his sincere cooperation and his unexhausted capacity for work in excellent harmony with every member of the Department were deeply appreciated. The Department of Science wishes to take this oportunity to express its gratitude to the Food and Agriculture Organization for sending such a learned person with a pleasant personality as Dr. van Fekelen to asist the Department.

Dr. van Eekelen left for the Netherlands on 20th August 1956 to take up his new appointment as the President of the National Research Council for Nutrition. In his place, the Department of Science received another expert on Food Technology from the Food and Agriculture Organization to continue the work for the year 1957--1958.

SPECIAL DUTY

Dr. Charng Ratanarat, the Director-General, was invited to become:

(1) National Committee member of the UNESCO,

(2) Chairman of the National Committee, Science Division of the UNESCO,

(3) Member of Committee of Industrial Economic Branch, National Economic Council,

(4) Member of the Board of Directors, Phamaceutical Factory,

(5) Member of the Committee on the Establishment of the Manure Production Organization of the Ministry of Agriculture,

(6) Member of the Committee on the Policy regarding the Promotion of Industries in the Country,

(7) Executive member of the Committee on Petroleum at Fang, Chiengmai,

(8) Member of the Board of Directors, Alcohol Distillery, Ayuthaya,

(9) Member of the National Air Defence Committee,

(10) Representative of the Ministry of Industry attending a meeting on the establishment of the Ministry of Defence's light ammunition factory,

(11) Member and Secretary-General of the Thai Atomic Energy Commission for Peace,

(12) Deputy Chairman of the Alum Plant Committee,

(13) Member representing the Ministry of Industry in the Export Quality Control Committee, which was organized by the Ministry of Economic Affairs,

(14) Member of the Committee to consider Thai Paper Project of the National Economic Development Corp. Ltd.,

(15) Secretary-General of the 9th Pacific Scientific Congress,

Etc.

GENERAL REVIEW

The Department of Science also served during this period as the offices of the secretariats for the Thai Atomic Energy Commission for Peace, the Executive Committee for the Ninth Pacific Science Congress, and the National Research Council. The three offices were headed by the Director-General of the Department of Science. Owing to the shortage of funds, some of the staff of the Department were called upon to render their services to these organizations resulting in heavier strain on the members of the staff as a whole.

Regarding the development of products intended to lead to eventual establishment of appropriate industries in this country, the quality of the products and the methods of production were improved. The Alum Plant, of which the Director-General of the Department of Science is the Vice-President and the Manager, had its operating process modified thus considerably reducing the production cost. Unfortunately, the plant had to be temporarily suspended owing to the shortage of sulphuric acid, but normal production had since been resumed. It had been hoped, however, that the production for the year 1957 would be sufficient to meet the local demand. The process development mentioned above was carried out in cooperation with the staff of the Thai Cement Company, the staff of the Division of Research, and the staff and the Head of the Division of Physics and Engineering.

During the period covered by this report, the Department of Science received further aid from the Food and Agriculture Organization of the United Nations. The term of the technical adviser was extended, for another year. Furthermore, two funds were made available to staff members of the Department to have their further training, one on Food Technology for a period of five months, and the other on Food Microbiology for a period of six months. The Department of Science also received some new equipment for food analysis from the Food and Agriculture Organization. Funds were also made available by the Government of Australia, under the Colombo Plan, for two scientific officers of the Department to have their training in various institutions in Australia on Food Analysis and Microbiology, each for a period of about twelve to eighteen months. Besides, there were exchanges of publications and scientific informations with other foreign institutions and distinguished visitors. Cooperation with other departments,

institutions, societies, and organizations were given. The Director-General and many officers of the Department of Science were elected to be committee members of the Science Society of Thailand under H.M. the King's Patronage, and to be committee members of the Chemical Section of that Society. The Department of Science gave two exhibitions, one in the "Industrial and Commercial Week Fair" at Loompini Park and the other in the "Industrial Fair" at the Dusit Zoological Garden, Kao Din Park. Members of the Department were invited to become special lecturers of various universities, institutes and schools, and also to be member of various committees formed by other governmental organizations. The Department of Science performed in cooperation with other departments in research as well as analytical work, and helped in the training of officials on many special courses. In all, it could be said that the work of the Department of Science has been increasingly appreciated and more extensively made use of than ever before.

As for the public dissemination of scientific knowledge, the "Science for the People" and the "Report upon the Work of the Department of Science" were monthly broadcasted. The former was a joint contribution by the Department of Science and the Science Society of Thailand under H M. the King's Patronage. "The Department of Science News" and the "Report Upon the Work of the Department of Science" were issued quarterly and annually respectively. In addition, pamphlets on the results of scientific investigation were occasionally published; among these the publication "Natural Springs in Thailand" was issued in Thai this year. This work represented four or five years of investigation and survey made on spring water at practically all localities

throughout the country. It was distributed to several institutes and departments.

The analyses carried out by the staff of the Department for the year 1956 amounted to 3,478 samples, while research work was carried out on 24 topics, some of which will be briefly discussed in this report.

The total number of the staff remained the same although the number of female staff increased by six. Department of Science thus had 85 male and 54 female staff, consisting of 4 special grade, 6 first grade, 28 second grade, 40 third grade, and 21 fourth grade civil officials and employees and 40 non-commissioned civil officials.

Although the routine work of the Department does not differ much from that of the previous year, special duties resulting from the Department being the centres of various committees, councils and commissions increased the strain on most of the staff, especially of the Registration Section, Office of the Secretary of the Department. The Statistics, Museum and Information Section, with its modernized system, provided statistics of the Department's analytical work and its relation with the number of the staff, which have been recorded at the end of this report.

The work of the Division of Chemistry was mostly routine analysis. Topics which may be of interest, such as chemical composition of detergents, textile materials and sheet metals, have been noted under appropriate headings in this report.

The Division of Analytical Chemistry Training had 13 new enrolments. The second and third year classes consisted of 17 students, making the total number of 30 students for the academic year 1956–1957. During the year, four students graduated. The number was rather low and insufficient to meet the urgent demands of other governmental departments and

various organizations. Efforts were being made, therefore, to raise the status of the School so that its graduates would be entitled to an university-recognized certificate, by revising its curriculum and by affiliation to the Chulalongkorn University. It was believed that this modification would attract more students to the School and thus provide sufficient supply of graduates needed in various institutions.

The work of the Division of Biological Science was concerned mainly with food analysis and research; some representative topics have been described in this report. In addition, the Division was the Office of the Secretary of the Thai Atomic Energy Commission for Peace and the Office of the Executive Committee for the Ninth Pacific Science Congress Meeting.

