THE DEVELOPMENT OF HIGH PROTEIN NOODLE

FROM SOY BEAN FOR THAILAND

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SUMMARY

A high protein soya noodle made from soy flour has been developed for Thailand, where there was a report of protein malnutrition. Soy bean was considered as the cheap source of protein in terms of quantity and quality and availability in the country.

The product was first made of 75% full fat soy flour, 25% wheat flour, with vitamins and minerals supplemented; and 5.5% dried egg yolk added to complete the standard identification of egg noodle. The texture of the product was not satisfactory when a consumer test was carried out among 50 Thai students.

The texture of the product was improved by changing the recipe and improving the method of processing. The new recipe was 55% full fat soy flour, 10% low fat soy flour, 25% wheat flour and 10% rice flour, with an addition of 22.5 g. fresh whole egg per 100 g. of dry mix.

The proximate chemical composition including vitamins and minerals and the amino acid composition of the noodle were analysed. A daily dietary standard for a reference Thai man was proposed for the calculation of vitamin and mineral needed to be supplemented to the noodle. Thiamine and niacin were added to the noodle in the amount that 200 g. of dry soya noodle would provide half of the daily requirement of these two vitamins. Calcium was added in the form of calcium carbonate so that the ratio of calcium to phosphorus in the noodle was 1:1.

The amino acid pattern of soya noodle was compared with the FAO 1957 pattern and it was decided to add DL methionine to balance the amino acid pattern in soya noodle.

The destruction of trypsin inhibitor in soya noodle was investigated and it was found that steaming the noodle at atmospheric pressure for 20 mins. adequately destroyed the trypsin inhibitor and the remainder was completely destroyed after cooking the final noodle.

The method of processing was investigated and a method of obtaining a uniform destribution of ingredients and a better texture of the product by controlling mixing was found. Better colour, texture and rehydration property of noodle were obtained by varying the drying condition, to give a three period drying cycle.

The noodle was packed in saran coated paper bags, with the predicted storage life of about 126-140 days. An accelerated storage test was carried out, and it was found that at the equivalent storage condition of Thailand, the product became unacceptable due to browning in 96 days and the mould occurred in 150 days.

In the assessment of the protein quality of soya noodle, the determination of available amino acids and a chicken feeding trial were used. The availability of amino acid in dry soya noodle was very low and the weight gain of young chickens fed dry soya noodle after four weeks was about 35-50% of the weight gain of chickens fed reference protein (meat meal and butter milk powder). It would have been better if the experiment was carried out with cooked soya noodle as it was thought that

the trypsin inhibitor interfered with the intake.

A preliminary cost of production was also estimated. With the batch operation of 2,000 packages of soya noodle per day, the production cost per package was 1.15 bahts. The return on investment after tax was 46%. A consumer test should be done in Thailand, before the product is going to be marketed.

I. INTRODUCTION

The World Problem of Protein Malnutrition

Protein malnutrition is the major nutritional problem in the world. Protein-calorie deficiency occurs at all ages but the effects of it are greater in infants and young children. It is often called "Kwashiorkor" in which protein deficiency predominates with the absence of serious calorie deficiency, whereas "marasmus" is referred to as severe malnutrition caused by both calorie and protein deficiency (Altschul, 1965). Childhood malnutrition causes both retardation of physical growth and mental development.

F.A.O. (1965) reported that apart from the effect on growth, mild or moderate protein deficiency renders infants and young children particularly susceptible to respiratory and gastro-intestinal infections. The incidence of such disease is much higher in malnourished than in well-nourished children; mortality in the age groups 1 to 4 years is 20 to 50 times higher in the developing than in the developed countries and it is probable that the difference is due in large part to malnutrition. Besides this, among people with low incomes in developing countries there is a high prevalence of weanling diarrhoea, because of the combined effect of poor hygiene and protein deficiency.

