Product and Process Development
Fall 2009

Market Analysis

With health becoming increasingly important to Americans, a product that provides quality nutrition in a convenient form while taking little preparation has never been more needed. A product like this will allow for health-conscious, active individuals to meet their fitness and lifestyle goals without disrupting their daily routine.

Ingredient Functionality

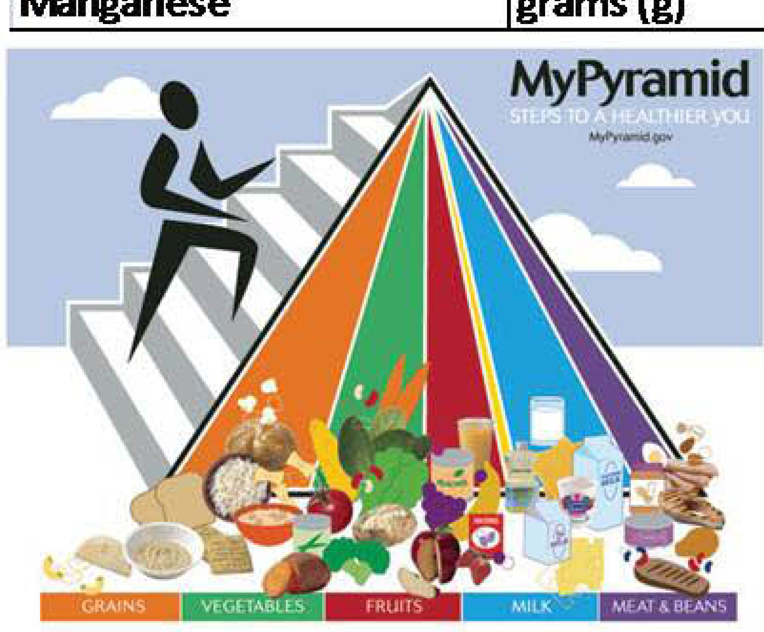
Ingredients were initially chosen based on nutritional value and flavor compatibility. Obstacles to overcome included texture, appearance, masking of over-dominant tastes, while meeting the RDA requirements set in place. The following ingredients were chosen:

Ingredient	Functionality	Obstacles
Apples	Fiber, Sweetness	Browning
Blueberries	Antioxidants, Energy, Vitamin B	Storage Life
Carrots	Vitamin A	
Cranberries	Antioxidants, Vitamin A, Minerals	Storage Life
Egg Whites	Protein	
Quinoa	9 Essential Amino Acids	Texture, Dissolution
Wheatgrass	Vitamins, Minerals, Antioxidants	Overpowering Taste, Texture
Whey Protein Isolate	Protein	Texture, Taste, Color

RDA Requirements

Experimental design was employed to determine the proper ingredient ratio in order to achieve the specified RDA requirements and appeal to the taste of the consumer. Where RDA values were lacking, certain ingredient amounts were increased to meet the requirements. Other ingredient amounts were then increased to maintain a palatable product.

Nutrient	Unit of Measure	Daily Value	1/6 Daily Value	Product
Protein	grams (g)	50	8.33	7.68017
Total Fat	grams (g)	65	10.83	1.419752
Total carbohydrate	grams (g)	300	50.00	72.02316
Fiber	grams (g)	25	4.17	12.05685
Ash	-	-	-	3.57425
Cholesterol	grams (g)	0.3	0.05	0.000642
Sodium	grams (g)	2.4	0.40	0.261235
Potassium	grams (g)	3.5	0.58	0.987715
Vitamin A	grams (g)	5000	833.33	383162.1
Vitamin C	grams (g)	0.06	0.01	0.032774
Calcium	grams (g)	1	0.17	0.47881
Iron	grams (g)	0.018	0.00	0.001524
Vitamin D	grams (g)	400	66.67	0
Vitamin E	grams (g)	30	5.00	0.002446
Vitamin K	grams (g)	8.00E-05	0.00	4.91E-05
Thiamin	grams (g)	0.0015	0.00	0.000254
Riboflavin	grams (g)	0.0017	0.00	0.000677
Niacin	grams (g)	0.02	0.00	0.001271
Vitamin B_6	grams (g)	0.002	0.00	0.000321
Folate	grams (g)	4.00E-04	0.00	0.007589
Vitamin B_{12}	grams (g)	6.00E-06	0.00	5.54E-07
Pantothenic acid	grams (g)	1.00E-02	0.00	0.001876
Phosphorus	grams (g)	1	0.17	0.379003
Magnesium	grams (g)	0.4	0.07	0.085707
Zinc	grams (g)	0.015	0.00	0.001989
Selenium	grams (g)	7.00E-05	0.00	1.09E-05
Copper	grams (g)	2.00E-03	0.00	0.000236
Manganese	grams (g)	2.00E-03	0.00	0.000973



