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Introduction of NaDES in cosmetic formulation: phycocyanin-enriched extracts as case study

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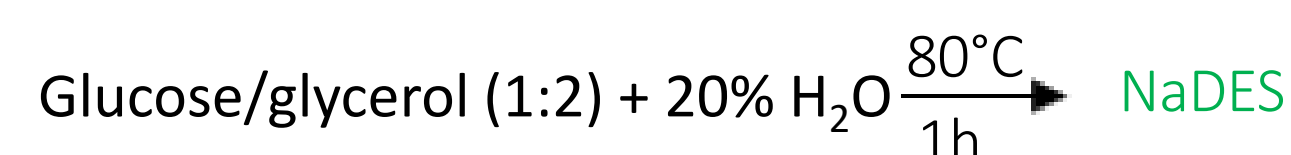
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Introduction: Natural deep Eutectic Solvents (NaDES) as novel green solvents have gained in recent years a positive momentum for cosmetic ingredients preparation. Their high solvent power, combined with their stabilizing ability, make NaDES a sustainable alternative to prepare ingredients from vegetal or biotechnological biomasses. Recently, spirulina (*Arthrospira platensis*) as a renewable source of numerous bioactive compounds has caught the attention of professionals in the cosmetic field. Glucose/Glycerol (GG) NaDES has displayed a great potential for both extraction and stabilization of several antioxidants and pigments from spirulina. This study aims to evaluate the impact of the incorporation of a NaDES-based phycocyanin-enriched extract in cosmetic formulations intended for skin application.

