An Alternative to Guar Gum in Ice Cream Applications
*With Aquacel™ GSA Cellulose Gum*

**Introduction**

Cellulose gum (E466), also known as sodium carboxymethylcellulose (CMC) is a widely used stabilizer in standard, premium and economical ice cream and frozen dessert formulations. Guar gum, also commonly used, has historically been a low-cost ice cream stabilizer used in concert with or to replace CMC. Current market conditions have put pressure on guar prices and supply. In many applications CMC can used to replace guar with little impact on or even improvements in performance.

The advantages of CMC include the following:

- Rapid hydration for quick viscosity
- High water binding
- Effectiveness at low concentrations
- Wide range of viscosity grades for desired thickness
- Variety of particle sizes to facilitate handling
- Low microbial contribution

Aquacel™ GSA CMC is specifically designed to supplement or replace guar in dairy applications. This unique CMC grade will enhance mouthfeel, control melt down and reduce heat shock impact on ice cream formulations.

CMC is used to control water mobility and texture for the following benefits:

- Stabilize against heat shock
- Control ice crystal size
- Provide desirable texture
- Highly rated eating quality
- Excellent overrun and stiffness parameters
- Control melt profile

In the following work, Aquacel GSA CMC is evaluated versus guar gum for performance in an 8% fat ice cream formulation. It was found that Aquacel GSA CMC used alone or in a blend with guar gum performed similarly or was superior to guar gum used alone in stability and eating quality.
Methods

The formulation shown in Table 1 and the following process was used to evaluate guar replacement with CMC in ice cream.

Table 1. Ice cream, 10% fat, formulation used for study

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Weight, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skim milk</td>
<td>53.65</td>
</tr>
<tr>
<td>Cream (40% fat)</td>
<td>25.00</td>
</tr>
<tr>
<td>Sugar</td>
<td>13.00</td>
</tr>
<tr>
<td>Nonfat dry milk, low heat</td>
<td>5.00</td>
</tr>
<tr>
<td>Corn syrup solids, 36 DE</td>
<td>3.00</td>
</tr>
<tr>
<td><strong>Stabilizer blend:</strong></td>
<td></td>
</tr>
<tr>
<td>Hydrocolloid</td>
<td>0.15</td>
</tr>
<tr>
<td>Emulsifier(^a)</td>
<td>0.18</td>
</tr>
<tr>
<td>Carrageenan</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
</tr>
</tbody>
</table>

\(^a\)Dur-Em 204 distilled monoglyceride, Loders Croklaan

Hydrocolloids used in this study were guar gum (approximately 5000 cP), and Aquacel™ GSA CMC. Guar gum and CMC were evaluated alone or in a blend, as outlined in Table 2. Whether gums were used individually or as a blend, total hydrocolloid was used at 0.2% ice cream batch weight.

Table 2. Hydrocolloid portion of the stabilizer blend used for study as ratio of CMC to guar gum and weight percent in ice cream batch

<table>
<thead>
<tr>
<th>Ratio CMC: guar gum</th>
<th>Weight, % CMC</th>
<th>Weight, % Guar gum</th>
</tr>
</thead>
<tbody>
<tr>
<td>100:0</td>
<td>0.15</td>
<td>0</td>
</tr>
<tr>
<td>70:30</td>
<td>0.105</td>
<td>0.045</td>
</tr>
<tr>
<td>50:50</td>
<td>0.075</td>
<td>0.075</td>
</tr>
<tr>
<td>0:100</td>
<td>0</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Ice cream mix was formulated by dry blending the hydrocolloid(s) with a portion of the sugar then adding to the skim milk under agitation by a Silverson homogenizer for several minutes until no lumps appeared. Mixes were stirred with an overhead mixer fitted with a large propeller-style attachment for addition of nonfat dry milk and corn syrup solids. Stirring continued for 1 hour, adjusting rpm as needed to ensure mixing and minimize air entrainment. Cream was added and mixing continued for 5 minutes.

Ice cream mix was processed on the MicroThermics HTST/UHT equipment for HTST (high temperature short time) using the following settings: preheat 30°C, final heat 78°C, 25 second hold, homogenized 2000/500 psi, cool to 10°C packout, pasteurization and homogenization. Mix was aged overnight before freezing.

