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SEMI-ANNUAL PROGRESS REPORT

X-M RICE TECHNOLOGY PROGRAM/AID

ADAPTATION OF AN INTEGRATED RICE MILLING PROCESS AND DEVELOPMENT OF RESULTANT FOOD PRODUCTS FOR USE IN SOUTHEAST ASIA, PHASE I

Riviana

RIVIANA FOODS INC. P. O. BOX 2636 • HOUSTON, TEXAS 77001 • PHONE JA 9-3251
Area Code 713

January 29, 1968

TO: Director
Nutrition and Child Feeding Service
Office of War on Hunger
Agency for International Development
Washington, D. C. 20523

Attention: Program Office, Contract No. AID/csd - 1583 (5 copies)

FROM: Lawrence Lynn for Riviana Foods Inc.

Subject: Semi-Annual (Substantive) Program Report

This report, covering work to date on Phase I of this project, is presented in accordance with the requirements of Contract AID/csd - 1583 with Riviana Foods Inc., P. O. Box 2636, Houston, Texas 77001, hereinafter referred to as Riviana.

The general objectives of this project, Phase I of which became effective June 30, 1967, were to (1) determine the applicability and adaptability of a rice milling process, newly developed in the United States, to countries of Southeast Asia; and (2) provide knowledge which is required to make this technologically advanced process commercially viable in a developing region, within the scope of the specific objectives set forth hereinafter. It was and is anticipated that this new milling process would offer major economic and nutritional advantages to countries in Southeast Asia.

Specific objectives, which are developed in detail in the Appendix of this report, included:

1) Developing and/or adapting miscella refining techniques specific for rice oil produced by the new X-M technology to render in-line refining economically feasible in foreign X-M plants for the production of edible oil.

2) Developing several nutritious consumer food products based on projected availability of a source of X-M rice bran and oriented toward use of other inexpensive raw materials in Southeast Asia, including "bar good" products and a beverage. Nutritional and keeping qualities of these products acceptable to the people of Southeast Asia were to be considered.

3) Determining the projected overall added value, in terms of rice milling yields, oil and wax yields, and high protein bran properties, which would be derived from the X-M solvent extractive milling processing of selected foreign rice varieties.

To review the background, the possible significant contribution to the lesser developed nations of the new X-M rice milling technology announced by Riviana was called to the attention of Riviana by AID personnel (Messrs H. L. Beemer, Bureau of East Asia and Max Milner, former Chief of the Nutrition Branch, War on Hunger). AID requested, in several discussions during late 1966 and early 1967, that Riviana set up a program to explore or develop X-M adaptability to prominent rice varieties of Southeast Asia as the area most likely to benefit from this new technology. Also, AID requested of Riviana permission for a critical evaluation of this new technology to be performed for AID by USDA. This was granted, and the survey thereafter reported to AID by Messrs Deobald and Hogan (October, 1966). Following several helpful orientation discussions with AID personnel and with Dr. Aaron M. Altschul of USDA, overseas visits were held in Thailand by Mr. F. A. Godchaux III, Chairman of the Board of Directors of Riviana and Mr. Lawrence Lynn, and by the latter in the Philippines. These visits (Feb.-March '67) included senior public and private sector personnel from each country, including Cabinet level officers, and assured us that the major and long range project being called for by AID/War on Hunger would be a well conceived and potentially important contribution. Formal project papers outlining the overall program, and detailing the first phase's work (June 30, 1967 - June 30, 1968), were provided to AID by Riviana accordingly and approved.

The work completed in the opening half of Phase I is presented in detail in the sub-project reports which follow, however, it may be helpful, at this point, to briefly recount the highlights and present our best current thinking as to the future direction of efforts:

I. Based upon a literature review and a series of bench scale experiments, it was learned that at least one approach to miscella refining of X-M rice oil appeared very encouraging. Work on a pilot unit was started and largely completed (photo pg. I-11), in which the process will be developed and demonstrated by June, 1968. The bench scale work has shown refined product oil samples which were felt to be storable, edible and relatively attractive.

If the process proves scalable at the pre-pilot level, it will be inferentially concluded that X-M rice mills located in the lesser developed countries may be capable of producing a high value, at least competitive edible rice oil without dependence on separate refining in conventional oil refineries, which would impose possibly severe additional capital needs as well as difficult logistical problems, particularly in areas underdeveloped as to transportation.

Presuming work to be successful in the remainder of Federal Fiscal '67-68, it will be recommended (a) that the oil from miscella refining be scaled to test market research quantities and (b) that a test market with appropriate marketing research be conducted either

in Thailand or the Philippines to assure that the product is marketable in Southeast Asia, as a preliminary to formal investment feasibility studies, engineering and subsequent capital committments. It is now believed that the chances are good that it will be possible to conduct such overseas test markets with appropriate oil samples exported from a low cost research pilot unit in the U. S. prior to exporting the technology per se for application in commercial units overseas.

II. Early exploratory development was directed to both the beverage and the solid product approaches to Southeast Asian human food utilization of (X-M) rice bran. It had been pointed out earlier by AID personnel and Dr. Altschul, of USDA, and recognized by Riviana, that success with either or both of these approaches could contribute very materially to improved indigenous food and specifically to protein supply in Southeast Asia.

Results from bench scale experimental work on the beverage concept and on two of the solid product concepts have been encouraging. A prototype beverage has been synthesized from X-M rice bran by a non-enzymatic method with a composition similar to cow's milk (pg. II-5 below) and with a color and texture somewhat similar to Vitasoy (Fig. III, pg. II-8). The latter is a relatively new Asiatic beverage which, after several years of market development, is reported to have outsold Coca Cola in 1966-7 in Hong Kong.

The X-M rice bran-derived beverage appears amenable to a wide spectrum of flavor and textural variations which are under study at this time. If scale-up to quantities adequate to in-lab panel tests project favorable acceptability and economic results, after formulation work in progress is completed, a strong recommendation will be brought forward for larger scale product and/or market testing in Thailand or the Philippines.

Similarly favorable results have started to be generated (Dec. '67, Jan. '68) for solid products of both (a) the formulated extruded type to be eaten as a finger food, and (b) noodle-like products which require a short cook time. The latter is particularly interesting in view of the almost universal appeal and usage of noodle shaped foods, and of the usage of exceptionally low protein, glutenous rice noodles in Southeast Asia. While some of the noodle-like products contain well over 10%-15% protein, this work is not considered far enough along to predict the probability of a favorable recommendation on this facet. At the present stage, it is known that research must stress solving problems in color and texture to attain a prototype worth overseas product/market research.

III. Research on selection and evaluation of key foreign varieties as to potential X-M milling benefits is behind schedule because of the encountered scarcity of worthwhile varieties data and several difficulties found in resolving conflicting information about the varieties. In the Philippines and Thailand together, almost 400 varieties are known to exist. This large group has been reduced to about 10 varieties from Thailand and 5 from the Philippines with the help of knowledgeable persons in both countries. As a by-product of this work, it was encouraging to learn of the awareness and great interest in this AID program on the part of key Thai and Filipino contacts made.

The fifteen varieties selected have been appraised as to analagous U. S. type, chemical composition and projected control (conventional) milling yields based on abrasive milling. Results (III, Tables I-IV) show that some of the earlier hearsay-type comments as to very poor indigenous yields are corroborated by standard USDA lab milling technique results. Whereas, for example, X-M head rice yields on typical analagous varieties run to 80-90 lb/bbl. of paddy, some of the rice samples obtained show corresponding 15-50 lb/bbl. of paddy yields. Perhaps the yield problem is more serious than either AID or we had realized at the start of the project.

We are proceeding next to get larger quantities of 3-4 of the varieties in widest availability for larger scale comparative milling tests by Thai and Filipino conventional mills and a short single-shot X-M milling trial run in the U. S. The oil and X-M bran derived from these tests will be utilized in sub-projects I and II of this program.

GENERAL

Since the inception of this work, requests have been received for similar exploratory research from senior personnel from the private and public sector in South Korea, India, Japan, China (Taiwan), Indonesia and Pakistan. Each such requester has been advised that adaptational research and development are proceeding with the fullest U. S. technical and public support that can be brought to bear on the problem and of the difficulties in extending prematurely the scope of this pioneering research which, we hope, ultimately also will benefit their rice and food supply in their countries. If this work reaches the point by Federal Fiscal '68-69, permitting work to start on key rice varieties of other countries, while not detracting from forward development progress for Thailand and the Philippines, such activities will be included at least at a low level in our recommendations for FY '68-69.

FOR RIVIANA FOODS INC.

L. Lynn

Lawrence Lynn, Vice President
Principal Investigator, AID csd - 1583

LL:dg

cc: Contracting Officer
Contract Services Division
Office of Procurement
Agency for International Development

Riviana Internal Report Distribution

PART I

RIVIANA FOODS, INC.
Houston, Texas

DEVELOPMENT OF RICE OIL MISCELLA REFINING TECHNOLOGY

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Circ. Copy: JN/NK/GS/Technical Center Library

Research & Development Dept.
Project 7.004
Interim Report No. 1
Development of Rice Oil
Miscella Refining Technology
DOS Contract No.AID/csd-1583
January 24, 1968

PART I

DEVELOPMENT OF RICE OIL MISCELLA REFINING TECHNOLOGY

Summary

A study of publications, patents, vendor literature and laboratory investigations on the subject of vegetable oil miscella refining has been made. This information showed the probable feasibility of rice oil miscella refining by a process similar to De Laval's cottonseed miscella refining process. The data shows reaction of rice oil miscella with caustic under controlled mixing conditions followed by centrifugal separating, bleaching, solvent stripping and deodorizing results in an appealing edible oil product.

Operational, economic and product practicality remains to be demonstrated. To help accomplish this, a pre-pilot unit has been constructed. This will help provide data for operational and economic evaluation and product samples for limited product evaluation. In future direction of efforts, we will test the process with dewaxed X-M rice oil, non-dewaxed X-M rice oil and South East Asian rice oil. This will bring us to the point of a recommendation for or against production of a large sample for market evaluation using a full pilot or commercial processing plant.

PART I

DEVELOPMENT OF RICE OIL MISCELLA REFINING TECHNOLOGY

Introduction

Crude rice oil such as produced by X-M milling technology can be refined to an edible oil. For this to be accomplished in South East Asia, in-line refining capacity is believed to be the preferred approach due to the burdens of toll refining fees, logistics and storage problems particular to South East Asia. This project seeks to answer the question of the feasibility of in-line miscella refining. The pertinent publications and patents have been reviewed along with equipment suppliers data and comments. This information with laboratory investigations isolated a preferred refining process for study in more depth. Detailed laboratory studies provided additional data to permit design of a pre-pilot unit for the production of edible rice oil from crude X-M oil by refining as a hexane miscella. Oil produced in the X-M unit in Abbeville, La., was used as the supply oil while awaiting response from our request for rice oil from Thailand. The project has reached the stage of completed construction of a pre-pilot unit.

