

❖ **Project title: “Improving the quality and application of chitin-chitosan from fishery waste in Vietnam”**

❖ **Objectives:** the main objective of the research project is improving the quality and application of chitin-chitosan from fishery waste in Vietnam. The specific goals have been as follows:

- Data collecting on quality of chitin/chitosan produced in Vietnam
- Proposing a process to produce high quality chitin/chitosan, chitin/chitosan oligomers, water soluble chitosan.
- Development of application of purified chitin/chitosan, chitin/chitosan oligomers, water soluble chitosan in medicine and food technology.
- Protein recovery in the chitin/chitosan production and application of these proteins.
- Establishing research group on biopolymer at NTU, strengthening the cooperation between NTU and Norwegian universities in research and training.

❖ **Contents:**

- Characterization of shrimp by-products used in chitin/chitosan production; characterization of chitin/chitosan produced from shrimp by-products in Central and South of Vietnam.
- Study on production of specific chitosan, chitin/chitosan oligomer and water soluble chitosan.
- Chitin/chitosan purification
- Protein recovery in production of chitin/chitosan
- Application of these products in food technology and pharmacy.
- Commercialization these products.

❖ **Implementing group:**

No.	Name	Date of Birth	Gender	Responsibility
1.	Ngo Đang Nghia	1960	M	Leader
2.	Trang Si Trung	1971	M	Technical advisor
3.	Nguyen Cong Minh	1982	M	researcher
4.	Nguyen Thanh Son	1978	M	researcher
5.	Nguyen Nhu Thuong	1984	F	researcher
6.	Khong Trung Thang	1972	M	PhD student
7.	Ngo Thi Hoai Duong	1972	F	PhD student

8.	Nguyen Thi Ngoc Hoai	1987	F	Master student
9.	Dao Thi Tuyet Mai	1988	F	Master student

❖ **Results:**

- Has elaborately studied on the chemical compositions of shrimp by-products (White and Black tiger) in order to understand the value and to orient in more efficiently utilisation of these by-products. The data on ash content, mineral content (As, Cd, Pb, Cu, Zn, Hg, Fe, Se, Na, K), amino acid, protein content, moisture content of different part (head and shell) of two shrimp species have been collected.
- Characterization of the chitin extracted from the Vietnamese raw materials (White and Black tiger shrimp); determination of isolating condition to improve the quality of chitin produced from Vietnamese raw materials. The results showed that the chemical composition of head and shell from the two shrimp species was very similar. However, there were large differences between head and shell. The protein content of head was  $44.39 \pm 0.50$  and  $48.56 \pm 1.33$  of the dry weight in WS and BT, respectively, which was ca. 50% higher than in the shell. The chitin content of shell was  $27.37 \pm 1.82$  and  $29.29 \pm 1.78$  of the dry weight in WS and BT, respectively, which was more than 2.5 times higher than in the head. The amino acid contents of the proteins were similar for both species, and for head and shell, and with a profile that was suitable as a source for fish feed. Chitin has been extracted from shell and head of two species using very mild extracting conditions (HCl 0.25 M or 0.75M at room temperature; NaOH 2% or 3% at 75<sup>0</sup>C) targeting to ash content lower than 1 % and protein content lower than 1 %. The degree of acetylation of chitin (determined by NMR) are very high, 98-99 %. The weight average molecular weight of chitin (determined by intrinsic viscosity) is up to 1,000,000 Da. These results show that the chitin extracted from Vietnamese source is very high in quality. Because of pronounced differences in chemical composition between the head and the shell of two shrimp species, the isolating conditions are quite different. Therefore, the head and the shell should be treated separately in chitin isolation and protein recovery.
- The kinetics of de-N-acetylation of the chitin dimer as a model substance has been studied. This fundamental study will contribute to the knowledge of chitin/chitosan field. The <sup>1</sup>H NMR spectrum of GlcNAc<sub>2</sub> in 2.77 M deuterated sodium-hydroxide solution was assigned, and the deacetylation reaction followed directly by obtaining spectra as a function of time. The total deacetylation reaction rate was determined as a function the hydroxide ion concentration, showing for the first time that this de-N-acetylation reaction is second order with respect to this ion. The activation energy for the reaction (27 to 54<sup>0</sup> C) was determined to 114.4 and 98.6 kJ/mol at 2.77 and 5.5 M NaOD, respectively.
- A new chitosan and alginate gel system has been studied i.e i) a gel system of neutral water soluble chitosan and mannuronan oligomer mixture; ii) a gel system of poly mannuronan and chitosan oligomer mixture. The study focused on the gel strength as a function of the ratio of alginate oligomers to chitosan and chitosan oligomer to poly

mannuronan; of the starting pH and the final pH; of ionic strength of the solvent. The results proved that the chitosan/alginate oligomer mixture gel and the alginate/chitosan oligomer mixture gel are ionically cross-linked hydrogels and the match in length between charges of chitosan and alginate is very important influencing the strength of both types of gels.

- A combined process using Pepsin and HCl has been established to recover chitin from white shrimp shell. After treating for 2 hours with HCl 1% at room temperature and 16 hours with Pepsin at the ratio of 20U/g protein the protein residue of shrimp shell was reduced under 3% (by dry base). The total chemicals utilized and production time were minimized significantly in comparison with the customary procedure. Approximately 70% of chemicals (NaOH and HCl) and 25% of time have been saved. Moreover, the protein hydrolysate shows the antioxidant ability and has high nutritional quality. This study contributes to the database and foundation of a new technology which enables the concurrent recovery of protein and chitin, and reduce the environmental impacts by less chemical used and waste water.
- One reactor for chitin production at pilot scale has been designed and manufactured. The output of the reactor is about 25 – 30 kg of raw material/batch. Some pilot experiments have been run using lab scale process. The trial gave chitin with good quality as follows:

- ❖ Colour: better color than using lab scale process
- ❖ Protein content: 1.2 – 1.5 %
- ❖ Ash content: 0.9 – 1.1 %

The pilot trial obtained the initial success showing the ability to apply this technology in larger scale and technological transfer.

- A research group on chitin/chitosan has been established with advisors and PhD students as key persons. This group is a sustainable achievement from the Project together with specialized laboratory.
- The trial study in mixing the protein hydrolysate into animal feed could not be done because of lack of time and economic resources.

In conclusion, all activities of the research project cover the large scope from fundamental to applied study to chitin/chitosan industry in Vietnam. The content of the research project has contributed to solve scientific, technological and environmental issues. From these achievements, the Group will conduct other research projects applicable in industry.

❖ ***Papers published:***

- 1 paper published in international journals.
- 6 papers presented at international conferences
- 1 paper presented at an national conference
- 2 papers published in national journals

❖ **Training:**

The results of training activity is shown in following table

No.	Name	Date of Birth	Gender	Training level	Status
1.	Khong Trung Thang	1972	M	PhD	Planned to defend in June, 2013
2.	Ngo Thi Hoai Duong	1973	F	PhD	Planned to defend in July, 2013
3.	Nguyen Thi Hoai	1987	F	Master	Done
4.	Dao Thi Tuyet Mai	1988	F	Master	Done

❖ **Technology transfer:**

The research group has received some requests from enterprises and individuals for high quality chitin/chitosan as well as for cooperation in production of chitin/chitosan. One contract has been signed with Long Sinh company for two years (from 2011 to 2012) to produce chitin-chitosan in large scale and to cooperate in developing a new fertilizer formula containing chitosan for some kind of plants. The results achieved through the contract have opened further opportunities of cooperation in future.