

Hydrocolloids: Clean Label Tools for Plant-Based Formulating

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Conference



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Overview

- Clean label discussion
- Plant-Based “Dairy”
 - Milks/Beverages
 - Plant based cultured products
 - Plant-based Ice cream
- Plant-Based Meat



Clean Label

- Current definitions
 - Short ingredient list
 - Recognizable/pronounceable ingredients
 - Natural colors/flavors
 - No chemical preservatives
 - Whatever the marketing department says it is
- Emotional Clean Label
 - Cruelty free
 - Sustainable
 - Circular economy
 - High employment factor



Plant-Based Beverages

Almond
Soy
Cashew
Coconut
Hemp
Oat
Pea protein



Hydrocolloids in Plant Based Milk

Hydrocolloid	Function	Type
Carrageenan	Suspension & mouthfeel	Kappa and iota type
High acyl gellan	Fluid-gel suspension, clean mouthfeel	Usually in combination with LBG
Locust bean gum	Mouthfeel, creaminess	
Alternate Ingredients		
Tara	Mouthfeel, creaminess	
Gum acacia	Emulsification, mouthfeel	Senegal
Oat Fiber	Suspension (?), mouthfeel	
Citrus Fiber	Mouthfeel	

Remember TIPPS

- Texture
- Ingredients
- pH
- Processing
- Shelf-life/Storage



TIPPS for Plant Based Milk

- Texture
 - Light, but creamy
- Ingredients
 - Proteins
 - Vegetable fats
- pH
 - Neutral
- Processing
 - UHT
- Shelf-life/Storage
 - Refrigerated
 - Shelf Stable