Present State of Vegetable Oil Refining

Review of the literature revealed extensive work in the general area of vegetable oil miscella refining, particularly as related to cottonseed oil. Some minor information on rice oil conventional refining and potential of miscella refining was also found. Three somewhat proven processes for miscella refining of cottonseed oil were found. These were by De Smet, Antwerp, Belgium; Ranchers Cotton Oil Company, California; and the De Laval Separator Company, Poughkeepsie, New York.

The process patented by Ranchers Cotton Oil Company utilizes a homogenizer to achieve the dispersion required for a good reaction between the water caustic layer and the miscella. This results in an emulsion of the formed soap stock and oil bearing miscella. The emulsion is broken by a series of heating and cooling exchangers which are reported to result in a stream which can be separated by liquid-liquid centrifugals. These two steps are the key to the process, 1. - dispersion and reaction of the two non miscible layers followed by 2. - efficient separation of the soap stock from the neutral oil miscella. A Sharples non-hermatic type centrifuge is used to achieve the separation. There is at least one commercial installation in operation in the United States using this process for the refining of cottonseed oil. It is believed the capital expense for equipment required to achieve the reaction and break the emulsion is high compared to other methods of oil refining.

De Smet a large European oil refining equipment supplier, has a process utilizing a two solvent system to achieve the separation of soap stock from cottonseed miscella. Caustic, crude oil, hexane

and alcohol are fed to a mixer in which the reaction takes place. This mixture is allowed to decant with the neutral oil remaining in the hexane layer going overhead and the alcohol water soap stock layer removed by bottom discharge. A third layer at the interface reportedly containing the gums is drawn off from the middle of the decanter. Both the heavy phase and the light phase layers require a washing step followed by a secondary decanting. This approach does provide a continuous process free of the problems of centrifugal separation: however, again the capital investment required for these key steps would appear to be relatively high. Further, although this company has mainly European operations it has no known miscella refining units operating in the United States. They report their process should be convertible from cottonseed to rice oil processing.

De Laval Separator Company a vegetable oil refining equipment supplier has a patented vegetable oil miscella refining process which utilizes a hermatic centrifuge to achieve separation of the stream from a carefully controlled mixing operation. Several cottonseed oil miscella refining plants within the United States are operated using this process.

Outside of the concepts covered by the above three companies the literature is limited to more exotic and unproven approaches to the solution of miscella refining of vegetable oils.

Laboratory Investigation

A brief laboratory investigation of the De Smet two solvent system was unsuccessful in achieving a decantable extractive solvent stream. This by no means indicates that the process is not feasible. It does however, indicate that potential problems exist for the commercial scale, by the tendency of rice oil, hexane and water to form a stable emulsion.

Limited operation of a Sharples Corporation laboratory scale centrifuge for stream separation as employed by the Ranchers Cotton Oil Company was also conducted. A separation was achieved, but with high atmospheric hexane losses and a semicontinuous soap stock discharge. The process was not completely satisfactory.

Initial studies following the De Laval Cottonseed Oil process and using a laboratory De Laval Gyrotester Separator showed this approach combined with other required refining steps such as filtering, bleaching and deodorizing to be the most promising area for further study.

Approximately thirty tests were made in which crude rice oil was refined, bleached and filtered. The variables studied included reactor type, acid treatment, caustic treatment, reaction time, reaction temperature, and miscella oil concentration. The procedure followed is briefly outlined below:

1. Make up 500 - 600, ml of miscella.

2. Warm to selected reaction temperature.

3. Begin mixing.

4. Add acid treat, if any.

5. Add caustic.

6. Hold for selected reaction time.

7. Separate with gyrotester or filter.

8. Reheat and bleach.

9. Filter.

10. Analyze for free fatty acid.

All equipment, including electric motors and heating sources must necessarily be explosion proof. The data obtained from the laboratory investigations shows an effective range of conditions for the major variables based on removal of free fatty acids from the neutral oil.

Three different stirrer types were used to serve as the mixing and reacting vessel. The need for acid treating was not confirmed or rejected. Run No. 26 represents a typical run in the effective (but not optimized) range of operating conditions.

Crude rice oil (1000 grams) containing 3.57% free fatty acids was blended to a 50/50 wt. % hexane mixcella. No acid treatment was utilized. The miscella was heated to 140°F and 20° Bé caustic solution was added at 1.17 times stoichiometric amounts. The reaction was continued for 10 minutes under high speed mixing. The sample was then filtered through a bed of filter aid and asbestos fibers. The filtrate was bleached with 75 grams of Milwhite Morac clay for 20 minutes at 100 - 140°F. The clay was removed by paper filtration and hexane removed by vacuum stripping. The product oil contained 0.04% FFA and had a 1.1 Red Lovibond color. Refer to Tables I and II for details of other test conditions and resulting data from these tests.

No significant yield data was determined on the laboratory tests due to the inherent limitations of laboratory equipment and related handling losses. This information must be determined using pre-pilot scale equipment.

In cottonseed oil refining, miscella refining generally results in a one to three per cent less refining loss than conventional refining.

depending upon the nature of the crude. The advantages of miscella refining are highest for low quality crudes. For soybean oil refining the advantage of miscella refining lies in color rather than improved refining loss since soybean oil, characteristically, has a low refining loss.

Pre-Pilot Unit Construction

With the results of the laboratory study, sufficient information was accumulated to permit design of a pre-pilot unit. The basic processing steps are as follows: Oil and hexane are blended to a controlled miscella concentration and warmed to approximately 120°F. An acidification step meters reaction solution in the parts per million range to the miscella. Almost immediately following, caustic is then metered in and mixed with an effective in-line blender. The mixing operation is the heart of the process for it is necessary to achieve intimate dispersion of the reactants without forming an emulsion. The mixed stream is then fed to a stirred reactor for a controlled contact time to complete the desired reactions. Reactor effluent is fed to a liquid-liquid hermatic pressurized centrifuge in which the soap stock is separated from the neutral oil miscella. The clarified miscella is then fed to a horizontal plate filter for a combination of filtering and bleaching which will utilize filter paper and bleaching clay. The bleached product is then accumulated in a stripper-deodorizer to be operated as a batch unit. Hexane is removed under vacuum, condensed and returned storage after separation of water from the sparge steam. At this point a higher vacuum and higher temperature are utilized for deodorization. The product is placed in drums for storage.

The pre-pilot unit is an outdoor unit utilizing scaled down commercial equipment which can generate much of the desired data. The process is continuous through bleaching; however, batch operation of the individual steps will be employed for the earlier tests. Batch solvent stripping and deodorizing was utilized in order to control capital cost of the pre-pilot unit. This unit has a maximum capacity of approximately one 55 gallon drum of oil per day based on an eight hour operating day, with a miscella feed rate of 30 gallons an hour. Refer to the pre-pilot plant schematic drawing and photographs for layout of the equipment. Due to the hazards of hexane vapors all equipment in the pre-pilot unit process area is also explosion proof.

Materials of construction are of carbon steel with the exception of the deodorizer and centrifuge. Stainless steel construction is reportedly required for the deodorizer because of flavor problems attributed to be imparted by mild steel at deodorizing temperatures. Stainless steel is the standard material of construction of this type of centrifuge. Utilities required and installed for this unit include 300 psig steam, refrigeration, compressed air, water and vacuum.

The unit is instrumented to allow for control of the major variables, and arranged such that individual processing steps can be studied without running the total unit.

The operating labor required will be a heavy demand typical of laboratory scale and pre-pilot operations. This is due in part to a high clean up burden because of short runs and limited automatic instrumentation.

Future Work

The process will be tested beginning with X-M oil from Abbeville, La. as a feed stock starting February, 1968. Variables will be defined within a range but not completely optimized. This will provide some of the data necessary for scale up of the processing steps studied and help to indicate what additional steps, if any, such as winterization, may be required. Product samples will be produced in sufficient quantities for kitchen storage stability and other non-market test evaluations. By changing the basic feed stock oil to an internal miscella stream from the X-M plant the requirement of dewaxing will be studied. This would of course require an additional concentration step before runs could be made. Upon receipt of rice oil from Thailand or rice oil domestically isolated from rice from Thailand, tests can be made and conclusions drawn as to the analogy between the two feed stocks.

BY

Approval

L. Lynn

John Nowlin

John W. Hunnell

TABLE I

LABORATORY MISCELLA REFINING OPERATING CONDITIONS

	Operating Conditions	Run No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
AGITATION	Stirrer, Hot H_2O Bath	X	X	X	X	X	X									X	X	X	X											
	Waring Blendor							X	X	X	X	X		X	X					X	X	X	X	X	X	X		X	X	X
	High Speed Stirrer																										X			
ACETIC ACID	0.0 ppm							X								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	700 ppm	X	X	X	X	X	X																							
	1000 ppm								X		X	X		X	X															
	3000 ppm									X																				
NAOH ADDED (20° Bé Sol'n)	1.02 X Stoich.																						X							
	1.05 " "														X	X														
	1.09 " "																X													
	1.13 " "																			X		X		X	X	X				
	1.15 " "																											X	X	X
	1.17 " "																										X			
	1.32 " "																	X	X											
	1.37 " "																				X									
	1.56 " "																X													
	2.23 " "							X	X	X	X	X																		
	2.57 " "	X	X	X																										
	2.69 " "				X	X	X																							
REACT. TIME	3 Min.											X																		
	6 "	X	X	X	X	X	X	X	X	X																				
	10 "										X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OIL, START	1.93% FFA, 0.13% A.I., 0.06% I.I.																											X		
	3.42% " 0.24% A.I., 0.06% "							X	X	X	X	X		X	X															
	3.45% " 0.21% A.I., 0.11% "																												X	X
	3.57% " 0.18% A.I., 0.06% "															X	X	X	X	X	X	X	X	X	X	X	X			
	5.16% " 0.38% A.I., 0.05% "				X	X	X																							
OIL WT.	250 g.	X			X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X		X	X	X
	500g.		X	X															X											
	1000 g.																										X			
MISC. CNC.	35%	X			X																									
	50%		X			X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	65%			X			X																							

TABLE I CONT.