Low protein intakes, often accompanied by low calorie intakes, occuring in adults in developing countries show only

a marginal deficiency, which is often seasonal or transient and does not cause obvious ill health unless it is complicated by acute or chronic disease. For pregnant women, the increase in body-weight during pregnancy observed in the women of low income groups in developing countries is often markedly less than that observed in well-nourished countries. Complications of pregnancy such as miscarriage, stillbirth or premature birth, seem to be more frequent in these situations. In the lactation period after pregnancy, although total protein content and amino acid composition of milk from malnourished mothers have not been found to be significantly different from those of milk from well-nourished mothers, there is evidence that in developing countries, the body-weights of women of low income groups may decrease progressively during the time they are feeding the baby.

The problem of protein deficiency arises from the uneven distribution of food supply among countries, within countries among families with different levels of income, and also within families, as a result of social, economic and cultural factors that limit the consumption of protein by vulnerable groups of thepopulation, even when the total supplies are adequate for the population as a whole.

A review of protein supplies for consumption in different regions of the world (Appendix I) shows the marked difference in the per capita protein supplied between the well developed and less developed regions. The amounts of protein supplied as vegetable protein are the same but, in contrast, protein supplied from animal sources is very much lower in the less developed regions where higher incidences of protein

malnutrition are reported.

The three main areas in which the protein-calorie deficiencies occur are Latin America, Africa and Asia. Most of the population in Latin America suffers from protein deficiency, and it is particularly prevalent and serious in children during weaning and post-weaning period. Foods which are adequate dietary sources of protein in quantity and quality are low in availability and the price is high. Large amounts of cereals are consumed especially corn, therefore, the diets are low in lysine, methionine and tryptophane content. (Bressani, 1966).

As Sai (1966) reported, although actual production figures in terms of available protein may be high in Africa, regional distribution may be so poor that some areas may be short. Much of the protein comes from cereals, especially maize, millets and sorghum, and in the wetter areas, from root crops and starchy fruits. Because of the poor storage, processing and marketing about 10 to 30 percent of the total production is wasted. Even where enough protein enters the family menu, the distribution may be such that the children may not have their fair share. Firstly, it is not generally realised that for his size a child needs more of everything than adults. Secondly, the order of meals requires the menfolk to eat first, and by the time it is the turn for the children and women to eat, there is very little left. This results in a high mortality rate in the children aged between 6 months through to 4 years. With a death rate of 20 to 50 percent of children with protein malnutrition there will be 5,000 deaths per million population per annum and protein malnutrition will account for 15 to 20 percent of all deaths under 5 years old.

Ahmad (1966) reported that in Asia, a study of the distribution of calorie supply in relation to the requirement for calories of the population has shown that at least one-fifth and possibly more of the people in this region go hungry, and protein-calorie under-nutrition is the most important problem impeding health and economic development. From data of food consumption (Appendix II), 60-80 percent of calories are supplied by cereals. Both total protein and animal protein consumption are low in comparison to the United States and United Kingdom. When protein is poor in both quantity and quality, the children who require most protein are likely to suffer, and in Asia, children up to the age of 14 constitute 38.2 percent of the population. Mortality rate of the children aged 1 to 4 is high in Asia, 11 per 1000 in Thailand, 33 in South India, 88 in East Pakistan as compared with 1 . 1 in U.S.A.

According to the 1963 F.A.O. Third World Food Survey, it was estimated that at least 20 percent of the population of the less developed areas was undernourished and that some 60 percent received diets inadequate in nutritional quality. For the world as a whole, it was concluded that 10 to 15 percent of the people were undernourished and nearly half suffered from hunger and/or malnutrition.

If the population grows according to the United Nations medium projection, the world's total food supply would have to be trebled by the year 2000 in order to provide a reasonably adequate level of nutrition. For the less developed areas, total food supplies would have to be quadrupled and the supplies of animal products would have to be raised to nine times the

present volume (F.A.O. 1967b).

But since the time of the Third World Food Survey, increase in food production has failed to keep pace with population growth. In Asia, Africa and Latin America, the population is increasing at a rate of from 2.5 to more than 3 percent per annum. The average rate of increase in food production from 1958 to 1965 was 2 percent per annum, with a reduction in the last four years of this period to about 1 percent. An increase of at least 3 percent per annum in food production will be needed to keep up with population expansion (U.S.President's Science Report, 1967).

