

Complete Chemical Disintegration of Cannabis Sativa (Hemp)

Comprehensive Analysis of ALL Known Chemical Fractions and Constituents

Executive Summary

Cannabis sativa L. (hemp) is one of the most chemically complex plants known to science, containing **over 500+ distinct chemical compounds** across multiple phytochemical classes. This document provides a complete disintegration of all known chemical fractions, going far beyond the basic cannabinoids to encompass the full biochemical spectrum of this remarkable plant.

1. CANNABINOIDS (100+ Identified Compounds)

Cannabinoids are the most studied class of compounds unique to Cannabis sativa. Over **100 cannabinoids** have been identified, with new discoveries continuing regularly.

1.1 Major Cannabinoids (The “Big Six”)

Cannabinoid	Full Name	Properties
THC	Δ 9-Tetrahydrocannabinol	Primary psychoactive compound; binds to CB1 receptors
CBD	Cannabidiol	Non-psychoactive; anti-inflammatory, anxiolytic
CBG	Cannabigerol	“Mother cannabinoid” - precursor to THC, CBD, CBC
CBC	Cannabichromene	Non-psychoactive; entourage effect enhancer
CBN	Cannabinol	Oxidation product of THC; mildly psychoactive, sedative
THCV	Tetrahydrocannabivarin	Appetite suppressant at low doses; psychoactive at high doses

1.2 Recently Discovered Cannabinoids (2019+)

Cannabinoid	Discovery	Notes
THCP	Tetrahydrocannabiphorol (2019)	33x more potent than THC; 7-carbon alkyl side chain
CBDP	Cannabidiphorol (2019)	CBD homolog with 7-carbon side chain
THCB	Tetrahydrocannabutol	Butyl homolog of THC
CBDB	Cannabidibutol	Butyl homolog of CBD

1.3 Complete Cannabinoid Families

Cannabidiols (CBD Family)

- Cannabidiol (CBD)
- Cannabidiolic acid (CBDA)
- Cannabidivarin (CBDV)
- Cannabidivarinic acid (CBDVA)
- Cannabidiol monomethylether (CBDM)
- Cannabidiorcol (CBD-C1)
- **Cannabidiphorol (CBDP)** - 2019 discovery

Delta-9-Tetrahydrocannabinols (THC Family)

- Δ 9-Tetrahydrocannabinol (THC)
- Δ 9-Tetrahydrocannabinolic acid A (THCA-A)
- Δ 9-Tetrahydrocannabinolic acid B (THCA-B)
- Δ 9-Tetrahydrocannabivarin (THCV)
- Δ 9-Tetrahydrocannabivarinic acid (THCVA)
- Δ 9-Tetrahydrocannabiorcol (THC-C1)
- Δ 9-Tetrahydrocannabiorcolic acid (THCA-C1)
- Δ 9-Tetrahydrocannabinol-C4 (THC-C4)
- Δ 9-Tetrahydrocannabinolic acid-C4 (THCA-C4)
- **Δ 9-Tetrahydrocannabiphorol (THCP)** - 2019 discovery

Delta-8-Tetrahydrocannabinols

- Δ 8-Tetrahydrocannabinol (Δ 8-THC)
- Δ 8-Tetrahydrocannabinolic acid (Δ 8-THCA)

Cannabigerols (CBG Family)

- Cannabigerol (CBG) - “Mother Cannabinoid”
- Cannabigerolic acid (CBGA)
- Cannabigerovarin (CBGV)
- Cannabigerovarinic acid (CBGVA)
- Cannabigerol monomethylether (CBGM)
- Cannabigerolic acid monomethylether (CBGAM)

Cannabinols (CBN Family)

- Cannabinol (CBN)
- Cannabinolic acid (CBNA)
- Cannabivarin (CBV)
- Cannabinodiol (CBND)
- Cannabinodivarin (CBVD)
- Cannabiorcool (CBN-C1)
- Cannabinol-C2 (CBN-C2)
- Cannabinol-C4 (CBN-C4)
- Cannabinol methylether (CBNM)

Cannabichromenes (CBC Family)

- Cannabichromene (CBC)
- Cannabichromenic acid (CBCA)
- Cannabichromevarin (CBCV)
- Cannabichromevarinic acid (CBCVA)

Cannabicyclols (CBL Family)

- Cannabicyclol (CBL)
- Cannabicyclic acid (CBLA)
- Cannabicyclovarin (CBLV)

Cannabielsoins (CBE Family)