NaDES and spirulina extracts preparation

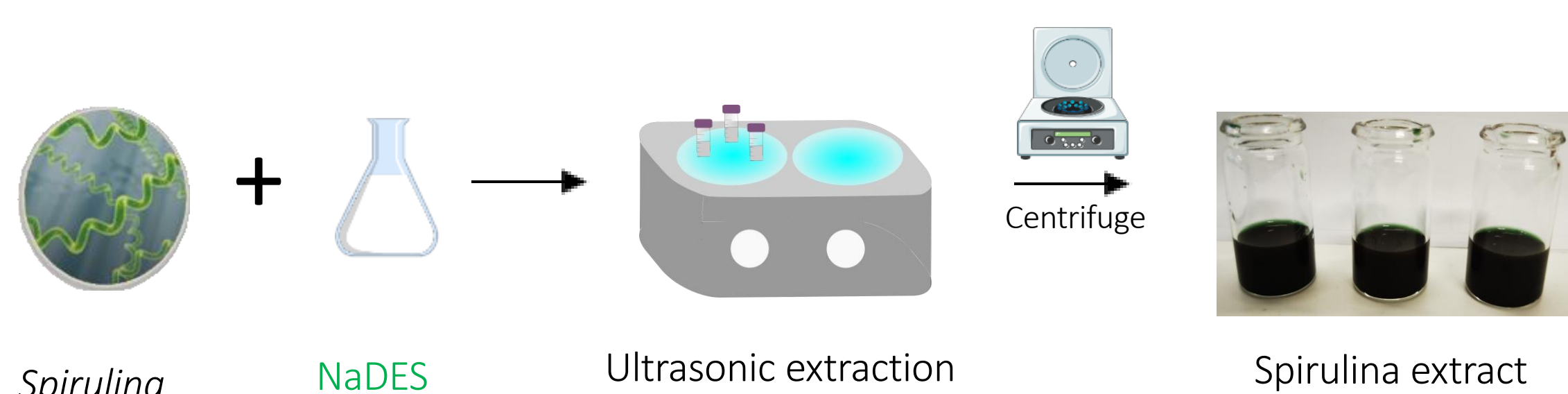
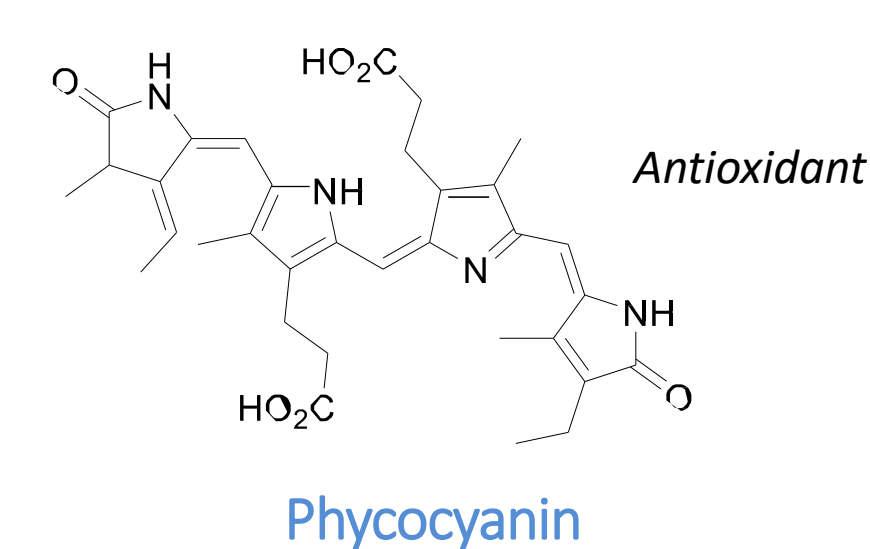
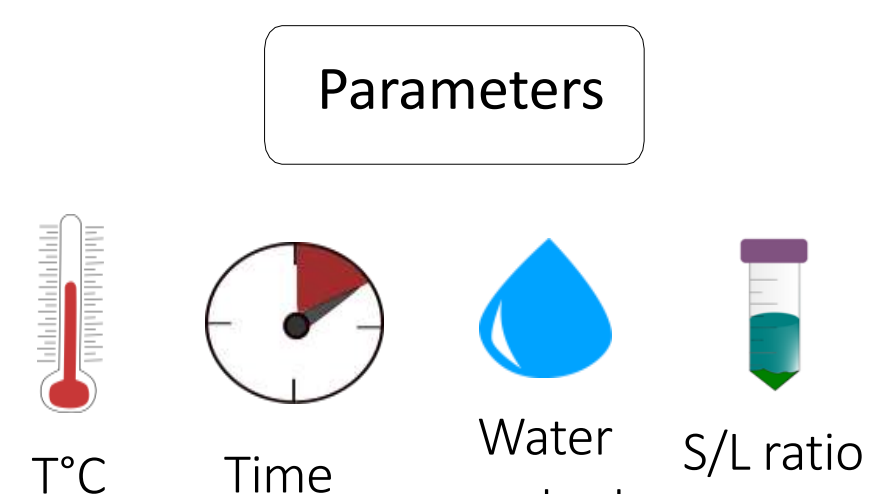


Mix of natural metabolites in specific concentration and temperature conditions.

