Thermostabilized Shelf Life Study

M.H. Perchonok, P.M. Catauro

NASA JSC, 2101 NASA Parkway, Houston, TX 77058

ABSTRACT

The objective of this project is to determine the shelf life and point-of-sale values of 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 prioritized 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 end source of nutrition to the crew, a significant loss in nutrition may determine when the shelf life approach 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.

RESULTS AND DISCUSSION

Entrées and 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 72°F.

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 was projected to be 48 months at 72°F.

Entrees (Broccoli, Soufflé, Vegetable Omlette)

Eggs: (Broccoli, Soufflé, Vegetable Omlette)
- It is difficult to produce a thermostabilized egg product due to dark pigment production from sulfur-amino reactions and changes in the protein resulting in a hardening of the texture.
- Both products were unacceptable shortly after production initiating a shelf life of 9 months.
- Shelf life for both products projected to be 65 months at 72°F.

Vegetables (Carrot Coins, Sugar Snap Peas)

Grilled Pork Chops
- Vitamin A, B1 and B12 demonstrated a linear decline with temperature.
- The overall flavor, level of sweetness, vanilla, and overall aftertaste showed a decline likely due to the Maillard Browning reactions. The three most prevalent ingredients; 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 72°F.

Vegetables: (Carrot Coins, Sugar Snap Peas)
- Vitamin B1 levels showed losses at higher storage temperatures.
- Dryness of the product was cited as a reason for product failure.
- Shelf life predicted to be 36 months at 72°F.
- Shelf life projected to be 48 months at 72°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).
- Color changes indicated a loss of green color in the spinach and a yellowing and a decreased green color for samples held at 95°F and 72°F.
- Shelf life for both products projected to be 20 months at 72°F.

Starch (Homestyle Potatoes)
- Flavor decreased over time due to acidic aftertaste, off aroma, and overall decrease in flavor.
- There was a declining trend in both potato and starch content.
- Shelf life projected to be 48 months at 72°F.

Materials and Methods

Fruits (Apricot Cobler, Rhubarb Applesauce)
- Vitamin C significantly declined over time. Apricot cobler declined from 179 mg/100g to 4.87 mg/100g. The level in rhubarb applesauce declined from 1.10 mg/100g to undetectable.
- Overall acceptance scores are consistent with previous shelf life studies.
- 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.

Sweets (Bread Pudding)
- High sugar items tend to have longer shelf lives 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.
- Vitamin A, B1 and B12 demonstrated a linear decline with temperature.
- Shelf life projected to be 48 months at 72°F.

Shelf Life Calculations

The shelf life will be determined by identifying the quality attribute, such as color, flavor, or texture, that will determine the shelf life.

Determine the Q10 for the product based on quality changes for the three temperatures.

The Q10 gives an idea 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.

SHELF LIFE CALCULATION

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Temperature</th>
<th>Shelf Life (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grilled Pork Chops</td>
<td>40°F</td>
<td>2 – 10 months</td>
</tr>
<tr>
<td>Broccoli</td>
<td>95°F</td>
<td>3 – 40 months</td>
</tr>
<tr>
<td>Tuna Noodle Casserole</td>
<td>72°F</td>
<td>36 – 48 months</td>
</tr>
<tr>
<td>Carrot Coins</td>
<td>72°F</td>
<td>48 – 52 months</td>
</tr>
<tr>
<td>Sugar Snap Peas</td>
<td>72°F</td>
<td>48 – 52 months</td>
</tr>
<tr>
<td>Apricot Cobler</td>
<td>72°F</td>
<td>15 – 20 months</td>
</tr>
<tr>
<td>Rhubarb Applesauce</td>
<td>72°F</td>
<td>15 – 20 months</td>
</tr>
<tr>
<td>Bread Pudding</td>
<td>72°F</td>
<td>48 – 52 months</td>
</tr>
</tbody>
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REFERENCES