Construction, repair work and chemical preparations composed the main of the division of Physics and Engineering's works. During the year 1956, the Division completed 679 items of repair and construction work. Also in addition to the routine testing of cement for the Thai Cement Co. and analytical and research work, the Division of Physics and Engineering prepared certain basic chemicals for use in the Department and for sale to other departments as requested, at production cost price.

In addition to the development and control of the Alum Plant, the Division of Research studied various topics, e.g. coconut oil from fresh coconut meat, flavour intensifier, kapok-seed oil, and pararubber-seed oil.

Apart from short discussions in the main report of each division, all research topics investigated during the year 1956 are listed at the end of this report. For further details, enquiry should be made to the Department of Science during the office hours.

SECRETARY'S OFFICE

Library

The Inter-library Association, which was promoted by the Department in the previous year, held two meetings in 1956. These were attended by representatives of 25 scientific and technical libraries.

The Department was also entrusted with the organization of the Library of the Thai Atomic Energy Commission for Peace.

During 1956 there were 543 persons, excluding the staff, who requested the use of the Library. The total number of books and periodicals was 9,880 bound and 5,736 unbound. The current periodicals received were 20 from the U.K. and 45 from the U.S. The Library still continued the exchange of its publications, the Report and the Thai Science Bulletin, for publications of foreign scientific organizations, either directly or through the United States Book Exchange.

Two officers of the Department received UNESCO fellowships to be trained in Library Science in New Delhi, India, for five weeks.

DIVISION OF CHEMISTRY

During 1956 the Division of Chemistry analyzed 2,977 samples, which were 515 samples more than the previous year. Though the number of opium samples decreased, owing to the Government's determination to abolish opium smoking in Thailand, the number of samples of drinking water, i.e. wells and municipal water, increased and more than compensated for the decrease. The number of samples analyzed during the year 1956 by each Section is shown below.

Section	Number of Samples Analyzed
Water	831
Fuel and Lubricant	128
Minerals and Ores	224
Metals and Alloys	255
Opium	382
General Analysis	1,157
Total	2,977

In the work of the General Analysis Section for the Department of Customs certain difficulties arose as to the definitions and classifications of the imported goods. As a result of recommendations made by the Department certain regulations on tariff were revised, in order to keep up with the increasing varieties of goods and be fair to all concerned.

1) Textiles

The tariff for textile consisting of more than 80% cotton was lower than for that with less than 80% cotton. Importers' claims for the lower tariff rate were often found to be false.

In the early days synthetic fibres were costly and considered to be luxury goods. The discovery and development of new processes reduced the production cost, and nowadays many types of synthetic fibre are available at a cost even lower than cotton. It is, therefore, advisable to reduce the tariff rate on textile containing more than 20% of such fibre.

2) Sheet Metal and Metal Foil

Generally speaking, foils are used mostly for decorative purposes, while sheets are made into containers, etc. The tariff rates on the two are not the same, the rate for foils being higher. Although their definitions had been clearly fixed by the Department of Customs so that sheet metal shall not

be thinner than 0.025 cm., difficulties sometimes occurred because thinner metal sheets were being used for vacuum coverings of cans. Revision of the Department of Customs' rules was therefore introduced.

3) Detergent

The tariff rate for detergents was higher than for pure chemicals. There were difficulties when a batch of dodecyl benzene sulphonate was imported into this country. Analysis of a sample submitted by the Department of Customs revealed the following composition:

Moisture	10.5%
Sodium dodecyl benzene sulphonate	54.8%
Silica, calculated as sodium silicate	9.2%
Sodium sulphate	23.1%
Other impurities	2.4%

Sodium dodecyl benzene sulphonate is one of the active ingredients in most detergents sold in the market. Since the sample analyzed above could be used directly as detergent and it was not a pure chemical, it might be considered as a detergent. On the other hand, if the manufacturing process is considered, sodium dodecyl benzene sulphonate can not be produced economically in pure state. From this point of view the sample might be considered as a chemical and not a detergent. The matter was therefore referred to the Department of Customs for consideration.

Other non-routine work of the Division of Chemistry included the publication of a pamphlet on "Natural Springs in Thailand" by the Deputy Chief of the Division, Mrs. Rabieb Prachankhadee.

DIVISION OF BIOLOGICAL SCIENCE

During 1956 the Division of Biological Science analyzed 601 samples, an increase of 110 samples over the previous year. Eight research problems were investigated, details of which will be found in the report of each Section.

The correspondent work of the Division during the period covered by this report increased consideratly because the Director of the Division was appointed secretary to various scientific committees. The Division thus had to serve as secretarial offices of :

1) The Thai Atomic Energy Commission for Peace,

2) The Executive Committee for the Ninth Pacific Science Congress Meeting, and

3) The Scientific Branch of the National Committee of the UNESCO.

Though the nature of the work was routine, no regular staff was available. The work had to be done by members of the Division and occasionally by members from other Divisions.

Biochemistry Section

Preparation of Fish Sauce and Sauces from Bean and Groundnut by Chemical Method

Summarized results of investigations continued from the preceding year are given below.

1) Crystallization of Calcium Phosphate at Various pH Values

Calcium phosphate present in fish bone usually crystallyzed out when the fish sauce prepared by chemical method was left standing. A study was therefore made to determine a suitable pH value at which most calcium phosphate would crystallyze. This was found to be at a pH value of 5.5. Calcium phosphate

was removed at this pH value and the resulting source showed no sign of calcium phosphate deposition after three-month keeping.

2) Soy-Sauce from Dried Bean-Curd Scum

Sauce prepared from soy-bean usually have a certain burnt smell. It was thought that this might be caused by the remaining carbohydrate in the bean. Experiment was therefore made using dried bean-curd scum because this product contained mostly protein. The sauce obtained showed no improvement in its smell. Moreover, the cost of production was rather high.

3) The Aroma of Fish Sauce

The aroma of fish sauce prepared by the traditional fermentation method was thought to be caused by the bacteria *Anaerobic Clostridium*. The Microbiology Section was asked to grow the bacteria from home-made fish sauce. The bacteria were then added to the fish sauce prepared by chemical method to improve its aroma. The bacteria, however, would not grow in the chemically prepared sauce. Further study was required.

4) Preparation of Ground-Nut Sauce from Protein Extracted from Ground-Nut Dross

Protein extracted from ground-nut dross by alkali was used in the preparation of sauce by chemical method. The sauce obtained had pleasing flavour and aroma, uncontaminated with the burnt smell as in the sauce prepared directly from ground-nut dross. This process would be used as a basis for future study.

