Thermostabilized Shelf Life Study
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RESULTS AND DISCUSSION

The objective of this project is to determine the shelf life 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 maintaining volume, mass, and waste. The Mars missions could be as long as 2.5 years with the potential of the food being provided 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 has been dehydrated and reconstituted, it is a significant loss. In addition, they determine when the shelf life endpoint has occurred.

Shelf life can be determined when the food item is no longer acceptable. Acceptability can be defined in terms of appearance, flavor, texture, or aroma.

Shelf life for all formulations was determined based on 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 a difference from control testing and overall acceptability testing.

Analytical tests can include texture, color, moisture, and water activity determination. Shelf life for both products projected to be 65 months at 72ºF.

Fruits (Apricot Cobbler, Rhubarb Applesauce)

Vitamin C significantly declined over time. Apricot cobbler declined from 179 mg/100g to 4.8 mg/100g. The level in rhubarb applesauce declined by about 44% 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 yellowing of the cream cheese over time.

Shelf life for both products projected to be 20 months at 72ºF.

Vegetables (Carrot Coins, Sugar Snap Peas)

Gradual decreases in all related color values for all temperatures over the storage period, yellow in particular. Tuna Color - Lightness.

The overall flavor, level of sweetness, level of vanilla, and overall decrease in flavor. There was a significant decline in folic acid and pantothenic acid from 0 months to 8 years, depending on formulation.

Shelf life for both products projected to be 20 months at 72ºF.

Sweets (Bread Pudding)

High sugar items tend to have longer shelf lives. Vitamin A, B1 and B12 demonstrated a linear decline with temperature. Vitamin K declined, and vitamin C showed linear decline as the holding temperature increased.

Shelf life for both products projected to be 48 months at 72ºF.

Grilled Pork Chops

- Vitamin B1 levels showed losses at higher storage temperatures.
- Dysthesia 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 hardness of noodles and darkening of color during the 36 month study.
- Shelf life projected to be 49 months at 72ºF.

Eggs (Broccoli Soufflé, Vegetable Omelet)

Color 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.

REFERENCES


NEXT STEPS

Complete analysis of shelf life data for the four last products - Roasted Vegetables and Thyme Stew Salad.

Based on the projected shelf lives of these 13 items, shelf lives of all of NASA's thermostabilized food products will be predicted. Report will be completed in April 2009.

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 did not provide acceptable products using the current thermostabilization process. Nutraceuticals tend to be less stable 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 microencapsulation, are resulting in higher quality products and should be investigated further.

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