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PRODUCTION, ACCEPTABILITY, AND NUTRITION ASPECTS OF SOY BEVERAGES IN THE PHILIPPINES

by

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Text of a lecture given at the meeting on "Potentials for Soy Beverages in the Philippines" at the Continuing Education Center, U. P. College of Agriculture on Friday, Jan. 29, 1971

INTRODUCTION

The most frequent nutritional deficiency in developing countries is that of protein. The diet of a large proportion of the population in these countries is deficient in both quantity and quality of protein. The effects of protein deficiency are most acute in young children. In extreme cases it appears as the disease kwashiorkor and sometimes as marasmus. But there are countless children in whom the protein deficiency is not severe enough to be manifested in the clinical symptoms of these diseases. Their malnourishment appears in the form of stunted growth and listlessness, a very high mortality rate for their age group, and physical and mental development that is well below their potential. The incidence of inadequate protein in the Philippine diet and the effect that the deficiency has on the health and well-being of children has been well documented, and it is unnecessary to labor the point at this time.

As a result of this grave deficiency of protein in the diet, there has been an intensive search by many groups for protein foods that will help bridge the gap between protein supply and protein need. Since the majority of the population are in the low income bracket, it is essential that the cost be low in order to be within the reach of their purchasing power. In addition to low cost, the protein food must be acceptable, that is, the people must enjoy consuming it strongly enough to want to consume it regularly. It is not sufficient to bring food to hungry or malnourished people and tell them to eat it because it is good for them. It is part of the perverseness of humans that they will refuse to eat that food unless it pleases the palate. Almost all potential sources of low cost protein have been examined in an attempt to ameliorate the problem of protein deficiency. This is the correct approach. No one single food will remedy the shortage. Every possible source of protein should be utilized because each one can make a contribution to the solution of the total protein problem.

The soybean is high on the list of potential sources of low cost protein. It is an excellent source of protein, its protein content is high; the protein quality is very good, and the soybean is cheap. In the Philippines the soybean provides the cheapest source of protein available among the usual foods. Table 1 shows that the soybean provides almost twice as much protein per peso as its nearest competitor, mungbeans; and nineteen times more protein per peso than pork.

On the basis of cost the soybean should be a major contributor towards bridging the protein gap. Unfortunately it makes a minor contribution and the reason for this is easy to find. Soybeans have a low acceptability. They are not very appetizing to most people, and consequently the consumption of soybeans is very small.

Table 1. Comparison of Soybean with other protein sources in the Philippines

Food	grams protein per kilo (as purchased)	grams protein per peso (as purchased)
Soybean	391	559
mungbean	244	287
maize	87	263
peanut (shelled)	256	213
dried shrimp	524	210
rice	74	123
skim milk powder	360	115
bread	101	101
pork	102	29
sweet potato	5	21

(based on prices at Bayambang, Philippines. Jan.-June 1965.)
(Above data taken from, "The Health Aspects of Food and Nutrition", published by World Health Organization Western Pacific Regional Office, Manila, 1969, pp. 24, 25)

One of the easiest products to make from soybean is the water extract of the dry mature bean which is commonly called soymilk. In this process, the mature soybeans are soaked in water for several hours, then ground to a fine state with water, and filtered to remove insoluble constituents. The water extract is a milky looking liquid that contains about 80% of the protein and about 60% of the fat of the bean. Soymilk is nutritious, easy to make, and cheap. The Chinese discovered the process about two thousand years ago. It looks as though soymilk should be a major contributor to the protein-calorie malnutrition of tropical countries. The problem however, is that soymilk has always had a strong flavor. The Chinese seem to like this flavor, but most non-Chinese find this flavor very disagreeable. We usually call this the "beany" flavor of soymilk.

