

Sustainable Recovery of Antioxidant Amphiphilic and Lipophilic Bioactives from Avocado By-Products via Green Extraction for Food and Cosmetic Applications

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ABSTRACT

Avocado is recognized for its high nutritional and functional value due to its rich profile of bioactive compounds. This study aimed to isolate extracts from avocado by-products using green extraction methods, as well as to evaluate their antioxidant potential. The extracts were characterized in terms of total amphiphilic content (TAC), total lipophilic content (TLC), total phenolic content (TPC), and total carotenoid content (TCC). Antioxidant activity was assessed using DPPH, ABTS, and FRAP assays. Spectroscopic analyses (ATR-FTIR, UV-Vis) confirmed the presence of phenolic acids and flavonoids. TAC extracts exhibited higher antioxidant activity, while TLCs were richer in carotenoids. Furthermore, TAC extracts from avocado and green apple were incorporated into jelly samples, which demonstrated limited stability in the absence of preservatives. These findings highlight the potential of avocado-derived extracts, whose compounds act synergistically against oxidative stress and inflammation, for application in functional foods and cosmetics, while promoting the valorization of agri-food waste through sustainable processing approaches.

Table 1. Total phenolic content (TPC), total carotenoid content (TCC) and antioxidant activity of green total amphiphilic compounds (TAC), total lipophilic compounds (TLC) and total lipids (TL) extracts (n=3) from avocado by-products.

Samples	TAC			TLC			TL		
	Min	Median	Max	Min	Median	Max	Min	Median	Max
TPC ^a	34.5	38.5*	43.6	14.2	14.3*	16.6	48.7	52.8	60.2
TCC ^b	59.1	61.9*	71.8	922	1519.2*	1899	980.7	1581	1971
DPPH ^c	2004	2349	3616	ND	ND	ND	2004	2349	3616
ABTS ^d	21.5	34.4	44.5	ND	ND	ND	21.5	34.4	44.5
FRAP ^e	187	224	269.5	ND	ND	ND	187	224	269.5

^a TPC = total phenolic content; Results are expressed as mg gallic acid equivalent (GAE)/g of dry weight (DW) of extract

^b TCC = total carotenoid content; Results are expressed as mg of β -carotene equivalent (CE)/g DW

^c DPPH = Antioxidant capacity measured by the DPPH assay; expressed as trolox equivalent antioxidant capacity (TEAC) values

^d ABTS = Antioxidant capacity measured by the ABTS assay; Results are expressed as ABTS values (μ mol Trolox equivalent (TE)/g DW)

^e FRAP = Antioxidant capacity measured by the FRAP assay; Results are expressed as FRAP values (μ mol TE/g DW)

*indicates statistically significant differences ($p < 0.05$) between TAC and TLC extracts.

RESULTS & DISCUSSION

ATR-FTIR analysis (Figure 1) of avocado TAC extracts confirmed the presence of amphiphilic bioactive compounds, with spectral data identifying phenolic constituents, including tannins (e.g. gallic acid) and flavonoids (e.g., catechin and quercetin). UV-Vis spectroscopy (Figure 2) further corroborated the presence of these bioactive compounds, with notable absorption in the UV spectrum, suggesting potential for sunscreen formulations and UV-protective cosmetics. As shown in Table 1, TAC extracts exhibited higher phenolic content, while TLC extracts had elevated carotenoid levels. Antioxidant assays (DPPH, ABTS, FRAP) revealed significantly stronger activity in TAC extracts, particularly in the DPPH assay. Despite lower phenolic and carotenoid concentrations compared to previous reports [3], the TAC extracts displayed robust antioxidant capacity, indicating selective enrichment of bioactive compounds. Additionally, TAC extracts incorporated into jelly samples exhibited stability for 15 days under refrigeration, but showed mold growth by day 28, highlighting the need for the addition of natural preservatives.

REFERENCES

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EXPERIMENTAL PROCEDURE

Total lipids were extracted from by-products of organically cultivated avocados using green methods, according to Tsoupras et al. [1], and subsequently separated into total lipophilic (TLC) and amphiphilic (TAC) fractions. The triplicated extracts were analyzed for total phenolic and carotenoid content, as well as antioxidant activity, using DPPH, ABTS, and FRAP assays, following validated protocols [2]. TAC extracts were further characterized by ATR-FTIR and UV-Vis spectroscopy [2]. All reagents, solvents, and standards (e.g., trolox, gallic acid, β -carotene) were obtained from Sigma Aldrich (St. Louis, MO, USA). Spectroscopic measurements were conducted using an LLG-uniSPEC 2 spectrophotometer and a Perkin Elmer Frontier ATR/FT-NIR/MIR spectrometer. Data were analyzed using the Kolmogorov-Smirnov test for normality and either ANOVA or Kruskal-Wallis tests, with significance set at $p < 0.05$.