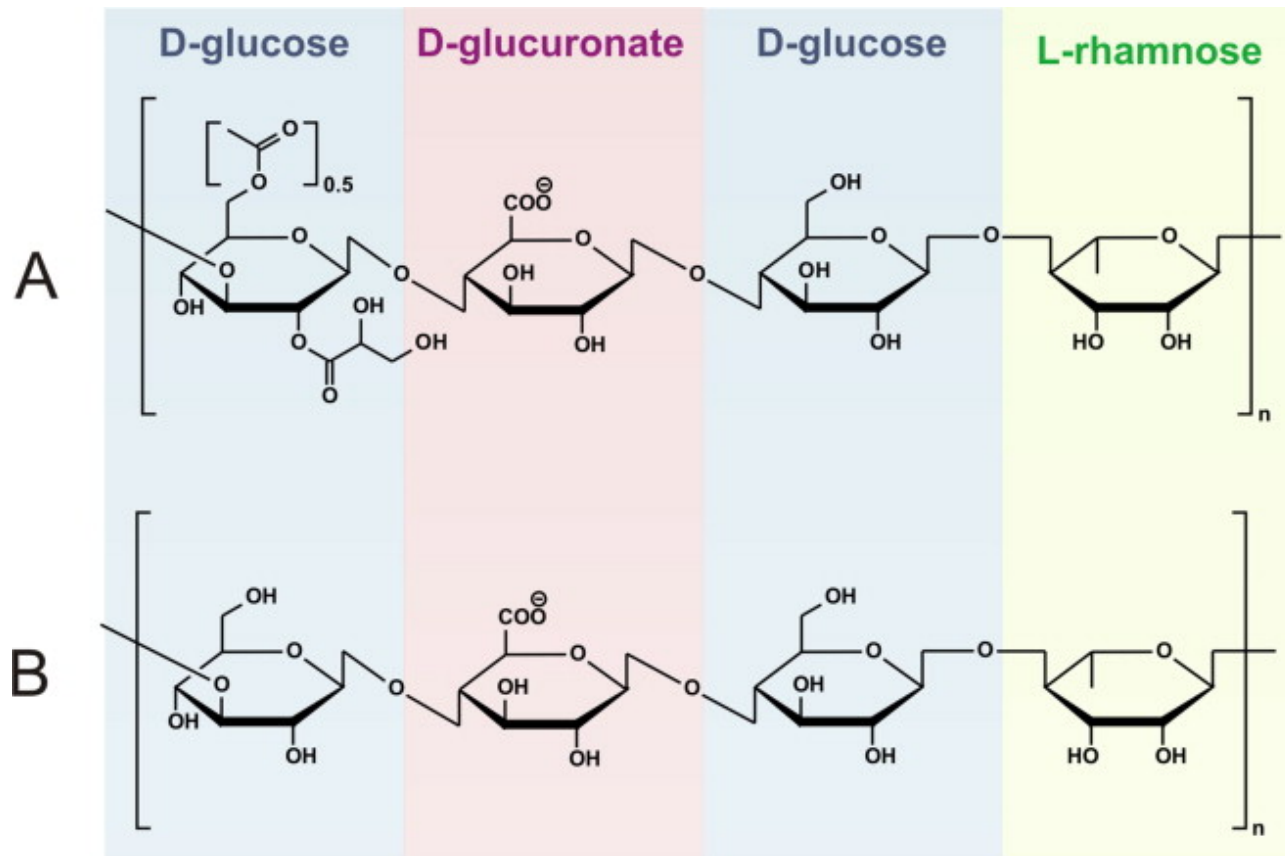


carrageenan

- Synergistic with milk protein
- Suspension
- Mouthfeel
- Emulsion stability
- HTST, UHT stable
- Use level 0.02-0.04%
- Cost effective (\$11-12/kg)
- High employment factor
- No synergy with plant based proteins
- Not retort stable
- “blurb”
- Controversy
 - <https://www.ncbi.nlm.nih.gov/pubmed/12389870> (+)
 - <https://marinalg.org/misinterpreted-science-used-against-carrageenan/> (+)
 - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1242073/> (-)