- ✓ Network of hydrogen bonds
- ✓ Decreased melting point

+++
Sustainability, biodegradability, solubilization power, non-flammable

???
Non-volatile solvent, Regulatory status, Sensory properties

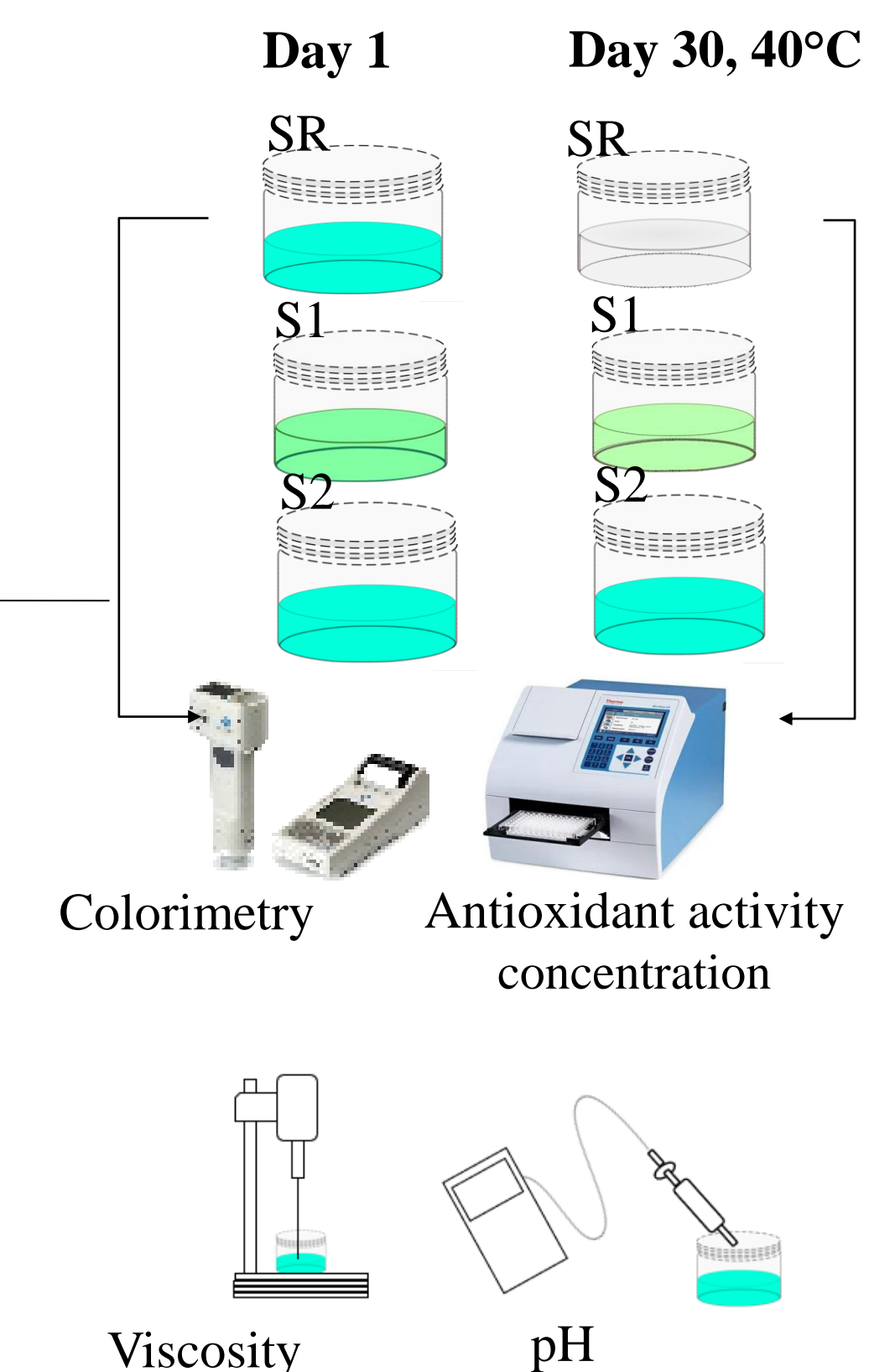
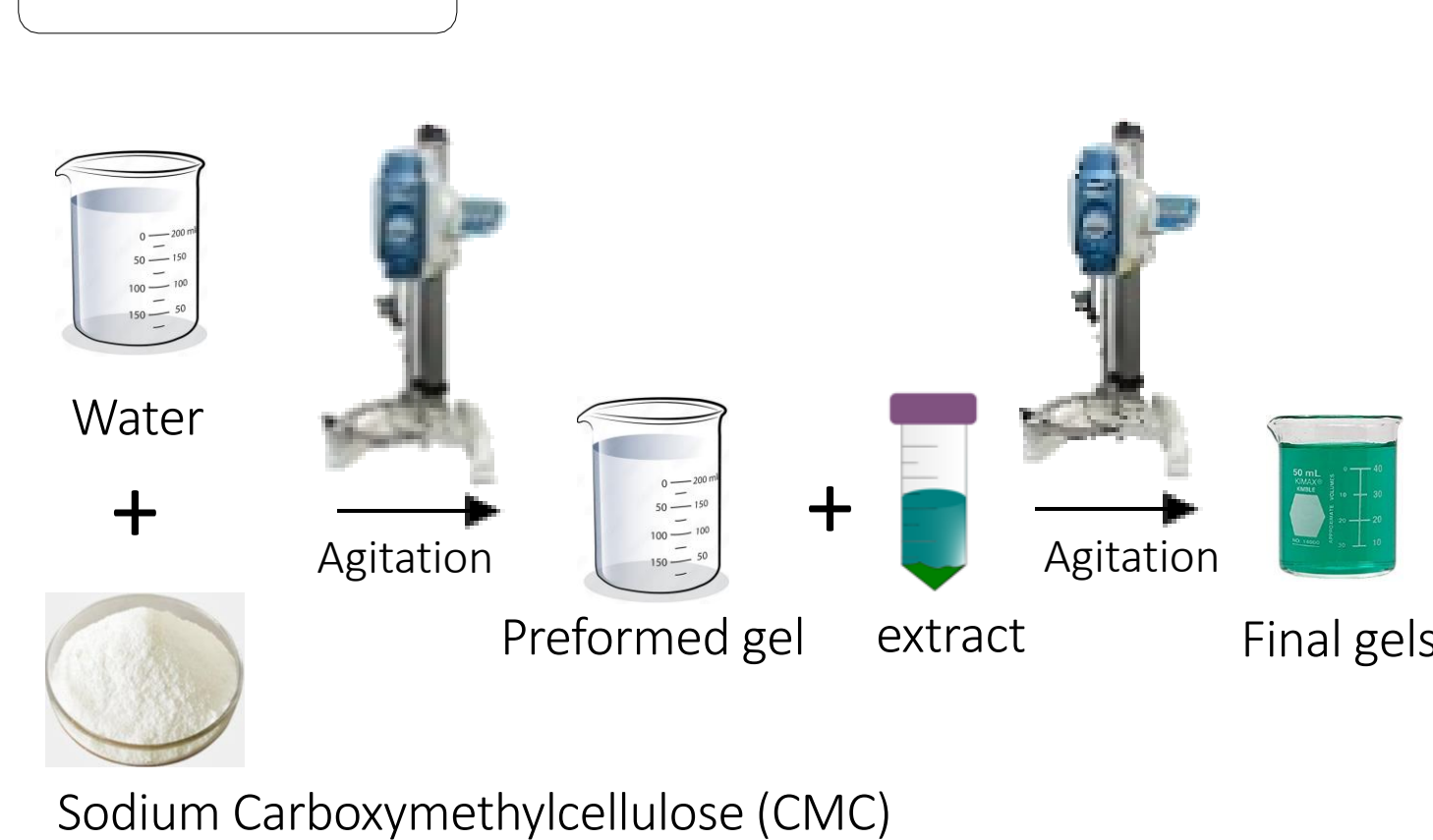


