Electronic Supplementary Material (ESI) for RSC Sustainability.

Supporting Information for:

Formulation of Biobased Soaps and Gels from Waste Oils and Fats

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Experimental Section (Materials)

Fresh oils including refined coconut oil (Brad's Organic), soybean oil (Crisco Pure Vegetable Oil), Bacon (Applegate Uncured Sunday Bacon), cauliflower, and a commercial blend oil of sunflower oil (20%) and olive oil (80%) (Palermo) were purchased from a local supermarket. Soybean oil was collected after frying cauliflower. Dr. Bronner's Pure-Castile Peppermint Liquid Soap was purchased from Bed Bath and Beyond. Enzyme Grade glycerol (Fisher Scientific), potassium hydroxide ACS grade reagent pellets >85% (Honeywell Fluka), and sodium hydroxide ACS grade reagent pellets (Fisher Scientific) were used as purchased.

Gellants used included 100% Pure Grass-Fed Beef Gelatin Thickening Protein Powder (Zint LLC), Agar Powder (Alfa Aesar), Agar-Agar Powder (Telephone Brand), Unflavored Vegetable Gelatin Powder (Marhaba), Gulaman Brand Agar-Agar Green (Aling Conching Native Products), Methyl Cellulose 4000 cPs (Alfa Aesar), Premium Fruit Pectin and Certo Premium Liquid Fruit Pectin (Sure-Jell), Sodium Alginate Powder (Fit Lane Nutrition), Calcium Chloride >97% (Pure Organic Ingredients), Guar Gum (Bob's Red Mill), and Chia Whole Black (Prana Organic).

Experimental Section (Methods)

Viscometry of Oils and Soap Solutions

A Brookfield DV-1 Viscometer was used to determine the viscosity of soap solutions. A 350 mL sample of a liquid mixture was added to a 600 mL beaker and left to settle for one hour. An HB-2 spindle was attached to the viscometer and lowered into the sample and allowed to equilibrate at 1.5 RPM for ten minutes before data was recorded. Shear rate was increased from 1.5 RPM to 60 RPM and temperature, viscosity, and torque were recorded.

Infrared Spectroscopy of Oils, Soap Solutions, and Gels.

Oils, stock soap solutions, and gels were analyzed directly on a Nicolet™ iS20 Fourier-transform Infrared Spectrometer using an Attenuated Total Reflectance sample holder. Data was collected using OMNIC Spectra software and a background spectrum was collected before each sample and subtracted from the average of 32 scans between 650 and 4000 cm^{-1}. Baseline subtraction was performed, the curves were plotted, and peaks identified using Plot2 software.

Melting Point Determination

Heated gel solutions (1 mL) were cast into a vial containing 5 mm open capillaries. After the gels were set, the melting point of the gels was determined for three replicates of each sample using a Mel-Temp II. Samples were cooled and inverted to determine whether samples formed thermoreversible gels.

SI Equation S1 - Calculating the Mass of Products as the Sum of Component Ingredients

