

PROCEEDINGS OF THE SIXTH INDOCHINA CONFERENCE  
ON PHARMACEUTICAL SCIENCES



# PHARMA INDOCHINA VI

THE DEVELOPMENT OF INDOCHINA PHARMACY  
IN THE CONTEXT OF GLOBAL ECONOMIC RECESSION



DECEMBER 15-18, 2009

Hue college of Medicine and Pharmacy, Hue city, Vietnam



NHÀ XUẤT BẢN ĐẠI HỌC HUẾ

# HỘI NGHỊ KHOA HỌC DƯỢC ĐÔNG DƯƠNG LẦN THỨ VI

## Preface

It is our great pleasure to welcome all participants to the 6<sup>th</sup> Indochina Conference on Pharmaceutical Sciences, hosted by Hue College of Medicine and Pharmacy.

In the spirit of integration in our area of Asia and other countries, the exchange and collaboration in training and technological research between international Universities and Training Centers have been strengthened. In 1994, on initiative of Hanoi University of Pharmacy, Faculty of Pharmacy - Ho Chi Minh City University of Medicine and Pharmacy and Faculty of Pharmacy - University of Mahidol, Thailand, the scientific conferences, generally named Pharma Indochina, have been alternately conducted once per 2 years in Thailand and Vietnam. After 5 conferences, the Pharma Indochina always gets participants' interest that also affirms the integration of Vietnamese scientists.

## PHARMA INDOCHINA VI

Approved by the Rectors of participating Universities, the 6<sup>th</sup> Pharma Indochina Conference is now being hosted by Hue College of Medicine and Pharmacy - Vietnam.

The theme of the conference is **PHÁT TRIỂN NGÀNH DƯỢC ĐÔNG DƯƠNG TRONG TÌNH HÌNH SUY THOẢI KINH TẾ TOÀN CẦU**. The oral and poster presentations will be held in Vietnamese and English. The Conference was accepted. On this opportunity, I am happy to acknowledge new Faculties of Vietnamese Universities to be our new members and they will be able to conduct further Pharma Indochina Conferences.

With this degree of interest in the theme in Asia and other countries, I feel committed to making this conference a great success.

Warmly welcome to the 6<sup>th</sup> Indochina Conference on Pharmaceutical Sciences and hope you would have a wonderful stay in Hue city, a World Cultural Heritage.

**Từ ngày 15 đến ngày 18 tháng 12 năm 2009  
Tại thành phố Huế, Việt Nam**

**NHÀ XUẤT BẢN ĐẠI HỌC HUẾ  
NĂM 2009**

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# A FEASIBILITY STUDY OF SOLUBLE CHITOSAN PRODUCTION FROM THAI RAW MATERIAL RESOURCES FOR PHARMACEUTICAL AND COSMETIC INDUSTRIES

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## ABSTRACT

The soluble form of chitosan has market potential for being raw material in pharmaceutical and cosmetic industries. This study was proposed to study feasibility of soluble chitosan production in Thailand. Feasibility study was employed in the aspects of technical, marketing and financial analysis. Amount of wastes from fishery industries were adequate for all season production. No need for high technology investment since the process of production were fundamentally chemical and spray dried technique. Marketing analysis revealed a major customer was cosmetic industry. Financial analysis with the scenario of price level at 2,500 THB per kg and 17.4 million THB investment would have pay back period at 1.5 year with 24.2% internal rate of return. To set up a plant for soluble chitosan production in Thailand was feasible. Few limitation of low percent yield was found and need to be further developed.

**Key words:** chitosan salts; economic feasibility; financial feasibility; marketing feasibility; technical feasibility

## 1. BACKGROUND

Chitin is a polysaccharide found in the outer skeleton of insects, crabs, shrimps and lobsters and in the internal structures of invertebrates. It is the second most abundant organic compound next to cellulose. Chitin is a precursor of chitosan. Chitosan's structure is deacetylated chitin, a polymer of  $\beta(1-4)$  acetyl - D glucosamine. It has various uses in the cosmetic, pharmaceutical and medical industries [1-3].

Innovative development of chitosan applications are strongly related to chitosan forms. In terms of solubility, several researchers were succeed in solubility improvement by develop a salt form of chitosan. Drug delivery or controlled release may be improved by chitosan salts or soluble chitosan [4, 5]. They are also extend the usage in cosmetic industry. At present, soluble chitosan used in Thailand were imported from foreign countries. None of soluble chitosan was produced locally. The investment of soluble chitosan production in Thailand need feasibility information for making decision. This study was aimed to explore the feasibility in the aspects of technical, marketing and financial analysis.