Ice cream mix was frozen in an Emerson batch freezer. Vanilla flavor was added and thoroughly mixed prior to freezing. Freezing parameters of temperature, overrun and stiffness were monitored to ensure consistent freezing process among batches. Ice cream was packed out at approximately −6.0°C. Ice cream was packed into 12 ounce cardboard cups with plastic lids. Samples were hardened overnight in a cryogenic freezer at −40°C. After hardening, samples were placed in a −18°C freezer for storage.

Melt profile evaluation is performed by allowing ice cream to melt in a controlled way and capturing those melting characteristics. Ice cream was placed on a screen that was then placed over a vessel. The weight of the melting ice cream was taken at specific time intervals. The melting ice cream was also photographed.
Results

Results on overrun and stiffness measurements taken at the time of freezing as well as information comparing melt down characteristics are presented in what follows.

In Figure 1 it can be seen that ice cream made with guar had a slightly higher overrun and lower stiffness than ice cream made with a blend or with all CMC. It is expected that lower stiffness is found in ice cream with higher overrun. Differences are quite small.

![Figure 1. Overrun and stiffness in ice cream made with Aquacel™ GSA CMC, guar gum or blend](image)

Ice cream made with guar gum versus CMC-stabilized ice cream melted at similar rates. It can be seen in Figure 1 that time before the first drip during melting was almost the same for all ice cream samples.
In Figure 2 the data for melting at ambient temperature can be seen; the ice cream stabilized with guar gum, CMC or the blends all performed in similar manners. This indicates the hydrocolloids provide structure to the ice cream aqueous phase in a similar way, thus providing protection from rapid melt down. Further analysis of the melt data shown in Figure 3 it can be seen that ice cream made with guar gum only had the shortest time before the first drip during the melting and ice cream made cellulose only had the longest time, however the times are quite similar.

Figure 2. Melt profile in ice cream stabilized with Aquacel™ GSA CMC, guar gum or blend

Figure 3. Melt profile study in ice cream made with Aquacel™ GSA CMC, guar gum or blends; time of first drip
The photographs in Figure 4 show the ice cream during the melt tests. These photos indicate that the ice cream structure was maintained in a similar way for ice cream made with guar gum, CMC or the blend.

**Figure 4. Melt profiles of various ice cream formulations**

**Sensory evaluation with Dr. Bruce Tharp**

Stabilizers in ice cream control ice crystal formation therefore ice cream was evaluated primarily for texture differences in smoothness, iciness, crunch, etc). Stabilizers also can impact ice cream body detected by the way ice cream breaks apart in the mouth, and may be described as full body, chewiness, or crumbliness.

A panel of 10 participants knowledgeable in ice cream was assembled and ice cream texture evaluation was conducted under the guidance of Bruce Tharp, PhD, of Tharp’s Food Technology, Wayne PA, expert well-known in ice cream, ice cream processing and stabilizers. All ice cream samples were evaluated blind.
Tasting results—Ice cream samples in normal storage

Ice cream samples (tasted blind) were very similar, with good textures. On a scale of 1 (worst) to 5 (best) the four samples had overall scores around 4. See Figure 5. Comments from participants included that differences in texture were not detected between ice creams made with guar gum, CMC or the blend; however, ice cream made with CMC had a bit more desirable body.

![Figure 5. Texture evaluation of ice cream in normal freezer storage and heat shocked made with Aquacel™ GSA CMC, guar gum and blends](image)

Tasting results—Heat shocked ice cream samples

Ice cream samples underwent three cycles of warming and refreezing prior to evaluation. Again using the rating system scale of 1 (worst) to 5 (best) the overall rating of the four samples was around 3 for texture and body, such a low rating would be expected for ice cream that had been subject to temperature abuse.

Conclusions

In this study, ice creams stabilized with guar gum, Aquacel™ GSA CMC or blends of the two were evaluated for their stability characteristics and mouthfeel. It was found that the ice creams performed similarly in overrun, stiffness and melt down properties. Sensory evaluation with an expert in the area also supported that there were no large differences between stabilizers in impact on texture or mouthfeel for ice cream stored under normal conditions or even in ice cream that had undergone temperature abuse (heat shock).