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Biochemistry Research in Thailand: Present Status and Foresight Studies

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ABSTRACT: Here, we present the status of biochemistry in Thai universities in many aspects such as departmental infrastructures, academic staffs, budgets for academic and research affairs, research activities including publications, mapping and directions, and finally foresight and policy prospects. This study provides a linkage of personnel and research activities, and lends further insights into the capability of Thai biochemists in terms of the publication in high impact journals. The data indicated that the average impact factor of the journal published by Thai biochemists was comparable to the average impact factor of the journals listed in biochemistry and molecular biology category in the Institute for Scientific Information-Web of Science (ISI-WOS). We hope that this study may serve as a model for other disciplines of science and technology in Thailand and help to enhance the capability of Thai researchers.

KEYWORDS: Thailand Biochemistry, Publications, Research mapping, Policy, Foresight.

INTRODUCTION

Biochemistry is a cross-discipline integrating chemistry and life in our world. The subject is linked to various biological sciences, e.g., medicine, para-medicine (e.g., pharmaceutical sciences, dentistry, veterinary medicine, medical technology, nurse, public health, etc.), agriculture, and also to other natural sciences, as well as to industry. The development of biochemistry in Thai universities started with the establishment of the Department of Biochemistry at the Faculty of Science at Mahidol University to train graduate students in 1964. Five years later, the Department of Biochemistry at the Faculty of Science at Chulalongkorn University started offering a Bachelor of Science degree in biochemistry. All departments responsible for teaching biochemistry in faculties of medicine were originally formed in combination with the Department of Physiology. For example, the Department of Biochemistry at the Faculty of Medicine at Chulalongkorn University, was initially established in 1947 and became independent in 1964.

At present, there are 15 departments of biochemistry distributed among nine state universities. Interestingly, only five departments offer undergraduate curricula in biochemistry, whereas up to 10 departments train graduate students in biochemistry and related subjects, e.g., molecular biology, genetic engineering and bioinformatics. Exceptionally, only the Department of Chemistry at Chiang Mai University offers a Bachelor of Science in biochemistry program, which is taught by staff in biochemistry. Although biochemistry research in Thailand originated more than 40 years ago as evidenced by the first biochemistry publication from Thailand in an international database in 1967 [1], the status of academic and research activities are not known. To our knowledge, there are very few attempts to analyze research performance and publication status of the Thai scientists both internationally [2-4] and nationally [5-7].

Here, we present our findings on the survey and analysis of biochemistry status in Thai universities in many aspects such as infrastructure, personnel, budgets for academic and research affairs, research activities, as well as publications, research mapping and directions, and finally foresight and policy prospects. The impact of research publications on biochemistry by Thai biochemists is also compared to that in the ISI-WOS database under the same category. This communication is a part of the final report on foresight project on physical and biological sciences at state universities during the period of 1998-2004 [8].

DEPARTMENTAL INFRASTRUCTURE OF BIOCHEMISTRY IN THAILAND

In the research project financially supported by Commission on Higher Education, Ministry of Education, we focused mainly on eight state universities. Among these eight universities, only one university had no Department of Biochemistry (Table 1). Totally, there are 13 departments of biochemistry in the Faculty of Science, Faculty of Medicine, Faculty of Pharmacy and

Table 1. Department of Biochemistry: infrastructure, academic staff and curricula in biochemistry and related subjects (data 2005).

