

Bibliographie : Cannabinoïdes, immunité et inflammation

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- 1 - Cannabinoïdes et Inflammation : 1 – 4
- 2 - Cannabinoïdes et Immunité : 5 - 6
- 3 - Cannabinoïdes et activité antibactérienne / antivirale : 7

1. BLAKE D.R., ROBSON P., HO M., JUBB R.W., MCCABE C.S. : Preliminary assessment of the efficacy, tolerability and safety of a cannabis-based medicine (Sativex) in the treatment of pain caused by rheumatoid arthritis, *Rheumatology*, 2006, 45, (1), 50-52.
2. BOOZ G.W. : Cannabidiol as an Emergent Therapeutic Strategy for Lessening the Impact of Inflammation on Oxidative Stress, *Free Radical Biology and Medicine*, 2011, 51, 5, 1054-1061.
Doi : 10.1016/j.freeradbiomed.2011.01.007
3. BRITCH S., GOODMAN A., WHILEY J., PONDELICK A., CRAFT R. : Antinociceptive and Immune Effects of Delta-9-tetrahydrocannabinol or Cannabidiol in Male Versus Female Rats with Persistent Inflammatory Pain, *Journal of Pharmacology and Experimental Therapeutics*, 2020.
Doi : 10.1124/jpet.119.263319
4. BURSTEIN S.H., ZURIER R.B. : Cannabinoids, Endocannabinoids, and Related Analogs in Inflammation, *The AAPS Journal*, 2009, 2, (1), 109-119.
Doi : 10.1208/s12248-009-9084-5
5. CALLEJAS G.H., FIGUEIRA R.L., GONÇALVES F.L.L., VOLPE F.A.P., ZUARDI A.W., CRIPPA J.A./, HALLAK J.E., SBRAGIA L. : Maternal administration of cannabidiol promotes an anti-inflammatory effect on the intestinal wall in a gastoschisis rat model, *Brazilian Journal of Medical and Biological Research*, 2018, 51, (5), e7132
Doi : 10.1590/1414-431X20177132
6. CHEN J., HOU C., CHEN X., WANG D., YANG P., HE X., ZHOU J., LI H. : Protective effect of cannabidiol on hydrogen peroxide-induced apoptosis, inflammation and oxidative stress in nucleus pulposus cells, *Molecular Medicine Reports*, 2016, 14, 2321-2327.
Doi : 10.3892/mmr.2016.5513
7. COUCH D.G., TASKER C., THEOPHILIDOU E. et al. : Cannabidiol and palmitoyl-ethanolamide are anti-inflammatory in the acutely inflamed human colon, *Clinical Science (London)*, 2017, 131, 2611-2626.
8. D'ARGENIO G., VALENTI M., SCAGLIONE G. et al. : Up-regulation of anandamide levels as an endogenous mechanism and a pharmacological strategy to limit colon inflammation, *FASEB Journal*, 2006, 20, 568–570.
9. Di MARZO V., MELK D., De PETROCELLIS L., BISOGNO T. : Cannabinimetic fatty acid derivatives in cancer and inflammation, *Prostaglandins and Other Lipid Mediators*, 2000, 61, (1-2), 43-61.