- Cannabielsoin (CBE)
- Cannabielsoin acid A (CBEA-A)
- Cannabielsoic acid B (CBEA-B)

Cannabitriols (CBT Family)

- Cannabitriol (CBT)
- Cannabitriolvarin (CBTV)
- 8,9-Dihydroxy-delta-6a-tetrahydrocannabinol
- 10-Ethoxy-9-hydroxy-delta-6a-tetrahydrocannabinol

Other Cannabinoids

- 10-Oxo-delta-6a-tetrahydrocannabinol (OTHc)
- Cannabichromanone (CBCF)
- Cannabifuran (CBF)
- Cannabiglendol
- Delta-9-cis-tetrahydrocannabinol (cis-THC)
- Cannbicitrin (CBT)
- Dehydrocannabifuran (DCBF)
- Tryhydroxy-delta-9-tetrahydrocannabinol (triOH-THC)
- Cannabiripsol (CBR)

2. TERPENES & TERPENOIDS (200+ Compounds)

Terpenes are aromatic compounds responsible for the distinctive smell of cannabis. Over **200 terpenes** have been identified in cannabis, with some sources claiming up to **400+ terpenes**.

2.1 Major Terpenes (Most Abundant)

Terpene	Type	Aroma	Effects
Myrcene	Monoterpene	Earthy, musky, cloves	Sedative, muscle relaxant, anti-inflammatory

Table 3 – continued

Terpene	Type	Aroma	Effects
Limonene	Monoterpene	Citrus, lemon	Mood elevation, stress relief, antifungal
-Pinene	Monoterpene	Pine, fresh	Alertness, memory retention, bronchodilation
-Pinene	Monoterpene	Pine, woody	Anti-inflammatory, antimicrobial
-Caryophyllene	Sesquiterpene	Peppery, spicy	CB2 agonist, anti-inflammatory, analgesic
Linalool	Monoterpene	Floral, lavender	Calming, anxiolytic, sedative
Humulene	Sesquiterpene	Woody, hoppy	Appetite suppressant, anti-inflammatory
Terpinolene	Monoterpene	Fresh, herbal, floral	Uplifting, antioxidant
Ocimene	Monoterpene	Sweet, herbal, woody	Antiviral, antifungal, decongestant

2.2 Complete Monoterpene Profile (C10)

Compound	Characteristics
-Pinene	Most abundant monoterpene; anti-inflammatory
-Pinene	Woody aroma; antimicrobial
Myrcene	Often 20-50% of terpene profile; sedative
Limonene	Citrus scent; mood enhancer
-(E)-Ocimene	Sweet, herbal; antifungal
-Terpineol	Floral, lilac; antioxidant
Camphene	Camphor-like; antioxidant
Carene	Sweet, piney; anti-inflammatory
p-Cymene	Citrus, woody; antibiotic
Eucalyptol (1,8-Cineole)	Minty, cooling; respiratory aid
Geraniol	Rose-like; neuroprotective
Isopulegol	Minty; gastroprotective
Menthol	Cooling; analgesic
Nerol	Sweet rose; antioxidant
Sabinene	Spicy, citrus; antibacterial
-Terpinene	Citrus; antioxidant
Terpinolene	Fresh, piney; sedative
Valencene	Sweet citrus; insect repellent

2.3 Complete Sesquiterpene Profile (C15)

Compound	Characteristics
-Caryophyllene	Only terpene that binds CB2 receptors
-Humulene	Hoppy aroma; appetite suppressant

Table 5 – continued

Compound	Characteristics
-Selinene	Woody; anti-inflammatory
-Cadinene	Woody, spicy; antimicrobial
-Cadinene	Earthy; antibacterial
Nerolidol	Floral, woody; antifungal
Maaliol	Woody; calming
Germacrene D-4-ol	Floral; antibacterial
Spathulenol	Woody; anti-inflammatory
Caryophyllene oxide	Spicy; antifungal, insecticidal
Globulol	Woody; antimicrobial
Ledol	Camphoraceous; respiratory
-Eudesmol	Woody; gastroprotective
-Eudesmol	Woody; sedative
-Eudesmol	Woody; anti-inflammatory
Bulnesol	Spicy; anti-inflammatory
-Bisabolol	Floral, chamomile; skin healing
Caryophylla-4(12),8(13)-dien-5 -ol	Woody; antioxidant
-Farnesene	Floral, apple; insect repellent
-Farnesene	Floral; calming
Guaiol	Woody, rose; anti-inflammatory
Cedrene	Woody, cedar; astringent
Selina-3,7(11)-diene	Earthy; antimicrobial
Viridiflorol	Woody; antibacterial