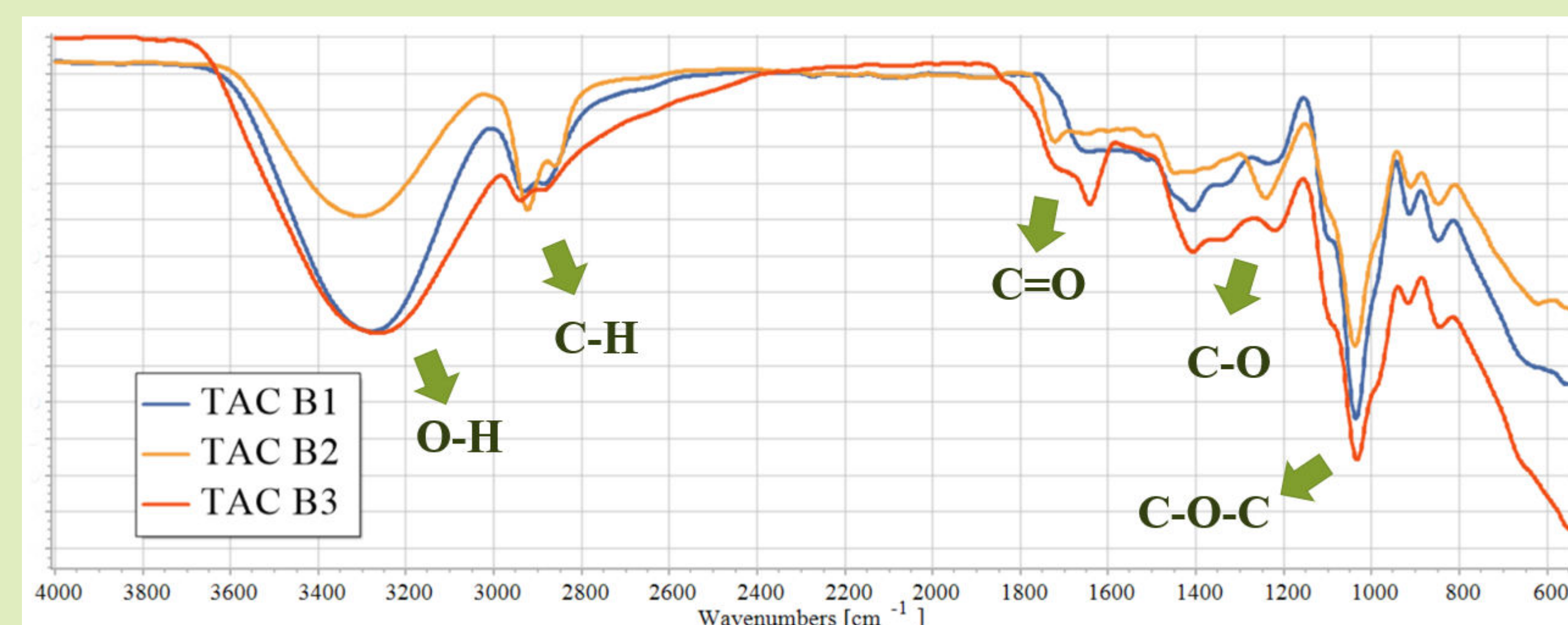


Figure 1. IR spectrum

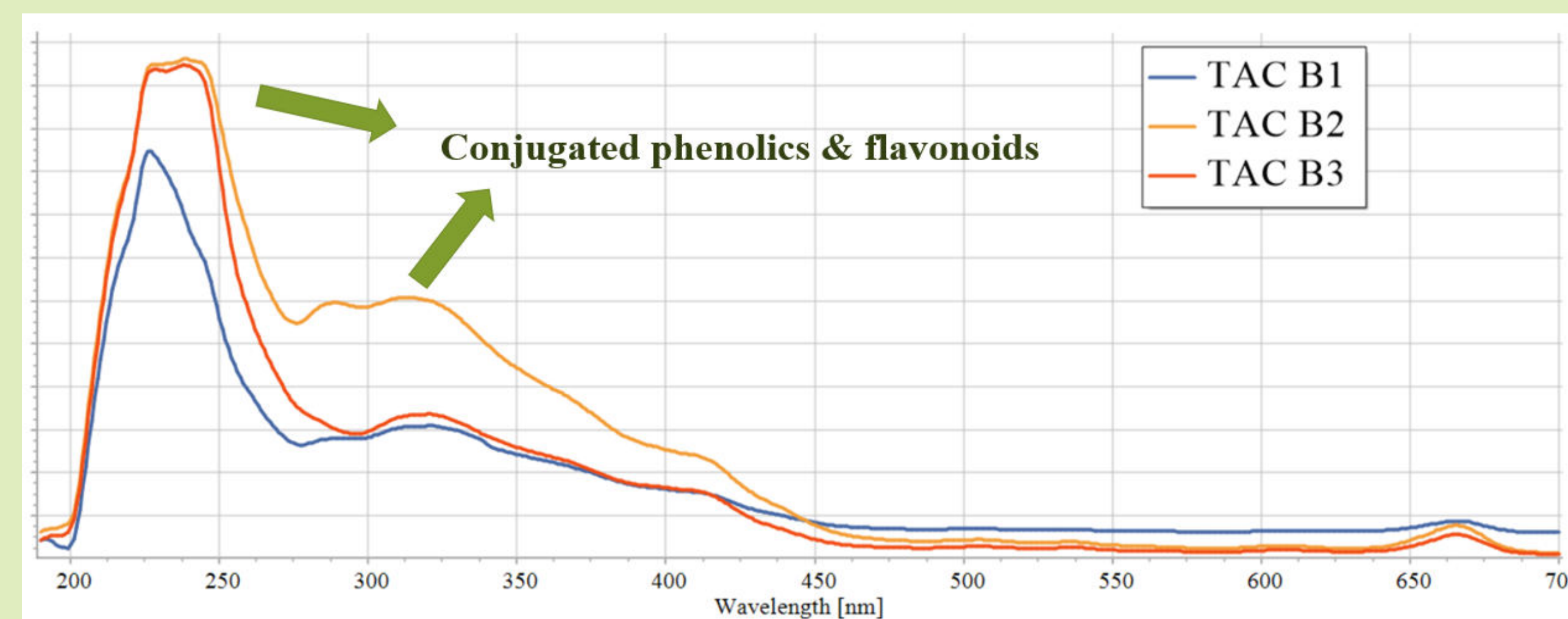


Figure 2. UV-Vis spectrum