While animal protein resources are rising in the developed countries, in the developing countries the total per capita protein supply has declined by about 6 percent since World War II, with increased dependence on protein from grain (Abbott, 1966). Therefore the other protein resources, apart from animal protein, must be developed to meet the nutritional needs of the population throughout the world.

The Situation of Protein Deficiency and Protein Supply in Thailand

Background. Thailand, a tropical country in South East Asia, had in 1967 a population of 32,452,000 of which 16,257,000 were males and 16,195,000 females; and over 40 percent of the total population were children under 14 years of age (Bhumiratana and Nondasuta, 1968).

Thailand is geographically divided into four parts, Northern, Central, North Eastern and Southern, and has a total area of 514,000 sq.kms.

Much of the North and East, which includes about three-fifths of the total area and more than half of the population, cannot be used for agriculture because of the mountainous character of the terrain. In the East, the additional problem of scanty rainfall limits the arable areas to small valleys that can be irrigated. Most of the agricultural area is in the delta region or central part of Thailand. Rice is the most important crop, with 78 per cent of total harvested area devoted to paddy rice. The Southern part of the country, where there is plenty of rainfall, is the main source of fish supply. Because of the agricultural difficulties, people in the North and North East regions are more likely to suffer from malnutrition than the other regions.

Kwashiorkor in Thailand. In 1955, Netrasiri and Netrasiri, as reported by Thanangkul et al (1966), said that there were fifty-four cases of kwashiorkor in Bangkok over a four year period. In one half of these cases, the disease occurred in one to two year old children.

According to Valyasevi (1964), kwashiorkor was reported in Bangkok, and also from hospitals in Northern, North Eastern, and other regions of Thailand. It has been estimated that for every case of reported kwashiorkor, there will be 100 cases of protein malnutrition, so the problem is much greater than these figures suggest.

In a recent report of Thanangkul et al (1966), there were one hundred and eleven patients with protein-calorie malnutrition admitted to Chienmai Hospital (Northern region of Thailand) from January 1 to December 31, 1964. Among this number, forty-nine children suffered from third degree protein-calorie

malnutrition with edema (kwashiorkor), fifty-one with third degree protein-calorie malnutrition without edema but with severe dehydration (marasmus) and only nine with second degree protein-calorie malnutrition (weight about 60-75 percent of normal weight). Those children who had third degree malnutrition with edema (kwashiorkor) were chronically and seriously ill. They showed weakness with inability to sit up, weak cry, irritability and lack of interest in surroundings and food. Muscle wasting and growth retardation were marked. Those who suffered without edema were extremely thin, weak, showed lack of appetite, were dehydrated and sometimes apathetic or irritable. There was marked muscle wasting and growth retardation. Twenty-seven deaths have been reported. Of the one hundred and eleven patients, 88 percent were between the ages of six months and four years, with the greatest number of the children between the ages of one and three years. The lack of transportation facilities and the inaccessibility of the outlying villages make it difficult to bring children to the hospital, and therefore it is likely that more children than reported by the hospital suffer from protein deficiency diseases.

Protein consumption in the past and present. There is a rather limited amount of information as there were only a few dietary surveys in Thailand between 1953 and 1957, and in 1963 as in Appendices III and IV, and one in 1960 (ICNND, 1960). The diet consists mostly of rice and glutaneous rice with some kind of vegetable and very little animal food, as summarised in Table I.

Table I. Summary of Thais Dietary Intake.

Area	Percentage of Total Intake		
	Animal Food	Rice and Starchy Food	Other Food
Bangkok (Chandapanon, 1955)	27.2	48.2	24.6
Uborn	12.6	72.0	16.4
Udorn	9.2	80.0	10.8
Chiengmai	5.4	69.0	25.6
Chiengrai (Bisolyyaputra, 1957)	4.8	72.0	23.2
Chonburi (Bisolyyaputra, 1953)	11.2	65.7	23.1

Area	Net Food Supply per Capita		
	Total Calorie k.cal	Total Protein g.	Animal Protein g.
Bangkok (Chandapanon, 1955)	1409	47.0	23.9
Uborn	2099	49.3	10.2
Udorn	1826	42.0	8.6
Chiengmai	2232	52.7	9.3
Chiengrai (Bisolyyaputra, 1957)	2207	47.0	7.2
Chonburi (Bisolyyaputra, 1953)	1746	48.0	15.0

The calorie intake of Bangkok and Chonburi is rather low in comparison with other parts of the country; this is due to lower consumption of rice and starchy food. Animal protein intake is high which is due to higher consumption of meat and meat products in Bangkok and fish and fish products in Chonburi.