10. DOWNER E.J. : Anti-inflammatory Potential of Terpenes Present in Cannabis sativa L., *ACS Chemical Neurosciences*, 2020, 11, (5), 659-662.
Doi : 10.1021/acschemneuro.0c00075
11. GALLILY R., YEKHTIN Z., HANUS L.O. : Overcoming the Bell-Shaped Dose-Response of cannabidiol by Using Cannabis Extract Enriched in Cannabidiol, *Pharmacology & Pharmacy*, 2015, 6, 75-85.
Doi : 10.4236/pp.2015.62010
12. GUGLIANDOLO A., POLLASTRO F., GRASSI G., BRAMANTI P., MAZZON E. : In Vitro Model of Neuroinflammation : Efficacy of Cannabigerol, a Non-Psychoactive Cannabinoid, *International Journal of Molecular Sciences*, 2018, 19, (7).
Doi : 10.3390/ijms19071992
13. GUZMÁN M., SÁNCHEZ C., GALVE-ROPERH I. : Control of the cell survival/death decision by cannabinoids, *Journal of Molecular Medicine*, 2001, 78, (11), 613-625.
14. HAMMELL D.C., ZHANG L.P., MA F. et al. : Transdermal cannabidiol reduces inflammation and pain-related behaviours in a rat model of arthritis, *European Journal of Pain*, 2016, 20, 936-948.
15. JAGGAR S.I., HASNIE F.S., SELLATURAY S., RICE A.S.C. : The anti-hyperalgesic actions of the cannabinoid anandamide and the putative CB2 receptor agonist palmitoylethanolamide in visceral and somatic inflammatory pain, *Pain*, 1998, 76, 189-199.
16. JOHNSON D.R., STEBULIS J.A., ROSSETTI R.G., BURSTEIN S.H., ZURIER R.B. : Suppression of fibroblast metalloproteinases by ajulemic acid, a nonpsychoactive cannabinoid acid, *Journal of Cellular Biochemistry*, 2007, 100, 184-190.
17. LI H., KONG W., CHAMBERS C.R. et al. : The non-psychotropic phytocannabinoid cannabidiol (CBD) attenuates pro-inflammatory mediators, T cell infiltration, and thermal sensitivity following spinal cord injury in mice, *Cell Immunology*, 2018, 329, 1-9.
18. LU C., LIU Y., SUN B., SUN Y., HOU B., ZHANG Y., MA Z., GU X. : Intrathecal Injection of JWH-015 Attenuates Bone Cancer Pain Via Time-Dependent Modification of Pro-inflammatory Cytokines Expression and Astrocytes Activity in Spinal Chord, *Inflammation*, 2015, 38, (5), 1880-1890.
Doi : 10.1007/s10753-015-0168-3
19. MALFAIT A.M., GALLILY R., SUMARIWALLA P.F., MALIK A.S., ANDREAKOS E., MECHOULAM R., FELDMANN M. : The non-psychotropic cannabis constituent cannabidiol is an oral anti-arthritis therapeutic in murine collagen-induced arthritis, *PNAS, Proceedings of the National Academy of Sciences USA*, 2000, 97, (17), 9561-9566.
Doi : 10.1073/pnas.160105897
20. MALLAT A., TEIXERA-CLERC F., DEVEAUX V., MANIN S., LOTERSZTAJN S. : The endocannabinoid system as a key mediator during liver diseases : new insights and therapeutic openings, *British Journal of Pharmacology*, 2011, 163, 1432-1440.
Doi : 10.1111/j.1476-5381.2011.01397
21. MARTIN-FONTECHA M., ANGELINA A., RÜCKERT B., RUEDA-ZUBIAURRE A., MARTIN-CRUZ L., van de VEEN W., AKDIS M., ORTEGA-GUTIERREZ S., LOPEZ-RODRIGUEZ M.L., AKDIS C.A., PALOMARES O. : A Fluorescent Probe to Unravel Functionnal Features of Cannabinoid receptor CB1 in Human Blood and Tonsil Immune System Cells, *Bioconjugate Chemistry*, 2018, A-H.
Doi : 10.1021/acs.bioconjchem.7b00680