Cosmetic formulation and characterization

Method 1 or S1



Method 2 or S2



Results and Discussions

Colored metabolites titration in NaDES extracts

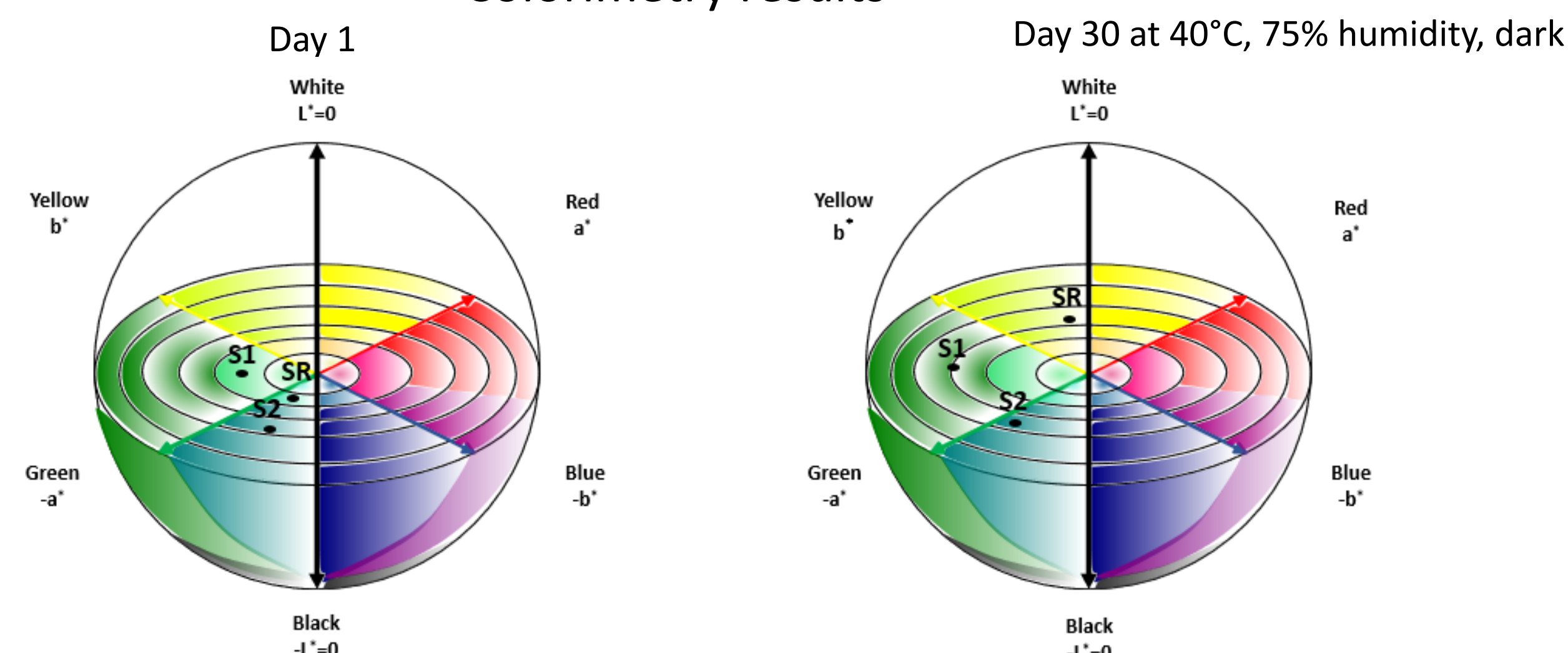
		Phycocyanin (mg/g biomass)	Chlorophyll (µg/g biomass)	Carotenoids (µg/g biomass)
Day 1	SR	0.25±0.02	35.25±3.18	5.89±0.68
	S1	0.16±0.03	32.05±0.50	4.57±0.99
	S2	0.25±0.01	28.81±2.27	4.01±0.22
Day 30 at 40°C, 75% humidity, dark	S1	0.12±0.02	26.16±1.11	4.15±1.24
	S2	0.21±0.01	24.73±5.16	3.21±0.25

The spirulina reference (SR) consisting of a 1% solution of the NaDES-based extract in water is unstable in time, while phycocyanin, chlorophyll and carotenoids persist in the gels.

Results at day 1 show that conditions of Method 2 are less destructive for the molecules of interest.