## 2. MATERIALS AND METHOD

Feasibility assessment of soluble chitosan production was conducted in three aspects: market analysis, technical analysis, and financial analysis. Firstly, to forecast market size of soluble chitosan, supply and demand of insoluble chitosan were reviewed from secondary documents e.g. original articles, research reports, government statistics. Furthermore, review of pharmaceutical and cosmetic market situations, law and regulation and fundamental data of fishery industry also be performed. Representatives of Thai chitosan manufacturers participated in-dept interviews and provided their view points regarding potential of local production and trend of chitosan market. Secondly, technical analysis was done, focusing on process of soluble chitosan production, availability of raw materials, technology required, location of plant and other infrastructures of business, such as transportation and utilities. Process and technology of insoluble and soluble chitosan production were acquired from previous studies. Lastly, financial analysis was aimed to examine investment and return of such investment. Some financial assumptions were set, including price of soluble chitosan, capacity of plant for each year, turnover rate of current assets and liability, income tax

regulation according to BOI. Balance sheet, income statement, and statement of cash flow were projected for 5 years ahead. Analysis of financial statements and break-even point were evaluated. To capture an uncertainty of some factors in financial analysis, sensitivity analysis was performed by varying price of soluble chitosan and yield.

### 3. RESULTS AND DISCUSSIONS

#### Market analysis

Supply of chitosan in the world market was 6,667 tons in 2002. Market value was estimated as \$US 67 million. Japan was a major player in the global market. In Thailand, 27 chitosan manufacturers were established. Of those, only 3 companies sold chitosan in local market. The others were chitosan exporters. Local capacity of chitosan production was estimated 2.4 – 12 tons per year [6].

On demand side, half of chitosan in the world were consumed as food supplement. 5% of those were spent by cosmetic industry [6]. Needs for chitosan in Thailand were from agricultural industry as for growth accelerators, food industry as for food additives, pharmaceutical industry as for weight reduction food supplement and cosmetic industry as for skin care products, hair care products [6-9].

Price of chitosan in local market depend highly on chitosan grade or % deacetylation. For instance, price of food grade chitosan was 1,200 THB per kg, while pharmaceutical grade chitosan was sold for 30,000 THB per kg.

An estimation of size of soluble chitosan market was based on a scenario of high promotion of the novel product that can expand more application than insoluble chitosan. Double increasing usage and 75% increasing for new chitosan user, compared with insoluble market place only, were assumed. Approximation of soluble chitosan market size was 18,200 kg per year.

#### Technical analysis

Source of crustacean shells, a major raw material of chitosan production, was found abundantly in Thailand, due to positioning as a leader of shrimp exporters in the world. Waste from fishery industry can be gathered to chitosan producers by a long term contract for waste management. This system assures adequacy of shrimp shells for all seasons.

Process of soluble chitosan production has two main steps: first step, insoluble chitosan production, and second step is the step of chitosan salts or soluble chitosan production. Figure 1 shows a basic step of chitosan production [1, 10, 11]. Decalcification and deacetylation processes were simple chemical reactions. None of advance technology was used for this step. Caution of high corrosive acid and base solution should be considered.

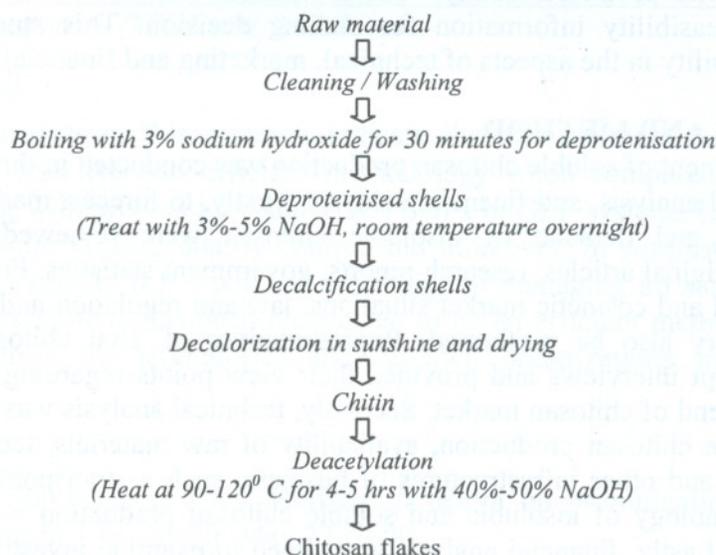


Figure 1. Illustration of the process

Step two, producing chitosan salts e.g chitosan aspartate, the process depends on a spray drier and its condition of spraying. So, this step needs investment for spray drier. Chitosan flakes were dissolved in an aqueous aspartic acid to make a solution. The solution was spray at a proper inlet temperature using spray drier. The obtained powder was soluble chitosan salts [4]. Glutamic, lactic or hydrochloric can be used as acid solution as well. Finish products should be examined quality by test of appearance, particle size, loss on drying, loss on ignition, pH, viscosity, degree of acetylation and heavy metal. At present, none of pilot plant or large scale production of soluble chitosan, the laboratory scale faced the problem of low yield. Thus development of higher yield should be further studied.

