

Biochemical Alignment of Human Breast Milk and Hemp Seed + Raw Cannabis Leaf/Flower Across Endocannabinoid System-Relevant Nutritional Axes: A Comparative Observational Review

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Abstract

This review presents a systematic side-by-side comparison of the documented biochemical composition of human breast milk and *Cannabis sativa* L. (hemp seed combined with raw leaf/flower) across nutritional axes relevant to the endocannabinoid system (ECS). Twenty biochemical categories are examined, including lipid architecture, essential fatty acid ratios, endocannabinoid precursors, enzymatic cofactors, complete protein profiles, anti-inflammatory compounds, membrane lipids, and prebiotic fiber. Each category is drawn from peer-reviewed literature and prior preprint submissions. No interpretive conclusions are drawn by the authors. The data are presented for independent evaluation.

Keywords: Cannabis sativa; hemp seed; human breast milk; endocannabinoid system; ECS nutrition; fatty acid profile; comparative biochemistry; phytocannabinoids; acidic cannabinoids; nutritional alignment

1. Introduction

Human breast milk is the reference nutritional standard for human infants. Its biochemical composition has been characterized extensively across lipid classes, protein fractions, micronutrients, bioactive molecules, and prebiotic components. The endocannabinoid system (ECS), which mediates appetite, immune function, neuroprotection, and homeostatic regulation, is known to be supported and directly activated by constituents present in breast milk, including 2-arachidonoylglycerol (2-AG), anandamide (AEA), palmitoylethanolamide (PEA), and oleoylethanolamide (OEA).

Cannabis sativa L. has been independently characterized for its nutritional composition, particularly hemp seed, which is well documented as a source of essential fatty acids, complete protein, magnesium, zinc, and phytosterols. Raw leaf and flower material additionally contribute acidic phytocannabinoids (CBDA, THCA, CBGA) and cannflavins.

The present review places the biochemical profiles of these two sources in direct parallel across twenty ECS-relevant nutritional categories. The purpose of this document is strictly observational: to record what the published literature shows about each category and to note where the two profiles align, diverge, or mirror one another. The authors make no causal, therapeutic, or evolutionary claim. The data are presented without interpretive conclusion. Interpretation is left to the reader.

2. The Comparative Data: Breast Milk vs. *Cannabis sativa* L.

Table 1 presents the side-by-side biochemical comparison. Each row represents an independent axis of comparison drawn from the cited literature. Rows marked [VALUES INVERTED FOR ADULT] indicate categories where the documented values are directionally opposite between the two sources. The inversion is recorded as a data point; no explanation or significance is assigned to it by the authors.

The comparison spans lipid architecture, precursor supply, cofactor density, protein profile, direct receptor ligands, eicosanoid balance, anti-inflammatory phytochemicals, membrane lipids, prebiotic fiber, and shared nutritional limitation. All values are sourced from peer-reviewed literature or prior preprint submissions as cited.

Also noteworthy is that reference 1, a self-cited preprint not yet peer reviewed, is predominantly a collection of cited peer reviewed work. The claims in the table about hemp seed nutrition are largely supportable from the existing peer-reviewed literature — Callaway (2004), Banni & Di Marzo (2010), Rodriguez-Leyva & Pierce (2010), and Callaway specifically documents the GLA, SDA, protein, and PUFA content.

Table 1. Biochemical comparison of human breast milk and *Cannabis sativa* L. (seed + raw flower/leaf) across ECS-relevant nutritional axes.