About ten years ago the Food Technology group at Cornell University under the leadership of Dr. D. B. Hand became interested in the soybean as a rich source of low-cost protein. They quickly came to the conclusion that soymilk provided a good vehicle to bring a nutritious, low cost protein food to people in the developing countries but that the bad flavor of soymilk was the principal obstacle to its widespread acceptance. A lengthy study of the chemistry, biochemistry and nutritional value of the soybean was initiated. In 1967 the Office of War-on-Hunger of the U. S. Agency for International Development supported this research program with a grant which enabled the tempo of the research to be greatly increased. When Dr. Hand retired, Dr. W. B. Robinson became the Director of the team working on this project.

One member of the Cornell team, Dr. K. H. Steinkraus, who was Associate Director of the project, came to Los Baños in 1967 and initiated an important section of the research program, namely to develop a product under Philippine conditions that was highly acceptable to the Philippine palate. Under the capable leadership of Dr. Steinkraus, a research program was started, and a pilot plant for making soymilk was established in temporary quarters in the Agricultural Chemistry building. Dr. Steinkraus and his group conducted acceptability studies with 6th grade Filipino children in several schools in this area. In this study they found that it was necessary to add sugar to the soymilk in order to make it acceptable to Filipino schoolchildren and that 7% sugar was the optimum level. They found that the addition of vanilla flavoring improved acceptability. Ninety five per cent of the children said they liked a formulation containing 7% sugar with added vanilla flavoring. The addition of chocolate flavoring increased acceptability to 96%. Dr. Steinkraus and the group in Los Baños also found that 5% coconut milk incorporated into soymilk containing 9% sugar made a good product with a 96% acceptability. Soymilk frozen in plastic bags in 60 ml. portions was very acceptable to the children as an ice candy. These results have been reported in detail in the Philippine Agriculturist. (Steinkraus, et. al. 1968)

Dr. Bourne took Dr. Steinkraus' place as leader of the Los Baños group when Dr. Steinkraus returned to Cornell in June 1969 and continued the research program that had been established in Los Baños.

The group at Cornell University discovered the source and nature of the strong beany flavor of soymilk by means of modern sophisticated chemical techniques, (Wilkens, Mattick and Hand 1967; Mattick and Hand 1969). It was found that the enzyme lipoxidase, which is naturally present in the soybean, was the cause of the trouble. The beany flavor is not present in the intact bean but as soon as the soybean is ground with water the lipoxidase acts on the unsaturated fatty acid chains producing a large number of smaller molecular weight compounds. Eighty volatile compounds were isolated from soymilk and 41 of them were identified. At least 31 of these volatile compounds have some flavor impact, and with few exceptions, the flavor of the compound is unpleasant. One compound in particular has typical "beany" note. This is ethyl vinyl ketone. The addition of 5 ppm of ethyl vinyl ketone to a bland flavored milk imparts a distinct "beany" flavor note.

The problem was, how to inactivate the lipoxidase before it caused flavor damage. Heating the milk immediately after grinding did not work because the lipoxidase acted so rapidly that the beany flavor was evident no matter how quickly the milk was heated. Heating the beans before grinding inactivated the lipoxidase and solved the flavor problem, but it also rendered the protein insoluble, thus giving almost no yield of true milk. After many trials the

answer to the problem was found, and it proved to be a very simple solution. Instead of grinding the beans with water at ambient temperature, beans were ground with boiling water. This simple modification of a centuries-old technique inactivates the lipoxidase before it produces the bad flavor, and at the same time it brings the protein into solution before it is rendered insoluble by the heat.

The so called "boiling water" grind produces a soymilk that is bland and pleasant tasting. The objectionable beany flavor is missing providing the temperature is always maintained above 80°C (180°F) throughout the grinding process. A faint pleasant odor and taste is present that resembles cooked cereals. Only one volatile compound can be isolated from soymilk made by the boiling water grind method, and this compound has a mildly pleasant flavor.

