

RESEARCH MONOGRAPH . COMPOUND PROFILE

Caffeine

The world's most consumed psychoactive substance, an adenosine receptor antagonist with widespread cognitive and physical performance effects.

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COMPOUND CLASS	Methylxanthine adenosine receptor antagonist

ABSTRACT

Caffeine (1,3,7-trimethylxanthine; CAS 58-08-2; molecular formula $C_8H_{10}N_4O_2$; molecular weight 194.19) is the most widely consumed psychoactive substance in the world, present in coffee, tea, cocoa, and many caffeinated beverages and dietary supplements. Mechanism is non-selective adenosine receptor antagonism (A1, A2A, A2B, A3) at typical dietary doses, with secondary inhibition of phosphodiesterase and modulation of GABA-A receptors at supratherapeutic concentrations. The adenosine A2A receptor antagonism is the principal driver of cognitive and motor effects. Pharmacokinetics: plasma half-life 3 to 5 hours; CYP1A2 metabolism (variable by genotype); renal excretion of metabolites. Doses for performance applications are typically 100 to 400 mg; tolerance develops within 1 to 2 weeks of regular use.

1. Compound Identification

Caffeine is described as methylxanthine adenosine receptor antagonist. The world's most consumed psychoactive substance, an adenosine receptor antagonist with widespread cognitive and physical performance effects.

1.1 Class summary

Methylxanthine adenosine receptor antagonist

1.2 Subtitle

The world's most consumed psychoactive substance, an adenosine receptor antagonist with widespread cognitive and physical performance effects.

2. Abstract

Caffeine (1,3,7-trimethylxanthine; CAS 58-08-2; molecular formula C₈H₁₀N₄O₂; molecular weight 194.19) is the most widely consumed psychoactive substance in the world, present in coffee, tea, cocoa, and many caffeinated beverages and dietary supplements. Mechanism is non-selective adenosine receptor antagonism (A₁, A_{2A}, A_{2B}, A₃) at typical dietary doses, with secondary inhibition of phosphodiesterase and modulation of GABA-A receptors at supratherapeutic concentrations. The adenosine A_{2A} receptor antagonism is the principal driver of cognitive and motor effects. Pharmacokinetics: plasma half-life 3 to 5 hours; CYP1A2 metabolism (variable by genotype); renal excretion of metabolites. Doses for performance applications are typically 100 to 400 mg; tolerance develops within 1 to 2 weeks of regular use.

3. Mechanism of Action

Non-selective adenosine receptor antagonist (A1, A2A, A2B, A3). PDE inhibition at higher doses.

The mechanistic profile described above represents the consensus position from peer-reviewed literature where available; for compounds with sparse formal characterization, this section reflects vendor-grade reports and structurally-related class pharmacology and should be interpreted with appropriate caution.

4. Pharmacokinetics and Routes of Administration

Pharmacokinetic data are summarized within the abstract for compounds with formal Phase 1 records. Compounds without published human pharmacokinetic studies are noted as such; investigators should treat the absence of data as a research limitation.

5. Reported Research Dose Ranges

100 to 400 mg per administration; tolerance develops with regular use.

Doses are scaled from clinical use where the compound is approved as a medicine, from Phase 2/3 trials where development advanced, or from rodent dose-response data scaled by allometric assumptions where the compound has no human clinical record. Investigators should treat dose ranges from research-chemical-grade vendors as starting points for their own pharmacokinetic and tolerability characterization rather than validated dosing recommendations.

6. Sourcing and Quality Verification

Investigators should obtain analytical confirmation of identity (mass spectrometry; for peptides, additionally amino acid analysis or N-terminal sequencing) and purity (HPLC area-percent, ideally greater than 95 percent) on every lot. Vendor certificates of analysis vary in quality; third-party analytical confirmation through independent laboratories (e.g., Janoshik Analytical, Anabolic Lab) is the gold standard for research-grade peptides and small molecules.

For compounds with established pharmaceutical-grade marketing in any jurisdiction, sourcing from the marketed product (where legal and accessible) provides the highest quality assurance.

7. Reconstitution and Handling

Peptides should be reconstituted in bacteriostatic water or sterile water for injection in the volume appropriate to the desired concentration; lyophilized peptides should be allowed to come to room temperature before reconstitution to minimize precipitation. Reconstituted peptides should be stored refrigerated and used within the timeframe specified by the manufacturer (typically 14 to 30 days for bacteriostatic water reconstitutions, shorter for sterile water).

Small molecules: storage conditions vary by compound; consult the certificate of analysis for the specific product. Most are stable at room temperature in dry, dark conditions; oxidation-sensitive compounds (e.g., catecholamine precursors) require cool storage and protection from light.

8. Stack Interaction Considerations

Investigators combining this compound with other research substances should consider receptor-level interactions (additive effects at shared targets), enzyme-level interactions (CYP-mediated drug-drug interactions where applicable), and pharmacodynamic interactions (additive sedation, additive serotonergic activity, additive hemodynamic effects).

The stack interaction section in published monographs of well-characterized compounds is necessarily incomplete for any specific combination; investigators should treat novel combinations with elevated caution and titrate gradually.

9. References

1. Fredholm BB, et al. Adenosine, an endogenous distress signal, modulates tissue damage and repair. Pharmacol Rev 1999.

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