There is a lot of variability among emulsifiers, some definitely seem to have a greater impact on gut health than others. One of our members, Shelley Stevens, who is a scientist with experience in this area, volunteered to investigate all the studies she could collect. She used the data to create a color-coded system as a guide for those who are working to reduce emulsifiers in their diets. While this is not an all-inclusive list, it is good place to start. We are very grateful to Shelley for her time and dedication to this project!

Emulsifier Score Card

Score[a]	Emulsifier[b]	Model System	Effects[c]	Reference(s)[e]
	Agar agar	in vitro: human fecal; human cells	**Unclear/Insufficient Data:** Irreversible decrease in bacterial density; unclear if this is a harmful effect.	Naimi et al. (2021)
	Acetic Acid Esters (ACETEM)	No Data		
	Acetylated Monoglycerides	No Data		
	Alginate	Rats, pigs	**Beneficial effect:** Mucosal replenishment Decreased inflammation	Brownlee et al. (2005); Wan et al. (2020); Wan et al. (2018)
	Alginate, ammonium	No Data		
	Alginate, potassium	No Data		
	Alginate, Sodium	Rats	**Beneficial effect:** Increased mucosal production Helps maintain mucosal barrier	Barcello et al. (2000); Yamamoto et al. (2014); Mackie et al. (2016)
	Alginate, Sodium calcium	Rats	**Possible beneficial effect:** Anti-inflammatory	Al-Najjar et al. (2021); Yamamoto et al. (2014); Mackie et al. (2016)
	Aluminum caprate	No Data		
	Aluminum laurate	No Data		
	Aluminum myristate	No Data		
	Aluminum palmitate	No Data		

	Arabinogalactan	Human, Mouse, Human (SHIME model)	**Beneficial effect:** Increased intestinal barrier integrity Decrease in harmful bacteria Decreased inflammation	Chen et al. (2021); Cao et al. (2021); Daguet et al. (2016); Wang et al. (2021)
	Bakers yeast Glycan (or beta-glucans)	Humans and Rodent models	**Mixed Results:** Mixed results from a variety of studies. Some people can develop antibodies to beta-glycan resulting in increased inflammation and this can contribute to IBS. Other studies report a beneficial effect, but it can be dependent upon the strain and processing (purity) of the beta-glycan.	Gudi et al. (2020); Gerard et al. (2013); Fernandex-Julia et al. (2021)
	Calcium caprate and caprylate	No Data		
	Calcium phosphate	Human, Rats	**Beneficial effect:** As reported in a review, dietary calcium showed a decrease in intestinal permeability in multiple studies.	Gomes et al. (2015)
	Carrageenan	Human, Rats, Mouse Guinea Pig, Rabbit; In vitro: Human intestinal epithelial cells, human fecal cells	**Negative effect:** Increased Inflammation and Colitis Increased intestinal permeability Increased bacterial translocation	Pogozhykh et al. 2011; Bhattacharyya et al. (2017); Naimi et al. (2021); Multiple studies (n = 16) as referenced in Bancil et al. (2020)
	Cellulose	Rats, mice	**Beneficial effect:** Anti-inflammatory Promotes mucosal integrity	Kim et al. (2020); Barcello et al. (2000); Brownlee et al. (2005)
	CMC (carboxymethylcellulose)	Human; Mouse; in vitro: human fecal; human cells	**Negative effect:** Increased inflammation Increased LPS Bacterial overgrowth Negative change to microbiota	Naimi et al. (2021); Swidsinski et al. (2009); as referenced in Bancil et al. (2020); Chassaing et al. (2020); Chassaing et al. (2022); Sandall et al. (2020); Miclotte et al. (2020); Rousta et al. (2021)

	Diacetyl tartic acid ester of mono-and-diglycerides (DATEM)	in vitro: human fecal; human cells	**Unclear/Insufficient data**: Irreversible decrease in bacterial density. Decrease in alpha diversity. It is unclear whether the observed effects are harmful.	Naimi et al. (2021)
	Emulsifier-Free Diet	Humans	**Improvements with Emulsifier Free Diet:** 20 volunteers with Chron's disease at an emulsifier-free diet for 14 days. A significant improvement/reduction in Chron's disease-related symptoms were observed.	Sandall et al. (2020)
	Gellan gum	No Data		
	Glycerol monoacetate	In vitro: Human fecal samples and HEK293 cells	**Unclear/Insufficient Data:** Microbial cultures tolerated exposure to glycerol monoacetate without significant negative changes. *Effect on LPS not evaluated	Elmen et al. (2020)
	Glycerol monolaurate	Mouse	**Mixed results:** Increased LPS synthesis, significant changes to microbiota, and pro-inflammatory changes were reported in some studies; however, other studies reported protection from colitis, reduced inflammation, and no induction of LPS.	Zhao et al. (2020); Jiang et al. (2020); Jiang et al. (2018); Mo et al. (2019); Mo et al. (2021)
	Glycerol monooleate	In vitro: Human fecal samples and human cells	**Mixed Results/Unclear:** No effect in one study, decreased bacterial density in another study; it is unclear if this effect is harmful.	Elmen et al. (2020); Naimi et al. (2021)
	Glycerol monostearate	In vitro: Human fecal samples and human cells	**Possible Negative effect:** Changes to the microbiota Increased inflammation Increased LPS	Elmen et al. (2020); Naimi et al. (2021)
	Guar gum	Human; Rat; mouse; in vitro: human fecal; human cells	**Beneficial effect:** Pre-treatment provided protection from induced colitis. Positive changes to the microbiome in humans. Protection and improvement of IBS symptoms.	Shiau and Chang (1986); Naimi et al. (2021); Takagi et al. (2016)