The boiling water grind technique has not been patented. It is available free, and without license to any interested party. The detailed procedure that is used for making soymilk in the Los Baños pilot plant is available as a mimeo handout that will be given to any person on request. It is attached to this report as Appendix B.

The USAID research contract to Cornell has now expired. Certain aspects of the research program are being continued at Cornell although at a slower rate than previously when the AID contract was in force. At Los Baños, the research program on soy beverages is being continued for the time being as a Ford Foundation sponsored UPCO research project.

ACCEPTABILITY OF SOYMILK

Dr. Steinkraus laid the foundation for acceptability studies in the Philippines during his tenure at Los Baños. These results have already been discussed. They showed conclusively that soymilk could be formulated into a beverage that is highly acceptable to the palate of the Filipino. Work that has continued since has confirmed Steinkraus' work, and we now have a standard formula for soymilk made at Los Baños (Puertollano, et. al. 1971). A chocolate formulation has also been developed. Both formulas are based on grinding 1 kg. dry mature soybeans with 10 kg. water at a temperature above 80°C and filtering.

Table 2. Formula for standard Soy Beverages Made at Los Baños

Ingredient	Standard Soymilk	Chocolate
sugar	7%	9%
sodium hydroxide	0.02%	0.02%
vanilla essence	20 ppm	100 ppm
salt	0	.05%
cocoa powder	0	1%

In an extensive study at the Anos Elementary School, Laguna, using every child in the school and giving each child a whole bottle of soymilk at each session, it was found that the standard soymilk was liked by 84% of the children if served at ambient temperature and 89% when served cold. A chocolate formulation was liked by 90% of the children when served at ambient temperature.

The standard formula soymilk has been given to groups of adults who have heard a lecture on the subject or who have visited the College of Agriculture at Los Baños. In each case they were asked to fill in a score sheet expressing whether they liked or disliked the beverage. The number of adults who liked the beverage ranged from 79% to 96%. Although the tests with the adults were not conduc ed under the same rigorous experimental conditions as with the child ren, it does show that on a sample size of several hundred adult Filipinos, a majority like the product.

The figure of 96% acceptability was obtained on two occasions under what might be called ideal circumstances. One hot afternoon a group of a more than 100 student nurses from Manila visited the campus. They came to us late in the afternoon, hot and thirsty. Being nurses they were very nutrition conscious. After a short talk about soy beverages they were each given a chilled bottle of soymilk. Ninety six per cent liked the product. On another occasion, chilled bottles of soymilk were given to 27 graduate students in nutrition at U.P. Diliman. All except one scored the product as likeable; a rate of 96% acceptability. These two cases should be looked upon as exceptionally high. The majority of the adult groups gave a per cent acceptability score in the low 80's.

AVENUES FOR USING SOYMILK

Soy beverages can be formulated in different ways:

1. as a light refreshing beverage similar to carbonated beverages. This product is sterilized in bottles. It has a shelf life of approximately 6 months at Los Baños.

2. as a heavier, milk-like drink. This can be sterilized in bottles or distributed fresh each day as refrigerated product. Distribution of the fresh product, and its shelf life would be similar to that of pasteurized cow's milk.

3. as a basis for various flavored drinks.

4. as a substitute for imported milk powder in manufactured foods, in order to save foreign exchange.

5. special dietary foods: baby formulations, weaning foods, dietetic foods, etc.

6. as a medium to tone the high fat content carabao milk without reducing its protein content.

In my opinion there is a fertile field for product development using the water extract of soybeans as a base. With the beany flavor absent, the soymilk can be formulated in many different flavorings, according to the desires of the manufacturer and the needs of the market. I believe that the main responsibility with soy beverages has moved from being a problem in basic research into a problem of product development and marketing.

Another area that needs to be studied is that of nutritional fortification of soybeverages. The Philippine diet is deficient in other factors besides protein. A commercial organization might well consult with nutritionists about the desirability of adding certain vitamins and minerals to soybeverages in the Philippines. The Los Baños group is willing to help with the technology of nutritional fortification once an authoritative decision has been made as to which particular minor nutrients are needed, and what would be a desirable level of addition.