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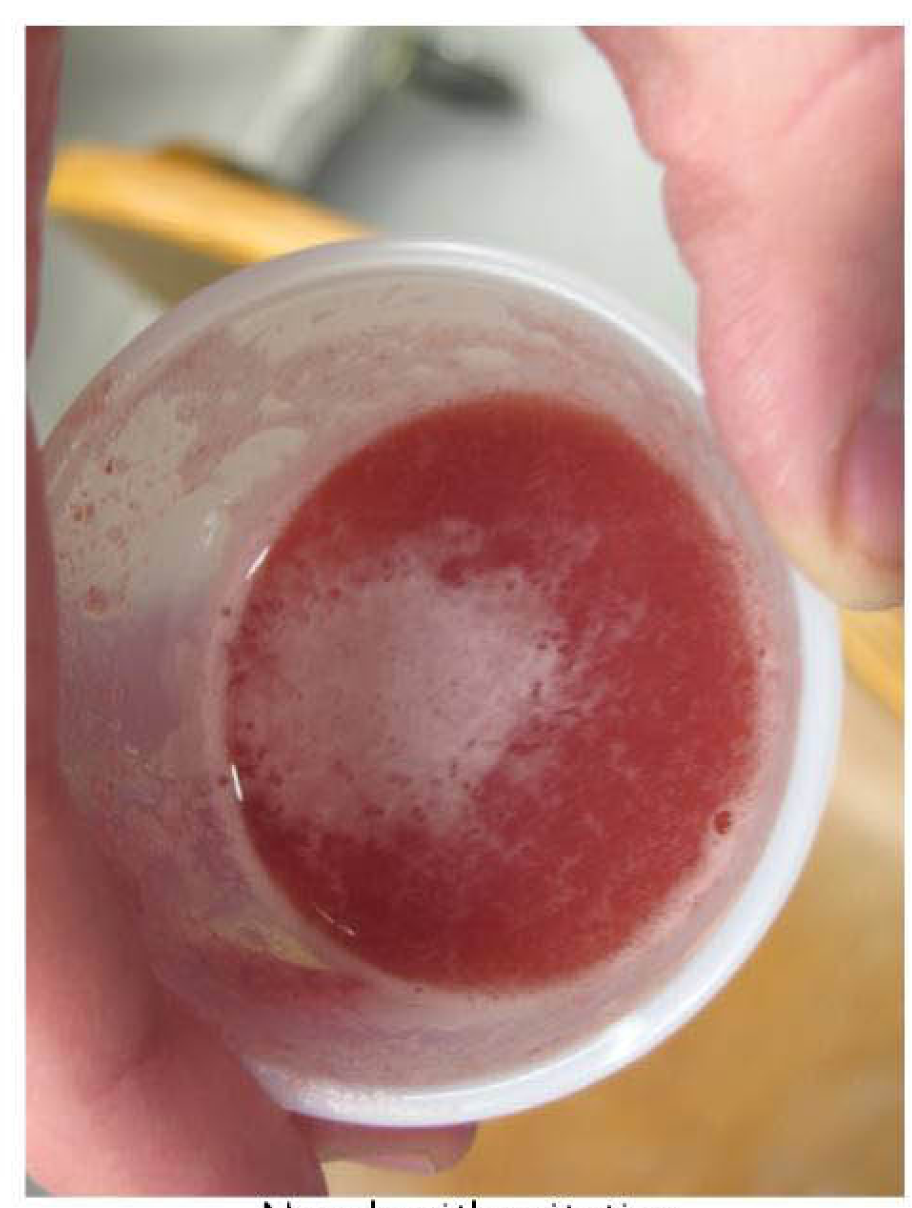
No pulp, no agitation