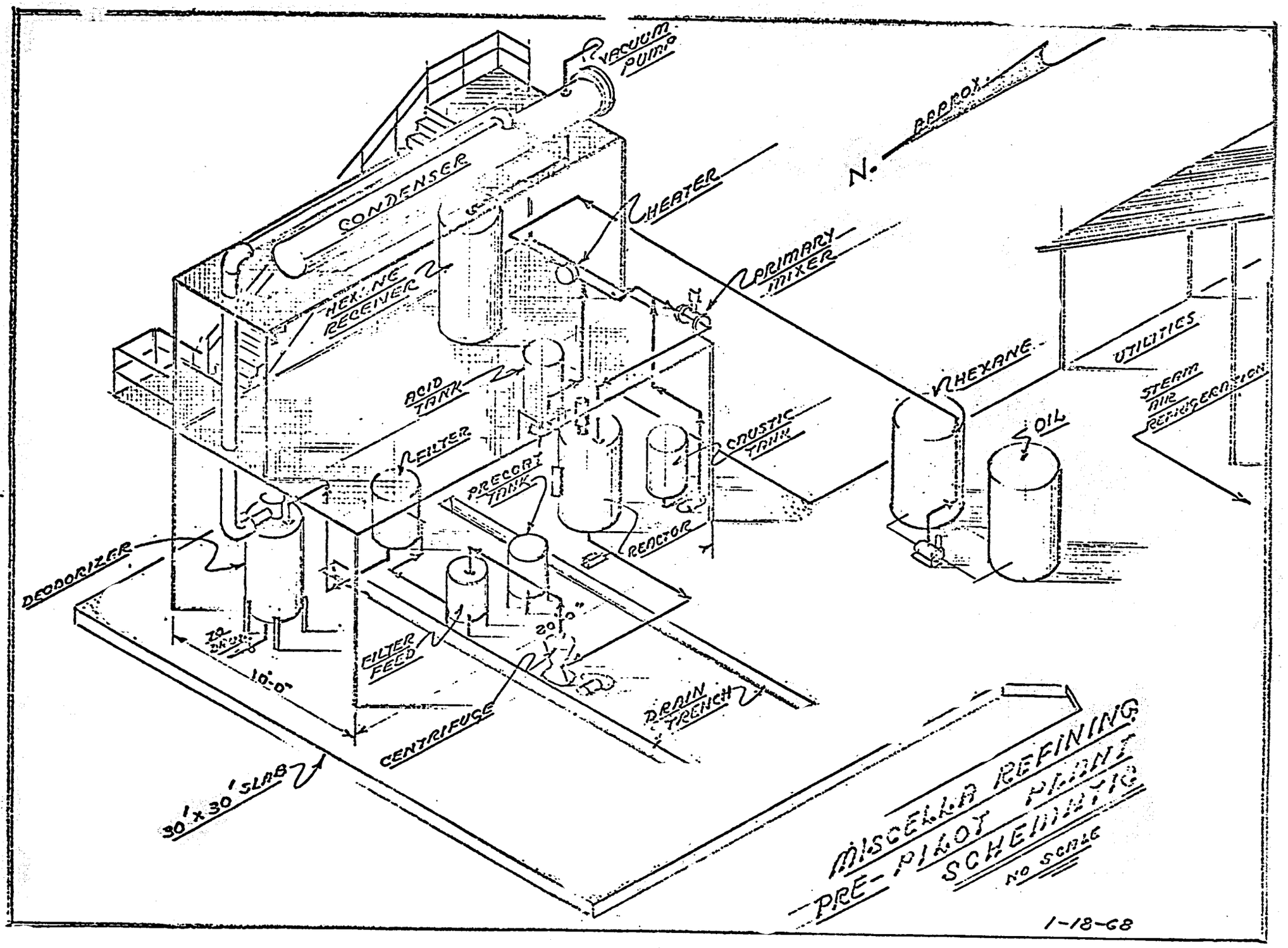
	Operating Conditions	Run No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
TEMPERATURE, START	19.0°C																													X	
	40.0																														X
	54.5	X																													
	55.0		X																												
	55.8			X																											
	56.0				X																										
	57.0					X																									
	57.5						X																								
	58.0															X	X	X	X												
	60.0							X	X	X	X	X		X	X					X	X	X	X	X	X	X	X	X	X		
SEP.*	Gyrotester Separation	X	X	X	X	X	X	X	X	X	X	X		X	X																
	Filtered (without Gyro Stp)															X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BLEACH	Vegaclay - I	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X								
	Milwhite Palex																							X							
	Milwhite Morac																								X		X	X	X	X	X
	Activated Charcoal																									X					
OIL OT.	0.050% FFA or Less			X			X	X			X									X	X			X	X	X	X	X	X		
	Between 0.050% & 0.100% FFA					X											X					X	X							X	X
	0.100% FFA or More	X	X		X				X	X		X		X	X	X		X	X												

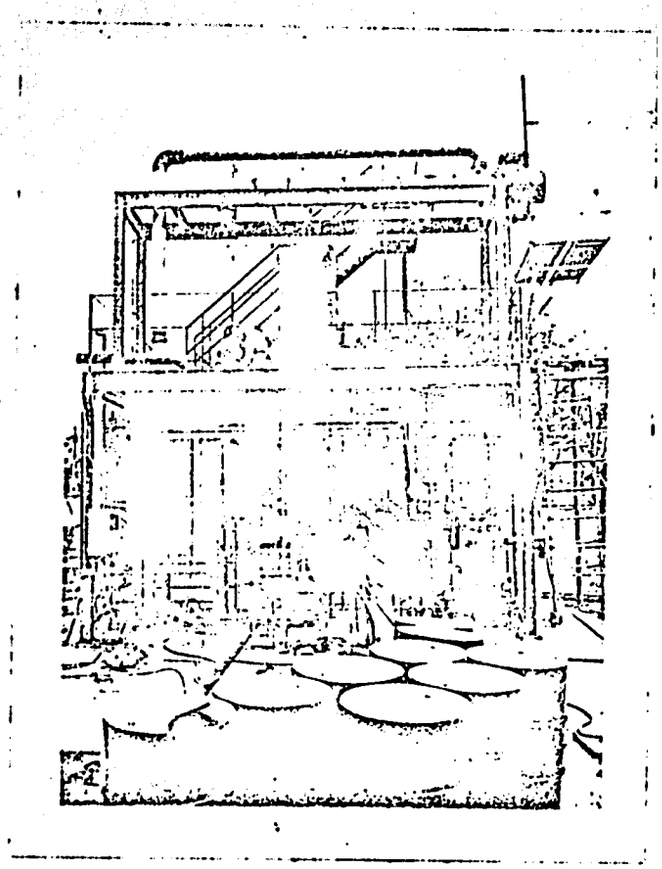
* Method of soap stock separation.

TABLE II

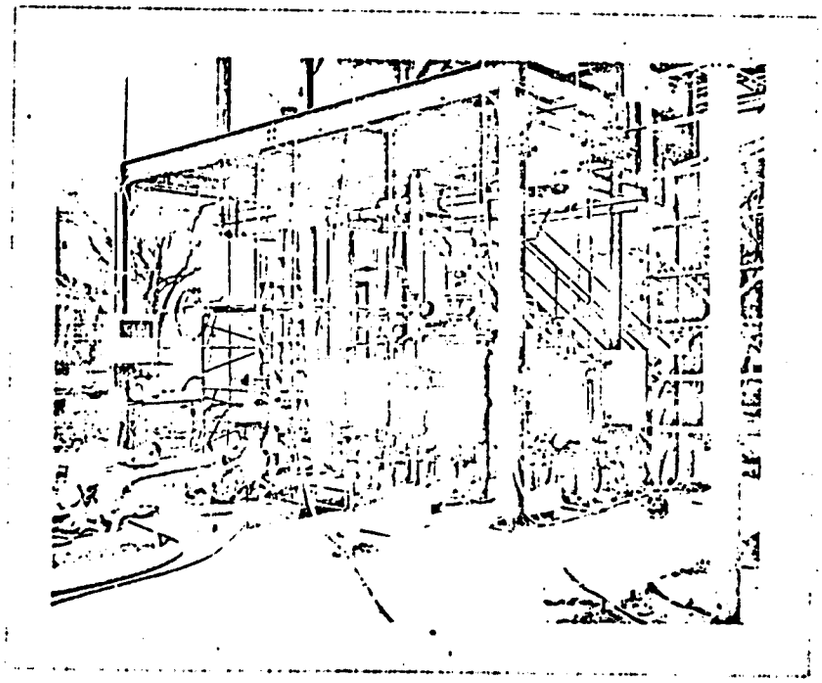
ANALYTICAL RESULTS OF LABORATORY MISCELLA REFINING OF RICE OIL

FFA (Final)	RUN
.025 %	27
.030	3
.030	23
.030	24
.030	25
.040	6
.040	7
.040	28
.040	10
.040	26
.040	19A
.050	19B
.050	20
.060	29
.060	30
.070	21
.080	16
.090	5
.090	22
.120	8
.180	9
.180	15
.200	11
.220	2
.230	17
.320	18
.350	14
.440	1
.470	13
.750	4

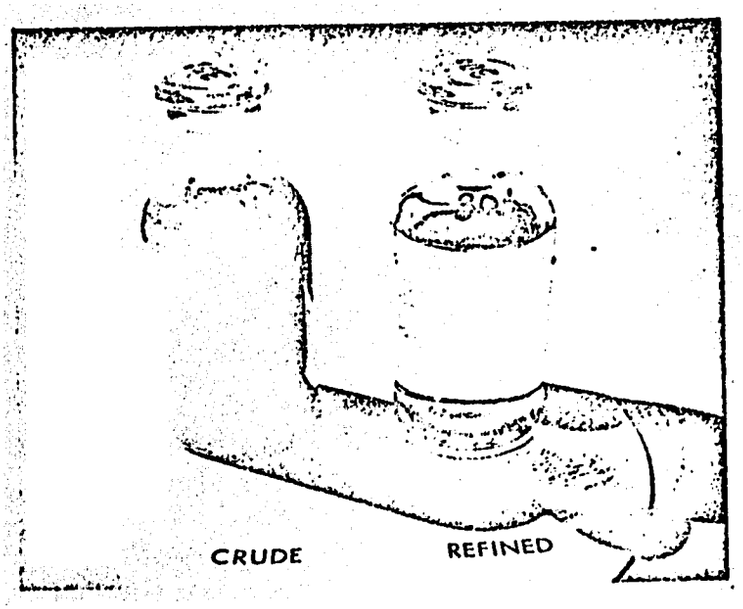

VACUUM PUMP
CONDENSER
HEXANE RECEIVER
HEATER
PRIMARY MIXER
N.
APPROX.
HEXANE
UTILITIES
STEAM
AIR
REFRIGERATION
OIL
ACID TANK
FILTER
PRECOAT TANK
CAUSTIC TANK
REACTOR
DEODORIZER
20'-0"
10'-0"
FILTER FEED
CENTRIFUGE
DRAIN TRENCH
30' x 30' SLAB
MISCELLA REFINING
PRE-PILOT PLANT
SCHEMATIC
NO SCALE
1-18-68



OVERALL VIEW OF
DIRECT PROCESSING AREA
TANKAGE AND UTILITIES
ARE REMOTE



GRADE LEVEL PROCESSING
EQUIPMENT INCLUDING
CENTRIFUGE, REACTOR AND
DEODORIZER



VISUAL COMPARISON OF CRUDE
RICE OIL WITH LABORATORY
MISCELLA REFINED RICE OIL

PART II

RIVIANA FOODS, INC.
Houston, Texas

DEVELOPMENT OF PROTEIN-RICH FOODS BASED ON X-M RICE BRAN

PART A BEVERAGE BASE
PART B SOLID FOOD PRODUCTS

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Based on X-M Rice Bran
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PART II

DEVELOPMENT OF PROTEIN-RICH FOODS BASED ON X-M RICE BRAN

A. BEVERAGE BASE

Summary

X-M rice bran has been utilized as raw material for the development of milk-like protein-rich beverage base prototypes, which hereafter will be referred to as rice milk.

