Production of a Low-cost Low-sodium Ground Beef Jerky

**Objective**
This senior design capstone project seeks to create a healthy beef jerky product that has a clear list of all ingredients. It will be sold at a lower price than current beef jerky products on the market. Currently, the annual beef jerky sales amount to almost $600 billion. The production goal is 1.1 million kg beef jerky annually.

**Global Factors**
Dietary trends in America have pushed for protein consumption over carbohydrate consumption. This trend has increased meat snack consumption and caused companies to produce meat snacks pertinent to specific diets. The health focused changes help confront the societal issue of obesity. Load required for thawing is 1189 kJ per batch. The duration of the thawing stage is 8.5 hours. During the mixing stage, 36.23 kJ is required per batch and 210 gallons of water were used to evaporate water and melted fat. 85.3 kW were required to be 58.72 kJ for each batch. In drying, waste includes approximately 1,500 kg/hr. The load required is found to be 190°C by using the variable cost of heating. The ideal temperature was found to be 135,593,974. The return on investment was calculated as 13.63%. Based on the return on investment, the beef jerky production process is profitable.

**Economic Analysis**
Using the equipment costs seen below in conjunction with Table 6-9 in PTW, the FCI and TCI were determined to be $847,468 and $996,896 respectively. To determine the total product cost, several assumptions were made using Table 6-18 in PTW. The result was a total product cost of $15.28/kg. The total annual production was 1,124,337 kg beef jerky. The annual cash flow was calculated to be $13,593,974. The return on investment was calculated as 13.63%. Based on the return on investment, the beef jerky production process is profitable.

**Alternatives**
Thawing (obtain a malleable base to create product):
- Reach-in Refrigerator
- Cold-room
Mixing (create a homogeneous mixture):
- Meat Grinder
- Baffles Mixer
- Ribbon Mixer
Forming (obtain uniform strips of meat):
- Extruder
- Sheeter
Drying (evaporate water and melt fat to dehydrate beef):
- Smokehouse
- Microwave
- Infrared Oven

**Recipe:**
- 1 lb. ground beef
- 1 tsp. Soy Sauce
- 1/2 tsp. Onion Powder
- 1/4 tsp. Salt
- 1 tsp. Black Pepper
- 1 tsp. Lemon Pepper
- 1 tsp. Red Curry Powder
- 1 tsp. Ginger Powder
- 1/4 tsp. Coriander
- 1/2 tsp. Garlic Powder
- 1 tbsp. Worcestershire Sauce

Initially, all ingredients were mixed together and rolled out. The meat slurry was then cut into strips of equal size and thickness. The stripes were then cooked at a low oven temperature for an extended time period.

**Design of Experiments**
A SuperPro flow diagram was developed to model the overall production. The total time for a batch was found to be 12.77 hours but due to operations occurring concurrently, the recipe cycle time is only 8.33 hours. This give 2.87 batches per day and 1,124,337 kg beef jerky annually.

**Process Controls and Optimization**
- Thawing requires manipulation of air flow.
- Mixing requires control over power and flowrate.
- Temperature is the significant factor in the dehydrating stage.
- Constant feed flow rate is crucial to the forming stage.

**Toughness Response ANOVA Data**
- No significant factor for taste response
- Lean % significant for toughness (p<0.05)

**Equipment**
- Condenser: $10,369
- Mixer: $50,000
- Former: $46,350
- Dryer: $30,000
- Evaporator: $42,763
- Conveyer: $16,993

**Production of a Low-cost Low-sodium Ground Beef Jerky**

**References:**
- *Department of Agricultural & Biological Engineering, Purdue University, Indiana, USA*