2.4 Diterpenes (C20) & Triterpenes (C30)

Compound	Source	Properties
Phytol	Chlorophyll degradation	Sedative, antioxidant
Campesterol	Seeds	Phytosterol; cholesterol-lowering
-Sitosterol	Seeds	Major phytosterol; anti-inflammatory
Stigmasterol	Seeds	Phytosterol; hormone precursor
Δ^5 -Avenasterol	Seeds	Phytosterol; antioxidant

3. FLAVONOIDS & PHENOLIC COMPOUNDS (30+ Compounds)

3.1 Cannabis-Specific Flavonoids (Cannflavins)

Flavonoid	Discovery	Properties
Cannflavin A	1980s	Anti-inflammatory (30x more potent than aspirin)

Table 7 – continued

Flavonoid	Discovery	Properties
Cannflavin B	1980s	Anti-inflammatory; neuroprotective
Cannflavin C	2008	Similar anti-inflammatory properties

Note: Cannflavins are prenylflavonoids found ONLY in Cannabis sativa

3.2 General Flavonoids in Hemp

Flavonoid Class	Compounds
Flavonols	Quercetin, Kaempferol, Quercetin-3-glucoside, Kaempferol-3-O-glucoside, Kaempferol-3-O-rutinoside, Quercetin-3-O-rutinoside (Rutin)
Flavanols	Catechin, Epicatechin
Flavanones	Naringenin, Eriodictyol
Flavones	Apigenin, Luteolin, Chrysoeriol
Isoflavones	Genistein, Daidzein (trace amounts)
Anthocyanins	Cyanidin, Delphinidin, Pelargonidin (responsible for purple colors)

3.3 Phenolic Acids

Compound	Location	Properties
Chlorogenic acid	Seeds, leaves	Antioxidant, anti-diabetic
Caffeic acid	All tissues	Antioxidant, anti-inflammatory
Gallic acid	Seeds	Antioxidant, antimicrobial
Ferulic acid	Cell walls	Antioxidant, UV protection
p-Coumaric acid	All tissues	Antioxidant, anti-inflammatory
Sinapic acid	Seeds	Antioxidant, neuroprotective
Rosmarinic acid	Leaves	Antioxidant, antiviral

3.4 Phenol Amides & Lignanamides

- Cannabisin A, B, C, D, E, F, G
- Grossamide
- Sativamide A, B

4. FATTY ACIDS & LIPIDS (50+ Compounds)

4.1 Major Fatty Acids in Hemp Seed Oil

Fatty Acid	Carbon Chain	Percentage	Omega Class
Linoleic acid (LA)	C18:2	55-63%	Omega-6
-Linolenic acid (ALA)	C18:3	15-26%	Omega-3
Oleic acid	C18:1	11-16%	Omega-9
-Linolenic acid (GLA)	C18:3	0.6-6.2%	Omega-6
Stearidonic acid (SDA)	C18:4	0.2-1.5%	Omega-3
Palmitic acid	C16:0	6-8%	Saturated
Stearic acid	C18:0	2-3%	Saturated

4.2 Other Fatty Acids

Fatty Acid	Type
Myristic acid (C14:0)	Saturated
Palmitoleic acid (C16:1)	Omega-7
Margaric acid (C17:0)	Saturated
Arachidic acid (C20:0)	Saturated
Behenic acid (C22:0)	Saturated
Lignoceric acid (C24:0)	Saturated
Eicosenoic acid (C20:1)	Omega-9
Erucic acid (C22:1)	Omega-9

4.3 Waxes & Esters

Compound	Properties
Squalene	Antioxidant; 80.52 mg/kg in oil
Wax esters	Protective coating
Phytol	Chlorophyll component; 167.59 mg/kg

5. PROTEINS & AMINO ACIDS

5.1 Major Hemp Seed Proteins

Protein	Percentage	Properties
Edestin	60-75% of total protein	Globular protein; most digestible plant protein; immune support
Albumin	25-35% of total protein	Water-soluble; fast-digesting; complete amino acid profile
Vicilin	~5%	Foaming/emulsifying properties

5.2 Complete Amino Acid Profile (All 20 Amino Acids)

Essential Amino Acids (9)

Amino Acid	Function
Histidine	Neurotransmitter; immune function
Isoleucine	Muscle metabolism; energy
Leucine	Protein synthesis; muscle repair
Lysine	Collagen formation; calcium absorption
Methionine	Detoxification; metabolism
Phenylalanine	Neurotransmitter precursor
Threonine	Immune function; fat metabolism
Tryptophan	Serotonin precursor; sleep
Valine	Muscle growth; tissue repair