5) The Preparation of Soy-Sauce Without Heating

A study was made to compare soy sauces prepared by chemical method with and without heating. In the method without heating, the beans was soaked in acid for approximately

3 months before it was used in sauce making. The product obtained was low in quality. And since the process took much time, the experiment was abandoned.

Plant Chemistry Section

1) Milk Substitute for Infant Feeding

The Department of Science, in collaboration with the Women and Children's Hospital, initiated in the previous year an experiment to search for a milk substitute suitable for infant feeding. Two recipes which had been tried showed some promise.

a) Duck egg yolk, banana's extract (Nam-wa), common salt and calcium lactate

The mixture was fed to over-three-month-old infants for a period of 2-3 months. The infants' weights increased irregularly. The results were, however, reasonably good compared with those of the feeding with milk powder, but in certain cases, the faeces were rather liquid and the quantities were too high.

b) Hen egg yolk, dextrin maltose, common salt, potassium chloride and calcium lactate

The mixture was tried on three-to-six-month-old infants. The increase in infants' weights was regular as compared with milk powder fed infants. Other indications were good, except that the faeces were a little too liquid.

Other recipes were tried but were found to be not so successful; the increase in weight of infants was not satisfactory.

Experiments on younger infants were planned using the above two recipes. Also observations were to be made on the infants already fed as to their physical developments.

During the shortage of imported milk, owing to the Suez Crisis, the result of the investigation, although incomplete, was publicized on the wireless and in many newspapers.

2) Study on Sugar in Various Species of Bananas

The study was made along with the investigation on milk substitutes. It was found that the sugar content in banana increased as the banana ripened, and reached the maximum when it was fully ripe. Then as the banana became over-ripe, the amount of sugar extracted decreased, owing to the decrease in the liquid extractable. The sugar contents of various species of fully-ripe banana are as follows:

Species	*Musa sapientum, Linn.*			
Variety	**Kluai Hom**	**Kluai Nam-wa**	**Kluai Khai**	**Kluai Hak-muk**
Reducing sugar (%)	11.66	10.88	6.62	16.44
Total invert sugar (%)	16.19	19.5	20.64	16.8
Non-reducing sugar (%)	4.53	8.62	14.02	0.36
pH	5.6	4.7	5.5	6.2

Kluai Khai has the highest total invert sugar and Kluai Hak-muk has the highest reducing sugar. The reducing sugar is a form of sugar that can be directly used by the body. This knowledge agrees with experience; in Thailand, Kluai Hak-muk was one of the most popular foods used in feeding children and sick persons. Kluai Hak-muk, unfortunately, was not available throughout the year, extract from Kluai Nam-wa was therefore selected for use in the preparation of milk substitute.

3) Study on Sugar in Corn-Sprout

The study was a part of the search for a suitable sugar to be used in the preparation of milk substitutes. Dry corn

were soaked in water overnight. They were then spreaded on a tray and covered with moist cloth, which was kept wet by occasional spraying. Enzymes in the corn converted the corn starch into sugar. After leaving them for two, three and four days respectively the corn were removed, and the sugar extracted and analyzed. Results showed that corn which had been sprouted for three days gave the highest total invert sugar, while maximum reducing sugar was found in four-day sprouted corn.

Nevertheless, sugar extracted from corn was not used in the making of milk substitutes, owing to its troublesome process which was unsuitable for domestic preparation. Further study, however, might lead to profitable applications, e.g. in the making of soft and alcoholic drinks.

Nutrition and Beverage Section

Study on Preserved Eggs

As already stated in the previous report, it was desired to find out whether Salmonella or Para-typhoid viruses presented in duck eggs would be killed in the process. In the study, co-operation was given by Dr. M. van Eekelen and Dr. Pote Putarangsi of the Department of Livestock Development.

The study revealed that Salmonella were destroyed after the eggs had been properly preserved; it was possible to preserve any kind of hen or duck eggs, and it was not necessary that the eggs should be unfertilized as generally believed.

Preserved eggs are sometimes called fermented eggs. This is misleading because it suggests that the eggs have gone through some fermentating process. Observation at various stages of the experiment proved that the changes in the composition and nature of the eggs were purely chemical and physical.

Microbiology Section

In co-ordination with the Biochemistry Section in the preparation of fish sauce by chemical method, the Microbiology Section worked on the identification and the separation of bacteria present in the fish during the process of fermentation. It was hoped to find the bacteria which gave fish-sauce its flavour and aroma so that they could be added to the chemically prepared fish-sauce.

DIVISION OF PHYSICS AND ENGINEERING

The Division of Physics and Engineering was composed of four Sections, i.e. the Physics Section, the Material Testing Section, the Chemical Engineering and Industrial Process Section and the Workshop Section. During the period covered by this report 1,927 analyses were made on 203 samples, 998 items of instrument construction and repair work, and 3,214 items of photographic work were carried out. Approximately 14,320 litres of distilled water, 60 litres of ammonia and some special grade of alcohol were produced for use in the Department and for sale.

The work on destructive distillation of wood showed slow progress. It was found that apart from yielding charcoal of the highest calorific value, Kongkang (*Rhisophora candelaria*) gave maximum valuable by-products.

One of the problems of the Chemical Engineering and Industrial Process Section was to search for raw materials for high grade porcelain and ceramics. Two quartz deposits were found, one in Chandaburi, and the other in Rayong. Though the quartz samples from both deposits were partly opaque, they could still be used in ceramics industries, e.g. in making

porcelain and glazing solution. Results of the analysis of the quartz from the two deposits are shown below.

	Quartz from Chandaburi (Per cent)	Quartz from Rayong (Per cent)
Loss on Ignition	0.12	0.23
Silica (SiO_2)	97.0	97.4
Alumina (Al_2O_3)	1.2	0.96
Iron Oxide (Fe_2O_3)	0.3	0.50
Calcium Oxide (CaO)	0.86	0.60
Magnesium Oxide (MgO)	0.54	0.32

DIVISION OF ANALYTICAL CHEMISTRY TRAINING

There were no changes in the curiculum of the School of Analytical Chemistry Training during the period covered by this report.

The number of new students attending the first year course was thirteen. The second year class and the third year class had three and thirteen students respectively. The total number of students was thus twenty-nine, and one official of the Royal State Railway of Thailand requested to be trained here.