The addition of edible oil to the soymilk also needs to be considered. The acceptability at the Anos elementary school showed that the addition of 2% coconut oil followed by homogenization made almost no difference to acceptability. (83.2% without oil compared with 84.6% with oil.) Adult Filipinos also gave almost identical scores for soymilk with and without added fat. In contrast to this, Americans show a strong preference for the product with the added fat. There may be a nutritional justification for adding fat to soybeverages, and if there is, we know that it will make almost no change in acceptability to Filipinos.

SOYBEAN VARIETY

A variety evaluation study is currently in progress at Los Baños. Sixteen varieties of soybeans from the Bureau of Plant Industry and fourteen varieties from the U.P. College of Agriculture are being made into soymilk using a standard procedure and a bean to water ratio of 1 to 10. Each one of these varieties was grown in the Philippines. The soybeans, and the soymilk are being subjected to proximate analysis. A brief summary of the results obtained on 16 varieties is given below.

Table 3. Proximate Analysis of 16 varieties of Philippine Soybeans.

	Average	Highest Value	Lowest Value
Soybeans (as is basis)			
protein content %	34.3	36.2	28.5
fat content %	19.4	22.6	16.7
Soymilk (as is basis)			
protein %	2.86	3.55	2.45
fat %	1.15	1.32	0.99
Insoluble Residue (dry basis)			
protein %	23.4	28.1	18.2
fat %	12.8	17.6	10.3
Protein Extractability (% protein of bean that enters milk)	84.1	93.1	74.7
Fat Extractability (% fat in bean that enters milk)	60.7	67.9	50.0

Soymilks made from these varieties have been screened for flavor by a trained adult taste panel in the laboratory. Fourteen of the 16 varieties so far tested were rated very acceptable in flavor quality but two varieties produced milks that were significantly lower in acceptability. This evidence, (which is not yet complete) indicates that most soybean varieties will make a very acceptable soy beverage. When this study has been completed the results will be submitted for publication in the Philippine Agriculturist.

I am often asked why we concentrate our attention on soybeans and is it possible to make a protein beverage from other common beans. The answer to this question is that the soybean is entirely different in its nature and composition from other beans. Following table contrasts soybeans with other beans.

Table 4. Comparison of soybeans with common dry beans

	Soybeans	Regular beans (navy, kidney, etc.)	Mungo beans
Botanical name:	*Glycine max*	*Phaseolus vulgaris*	*Phaseolus aureus*, *Roxb.*
Protein	30-40%	16-23%	24.4%
Fat	18-21	1-3	1.0
Starch	0	60-65	64.6

The soybean contains about twice the protein and ten times the fat of common beans and no starch while the common beans are about two thirds starch. The common beans have an important role to play in increasing the protein intake in the Philippines, and they should be used more extensively, but they do not lend themselves to the making of protein beverages as easily or as economically as the soybean.

NUTRITIONAL VALUE OF SOY BEVERAGES

When soymilk is made with a bean to water ratio of 1/10, the protein content of the extract will normally be fairly close to 3.0%. This compares with an average protein content of 3.3% for cows milk. The protein content will of course vary from this average value depending on the protein content of the soybeans that are used. Soybeans with a low protein content will not yield as high a protein content beverage as soybeans with a high protein content.

The other important factor affecting protein content of the beverage is the bean to water ratio. The Cornell and Los Baños groups have used a 1 to 10 ratio because this gives a product with a reasonable protein content, reasonable viscosity and flavor intensity, reasonable cost, and the ratio is sufficient to maintain a grinding temperature above 180°F. However, ratios other than 1 to 10 can be used and this will affect both the protein content of the beverage and its cost. Soymilk is the water extract of dry mature soybeans, but the question of how much water should be used to make the extract cannot be answered with a definite number.