High Acyl Gellan Gum



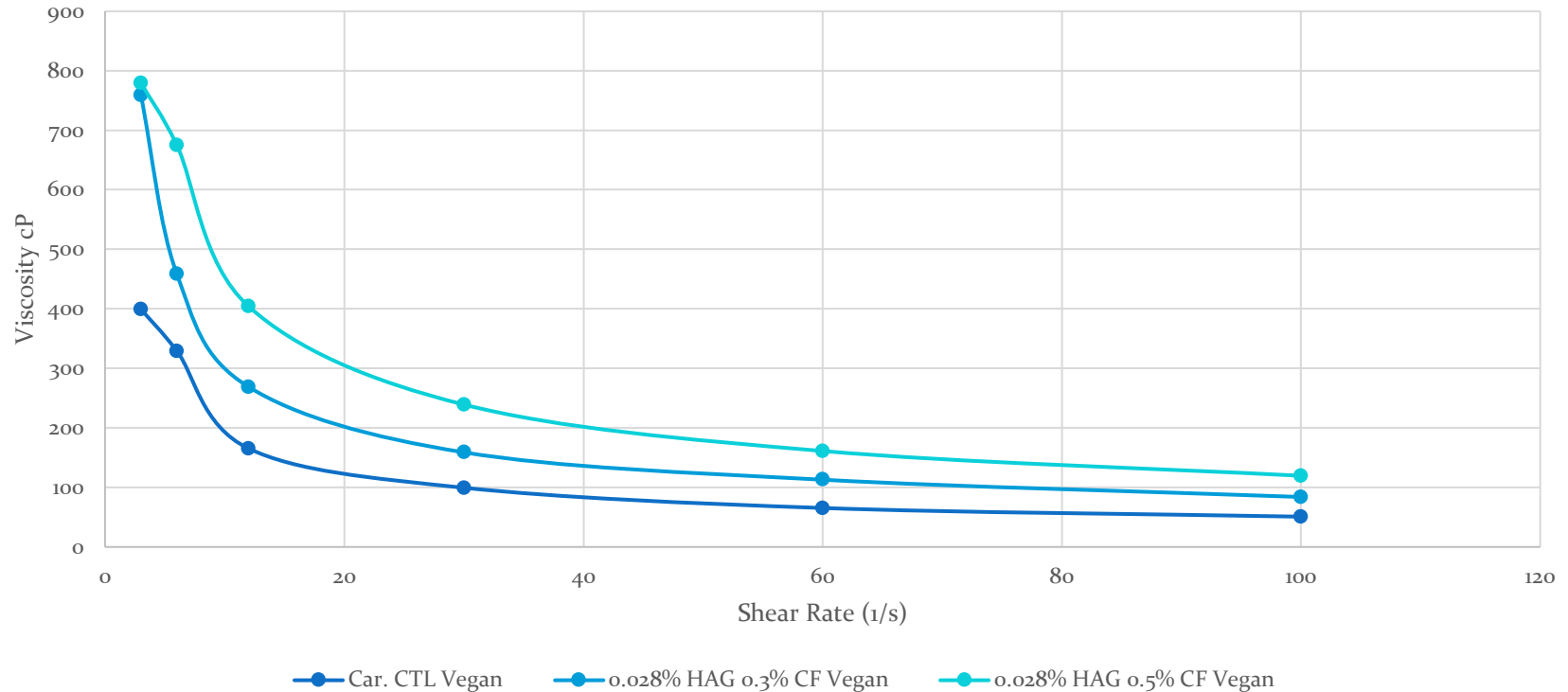
Gellan gum

- High acyl
- Suspension
- Clean mouthfeel
- Use level 0.025-0.035%
- Used in combination with LBG or other
- HTST, UHT processing
- Cost
- No retort processing
- Negative connotation (?)

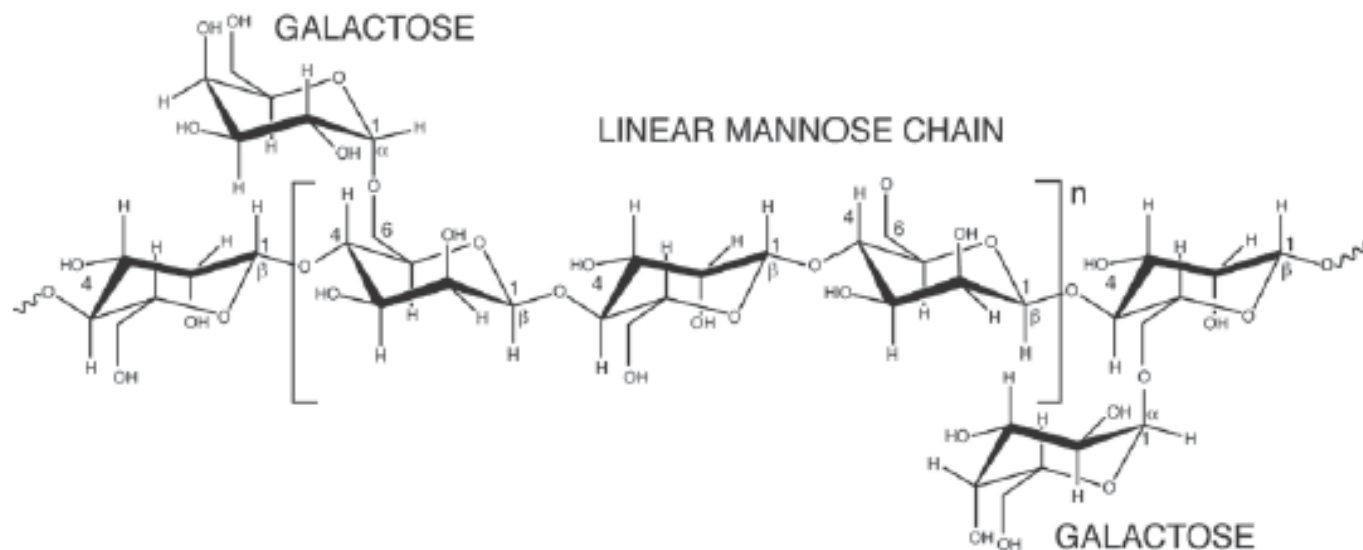


Viscosity Comparison

Viscosity Comparison of Vegan Chocolate Beverage with Carrageenan or High Acyl Gellan Gum and Citrus Flour