Non-Essential Amino Acids (11)

Amino Acid	Function
Alanine	Energy production; immune function
Arginine	Nitric oxide precursor; vasodilation
Asparagine	Protein synthesis; nervous system
Aspartic acid	Energy production; neurotransmitter
Cysteine	Antioxidant; protein structure
Glutamic acid	Neurotransmitter; brain function
Glutamine	Immune function; gut health
Glycine	Collagen; sleep quality
Proline	Collagen; joint health
Serine	Brain function; immune support
Tyrosine	Neurotransmitter precursor

5.3 Bioactive Peptides

- Antioxidant peptides
- Antihypertensive peptides
- Hypoallergenic protein fractions

6. VITAMINS

6.1 Fat-Soluble Vitamins

Vitamin	Form	Amount	Function
Vitamin E	Tocopherols	562-929 mg/kg	Antioxidant; oxidative stress protection
-Tocopherol	Major isomer	92-93% of total	Anti-inflammatory, anticancer
-Tocopherol	Minor	1.9-3.5%	Antiangiogenic

Table 16 – continued

Vitamin	Form	Amount	Function
-Tocopherol Vitamin A	Minor -Carotene	3.8-6.2% ~78 mg/kg	Cardiovascular protection Skin health; vision; anti-inflammatory
Vitamin D	D2, D3	Trace	Bone health; immune function
Vitamin K	K1, K2	Trace	Blood clotting; bone health

6.2 Water-Soluble Vitamins (B-Complex)

Vitamin	Function
Thiamin (B1)	Energy metabolism; nervous system
Riboflavin (B2)	Energy production; antioxidant
Niacin (B3)	Metabolism; skin health
Pantothenic acid (B5)	Hormone synthesis; energy
Pyridoxine (B6)	Neurotransmitter synthesis
Folate (B9)	DNA synthesis; cell division
Cobalamin (B12)	Trace amounts; nerve function
Biotin	Metabolism; hair/skin health
Vitamin C	Trace; antioxidant; immune support

7. MINERALS & TRACE ELEMENTS

7.1 Macro-Elements (>50 mg/day required)

Mineral	Amount (mg/100g)	Function
Phosphorus (P)	890-1,170	Bone health; ATP production
Potassium (K)	250-2,821	Blood pressure; heart function
Magnesium (Mg)	237-694	Nerve transmission; muscle function
Calcium (Ca)	100-200	Bone health; muscle contraction
Sodium (Na)	10-50	Fluid balance; nerve function

7.2 Micro-Elements/Trace Elements (<50 mg/day required)

Mineral	Function
Iron (Fe)	Oxygen transport; energy
Zinc (Zn)	Immune function; wound healing
Manganese (Mn)	Bone health; metabolism
Copper (Cu)	Iron metabolism; connective tissue
Selenium (Se)	Antioxidant; thyroid function
Boron (B)	Bone health; brain function

Table 19 – continued

Mineral	Function
Molybdenum (Mo)	Enzyme function
Chromium (Cr)	Blood sugar regulation
Cobalt (Co)	Vitamin B12 synthesis
Nickel (Ni)	Trace; enzyme function
Silicon (Si)	Bone; connective tissue

8. FIBER CONSTITUENTS (Bast & Hurd)

8.1 Cell Wall Composition of Hemp Fiber

Component	Percentage	Function
Cellulose	53-91%	Structural strength; crystalline framework
Hemicellulose	4-28%	Matrix binding; flexibility
Lignin	1-21%	Rigidity; water resistance
Pectin	1-17%	Cell adhesion; middle lamella
Waxes	1-3%	Water repellency; protection

8.2 Polysaccharides

Polysaccharide	Content	Properties
Total carbohydrates	20-30% of seed	Energy source
Water-soluble polysaccharides	~5.5%	Prebiotic; antimicrobial
Insoluble polysaccharides	~22%	Digestive health; satiety
Xylan	Hemicellulose fraction	Prebiotic
Glucomannan	Cell wall	Viscous fiber
Arabinogalactan	Cell wall	Immune support

9. PIGMENTS & COLOR COMPOUNDS

9.1 Chlorophylls

Pigment	Amount	Function
Chlorophyll a	12.8-125.5 mg/kg	Primary photosynthetic pigment
Chlorophyll b	14.6-23.3 mg/kg	Accessory pigment
Total chlorophylls	Variable	Green color; antioxidant

