PD-ABJ-792

SWAZILAND WEANING FOOD PROJECT
FINAL REPORT

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David Gottneid

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Penelope M. Johnson

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PROJECT SUSTAIN

SWAZILAND INFANT WEANING FOOD PROJECT

I. Development Program Recommendation

Background

The Improved Infant and Child Feeding Project is jointly funded by UNICEF/Swaziland and USAID. The Swaziland National Nutrition Council manages the project.

Feeding behaviors have been analyzed through data gathered by household surveys and focus groups. Currently, a communication strategy and associated materials are in preparation.

Problem

Weaning food is typically made from traditional thick porridge thinned with (cold) water. This practice dilutes caloric density and can introduce unboiled water to infant food.

Objective

To develop a product, devise a delivery strategy, and implement a program in Swaziland that makes available to infants' mothers a safe, culturally acceptable, affordable malt. An amylolitic reaction thins traditional thick porridge to a consistency readily accepted by infants.

Technical - Resolve issues of sanitation, effectiveness and consistency of sorghum malt. Recommend malting and manufacturing plan.

Program - Develop packaging, delivery system, benefit communication usage directions, verification research, distribution channel, administration, and financial parameters.

PROGRAM SUMMARY

The weaning food project objectives would be satisfied by an independent and self-sustaining program. To initiate, develop, and verify the program in Swaziland requires professional, technical, and engineering expertise for production start-up, as well as continuing marketing management through the distribution channel. Initial operating expense would be required to support packaging development and consumer research. Capital investment is needed to support start-up of controlled malting, milling, and packaging facility at MITC.

The recommendation is to create a controlled malting facility at the Manzini Industrial Training Center. Packaging and printing could also take place there. The new facility is recommended because surveys of existing Swazi facilities for production, packaging, and distribution did not yield an appropriate alternative for commercialization. The program meets the determined need to deliver an effective, sanitary product that users could easily and willingly adapt into existing feeding behaviors and provides a new opportunity in Swaziland for vocational training and business start-up. IN OTHER WORDS, THIS IS A VENTURE NO COMMERCIAL FIRM WANTS, PROBABLY BECAUSE IT WILL NEVER PAY. WILL IT, therefore, be SUSTAINABLE?

Technical and consumer research support is driven by an unquestionable need for assurance that the product: works as designed; affects nutritional needs positively and predictably; has minimum 6 month shelf life; usage is clearly communicated and followed.

Distribution is recommended through the national clinic system to capture the credibility of the health care provider's recommendation to provide qualified training motivation, observation, and results reporting. WHAT DOES THIS MEAN?!

Branding and marketing recommendations flow from two points: (1) Branded Red Hat or Happy Baby promotes association with health care; (2) The critical mass necessary for a commercially viable investment is not promised by the available target population in Swaziland (25,000). Purchase interest is not established. Further, it is estimated that time, measured in years, could be required to assimilate use of the product into the cultural practices of Swaziland since the nutritional benefits are not immediately observable by the user.

OR SO WE ASSUME

IN other WORDS, WE have no IDEA if ANYONE will buy this stuff AND, EVEN if they were, we couldn't sell ENOUGH to cover costs.

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THE PRODUCT

WHAT IS 'APROPRIATE' IN THIS CASE?

A daily requirement of malt is packaged in single-use, clear, printed cello package. Dosage is (appropriately) sized to thin the amount of porridge normally consumed by a 4-12 month old infant. Thirty cello packets are delivered in a cardboard canister with reclosable plastic lid. Usage instructions are printed on the canister and illustrated with line drawings for clarity. "Baby's own" cup may be delivered with first presentation. GIVEN SSS EXPERIENCE, ONE CAN PREDICT WHAT WILL HAPPEN WHEN MOTHERS MIX THIS STUFF.

The canister is a packaging form familiar to mothers of infants. It carries a strong association with baby food. Dry fourmulas are marketed in canisters and the typical cylindrial can is used for wet formulas.

The reclosable "container" provides a special protected place to store the malt in the home, and may add to shelf life, depending materials used in manufacture. Initial delivery of product in the "daily dose" cello packs is strongly recommended to reinforce the new behavior. WHAT IS THE 'DAILY DOSE'?

Consideration could be given to structuring the canister as a baby cup for the first delivery. CARDBOARD? The cello packs would be stacked inside, sealed with the plastic lid. Should the product later become commercially available, the same canister could be used to deliver malt that is measured out in the home.

The product is introduced through the clinic system at the monthly well-baby check-up. Some product cost recovery could be considered by charging a nominal sum. Monies thus collected could be returned to the Health Ministry to create a revenue stream.

INVITATION TO DISASTER. GOVERNMENT BUREAUCRACIES ARE NOTORIOUSLY INEFFECTIVE AT THIS KIND OF THING. FEEDING PROGRAMS IN CLINICS ALMOST NEVER WORK.

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DEVELOPMENT ACTIVITIES/RESEARCH

1. Production

SOURCE ?

A small controllable sorghum malting facility is recommended to be established, possibly at MITC. Technical malting and engineering expertise are necessary to set up a malt production facility and ensure product quality. Basic steps in malt production process are:

Rigorous cleaning of the grain
Steeping: temperature, pot, aeration
Germination: moisture temperature, aeration
Kilning: sulfured
Shoot and root removal
Milling
Packaging: moisture barrier type

Investment in a small hammer mill and packaging equipment required. Printing design and production are also available at MITC and require investment. TRAINING IN MILL USE ? MAINTENANCE ?

Benefit - Vocational and business training not otherwise available to young Swazis.

Alternative - Purchase brewers malt from Swaziland. Brewers Ltd. Estimated cost R 1.45/kg. Will require milling and packaging operations.

2. Research - Technical

? NOT DONE YET ?!

a. Identify malt product
b. Determine packaging
c. Shelf-life study - real use conditions in Swaziland. Technical assistance in study design and product safety recommended.
d. Evaluation of chemical, biological, and nutritional aspects of malt-thinned porridge with respect to Swazi infant feeding practices and nutritional needs. ??

3. Packaging Development

a. Suitable material to offer shelf life and product protection, and to meet printing needs and production requirements.
b. Develop instructions and artwork.
c. Source and cost materials.
d. Procure packaging equipment.

TALL ORDER !

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WEANING FOOD PROJECT - SWAZILAND
PROGRAM SUMMARY

	RECOMMENDATION	SOURCE	ALTERNATIVE	CRITICAL ISSUES
PRODUCT	Ground Sorghum Malt	Swaziland	Imported brewers malt or flour malt	Functional and safe
PACKAGE	Moisture barrier & limited servings size. Clear printed cello.	Locally	Paper board container with measuring spoon	Directions for use. Brand recognition device. Product integrity, shelf life & cost
PRODUCTION	Small controlled melting facility	MITC Adapt modern technologies	Import total package w/o adapting	Controlled reproducible process
DISTRIBUTION	Clinics	Health Ministry		Accessibility
REVENUE	Product: Price at cost Money: Flat fee to producer	UNICEF donors	Free sample for first year	Revenues collected at clinics return to Health Ministry
ADMINISTRATION	UNICEF/Health Ministry	Rodney Phillips Juliet Aphane	US AID NO!!	Continuity follow-up. Process refinement. Funds reinvested in project.
BUSINESS	Not for profit	----------	None recommended	Give away devalues long-term. Must be affordable to rural. Projected critical mass not sufficient viable commercial product year 1.