In chiengmai and Chiengrai, almost all of the rice is glutaneous rice, which is soaked overnight in water that is discarded before steaming the next day. Large quantities of this nutritionally depleted rice are eaten with small portions of fried pork, beef, chicken and fish, primarily to give flavour to the rice. Vegetables and pulses are the main source of protein in the diet. Because of the low intake of animal protein in the diet and the traditional way of cooking, people in this area often suffer from protein malnutrition, beri beri and goitre (ICNND, 1960).

The main sources of animal protein of the North East are fresh water fish, frogs, and fermented fish products. Fruit and vegetables are rarely eaten. People in this area suffer from vitamin and mineral deficiencies as well as protein malnutrition. A high incidence of bladder stone disease is reported in this region. (Valyasevi et al, 1967).

The food consumption pattern has changed since 1957. In the North East, take Uborn as an example, the total calories decreased from 2099 (Bisolyyaputra, 1957) to 1743-1877 (Valyasevi, et al 1967). There was an increase of protein consumption, especially animal protein. The total protein intake in 1963 was about 10 percent higher than 1957 and animal protein intake was doubled.

Although there was an increase in animal protein consumption, the average daily protein intake of the North East population was

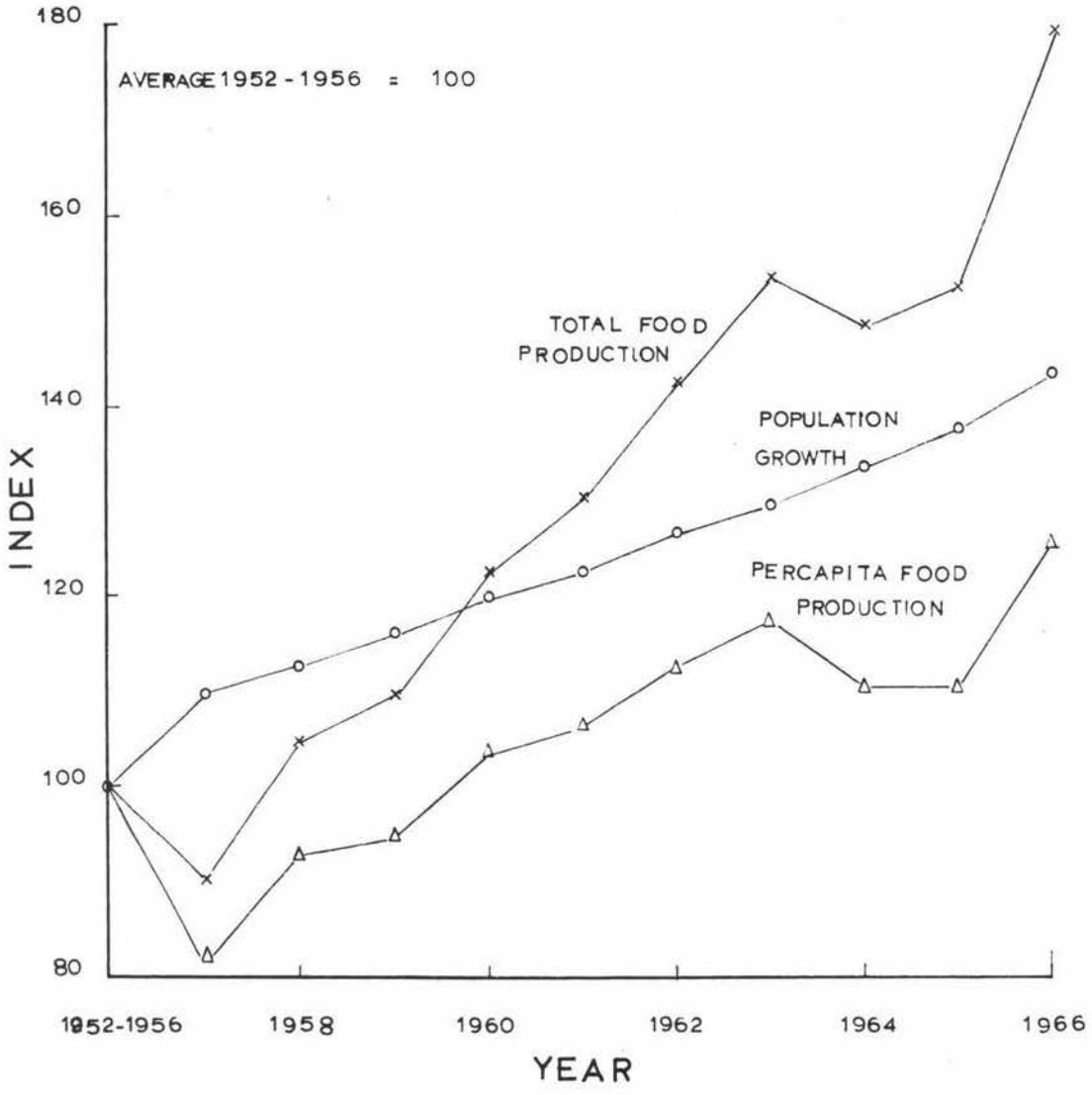

Figure 1 Trends in Food Production and Populatior in Thailand

(FAO , 1967)

still low. According to Bhumiratana and Nondasuta (1968), the protein intake from the result of the 1966 dietary surveys in the North East figures were 1.1 * 0.2 g/kg body weight/day. If we assume that the low income families had daily protein intakes of less than one standard deviation below the mean, then they were living on 0.9 g/kg body weight, or less, per day. The protein intake per kg body weight of a pre-school child is considered to be the same as or less than that of the adult because the eating pattern of rural Thais allows no