University	Faculty	Department	Staff	Curriculum[1]		
				B.Sc.	M.Sc.	Ph.D.
Chulalongkorn (CU)	Science	CU SCI	23	+	+	+
	Medicine	CU MED	10	-	+	-
	Pharmacy	CU PHARM	10	-	-	-
	Dentistry	CU DENT	6	-	-	-
Chiang Mai (CMU)	Science	NA[2]	NA[2]	+	-	-
	Medicine	CMU MED	19	-	+	+
Kasetsart (KU)	Science	KU SCI	11	+	+	+
Khon Kaen (KKU)	Science	KKU SCI	11	+	+	-
	Medicine	KKU MED	18	-	+	+
Mahidol (MU)	Science	MU SCI	21	-	+	+
	Medicine	MU MED	11	-	+	+
	Pharmacy	MU PHARM	5	-	-	-
Prince of Songklanakarin (PSU)	Science	PSU SCI	15	+	+	+
Suranaree University of Technology (SUT)	Science	NA[2]		-	+	+
Srinakarinwirot (SWU)	Science	NA[2]		-	-	-
	Medicine	SWU MED	8	-	+	+
Burapha (BU)	Science	ND[3]		+	-	-
Naresuan (NU)	Medical Science	ND[3]		-	+	+

[1] + and – indicate the existence and non-existence of the curriculum, respectively.
[2]Data are not available.
[3]BU and NU are not included in the research project.

Faculty of Dentistry of seven universities, namely Chulalongkorn University (CU), Chiang Mai University (CMU), Kasetsart University (KU), Khon Kaen University (KKU), Mahidol University (MU), Prince of Songkla University (PSU) and Srinakarinwirot University (SWU). The only university that had no Department of Biochemistry is Suranaree University of Technology (SUT). There are also two Departments of Biochemistry which are not included in this research: at the Faculty of Science, Burapha University (BU) and Faculty of Medical Science, Naresuan University (NU).

Personnel: Number, Education, Academic Position and Age

From all 13 departments, there were 168 staff and 51% of these were at CU and MU. The percentage of their educational background can be described as follows: Ph.D. (77%), M.Sc. (20%), B.Sc. (1.5%) and Certificate or Medical Board (1.5%). Their academic positions were Professor (5%), Associate Professor (39%), Assistant Professor (24%) and Lecturer (32%). The personnel categorized as teaching staff with different age range were 21-35 years old (young or new generation, 20%), 36-50 years old (middle-age generation, 47%) and 51-65 years old (senior generation, 33%). Interestingly, an analysis of the number of staff among these three generations of age ranges yielded a normal distribution profile with the majority of staff in the age range 41-55 years old. Notably, two-thirds of staff in the CU departments were of senior generation. It is also noted that academic staff with academic position of Assistant Professor and Lecturer constitute a major portion (56%) of the whole staff. Approximately 70% of the senior generation were Associate Professors, whereas 40% of the middle-age generation were Assistant Professors. Eighty five percent of the young generation were still Lecturers. Interestingly, 75% of both middle-age and senior generations were Ph.D. holders, whereas about 85% of the young generation were Ph.D.s. Despite the limited numbers in all departments, the academic staff had very good educational background with some having had postdoctoral training abroad. This is an important asset for strengthening the biochemical research and postgraduate study in these departments.

Budget for Academic and Research Affairs

The total budget and income from all departments of biochemistry in seven universities was valued at 162.54 million Baht for the period 1998-2004 and as average per person per year was valued at 153,000 Baht for expenses in teaching activities for bachelor degree, master degree and doctoral degree, both in the field of biochemistry and other related programs.

All Departments of Biochemistry received research funding from both the universities themselves and outside the university totaling 289 million Baht. This can be divided into 218 million Baht (external source) and 71 million Baht (internal source), i.e. the ratio of external source to internal source was 3:1. The

average amount of research funding that faculty members from seven universities received externally and internally was 191,000 Baht and 61,800 Baht per person each year, respectively. It is worth mentioning that MU and CU received support from external research fund amounting to 61% of the research fund received by all seven universities. In particular, the Department of Biochemistry, Faculty of Science at MU ranked first in the amount of external research funding. The ability to obtain research funds, especially from external sources, is somewhat related to the productivity in terms of the number of publications, i.e. MU and CU contributed about 65% of total publications from all seven universities produced during the same period (see later section).