The result of the examination for the Academic Year 1955 was as follows:

First year students	:	8 passed, 9 failed
Second year students	:	12 passed, 3 failed
Third year students	:	4 passed and graduated
Second year trainee	:	1 passed

The number of first year and second year students who resigned from the school after their examination was seventeen.

DIVISION OF RESEARCH

The work of the Division consisted mainly of research, process testing and experimental production of goods to encourage new industries. Analytical work was also carried out in connexion with research work and on items which presented special problems.

During the period covered by this report, the Division was working on 13 research problems, carried out 738 analyses, and produced six kinds of goods. Some of the more interesting topics are given below.

Research and Process Testing

1) Recovery of Alum from White Clay Mud

In the production of alum from white clay, about 20 per cent of alum was usually left in the slurry. Filtration and washing took excessive time, the particles in the slurry being very fine. Two methods to recover the alum were found practical.

In one method, the mud was dried and heated to 700–750°C for about 10 minutes, and then hot water was added and the slurry filtered. After two washings with hot water, most of the alum was removed. The other method involved an addition of a filter aid such as sand or diatomaceous earth to the mud. The first method was more satisfactory and was used with success in the Alum Plant.

2) Research on China Ware

2.1 The Raw Materials.

A search for a source of raw materials for high grade china ware was not successful during 1956. The materials found could only be used to make earthen ware.

2.2 The Glaze

Both transparent glaze and opaque glaze were tried on bodies formed by hand and by the jigger. Both gave satisfactory results. Unfortunately, the clay object before glazing was not of pure white; with transparent glaze, the colour of the finished product thus appeared to be pinkish cream.

2.3 Coloured Earthen Ware

Experiments to produce coloured earthen ware articles were made.

a) Coloured chemicals were added to the glazes which were tried on ordinary earthen ware. After proper firing, uncovered surface still appeared, especially at the edges and corners.

b) Coloured chemicals were added directly to the prepared clay. After firing the article was covered with transparent glaze. Satisfactory results were obtained in green, blue and sky-blue. Experiments on other colours were being made.

The results of the investigation were sent to the Ministry of Industry's Earthen Ware Factory to be considered for commercial-scale production.

3) Coconut Oil from Fresh Coconut Meat

In the 18th report, it was stated that coconut oil of good keeping quality with low free fatty acid could be obtained from fresh coconut milk. The yield was, however, rather low because a certain amount of oil still remained in the coconut cake. In order to increase the yield the following experiments were carrided out.

3.1 A hydraulic press was used with a stainless steel cylinder, 7.5 inches high and 10 square inches cross-sectional area, the wall of which is provided with 1 mm x 4 mm holes

for the flow of the coconut milk. The cylinder could be filled with approximately 900 grams of coconut meat.

In the first experiment, after as much milk as possible had been squeezed out, about 450 c c. of water was added to the cake and the pressure was re - applied. This was repeated many times, each time with an addition of 450 c.c. of water.

The results are tabulated below.

Table 3.1

The quantities of oil obtained by using a hydraulic press on fresh coconut meat

	Fresh coconut meat	Cake after 1st pressing	Cake after 2nd pressing	Cake after 3rd pressing	Cake after 4th pressing	Cake after 5th pressing
Total amount of fresh coconut meat (grams)	900	–	–	–	–	–
Weight of cake (grams)	–	400	370	316	276	256
Cake (per cent of the total coconut meat)	–	44.5	41.2	35.2	30.6	29.4
Moisture (per cent)	52.2	–	48.1	46 9	43.7	46.8
Oil in fresh coconut meat or cake (per cent)	31.6	–	29.6	28.2	29.6	26.3
Weight of oil in coconut meat or cake (grams)	284	–	110	89	82	62
Weight of oil obtained (grams)	–	–	173	195	202	222
Total oil yield (per cent)	–	–	61.3	68.7	71.1	78.3

3.2 The same equipment as in 3.1 was used, but cold water (approximately 50 % by weight of the meat) was added to the fresh coconut meat before the first pressing.

Table 3.2

The quantities of oil obtained by using a hydraulic press on fresh coconut meat (with cold water added before the first pressing)

	Fresh coconut meat	Cake after 1st pressing	Cake after 2nd pressing	Cake after 3rd pressing
Total amount of fresh coconut (grams)	900	--	–	–
Weight of cake (grams)	–	410	360	330
Cake (per cent of the total coconut meat)	–	45.5	40.0	36.6
Moisture (per cent)	49.5	45.8	44.0	44.2
Oil in fresh coconut meat or cake (per cent)	34.0	34.8	35.8	35.0
Weight of oil in fresh coconut meat or cake (grams)	306	143	129	116
Weight of oil obtained by pressing (grams)	–	163	177	190
Total oil yield (per cent)	–	53.0	58.0	62.0

3.3 The coconut meat was cooked in boiling water for two hours before it was pressed. Before each successive pressing that followed, hot water (about 50% by weight of the meat) was added. The experiment was repeated with the coconut meat cooked at 100°C without water.

Table 3.3

Comparison of quantities of oil obtained by using a hydraulic press on fresh coconut meat cooked with and without water respectively

	Fresh coconut meat	Cooked without water			Cooked in boiling water		
		Cake after 1st pressing	Cake after 2nd pressing	Cake after 3rd pressing	Cake after 1st pressing	Cake after 2nd pressing	Cake after 3rd pressing
Total amount of fresh coconut meat (grams)	400	–	–	–	–	–	–
Weight of cake (grams)	–	210	175	150	224	185	160
Cake (per cent of the total coconut meat)	–	52.5	43.8	37.0	56.0	46.2	40.0
Moisture (per cent)	51.2		36.4	37.8	37.6	41.3	43.5
Oil in fresh coconut meat or cake (per cent)	30.2		39.1	37.2	43.0	37.8	33.8
Weight of oil in fresh coconut meat or cake (grams)	120.8		68.3	55.8	96.3	70.0	54.0
Weight of oil obtained by pressing (grams)	–		52.5	65.0	24.5	50.8	66.8
Total oil yield (per cent)	–		43.5	53.9	20.3	42.1	55.4

3.4 By wrapping the coconut meat in a piece of cloth, the pressure could be increased to as high as 2,000 pounds per square inch, thus increasing the milk yield. An experiment was carried out at a pressure of 1,900 pounds per square inch which was held for 15 minutes for each successive pressing. Cold water (fifty per cent by weight of the cake) was added before the second and the third pressings.