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4. Research - Consumer

   a. Home use trials

      Produce test sample lot in quantity sufficient for valid trials (100). Sample should include representation of urban, peri-urban, and rural users. Place product through clinic system to test distribution and administrative mechanisms.

      Key measures: Care giver's acceptance, willingness to adopt; Babies' acceptance - taste, mouth feel, clarity of usage instructions. Viability of clinic approach to distribution and data gathering for research. Willingness to pay nominal sum. Value.

5. Presentation Material ?

   To introduce product to care givers.
   To train clinic system personnel.
   Requires investment in creative and production.

6. Administration

   IS THIS LIKELY FROM MOH?

   a. Develop system for consistent management of product and data across the clinic system.
   b. Devise method for tracking and managing finances.
   c. Integrate client data into health care management system.

7. Finance

   a. Development activities expense
      - malting, engineering
      - site development
      - product performance - technical
      - shelf life studies - technical
      - package design and development

   b. Implementation Expense
      - home use test - research and product in test packages
      - presentation and administration materials

   c. Capital investment
      - malting, milling, packaging equipment
      - site preparation

   d. Underwriting MOH?
      - program administration pays flat producer fee to MITC.
      - Cost of goods recovered through client fees retained by Health Ministry.

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Comment

As the program moves into implementation, the mechanism used by the Women, Infants, and Children (WIC) program in the U.S. to retain clients and provide follow-up may be worthy of study for use in Swaziland. Performance is attached to program participation through coupon distribution.

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PJ/0135B/8

Project SUSTAIN Visit to Swaziland - Weaning Food Project

Summary Technical Report by David J. Gottneid

PURPOSE - TECHNICAL

To develop a protocol to ensure that germinated sorghum or substitute source would be a safe and effective porridge thinning agent. To determine the steps a Swazi mother would have to take to prepare the weaning food in a home situation. Specific questions that need to be addressed:

- What conditions are needed to make a quality product?
- Do these conditions exist in Swaziland? If no, what is required to create these conditions?
- What is the stability/shelf-life of the malt product?
- Address health, safety and stability aspects of the malt-thinned porridge

RESULTS

Pre-visit Findings - Products

1. John Nelson of the Reconnaissance Team provided a sample of ground malted sorghum from Swaziland Milling and a sample of LIGUGU brand Special Maize Meal. Analyses of these samples are provided in Appendix A. Analysis of the malt showed:

   - very low diastatic power
   - high moisture
   - acidic, fermented odor
   - unacceptably high microbial content, although no pathogens were detected

2. Brewers Malt (6 Row Barley) and Flour Malt (High Diastatic Food Malt) were obtained from Fleischmann-Kurth Malting Company. (Appendix B) ?

Price Information (approximate)

Brewers Malt	$5.08 - 5.58 per 34 lb bushel
Flour Malt	$4.50 - 5.00 per 34 lb bushel

3. Food Grade Alpha-amylases were obtained from Enzyme Bio-Systems Ltd. and Amano International Enzyme Co., Inc. (Appendix C)

Price Information (approximate)

G-ZYME G998 Fungal amylase	$2.00 per liquid lb
G-ZYME G995 Bacterial amylase	$1.80 per liquid lb
Biozyme S Fungal amylase	$30.00 per kg powder
Amano "17" Bacterial amylase	$18.00 per kg powder

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Pre-visit Findings - Thinning Trials

Porridge was prepared from LIGUGU maize meal. Porridge thinning trials were conducted using Swaziland Milling malted sorghum, Kurth flour malt and brewers malt, and Enzyme Bio-Systems bacterial and fungal alpha-amylases. Thinning trial results are provided in Appendix D. Summary observations:

(THIS WILL BE EASY TO GET MOTHERS TO DO!!) *

- the porridge **must** be cooled (to approximately 75 C) prior to adding malt enzyme to assure optimal enzyme activity

- sorghum malt - worked only marginally and had to be utilized at increased usage levels

- flour malt, brewers malt and fungal alpha-amylase - all worked very well at low usage levels

- bacterial amylase - showed very high activity and was heat stable (90 C)

Swaziland Visit Findings

The technical findings will be reported in the form of a day-by-day trip report which follows below:

Monday, April 17

- **Briefing with USAID** (Mary Pat Selvaggio, Lalit Kraushaar)

  Background on the project, discussed proposed itinerary and specific issues that needed to be addressed.

- **Briefing with Project Team at Ministry of Agriculture** (Juliet Aphane, Angela Mbuli, Selvaggio and Kraushaar)

  Discussed analysis of the sorghum malt produced by Swaziland Milling and Kurth's barley malts; lab porridge thinning trials; and issues of acceptance, safety, storage trials and marketing strategies.

- **Lunch** (Harry Johnson, Selvaggio, Kraushaar)

  Reviewed mission activities, USAID Programs and role in Swaziland.

- **Field Visit** (Marion Peterson, Kraushaar)

  Visited supermarket, shops and markets in urban and para-urban settings in Mbabane suburbs.

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Tuesday, April 18 (Aphane, Mbuli, Kraushaar)

- **KS II Clinic**, near Manzini

  Met with the nurse in charge of the clinic and observed the clinic's routines: monitoring the development of the infants and educating the mothers.

- **Swaziland Milling**, Manzini (Ben Mndewe)

  Toured existing sorghum malting operation. Noted lack of adequate sanitation and process controls.

  Obtained malt samples for future testing.

- **Manzini Industrial Training Center** - MITC (Sister Judith Dean)

  MITC provides on-the-job training experience for school drop-outs. Its goal is to teach skills that can produce employment and encourage the establishment of small, local businesses.

  This may be a possible site for some type of malt-producing facility. Funding and expertise would be needed for its establishment.

- **CARE** Small Business Project (Jaime Reibel)

  General discussion of problems facing small businesses ie., conflicting interests with big business; unfavorable government policies

- **Metro** a wholesale facility (Assistant Manager)

  Learned capabilites and practices of a Swaziland distributor.

- **Swaziland Brewers Limited**, Manzini (Kim Haack - Production Mgr, Vincent Manyatzi - Brewing Mgr)

  Brewery uses approximately 250 tons/yr of European barley malt, imported via South Africa. A malt sample was obtained for future testing. Possibility exists of purchasing malt from them at cost: 1.45 Rand per kg - supplied in 50 kg bags.

  (Note: another source of malted sorghum was mentioned. Ngwane Brewery (PTY) Ltd is a local brewery which uses malted sorghum. Contact person - Dave Hunt.)