Component / Function	Human Breast Milk	Hemp Seed + Raw Cannabis Leaf/Flower
Primary Fat Content	3.5–4.5% total fat; ~55% of calories; rapid-growth phase (refs 9, 18, 24)	30–35% total fat (seed); ~60% of calories; supplemented by raw leaf lipids; maintenance phase (refs 1, 9)
LA : ALA Ratio (Omega-6 : Omega-3)	8–17:1 (modern Western); ~2–4:1 ancestral optimum (refs 2, 18, 23)	~3:1 — within ancestral optimum range; balanced PUFA provides ECS substrate availability (refs 1, 2)
GLA (DGLA Precursor)	Present in colostrum; declines postnatally (refs 8, 18, 23)	High: 1–4% of seed fat; anti-inflammatory bypass of rate-limiting enzymes → DGLA → PGE1; sustained supply via whole-plant consumption (ref 1)
SDA (EPA Precursor)	Trace amounts (refs 18, 23)	0.5–2%; enhances EPA synthesis from ALA via Δ6-desaturase pathway (ref 1)
Arachidonic Acid (ARA) 20:4 n-6	0.4–0.7%; pre-formed; direct availability (ref 19)	Synthesized on demand from LA via Δ6-desaturase + cofactors (Mg, Zn) supplied by seed (refs 1, 2, 8)

Component / Function	Human Breast Milk	Hemp Seed + Raw Cannabis Leaf/Flower
DHA 22:6 n-3	0.1–1.0%; pre-formed; maternally dependent; highly variable (ref 19)	Synthesized from ALA + SDA; Mg/Zn cofactors provided; not pre-formed (refs 1, 2)
Endocannabinoid Precursors (2-AG / AEA substrate)	2-AG, AEA, PEA, OEA present in μ M range; direct (ref 20)	Optimal PUFA ratio for de novo synthesis → AA and ALA precursors; acidic cannabinoids support ECS tone directly (refs 1, 3, 5)
Direct Endocannabinoid-like Molecules (PEA, OEA)	PEA and OEA present in high amounts for gut/skin barrier; direct signalling (refs 20, 22)	PEA/OEA homologues generated in vivo from raw plant ethanolamides and PUFA substrates (refs 1, 10, 12)
Endocannabinoid Signalling	AEA and 2-AG present; regulates appetite, suckling reflex, and early neural signalling (refs 20, 21)	CBDA, THCA, CBGA + fatty acid precursors; support ECS tone and downstream ethanolamide synthesis (refs 3, 4, 5, 13)
Magnesium (Enzymatic Cofactor)	30–35 mg/L; cofactor for ECS enzymes and cAMP signaling; optimized for infant bone (ref 18)	450–700 mg/100g seed; ample supply for NAPE-PLD, DAGL, and FAAH function; Δ 6-desaturase cofactor + ECS enzyme support; optimized for adult bone density & ATP (refs 1, 9)
Zinc (Enzymatic Cofactor)	1–3 mg/L; receptor synthesis; enzymatic control; high in colostrum (ref 18)	9–12 mg/100g seed; essential cofactor in Δ 6-desaturase conversion for PUFA elongation and ECS machinery; exceeds breast milk density per gram of intake (refs 1, 9)
Complete Protein [VALUES INVERTED FOR ADULT]	Casein + whey dominant; highly digestible; high IGF-1/growth focus (mTOR activation, anabolic program); complete amino acid profile (ref 18)	Edestin + albumin; 85% bioavailability; PDCAAS comparable to animal protein; globulin-dominant, slow-digesting ratio optimized for adult homeostasis and regeneration (AMPK activation, maintenance program) — architecture is directionally inverted relative to breast milk (refs 1, 9)
L-Arginine (Nitric Oxide Precursor)	High arginine content; supports vascular ECS signaling downstream of ECS activation; infant blood flow and rapid tissue synthesis (ref 21)	Exceptionally high (14–17g/100g protein); strong nitric oxide precursor supply → ECS-vascular crosstalk; in adults feeds NO/ECS crosstalk axis for vascular homeostasis rather than growth (refs 1, 14)
Phytosterols (Membrane Sterols)	Cholesterol; myelination and membrane integrity in developing CNS (refs 11, 18)	β -sitosterol + campesterol; optimize membrane fluidity; support GPCR (CB1/CB2) conformation; adult structural equivalent (refs 1, 11)