In the literature of food technology and nutrition similar beverages and protein supplements have been reported to be made from soybeans, wheat and other economic plant materials. None reviewed have been based primarily on rice or rice products. Two rice milk prototype bases have been developed. One rice milk incorporates maximum practical conversion of the X-M rice bran into a liquefied form but potential flavor problems are more apparent. The other rice milk represents a smaller raw material fraction, but yields a bland flavor and greater nutritional potential for beverage formulation. The first approach resulted in the conversion of 70 percent of the X-M rice bran to a liquid form by combined enzymatic and chemical treatments. The latter approach resulted in a 35 percent conversion of the raw material through chemical treatment alone. Either rice milk base may be made into a palatable beverage by homogenizing with oil and adding flavor. The prototype made by the simpler chemical conversion technique was found to contain approximately twice the total protein level of cows milk.

Future work will be concentrated in the following areas. Pre-pilot scale up will be started to provide adequate quantities for formal testing using conventional taste panel techniques, stability studies and nutritional evaluation. Based on the data accumulated and the methods for preparation of the rice milk product, economic feasibility will be established in so far as may be possible. If encouraging results continue, pilot scale process development will be recommended leading into sample shipment to Thailand and the Philippines for major consumer tests and test marketing.

Part. B. SOLID FOOD PRODUCTS

Summary

X-M rice bran and rice by-products have been investigated as raw materials for inclusion into extruded food products to obtain the nutritional advantage of the high protein content of the bran. Three general concepts have been studied in this effort:

1. Extruded dry products.

2. Puffed or heat modified products.

3. Soft-center, hard shell products including fruit or vegetable pulp.

Various formulations using X-M rice bran, par-boiled and regular rice flours and rice protein concentrate were extruded in a laboratory extruder to produce prototypes for these concepts.

Extruded dried prototypes with encouraging texture and structural characteristics, including noodle-type products were made from X-M rice bran in 10-100% concentrations with pre-gelatinized rice flour making up the remainder.

Puffed extruded prototypes were limited to a 20% rice bran content in order to retain structural integrity. A puffed prototype containing 25% total protein was made from 60% rice flour and 40% of a rice protein concentrate. This latter product was highly acceptable to laboratory tasters.

Soft-center products were formulated from X-M rice bran, rice flour, rice oil, and a variety of fruit and vegetable pulps. The rice protein concentrate has also been applied effectively in this concept.

Flavor problems were noted when rice bran concentrations of 50% or more were used. The significance of the flavor tending toward a bitterness at these high levels has not been determined.

Future work will establish a formulation and process necessary to make two or three of the more promising prototypes in sufficient quantity to test locally for acceptability, nutritional quality and stability. These prototypes will be developed and evaluated for snack or finger food use and as components of home prepared foods. Ultimately preliminary economic projections must be made of the processes and items showing greatest potential to select prototypes for consumer testing and market research in South East Asia.

PART II

DEVELOPMENT OF PROTEIN-RICH FOODS BASED ON X-M RICE BRAN

A. BEVERAGE BASE

Introduction

Methodology used for the manufacture of soy milk and other beverages such as the wheat beverage concept recently published by the U.S.D.A. Western Regional Laboratory was not directly applicable to the development of a X-M rice milk because of the inherent biochemical differences between rice and other raw materials. Although X-M rice bran contains up to 20% protein, its crude fiber and ash content makes total utilization nutritionally impractical. However, the total X-M bran stream may be put into a stable suspension when finely ground and after a gelatinization treatment. Thus the basic approach to the development of a nutritionally advantageous rice milk has been the chemical and physical concentration of the desirable nutrient materials in X-M bran.

Available Commercial Materials and Laboratory Methods

The approach to this portion of the project has been to survey those materials and treatments located through published technical and trade literature for possible activity in the solubilization of X-M rice bran.

From this survey, commercial enzyme preparations offering potential in breaking down the polymeric carbohydrates and other constituents were obtained and evaluated in the laboratory. As presented in Table I, liquefying amylases proved to be reasonably effective, whereas proteases, cellulases and pentosanases did not.

Similarly, X-M rice bran was subjected to heating and freezing in aqueous suspension, acid and alkali treatments and particle size reduction, both singularly and in various combinations. Gelatinization of starch present in the bran enhanced the diastatic activity. Protein was extractable with dilute alkali and was then precipitated with acid at its iso-electric point. The best conversion obtained of X-M rice bran to the soluble state was through a combination of cellulase enzyme and amylase enzyme treatments followed by a series of alkaline protein extractions. Approximately 70 percent solubilization was achieved. The 30 percent residue was primarily fiber and ash.

Experimental work indicated a need for determination of gelatinization temperatures and enzyme treatments as a condition for efficient carbohydrate depolymerization and protein extraction. Enzyme conversion was reduced slightly by gelatinization at 80°C as compared to gelatinization by boiling. Boiling, however, greatly reduced protein extraction. Gelatinization at 80°C followed by a liquefying diastase, allowed efficient carbohydrate conversion and efficient protein extraction.

Protein extraction in the pH 11.25 to pH 11.75 range appears to be optimum within yield and flavor parameters. Glutelin, about 90% of the available rice protein, has been reported as somewhat soluble in dilute acid as well as dilute alkali. Acid extractions removed considerable mineral material but almost no protein.

Attempts at flavor and odor refinement of the enzymatic carbohydrate extract met with only limited success. Activated carbon treatment largely removed color and some odor. A totally clarified extract still retained much of the objectionable bitter and grassy flavors. Deactivation of lipolytic enzymes in the X-M rice bran improved the flavor of the base product.

Prototype Development

Two base materials for the rice milk concept were prepared. They are:

(a) The combination of the enzyme digested carbohydrate extract and the alkali extracted protein. This preparation contains 68-72 percent of the starting material and 25% of these solids are protein. But this also was found to have the most serious flavor problems. A flow sheet and material balance for this preparation is presented in Figure I.

(b) The proteinaceous alkaline extract represents 30-35 percent of the original material. Although the enzymatic extraction is not performed, the alkaline extract contains 30-40 percent carbohydrate on a moisture free basis. The remainder is protein. The extract obtained had almost no objectionable bitter flavor and only a mild native grassy taste. A material balance for this preparation is presented in Figure II.

Either base material (a) or (b) has been flavored and homogenized with refined rice oil into a beverage whose composition is consistent with the nutritional objectives, and may be preserved for extended periods of time by heat sterilization making market distribution possible.

The rice milk prototype made from the base material described in (b) has been found acceptable in flavor to tasters in the laboratory. No formal panel studies or nutritional studies have been instituted at present.

The general composition comparison between this product, cow's milk and a commercial product, Vitasoy are in the following table. A rice milk beverage, Vitasoy obtained from Hong Kong and a soy milk product obtained from Taiwan are shown in the photograph in Figure III.

COMPARISON-RICE MILK, VITASOY & COWS MILK

Component	Vitasoy * Soybean milk	Rice Milk *	Cow's Milk *
Protein %	3.0	7.58	3.42
Fat %	2.3	4.00	3.67
Mineral %	0.6	0.70	0.73
Carbohydrate %	5.7	4.82	8.77
Water %	88.4	83.1	87.3
	*Analysis from bottle label and laboratory data	*Rice Milk base Alternate (b)	*Meyer, L.H. 1960, Food Chemistry Reinhold, N.Y. 385 pages

Future Work

A process will be developed to produce sample quantities for further evaluation. This will make use of pre-pilot equipment such as stainless steel jacketed kettles and a continuous solids-liquid separating centrifuge. From such equipment a process study and economic recommendation will be possible anticipating direction toward large scale product tests, process and product development.

From an expanded sample production capability quantities will be made for:

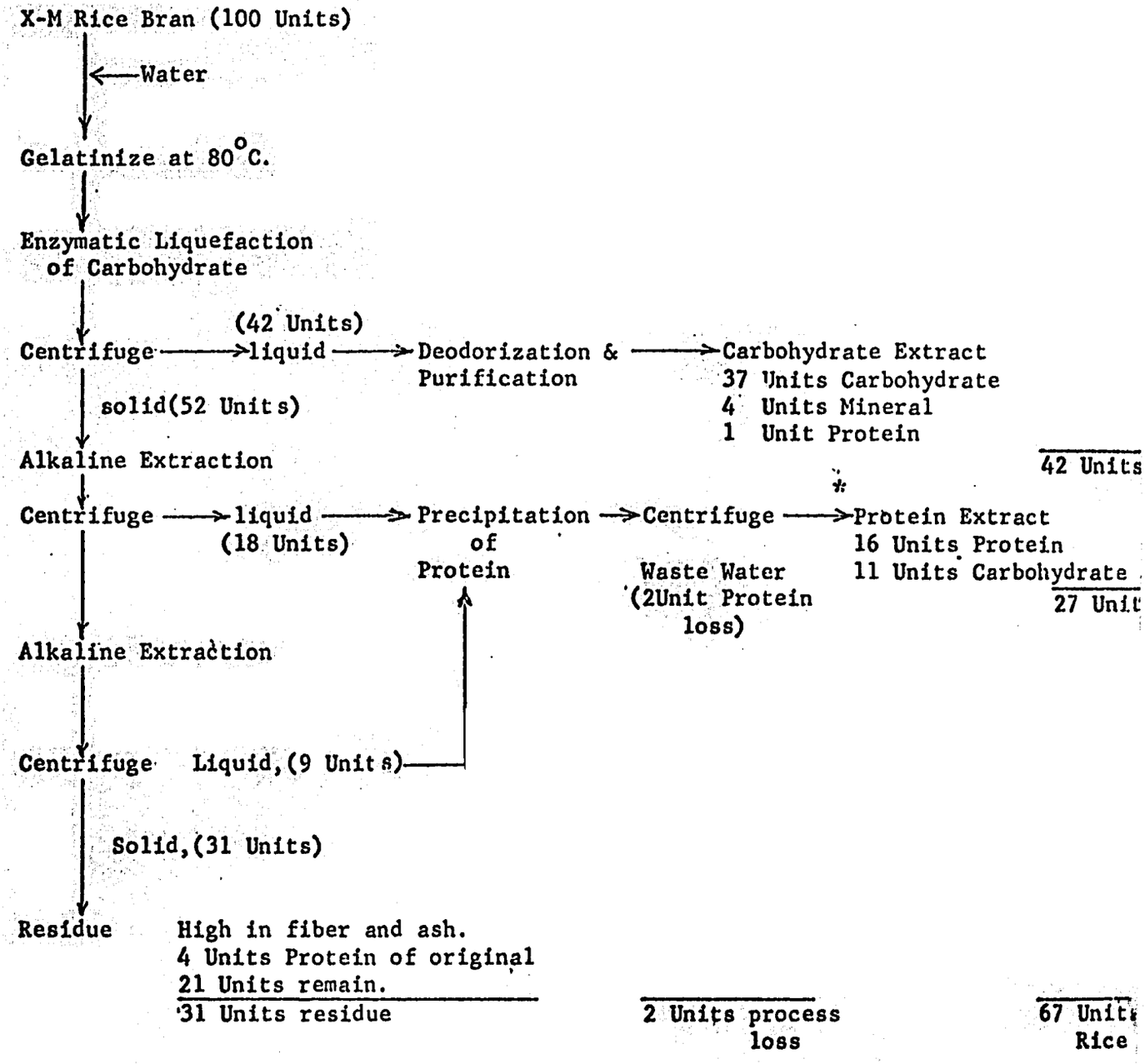
1. Stability testing by means of abusive storage in various packaging forms. Because the product as seen thus far is stable at elevated temperatures it is anticipated that it can be produced as a fully sterilized product.