Wednesday, April 19

- A national holiday. Met informally with Selvaggio.

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Thursday, April 20 (Aphane, Mbuli, Kraushaar)

- **Field trip**

  Visited shops in rural areas to gain a perspective of rural life, customs, and availability of goods and services in contrast to urban settings.

- **Porridge Thinning Demonstration**

  Met at Juliet Aphane's home, an urban apartment equipped with modern conveniences and an electric stove. Compared several malts:

  - fresh sorghum malt from Swaziland Milling
  - brewers malt from Swaziland Brewers Ltd
  - flour malt and brewers malt from Kurth Malting

  All malts did thin the porridge although the fresh sorghum malt from Swaziland Milling required a higher usage level. Observations after 24 hours showed no noticeable change in thinned porridge viscosity.

  Per Juliet and Angela, the consistency preferred by local Swaziland mothers was actually thicker than the viscosity targetted by our lab trials (and the viscosity suggested in the literature). The consistency/ viscosity preferred locally could be described more as "spoonable" rather than "pourable".

- **Debriefing with UNICEF** (Rodney Phillips)

  Shared recommendations for a malt production facility (See OPTIONS AND RECOMMENDATIONS section of this report).

  Rodney Phillips suggested:

  - local equipment, materials, resources, and women's groups should be utilized as much as possible.

  - MITC could be contracted or paid a flat fee to produce the malt if a not-for-profit program is designed.

Friday, April 21

- **Debriefing with USAID** (Alan Foose, Kraushaar)

  Alan Foose mentioned:

  - importation would entail a 20% surcharge and 10% sales tax in addition to the normal tariffs and import cost.

  - target time-frame would be approximately 2 years to develop a self-sustaining program.

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- **University of Swaziland Agricultural College** (Professor A. Engoru-Ebinu)

  Engoru-Ebinu mentioned:

  - different varieties of sorghum, both red and white, are locally available.

  - the importance of using technology that is appropriate for Swaziland and is locally serviceable.

  - equipments locally available (eg. small Hammer Mill).

- **Debriefing with the Ministry of Agriculture** (Magalela Ngwenya - Deputy Director of Agriculture and Chairman of the National Nutritional Council)

Saturday, April 22

- Departed for US.

Post-visit Findings - Analysis of Malt Samples

Samples of fresh sorghum malt from Swaziland Milling and brewers malt from Swaziland Brewers, obtained on our visit, were analyzed. Analyses of these samples are provided in Appendix E.

OPTIONS AND RECOMMENDATIONS

If it is the premise that the Weaning Food Project is to be independent and self-sustaining, then the following recommendations are offered in order of decreasing independence.

Production of Porridge Thinning Agent

1. A small, controllable malting facility should be established, possibly at MITC. This facility could utilize raw materials which are locally available and technology/equipment which is appropriate to the locale. Technical malting and Engineering expertise will be required to set-up a malt production facility. Some of the basic steps in the malt production process are:

   - Rigorous cleaning of the grain
   - Steeping: temperature, pH, aeration
   - Germination: moisture, temperature, aeration
   - Kilning: sulfured
   - Shoot and root removal
   - Milling
   - Packaging: moisture barrier type

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2. **Purchase brewer malt from Swaziland Brewers Ltd.**

   - **Possibly at cost: R 1.45/kg**
   - **Will require milling and packaging**

3. **Import malt.**

   - **Tariffs, import duties, surcharge and taxes**
   - **Identify a business arrangement to administer**
   - **Will require milling and packaging**

4. **Utilize purified enzymes.**

   - Other ingredients to include nutritional supplements, diluents
   - Will require blending and packaging either at source or in Swaziland

Safety and Shelf-life Issues

These issues can only be addressed after the malt product is identified and the packaging determined. Preferrably the shelf-life study should be conducted in Swaziland under real-use conditions. Technical assistance in designing the shelf-life study and in determining the malt product's safety would be recommended. The chemical, biological and nutritional aspects of the malt-thinned porridge must also be evaluated in light of Swazi infant feeding practices and nutritional needs.

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A personal comment: I would like to thank Project SUSTAIN for the opportunity extended to me to visit Swaziland and all the people in Swaziland who made the visit productive and enriching. I would also thank American Maize-Products Co., especially Mrs. Francis Katz, for donating my time and lab resources. A special word of thanks to Dr. Bruce Sebree of Fleischmann-Kurth Malting Company for generously sharing his malting expertise and lab resources.

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AMAIZO

American Maize-Products Company

1100 Indianapolis Boulevard • Hammond, IN 46320-1094

TELETYPE
TWX 910-699-2032 AMERMAIZE OF

TELEPHONES
CHICAGO, ILLINOIS 312-374-1400
HAMMOND, INDIANA 219-659-2000

ANALYTICAL DATA

Sample - LIGUGU - Special Maize Meal, Vitamin Enriched

Proximate Analysis (Results dry basis)

% Moisture	9.6
% Starch	78.6
% Protein (x6.25)	8.1
% Oil (CCl_4)	2.8
% Crude Fiber	0.9
% Ash	0.8
pH (1:3)	6.2

Sample - MALTED SORGHUM - Swazimills

Microbiological Analysis

Standard Plate Count	3.3×10^8
Yeast/g	1.8×10^6
Mold/g	1×10^5
Coliforms/g	4.2×10^7
Thermophiles	
Flat Sour spores/10g	800
Total Thermophile Spores/10g	800
E.Coli	< 3
Salmonella	Neg.
Staphylococci	< 100
Pseudomonas	Neg.

4/89

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2100 South 43rd Street
PO Box 19909
Milwaukee WI 53219-0909
414 384 7406
FAX 1 414 384 8718

FLEISCHMANN·KURTH

Malt Analysis Report

Shipped To: Amaizo
Attn: David Gottneid

Date Shipped: 4-11-89

Car No.: Sample

Order No.: ---

Shipped From: Corporate Laboratories
Milwaukee, WI

Varietal Blend:

Crop Year	Variety	Percent
	Sorghum Malt (Swazi Mills)	

Mealiness

Mealy	
Half-Glassy	
Glassy	

Physical Analysis:

	Bushelweight (Pounds)	
Growth %	0-¼	
	¼-½	
	½-¾	
	¾-1	
	Overgrown	
Assortment		
	7/64	
	6/64	
	5/64	
	Thru	
	Foreign Seeds	
	Broken Kernels	
	% Skinned	

Chemical Analysis

Moisture	14.1
Extract, Fine Grind, As Is	
Extract, Fine Grind, Dry Basis	
Extract, Coarse Grind, Dry Basis	
Fine / Coarse Difference	
Conversion in Minutes	
Color of Lab Wort Lovibond	2.85
Odor of Mash	Acidic - Ferment
Degree of Clarity	180
Speed of Filtration	
Diastatic Power, °L	5
Alpha Amylase, 20°DU	2.5
Total Protein	9.2
Soluble Protein	4.9
Soluble / Total %	53.8
Viscosity	1.23
pH	5.34