extra share of protein in favour of the children. The protein requirements of children and adults are between 0.7-0.9 g/kg body weight per day for the reference protein (NPU = 100) (F.A.O. 1965). Because of the low quality of protein intake, the daily protein requirement should be double. This i.e. 1.4-1.8 g/kg body weight per day, and therefore there is a lack of protein in the North Eastern diet.

To increase the protein intake of the population, both quantitatively and qualitatively, major high quality protein sources should be developed.

Population growth and agricultural production. The population in Thailand is increasing at the same rate as the average for Asian countries, 3 percent per annum. The rate of food production is increasing at a rate higher than the population growth - 4.8 per cent per annum (United Nations, 1964).

Although the country seems to have been able to keep total food production well ahead of population growth (Figure 1), the increasing of protein food supplies may not be able to keep pace with the increasing population. Therefore the problem of protein malnutrition in Thailand may arise from this difficulty in

increasing total protein food production, together with the uneven distribution of protein food supplies in the country. The sources of protein food supplies should be investigated.

1. Cereal protein:

Rice and corn are the two important cereal products in Thailand. The total consumption of rice in 1963 was 3.4 million tons and projected to 1985 is 6.6 million tons. Total production in 1963 was 9 million tons and in 1967 was 11 million tons (F.A.O. 1967a). There will be plenty of rice to feed the increasing population even if the amount of consumption were doubled to increase the protein level in the diet. At the present time, there is a large amount exported. Corn production has shown an important expansion, from 68 thousand metric tons in 1952-1956 to 665 thousand metric tons in 1962, and nearly double the production of 1962 in 1966. Most of the production is exported as animal feeding stuff (F.A.O. 1967a).

