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 is to develop long duration exploratory resources 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 is determined by 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 6 months to 8 years, depending on formulation.

RESULTS AND DISCUSSION

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 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.

<table>
<thead>
<tr>
<th>Preservation Method</th>
<th>Typical Q10 Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermo Processed</td>
<td>1 – 4</td>
</tr>
<tr>
<td>Dehydrated</td>
<td>10 – 20</td>
</tr>
<tr>
<td>Frozen</td>
<td>3 – 40</td>
</tr>
</tbody>
</table>

- Testing is still in progress for three vegetable products, one fruit, and one starch item. Testing will be completed in November 2005.

RESULTS AND DISCUSSION

MATERIALS AND METHODS

- Products stored at three temperatures – 40°F, 72°F and 95°F for an accelerated shelf life test.
- Products are evaluated for baseline within 3 weeks of production.
- Evaluations are every 4 months for the first 2 years and every 8 months for the 3rd year.
- Sensory testing includes difference from control testing and overall acceptance testing.
- Analytical tests include texture, color, moisture, and water activity determination.

ENTRÉES (PORK CHOPS, TUNA NOODLE CASSEROLE)

- Meats in general:
  - Texture is the most altered quality attribute due to denaturation of the muscle proteins and the migration of free water, cross-linking of proteins and without protein solubility contributes to the toughness of meat.
  - Fatty tissues and pork, with higher unaltered lipid content are more susceptible to oxidation.

- Grilled Pork Chops:
  - Vitamin B3 levels showed losses at higher storage temperatures.
  - Dome shape 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 decaying scores for hardness of noodles and declining of color during the 36 month study.
  - Vitamin B6, nicotinic acid and pantothenic acid showed linear decline as the holding temperature increased.
  - Shelf life projected to be 48 months at 72°F.

VEGETABLES (CARROT COINS)

- Gravel increases in all related color values at all temperatures over the storage period, yellow in particular.
- Overall acceptance and shelf life were stable over the storage period with the comments as “too mushy”.
- Shelf life projected to be 48 months at 72°F.

EGGS (BROCCOLI SOUFFLÉ, VEGETABLE OMELET)

- It is difficult to product a thermostabilized egg product due to egg-white-protein reactions cause dark pigment, decreasing the nutritive value of the proteins and resulting in a harder of cooking.
- Both products were unacceptable shortly after production indicating a shelf life of 6 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_adjusting texture and brown color.
  - Color continued to darken over time but the texture did not change.
  - Vitamin E, B1, B6, pantothenic acid and folic acid demonstrated a clear linear decline with time and temperature.

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

RESULTS AND DISCUSSION

FRUITS (APRICOT COBBLER)

- All three products maintained their functionality over the three year test suggesting that the shelf life is at least 8 years.

- Corn Starch:
  - Starch can contribute to texture, viscosity, gel formation, adhesion, binding, moisture retention and film formation.
  - There was a big increase in yellow hues for all three categories.
  - Any of these criteria can be the limiting factor in determining the shelf life.

- Dried Egg Whites:
  - Fruit products tend to brown over time. The Maillard reaction is a sugar-amino reaction produces dark pigments, decreasing the nutritive value of the proteins and resulting in a hardening of the texture.
  - There was little color changes of color regardless of storage temperature and time.
  - Overall the foam stability increased over time regardless of storage temperature.

- Cocoa Powder:
  - There was a big increase in yellow hues for all three categories.
  - Any of these criteria can be the limiting factor in determining the shelf life.

RESULTS AND DISCUSSION

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 brown over time. The Maillard reaction affects color and flavor.
- The current thermostabilization process will not provide a 5 year shelf life for all formulations.
- The emerging technologies of high pressure processing and microwave sterilization appear to result in high quality products and should be investigated further.

REFERENCES