Bruce R. Sebree, PhD 4-11-89
Vice President Date
Research/Qualtiy Cotnrol

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FLEISCHMANN • KURTH MALTING COMPANY

Appendix B

FLEISCHMANN·KURTH

Malt Analysis Report

Shipped To: Amaizo
Attn: David Gottneid

Date Shipped: 4-11-89

Car No.: Sampel

Order No.: ---

Shipped From: Corporate Laboratories
Milwaukee, WI

Varietal Blend:

Crop Year	Variety	Percent
1988	Robust	100%
	6 Row Brewers Malt	100%

Physical Analysis:

Bushelweight (Pounds)	39.75
Growth % 0-¼	1
¼-½	1
½-¾	3
¾-1	85
Overgrown	10
Assortment	
7/64	
6/64	83.7
5/64	14.9
Thru	1.4
Foreign Seeds	
Broken Kernels	
% Skinned	

Mealiness

Mealy	99
Half-Glassy	1
Glassy	0

Chemical Analysis

Moisture	4.1
Extract, Fine Grind, As Is	76.2
Extract, Fine Grind Dry Basis	79.5
Extract, Coarse Grind, Dry Basis	78.1
Fine / Coarse Difference	1.4
Conversion in Minutes	-5
Color of Lab Wort Lovibond	1.86
Odor of Mash	Aromatic
Degree of Clarity	C6
Speed of Filtration	Normal
Diastatic Power, °L	148
Alpha Amylase, 20°DU	41.9
Total Protein	13.1
Soluble Protein	5.7
Soluble / Total %	43.6
Viscosity	1.44
pH	5.86

Bruce R. Sebree, PhD
Vice President
Research/Qualtiy Control

4-11-89
Date

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FLEISCHMANN·KURTH

Malt Analysis Report

Shipped To: Amaizo
Attn: David Gottneid
Date Shipped: 4-11-89
Car No.: Sample
Order No.: ---
Shipped From: Corporate Laboratories
Milwaukee, WI

Varietal Blend:

Crop Year	Variety	Percent
1988	Robust	100%

High Diastatic Food Malt 100%
(Flour Malt)

Mealiness

Mealy	98
Half-Glassy	1
Glassy	1

Physical Analysis:

Bushelweight (Pounds)	37.25
Growth % 0-¼	1
¼-½	1
½-¾	1
¾-1	82
Overgrown	15
Assortment	
7/64	
6/64	61.2
5/64	32.4
Thru	6.4
Foreign Seeds	
Broken Kernels	
% Skinned	

Chemical Analysis

Moisture	6.2
Extract, Fine Grind, As Is	
Extract, Fine Grind, Dry Basis	
Extract, Coarse Grind, Dry Basis	
Fine / Coarse Difference	
Conversion in Minutes	
Color of Lab Wort Lovibond	2.30
Odor of Mash	Aromatic
Degree of Clarity	
Speed of Filtration	
Diastatic Power, °L	266
Alpha Amylase, 20°DU	68.4
Total Protein	13.8
Soluble Protein	6.90
Soluble / Total %	50.4
Viscosity	1.34
pH	5.68

Bruce R. Sebree, PhD — 4-11-89
Vice President — Date
Research/Qualtiy Control

G-ZYME® G995

Alpha-amylase for Corn Wet Milling

STARCH BUSTERS®
HIGH PERFORMANCE STARCH ENZYMES

Description

G-ZYME® G995 is a new food-grade bacterial *alpha*-amylase from *Bacillus stearothermophilus*. This enzyme randomly hydrolyzes the *alpha*-D-1,4 glycosidic linkages of starch to produce soluble dextrins and low levels of glucose.

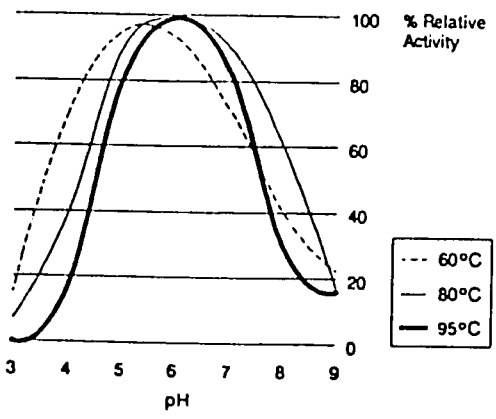
G-ZYME® G995 is extremely thermostable and performs well at low pH levels.

Effect of pH

G995 is most active between pH 5.0 and 7.0. As shown in Figure 1, a low operating pH gives high activity even at high temperatures. In actual use for starch liquefaction, a pH of 5.5 is compatible with temperatures as high as 108°C. The ability to operate at the low pH effectively eliminates the loss of dextrose due to formation of maltulose.

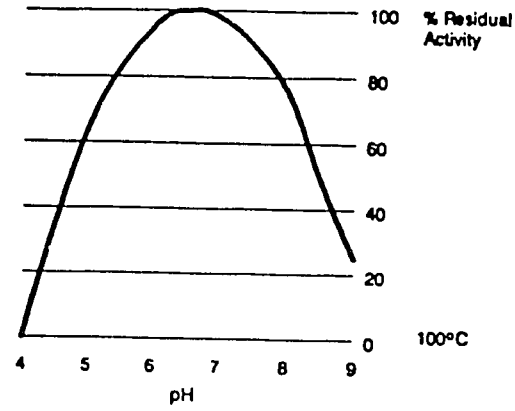
The effect of pH on enzyme stability at 100°C is shown in Figure 2. G995 is much more stable at low pH levels than any other commercially available *alpha*-amylase.

Figure 1 EFFECT OF pH ON G995 ACTIVITY



0.5% soluble starch.

Figure 2 EFFECT OF pH ON G995 STABILITY

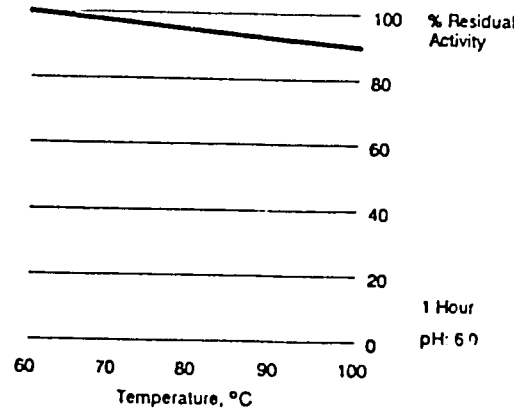


30% maltodextrin, 2 u/g, 1 hour, greater than 30 ppm Ca.

Effect of Temperature

The performance of G995 rises with an increase in temperature and reaches a maximum in the range of 100° to 110°C. After one hour at 100°C, 90% of the original enzyme activity still remains (Figure 3).

Figure 3 EFFECT OF TEMPERATURE ON G995 STABILITY



30% maltodextrin, 2 u/g, 1 hour, greater than 30 ppm Ca.

