

Techno-Economic Analysis and Life-Cycle Assessment of Dairy, Non-Dairy, and Vegan Whipping Creams

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Abstract

Background. Whipping creams span dairy, non-dairy, vegan classes widely assumed to embody a cost–environment trade-off, with animal formulations cheaper but dirtier, plant-based cleaner but costlier – *This Assumption has not been quantitatively tested.*

Methods. 89 public resources yielded 52 mass-balanced optimal recipes (23 dairy, 19 non-dairy, 10 vegan); each ingredient priced and tagged with cradle-to-gate Global Warming Potential using ≥ 3 references. Functional unit: 1 kg pre-whip emulsion.

Results. Class medians rise monotonically vegan $\rightarrow$ non-dairy $\rightarrow$ dairy: cost 0.81 $\rightarrow$ 0.96 $\rightarrow$ 3.62 SGD/kg; GWP 0.81 $\rightarrow$ 1.32 $\rightarrow$ 4.10 kg CO₂-equivalent/kg ($5.1\times$ dairy/vegan ratio). Animal-share correlates positively with cost (r [Pearson correlation coefficient] = +0.678) and emissions (r = +0.676); cost and emissions co-rise (recipe r = +0.833; ingredient-level r = +0.943). The Pareto frontier collapses to a single lentil-our vegan recipe (0.26 SGD/kg; 0.15 kg CO₂-eq/kg; $14\times$ lower in cost, $27\times$ lower in emissions than dairy median), dominating all others. Three ingredients — anhydrous milk fat, dairy cream, hydrogenated palm kernel oil — account for 53% of cost and 63% of emissions; anhydrous milk fat alone delivers 36% of total emissions.

Conclusions. This dataset falsifies the cost–environment trade-off hypothesis: cost and emissions co-rise with animal-origin share, leaving no interior sweet-spot. The optimum lies at the plant-only end.

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