Research Activity: Past Records, Present Status and Foresight

Research output

There were totally 323 research articles published by seven state universities (the ISI-WOS database, 1998-2004) [9] or 93% of total publications from Department of Biochemistry in all universities nationwide (346 articles). MU had the highest number accounting for 1.6 fold of that from CU, the second-ranked in publication output. As a whole, each Thai biochemist published approximately 0.28 international research publications per year, which was double the number published by the physical science researchers [10]. The first three Departments of Biochemistry having the highest productivity in terms of the number of research publications per person per year, were MU SCI, CU MED, KKU MED with values of 0.88, 0.53 and 0.40, respectively. With regard to the research funding mentioned in the previous section, the research expense for one paper to be published averaged about 900,000 Baht.

Research system and individual interests: strength and weakness of biochemistry in Thailand

Research in the field of biochemistry depends on the individual rather than on the system. There are some reasons/characteristics for the strength of biochemistry research in Thailand:

(1).There was a very high percentage of faculty members with Ph.D. degree (77% of total faculty members in department of biochemistry). These Ph.D.s were also the most productive (0.34 article/person/year) compared to those without Ph.D. degree, i.e., M.Sc. (0.17 article/person/year) and B.Sc. (no productivity).

(2).The middle-age generation of staff was the most productive (0.39 article/person/year) when compared to the senior (0.36 article/person/year) and young (0.05 article/person/year) generation staff. In addition, the number of middle-age generation staff represented about a half of the total staff.

(3). Even though faculty members having Professor position represent only about 5 % of total members, they were the most productive (2.1 articles/person/year) compared to those having other academic positions, i.e.Associate Professor (0.9 article/person/year), Assistant Professor and Lecturer (0.36 article/person/year).

(4). Thai biochemists published their papers in journals listed in the ISI-WOS database (1998-2004) with the average impact factor (IFa) of 2.141 which is comparable to the international standard using the ISI-WOS database (IFa = 2.292, an average for 261 journals in biochemistry and molecular biology discipline). Furthermore, these publications by Thai biochemists were cited on the average of 5.5 citations per article, and more importantly 37% of these papers were cited more than five times per article.

(5). Up to 68% of total articles involved the cooperation of at least two institutes. Two institutional collaborators comprised 55%. Co-authorships with foreign universities accounted for 37%.

(6). Most departments had Ph.D. curricula in biochemistry and related fields. This facilitates the production of critical mass of graduate students resulting in high output of publications.

(7). The academic staff in some departments combine to form research units/centers, which can be upgraded to Center of Excellence. This is an effective strategy to produce high quality publications.

(8). Biochemistry academic staff had high potential to obtain research funds from external organizations, including some prestigious overseas funding agencies such as Rockefeller Foundation, World Health Organization, NIH USA, and USAID, etc.

(9). Four out of 37 outstanding scientists, announced by Foundation for the Promotion of Science and Technology under the Patronage of His Majesty the King during 1982-2007, are Thai biochemists belonging to one department [11].

On the other hand, there are reasons/characteristics for the research weakness in our biochemistry community:

(1). The number of faculty members having publications in journals listed in the ISI-WOS database (1998-2004) represented only 40% of total members. This means that the majority of our staff had no such publications, reflecting weak research performance in these departments.

(2). Surprisingly, two-thirds of the research publications were from only nineteen academic staff, six of whom published ≥ 2 articles per person per year.

(3). The new generation staff, comprising 21% of total staff and having more percentage of Ph.D. background, produced only 5% of total publications in the ISI-WOS database (around 0.05 article per person each year).

These analyses indicate that the research strength and weakness in our biochemistry community relies upon individual interests. However, our study provides a linkage between strong academic staff and research activities, and lends further insights into the impact of Thai biochemists, which is comparable to the average impact of biochemistry and molecular biology category on the ISI-WOS database. In addition, the young generation should be encouraged to engage in active research with more publication output.