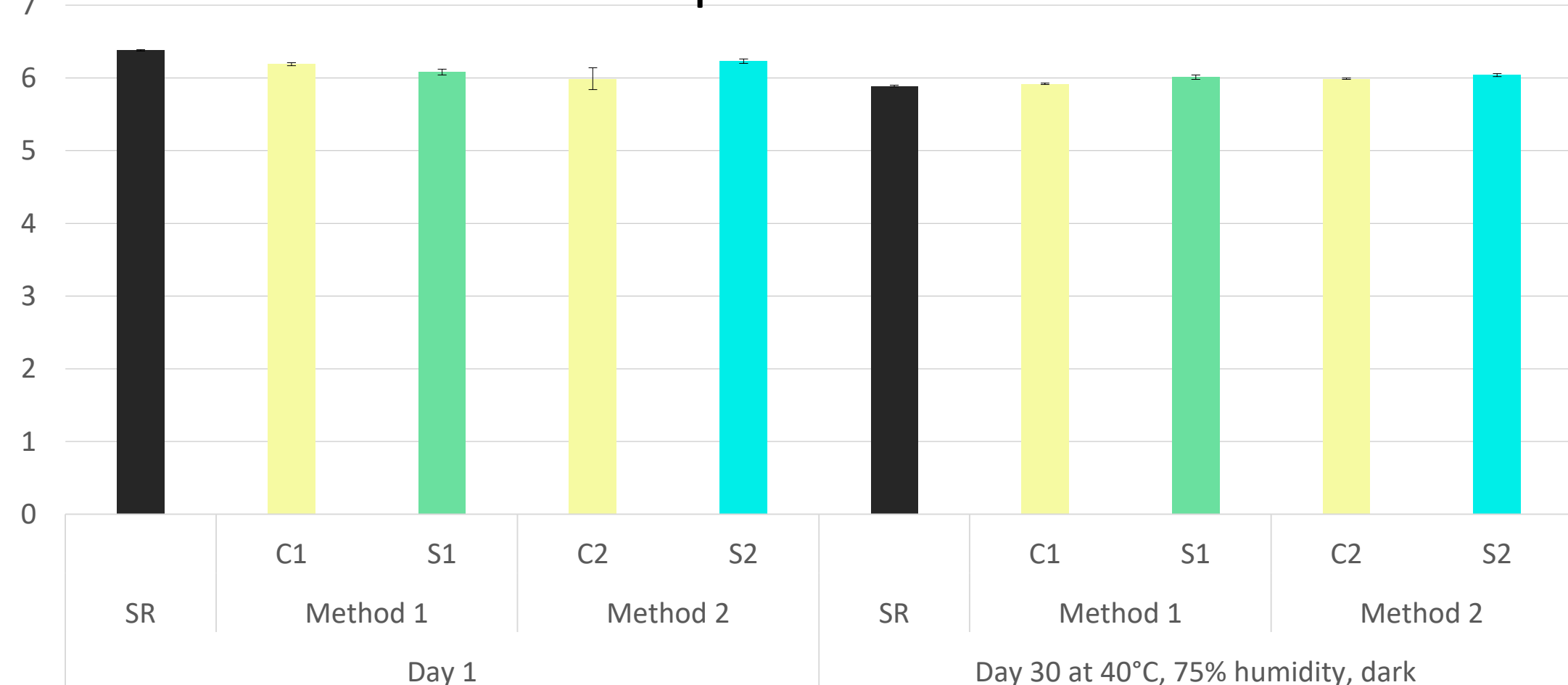
Results at Day 30 show that Phycocyanin is more stable in the gels prepared by Method 2.