Galactomannans



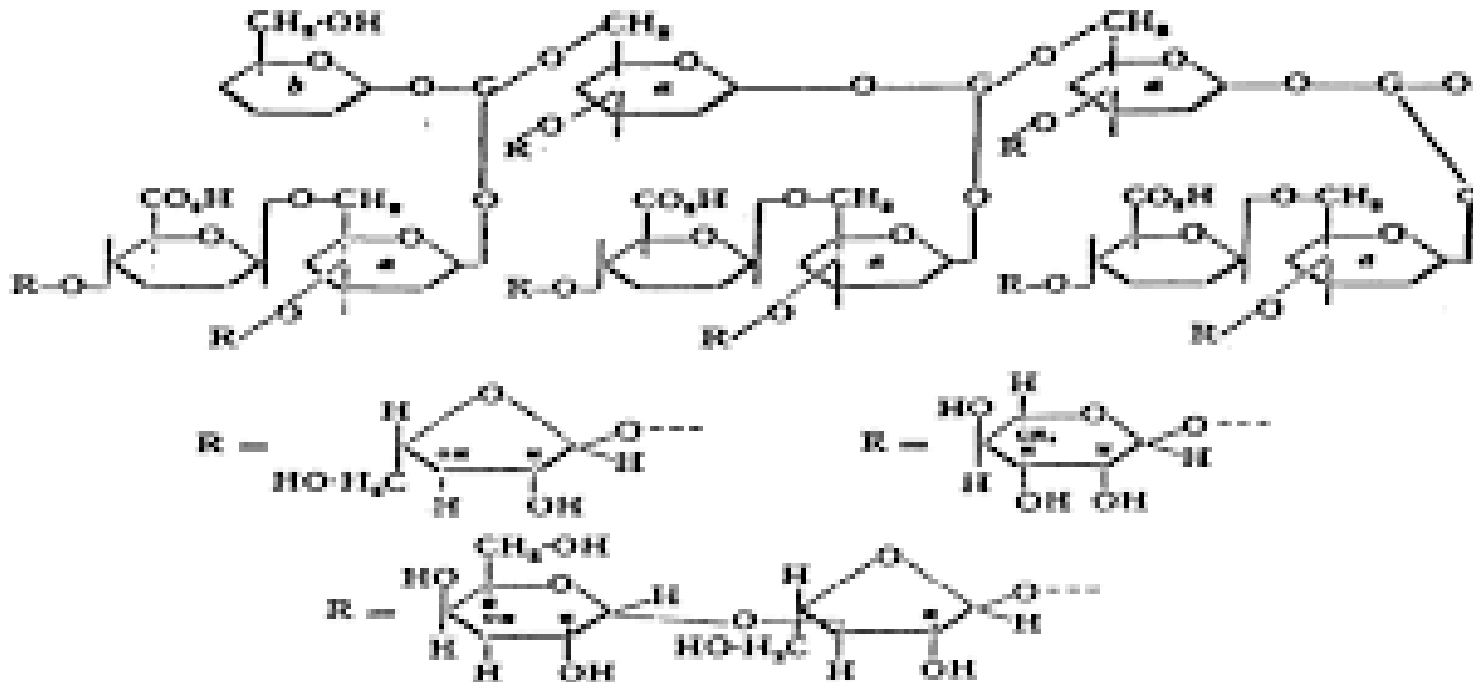
Gum	Galactose: Mannose Ratio	% Cold Water Solub.
Fenugreek	1:1	85
Guar	2:1	65
Tara	3:1	34
Locust bean gum	4:1	29
Cassia	5:1	25

Galactomannans

Fenugreek	Guar	Tara	Locust Bean Gum
Cold water soluble	Cold water soluble	Partially cold water soluble	Hot water soluble >85°C
Thickening	Thickening	Thickening	Thickening
Shear thinning	Shear thinning	Shear thinning	Shear thinning
Non gelling	Non gelling	Gelling synergism	Gelling synergism
Non-ionic	Non-ionic	Non-ionic	Non-ionic
	\$	\$\$	\$\$\$\$

