Thermostabilized Shelf Life Study

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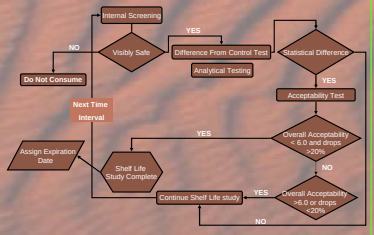
ABSTRACT

- The objective of this project is to determine the shelf life end-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 missions 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 missions will require a 5 year shelf life
- Shelf life criteria are safety, nutrition, and acceptability. Any of these criteria can be the limiting factor in determining the food's shelf life
- Due to the heat sterilization process used for the thermostabilized food items, safety 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, a significant loss in nutrition may determine when the shelf life endpoint has occurred
  - Shelf life can be defined when the food item is no longer acceptable. Acceptability can be defined in terms of appearance, flavor, texture, or aroma
- **Results 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**

MATERIALS AND METHODS

- Products stored at three temperatures: 40ºF, 72ºF and 95ºF for an accelerated shelf life test
- Products are evaluated for baseline 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 acceptance testing
- Analytical tests can include texture, color, moisture, and water activity determination



SHELF LIFE CALCULATIONS

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

$$\frac{\text{Shelf life at temperature T°C}}{\text{Shelf life at temperature (T°C + 10)}}$$

Preservation Method	Typical Q_{10} Values
Thermally Processed	1 – 4
Dehydrated	2 – 10
Frozen	3 – 40

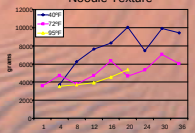
RESULTS AND DISCUSSION

Entrées Pork Chops, Tuna Noodle Casserole

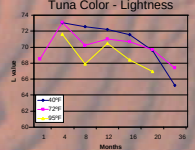
Grilled Pork Chops
- Vitamin B1 levels showed losses at higher storage temperatures
- Dryness of the product was cited as a reason for product failure
- **Shelf life projected to be 87 months at 72ºF**

Tuna Noodle Casserole
- Product failure was attributed to declining scores for hardening of noodles and darkening of color during the 36 month study
- Vitamin B6, folic acid and pantothenic acid showed linear decline as the holding temperature increased
- **Shelf life projected to be 49 months at 72ºF**

Noodle Texture

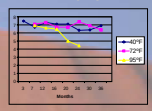


Tuna Color - Lightness



Sweets (Bread Pudding)

- High sugar items tend to have longer shelf lives
- Vitamins A, B1 and B12 demonstrated a linear decline with temperature
- The overall flavor, level of sweetness, level of vanilla, and overall aftertaste showed a decline likely due to the Maillard Browning reactions. The three most prevalent ingredients; skim milk, sugar and egg, would provide sufficient amounts of free amino groups and reducing sugar to allow for condensation reactions to occur
- **Shelf life projected to be 48 months at 72ºF**



	40F	72F	95F
Vitamin A	157	123	100
Vitamin B1	0.16	0.10	0.06
Vitamin B12	0.32	0.12	0.12

Vegetables (Carrot Coins, Sugar Snap Peas)

- Gradual decreases in all related color values for all temperatures over the storage period, yellow in particular.
- Texture declined over time
- About 33% of the folic acid was lost over the shelf life
- Overall acceptance score for carrot coins declined gradually over the storage period with the comments as "too mushy". The 40ºF and 72ºF samples were still acceptable after three years.
- The sugar snap peas were unacceptable at all temperatures at 20 months due to bitter aftertaste and darker color.
- **Carrot coins shelf life projected to be 48 months at 72ºF**
- **Sugar snap peas shelf life projected to be 20 months at 72oF**

Fruits (Apricot Cobbler, Rhubarb Applesauce)

- Vitamin C significantly declined over time. Apricot cobbler declined from 179 mg/100g to 4.87 mg/100g. The level in rhubarb applesauce declined from 1.16 mg. to undetectable.
- Folic acid declined by 48% in rhubarb applesauce.
- Products darkened in color over time with the higher temperatures darkening more than the 40ºF sample
- **Shelf life for both products projected to be 65 months at 72ºF**

Cheese and Vegetable (Palak Paneer)

- Overall acceptability and specifically aroma scores decreased over time likely due to oxidation of the spices and lipids (cheese)
- Color changes indicated a loss of green color in the spinach and a darkening of the cheese over time.
- **Shelf life for both products projected to be 39 months at 72ºF**

Eggs(Broccoli Soufflé, Vegetable Omelet)

It is difficult to produce a thermostabilized egg product due to dark pigment production from sugar-amino reactions and changes in the proteins resulting in a hardening of the texture

- **Both products were unacceptable shortly after production indicating a shelf life of 0 months**
- Testing was conducted to analytical data to try to better understand where the deterioration happens

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
- Vitamins E, B1, B6, pantothenic acid and folic acid demonstrate a clear linear decline with time and temperature

Broccoli Soufflé
- Sensory testing shortly after production yielded an overall acceptance score below the established acceptance level
- Overall darkening of product color over time and a decreased in green color for samples held at 95°F and 72°

Starch (Homestyle Potatoes)

- Flavor decreased over time due to acidic aftertaste, off aroma, and overall decrease in flavor.
- There was a significant decline in folic acid and pantothenic acid .
- **Shelf life projected to be 48 months at 72ºF**

LUSIONS

- Shelf life is d… content
  - Safety is …
  - Acceptab… condition…
  - Nutrition …
- Sugar can pr…
- Formulations … not provide… thermostabiliz…
- Fruit products … reaction affec…
- The current th… shelf life for a…
- External stu… pressure proc… higher quality…

…safety, acceptability, and nutritional …ue to the processing …dant on formulation and processing …e …from degradation …whole eggs at a significant level do …products using the current …n over time. The Maillard Browning …avor …tion process will not provide a 5 year …rging technologies, such as high …icrowave sterilization, are resulting in …should be investigated further

T STEPS

- Complete ar… – Roasted V…
- Based on th… lives of all of… predicted. R…

…onth data for the last two products … Three Bean Salad …elf lives of these 13 items, shelf …nostabilized food products will be …ompleted in April 2009.

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