Colorimetry results



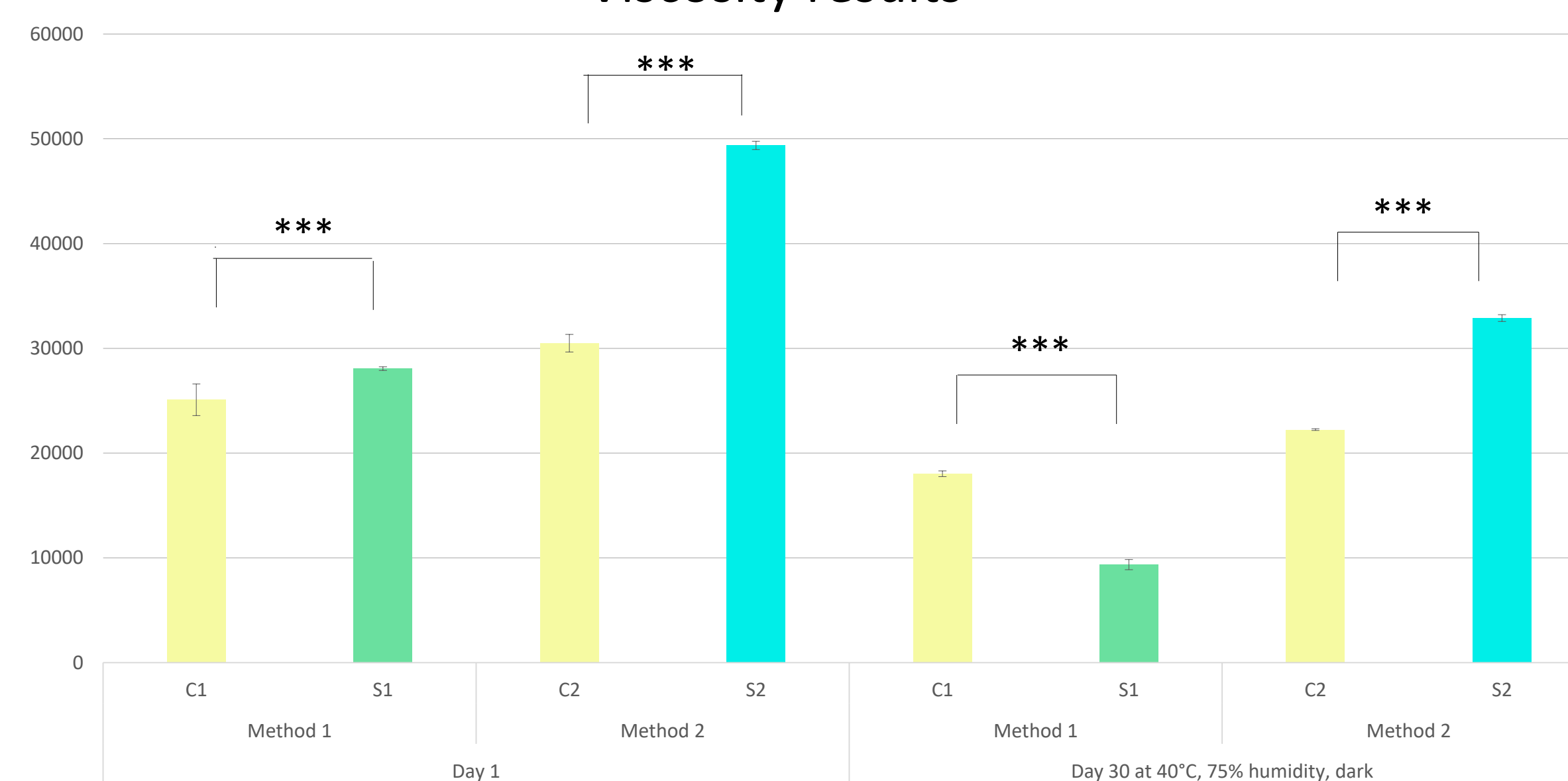
Phycocyanin seems to disappear from SR during the accelerated aging stability test. S1 changed color from dark green to yellow-green showing a possible decrease of the phycocyanin contents. S2 remained blue-green after 30 days.

pH results



pH of all the sample is suitable for cosmetic gels formulation. No significant difference was observed between pH in each formula during storage time (p>0.05).

Viscosity results



Gels prepared by Method 2 show a higher viscosity than those prepared by Method 1 in our conditions of measurements (low shearing). After accelerated aging, all gels show a decrease in viscosity, but S2 stays more viscous than the control whereas the viscosity of S1 collapses.

Conclusions and perspectives

- The incorporation of NaDES-based spirulina extract in gels does not change significantly the pH of the formulations, but has a variable impact on the viscosity, color, and chemical composition of the gels.
- The method consisting of adding the NaDES-based extract after the formation of the gel seems to lead to a more chemically and physically stable gels, but showing a higher viscosity. A complete rheology study will permit to evaluate if this increase modifies the gripping or the spreading of the product.
- GG NaDES-based spirulina extracts seem to be a relevant sustainable ingredient to provide color and protection to a cosmetic product when the incorporation process is being controlled.

ACKNOWLEDGEMENTS

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