Table 3 4

The quantities of oil obtained by using a hydraulic press on fresh coconut meat wrapped in a piece of cloth

	Fresh coconut meat	Cake after 1st pressing	Cake after 2nd pressing	Cake after 3rd pressing
Total amount of fresh coconut meat (grams)	907	–	–	–
Weight of cake (grams)	–	311	260	235
Cake (per cent of the total coconut meat)	–	34.3	28.6	25.9
Moisture (per cent)	47.6	36.1	36.3	40.6
Oil in fresh coconut meat or cake (per cent)	36.1	36.9	36.2	32.4
Weight of oil in fresh coconut meat or cake (grams)	328	115	94.0	76.2
Weight of oil obtained by pressing (grams)	–	213	234	252
Total oil yield (per cent)	–	65.0	71.3	76.8

3.5 It was reported in the Philippine Journal of Science Vols. 74–75, 1941, that by using a ten-inch (or larger) diameter rollers on the coconut meat thrice, 96 per cent of oil would be squeezed out. Experiment was carried out at the Department with a 3.5 inch diameter rollers available. The yield of coconut milk was rather low and the milk contained much meat.

3.6 The method generally used in almost every kitchen, i.e. the squeezing of the meat by hand, was tried The amounts of water added to the 900 grams of meat before the first, second and third squeezing were 500, 1000 and 1000 c.c. respectively. The combined oil yield was 78 per cent.

3.7 Two methods of separating the oil from the coconut milk were studied. In the first method, a supercentrifuge was used. The result obtained was variable. Further study was in progress.

In the second method, the coconut milk was merely left standing. If no preservative was present, the milk would turn rancid in approximately three hours and little water separated out. When about 10 per cent of common salt was added, the separation took place at a faster rate, the oil yield was higher, and rancidity started very much later than in the raw milk. The disadvantage of this method was that the skimmed coconut milk and the protein remained in it were too salty.

3.8 A third method of obtaining oil, i.e. by ordinary evaporation, was also studied. The resulting oil was yellowish in colour and had a high tendency to turn rancid.

An attempt was made to separate the oil by adding an acid. This had to be abandoned also, because the acid content of the oil was too high.

A study on the method of Bobbledano - Luzuriaga (Bobbledano - Luzuriaga, Coconut Oil Extraction Process, Philippine Patent No. 1) was also made. The coconut milk was first cooled below 18°C and then warmed to between 30°- 50°C. The three layers separated out were, from top to bottom, an oil layer, a protein layer and a water layer respectively. The oil layer was run off and centrifuged, then passed through diatomaceous earth. The free fatty acid content of the oil at this stage was approximately 0.3 per cent. The oil still retained its specific odour, but was clean and colourless. Further purification by alkaline refining reduced the free fatty acid content to 0.03 per cent and the oil was odourless, and had an excellent keeping quality.

The disadvantages of the process were that it was lengthy, and that large amount of oil still remained in the protein layer. To recover this, solvent extraction had to be resorted to, when an addition of 37.6 per cent was gained, bringing up the total yield to 92.9 per cent.

The composition of the cake after solvent extraction was as follows:

	Per cent
Oil	4.2
Protein	11.1
Ash	2.8
Residue	24.8

3.9 The composition of a sample of skimmed coconut milk is shown below.

	Grams per 100 c.c. skimmed coconut milk
Total solids	17.2
Ash	1.1

	Grams per 100 c c. skimmed coconut milk
Protein	1.7
Oil	0.3

The skimmed coconut milk could be used as a drink and tasted like the juice inside the coconut. Its total solid content was, however, about four times that in the juice.

3.10 The coconut cakes after pressing had the following composition.

Kind	Moisture per cent	Oil per cent	Protein per cent	Ash per cent	Residue per cent
Peeled fresh coconut meat	52.2	31.5	3.2	1.0	2.9
Once pressed coconut cake without an addition of water	35.4	38.5	3.2	0.9	7.1
Coconut cake after the fifth pressing (no water added before the first pressing; for each pressing that followed, 50 per cent (by weight of the cake) of water was added)	46.8	26.3	1.9	0.3	–

The coconut cake after pressing was edible. If the cake had only been pressed once, it could be dried and used in various sweets. The cake after many pressings might be ground and made into coconut meal. Though the meal could be used for cooking purposes its food value was rather low.

In the methods described above, if the dark skin of the coconut meat was peeled off before the meat was pressed, the oil obtained would be almost colourless. The peeled skin,

which constituted about 8 per cent of the whole meat, might be toasted and pressed. The oil collected was yellow in colour, and the residue could be used as fodder or fertilizer.

Conclusions

1) The use of a hydraulic press gave a rather low yield of oil. In re-pressing to obtain more oil, large volume of water had to be used.

2) The first pressing gave the highest amount of oil.

3) Maximum yield of approximately 93 per cent could be obtained by hydraulic pressing followed by solvent extraction.

4) The Bobbledano-Luzuriaga method of separating the oil from the coconut milk gave the most satisfactory results.

5) After many pressing the remaining coconut cake had low food value.

6) Coconut oil obtained by this method had excellent keeping quality. It had a pleasant characteristic odour and low free fatty acid content. The oil was almost colourless.

4) Kapok-seed Oil

In Europe, kapok-seed oil is prefered to cotton seed oil owing to the former's superior qualities. Kapok-seed meal, after the oil has been removed, is also a better animal food, since it contains no toxic gossypol as in cotton-seed meal.

Kapok seed contain approximately 20 per cent of oil, which had many uses. An investigation on its extraction was, therefore, started by the Division of Research. At this stage only preliminary work had been done. A hydraulic press was used and the seed were pressed in the form of whole seed, kernel, ground whole seed and steamed whole seed. Compositions of whole seed, kernel, and hull are as follows:

Item		Whole seed	Kernel	Hull
Moisture	(per cent)	13.5	8.8	17.3
Oil	(per cent)	20.0	34.3	0.3
Protein	(per cent)	23.7	37.2	5.5
Ash	(per cent)	4.8	6.5	4.4
Residue	(per cent)	18.1	1.4	40.1

5) Drying Oil from Pararubber Seed

This problem had previously been studied by the old Division of Industrial Research. The oil produced at that time was reported to contain a certain amount of dissolved rubber, which was believed to retard the drying rate. Purification by acetone extraction would considerably increase the drying rate. It would also increase production cost, and was undoubtedly unsuitable for large scale production.