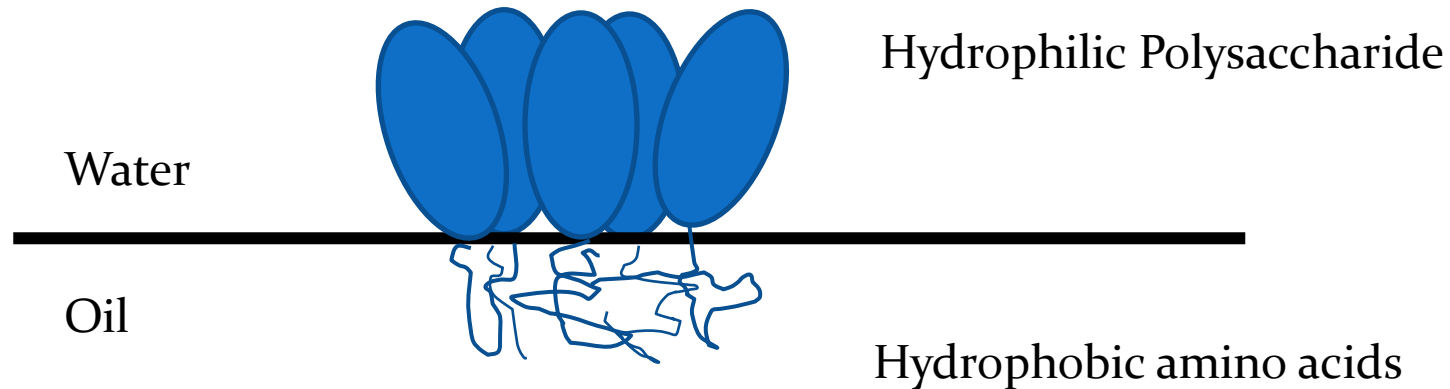


Gum Acacia



Arabinogalactan-Protein Complex

Oil-Water Interface



Oat/Citrus Fiber

- Soluble & insoluble fractions
- Mouthfeel
- Stabilize fluid-gel network
- Stoke's Law
 - Particle size
 - Particle density
 - Viscosity of the fluid
- Use with high acyl gellan gum

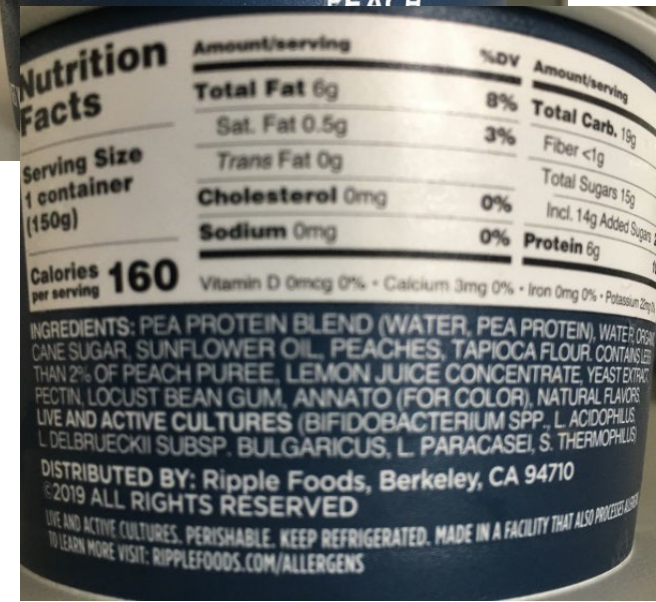
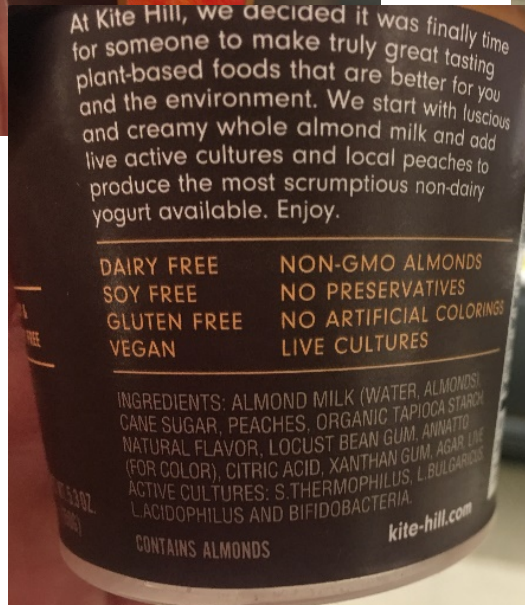


Beverage Troubleshooting

- Dial in use hydrocolloid use level
- Insure proper hydration
- Insure proper fill temperature
- Start with good quality proteins
- Buffer, buffer, buffer (especially UHT)