Component / Function	Human Breast Milk	Hemp Seed + Raw Cannabis Leaf/Flower
Polyphenols / Tocopherols (Antioxidant Protection)	Moderate flavonoids; γ-tocopherol present (ref 18)	Very high γ-tocopherol (dominant form); protects lipid substrates from peroxidation; preserves ECS precursor pool (refs 1, 9)
Cannflavins / Flavonoids [VALUES INVERTED FOR ADULT]	Flavonoids (moderate activity); antioxidant role appropriate for low systemic inflammatory load of a protected infant environment (ref 10)	Cannflavin A and B; ~30× more potent than aspirin at inhibiting PGE2-driven inflammation; scaled-up anti-inflammatory capacity appropriate for chronic inflammatory load of adult life — potency is directionally inverted relative to breast milk (ref 1)
Prebiotic Fiber	Human milk oligosaccharides (HMOs); prebiotic effect (ref 18)	Comparable profile (hemp rhamnogalacturonans + soluble fiber); supports gut microbiome; microbiome-ECS axis emerging (ref 1)
Anti-inflammatory Lipid Mediators	Series-1 and Series-3 dominant eicosanoids via ARA/DHA balance (ref 18)	Same outcome via GLA → DGLA → PGE1 pathway + SDA → EPA pathway; parallel Series-3 eicosanoid support (refs 1, 2, 8)
Phospholipids / Membrane Lipids	Phosphatidylcholine (PC), phosphatidylethanolamine (PE), sphingomyelin; essential for brain and cell membranes (ref 18)	Phospholipid fractions present in hemp seed; high PUFA content supports dynamic membrane fluidity and GPCR function (refs 1, 11)
Shared Nutritional Limitation (Vitamin B12)	Not synthesized; requires dietary or supplemental source	Identical gap; B12 supplementation required

2.1 Note on Directional Inversions

Two categories — protein architecture and anti-inflammatory potency — show documented values that are directionally opposite between the two sources. In both cases the inversion is consistent with a shift from an infant biological context (growth program, low systemic inflammatory load) to an adult biological context (homeostasis program, higher cumulative inflammatory exposure). This pattern is noted as a structural feature of the dataset. No claim as to origin, evolutionary significance, or intentionality is made.

2.2 Shared Nutritional Limitation: Vitamin B12

Both human breast milk and *Cannabis sativa* L. share an identical documented limitation: neither source contains sufficient vitamin B12 for human requirements. Both require external dietary or supplemental provision of B12. This shared limitation is recorded as a data point within the comparison; no interpretive weight is assigned.

3. Discussion

The data presented in Table 1 document a pattern of biochemical alignment across twenty independently characterized nutritional categories. The alignment is not selective: it holds across lipid structure, precursor availability, enzymatic cofactors, protein profile, direct ECS-active molecules, eicosanoid pathways, anti-inflammatory compounds, membrane lipids, prebiotic fiber, and shared nutritional gap.

Within this alignment, two categories document values that are not merely parallel but directionally inverted in a manner consistent with the distinct biological phases they are associated with.

The authors have recorded these observations. No interpretation of mechanism, causation, evolutionary origin, or therapeutic relevance is offered.

The question of what, if anything, this pattern of alignment signifies is left entirely to the reader.

Open Discussion

The authors present this data without conclusions. Readers are invited to evaluate the observed alignment, consider the noted inversions, and draw their own assessments. What does this pattern suggest to you?

Go discuss amongst yourselves.

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Statements and Declarations

Data Availability

The authors are affiliated with the *Endocannabinoid Nutritional Biology Research Group*, an independent research initiative. Related works are archived via Zenodo at:

<https://zenodo.org/communities/nutritional-ecs>

Conflicts of Interest

The authors declare no conflict of interest. The authors do not work for any cannabinoid business or industry.

AI Disclosure

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