The problem was re-examined by the Division of Research. The rubber seed used were rather old and the extracted oil had an acid value of 75. When left standing, a large quantity of free fatty acid crystallized out. This free fatty acid had an acid value of about 175, and a low iodine value of 30-80. Even with a higher iodine value of 140, but with a high free fatty acid content as was found above, the oil would not dry completely. Also the rubber content of the oil was only 0.5 per cent. It was concluded that the free fatty acid content was one of the factors, if not the most important factor, which retarded the drying.

Further experiments were in progress with fresh para-rubber seed. The formation and prevention of the free fatty acid and the dissolved rubber in the oil would be studied.

Analytical Work

1) Quantitative Analysis of Vitamin E in Rice-bran Oil

The Emmeric and Engel method, using spectrophotometer, was employed. The sample was found to contain approximately 0.1 per cent of vitamin E.

2) Analysis of Water Bug's Carcass

Analysis of water bugs' carcasses after the odorous oil had been extracted showed the following results.

Item	Protein (per cent)	Oil (per cent)	Ash (per cent)
Whole water bug's carcass	74	12	0.32
Water bug's head	75	6.6	0.45

3) Analysis of Coloured Soil from Chiengmai

A sample of coloured soil from Chiengmai was submitted by the Department of Industrial Promotion, who wanted to know whether it could be used as a pigment. The result of the analysis is shown below.

	Per cent
Moisture	17.4
Fe_2O_3 (dry basis)	26.5
Al_2O_3 (dry basis)	27.6
Free Silica	19.0

After roasting, removing of sand, and grinding into a very fine powder, the soil yielded a pigment which could be used in house painting with a reasonably good result.

STATISTICS ON THE STAFF OF THE DEPARTMENT OF SCIENCE

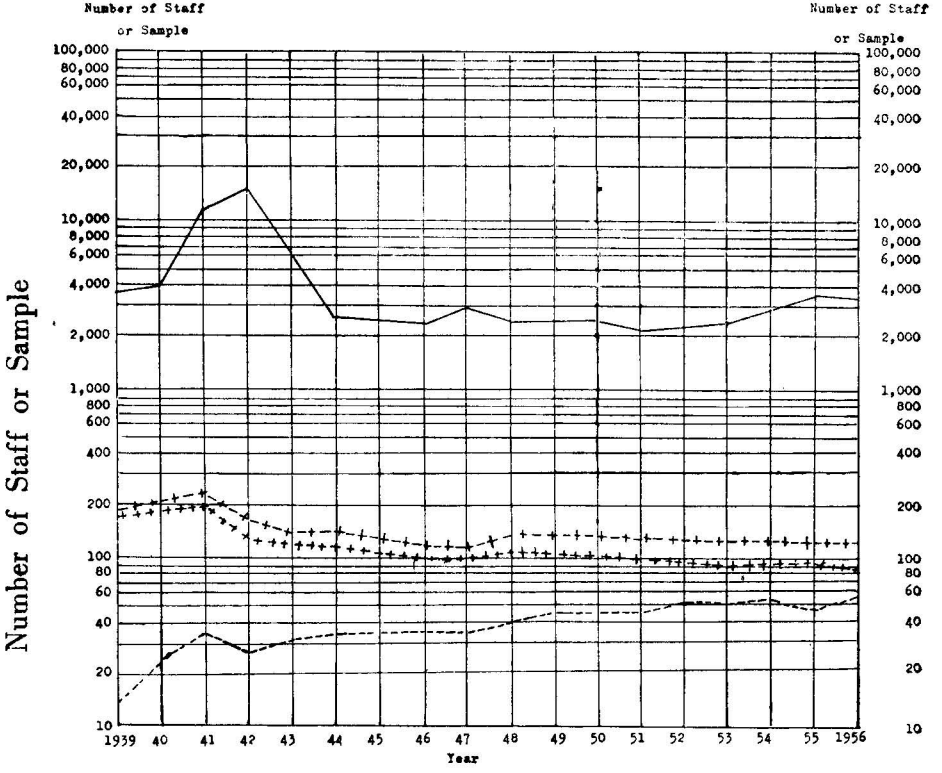
Year	Staff total	Male staff	Female staff	Number of Staff classified by Grade					
				Special	First	Second	Third	Fourth	Non-Commissioned
1939	188	174	14	1	5	26	22	61	73
1940	205	181	24	1	5	27	28	64	80
1941	225	189	36	1	5	30	44	70	75
1942	171	143	28	1	3	21	32	63	51
1943	155	123	32	1	4	21	35	54	40
1944	156	121	35	1	5	21	41	47	41
1945	143	107	36	1	5	21	41	39	36
1946	136	99	37	1	5	21	40	32	37
1947	135	99	36	1	5	23	41	27	38
1948	149	109	40	1	5	23	43	38	39
1949	149	104	45	1	7	27	39	35	40
1950	149	103	46	1	8	30	37	34	39
1951	146	100	46	1	7	29	36	35	38
1952	146	95	51	1	8	28	36	31	42
1953	139	89	50	1	8	29	31	28	42
1954	143	91	52	1	8	29	39	23	43
1955	139	91	48	3	5	27	36	24	44
1956	139	85	54	3	5	28	40	21	42

ANALYSIS STATISTICS FROM 1939-1956

(Source Classification)

From	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956
Secretariat of the Prime Minister	–	–	6	10	–	5	–	–	–	–	–	–	–	–	–	–	–	–
Ministry of Defence	540	903	676	721	707	145	271	262	400	459	44	48	90	42	42	85	72	372
Ministry of Finance	1570	1064	8566	10187	1979	1343	1415	1106	674	659	931	1025	1121	999	1256	1377	1740	1293
Ministry of Agriculture	121	523	583	698	64	2	1	3	–	9	14	17	13	17	35	40	74	15
Ministry of Communications	–	–	1	42	74	73	17	45	99	49	519	364	52	326	20	–	4	–
Ministry of Economic Affairs	883	760	779	869	18	8	77	–	–	7	3	3	3	9	4	1	12	–
Ministry of Interior	526	478	578	708	377	364	231	292	281	275	387	276	322	312	426	302	253	609
Ministry of Justice	4	3	14	2	9	–	1	2	–	1	4	–	–	–	–	–	–	–
Ministry of Education	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	11
Ministry of Cooperative	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	2	4	7
Ministry of Public Health	–	–	–	–	988	85	16	62	123	233	48	133	38	125	77	13	1	10
Ministry of Industry	–	–	–	73	137	173	55	102	276	341	209	311	282	258	185	535	564	415
Municipals and Provinces	–	–	–	–	50	44	59	50	66	58	65	60	57	26	-	–	–	–
Banks and Governmental Organizations	–	–	–	–	–	–	–	–	29	6	17	27	8	–	225	348	578	431
Semi-Governmental Companies	–	–	–	245	998	132	12	58	29	20	35	11	10	3	3	–	9	–
Companies and Public	293	263	456	834	813	270	272	383	939	493	391	253	448	225	192	238	222	315
Total	3937	3994	11659	14389	6214	2644	2427	2365	2916	2610	2677	2708	2244	2342	2468	2943	3535	3478