If the nutritional feature of soybeverages is featured in any way in marketing it would be desirable to establish a minimum protein content in order to prevent unscrupulous manufacturers from benefiting from the public belief that soymilk has a valuable protein content, while putting out a low protein beverage. For example, it is quite possible for a manufacturer to use a bean to water ratio of 1 to 60 which would yield a beverage with a protein content of about 0.5%. This would be a very cheap drink, but does it qualify as a protein beverage? On one occasion we analysed a sample of soymilk that is retailed in ketchup bottles fresh each day in Manila and its protein content was 1.2%.

Raw soybeans and uncooked soybean foods contain a substance called antitrypsin which limits the utilization of the protein content. The antitrypsin must be destroyed by heating before the protein content can be properly utilized by the human body. A soy beverage that has been sterilized in the bottle has been given sufficient heat during the sterilization process to destroy the antitrypsin. A soy beverage that is sold fresh each day without being sterilized should

be held at the boiling point for about 30 minutes in order to destroy the antitrypsin. This step can be incorporated into the manufacturing procedure fairly easily.

Extensive nutritional studies have been conducted on various processed soybean products at Cornell under the leadership of Dr. L. R. Hackler. This work includes feeding studies on rats and amino acid analysis. Protein efficiency ratio (PER) of sterilized bottle soymilks is in the range 2.2-2.4 adjusted to a casein standard with a PER of 2.5. The limiting amino acids in soymilk are the sulphur-amino acids, methionine and cystine. The essential amino acid index (EAAI) is 75.1 and the requirement index (RI) is 85.9.

Table 5 shows the percent of daily protein intake supplied to various age groups by one seven fluid oz. serving of soymilk assuming a protein content of 3%. Two standards of reference are listed. One is the FAO-WHO recommended daily protein intake. The other is the WHO-Interim Standard for the Western Pacific which is about 20% lower than the FAO-WHO world standard. Using either scale it can be seen that one serving of soymilk can supply a significant proportion of the daily protein requirement to every age group. In the age group most susceptible to protein-calorie-malnutrition (the preschool child), a single serving of soymilk can supply as much as 50% of the recommended daily protein intake.

Table 5. Protein Supplied by Soymilk

Type of Person	WHO-Western Pacific Interim Standard for Daily Protein Intake		FAO-WHO Recommended Daily Protein Intake	
	Standard grams	% of standard supplied by 7 fl oz soymilk	Standard grams	% of standard supplied by 7 fl oz soymilk
Toddler (1 to 3 years)	11.7	51	14.3	42
Preschool (4 to 6 years)	14.6	41	17.5	34
Schoolage (7 to 9 years)	18.4	33	24.9	24
Schoolage (10 to 12 yrs.)	22.4	27	31.0	19
Schoolage (13 to 15 yrs.)	32.8	18	41.1	15
Adult male	39	15	46	13
Adult female	35	17	39	15
Lactating female	38.5	16	54	11

(based on a protein content of 3.0% in the soymilk.)
(Standards taken from, "The Health Aspects of Food and Nutrition", published by WHO, Western Pacific Regional Office, Manila, 1969, pp. 244-245.)

The fat content of soymilk made with a bean to water ratio of 1 to 10 is slightly over 1% and it is derived entirely from the soybean. Soybean oil is noted for its high content of polyunsaturated fatty acids, and this desirable property will be carried over into the oil fraction of the soymilk. The fat content of soymilk can be increased by adding edible oil to the soymilk and homogenizing. When oil is added, the characteristics of the added oil must be taken into account before making any statements about the degree of unsaturation of the oil in the fat-enriched soymilk.

Published data on soymilk indicate that it has a calcium content about one fifth of cows milk. The calcium content can be increased quite cheaply by the addition of a salt such as calcium gluconate. If too much calcium is added, the soymilk will curdle during the sterilization process.