Research mapping and direction

As mentioned earlier, research depends on the individual Thai biochemist. Using the information on all publications, citations and particular keywords for mapping research areas, the top ten categories (% distribution) in research mapping were analyzed and found to be: (1) protein (23% of total papers), (2) human, (3) enzyme, (4) polymerase chain reaction, (5) cancer, (6) drugs, (7) liver, (8) malaria, (9) virus, (10) shrimp (7% of total papers). Analyzing the citations per paper in each category provides the impact or strength of each research map as shown in Table 2. Drugs, shrimp and malaria are the three top ranked research directions and areas of expertise for our Thai biochemistry community (Table 2).

In comparison with research publication topics in the Journal of Biological Chemistry (*J. Biol. Chem.*), the top ranked journal in biochemistry with the highest citations and number of publications in biochemistry and molecular biology category during 2002-2005 based on the Science Citation Index database[9], the topics of publication are categorized as shown in Table 3[12]. The top five ranks are summarized: (1) signal transduction, (2) membrane, (3) protein structure, (4) gene structure and regulation, and (5) cell and development biology. The international topics and trend of researches here are not related to research mapping of biochemistry in Thailand found in the present study (Table 2).

Table 3. Research publication topics classified in *J. Biol. Chem.* during 2003-2005 (data updated in 2006).

Rank	Topics	%
1	Signal transduction	20
2	Membrane (transport, functions, structure, biogenesis)	15
3	Protein structure	13
4	Gene structure and regulation	10
5	Cell and Development Biology	9
6	Protein synthesis	7
6	Enzyme catalysis	7
7	DNA replication, repair, recombination	6
8	Metabolism and Bioenergetics	4
9	RNA structure, catalysis	3
9	Glycoprotein	3
10	Lipids	2
11	Genomics, proteomics, bioinformatics	1

Research foresight on production of publications

During the past 10 years, researches in Departments of Biochemistry have been published in international journals indexed by the PubMed MEDLINE and the ISI-WOS databases. Table 4 shows number of publications searched by name of academic staff and research work addressed by the Thai departments of biochemistry in the ISI database during 1998-2004. The productivity of research output is calculated as number of papers per person per year. It should be noted that the efficiency and the productivity increased about twice every 5 years.

In the next 3-4 years, it can be expected that the productivity will be at least 150 articles per year published (Figure 1). This will enable, in 2007-2008, Departments of Biochemistry to publish 0.85-1 article per person per year, which is comparable to department

Table 2. Department of Biochemistry: research mapping, citations per paper of the top ten research category of articles published during 1998-2004 with 2,012 total citations (data updated in 2006).

Rank	Citations per paper	Category	Papers	%of total papers	Citations	% of total citations
1	10.4	Drugs	45	12	467	23
2	9.5	Shrimp	26	7	247	12
3	9.1	Malaria	39	11	353	18
4	8.9	Virus	33	9	293	15
5	6.2	Enzyme	71	19	439	22
6	5.8	PCR	65	18	375	19
7	5.3	Protein	85	23	451	22
8	4.8	Liver	43	12	208	10
9	4.5	Human	72	20	321	16
10	3.8	Cancer	47	13	158	8

Table 4. Departments of Biochemistry: number of articles published during 1998-2005 in the SCI ISI database (data update on 2006) and the expected output during 2006-2010 (italic numbers).

Year	Papers	Paper/person/year
1998	35	0.21
1999	42	0.25
2000	39	0.23
2001	43	0.26
2002	56	0.33
2003	75	0.45
2004	79	0.47
2005	84	0.50
2006	*100*	*0.60*
2007	*118*	*0.70*
2008	*134*	*0.80*
2009	*151*	*0.80*
2010	*168*	*1.0*

