Thermostabilized Shelf Life Study

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ABSTRACT

- The objective of this project is to determine the shelf life and point of various food items by means of actual measurement or mathematical projection.
- The primary goal of the Advanced Food Technology Project in these long duration exploratory missions is to provide the crew with a palatable, nutritious and safe food system while minimizing volume, mass, and waste.
- The Mars mars mission could be as long as 2.5 years with the potential of the food being positioned prior to the crew arrival.
- Therefore, it is anticipated that foods that are used during the Mars mission will require a 5 year shelf life.
- Shelf life criteria are safety, nutrition, and acceptability. Any of these criteria can be limiting factors in determining the food’s shelf life.
- Due to the heat sterilization process used for the thermostabilized food items, shelf life will be preserved as long as the integrity of the package is maintained.
- Nutrition and acceptability will change over time. Since the food can be the sole source of nutrition to the crew, it is significant to lose in calories they determine when the shelf life expired has expired.
- Shelf life can be defined when the food is no longer acceptable. Acceptability can be defined in terms of appearance, taste, texture, or aroma.
- Shelves from shelf life studies of the thermostabilized food items suggest that the shelf life of the foods range from 0 months to 8 years, depending on formulation.

RESULTS AND DISCUSSION

Entrées Pork Chops, Tuna Noodle Casserole
- Grilled Pork Chops
- Vitamin B1 values showed losses at higher storage temperatures.
- Dryness of the product was cited as a reason for product failure.
- Shelf life projected to be 87 months at 72°F.

Tuna Noodle Casserole
- Product failure was attributed to declining scores for hardening of noodles and darkening of color during the 36 month study.
- Vitamin A, B1, B2, B3, B6, and pantothenic acid showed linear decline as the holding temperature increased.
- Shelf life projected to be 46 months at 72°F.

Sweets (Bread Pudding)
- High sugar items tend to have longer shelf lives.
- Vitamin A, B1 and B12 demonstrated a linear decline with temperature.
- The overall flavor, level of sweetness, quality and color at the end of the shelf life exceeded the anticipated activity of yeasts, mold or bacteria.
- Shelf life projected to be 48 months at 72°F.

Vegetables (Carrot Coins, Sugar Snap Peas)
- Gradual decreases in all related color values at all temperatures over the storage period, yellow in particular.
- Vitamin A, B1, B2, B3, B6, pantothenic acid and folic acid showed linear decline as the holding temperature increased.
- Shelf life projected to be 20 months at 95°F.

Cheese and Vegetable (Palak Paneer)
- Overall acceptability and specifically aroma scores decreased over time likely due to oxidation of the spices and lipids (cheese).
- Folic acid declined by 48% in rhubarb applesauce.
- Shelf life projected to be 24 months at 72°F.

Shelf life for both products projected to be 15 months at 72°F.

Fruits (Apricot Cobbler, Rhubarb Applesauce)
- Vitamin C significantly declined over time.
- Apricot cobbler declined from 179 mg/100g to 48.7 mg/100g. The level in rhubarb applesauce declined from 1.16 mg/g to undetectable.
- Folic acid declined by 44% in rhubarb applesauce.
- Products darkened in color over time with the higher temperatures darkening more than the 40°F sample.
- Shelf life for both products projected to be 15 months at 72°F.

Sensory panel did not find the 0 month (baseline) product to be acceptable, due to rubbery texture and brown color. Color continued to darken over time but the texture did not change.

Eggs (Broccoli Soufflé, Vegetable Omelet)
- It is difficult to produce a thermostabilized egg product due to dark pigment production from sulfur amino reactions and changes in the proteolytic resulting in a hardening of the texture.
- Both products were unacceptable shortly after production initiating a shelf life of 9 months.
- Testing was conducted to analytical data to try to better understand where the deterioration happened.

Vegetable omelet
- Sensory panel did not find the 0 month (baseline) product to be acceptable, due to rubbery texture and brown color.
- Color continued to darken over time but the texture did not change.
- Vitamin E, B, B1, pantothenic acid and folic acid demonstrated a slow linear decline with time and temperature.

Broccoli Soufflé
- Sensory testing shortly after production yielded an overall acceptable score below the established acceptance level.
- Overall darkening of product color over time and a decreased in green color for samples held at 90° F and 72°F.

Shelf life projected to be 40 months at 72°F.

SHELF LIFE CALCULATIONS

Shelf life will be determined by:
- Visually the quality attribute, such as color, flavor, or texture, that will determine the shelf life.
- The Q10 for the product based on quality changes for the three temperatures. The Q10 is a measure of how the rate of a reaction changes for every 10°C change in temperature.
- The Q10 provides a prediction of shelf life at different temperatures.

CONCLUSIONS

- Shelf life is determined by safety, acceptability, and nutritional content.
- Safety is not an issue due to the processing.
- Acceptability is dependent on formulation and processing conditions.
- Nutrition is lost over time.
- Sugar can protect the food from degradation.
- Formulations that contain whole eggs at a significant level do not provide acceptable products using the current thermostabilization process.
- Fruit products tend to be broken over time. The Maillard Browning reaction affects color and flavor.
- The current thermostabilization process will not provide a 5 year shelf life for all formulations.
- External studies on emerging technologies, such as high pressure processing and microwave sterilization, are resulting in higher quality products and should be investigated further.

MATERIALS AND METHODS

- Products stored at three temperatures, 40°F, 72°F, and 95°F for an acceptable shelf life.
- Products are examined for texture within 3 weeks of production.
- Evaluations are every four months for the first 2 years and every 6 months for the 3rd year.
- Sensory testing includes difference from control testing and overall acceptability testing.
- Textural analysis includes texture, color, moisture, and water activity determination.

REFERENCES