Plant-Based Yogurt



Hydrocolloids in Plant Based Yogurt

Hydrocolloid	Function	Type
Pectin	Forms gel, rehealing	HM/LMC/LMA
Locust bean gum	Mouthfeel, creaminess	
Starch	Texture	Tapioca
Agar	Texture, sheen, binding	Gracilaria
Xanthan	Viscosity, mouthfeel	In combination with LBG
Guar	Mouthfeel, creaminess	



TIPPS for Plant Based Yogurt

- Texture
 - Custard style
 - Fluid
- Ingredients
 - Proteins
 - Vegetable fats
- pH
 - 4.2-4.6
- Processing
- Storage
 - Refrigerated



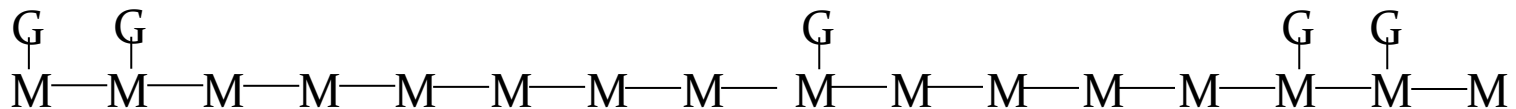
Pectin

	HM	LM	LMA
pH Range	2.5-3.8	2.5-6.0	2.5-6.0
Soluble Solids Range	55-85%	25-55%	25-55%
Thermal Reversible	No	Maybe	Yes
Texture > 3.5 pH	No gel	Spreadable/soft	Spreadable/soft
Texture < 3.5 pH	Firm	Spreadable	Spreadable/slightly rubbery
Use Level	0.1-0.2%	0.1-0.2%	0.1-0.2%

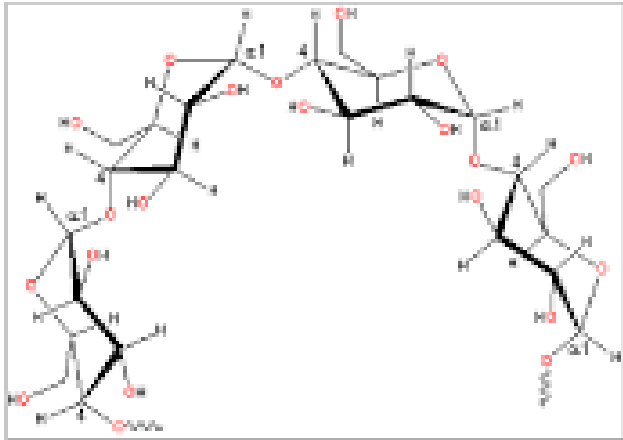


Structure-Function

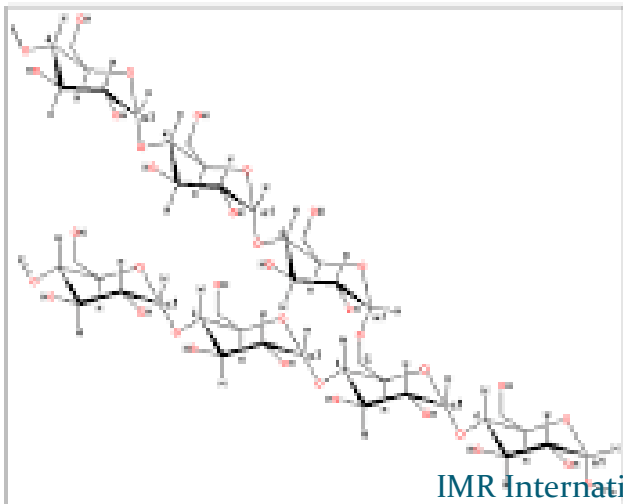
- Mannose backbone
- Galactose side chains



Tapioca Starch



(a)



(b)



Tapioca Starch

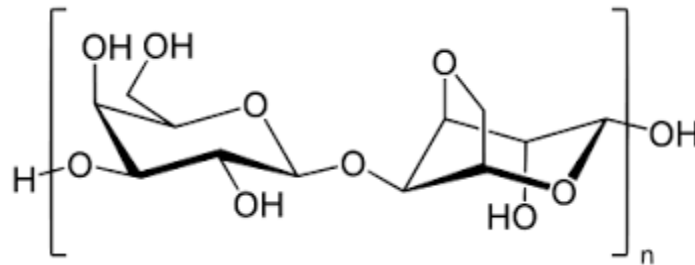
- Starch or flour
- 15-20% amylose
- Bland flavor
- Clear gel after heating
- Soft gel texture
- Acid tolerant
- Less heat resistant than corn starch