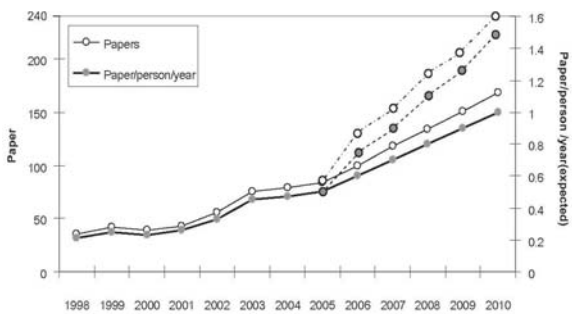

Fig 1. Department of Biochemistry: research foresight on publications. Progressive curve illustrating the output rate (total papers/year) and the productivity rate (paper/person/year) of papers published during 1998-2010 by Department of Biochemistry, Thailand. Solid lines= the forecast; broken lines = the foresight.

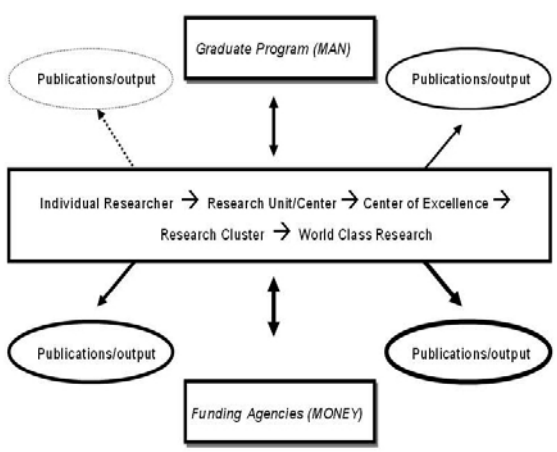

Fig 2. Strategic planning for development of biochemistry research in Thailand: integration of academic staff, graduate training and financial support to world class research in the near future.

MU SCI. This expectation is also dependent on the trend of research funding which is expected to increase, i.e., the Thailand Research Fund [13], the Commission on Higher Education [14] etc. Based on the information in 2005-2006 revealing that currently, departments MU SCI, CU MED and KKU MED have published more than one article/person/year, the above expectation can be met. Moreover, unless there are some unforeseen factors such as a decrease in research funding and graduate students [15], it is anticipated that MU may have a rate of publication in 2009-2010 equal to 0.85-1.0 article/person/year.

Research: Future Direction and Policy

By making site-visits, interviewing the chairperson, researchers and other staff (having research activity or not) in all departments, making research mapping of areas and expertise, we overview the research direction and the strategic planning for the future of Biochemistry in Thailand, as shown in Figure 2.

The strategies will be achieved by having both more research funding [13,14] and more graduate students training/programs [14,15] than in the past. This will generate novel research output, both in terms of publications and patents, for national development in terms of academic-industry co-operation and also for international competitiveness. This will be strengthened by the impact of national researchers in the biological and medical sciences [16]. In 2006, Thailand was ranked 46th (having 1,072 articles per year, ~0.13% of global publications) among selected 61 countries (mean = 11,788 articles per year), whereas Singapore was ranked 33rd (3,122 articles per year), being the first among the ASEAN countries. These results were ranked by the Institute for Management Development (IMD), Switzerland [17] which was obtained from the world competitiveness using number of scientific articles published by origin of author as an indicator, collected in year 2003 from the US National Science Foundation. USA was ranked at first in the world with 211,233 articles per year, accounting for ~25% of international publications. The results indicate that Thai researchers do not have high productivity, and have relatively low competitiveness in making contribution to scientific research.

Concluding Remarks

In general, Departments of Biochemistry in Thailand have high impact in research in some particular areas, e.g., drugs, protein, enzyme, etc., as measured by their individual publications in the ISI-WOS database. Publications by Thai biochemists have high impact comparable to the average impact factor of publication

in international journals of biochemistry and molecular biology category. There are many factors governing strength of their research; academic staff, graduate student training and funding support are predominant parameters. Weaknesses in research need further improvement with particular emphasis on more output from young generation staff. This study may serve as a model for other disciplines especially in science and technology.

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