No pulp with agitation


Pulp added with agitation


No pulp with agitation

PURDUE UNIVERSITY

Whole Food Smoothie. Avon, Bartkowiak, Horton, Mason. BFPE

Spring 2010

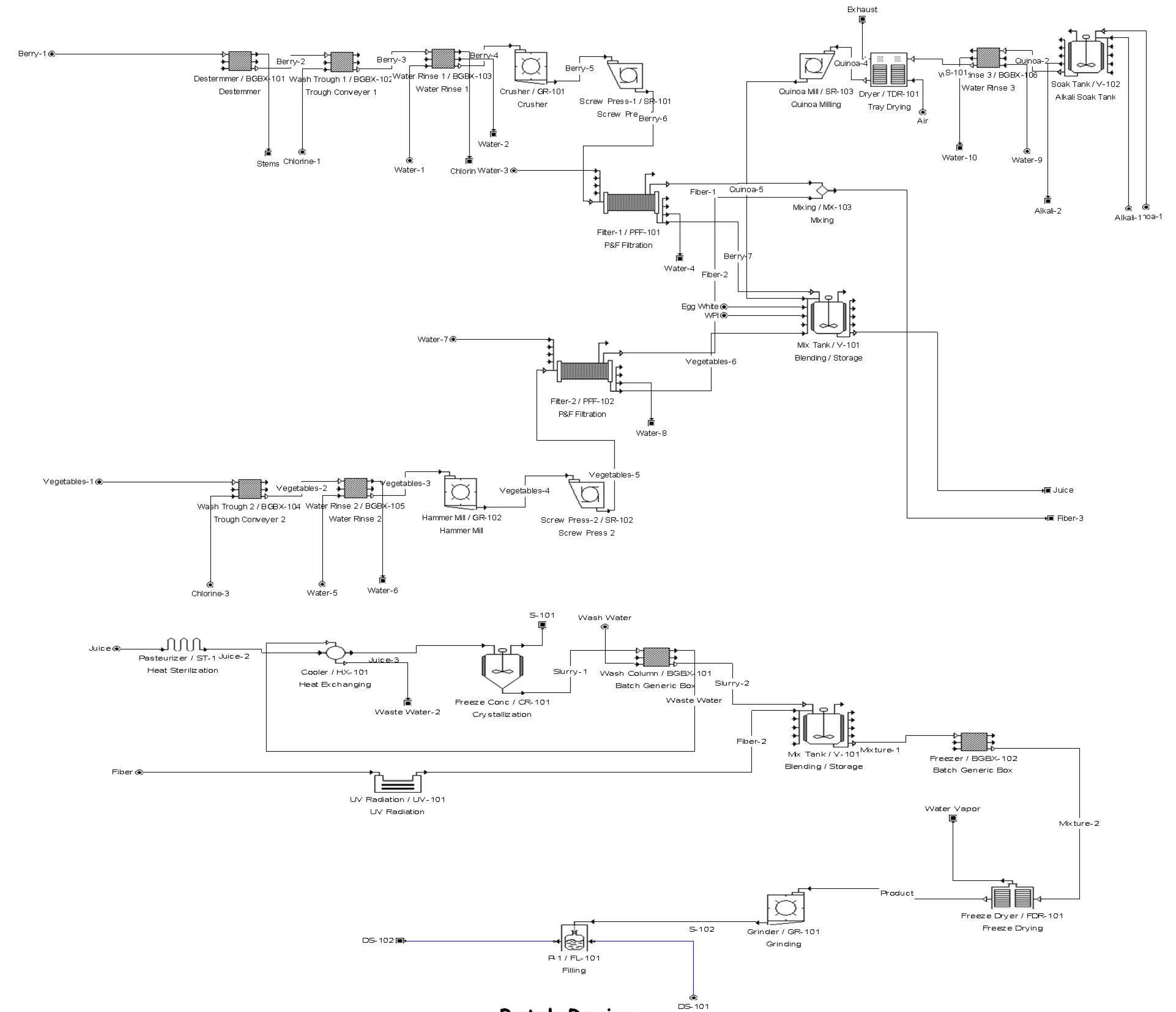
Whole Food Smoothie

Nicholas Avon, Lisa Bartkowiak, Victoria Horton, Jeff Mason

Objective

To provide a high quality, delicious, whole food smoothie/frozen treat. The smoothie will incorporate aspects from every food group and will give the consumer at least one-sixth of the recommended daily allowances (RDAs) of all nutrients. The plant used to produce this smoothie should operate with the overall goal of sustainability. The goal of the plant design is to minimize process cost which will be reflected by the product cost. Energy efficiency optimization will be employed to meet this goal. Waste will be kept to a minimum as nearly all parts of the raw materials are used in the product. Energy will be conserved through smart, environmental design of the production process.