Soymilk contains about 1% of carbohydrates derived from the bean. The total carbohydrate content of soybeverages therefore depends almost entirely upon the nature and amount of carbohydrate that is added to it. With the addition of 7% sucrose the total carbohydrates will be approximately 8%.

On the basis of 3% protein, 1% fat and 1% carbohydrate derived from the bean, plus 7% of added sugar, one seven ounce serving of soymilk will supply 106 calories. If the added sugar content is raised to 9% the calorie value will increase to 122 calories. If 2% fat and 7% sugar is added there will be 142 calories per serving.

ECONOMIC FACTORS

It is very difficult to set up cost estimates when the cost of containers, labor, overhead, marketing, and other expenses are not known, and when the cost of the principal raw material, the soybean, is more a matter of discussion than fact. Nevertheless some attempt will now be made to at least provide a rough guide to the ingredient cost.

The figures set out below are based upon actual yields obtained in the pilot plant at Los Baños using a bean to water ratio of 1 to 10. The calculation is set out in such a way that a processor can put in his own cost estimates for ingredients, using this outline as a guide.

1) One kilogram of dry mature soybeans yields 9.5 to 10 liters of soymilk. This is equivalent to 47 to 50 servings, each 7 fl. oz. Say two cases of soymilk per kilograms of dry beans (24 bottles per case).

2) Standard Formula (7% sugar, 20 ppm flavoring, .02% sodium hydroxide).

1 kg. soybeans at ₱.80 per kg.	₱0.80
0.7 kg. sugar at ₱.80 per kg.	.56
0.2 cc vanilla essence at ₱35.00 per liter	.01
2 grams sodium hydroxide at ₱3.60 per kg.	.01
	₱ 1.38

This yields approximately 2 cases
Ingredient cost per case ₱0.69

An insoluble residue (filter cake) is a by-product in the manufacture of soymilk. It represents 36% to 49% of the dry matter of the raw soybeans. In our variety evaluation study the protein content of the insoluble residue, (dry matter basis), has ranged from 18.2% to 28.1% with a mean value of 23.4% while the fat content has ranged from 10.3% to 17.6% with a mean value of 12.8%. If pressed out very dry, the insoluble residue is about 25% dry matter and 75% moisture as it comes from the filter. This residue should have some value as a cattle feed ingredient. It could be fed to animals in the moist condition, or dried and incorporated into a feed ration. However, since it is moist and warm, it will turn sour within hours unless it is dried promptly. We have no figures on what the value of the residue would be in the moist condition, or whether the value of the dried material would warrant the cost of drying it. The residue would impose a charge to the cost of production if it was hauled away to the dump. On the other hand, it would help cover some of the costs if its value as feed was sufficiently high. The effect of the residue on cost has been ignored in section 2 above.

SOURCE OF ADDITIONAL INFORMATION

The group at Los Baños and the team at Cornell are willing to help, (within the limits of their resources), commercial enterprises establish or utilize soy beverages. Appendix A lists the publications that have resulted from this research program. Copies may be obtained by writing directly to the authors or to Dr. W. B. Robinson at Cornell.

Inquiries in person or by mail are welcomed and will be given serious attention. A demonstration of the boiling water grind technique can be arranged by appointment. In the Philippines contact Dr. Banzon or Dr. Bourne at the U.P. College of Agriculture, Los Baños. In the U.S.A. contact Dr. W.B. Robinson, NYS Agricultural Experiment Station, Cornell University, Geneva, New York 14456, U.S.A.