GRAPHICAL COMPARISON OF THE NUMBER OF MALE AND FEMALE STAFF AND THE NUMBER OF SAMPLE ANALYZED WITH THE TOTAL NUMBER OF STAFF FROM 1939 TO 1956



GRAPHICAL COMPARISON OF THE NUMBER OF MALE AND FEMALE STAFF AND THE NUMBER OF SAMPLE ANALYZED WITH THE TOTAL NUMBER OF STAFF FROM 1939 TO 1956

———————— Sample

++++++++++++++++ Male Staff

+ - + - + - + - + Total Staff

---------- Female Staff

ANALYSIS STATISTICS FOR THE YEAR 1956
(Source Classification)

From	January		February		March		April		May		June		July		August		September		October		November		December		Total	
	*S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
Ministry of Defence	4	40	4	18	6	18	5	101	4	57	–	–	7	26	–	–	65	82	159	203	108	219	10	49	372	813
Ministry of Finance	140	185	171	228	87	121	80	120	195	222	92	108	110	155	131	199	113	191	62	89	73	118	39	57	1293	1793
Ministry of Agriculture	–	–	1	15	–	–	2	4	–	–	6	55	1	6	2	20	1	18	–	–	–	–	2	16	15	134
Ministry of Interior	62	1103	42	756	32	559	52	833	40	654	84	1512	46	998	57	1026	70	1260	15	236	39	738	70	1219	609	10894
Ministry of Education	–	–	4	32	3	54	–	–	–	–	1	2	1	18	–	–	–	–	–	–	1	10	1	18	11	134
Ministry of Cooperative	1	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	48	–	–	–	–	7	66
Ministry of Public Health	–	–	1	2	2	7	1	3	1	10	5	30	–	–	–	–	–	–	–	–	–	–	–	–	10	52
Ministry of Industry	31	302	26	108	23	221	14	90	19	92	28	116	72	314	62	292	53	103	45	67	25	88	17	59	415	1852
Banks and Governmental Organizations	6	10	8	54	4	18	6	71	5	45	264	323	20	126	61	519	27	143	10	59	11	78	9	121	431	1567
Companies and Public	32	92	5	41	18	100	10	16	22	160	18	114	15	114	44	103	47	206	26	60	65	189	15	110	315	1305
Total	276	1750	262	1254	175	1098	170	1238	286	1240	498	2260	272	1757	357	2159	376	2003	321	762	322	1440	163	1649	3478	18610

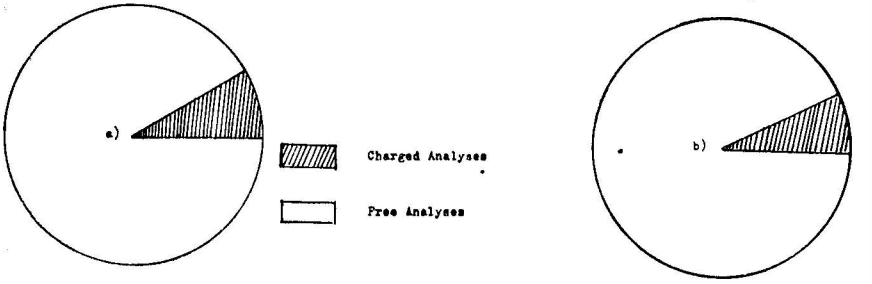
*S – Numbers of Sample ; A – Numbers of Analysis

DIAGRAMMATICAL COMPARISON OF FREE AND CHARGED ANALYSES

a) Comparison of free and charged analyses based on Numbers of Sample

Total Analytical Fee for 1956
153,516.70 Baht

b) Comparison of Free and charged analyses based on Numbers of Analysis



ANALYSIS STATISTICS

(Item and Source Classification)

From	Item	Number of Samples	Number of Analyses
Ministry of Defence	Well water	23	305
	Sea water	298	298
	Liquid fuel	8	18
	Lubricant	6	42
	Antimony	1	3
	Miscellaneous ore	1	3
	Soap	1	5
	Acids	2	6
	Salts	3	24
	Miscellaneous chemicals	16	72
	Flour	7	27
	Miscellaneous soil	1	3
	Textiles and fabrics	4	4
	Writing and printing paper	1	3
	Total	372	813
Ministry of Finance	Liquid fuel	1	1
	Boiled opium exhibit	1	1
	Raw opium exhibits	2	2
	Miscellaneous exhibit	1	1
	Ferrous metal	1	1
	Tin	45	45
	Coinage tin	43	70
	Lead	4	4

From	Item	Number of Samples	Number of Analyses
Ministry of Finance (Cont'd)	Antimony	1	1
	Metals and Alloys	79	172
	Gold	8	8
	Silver	6	6
	Tin ore	3	4
	Wolfram ore	164	166
	Miscellaneous ores	30	30
	Fertilizer	1	1
	Vinegar	1	1
	Wood naphtha and pyridine	7	9
	Ink	1	1
	Miscellaneous chemicals	8	13
	Boiled opium	265	265
	Raw opium	129	139
	Miscellaneous oil	3	3
	Alcoholic beverages from the Department of Customs	13	16
	Non-alcoholic beverages	1	3
	Fresh milk	18	36
	Non-sweetened evaporated milk	91	182
	Sweetened condensed milk	180	180
	Milk powder	56	112
	Textiles and fabrics	112	302
	Dye	6	6
	Paint	8	8
	Writing and Printing paper	4	4
	Total	1,293	1,793

From	Item	Number of Samples	Number of Analgses
Ministry of Agriculture	Well water	1	18
	Miscellaneous water	1	1
	Salt	1	12
	Sulphur	1	2
	Miscellaneous food	2	35
	Miscellaneous fodder	6	48
	Paint	1	2
	Miscellaneous	2	16
	Total	15	134
Ministry of Interior	Provincial municipal water	337	6,822
	Well water	196	3,516
	Miscellaneous water	27	486
	Seminal stains	2	2
	Tin and tin ore	1	1
	Miscellaneous exhibits	5	66
	Miscellaneous oil	1	1
	Total	609	10,894
Ministry of Education	Well water	8	80
	Miscellaneous water	3	54
	Total	11	134
Ministry of Cooperative	Well water	1	18
	Fish sauce	6	48
	Total	7	66