Enzyme Bio-Systems Ltd.
Executive Offices:
International Plaza, Englewood Cliffs, NJ 07632 USA
Telephone: 201/894-2320 Fax: 201/894-4955

Effect of Calcium

G995 contains calcium bound tightly to the enzyme; low levels of added calcium further stabilize the enzyme at temperatures above 60°C. Calcium concentrations of 30 to 75 ppm on a dry substance basis are adequate for enzyme usage at temperatures up to 110°C.

Effect of Solids

At dry substance levels between 10% and 40%, dry substance of the starch supply has no appreciable effect on the stability of the *alpha*-amylase. Levels below 10% dry substance may diminish effective stability.

Enzyme Classification

Trivial Name:	*alpha*-Amylase
Classification:	Carbohydrase
Source:	*Bacillus stearothermophilus*
Systematic Name:	1,4-*alpha*-D-Glucan glucanohydrolase
IUB No.:	3.2.1.1

Properties

Form:	Nonviscous liquid
Color:	Brown
Specific Gravity:	1.15 to 1.20 g/ml
Viscosity:	Less than 100 cps
Activities:	3000 units/g 4000 units/g

Limits of Impurities

Bacterial Count and Heavy Metals:	Conform to Food Chemicals Codex

Storage and Handling

G995 should be stored at room temperature. For maximum stability, extended storage at temperatures above 21°C (70°F) should be avoided. Refrigeration is not normally required.

Activity Determination

One *alpha*-amylase unit is defined as the amount of enzyme which will hydrolyze 10 mg of starch in ten minutes under use conditions.

Data on specific applications and assay methods are available upon request.

These suggestions and data are based on information we believe to be reliable. They are offered in good faith, but without guarantee since conditions and method of use of our products are beyond our control. Suggestions for use of our products should not be understood as recommendations that they be used in violation of any patents.

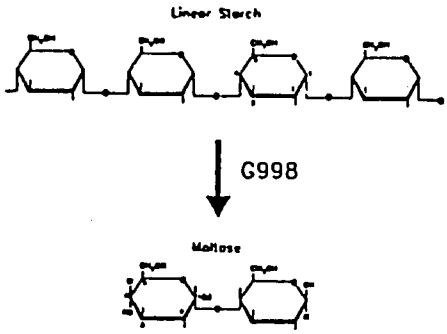
G-ZYME® G998 Alpha-Amylase

STARCH BUSTERS®
HIGH PERFORMANCE STARCH ENZYMES

Description

G-ZYME® G998 is an intermediate temperature stability, acid-uric, food-grade fungal *alpha*-amylase from *Aspergillus niger*. This enzyme hydrolyzes the *alpha*-D-1,4 glycosidic linkages of starch to produce predominantly maltose.

Figure 1 ACTION OF G998 ON STARCH



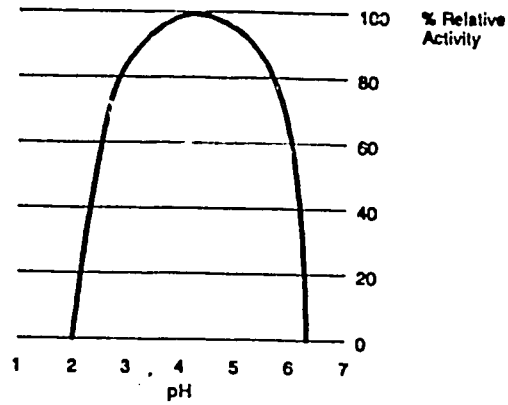
Advantages

Like conventional fungal amylases, G998 can be used to liquefy starch and to provide a slight sweetening. While G998 is more thermostable than conventional fungal amylases, it is less thermostable than bacterial amylases. G998 has a pH range broader than the rest. Given these characteristics, G998 will perform where other amylases cannot, yet still may be easily inactivated with heat.

Effect of pH and Temperature

Figure 2 shows the effect of pH on G998 activity. This enzyme is most active between pH 3.0 and 6.0. G998 maintains 90% or greater of its optimum activity at pH 3.5.

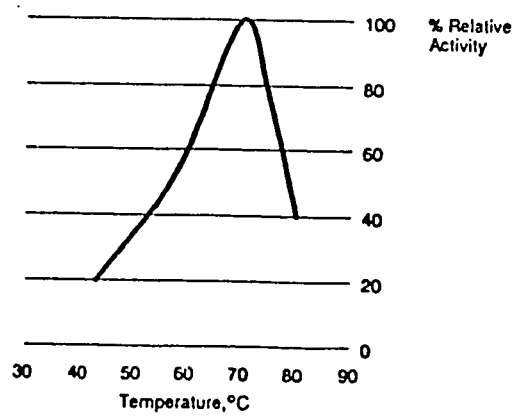
Figure 2 EFFECT OF pH ON G998 ACTIVITY



Assays conducted at 60°C.

Figure 3 illustrates the effect of temperature on G998 activity. Although the enzyme is most active in the temperature range of 65°C to 75°C, maximum stability is best achieved by use between 40°C and 60°C.

Figure 3 EFFECT OF TEMPERATURE ON G998 ACTIVITY



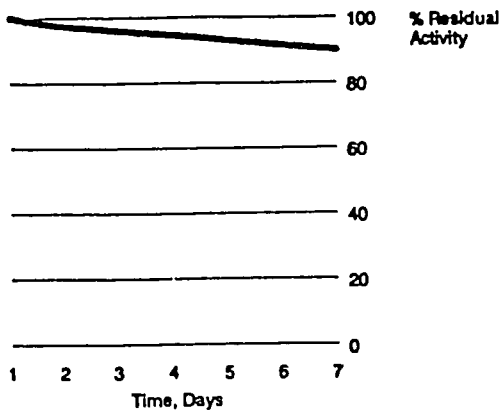
Assays conducted at pH 4.5.

Enzyme Bio-Systems Ltd.
Executive Offices:
International Plaza, Englewood Cliffs, NJ 07632 USA
Telephone: 201/894-2320 Fax: 201/894-4955

Thermostability of G998

Figure 4 depicts the thermostability of G998 at pH 4.3 at 60°C in the presence of a maltodextrin substrate. Under these conditions the enzyme retains more than 80% of its activity for more than seven days.

Figure 4 THERMOSTABILITY OF G998



Enzyme Classification

Trivial Name:	*alpha*-Amylase
Classification:	Carbohydrase
Source:	*Aspergillus niger*
Systematic Name:	1,4-*alpha*-D-Glucan glucanohydrolase
IUB No.:	3.2.1.1

Properties

Form:	Nonviscous liquid
Color:	Light amber
Specific Gravity:	1.0 to 1.1 g/ml
Viscosity:	Less than 100 cps
Activity:	1000 units/g

Limits of Impurities

Bacterial Count and Heavy Metals:	Conform to Food Chemicals Codex

Storage and Handling

G998 should be stored at room temperature. For maximum stability, extended storage under refrigeration is recommended.