Selected location of production plant in the present study was nearby one of the center of fishery industry in Thailand, Samut sakorn province. The transportation infrastructure and other infrastructures e.g. electricity was fine.

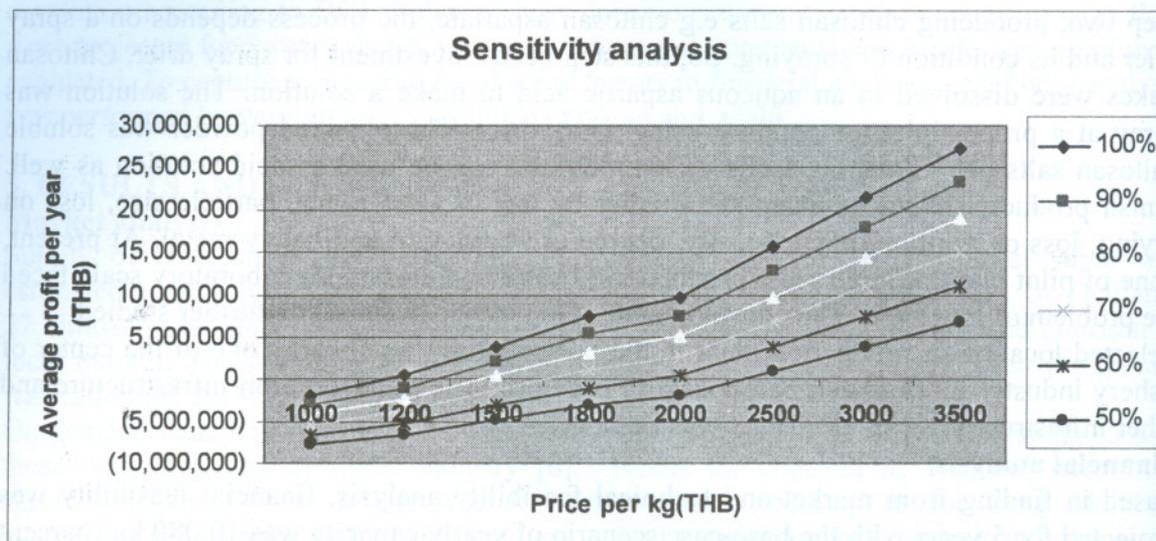
#### Financial analysis

Based in finding from market and technical feasibility analysis, financial feasibility was projected for 5 years with the base-case scenario of yearly capacity was 10,080 kg (percent yield = 80%) at the price level 2,500 THB per kg. Results of financial analysis was displayed in Table 1. It is indicated that 17.4 million THB investment would have pay back period at 1.5 year with 24.2% internal rate of return.

**Table 1.** Financial feasibility

Financial outputs		
Total investment	17,438,100	THB
Owner's investment	10,000,000	THB
Bank loan	7,438,100	THB
Working capital	1,800,000	THB
Average profit per year	9,775,515	THB
Pay back period	1.5	year
Internal rate of return	24.2%	
Break-even point ( unit of production)	14,825	kg
Break-even point ( sales)	36,361,268	THB

Sensitivity analysis of finance was performed by vary chitosan price and % yield. The finding indicated that at level of 50% yield, pricing of soluble chitosan should be 3,500 THB per kg to get the internal rate of return (IRR) 11%. If soluble chitosan yield increases to 80%, the price can be set at 2,500 THB per kg with IRR 24%. If the yield exceeds 80%, price level at 2,000 THB can be sold with the acceptable IRR. Moreover, focusing on average profit per year (Figure 2), the investor could select average profit level and determine the price level for each yield.



**Figure 2.** Average profit per year of various yield level

#### 4. CONCLUSION

To set up a plant for soluble chitosan production in Thailand was feasible. Potential market was found especially pharmaceutical and cosmetic industry. Process of production used only simple chemical technique. Investment of spray dry equipment is needed. Finance feasibility showed IRR 24% and payback period 1.5 year from 17 million THB investment. Few limitation of low percent yield was found and need to be further developed.

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