Process Flow Diagram



Batch Recipe

Material	kg/yr	kg/batch
Blueberries	147,274	110.982
Cranberries	144,862	109.165
Fiber	16,232	12.232
Stems	301	0.227
NaOH (1 M)	16,229,175	12,229.974
Chlorine	55,734	42.000
Water	3,258,693	2,455.684
Apples	247,366	186.410
Carrots	25,888	19.509
Wheatgrass	5,928	4.467
Egg Whites	31,185	23.500
Whey Protein Is	32,607	24.572
NaCl (0.5 M)	36,758	27.700
Quinoa	11,857	8.935
TOTAL	20,243,859	15,255.357

PURDUE UNIVERSITY

Plant and Economic Development
Spring 2010

Plant Location Considerations

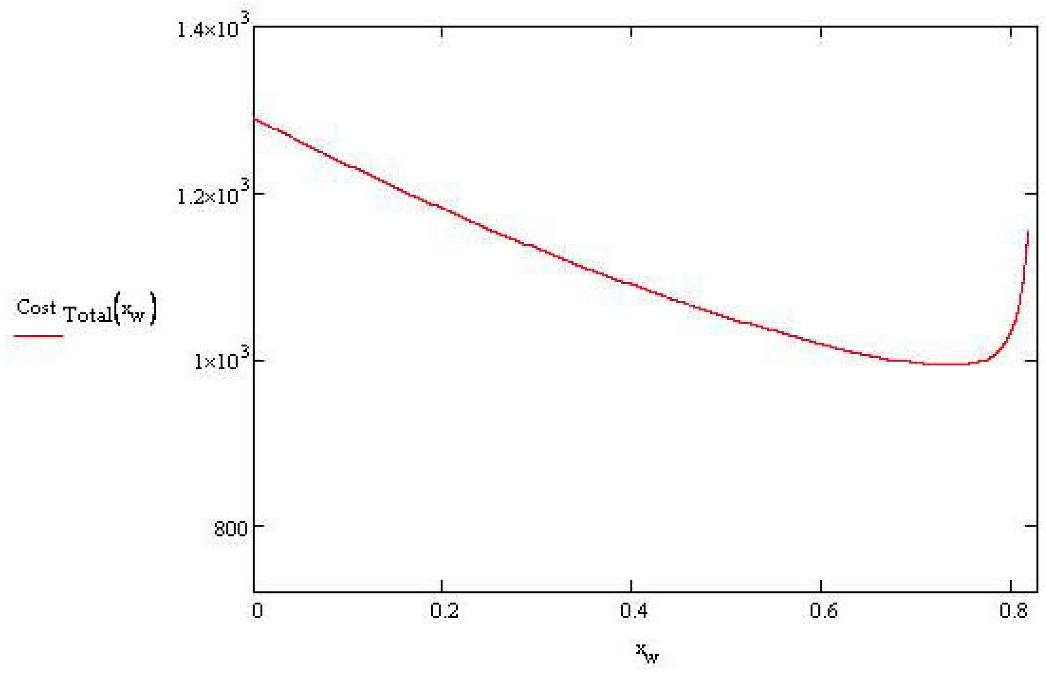
The Chicago area was chosen as the site of the new plant. It is in close proximity to raw materials, has a good climate, is a major market itself and also has easy access to other major markets. In addition, Chicago is a major rail center for the entire United States and its Interstate system can connect to any part of the country. Since Chicago is located in the Midwest, it will be easy to ship the product to either the East or West coasts. It is the perfect location for the plant and a good community for the employees.