Data on specific applications and assay methods are available upon request.

These suggestions and data are based on information we believe to be reliable. They are offered in good faith, but without guarantee since conditions and method of use of our products are beyond our control. Suggestions for use of our products should not be understood as recommendations that they be used in violation of any patents.

INDUSTRIAL AND FOOD ENZYMES, BIOCHEMICALS

		FORM	ACTIVITY*	SOURCE
Amino Acid Production	Acylase	Powder	15,000 u/gm	Aspergillus oryzae
Amylases	Amyloglucosidases			
	GNL-3000	Liquid	225 AG u/ml	Aspergillus niger
	AG-975	Powder	975 AG u/gm	Rhizopus oryzae
	Fungal Amylase			
	Biozyme S	Powder	100,000 SKB/gm	Aspergillus oryzae
	Biozyme L	Liquid	38,000 SKB/ml	Aspergillus oryzae
	Bacterial Amylase			
	"17"	Powder	17,000 BAU/gm	Bacillus subtilis
	CONC	Powder	176,000 BAU/gm	Bacillus subtilis
	Beta Amylase			
	MBA (Microbial)	Liquid	8,000 u/ml	Bacillus Cereus
	Malt	Powder	4,000 u/gm	Malt
	Soy	Powder	4,000 u/gm	Soy
	Pullulanase			
	CK-20	Liquid	6,000 u/ml	Aerobacter
Catalase		Liquid	50,000 u/ml	Porcine Liver
Cellulases	AP	Powder	120,000 CMC u/gm	Aspergillus niger
	TV-2, 4, 6, CONC	Powder	20,000, 40,000, 60,000, 160,000 u/gm	Trichoderma Viride
	Hemicellulase	Powder	10,000 u/gm	Aspergillus niger
	Cellulase "L"	Liquid	50,000 CMC/ml	Aspergillus niger
Deaminase	Deamizyme	Powder	50,000 u/gm	Aspergillus niger
Dextranase	Sugarase	Powder	2,000 u/gm	Penicillium
Glucose Oxidase	Hidelase	Powder	15,000 u/gm	Aspergillus niger
Glucose Isomerase	(Immobilized)	Granule	300-350 IGI/gm	Streptomyces griseofuscus
Hesperidinase		Powder	12,000 u/gm	Penicillium
Lactase	AIE (Acid Stable)	Powder	5,000 ONPG u/gm	Aspergillus oryzae
	YL	Liquid	12,000 ONPG u/ml	Kluyvermyces lactis
Lipases (Fungal)	AP (Acid Stable)	Powder	120,000 LU/gm	Aspergillus niger
	MAP	Powder	10,000 ILU/gm	Mucor
	FAP	Powder	750,000 LU/gm	Rhizopus oryzae
Naringinase		Powder	5,000 u/gm	Penicillium
Pectinases	Super Pec G	Powder	200 JCU/gm	Aspergillus niger
	Super Pec GL	Liquid	100 JCU/ml	Aspergillus niger
	Super PEC PII	Powder	3500 PG/gm	Aspergillus niger
	Super Pec P	Powder	1750 PG/gm	Aspergillus niger
	Super Pec PL	Liquid	1300 PG/ml	Aspergillus niger
	Starch Clear	Liquid	225 u/ml	Aspergillus niger
Phosphodiesterase		Powder	13 x 10^4 Nuclease u/gm	Penicillium
Proteases	Fungal Protease (Neutral)			
	Amano "A"	Powder	20,000 u/gm (320,000 HUT/gm)	Aspergillus oryzae
	Prozyme	Powder	60,000 u/gm	Aspergillus oryzae
	Acid Stable	Powder	7,000 u/gm	Rhizopus
	Protease N (bacterial neutral)	Powder	1800 northrup u/gm	Bacillus subtilis
	Papain	Powder	300 MCU/gm & 700 MCU/gm	Papaya
Micro Organisms				
Lactobacillus	Acidophilus	Powder	4 billion viable organisms/gm	
	Plantarum	Powder	various	
Streptococcus	Faecalis	Powder	12 billion viable organisms/gm	

*All activities are determined using Amano's Test Method unless otherwise indicated. Technical bulletins and samples are available upon request.

Amano began producing enzymes in 1948 and has since emerged as a world leader in biotechnology and fermentation technology. At the present time Amano employs over 200 people in Research and Development This commitment to research has enabled Amano to be a leader in new technology with the capability to handle your immediate and future requirements.

Ordering Information

To place an order call toll free 1-800-446-7652 or write:

AMANO INTERNATIONAL ENZYME CO., INC.
P.O. Box 1000
Troy, Virginia 22974 Telex 822438

Purchase orders sent as confirmation of a telephone call or standing order should be so marked to avoid duplication.

Shipping, Availability and Packaging

All of the products in this catalogue are generally stocked in bulk and all are available in both bulk and small quantities. Shipments are FOB Troy, VA. Methods of shipment are at our discretion unless otherwise requested. All of our diagnostic enzymes are packed in double sealed polyethylene bottles which are placed in specially insulated styrofoam cartons and packed with chemical refrigerants. This will assure you delivery of the highest quality enzymes.

Prices

Call us for a quote toll-free 1-800-446-7652. Please specify the product and quantity that you require.

Payment Terms

All invoices are due net 30 days.

The following is a list of Amano's enzyme products. They encompass enzymes and biochemicals applicable for food, industrial, pharmaceutical and diagnostic uses. We produce all the products which are listed.

AMAIZO

American Maize-Products Company

1100 Indianapolis Boulevard • Hammond, IN 46320-1094

TELETYPE
TWX 910-699-2032 AMERMAIZE OF

TELEPHONES
CHICAGO, ILLINOIS 312-374-1400
HAMMOND, INDIANA 219-659-2000

Appendix D

GRUEL THINNING TRIALS

Procedure: 100 ml boiling water added to 25g (dry solids) maize meal. Cooked 5 min. with constant stirring on hot plate. Removed from heat, cooled, added malt or enzyme and stirred. Viscosity measured with a Brookfield Synchrolectic Viscometer, model RVF at 20 rpm.

Added to Gruel	Temp. of Gruel when enzyme added	Spindle	Viscosity cps
1g Malted Sorghum	75°C	7	off scale
5g Malted Sorghum	75°C	5	17,000
1g Flour Malt	75°C	5	3200*
1g Brewers Malt	75°C	5	4400*
1g Flour Malt + 3g. Whey Pwd.	75°C	5	4000*
1g Flour Malt	90°C	7	102,000
5 drops (115mg) G998	75°C	5	1800*
2 drops (42mg) G995	90°C	5	800
1 drop (21mg) G995	90°C	5	1100
Control	-	7	off scale

* Perceived to be acceptable viscosity to parents

4/89

AMAIZO

American Maize-Products Company

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TELETYPE
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TELEPHONES
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HAMMOND, INDIANA 219-659-2000

MICROBIOLOGICAL ANALYSIS

Sample - **MALTED SORGHUM** - Swaziland Milling

Standard Plate Count	6.4×10^7
Yeast/g	1.9×10^7
Mold/g	1×10^5
Coliforms/g	< 10
Thermophiles	
Flat Sour spores/10g	130
Total Thermophile spores	130
E.Coli	< 3
Salmonella	Neg.
Staphylococci	< 10
Pseudomonas	Neg.