2. Legume protein:

Peanuts, mungbeans and soybeans are the main sources of legume protein produced in Thailand. From the F.A.O. production year book of 1967, the production of peanuts increased from 88 thousand metric tons in 1956 to 130 thousand metric tons in 1966. Although mungbeans are not included in the government project to expand agricultural production as are corn and soybeans, the production of mungbeans has been increasing rapidly. The production in 1966 was about 130 thousand tons which was four times the production of 1953 (Bhumiratana and Nondasuta, 1968). Soybeans are used for numerous food preparations, and in particular the demand for soybean oil is now increasing. The number of vegetable oil extraction mills being established has resulted in a big requirement for soybeans. Between 1950 and 1963 acreage rose and production

expanded. However, production fell off from a 1963 high of 33,000 metric tons to 19,200 metric tons in 1965 (F.A.O. 1967a). There appears to be some doubt as to the accuracy of these statistics, as according to the agricultural statistics of the Thai Ministry of Agriculture, the production of soybean in 1966 was 37,900 tons (Bhumiratana and Nondasuta, 1968) and the government intends to produce 50 thousand tons in 1971 (Polgraigriongrild, 1968).

3. Animal protein:

Only a small percentage of animal protein is consumed in the country. Cattle, swine and buffalo production have remained stable since 1962 and there was also a reduction in the number of animals exported. There was an increase in poultry production from 1950 to 1965, but since then the production remained stable (F.A.O. 1967a).

4. Fish:

In the past ten years, the total catch has risen about 10 times, from 196.3 thousand tons in 1958 to 847.2 thousand tons in 1967 and 1089 thousand tons in 1968. Fifty percent of the total catch is marketed as fresh fish and 48 percent are used for miscellaneous purposes. From 1966 to 1968 the amount of exported and imported fish remained stable, and therefore there is an increase of fish consumption in the country (F.A.O. Fishery Statistic, 1968).

Because of the shortage of animals, the only possible sources of protein for development of protein rich foods are vegetables and fish.

Although the amount of fish is increasing every year, fish is

caught mainly in the Southern part of Thailand. Even if a factory is set up there, because of the cold storage and transportation costs, the price of the product will be too high for the low income group of people in the North and North East. Therefore, fish was excluded in considering a source of protein for the development of high protein products.

In cereals, although a new high protein content variety of rice and corn has been developed, the protein content is still low when comparing it with other vegetable protein sources such as legume protein. It is unlikely that the proportion contributed by cereal to the population's protein supply can be increased, as there is a limit to the amount of such relatively bulky food that a person can consume, especially children.

Only legume protein remains as a possible source. In comparing peanuts, mungbeans and soybeans, the production of peanuts and mungbeans is about four times higher than the production of soybeans. Prices per ton of peanuts, mungbeans and soybeans are 5,500, 2,500 and 2,500 bahts respectively. (Bhumiratana and Nondasuta, 1968). The protein content of peanuts and soybeans is 27 and 42 percent respectively (Milner, 1966) and the protein content of mungbeans is 21.1 percent (Bhumiratana and Nondasuta, 1968). Although the production figure for soybeans is lower than that of peanuts and mungbeans, soybeans are the cheapest souce of protein in terms of cost per protein unit.

On comparing the amino acid pattern in the proteins (g.amino acid per 16 g.N) of peanuts, mungbeans and soybeans as in Appendix V, the amino acid pattern of soybeans is better than

that of peanuts in having a higher tryptophan and lysine content, but is slightly inferior to that of mungbeans in having a slightly lower proportion of all the essential amino acid content. However the protein content of soybeans is about double that of mungbeans, so the percentage of individual amino acids in soybeans will be nearly double that of mungbeans.

Soybeans have been used more extensively in food production than peanuts and mungbeans. The drawback of soybeans is that their use is limited by the bitter flavour of the mature bean, which is not easily removed. By careful searching for the proper method of processing, soybeans could be used as an excellent protein source in the future.

Moreover, the area of soybean production is found mainly in Sukhothai which is situated in the central plain and the Northern part of Thailand and in Cheingmai which is in the North. If a factory is set up there where the raw material is most abundant, it will be easy to distribute the product to other Northern areas, and Central and North East areas. The additional cost on the product due to transport will be low.

For the reasons of the high protein and amino acid content, low price, extensive uses and suitable production location soybeans were chosen as a protein source for development of high protein food.