2. Nutritional evaluation by means of vitamin and mineral analyses, amino acid analyses and possible weanling rat weight response if deemed desireable from the above data. From such information recommendations can be made on supplementation if any is indicated.

3. Product evaluation by means of conventional panels and profiles with adults and children will be conducted with comparisons made against Vitasoy and other definable commercial products that can be obtained in adequate quantities.

FIGURE I

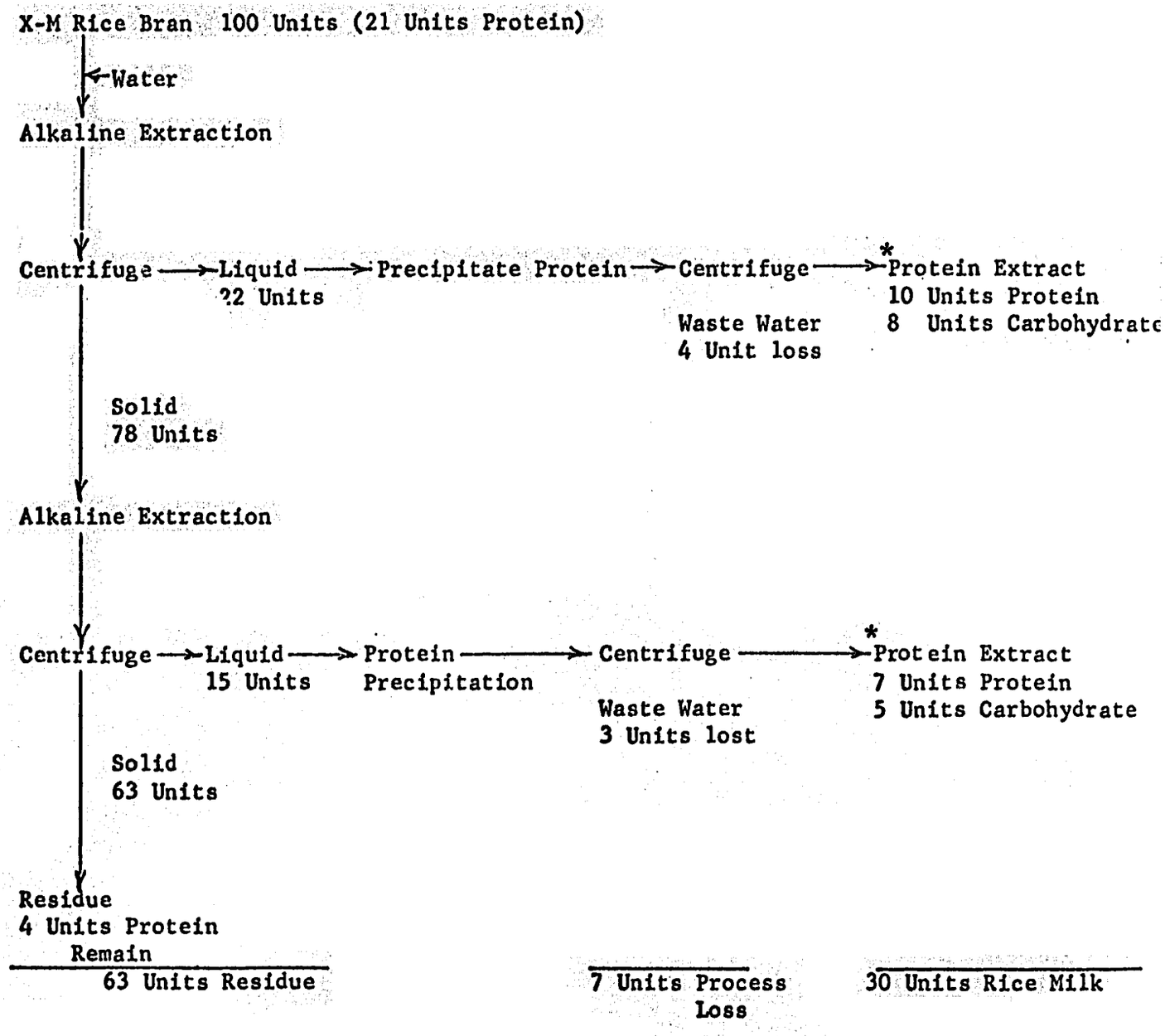
Flow Sheet and Material Balance for Rice Milk Using Enzymatic Carbohydrate and Alkaline Protein Extract



* End product carbohydrate extract and protein extract may then be used in the formulation of rice milk.

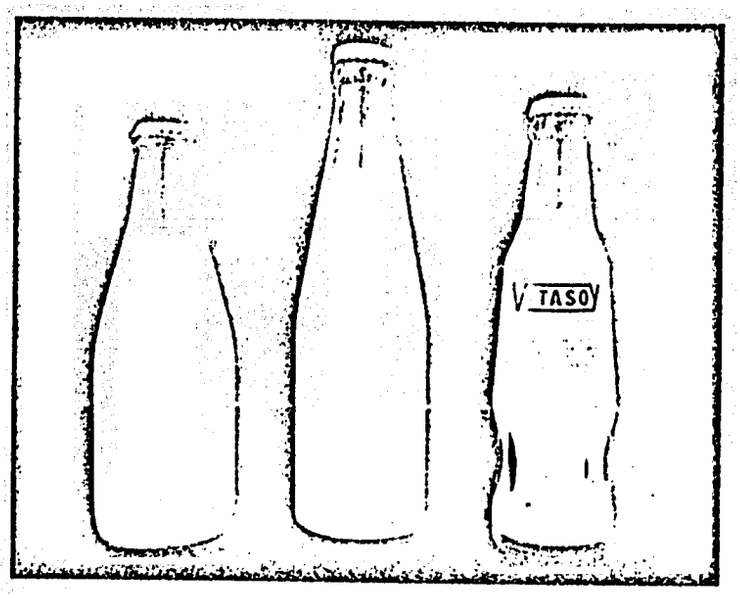
FIGURE II

Flow Sheet and Material Balance for Rice Milk Using Alkaline Protein Extract.



*. Protein Extracts may then be used in the formulation of rice milk

FIGURE III



The three products shown in this photograph are from left to right.

1. Rice milk made from a X-M rice bran protein concentrate homogenized with refined rice oil.

2. A commercial soybean milk product obtained from Taiwan.

3. A commercial soybean milk product obtained from Hong Kong.

TABLE I

COMMERCIAL ENZYME PREPARATIONS INVESTIGATED

ENZYME	ACTIVITY ON BRAN
Rohm & Haas Cellulase 36	Slight
Miles Cellulase 4000	Slight
Wallerstein Cellulase 1000	Slight
Wallerstein Cellzyme	Slight
Meiji Seika Kaisha Ltd. Meicellase	Slight
Rhozyme H-39	Good
Rhozyme P-11	Undetectable
Rhozyme S	Good
Rhozyme BP 150	Undetectable
Enzeco Bacterial Amylase Concentrate	Good
Hansens Peptolac	Undetectable
Premierzyme LA	Undetectable
Miles HT Proteolytic 200	Undetectable
Baroid Tansul	Undetectable
Wallerstein WC-8	Good
Pepsin	Slight
Papain	Slight
Reheis Pancreatin Powder	Undetectable
Rehyzme PL 600	Undetectable
Rhozyme A-4	Undetectable
Rhozyme 41	Undetectable
Ficin	Slight
Miles Protease	Undetectable

PART B

Part B. SOLID FOOD PRODUCTS

Introduction

From published literature it is evident much effort has been expended to find uses for rice bran, but little has been accomplished toward its utilization for human consumption. By the incorporation into "bar goods" or "snack foods" prototypes protein-rich X-M rice bran has shown promise as a nutritious ingredient for such foods. By using broken rice or rice flours in conjunction with the X-M rice bran a variety of extruded products were prepared.

Commercial finger food products typical of South East Asian markets were obtained and examined for characteristic flavors and textures. Prototypes were designed with these properties in mind.

Laboratory Investigation

The X-M rice bran as it comes from the X-M plant in Abbeville, La. is rather coarse, just passing a 20 mesh screen, and does not have good native extrusion properties. When the particle size is reduced to pass a 140 mesh screen extrusion is practical and the texture of the final product is greatly improved. The products from such material had a bitter taste objectionable to laboratory tasters when more than 50% X-M bran was used. When enzyme deactivated bran was used this objectionable bitter taste was reduced significantly.

Par-boiled and regular rice flours of various particle sizes were incorporated into these prototypes in order to impart cohesiveness during extrusion. The par-boiled flour was superior to regular rice flour, possibly because of starch gelatinization during the par-boil treatment.

A rice protein concentrate enhanced the extrusion and "puffing" quality of the extruded products. This protein-rich material was isolated from deactivated X-M rice bran by mild alkaline extraction followed by acid precipitation and drying. On a moisture free basis such dry extracts are 50 to 60% protein.

Prototype products were prepared on an Ambretti laboratory extruder. Premixes were made as moistened dry blends or worked into doughs depending upon composition. A wide range in extrusion conditions of temperature and moisture were explored.

Increasing temperatures during extrusion of blended X-M bran and rice flour gave increasingly more stable dry products which resembled spaghetti and pretzels when put through a round die and noodles when put through a flat die. At low moistures and relatively high temperatures, 250°F, a thoroughly cohesive character is obtained.

If the native X-M bran is replaced with a high protein content fraction derived from it, a noodle-like extrusion results that was found attractive to laboratory tasters, after fat frying in 350°F rice oil to puff and crisp it or after boiling in water or broth as a noodle material. Formulations of this type can carry up to 25% total protein.

The exploration work was targeted toward end product stability i.e. the ability to be stable and bond together, machinability without rheological problems, and edibility. Pregrinding to give uniformity to the X-M bran was found helpful. Enzyme deactivation of the X-M bran gave a definite flavor advantage in the form of a blander extruded product. All formulations from 10 to 100% X-M bran would extrude but in a formula containing more than 50% bran an objectionable taste became evident. Formulations above 20% bran drastically loose their ability to puff when fried in 350°F hot oil. Limited chemical leavening puffing work did not indicate this to be an effective approach. Many toasted extrusions tasted similar to typical American 40% bran flake breakfast cereals.