Agar



From: oceandocs.org



Agar

- Hot hydration $>85^{\circ}\text{C}$
- Low hot viscosity
- Hysteresis
 - Set @ $32-39^{\circ}\text{C}$
 - Melt at $>85^{\circ}\text{C}$
- Firm, brittle gel
- No gelling ion requirement (Ca^{++} etc)
- Synergistic with LBG & Tara (gelidium)
- Use level: 0.05-0.15%
- \$\$
- pH sensitive while fluid
- Not compatible with tannins



Trouble shooting

- Low Viscosity
 - Change up stabilizer system
 - Check homogenization pressure
 - Insure proper heat treatment
 - Work closely with your culture house
 - Fermentation temperature incorrect
 - Disturbing the curd while $\text{pH} > 4.6$



Plant-Based Ice Cream



SUNFLOWER MILK (WATER, ROASTED SUNFLOWER SEEDS), LIQUID SUGAR (SUGAR, WATER), COCONUT OIL, CORN SYRUP, CORN SYRUP SOLIDS, WHEAT FLOUR, BROWN SUGAR, SUGAR, PEA PROTEIN, SOYBEAN OIL, NATURAL FLAVOR (SESAME, COCONUT), CARAMELIZED SUGAR SYRUP, SUNFLOWER LECITHIN, CORN STARCH, MOLASSES, SALT, BAKING SODA, SEA SALT, GUAR GUM, LOCUST BEAN GUM, CARAMEL COLOR, CARRAGEENAN, DRY MALT EXTRACT, SOY LECITHIN



Hydrocolloids in Plant Based Ice Cream

Hydrocolloid	Function	Type
Carrageenan	Stabilize mix	Kappa/iota
Locust bean gum	Mix viscosity, air incorporation, slows melt	
Guar	Mix viscosity, air incorporation, slows melt	
Tara	Mix viscosity, air incorporation, slows melt	
Starches	Increase viscosity , creaminess	Corn
Alternatives		
Tamarind Seed Gum	Mix viscosity, air incorporation, slows melt	
Oat/Citrus Fiber	Emulsification, water binding	



TIPPS for Plant Based Ice Cream

- Texture
 - Traditional
 - Custard
 - Gelato
- Ingredients
 - Proteins
 - Vegetable fats
- pH
 - Neutral
 - 4.2-4.8
- Processing
- Storage
 - Frozen