Sample - **EUROPEAN 2 ROW MALT** - (Swailand Brewers)

Standard Plate Count	6.4×10^6
Yeast/g	3.2×10^5
Mold/g	< 10
Coliforms/g	< 10
Thermophiles	
Flat Sour spores	< 5
Total Thermophile spores	< 5
E.Coli	< 3
Salmonella	Neg.
Staphylococci	< 10
Pseudomonas	Neg.

6/89

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2100 South 43rd Street
PO Box 19908
Milwaukee WI 53219-0908
414 384 7405
FAX 1 414 384 8718

FLEISCHMANN·KURTH

Malt Analysis Report

Shipped To: American Maize
Attn: David Gottreid

Date Shipped: 05/04/89

Car No.: Swazimill

Order No.: 32284

Shipped From: Corporate Laboratories
Milwaukee, WI

Varietal Blend:

Crop Year	Variety	Percent
	PreGround Sorghum Malt	100%

Mealiness

Mealy	
Half-Glassy	
Glassy	

Physical Analysis:

	Bushelweight (Pounds)	
Growth %	0-¼	
	¼-½	
	½-¾	
	¾-1	
	Overgrown	
Assortment		
	7/64	
	6/64	
	5/64	
	Thru	
	Foreign Seeds	
	Broken Kernels	
	% Skinned	

Chemical Analysis

Moisture	12.7
Extract, Fine Grind, As Is	41.6
Extract, Fine Grind, Dry Basis	47.7
Extract, Coarse Grind, Dry Basis	
Fine / Coarse Difference	
Conversion in Minutes	Slow
Color of Lab Wort Lovibond	2.53
Odor of Mash	Acidic
Degree of Clarity	12 (Clear)
Speed of Filtration	N
Diastatic Power, °L	19
Alpha Amylase, 20°DU	10.6
Total Protein	9.2
Soluble Protein	3.53
Soluble / Total %	38.4
Viscosity	1.12
NDMA	0 ppb
Beta Glucan	8 ppm

Bruce R. Sebree, PhD 05/22/89

Director of Quality Assurance — Date
Vice President Research/Quality Contr.

A Division of
Archer Daniels Midland Co

2100 South 43rd Street
PO Box 19808
Milwaukee WI 53219-0808
414 384 7406
FAX 1 414 384 8718

FLEISCHMANN·KURTH

Malt Analysis Report

Shipped To: American Maize
Attn: David Gottreid

Date Shipped: 05/04/89

Car No.: Swazibrew

Order No.: 32285

Shipped From: Corporate Laboratories
Milwaukee, WI

Varietal Blend:

Crop Year	Variety	Percent
	European 2 Row Malt	100%

Physical Analysis:

	Bushelweight (Pounds)	43.00
Growth %	0-¼	
	¼-½	
	½-¾	
	¾-1	
	Overgrown	
Assortment		
	7/64	77.4
	6/64	19.3
	5/64	3.0
	Thru	0.3
	Foreign Seeds	
	Broken Kernels	
	% Skinned	

Mealiness

Mealy	
Half-Glassy	
Glassy	

Chemical Analysis

Moisture	5.2
Extract, Fine Grind, As Is	77.6
Extract, Fine Grind, Dry Basis	81.9
Extract, Coarse Grind, Dry Basis	
Fine / Coarse Difference	
Conversion in Minutes	-5
Color of Lab Wort Lovibond	1.61
Odor of Mash	Aromatic
Degree of Clarity	10 (Clear)
Speed of Filtration	N
Diastatic Power, °L	102
Alpha Amylase, 20°DU	30.9
Total Protein	10.5
Soluble Protein	4.28
Soluble / Total %	40.8
Viscosity	1.45
NDMA	2.5 ppb
Beta Glucan	142 ppm

Bruce R. Sebree, PhD — 05/22/89
Director of Quality Assurance — Date

III. Consumption System Findings

Penelope M. Johnson
Infant Weaning Food - Swaziland 4/17/89 - 4/21/89

The objective of the Project Sustain consultancy's visit to Swaziland was to devise a marketing program for malt as a weaning food adjunct. Serious questions with respect to the effectiveness, consistency, and sanitation of the malt remained from the February reconnaissance team's visit.

The Concept: Add an amylolytic enzyme to mealie meal to partially liquify corn starch. The less viscous product that results delivers higher caloric density, appears to be acceptable viscosity to feed an infant, and avoids use of (possibly contaminated and sometimes precious) water and, therefore, dilution. This low cost weaning food combined high nutrient-density and low bulk properties, uses low cost and locally available cereal, and relies on simple existing culturally traditional home preparation methods. The key element is the use of a single staple of importance to culturally rooted feeding practices.

PROJECT SUSTAIN - SWAZILAND WEANING FOOD PROJECT

Consumption System Findings
Penelope M. Johnson

Monday, April 17

U.S. Aid Briefing
Mary Pat Selvaggio, Lalit Kraushaar, Alan Foose
- General project information, Monday schedule

L. Kraushaar: - contact for weaning food implementation due to Selvaggio's departure in July.

Project Team Briefing - Ministry of Agriculture
Juliette Aphane, Angela Mbuli, M.P. Selvaggio, L. Kraushaar
(Christabel Mętza was not available that week.)
Lunch - Harry Johnson, Deputy Mission Director, USAID Swaziland.
Project funding issues.

Field Work - Shops and Grocery Stores (L. Kraushaar, M. Peterson)
Visited a range of retail outlets in Mbabane, Msunduza Sidwashini, including OK and a host of small "corner" grocery stores. Metro warehouse is source of distribution for entire range of outlets. Requested visit to Mbabane and Manzini operations (six metros supply Swaziland).

Tuesday, April 18 - Escorted entire day by A. Mbuli, J. Aphane, L. Kraushaar

King Sobhuza II Clinic - Khumalo
There are 130 clinics in Swaziland. We visited one of the largest and well run. The clinic is focal point for health care information and treatment. All babies have a health care record where caretaker at home records health progress, significant events such as illness, new foods added to diet. The babies weight and size are recorded parallel to a growth curve for easy graphic interpretation of progress. We were guided through the clinic by Beauty Nxumalo who had trained at Meharry in Nashville in the mid 70's. Six nurses staff the clinic where 25-30 well babies are seen daily, 4-6 sick babies are treated daily, or referred to a hospital for treatment. Counseling with the nurses is a routine part of the well-baby visit. The clinics appear to be the natural point of distribution for these products. There is a dependable routine of visits. The credibility of the nurses, and the counseling segment of each visit serve as communication and follow-up. The nurses' uniform, distinctive for its bright red hat, could be a visual symbol carried on the packaging.