A different approach from the severe extrusion conditions was the blending of sugar stabilized fruit and vegetable pulps with X-M bran and rice flours and extruding under the lower pressures typical of sausage stuffing processing.

The formulations carried approximately 1/3 pulp such as peach, apricot, banana-pineapple, sweet potato, pumpkin, etc, at 30 to 35% solids, 1/3 X-M bran, and the remainder as variable amounts of sugar and rice flour.

These ingredients are blended and extruded as a uniform mixture. The extruded pieces are allowed to air dry or are dried in an oven where the surface case hardens into a cracker-like crust over the stable, soft-moist center. The non pulp ingredients will have a protein content higher than that found in available whole cereal grain.

All formulations have been found to respond satisfactorily to flavoring ingredients added to the blends before extrusion as well as flavorful coatings added afterwards. Meat-salt, fruit-sugar, spices and other materials have been tested.

Future Work

The direction of future work will be to take two or three formulations chosen from the spectrum of prototype products and position sufficient equipment presently on hand to make them on a continuous basis in quantities up to 10 lbs. per hour.

From such experience a very preliminary cost estimate can be prepared. The products thereby made will be subjected to abusive stability and packaging studies, nutritional evaluation through vitamin, mineral, amino acids and possibly animal feeding studies.

These products will be evaluated using taste panel techniques with adults and children. Commercial products attained from Asian areas will be used for comparison studies. Evaluation of cooking properties of these products as noodle-like foods will also be conducted in the test kitchen. Results will lead into recommendation for consumer tests and market testing in South East Asia.

Approval

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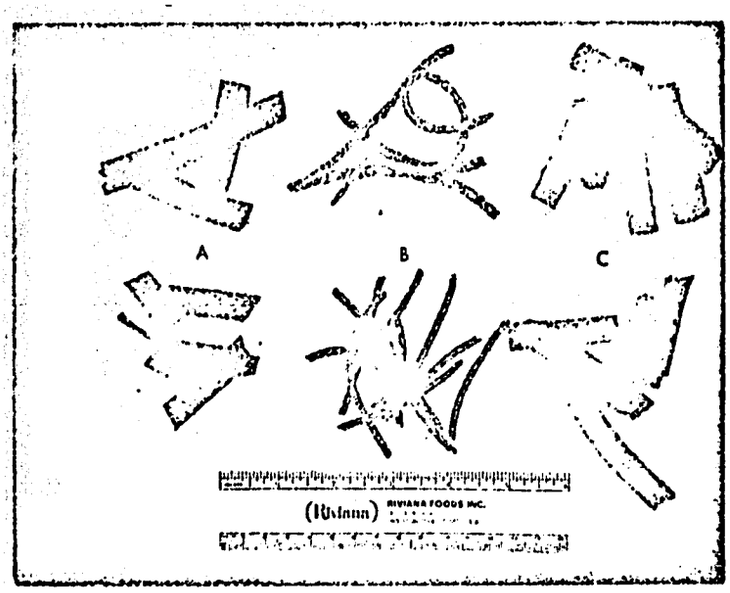
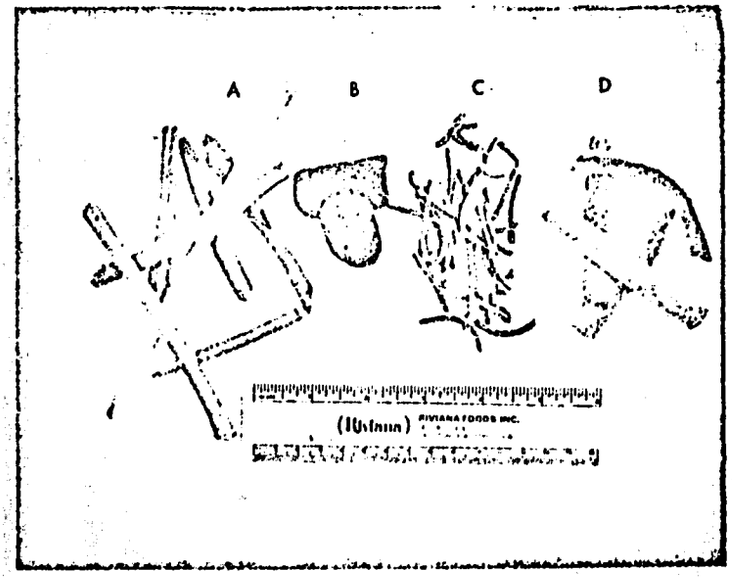


EXTRUDED PROTOTYPES OF HIGH PROTEIN CONCENTRATE
RICE FLOUR FORMULATION --25% TOTAL PROTEIN
TOP ROW PRODUCTS ARE DEEP FAT FRIED



A & C TOASTED PROTOTYPES COMPOSED OF RICE FLOUR AND X-M RICE BRAN

B SOFT-CENTER HARD SHELL PROTOTYPES FROM SWEET POTATO PULP AND X-M RICE BRAN

D FAT-FRIED PROTOTYPES COMPOSED OF RICE FLOUR AND X-M RICE BRAN

RIVIANA FOODS INC. PART III

Houston, Texas

KEY FOREIGN RICE VARIETY

X-M EVALUATION

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Research & Development Department
Project 1.007
Interim Report No. 1
Key Foreign Rice Variety X-M Evaluation
DOS Contract No. AID/csd-1583
January 25, 1968

KEY FOREIGN RICE VARIETY X-M EVALUATION

Summary

Study of the literature and direct information from governmental and private sector business interests in Thailand and the Philippines led to the selection and securing of samples of paddy rice. These samples, representing the more commercially important varieties in each country, were evaluated physically, chemically, and in laboratory milling. The laboratory milling procedures yielded information relating to estimated yield performance in conventional milling. Key varieties are being selected on the basis of these evaluations for larger scale evaluation in X-M milling. Upon receipt of the large samples from Thailand and the Philippines, the second part of this phase of the project will be completed.

KEY FOREIGN RICE VARIETY X-M EVALUATION

In keeping with the Work Outline dated 7/14/67 (attached), the project has been divided into two parts:

Part I - The evaluation of small samples in laboratory scale to determine the physical, chemical, and milling characteristics of the foreign varieties which would lead to selection of certain varieties for larger scale milling tests in conventional and X-M milling.

Part II - Comparative milling of selected key foreign varieties to determine the projected overall added value of X-M milling in terms of rice yields, oil, and bran.

The results of the Part I study are reported herein.

Conclusions

1. All except one of the Philippine varieties evaluated are very similar in terms of physical and chemical characteristics as well as milling yields. The four most important varieties are of a long grain type while one, Binato, is a medium grain type.

2. The Thailand rices are long grain types when compared on the basis of grain dimensions. Two samples evaluated are the waxy type and the remainder are the standard type.

3. One of the waxy types and one of the standard types yielded bran with about 20% fat.

4. The milling quality (yield) of the Thailand rice varied from extremely poor (35 lbs head/bbl) to extremely good (102 lbs head/bbl).

5. No problems are anticipated in the processing of any of the varieties in X-M milling, except from a material handling standpoint, i.e. excessive requirement for handling broken rice.

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Direction of Further Research

1. Proceed to obtain 4000 - 5000 lbs of brown rice, IR-8, from the Philippines for large scale milling tests. IR-8 is selected because of its characteristics and increasing economic importance.

2. Select at least two, and possibly three, of the Thai varieties on the basis of availability, high oil content, and estimated yield. A variety indicating low head rice yield will be included, provided it is commercially important in terms of availability. Information concerning availability and importance of each variety is being obtained from Dr. Lewis Wrenshall, Applied Scientific Research Corporation of Thailand; Mr. Chitr Kamolsiri, The Thai Rice Co. Ltd.; and Dr. Sala Dasananda, Ministry of Agriculture, Thailand.

3. Upon receipt of brown rice, proceed as soon as possible to implement remainder of project - as presented in work outline of 7/14/67.

General Discussion

Through the help of the International Rice Research Institute, Applied Scientific Research Corporation of Thailand, the U.S.D.A., The Rockefeller Foundation, and several other governmental agencies and private sector business firms, samples of rough or paddy rice were received from the Philippines and Thailand. Five samples of paddy were obtained from the Philippines and ten from Thailand which were reported to be of substantial economic importance to the respective countries and to be typical of the quality of normal production.

These samples were evaluated in the laboratory to learn as much as possible about the rice in terms of physical characteristics, general chemical composition, and control (conventional) milling characteristics. This was done to categorize the rice into various types and identify, if possible, potential problems in utilizing the X-M milling process for milling these foreign rices. This work was necessary in order to help select the important few varieties for X-M milling experiments.

Scope of Work

The following information was obtained on each sample of rice received:

..... 3

A. Milling

1) Head and total yield in standard laboratory milling. Laboratory millings were conducted in the McGill #3 Laboratory Mill using procedures established by the United States Department of Agriculture for estimating yield in terms of whole grain and total rice yield.

2) Material balance - rice, bran, and hulls

3) Bulk density of paddy

4) Subjective quality appraisal

B. Chemical Composition

1) Rice
2) Bran
3) Hulls

- % Fat
% Moisture
% Protein
% Crude Fiber
% Ash

Results

See attached data.