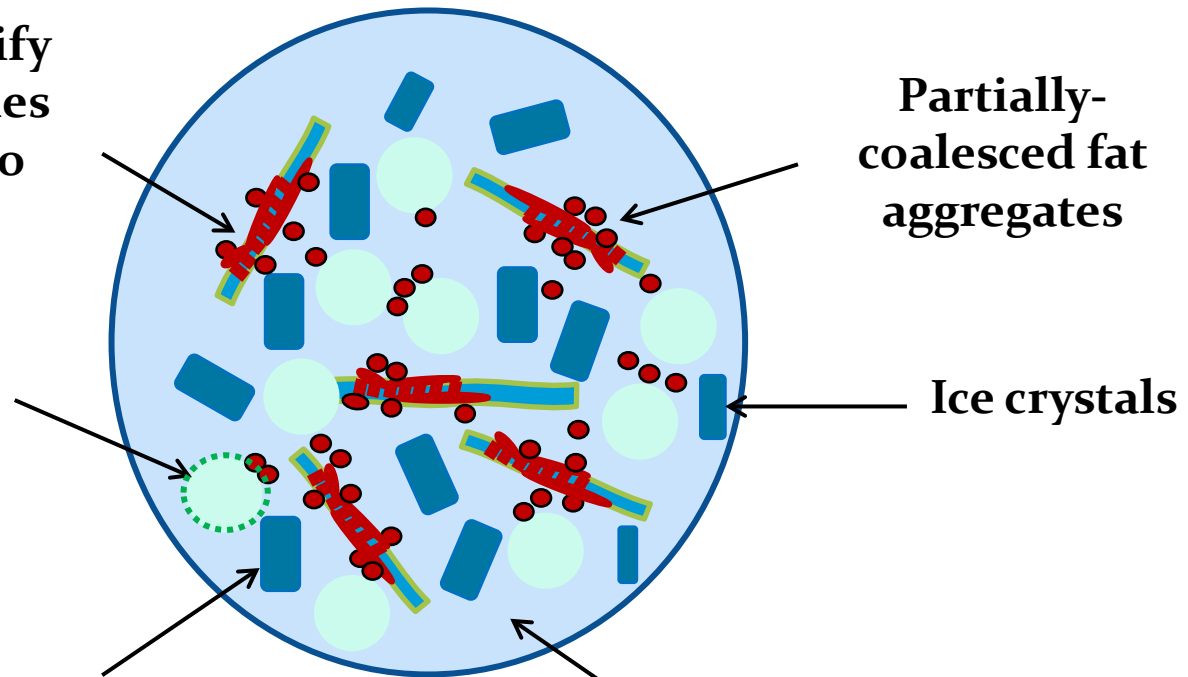


Ice Cream

Hydrocolloids emulsify the fat to keep globules from aggregating too much

Proteins and hydrocolloids stabilize air cells

Hydrocolloids restrict movement of large amounts of unfrozen water, reducing the possibility of enlarging ice crystals



Partially-coalesced fat aggregates

Ice crystals

Freeze concentrated unfrozen water with dissolved sugars

Troubleshooting

- Sandiness
 - Insure correct hydrocolloid use levels
 - Insure proper freezer speed and temperature
 - Temper/age mix
- Melt
 - Switch hydrocolloid system
 - Change fat type



Plant Based Meat

- 2 Categories
 - Cold cuts
 - Hot consumed



Plant-Based Cold Cuts

What	Why	Which type
Carrageenan	Forms gel – good bite	Kappa
Xanthan	Increases viscosity - binding	
Locust bean gum	Increases viscosity – binding (synergy)	
Proteins	Form gel – good bite, get dry at high dosages	Wheat, Soy, Pea
Starches	Increase viscosity - binding	Wheat, corn



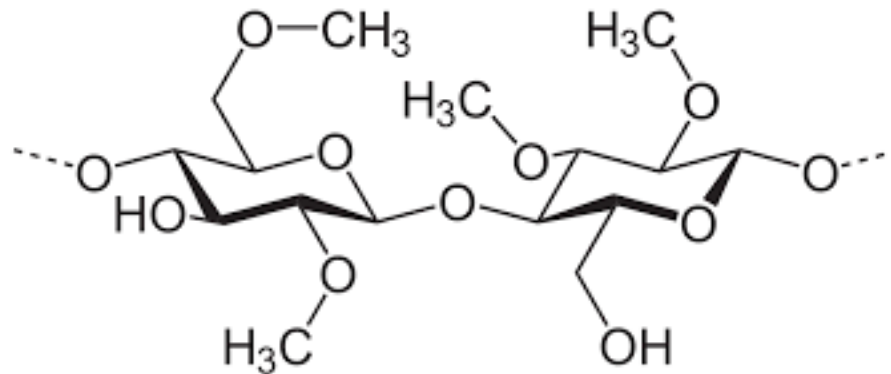
Plant-Based Hot Consumed Meat

What	Why	Which type
Methylcellulose	Forms gel in hot – perfect bite in hot	High viscous types with strong gelation
Carrageenan	Forms gel in cold – good cold bite	
Proteins	Increases viscosity - binding	Egg, Pea, Soy, Wheat, Potato
Starches	Increase viscosity - binding	Wheat, Corn, potato



Methylcellulose

- Unique functionality
 - Gels hot
 - Viscosifies cold



Conclusions

- Category growing
 - Market growth of 18% (GFI)
 - Traditional meat growth 3% (GFI)
- Highly processed
- Fall into the “Emotional Clean Label”
- Hydrocolloids provide unique functionality



Thank you!



Publishers of *The Quarterly Review of Hydrocolloids*

