PURDUE UNIVERSITY

CAPSTONE EXPERIENCE 2014

Agricultural & Biological ENGINEERING

Ready-to-Use Therapeutic Foods - Ghana

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Statement of Problem

The goal of this project is to determine optimal processing conditions to manufacture RUTF products for a plant located in Ghana. The plant must be energy-efficient, sustainable, and operate at a minimal cost. All ingredients used will be locally sourced and indigenous to Ghana.

Background Information

Ready-to-use therapeutic food (RUTF) is a term used to describe high-energy, high-nutrition food products specifically designed for children aged 0 to 5 years with severe acute malnutrition (SAM). This project is a collaborative effort between Purdue University in West Lafayette, Indiana and Washington University School of Medicine in Saint Louis, Missouri.

- Reference Company: Mother Administrated Nutritive Aid (MANA) Organization
- Experimental design centered around extrusion cooking of grains

Figure 1. MANA

Experimental Design

- **Extrusion:** cooking grains via shear stress
- **Mixing:** uniform recipe
- **Drying:** lowering moisture content, roasting seeds
- **Milling:** uniform particle size
- **Grinding:** homogenizing final mixture
- **Pasteurization:** reducing contamination

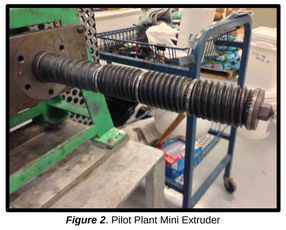


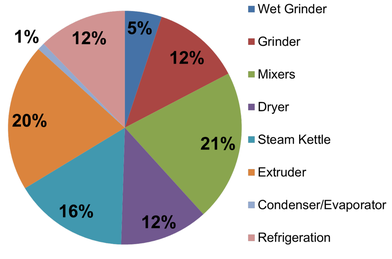
Figure 2. Pilot Plant Mini Extruder

Economics

Economic Analysis

Cost	Formula 82	Formula 106
Direct Costs	$284,200.00	$284,200.00
Indirect Costs	$104,344.03	$104,344.03
Working Capital	$68,709.53	$68,709.53
Total Capital Investment	$458,063.53	$458,063.53
Annual Operating Cost	$20,060.00	$16,500.00
Annual Ingredient Cost	$214,800.00	$239,600.00
Annual Packaging Cost	$409,000.00	$409,000.00
Return on Investment	42.51%	34.06%
Payback Period	1.6 years	2.8 years

Equipment Cost Distribution



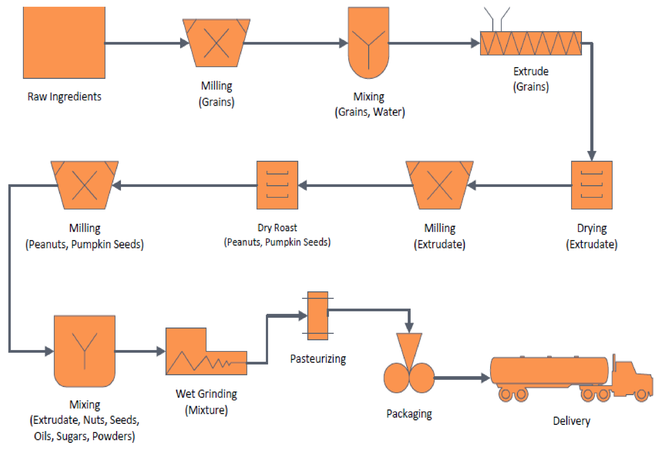
Ghana and SAM

- Ghana Population: 25 million people
- Children (<5) with SAM: 56,784
- Average Monthly Wages: $127.62
- Package: 270 grams (0.5 lbs)
- Price: $1.70 per pound ($0.85/day)
- Dosage: 6 weeks for 3 servings a day
- Plant Production: 1440 lbs/day
- RUTF-Ghana Total Price: $35.70 for dosage period

Figure 3. Ghana High Commission

Figure 4. CDC

Process Flow Diagram



Global and Societal Impact

- Curing severe acute malnutrition
- Empowering mothers
- Sustainable process
- Creating jobs

Figure 5. UNICEF

Sustainability

- Uncooked extrudate sold as animal feed
- Recapturing water vapor from dryer
- Indigenous ingredients

RUTF Formulas

Ingredient Type	Formula 82		Formula 106	
	Ingredient Name	(%)	Ingredient Name	(%)
Cereal/Grain	White Maize (flour of whole grain)	3.34	Oats	1.91
Legume	Ground Peanut (Shelled, Dried and Raw)	10	Ground Peanut (Shelled, Dried and Raw)	10
	Peas (pisum sativum)	7.73	Soybeans (glycine max, G. hispida, G. soja)	6.48
Oil	Canola/Repseed	7.9	Canola/Repseed	11.61
	Palm	16.02	Palm	15.55
	Soybean	0.23	-	-
Seed	Pumpkin	9.32	-	-
Sugar	Brown	5.79	White	18.9
	White	12.31	-	-
Milk	Whey Protein Concentrate 34	21.43	Acid whey powder	14.43
	-	-	Whey Protein Concentrate 34	10.5
	-	-	Whey Protein Concentrate 80	5.53
Vitamins/Minerals	Dimodan HSKA	2	Dimodan HSKA	2
	MNP	3.93	MNP	3.06
	Total	**100**	**Total**	**100**

Processing Conditions

Formula 82

Equipment	Ingredient	Temp (°C)	Mass (lb)	Time (min)	Flow (lb/min)
Mill	Peas and Maize	STP	168.741	65.607	2.572
Mixer	Peas and Maize and Water	STP	216.953		Batch
Extruder	Peas and Maize and Water	(250 rpm)	216.953	180.794	1.2
Dryer	Extrudate	60	204.953	720	Batch
Dryer	Peanuts and Pumpkin Seed	160	278.208	20	Batch
Mill	Dried Peanuts and Pumpkin Seed	STP	278.208	108.168	2.572
Mixer	All Ingredients	STP	1440		Batch
Pasteurization	All Ingredients	100	1440		Batch

Formula 106

Equipment	Ingredient	Temp (°C)	Mass (lb)	Time (min)	Flow (lb/min)
Mill	Oats	STP	33.280	12.940	2.572
Mixer	Oats and Water	STP	46.082		Batch
Extruder	Oats and Water	(200 rpm)	46.082	57.603	0.800
Dryer	Oat Extrudate	60	38.082	720	Batch
Extruder	Soy grits	(900 rpm)	93.312	103.312	1.000
Dryer	Peanuts	160	144	20	Batch
Mill	Dried Peanuts	STP	144	55.987	2.572
Mixer	All Ingredients	STP	1440		Batch
Pasteurization	All Ingredients	100	1440		Batch

Alternative Solutions

- High Temperature Short Time (HTST) Pasteurization
- Cooking of grains using non-extrusion
- Reducing footprint from packaging
- Alternative Recipes

Figure 6. Packaged Final Product

Future Considerations

- Quality and sensory tests
- Harnessing solar power
- Shelf life determination

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