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Approved:

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TABLE I

THAILAND RICE

Physical Characteristics

Variety		Milling Yield % Head	Milling Yield % Total	Milling Yield Lb/Bbl Head	Milling Yield Lb/Bbl Total	Bulk Density	Material Balance From Lab Milling Gms Rice	Material Balance From Lab Milling Gms Bran	Material Balance From Lab Milling Gms Hulls	Comments
Pin Gaew-56	A	33.4	65.3	54.1	105.8	.5916	653	135	201	Similar to U.S. rice in appearance
	B	22.4	61.7	36.3	100.0		617	170	215	
Gam Pai-41	A	45.0	68.6	72.9	111.1	.568	686	61	242	Bug eaten. Milled rice has chalky appearance to it. Possibly genetic.
	B	42.8	66.8	69.3	108.0		668	88	242	
Nahng Mon S-4	A	33.0	66.0	53.5	106.9	.568	660	83	247	Bug eaten. Very good looking milled rice.
	B	28.0	64.7	45.3	104.8		647	92	256	
Bahng Khem-293	A	49.6	70.5	80.4	114.2	.617	705	90	198	Bug eaten. Some hulls with no grain in them. Rough rice seems to be a little immature when harvested.
	B	40.6	67.4	65.8	109.2		674	90	234	
Leb Meu Nahng-111	A	15.0	65.7	24.3	106.4	.604	657	110	223	Small amount of shelled grain present in rough rice slightly bug eaten.
	B	9.3	61.1	15.1	99.0		611	152	232	
Puang Nahk-16	A	63.0	71.6	102.1	116.0	.604	716	82	193	Dark spot on barb end of grain. Milled rice looks very well.
	B	55.8	69.8	90.4	113.1		698	88	214	
Tapow Gaew-161	A	27.4	66.7	44.4	108.1	.592	667	95	224	Some shelled grain present in rough rice. Milled rice has good appearance.
	B	22.0	67.3	35.6	109.0		673	105	220	
Khi Tom Yai-98	A	32.5	68.6	52.7	111.1	.568	686	68	228	Slightly bug eaten. Dark ridges and areas on rough rice grains. Milled rice has chalky appearance.
	B	27.2	64.4	44.1	104.3		644	100	250	
Khao Tah Haeng-17	A	31.0	68.3	50.3	110.5	.592	683	70	224	Small amount of red rice bug eaten very little. Milled rice looks good.
	B	26.1	66.6	42.3	107.9		666	100	232	
Leuang Pratew-28	A	33.6	66.5	53.5	107.9	.592	665	87	227	Bug eaten very much. Dark areas on hulls; no special area.
	B	25.4	64.1	41.1	103.4		641	124	234	

1/25/68

THAILAND RICE

Chemical Composition

Variety		% Fat			% Moisture			% Protein			% Crude Fiber			% Ash		
		Rice	Bran	Hulls	Rice	Bran	Hulls	Rice	Bran	Hulls	Rice	Bran	Hulls	Rice	Bran	Hulls
Pin Gaew-56	A	0.51	15.3	1.26	10.6	9.1	8.4	7.42	10.75	3.0	0.33	9.95	39.60	0.51	6.5	16.4
	B	0.28	13.27	1.08	11.4	10.1	9.4	6.84	10.55	2.5	0.66	5.72	46.64	0.27	5.24	16.23
Gam Pai-41	A	0.79	24.9	1.06	9.9	7.9	8.5	8.28	15.8	3.03	0.34	-	44.15	0.49	7.17	23.66
	B	0.60	21.15	0.97	11.1	10.0	9.0	6.84	13.65	2.4	0.34	8.78	81.06	1.25	6.91	18.51
Nahng Mon S-4	A	0.69	16.0	1.10	9.8	8.2	8.7	7.9	11.1	7.09	0.085	22.18	42.32	0.37	9.31	17.51
	B	0.41	17.90	0.85	12.2	12.4	10.4	8.12	12.0	3.4	0.11	10.43	49.34	1.16	7.37	19.0
Bahng Khem-293	A	0.58	17.0	1.03	9.8	8.7	8.5	8.25	11.61	3.34	0.24	20.47	41.02	0.32	8.74	17.49
	B	0.42	19.68	0.49	12.0	12.8	11.0	7.67	14.75	1.3	0.46	9.99	46.97	0.35	6.84	18.52
Leb Meu Nahng-111	A	0.52	11.9	1.10	9.5	8.8	8.3	8.16	11.5	3.22	0.18	7.63	44.27	0.19	4.91	19.05
	B	0.40	11.76	0.36	14.4	12.0	10.6	7.27	11.2	2.8	0.13	5.24	40.52	0.52	3.78	18.27
Puang Nahk-16	A	0.45	19.6	1.18	10.5	8.5	8.6	9.53	12.41	4.71	0.15	20.12	46.85	0.27	10.14	15.3
	B	0.36	21.11	0.54	11.2	10.2	9.8	7.23	12.7	3.4	0.13	10.17	53.65	0.31	8.76	14.69
Tapow Gaew-161	A	0.45	12.7	1.01	10.2	8.2	8.4	9.03	11.84	3.21	0.14	11.92	39.46	0.31	5.58	17.16
	B	0.36	15.37	0.36	10.6	9.8	9.0	9.66	10.9	2.8	0.12	7.93	49.06	0.81	3.10	9.26
Khi Tom Yai-98	A	0.78	15.3	3.74	8.8	8.1	8.5	8.12	12.19	3.80	0.305	19.54	47.68	0.45	11.10	18.89
	B	0.48	16.91	0.56	11.6	13.2	10.6	9.43	14.3	1.87	0.12	6.91	45.46	0.27	5.17	14.7
Khao Tah Haeng-17	A	0.33	14.74	0.96	11.9	9.6	7.7	8.22	13.93	4.29	0.15	12.50	46.07	0.38	8.36	19.5
	B	0.28	16.18	0.61	12.8	13.0	10.0	7.74	11.2	2.58	0.085	9.58	44.00	0.26	7.96	18.79
Leuang Pratew-28	A	0.56	12.88	0.73	11.8	10.1	8.3	9.14	12.84	4.58	0.07	8.59	45.47	0.39	7.71	18.46
	B	0.33	13.96	0.36	11.0	10.0	9.4	10.10	10.75	2.19	0.17	8.62	41.96	1.80	5.34	18.9

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TABLE III

PHILIPPINE RICE

Physical Characteristics

Variety		Milling Yield				Bulk Density	Material Balance From Lab Milling			Comments
		% Head	% Total	Lb/Bbl Head	Lb/Bbl Total		Gms Rice	Gms Bran	Gms Hulls	
IR-8	A	55.2	72.3	89.4	117.1	.631	723	72	193	Noticeable musky odor. Milled rice has molded color. Chalky area on belly side of the grain.
	B	47.1	69.8	76.3	113.1		698	93	202	
Intan	A	54.0	70.9	87.5	114.9	.645	709	90	189	Large amount of red rice appears to be a mixture of long grain and medium grain.
	B	41.1	61.7	66.6	100.0		617	140	226	
BPI-76	A	61.1	69.1	99.0	111.9	.604	691	136	164	Dark area near barb end of kernel. Noticeable odor in milled rice. Chalky area on belly of grain.
	B	40.1	66.8	65.0	108.0		668	95	233	
Peta	A	57.3	71.0	92.8	115.0	.645	710	77	200	Some shelled grain noticeable. Heat damaged grain noticeable. Slight musky odor.
Ordinary Binato	A	49.5	65.0	80.1	105.2	.604	650	100	220	Large amount of red rice present in rice, approximately 40%. Long barb on rough rice. Bran has rusty color. Small amount of stack burned.

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TABLE IV

PHILIPPINE RICE

Chemical Composition

Variety		% Fat			% Moisture			% Protein			% Crude Fiber			% Ash		
		Rice	Bran	Hulls	Rice	Bran	Hulls	Rice	Bran	Hulls	Rice	Bran	Hulls	Rice	Bran	Hulls
IR-8	A	0.35	18.6	1.02	10.9	9.4	8.6	9.01	13.75	2.03	0.12	13.39	52.05	0.34	11.42	20.57
	B	0.29	12.12	0.74	13.2	12.4	12.2	9.10	13.95	2.44	0.27	7.53	48.16	1.22	9.17	19.36
Intan	A	0.32	17.5	1.01	11.0	9.6	8.9	6.04	11.75	2.88	0.11	12.38	39.92	0.25	13.5	23.36
	B	0.23	12.49	0.34	14.6	15.4	15.0	7.05	10.8	2.28	0.23	9.49	44.25	1.71	8.36	17.48
BPI-76	A	0.32	12.3	2.91	10.3	9.3	8.6	9.89	9.32	2.31	0.16	26.62	42.60	0.66	16.66	22.82
	B	0.39	16.32	0.15	11.8	11.2	9.6	11.20	14.55	2.52	0.27	11.76	42.03	2.00	8.92	22.0
Peta	A	0.42	21.8	1.11	10.3	9.7	8.4	9.69	13.75	2.98	0.10	12.88	43.35	0.37	11.99	21.3
Ordinary Binato	A	0.30	14.97	0.65	9.7	13.2	12.1	8.46	13.08	3.50	0.19	13.30	45.41	0.44	9.99	20.87

WORK OUTLINE

Project 1.007 - Key Foreign Rice Variety X-M Evaluation

GENERAL OBJECTIVE

To determine the projected overall added value, in terms of rice milling yields, oil and wax yields, and high protein bran properties, which would be derived from the X-M solvent extractive milling processing of selected foreign rice varieties.

DETAILS OF WORK PLAN

1. Secure through the available literature, information relating to the types and varieties of rice produced in Thailand and the Philippines to determine:
   a) the principle types and varieties based on annual production and usage trends,
   b) the characteristics of those identified in 1,a).

In addition to that information found in the literature, obtain advice concerning identification of principle types and varieties through industrial and governmental contacts in the Thailand/Philippines areas as well as local USDA contacts.

2. Select types and varieties for evaluation based on the results of 1 and secure sample of each variety selected. Approximately 50 lbs. of each variety from at least four (4) localities would be needed for the first phase of the evaluation. These samples should be of paddy rice and representative of normal post harvest handling.

If feasible, prior to selection of varieties for the 50 lb. samples, secure small (2-5 lbs.) samples of several varieties for initial screening and aiding in selection of the larger samples.

a) Upon receipt of samples determine the following:
   1) Milling yield (McGill Mill)
   2) Bulk density
   3) Physical material balance
   4) Chemical composition of hulls, bran, and rice:
      % Fat
      % H_2O
      % Protein
      % Crude Fiber
      % Ash

In order to establish realistic controls for milled rice quality, secure sufficient samples of typical milled rice representative of that used for consumption in the Philippines and Thailand and, if applicable, that sold through export channels.

3. After initial evaluation, select key types or varieties for further evaluation. Obtain about 6,000-8,000 lbs. of each type paddy rice to be further evaluated in pilot scale conventional and X-M milling.

4. Upon receipt of large samples, mill about 2,000 lbs. through conventional (Satake pearler) mills which have been isolated for total recovery of rice and bran for evaluation of yield through conventional equipment. This should be done by experienced miller, probably in Houston, and milled to an equivalent degree of bran removal typical of that normally produced in the respective countries.

5. During milling on conventional equipment, collect bran removed and immediately transfer to 55 gallon drums containing hexane in order to secure substantial quantities of solvent extracted bran. These samples should then be evaluated for complete chemical composition and properties in selected applications.

6. In conjunction with item 5, retain miscella for subsequent filtering and oil recovery using pilot equipment with the objective of securing about 2 gals. of crude oil.

Note: It would be extremely difficult to obtain oil and extracted bran from the rice being evaluated in the X-M plant, even with isolated mills. Therefore, even though the X-M process is not being duplicated, it is believed that obtaining bran and oil as described in items 5 & 6 is the best approach. Specific details for accomplishment of items 5 & 6 to be completed later.

The crude oil will be subjected to complete chemical evaluation including fatty acid ester composition via GLC. The oil will also be refined, bleached, and deodorized.

7. After completion of item 4, the remainder of the rice will be transferred to Abbeville for evaluation of X-M milling on the rice in mills isolated from the regular X-M milling operation. These tests are to be conducted in a manner similar to the yield optimization project just completed. That is, the test rice will be treated with rice oil manually, conditioned, and fed to the isolated mills through hoppers which are provided.

Optimum conditions presently being used in the X-M milling operation will be used for initial work. The entire rice stream will be collected but since the miscella used will be common to the normal operation, no attempt to collect bran or oil will be made because of contamination with oil and bran from American varieties.