(1) $$Mass\ of\ Product\ (g) = \sum_{i} Mass\ of\ Component\ (g)_i$$

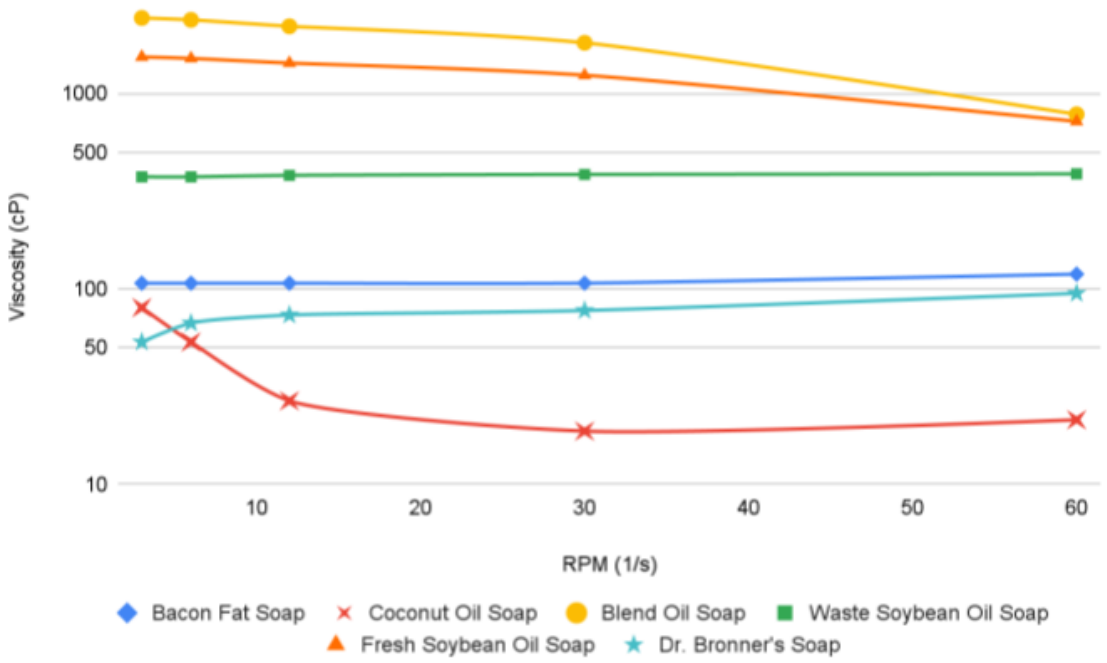
SI Equation S2 - Calculating the Percentage of Waste in Product Formulations

(2) $$Percentage\ Waste\ Included\ (\%) = \frac{Total\ Mass\ of\ Waste\ Included\ (g)}{Mass\ of\ Product\ (g)}\ x\ 100\%$$

SI Table SI - Gellants screened with waste soybean oil soaps, the concentration used, and the formulated mixture's classification

Name	Gellant Type	Concentration (wt. %)	Mixture Category
Agar Powder	Polysaccharide	2.00	Homogeneous Solution
Unflavored Vegetable 'Gelatin' Powder (Agar-Agar)	Polysaccharide	2.00	Homogeneous Solution
Agar-Agar 'Green'	Polysaccharide	2.00	Heterogeneous Solution
Carrageenan	Polysaccharide	2.00	Homogeneous Solution
Methyl Cellulose 4000 cPs	Polysaccharide	2.00	Gel
Premium Fruit Pectin	Polysaccharide	3.75	Homogeneous Solution
Certo Premium Liquid Fruit Pectin	Polysaccharide	3.75	Homogeneous Solution
Sodium Alginate and Calcium Chloride	Polysaccharide	2.00	Weak gel
Guar Gum	Polysaccharide	1.75	Homogeneous Solution
Chia Whole Black	Polysaccharide	15.0	Weak gel
Gelatin Thickening Protein Powder	Protein	3.75	Gel

SI Figure S1 - Viscometry of Waste and Fresh Derived Soaps Compared to a Commercial Product



SI Figure S1 - Viscometry of waste and fresh derived soaps compared to a commercial product.

SI Table SII - Melting points of biobased soap gels.

Soap Gel Sample	Base Used	Melting Point Range (°C)
Coconut Oil Soap Gel	KOH	28 - 30
Fresh Soybean Oil Soap Gel	KOH	36 - 37
Waste Soybean Oil Soap Gel	KOH	31 - 34
Bacon Fat Soap Gel	KOH	36 - 37
Blend Oil Soap Gel	KOH	35 - 37
Blend Oil Soap Gel	NaOH	34 - 35
Dr. Bronner’s Soap Gel	KOH	30 - 31

SI Table SIII - Percentage Waste Included in Soap and Soap Gel Formulations

Oil or Fat	Base Used	Mass of Waste In Soap (g)	Total Mass Components (g)	Percentage Waste Included in Soaps (%)	Mass of Waste in Soap Gel (g)	Total Mass of Product (g)	Percentage of Waste Included in Gels (%)
Coconut Oil Soap	KOH	0	350	0	0	400	0
Fresh Soybean Oil Soap	KOH	0	338	0	0	400	0
Waste Soybean Oil Soap	KOH	200	338	59	124	400	31
Bacon Fat Soap	KOH	200	340	59	124	400	31
Blend Oil Soap	KOH	0	338	0	0	400	0
Blend Oil Soap	NaOH	0	288	0	0	400	0