Swaziland Milling - Ben Mndewe
John Masson was out of town all week. We reviewed the malting and packaging operations at the mill. Sanitation remains an issue. The mill operates form, fill and seal equipment that could be sealed to fill small cello/plastic envelopes of the product.

PJ/0135B/2

Manzini Industrial Training Center - Sister Judith
Sister Judith briefed us on the history and purpose of MITC. We saw some existing small businesses; trainees building the final parts of the jam factory. As we toured the nearly completed building, we discussed availability of approximate space to locate a small controlled malting and milling operation at the training center. Siting the operation at MITC would avoid using Swazi Milling. Key to setting up training (dual purpose operation) would be sourcing milling and filling equipment, sourcing appropriate sorghum and provision of expertise to start up the malting and milling facility in terms of training and engineering. (MITC jams will be distributed through Metro.) Major requirement for funding. MITC also has print shop.

CARE - Small Business Project - Jamie Riebel, Director
Mr. Riebel briefed us on the monopolistic economic system in Swaziland. His appraisal of MITC was less than favorable in terms of methods and location. He reinforced our concerns about the suitability of Swazi Milling as a source of a product for infants. His information about wholesaling reinforced our doubts about the profit potential of the proposed product. He has a consultant studying the Food Processing Industry in Swaziland (Crispin Pemberton). Report due July.

Metro Warehouse - Manzini
The assistant manager described a membership card-based system of distribution to the retail outlets we visited yesterday. We observed several pick-up trucks loading up outside. The shopkeeper must come to the warehouse. Some share orders to get better quantity pricing. The store at Piggs Peak operates as a secondary distribution point for its area. Metro requires promotional spending by the manufacturer of a new product ±20%. Shelf price on baby food products was 20-25% lower than OK grocery, -30% compared to small stores indicating typical distributor margins.

Swaziland Brewery - Kim Haack, production manager. Discussed brewery - (See David Gottneid's technical report) sourced malt.

Wednesday, April 19 - King's Birthday Celebration Holiday

We met with M.P. Selvaggio for about one hour at poolside. Discussion centered on Market Research methodology and objectives, plus the business potential of the malt product. We recommended a product at cost, not for profit, single use packaging delivered and effectiveness follow-up through the clinic system. MITC could be site of pilot malting, milling and packaging facility thus supplying product and providing training opportunities plus small business potential.

PJ/0135B/3

Thursday, April 20 - A. Mbuli, L. Kraushaar, J. Aphane

Mojani Area Homestead - Field Trip
50-60% of the target group lives in Homesteads. We interviewed 2 shopkeepers and observed Homestead practices. Reinforced potential difficulties of for-profit distribution through grocery outlets--cost, greens fees, supply guarantees, availability, control.

Porridge Thinning Demonstration - J. Aphane's Kitchen. C-ref Gottneid.

Debriefing - Rodney Phillips, UNICEF A. Mbuli, J. Aphane
Conclusion of debriefing was Mr. Phillip's request for Project Sustain to submit its recommendation in the form of a proposal that could be taken to donors. Mr. Phillip's felt that the program was politically on target since it provides the double benefit of (1) weaning food product delivered appropriately to target, (2) training at MITC, business development. Phillips' proposal includes 2 other dimensions: (1) paying a flat service fee to MITC for sourcing, production and distribution, (2) returning nominal fees charged for product to the Health Ministry to support administration of the program.

Friday, April 21

Debriefing - Alan Foose, USAID - L. Kraushaar
Described program as presented to R. Phillips. Gained general agreement on program plan and objectives. Noted: Incremental import fees; 2 year time frame.

University of Swaziland - J. Aphane, L. Kraushaar
Professor A. Engoru-Ebinu
The result of the visit was to source expertise in setting up a small, clean controlled malting facility to produce uniform product and in sourcing locally a small mill. The Professor was very knowledgeable about local sourcing of sorghum and equipment and indicated willingness to support set up and sourcing needs. He is seen as a key resource in making the project go past the concept stage.

Debriefing - National Nutrition Council Chairman, Deputy Director of Agriculture. Magalela Ngwenya
Supported the program outlined. Caution expressed with respect to brewery as malt source alternative.

Debriefing - L. Kraushaar, U.S. Aid
Provided research program recommendations - methodology, objectives and sequence.

PJ/0135B/4

The program recommendation turns on the elements outlined below.

1. Product: (1) Sorghum Malt, (2) Barley Malt (imported)

   Issues: Source, processing, safety, availability, acceptability, integrity, performance, stability

2. Packaging: Single use envelopes (6 grams), cylindrical container with re-sealable lid, spoon, (200-250 grams)

   Issues: Cost, availability, manufacturing, printing, shelf life contribution, directions for use

3. Production: Controlled malting facility set up at Manzini

   Industrial Training Center - Print containers and related product materials at MITC print shop.

   Issues: Funding, space, raw material delivery, training support for sanitary, and effective malting operation, warehousing

4. Source of Funding:

   Issues: UNICEF donors

5. Distribution: Through the clinic system. Mothers visit monthly. Can the Health Ministry be attracted by and administer the "nominal fee" concept.

Program Elements

1. Malt

   50 Tons/yr @ 100% penetration - 6 gr.

   Sourcing, processing, sanitation, milling, performance testing

2. Packaging

   Single use envelopes

3. Manufacturing - controlled malting facility started up at Manzini Industrial Training Center.

   Printing - MITC Training Center

   Container with measuring spoon

4. Directions for use

   Written and tested in native language. Supplemented by explicit drawings.

5. Acceptability/continuity of use measurement

   Controlled test through clinic system.

6. Cost/Funding

   Revenue source/revenue stream/affordability

   Rodney Phillips - UNICEF. To take proposal to Donors to pay flat manufacturer's fee to Sister Judith's Training Center. Double benefit.

7. Distribution

   Through clinic system - revenues collected through clinics to be returned to Health Ministry

8. Program continuity and follow-up

   Initial product get cost through system. Ability to market for profit to be determined after one year in clinic system.

   Positioning: Now you cna make baby's food from your own cook pot without water

   Cultural Acceptance: Depends on minimal departure from existing behavior

PJ/0135B/6

Program Benefits

Upgrade nutritional quality

Provide new jobs/training

Internal substitution of processed foods

Further Testing Required

1. Evaluate acceptability

   Mothers/caretakers - preparation and usage
   Infants - viscosity, intake
   long term effect on nutritional health

   Organolyptic Testing

2. Product Characteristics to be affirmed

   Shelf life

   Consistency of production

   Predictability of results

   Temperature of mealie meal at use

3. Distribution of Product - Clinics

   Third party endorsement by Nurses? (Red Hat)

   Administration:

   - Record keeping
   - Monthly follow-up at clinic visit
   - Charge nominal fee
   - Create audit trail to ensure monies go back to Health Ministry

PJ/0135B/7