	Gum acacia (Gum arabic)	Rats, Mouse, in vitro: human fecal, human cells	**Beneficial effect:** Anti-inflammatory Increase in good bacteria No effect on mucosal layer	Al-Asmakh et al. (2020); Ali et al. (2013); Alarifi et al. (2018); Sandall et al. (2020); Barcello et al. (2000); Naimi et al. (2021)
	Hydroxypropyl methyl cellulose (HPMC)	in vitro: human fecal; human cells	**Possible negative effect:** Irreversible decrease in bacterial density. Decrease in alpha diversity.	Naimi et al. (2021)
	Locust bean gum	in vitro: human fecal; human cells	**Possible Negative effect:** Significantly impacted microbiota composition. Increased levels of flagellin	Naimi et al. (2021)
	Maltodextran	Mouse, In vitro: mouse intestinal crypt, human mucosal cells	**Negative effect: (including in neonates)** Injury to mucosal layer Increased inflammation and colitis Increased LPS Increased proximity of microbes to intestinal epithelium	Laudisi et al. (2019); Naimi et al. (2021); Zangara et al. (2022); Singh et al. (2020)
	Methylcellulose	Mouse	**Negative effect:** Increased inflammation and colitis	Llewellyn et al. (2018); as referenced in Bancil et al. (2020)
	Palmitic acid	in vitro: human intestinal epithelial cells	**Possible Negative effect:** Increased permeability	Gori et al. (2020)
	Pectin	Rats	**Unclear; Mixed results:** Reduced ability to heal/replenish mucosal layer No effect on production of mucin	Brownlee et al. (2005); Barcello et al. (2000)
	Potassium phosphate	Rats	**Negative effect:** Reduction in epithelial integrity Increased inflammation Exacerbated colitis	Sugihara at el. (2016)
	P80	Rat, Mouse, Murine & M-SHIME model, Porcine mucus model, In vitro: Human fecal samples, human cells, Caco-2 cells	**Negative effect:** Increased bacterial translocation Increased inflammation Increased permeability Decreased mucosal barrier Significant changes to microbiota	Bancil et al. (2020); Jin et al. (2021); Miclotte et al. (2020); Sandall et al. (2020); Singh et al. (2016a, 2016b); Zhu et al. (2021); Naimi et al. (2021); Rousta et al. (2021)

	Propylene glycol alginate	in vitro: human fecal; human cells	**Unclear:** Significantly impacted microbiota composition. It is unclear whether the changes are harmful	Naimi et al. (2021)
	Propylene glycol monostearate	In vitro: Human fecal samples and HEK293 cells	**Unclear:** Microbiota changes resulting in increased abundance of Enterobacteriaceae and reduced abundance of Erysipelotriachaceae. It is unclear if these effects are harmful. *Effect on LPS not evaluated	Elmen et al. (2020)
	Sodium caprate and carprylate	In situ: rat, pig	**Possible negative effect:** Typically used as an intestinal permeation enhancer for drug delivery and works by reversibly opening epithelial tight junctions at high doses. Causes a mild increase in permeability.	Twarog et al. (2019); Twarog et al. (2021)
	Sodium stearoyl lactylate	In vitro: Human fecal samples and HEK293 cells	**Possible Negative effect:** Significant changes to microbiota Pro-inflammatory Increased LPS and flagellin	Elmen et al. (2020)
	Sorbitan monostearate	in vitro: human fecal; human cells	**Possible Negative effect:** Increased bacterial density. Decrease in alpha diversity. Increased LPS	Naimi et al. (2021)
	Soy Lecithin	Mouse, In vitro: Human fecal samples and HEK293 cells	**Mixed Results:** No effects in mice exposed for 12-week Mixed results in in vitro studies, increased LPS was observed in some studies.	Sandall et al. (2020); Miclotte et al. (2020); Miclotte et al. (2021); Naimi et al. (2021)
	Sucrose monoester fatty acids; including sucrose monolaurate	In vitro: human cells	**Possible negative effect:** Decreased transepithelial electrical resistance (suggestive of increased permeability), and caused some cell death.	Mine and Zhang (2003); Glynn et al. (2017)
	xantham gum	in vitro: human fecal; human cells	**Mixed results** Increased LPS; Increased levels of flagellin in vitro, but protection of microbiota in mice given an antibiotic challenge. Changes to the microbiota are observed in humans; it is unclear whether this change is beneficial, harmful, or neutral.	Naimi et al. (2021); Schnizlein et al. (2020); Martens (2021)

[a]**Green** = Beneficial effect: Available evidence indicates this emulsifier has a beneficial/protective effect on the gut.
Yellow = Unclear, mixed results, or possible negative effect: Results are unclear or not definitive due to insufficient data (e.g., in vitro data only), or the impact of the change (beneficial, harmful, or neutral) cannot be determined, or the study is unclear due to mixed results (data reporting both beneficial and negative effects are available).
Red = Negative effect: Available evidence from humans or animals indicate this emulsifier has a negative effect on gut health.
Grey = No relevant data related to potential effects on gut health were identified.
[b]Food additives classified as emulsifiers (https://academic.oup.com/nutritionreviews/article/79/6/726/5867654) ** Not an exhaustive list.
[c]Effects represent professional judgement based on freely available published, peer-reviewed scientific literature available as primary full-text, reviews and abstracts. A more detailed description of effects reported in each study is available upon request.
[d]References reviewed for effect determination. Links to each reference are available upon request.