**Experimental Design Matrix**

**Cottonseed Oil/Combitherm**

**Cheerios/Combitherm**

**Peanuts/Combitherm**

**Cheerios/Technipaq**

**Peanuts/Technipaq**

**Cottonseed Oil/Technipaq**

**Peanuts/Tolas**

**Technipaq/Tolas**

**Cheerios/Tolas**

**Cottonseed Oil/Tolas**

**MATERIALS**

- **FOOD SAMPLES**
  - Cottonseed Oil
  - Cheerios
  - Peanuts

**Storage:**
- 3 variables
  - *72°F & 25%RH
  - *72°F & 50%RH
  - *72°F & 75%RH

**Analyses:**
- Free Fatty Acid
- Peroxide Value
- Moisture
- Sensory

**Hexanal**

**Rate of Analysis:**
- Full testing once every 3 months for 18 months, then quantitative analyses only through 36 months.

**PURPOSE**

- Evaluate new high barrier food packaging films for use on long duration space missions.
- Determine the effects of:
  - High temperatures during heat sealing
  - Stress cracking from folds in the films caused by vacuum packing
  - Relative humidity during storage

**Deliverables**

- Quantitatively evaluate each packaging material after final processing for oxygen and water vapor transmission through analysis of ingredients susceptible to moisture uptake and lipid oxidation.
- Qualitatively determine changes in food product attributes through sensory evaluation methods after storage in 3 different packaging films.
- Evaluate the potential of each packaging material based on qualitative and quantitative results.

**Food Sample Selection**

- Dry cereal is prone to reduced quality from absorption of water vapor.
- Cottonseed oil is susceptible to lipid oxidation in the presence of oxygen.
- Peanuts produce a rancidity marker, hexanal, which can be quantified by analysis of the gas in the headspace of the package.

**Permeation Rate Comparison**

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>OTR @ 73°F &amp; 100%RH (grams/100in²/day)</th>
<th>WVTR @ 100°F &amp; 100%RH (grams/100in²/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combitherm Film</td>
<td>&lt;0.0003</td>
<td>&lt;0.0030</td>
</tr>
<tr>
<td>Technipaq Film</td>
<td>&lt;0.0003</td>
<td>&lt;0.0003</td>
</tr>
<tr>
<td>Technipaq/Tolas</td>
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<td>&lt;0.0003</td>
</tr>
<tr>
<td>Tolas Film</td>
<td>0.35</td>
<td>25</td>
</tr>
</tbody>
</table>

**Comparative Packaging Study**

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<table>
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</tr>
<tr>
<td>Tolas</td>
<td>Peanuts in Combitherm</td>
</tr>
<tr>
<td>Oil in Combitherm</td>
<td></td>
</tr>
</tbody>
</table>

**Packaging Material Information**

**Combitherm Film**

- Structure: Nylon/EVOH/Nylon/High Ethylene Vinyl Acetate Polyethylene/LLDPE
- PROS: Lightweight and transparent. Microwavable and can be incinerated.
- CONS: Requires an overwrap film due to poor barrier properties. Overwrap causes a major increase in mass for food system.

**Technipaq Film**

- Structure: A quadlaminate film. PET/Polyethylene/Aluminum/Inomer
- PROS: Best barrier properties available in a film.
- CONS: Film cannot be incinerated or microwaved due to aluminum layer. Film is not clear to allow for food identification.

**Tolas Film**

- Structure: A PET film coated with a thin layer of aluminum oxide.
- PROS: Very lightweight with excellent barrier properties. Transparent film. Microwavable and can be incinerated.
- CONS: Stress cracking caused by wrinkles during vacuum packaging may reduce the barrier properties.