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APPENDIX B

Pilot Plant Procedure for Making PHILSOY at Los Baños, Philippines

Procedure:	Comments:
1. Soak clean whole soybeans in water at ambient temperature until saturated (about 4-5 hours).	a. Soaking time can be extended to 10 or 12 hours without harm. Excessive soaking time may give fermentation and/or hard beans that are difficult to grind.
	b. Dehulled beans can be used if desired but we see no advantage in dehulling first. In fact there seems to be a slight flavor preference for milk made from beans that have not been dehulled.
2. Discard soak water. Remove any defective beans.	
3. Pre-heat grinding machine.	a. This step is necessary to ensure that the first lot of material ground does not fall below 80°C.
	We use a Rietz Disintegrator but other grinding machines, including motorized stone grinders and large Waring Blenders have proved satisfactory.
	We preheat by passing boiling water through the grinding machine. Other methods of preheating should be satisfactory.
Grind beans at ambient temperature with boiling water. Temperature of bean-water slurry must never fall below 80°C (180°F).	a. Beans should not be over 55°C before entering grinder or protein solubility will be lowered.
	b. Beans should be ground to a fine state in order to obtain maximum extraction of protein.
It is advisable to hold the slurry at 80°C or higher for about 5 minutes before proceeding to the next step.	c. We grind with <u>slightly</u> less than the required amount of water and adjust to correct weight by adding water to the slurry. For example: 5 kg. dry beans will be adjusted to a final weight of 55 kg. (5 kg. beans + 50 kg. water). This is done after step 5.

Ratio is 1 part by weight of dry beans plus 10 parts by weight of water. This is approximately equivalent to 1 volume of soaked beans to 3 volumes of boiling water.

d. Beans and water should be metered continuously into grinder. (We do this by hand using 2 operators, on pouring beans and the other pourin water.)

e. Sometimes foaming is a problem. W control this by using Dow Corning antifoam spray A. The foam is controlled at Cornell by injecting live steam into the grinding machine. As soon as the foam cools it collapses.

5. Boil for 5 to 10 minutes.

a. This is best done by injection of live steam because heated metal surfaces burn easily. This step removes traces of volatiles that sometimes appear. It causes a slight flavor improvement.

6. Filter off insoluble residue.

a. We use a plate and frame filter press. Other equipment such as centrifuges should be satisfactory.

b. Insoluble residue should be squeezed as dry as possible in order to extract maximum yield of milk.

c. The insoluble residue is a by-product of the process. It can be used as cattle feed because it has a valuable protein content.

7. Formulate.

a. We add 7% sucrose and 20 ppm of essence of vanilla in order to achieve a smooth well-rounded flavor. No other additives are used in PHILSOY.

b. Many other flavors can be used successfully. Minor nutrients such as calcium, Vitamin A etc. can be added at this point if desired. If a higher fat content is desired it is added as an edible oil and emulsified with the soymilk at this point.

. Fill into 7 oz. bottles and seal.

a. Allow room for expansion of milk in bottle during processing.

9. Process in steam 12 minutes at 250°F. (15 lbs. pressure.)	a. We would prefer to process in water and cool in water but are waiting on additional heat transfer data to establish a safe process time for a water cook.
10. Cool in air.	a. Hot bottles are under pressure and constitute a potential hazard. Care must be taken to minimize handling of hot bottles. Operators should wear safety glasses and waterproof aprons.

General Notes

a. The sterilization in the bottle is sufficient to inactivate antitrypsin. If a fresh product is desired that has not been sterilized, it is necessary to maintain the milk at near the boiling point for approximately 30 minutes in order to destroy the antitrypsin.

b. The sterilized PHILSOY keeps well in storage at ambient temperature for several months. Our taste panel detect a slight loss of flavor after 6 months storage at ambient temperature although the taste is still acceptable. The beany flavor does not appear in stored samples.

c. A "cream line" sometimes forms after one or two weeks storage. This can easily be dispersed into the milk by shaking manually. Homogenization reduces the size of the cream line.

d. When the bottles are stored in direct sunlight for several weeks continuously there may be some separation. There may be some separation after 8-10 months storage in the dark at ambient temperature. (Ambient temperature at Los Baños is usually 75° to 95°F. Extreme annual temperatures are 65° and 100°F.)

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