8. After initial milling in the X-M mills, key process variables will be studied including:

a) Treatment oil concentration
b) Treatment time
c) Rice Feed rate
d) Number of breaks

9. Rice obtained from X-M milling, (items 7 & 8) and conventional milling (item 4) will be compared for cooked rice characteristics.

10. In order to supplement comparison of X-M head and total yields to conventional and McGill laboratory milling, solicit assistance from the USDA for determining theoretical or maximum possible yields. This will allow a three way yield comparison, i.e., conventional, laboratory estimate, and total theoretical.

GENERAL

Specific details concerning exact conditions and specific analysis required will be developed later. During the course of the work, special note will be made of characteristics important to the design of X-M units and processing in these units.

When the work is completed, thoroughly appraise the results as outlined in Specific Objective #4, Project Agenda, with particular emphasis placed on the specific needs of each country, such as "total yield" in the Philippines and "head yield" in Thailand.

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APPENDIX

PROJECT AGENDA SHEETS

Sub-Project 1.007	Key Foreign Rice Variety, X-M Evaluation
Sub-Project 7.003	Development of Protein-Rich Foods Based on X-M Rice Bran
	Part A - Beverage Base
	Part B - Solid Food Products
Sub-Project 7.004	Development of Rice Oil Miscella Refining Technology

PROJECT AGENDA FY-'67-'68

Project 1.007 - KEY FOREIGN RICE VARIETY X-M EVALUATION

EVALUATION OF X-M SOLVENT EXTRACTIVE MILLING TECHNOLOGY FOREIGN RICE VARIETIES

DOS Contract No. AID/csd-1583

GENERAL OBJECTIVE

To determine the projected overall added value, in terms of rice milling yields, oil and wax yields, and high protein bran properties, which would be derived from the X-M solvent extractive milling processing of selected foreign rice varieties.

BACKGROUND and SIGNIFICANCE

While the advantages of the X-M process as applied to milling major domestic varieties have been reasonably well identified and documented during 1966, potential advantages to more rice dependent areas of the world remain to be determined, using varieties most favored in foreign agricultural and/or diet preference. By like token, it is important to determine which varieties lend themselves most readily to highest yield upgrading via X-M processing, so that pre-investment surveys may be oriented toward most propitious varieties. It is likely, in view of the different rates, operating conditions and results already found, e.g., with domestic Bluebonnet long grain vs Nato medium grain, that wide differences will be encountered with foreign varieties which must bear upon technical-economic evaluation and planning for X-M technology as applied to these varieties. Finally, and importantly, based on regression analysis it was noted with some U.S. varieties that the poorer the rice variety and specific lot involved the greater the yield advantages for X-M over conventional milling; this factor could be even more important overseas than domestically.

SCOPE

While this project, dependent on initial results, should eventually be applied broadly to evaluation of all major foreign varieties because of the possible broad-scale impact on food supply, i.e., Far East, Near East, Latin America, the initial scope and budget are restricted to selection and evaluation in depth based on two key varieties, preferably prevalent in S.E. Asia and specifically occurring in Thailand and the Philippines.

As a corollary to yield and related points of comparison, this evaluation should also try to uncover any now unforeseen design or operational problems which may derive from X-M milling of rice, and which would bear upon pre-investment surveys by Riviana or potential X-M licensees.

SPECIFIC OBJECTIVES

1. To select several varieties for evaluation based on availability, local usage and trends, local export price and volume, data on existing conventional yields and related factors.

2. To obtain representative samples, illustrative if possible, not only of the variety but also of probably prevalent storage and drying practice, since these factors will have a bearing on yield increments.

3. To test mill these varieties on small and large scale, adjusting the process insofar as possible to optimize results, and with the large scale milling results restricted to two varieties and contrast results with conventional milling.

4. To appraise comparative rice yields (whole grain and total) and quality, oil and wax yields and quality, X-M high protein bran yields and properties, and processing rates and problems.

TIMING

This project, which is part of A.I.D./csd-1583, must be completed before June 30, 1968 to the point of recommendation in detail for such economic studies, large scale product tests, market tests, further product development or engineering work as may be required in Phase II and Phase III.

BUDGET

Phase I, $8,000

Project 7.003 DEVELOPMENT OF NUTRITIOUS, PROTEIN-RICH CONSUMER FOOD PRODUCTS FOR S.E. ASIA BASED ON X-M RICE BRAN

DOS Contract No. A.I.D./csd-1583

GENERAL OBJECTIVE

To develop several nutritious consumer food products based on projected availability of a source of X-M rice bran oriented toward use of other inexpensive raw materials in S. E. Asia, including "bar good" products and a beverage.

BACKGROUND AND SIGNIFICANCE

Conventional rice bran is extremely unstable in storage, contains about 12% protein, is bitter and branny in flavor, typically is bacteriologically unclean and, because of these and related factors, has not been successfully employed as a human food ingredient despite its abundant availability even in the heavy rice consuming areas of S. E. Asia. The new X-M bran, on the other hand, is characterized by a bland, almost sweet flavor, is relatively white and clean looking, is vastly more stable and can easily be stabilized further for storage or usage in food processing and contains 18 - 20% protein with a good amino acid balance.

1. The Agency for International Development has estimated that in the developing countries there are some 667 million children under 15 years of age and currently some 269 million are suffering serious malnutrition. The Food for Peace donations reach about 15% of the 7 to 14 years group with milk and grain foods, but only 2% of the pre-school group are reached.

Nutritionally deprived children are found in Asia, Latin America, and Africa's developing areas. A protein-rich food supplement that is derived from rice would not be foreign to any group. Such a supplement ideally would lend itself to addition added to the diet as a dry powder which can be prepared into a colloid-like milk type drink or as a base for soup type products or gruels. Such a material can be made from the portion of the rice kernal which until now has been discarded, but contains in excess of 20% protein, most of the grain's vitamin content, required minerals such as calcium and phosphorus and finally, is an excellent energy source. The fiber content is low enough to be non-irritating to the gut.

2. Wafers. crackers, biscuits and bar goods are found and accepted in almost all cultures. Many areas with substandard transportation and little refrigeration are unable to utilize fruit and vegetable crops other than to the extent which they can be

consumed or sold locally before spoilage.

Products with moderate shelf life can be utilized in developing countries by being incorporated into distribution systems such as the street hawkers of Thailand, Philippines, Indonesia, etc., and the peddlers of Latin America. High acceptance of fruit flavored foods already exists in these areas.

SCOPE

This project is to be directed to explore the feasibility of capturing the advantages inherent in the new, relatively stable high-protein X-M rice bran to develop human food products using X-M bran as a raw material or important ingredient which will be acceptable to consumers, particular reference to S. E. Asia but with relevance elsewhere as well.

TIMING

This project, which is part of A.I.D./csd-1583, must be completed before June 30, 1968 to the point of recommendation in detail for such economic studies, large scale product tests, market tests; further product development or engineering work as may be required in Phase II and Phase III.

SPECIFIC OBJECTIVES

1. To develop background information on regional preferences in fruits, vegetables and protein food plus existing Technologies through search of scientific, legal, commercial, and socio-economic literature.

2. To obtain samples of beverage and dried and/or baked foods currently eaten to establish characteristics of flavor, texture, shape etc. with sufficient objectivity to define model products for development.

3. Based on the accumulated information obtained in Specific Objectives 1 and 2 and on known chemical, physical and nutritional properties of X-M rice bran to identify the product concepts and development approaches most likely to find acceptance by the intended users.

4. To investigate the technical, nutritional, and economic feasibility of a beverage concept and a solid food concept in the laboratory and to develop the process for making prototypes through pilot plant studies of sufficient size to produce samples for preliminary nutritional performance and acceptance information as well as the necessary data to permit an exploratory economic evaluation of the products.

5. If warranted by progress in attaining the other objectives develop the requirements for Phase II to carry highly promising products through further development, acceptance tests, and test markets.

BUDGET

Phase I $71,000

Project 7.004 DEVELOPMENT AND APPLICATION OF MISCELLA REFINING TECHNIQUES TO RICE MILLING TECHNOLOGY

DOS Contract No. A.I.D./csd-1583

GENERAL OBJECTIVE

To develop and/or adapt miscella refining techniques specific for rice oil produced by the new X-M technology to render in-line refining economically feasible in foreign X-M plants for the production of edible oil.

BACKGROUND AND SIGNIFICANCE

Crude X-M oil is a concomitant product of the X-M rice solvent extractive milling process regardless of mill size, and hence will accompany even relatively small as well as large scale plants. This is so principally because of the basic technological innovation wherein the bran and rice are oil-extracted virtually concurrently with the bran removal from the rice endosperm. Solvent extraction of conventional bran from traditional abrasive milling, on the other hand, is only feasible on a massive scale and has been attendant by so many practical difficulties in storage, transport, conventional bran instability, complex extraction technology and logistical problems, that rice bran oil is not a widely produced commodity, even in oil deficient areas in which rice is a basic food ingredient.

While crude oil is readily available via the X-M process, its upgrading to edible oil would entail the burdens of toll refining fees where refining capacity exists and can be negotiated, transport and storage problems and conventionally large refining losses. Indeed, in some areas of S. E. Asia refining might not be possible and this potentially valuable concomitant product of X-M technology would be wasted. Hence, if feasible at probable volume levels, in-line refining could provide a strong economic boost to X-M attractiveness as a logical investment for joint ventures and licensees by making available high-quality edible oil even in rice areas remote from refineries. Also, since X-M rice milling involves use of thin miscellas, in-line refining theoretically should require far lower levels of capital and expense per barrel of oil than separate oil refining.

SCOPE

This project should seek to collect, collate and evaluate known information on miscella refining, adapting or developing and demonstrating most promising techniques for an economical in-line X-M refining process which is of practical value in S. E. Asia but relevant elsewhere as well. The development should take into account rice varietal availability in Thailand and the Philippines specifically, as well as desired product attributes and probable end-use markets for the edible oils so produced.

Ideally, the in-line refining technique should be developed to be feasible as a self-contained unit within or for small or remote X-M plants for operations in the rice growing areas of developing countries, where sophisticated oil technology will be unavailable.

TIMING

This project, which is part of A.I.D./csd-1583, must be completed before June 30, 1968 to the point of recommendation in detail for such economic studies, large scale product tests, market tests, further product development or engineering work as may be required in Phase II and Phase III.

SPECIFIC OBJECTIVES

1. To search the scientific and patent literature for possibly related prior art, with assistance of Counsel as required in search or interpretation.

2. To obtain possibly competitive samples from abroad and to characterize these as to objective and subjective properties in order to establish targets.

3. Based on the literature, supplier contacts and other sources of information, to identify the approaches most likely to warrant development.

4. To investigate the technical and economic feasibility of the approaches selected from No. 3 at the bench level and to develop at least one through small pilot level studies in order to obtain data and samples permitting evaluation of the approach to the point of a recommendation.

BUDGET

Phase I $81,000