22. MORI M.A., MEYER E., SOARES L.M., MILANI H., GUIMARAES F.S., de OLIVEIRA R.M. : Cannabidiol reduces neuroinflammation and promotes neuroplasticity and functional recovery after brain ischemia, *Progress in Neuropsychopharmacology and Biological Psychiatry*, 2017, 75, 94-105.
23. NAFTALI T., MECHOULAM R., MARII A., GABAY G., STEIN A., BRONSHTAIN M., LAISH I., BENJAMINOV F., KONIKOFF F.M. : Low-Dose Cannabidiol Is Safe but Not Effective in the Treatment for Crohn'S Disease, a Randomized Controlled Trial, *Digestive Diseases and Sciences*, 2017, 62, 1615-1620.
Doi : 10.1007/s10620-017-4540-z
24. NAFTALI T. : An overview of cannabis based treatment in Crohn's disease, *Expert Review Gastroenterology & Hepatology*, 2020, 1-5.
Doi : 10.1080/17474124.2020.1740590
25. NAGARKATTI P., PANDEY R., RIEDER S.A., HEGDE, V.L., NAGARKATTI M. : Cannabinoids as novel anti-inflammatory drugs, *Future Medicinal Chemistry*, 2009, 1, (7), 1333-1349.
26. NICHOLS J.M., KAPLAN B.L.F. : Immune Responses Regulated by Cannabidiol, *Cannabis and Cannabinoid Research*, 2019.
Doi : 10.1089/can.2018.0073
27. OLAH A., MARKOVICS A., SZABO-PAPP J., SZABO P.T., STOTT C., ZOUBOULIS C.C., BIRO T. : Differential effectiveness of selected non-psychotropic phytocannabinoids on human sebocyte functions implicates their introduction in dry/seborrheic skin and acne treatment, *Experimental Dermatology*, 2016, 25, (9), 701-707.
28. OLAH A., TOTH B.I., BORBIRO I., SUGAWARA K., SZOLLOSI A.G. et al. : Cannabidiol exerts sebostatic and anti-inflammatory effects on human sebocytes, *Journal of Clinical Investigation*, 2014, 42, (7), 1447-1457.
29. PAGANO E., CAPASSO R., PISCITELLI F., ROMANO B., PARISI O.A., FINIZIO S., LAURITANO A., Di MARZO V. et al. : An Orally Active Cannabis Extract with High Content in Cannabidiol attenuates Chemically-induced Intestinal Inflammation and Hypermotility in the Mouse, *Frontiers in Pharmacology*, 2016, Vol 7, Article 341.
Doi : 10.3389/fphar.2016.00341
30. RAJAN T.S., GIACOPPO S., IORI R., De NICOLA G.R. et al : Anti-inflammatory and antioxidant effects of a combination of cannabidiol and moringin in LPS-stimulated macrophages, *Fitoterapia*, 2016, 112, 104-115.
Doi : 10.1016/j.fitote.2016.05.008
31. RICHARDSON J.D., KILO S., HARGREAVES K.M. : Cannabinoids reduce hyperalgesia and inflammation via interaction with peripheral CB1 receptors, *Pain*, 1998, 75, 111-119.
32. RUIZ-VALDEPENAS L., MARTINEZ-ORGADO J.A., BENITO C., MILLAN A., TOLON R.M., ROMERO J. : Cannabidiol reduces lipopolysaccharide-induced vascular changes and inflammation in the mouse brain : an intravital microscopy study, *Journal of Neuroinflammation*, 2011, 8, (1), 5.
33. SAITO V.M., REZENDE R.M., TEIXEIRA A.L. : Cannabinoid Modulation of Neuroinflammatory Disorders, *Current Neuropharmacology*, 2012, 10, (2), 159-166 159.
Doi : 10.2174/157015912800604515
34. SHERIFF T., LIN M.J., DUBIN D., KHORASANI H. : The potential role of cannabinoids in dermatology, *Journal of Dermatological Treatment*, 2019.