Plant Costs

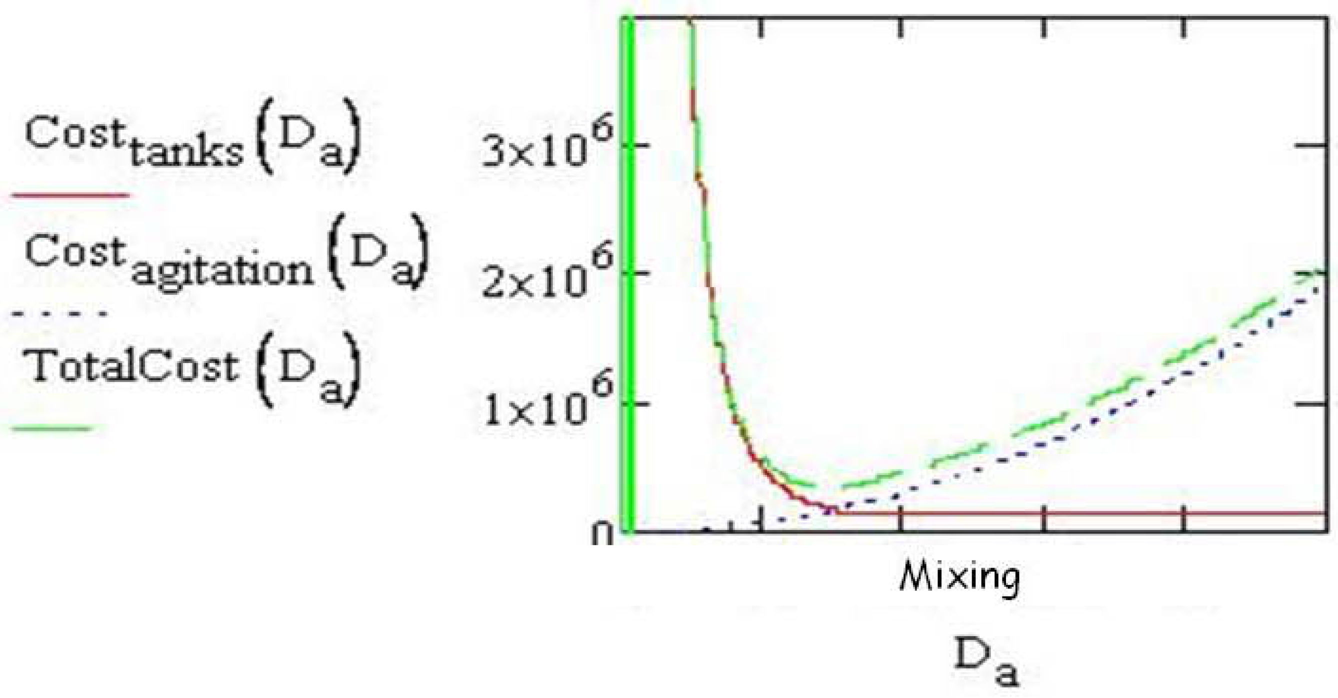
The total capital cost of this project included the equipment, equipment installation, piping, land, buildings, construction, and other fees. The total came out to be $26,821,000. Annual operating costs were also taken into account. These included labor, raw materials, electricity, steam, maintenance, and transportation. The annual expense was approximately $9,000,000.

Cost Savings Measures

Optimizations – To save money, costly processes were optimized in order to minimize operating costs. Freeze concentration, freeze drying, mixing, and pasteurization were the operations considered. The results of the optimizations are as follows:



Freeze Concentration/Freeze Drying



Mixing

Energy and Material Integration – Where possible, energy integration was utilized to save money. The fundamentals of heat transfer were used to incorporate process materials in multiple operations. Possible areas for integration include: heat exchanger regeneration, freeze concentration pre-cooling, and input to wash troughs.

Packaging

Initially three packaging designs were considered including single serving travel pouches, family-size bulk containers, and three pitcher packs. The three pitcher pack option was chosen as it presented a cost savings over the single serving travel pouches and better shelf stability than the family-size bulk containers.

Conclusion

After design optimization and economic evaluation, it was determined that the feasibility of producing such a high quality product at a reasonable price was unrealistic. This was due to the high capital and operating costs incurred during the concentration and dehydration stages of the process. Future considerations for making a more economically reasonable product include changing concentration and dehydration procedures such as using evaporators or heated dryers. Different product forms such as popsicles, frozen concentrate, and ready-to-drink may also be considered.