From	Item	Number of Samples	Number of Analyses
Ministry of Public Health	Well water	1	10
	Miscellaneous water	6	34
	Rice	1	3
	White clay	1	2
	Clay and firebrick	1	3
	Total	10	52
Ministry of Industry	Well water	7	54
	Miscellaneous waters	1	46
	Lubricant	1	5
	Tin	1	1
	Copper	1	1
	Metals and alloys	1	3
	Gold	2	12
	Fertilizer	9	35
	Miscellaneous ores	8	56
	Acids	7	61
	Bases	5	8
	Salts	4	36
	Alum	182	221
	Lime and cement	7	12
	Vinegar	1	15
	Sulphur	4	14
	Miscellaneous chemicals	59	716
	Miscellaneous oil	1	2
	Specially blended alcoholic beverages	33	339
	White clay	26	59

From	Item	Number of Samples	Number of Analyses
Ministry of Industry (Cont'd)	Clay and firebrick	14	34
	Miscellaneous soils	34	88
	Miscellaneous rocks	5	30
	Writing and printing paper	2	4
	Total	415	1,852
Banks and Governmental Organizations	Well water	7	89
	Miscellaneous water	16	288
	Sea water	246	246
	Liquid fuels	10	91
	Lubricant	62	538
	Coal	6	39
	Coke	10	46
	Miscellaneous fuels	3	6
	Ferrous metal	19	103
	Tin	6	6
	Lead	3	7
	Copper	11	11
	Metals and alloys	14	43
	Acids	3	9
	Bases	2	8
	Miscellaneous chemicals	5	5
	Miscellaneous oil	1	10
	Miscellaneous soil	1	3
	Textiles and Fabrics	6	19
	Total	431	1,567

From	Item	Number of Samples	Number of Analyses
Companies and Public	Municipal water	1	18
	Well water	54	537
	Miscellaneous water	30	106
	Liquid fuels	7	40
	Lubricant	7	91
	Ferrous metal	2	7
	Antimony	1	1
	Metals and alloys	13	27
	Silver	10	10
	Tin ore	12	17
	Wolfram ore	4	11
	Miscellaneous ores	13	41
	Soap	1	5
	Fertilizer	1	1
	Lime and cement	30	136
	Wood naphtha and pyridine	1	6
	Miscellaneous chemicals	5	1
	Miscellaneous oils	11	20
	Specially blended alcoholic beverage	1	1
	Sweetened condensed milk	2	2
	Milk powder	1	2
	Flour	1	7
	Sugar	1	1
	Fish sauce	3	3
	Fish powder	4	24
	Miscellaneous fodder	2	6
	Medicinal plant	1	2

From	Item	Number of Samples	Number of Analyses
Companies and Public (Cont'd)	White clay	2	4
	Miscellaneous soil	1	10
	Miscellaneous rock	1	7
	Textiles and fabrics	48	117
	Damaged goods	2	2
	Paint	1	1
	Tannin	1	1
	Preparations of solvents	15	15
	Certifications	25	25
	Total	315	1,305
	Grand Total	3,478	18,610

LIST OF RESEARCH PROBLEMS

1956

Reference Number	Title	Researcher
Re. No. 48	Destructive Distillation of Wood	Sunat Bhubhanichya
Re. No. 50	Improvement of Table Salt	Chiet Apaiwongse and Nidnoi Sucharitakul
Re. No. 63	Agar from Thai Seaweed	Rungtavan Bunnag
Re. No. 64	Fermentation of Glutinous Rice to produce Media and Alcohol	Rungtavan Bunnag
Re. No. 65	Preparation of Alcohol using various Yeasts	Rungtavan Bunnag
Re. No. 66	Improvement of the Keeping Quality of Lard	Viengvibha Charutamra
Re. No. 70	Alum (Aluminium Sulphate)	Tiraporn Vongsratana
Re. No. 71	Alum (Aluminium Sulphate)	Wandhani Sastrakhom
Re. No. 77	Water Bug's Extract and Uses of the Extracted Water Bug Carcass	Chiet Apaiwongse and Nidnoi Sucharitakul
Re. No. 78	Coconut Oil from Fresh Coconut Meat	Sompule Suyasinto
Re. No. 80	Quality Improvement of Eau de Cologne and Eau de Quinine	Sumalee Namankalakul

Reference Number	Title	Researcher
Re. No. 88	Quality Improvement of Shoe Polish	Suradee Bubphaves
Re. No. 89	White Shoe Cleaner	Suradee Bubphaves
Re. No. 90	Preparation of Fish Sauce and Sauces from Bean and Ground-nut by Chemical Method	Phannipa Varavej
Re. No. 97	Preparation of Pine-apple wine	Charungchantana Phalajivin and Anu Osathanonda
Re. No. 101	Flavour Intensifier	Priya Chandravekin
Re. No. 103	Quality Improvement of Fountain-pen Ink	Tiraporn Vongsaratana and Wandhani Sastrakhom
Re. No. 104-109	Research on China Ware	Nimit Verabandha
Re. No. 110	Preservation of Rice Bran	Vilai Tevakul
Re. No. 111	Milk Substitute for Infant Feeding	Vilai Tevakul
Re. No. 113	Study on Preserved Eggs	Virada Thisyamondala
Re. No. 114	Preparation of Vinegar by a Quick Process	Sunanta Subbhasiddhi
Re. No. 115	Preservation of Orange and Lime Juices	Virada Thisyamondala and Prapiepit Donavanik

Reference Number	Title	Researcher
Re. No. 116 a.	Comparison of Water Bug's Extract and Oil extracted from Tum-Mung Wood	Chiet Apaiwongse
Re. No 116 b.	Comparison of Water Bug's Extract and Oil extracted from Tum-Mung Leaves	Chiet Apaiwongse
Re. No. 116 c.	Comparison of Water Bug's Extract and Oil extracted from Tum-Mung Young Leaves	Chiet Apaiwongse
Re. No. 117	Kapok-seed oil	Nidnoi Sucharitakul and Sompule Suyasinto
Re. No. 120	Drying Oil from Para-rubber Seed	Puan Proysuwana
Re. No. 121	Preparation of Medicated Soap	Sumalee Namankalakul
Re. No. 122	Quantitative Analysis of Vitamin E in Rice Bran Oil	Puan Proysuwana