Doi : 10.1080/09546634.2019.1675854

35. VILELA L.R., GOMIDES L.F., DAVID B.A., ANTUNES M.M., DINIZ A.B., de ARAUJO MOREIRA F., MENEZES G.B. : Cannabidiol rescue Acute Hepatic Toxicity and Seizure Induced by Cocaine, *Mediators of Inflammation*, Hindawi Publishing Corporation, 2015, Art 523418, 12 p.
Doi : 10.1155/2015/523418
36. YANG L., ROZENFELD R., WU D., DEVI L., ZHANG Z., CEDERBAUM A. : Cannabidiol protects liver from binge alcohol-induced steatosis by mechanisms including inhibition of oxidative stress and increase in autophagy, *Free Radical Biology & Medicine*, 2014, 68, 260-267.
Doi : 10.1016/j.freeradbiomed.2013.12.026
37. ZURIER R.B., ROSSETTI R.G., LANE J.H., GOLDBERG J.M., HUNTER S.A., BURSTEIN S.H. : Dimethylheptyl-THC-11 oic acid: a nonpsychoactive antiinflammatory agent with a cannabinoid template structure, *Arthritis Rheumatology*, 1998, 41, 163-170.

Cannabinoïdes et Immunité

1. BUCKLEY N.E., BURBRIDGED., BURANAPRAMEST M., FERGUSON T., PAAU R.Y. : Experimental Methods to Study the Role of the Peripheral Cannabinoid Receptor in Immune Function, Chapter 2, in "*Marijuana and Cannabinoid Research. Methods and protocols*", Edited by Emmanuel S. Onaivi, Humana Press, Totowa, New Jersey, USA, 2006, 19-40.
2. CABRAL G., DOVE PETTIT D.A. : Drugs and immunity : cannabinoids and their role in decreased resistance to infectious diseases, *Journal of Neuroimmunology*, 1998, 83, 116-123.
3. HEGDE V.L., TOMAR S., JACKSON A., RAO R., YANG X., SINGH U.P., SINGH N.P., NAGARKATTI P.S., NAGARKATTI M. : Distinct MicroRNA Expression Profile and Targeted Biological Pathways in Functional Myeloid-derived Suppressor Cells Induced by $\Delta 9$ -Tetrahydrocannabinol *in Vivo*, *The Journal of Biological Chemistry*, 2013, 288, (52), 36810-36826.
Doi : 10.1074/jbc.M113503037
4. HEGDE V.L., SINGH U.P., NAGARKATTI P.S., NAGARKATTI M. : Critical Role of Mast Cells and Peroxisome Proliferator-Activated Receptor γ in the Induction of Myeloid-Derived Suppressor Cells by Marijuana Cannabidiol *In Vivo*, *The Journal of Immunology*, 2015, 194, 5211-5222.
Doi : 10.4049/jimmunol.1401844
5. HENRY R.J., KERR D.M., FINN D.P., ROCHE M. : For whom the endocannabinoid tolls : Modulation of innate immune functions and implications for psychiatric disorders, *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 2015, 14 p.
Doi : 10.1016/j.pnpbp.2015.03.006
6. JUKNAT A., GAO F., COPPOLA G., VOGEL Z., KOZELA E. : MiRNA expression profiles and molecular networks in resting and LPS-activated BV-2 microglia – Effect of cannabinoids, *PLoS One*, 2019, 1-25.
Doi : 10.1371/journal.pone.0212039
7. KAPLAN B.L. : The role of CB1 in immune modulation by cannabinoids, *Pharmacology & Therapeutics*, 2013, 137, (3), 365-374.
Doi : 10.1016/j.pharmthera.2012.12.004
8. KILLESTEIN J., HOOGERVORST E.L.J., REIF M. et al. : Immunomodulatory effects of orally administered cannabinoids in multiple sclerosis, *Journal of Neuroimmunology*, 2003, 137, 140-143.
9. KLEIN T.W., NEWTON C., LARSEN K. et al : The cannabinoid system and immune modulation, *Journal of Leukocyte Biology*, 2003, 74, 4, 486-496.
Doi : 10.1189/jlb.0303101
10. KOZELA E., KAUSHANSKY N., EILAM R., RIMMERMAN N., BEN-NUN A., JUKNAT A., VOGEL Z. : Cannabidiol inhibits pathogenic T cells, decreases spinal microglial activation and ameliorates multiple sclerosis-like disease in C57Bl/6 mice, *British Journal of Pharmacology*, 2011, 163, (7), 1507-1519.
Doi : 10.1111/j.1476-5381.2011.01379.x
11. KOZELA E., JUKNAT A., KAUSHANSKY N., RIMMERMAN N., BEN-NUN A., VOGEL Z. : Cannabinoids decrease the Th17 inflammatory autoimmune phenotype, *Journal of Neuroimmune Pharmacology*, 2013, 8, (5), 1265-1276.
Doi : 10.1007/s11481-013-9493-1