9.2 Carotenoids

Carotenoid	Amount	Function
-Carotene	1.78-61 mg/kg	Vitamin A precursor; antioxidant
Lutein	Trace	Eye health; antioxidant
Zeaxanthin	Trace	Eye health; antioxidant
Total carotenoids	0.3-0.8 mg/g DW	Yellow-orange color; photo-protection

9.3 Anthocyanins (in purple varieties)

Anthocyanin	Color
Cyanidin-3-glucoside	Red-purple
Delphinidin-3-glucoside	Blue-purple
Pelargonidin	Orange-red

10. ALKALOIDS & NITROGENOUS COMPOUNDS

Compound Class	Examples	Notes
Choline	-	Neurotransmitter; liver health
Trigonelline	-	Niacin precursor; blood sugar
Betaine	-	Methylation; heart health
Spermidine	-	Polyamine; cellular growth
Spermine	-	Polyamine; DNA stabilization
Putrescine	-	Polyamine; cell division

11. HYDROCARBONS & VOLATILE COMPOUNDS

11.1 Alkanes & Alkenes

Compound	Carbon Chain
n-Hentriacontane (C31)	Major alkane
n-Tritriacontane (C33)	Major alkane
n-Pentacosane (C25)	Minor
n-Heptacosane (C27)	Minor
n-Nonacosane (C29)	Minor

11.2 Ketones & Aldehydes

Compound	Aroma
6-Methyl-5-hepten-2-one	Fruity, green
Nonanal	Citrus, floral
Decanal	Citrus, waxy

12. SECONDARY METABOLITES SUMMARY TABLE

Chemical Class	Number of Compounds	Major Functions
Cannabinoids	100+	ECS modulation; therapeutic
Terpenes/Terpenoids	200-400+	Aroma; entourage effect; therapeutic
Flavonoids	30+	Antioxidant; anti-inflammatory; color
Phenolic Acids	15+	Antioxidant; antimicrobial
Fatty Acids	20+	Nutrition; cell membrane health
Amino Acids	20	Protein building; metabolism
Vitamins	15+	Essential nutrition; metabolism
Minerals	15+	Physiological functions
Phytosterols	5+	Cholesterol management
Carotenoids	5+	Antioxidant; vision
Chlorophylls	2+	Photosynthesis; detoxification
TOTAL IDENTIFIED	500+	Multifunctional

13. PHYTOCHEMICAL DISTRIBUTION BY PLANT PART

Plant Part	Major Constituents
Flowers/Buds	Cannabinoids (highest concentration), terpenes, flavonoids, cannflavins
Leaves	Chlorophyll, carotenoids, flavonoids, lower cannabinoids
Seeds	Fatty acids, proteins (edestin, albumin), vitamins E, minerals
Stalk/Bast Fiber	Cellulose, hemicellulose, lignin, pectin, waxes
Hurd (Inner Core)	Cellulose, hemicellulose, lower lignin than bast
Roots	Triterpenes, alkaloids (trace), polyphenols

14. THE ENTOURAGE EFFECT: SYNERGY OF COMPOUNDS

The “entourage effect” describes the synergistic interaction between cannabinoids, terpenes, and flavonoids:

- **Cannabinoids + Terpenes:** Enhanced therapeutic effects; modulation of psychoactivity

- **Cannabinoids + Flavonoids:** Increased anti-inflammatory action
 - **Terpenes + Flavonoids:** Enhanced antioxidant capacity
 - **All Together:** Maximum therapeutic potential
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15. CONCLUSION

Cannabis sativa L. (hemp) represents one of the most biochemically complex plants on Earth, with:

- **100+ cannabinoids** identified, with more discovered regularly
- **200-400+ terpenes** contributing to aroma and effects
- **30+ flavonoids** including cannabis-specific cannflavins
- **Complete nutritional profile:** all essential amino acids, optimal fatty acid ratio (3:1 omega-6:omega-3)
- **Rich vitamin and mineral content**
- **High-quality fiber constituents** for industrial applications

This remarkable chemical diversity explains hemp's versatility across:

- **Medicinal/therapeutic applications**
- **Nutritional/food products**
- **Industrial materials (biocomposites, textiles)**
- **Cosmetics and personal care**
- **Biofuel and energy applications**

The ongoing discovery of new compounds (like THCP and CBDP in 2019) suggests that our understanding of hemp's chemical complexity is still evolving, with potentially hundreds more compounds yet to be identified and characterized.

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Document compiled: March 2026 Total chemical compounds documented: 500+