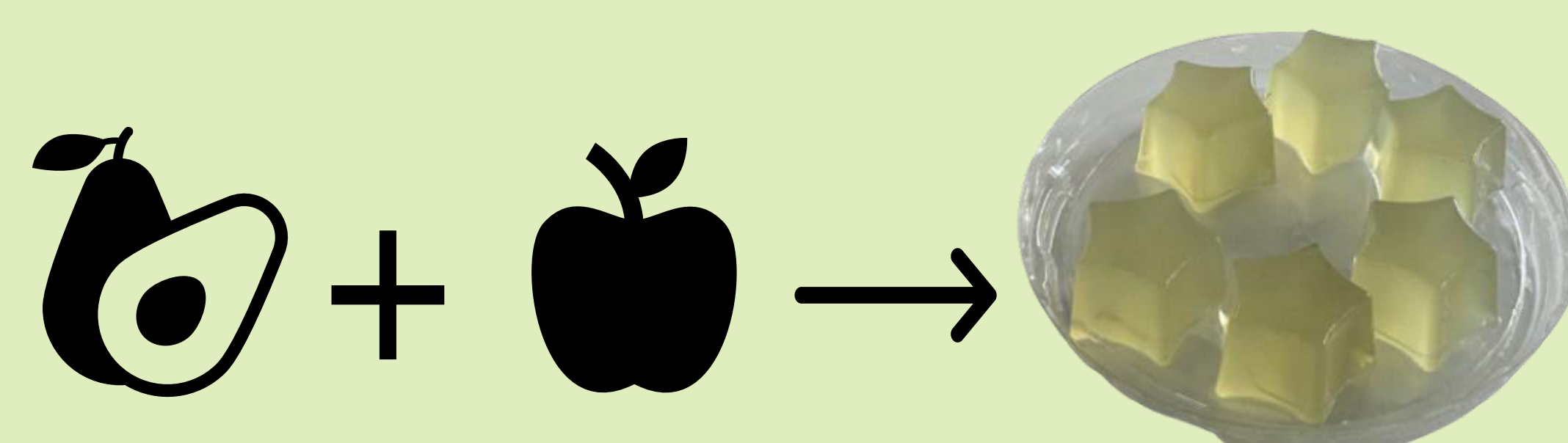


Figure 3. Preparation of Jelly Samples by avocado and apple extracts