12. KOZELA E., JUKNAT A., GAO F., KAUSHANSKY N., COPPOLA G., VOGEL Z. : Pathways and gene networks mediating the regulatory effects of cannabidiol, a nonpsychoactive cannabinoid, in autoimmune T cells, *Journal of Neuroinflammation*, 2016, 13, (1), Art 136, 1-19.
Doi : 10.1186/s12974-016-0603-x
13. KOZELA E., JUKNAT A., VOGEL Z. : Modulation of Astrocyte Activity by Cannabidiol, a Nonpsychoactive Cannabinoid, *International Journal of Molecular Sciences*, 2017, 18, 1669, 1-20.
Doi : 10.3390/ijms18081669
14. KRAFT B, KRESS HG. : Cannabinoids and the immune system of men, mice and cells, *Der Schmerz*, 2004, 18, 203-210.
15. LEE M., YANG K.H., KAMINSKI N.E. : Effects of putative cannabinoid receptor ligands, anandamide and 2-Arachidonyl-Glycerol, on immune function in B6C3F1 mouse splenocytes, *Journal of Pharmacology and Experimental Therapeutics*, 1995, 275, 529.
16. MARTIN-FONTECHA M., ANGELINA A., RUCKERT B., RUEDA-ZUBIAURRE A. et al : A Fluorescent Probe to Unravel Functionnal Features of Cannabinoid Receptor CB1 in Human Blood and Tonsil Immune System Cells, *Bioconjugate Chemistry*, 2018, 29, 2, 8 p.
Doi : 10.1021/acs.bioconjchem.7b00680
17. NICHOLS J.M., KAPLAN B.L.F. : Immune Responses Regulated by Cannabidiol, *Cannabis and Cannabinoid Research*, 2019.
Doi : 10.1089/can.2018.0073
18. PACHER P., R. MECHOULAM R. : Is lipid signaling through cannabinoid 2 receptors part of a protective system ?, *Progress in Lipid Research*, 2011, 50, (2), 193-211.
Doi : 10.1016/j.plipres.2011.01.001
19. PACIFICI R., ZUCCARO P., PICHINI S., ROSET P.R., POUDEVIDA S., FARRE M., SEGURA J., de la TORRE R. : Modulation of the immune system in cannabis users, *Journal of the American Medical Association*, 2003, 289, 1929-1931.
20. PARKER J., ATEZ F., ROSSETTI R.G., SKULAS A., PATEL R., ZURIER R.B. : Suppression of human macrophage interleukin-6 by a nonpsychoactive cannabinoid acid, *Rheumatology International*, 2008, 28, 631-635.
21. ROTH M.D., BALDWIN G.C., TASKHIN D.P. : Effects of delta-9-tetrahydrocannabinol on human immune function and host defense, *Chemistry and Physics of Lipids*, 2002, 121, 229-239.
22. SCHWARZ H., BLANCO F.J., LOTZ M. : Anandamide, an endogenous cannabinoid receptor agonist inhibits lymphocyte proliferation and induces apoptosis, *Journal of Neuroimmunology*, 1994, 55, 107.
23. SRIVASTAVA M.D., SRIVASTAVA B.I., BROUHARD B. : delta-9-tetrahydrocannabinol and cannabidiol alter cytokine production by human immune cells, *Immunopharmacology*, 1998, 40, 179-185.
24. TANG J.L., LANCZ G., SPECTER S. : Delta-9-tetrahydrocannabinol (THC) mediated inhibition of macrophage macromolecular metabolism is antagonized by human serum proteins and by cell surface proteins, *International Journal of Immunopharmacology*, 1993, 15, 665.

Cannabinoides et activité antibactérienne / antivirale

1. APPENDINO G., GIBBONS S., GIANA A., PAGANI A., GRASSI G., STAVRI M., SMITH E., RAHMAN M.M. : Antibacterial cannabinoids from Cannabis sativa : a structure-activity study, *Journal of Natural Products*, 2008, 71, (8), 1427–30.
2. BASS R., ENGELHARD D., TREMBOVLER V., SHOHAMI E. : A novel non-psychotropic cannabinoid, HU-211, in the treatment of experimental pneumococcal meningitis, *Journal of Infectious Diseases*, 1996, 173, (3), 735-738.
3. BLASKOVICH M.A.T., KAVANAGH A., RAMU S., LEV, S., CALLAHA, M., THURN M. : Cannabidiol is a Remarkably Active Gram-Positive Antibiotic, in *ASM Microbe Conference*, San Francisco, CA, 2019.
4. BUCHWEITZ J.P., KARMAUS P.W., WILLIAMS K.J., HARKEMA J.R., KAMINSKI N.E. : Targeted deletion of cannabinoid receptors CB1 and CB2 produced enhanced inflammatory responses to influenza A/PR/8/34 in the absence and presence of Δ9-tetrahydrocannabinol, *Journal of Leukocyte Biology*, 2008, 83, (3), 785-796.
5. BUCHWEITZ J.P., KARMAUS P.W., HARKEMA J.R., WILLIAMS K.J., KAMINSKI N.E. : Modulation of airway responses to influenza A/PR/8/34 by Δ9-tetrahydrocannabinol in C57BL/6 mice, *Journal of Pharmacology and Experimental Therapeutics*, 2007, 323, (2), 675-683.
6. CABRAL G., DOVE PETTIT D.A. : Drugs and immunity : cannabinoids and their role in decreased resistance to infectious diseases, *Journal of Neuroimmunology*, 1998, 83, 116-123.
7. FARHA M.F., EL-HALFWY O.M, GALE R.T., MACNAIR C.R., CARFRAE L.A., ZHANG X., JENTSCH N.G., MAGOLAN J., BROWN E.D. : Uncovering the Hidden Antibiotic Potential of Cannabis, *ACS Infectious Diseases*, 2019, 1-9.
Doi : 10.1021/acsinfecdis.9b00419
8. HERNÁNDEZ-CERVANTES R., MÉNDEZ-DÍAZ M., PROSPÉRO-GARCÍA Ó., MORALES-MONTOR J. : Immunoregulatory role of cannabinoids during infectious disease, *Neuroimmunomodulation*, 2017, 24, (4-5), 183-199.
9. MABOU TAGNE A.M., PACCHETTI B., SODERGREN M., COSENTINO M., MARINO F. : Cannabidiol for Viral Diseases : Hype or Hope ?, *Cannabis and Cannabinoid Research*, 2020, 1-11.
Doi : 10.1089/can.2019.0060
10. NISSEN L, ZATTA A., STEFANINI I., GRANDI S., SGORBATI B., BIAVATI B., MONTI A. : Characterization and antimicrobial activity of essential oils of industrial hemp varieties (*Cannabis sativa* L.), *Fitoterapia*, 2010, 81, 413-419.
11. Van KLINGEREN B., TEN HAM M. : Antibacterial activity of delta9-tetrahydrocannabinol and cannabidiol, *Antonie van Leeuwenhoek*, 1976, 42 (1-2), 9-12.