

References

In this guide

[In this guide](#)

1. [The potential health effects of Echinacea in the maternal diet - Introduction and Background](#)
2. [Existing authorisations for Echinacea products in the UK](#)
3. [EMA assessment reports and conclusions](#)
4. [Health-based guidance values \(HBGV\)](#)
5. [Mechanism of action](#)
6. [Drug-herb interaction potential: effects on cytochrome P450 and P-glycoprotein](#)
7. [The potential health effects of Echinacea in the maternal diet -Toxicity Studies](#)
8. [Contaminants](#)
9. [The potential health effects of Echinacea in the maternal diet - Exposure Assessment](#)
10. [The potential health effects of Echinacea in the maternal diet - Risk Characterization](#)
11. [The potential health effects of Echinacea in the maternal diet - Conclusions](#)
12. [The potential health effects of Echinacea in the maternal diet - List of Abbreviations](#)
13. [The potential health effects of Echinacea in the maternal diet - References](#)
14. [TOX/2024/45 Annex A](#)
15. [TOX/2024/45 Annex B](#)

This is a paper for discussion. This does not represent the views of the Committee and should not be cited.

Ahmadi, F., Kariman, K., Mousavi, M., Rengel, Z. (2024). *Echinacea*: Bioactive Compounds and Agronomy. Plants 13, 1235. [Echinacea: Bioactive Compounds and Agronomy](#)

Ardjomand-Woelkart, K., Bauer, R. (2015). Review and Assessment of Medicinal Safety Data of Orally Used *Echinacea* Preparations. *Planta Med.* 82, 17–31.

[Thieme E-Journals - Planta Medica / Abstract](#)

Ardjomand-Woelkart, K., Kollroser, M., Derendorf, H., Bauer, R., Butterweck, V. (2012). Herb-Drug Interactions: Effects of *Echinacea* preparations on cytochrome P450 activities in rats. *Planta Med.* 78.

Barcz, E., Sommer, E., Nartowska, J., Balan, B.J., Chorostowska-Wynimko, J., Ewa, Skopińska-Różewska, E. (2007). Influence of *Echinacea purpurea* intake during pregnancy on fetal growth and tissue angiogenic activity. *Folia Histochem Cytobiol.* ;45 Suppl 1:S35-9.

Barnes, J., Anderson, L.A., Gibbons, S., Phillipson, J.D. (2010). *Echinacea* species (*Echinacea angustifolia* (DC.) Hell., *Echinacea pallida* (Nutt.) Nutt., *Echinacea purpurea* (L.) Moench): a review of their chemistry, pharmacology and clinical properties. *J. Pharm. Pharmacol.* 57, 929–954. [Echinacea species \(Echinacea angustifolia \(DC.\) Hell., Echinacea pallida \(Nutt.\) Nutt., Echinacea purpurea \(L.\) Moench\): a review of their chemistry, pharmacology and clinical properties | Journal of Pharmacy and Pharmacology | Oxford Academic](#)

[Bates, B.; Lennox, A.; Prentice, A.; Bates, C.; Page, P.; Nicholson, S.; Swan, G. \(2014\) National Diet and Nutrition Survey Results from Years 1, 2, 3 and 4 \(combined\) of the Rolling Programme \(2008/2009 – 2011/2012\) Main heading \(publishing.service.gov.uk\)](#)

[Bates, B.; Cox, L.; Nicholson, S.; Page, P.; Prentice, A.; Steer, T.; Swan, G. \(2016\) National Diet and Nutrition Survey Results from Years 5 and 6 \(combined\) of the Rolling Programme \(2012/2013 – 2013/2014\) Main heading \(publishing.service.gov.uk\)](#)

Binns, S.E., Hudson, J., Merali, S., Arnason, J.T. (2002). Antiviral Activity of Characterized Extracts from *Echinacea* spp. (Heliantheae: Asteraceae) against Herpes simplex Virus (HSV-I). *Planta Med.* 68, 780–783. [Thieme E-Journals - Planta Medica / Abstract](#)

Blumenthal, M., Busse, W.R., Bundesinstitut für Arzneimittel und Medizinprodukte (Eds.), (1999). The Complete German Commission E monographs: therapeutic guide to herbal medicines, Reprint. ed. American Botanical Council [u.a.], Austin, Texas.

Buettner, C., Mukamal, K.J., Gardiner, P., Davis, R.B., Phillips, R.S., Mittleman, M.A., (2009). Herbal Supplement Use and Blood Lead Levels of United States Adults. J. Gen. Intern. Med. 24, 1175–1182. [Herbal Supplement Use and Blood Lead Levels of United States Adults | Journal of General Internal Medicine](#)

Burger, R.A., Torres, A.R., Warren, R.P., Caldwell, V.D., Hughes, B.G. (1997). *Echinacea*-induced cytokine production by human macrophages. Int. J. Immunopharmacol. 19, 371–379. [https://doi.org/10.1016/S0192-0561\(97\)00061-1](https://doi.org/10.1016/S0192-0561(97)00061-1)

Burlou-Nagy, C., Bănică, F., Jurca, T., Vicaș, L.G., Marian, E., Muresan, M.E., Bácskay, I., Kiss, R., Fehér, P., Pallag, A. (2022). *Echinacea purpurea* (L.) Moench: Biological and Pharmacological Properties. A Review. Plants 11, 1244. <https://doi.org/10.3390/plants11091244>

Chow, G., Johns, T., Miller, S.C. (2006). Dietary *Echinacea purpurea* during Murine Pregnancy: Effect on Maternal Hemopoiesis and Fetal Growth. Neonatology 89, 133–138. <https://doi.org/10.1159/000088795>

Clifford, L.J., Nair, M.G., Rana, J., Dewitt, D.L. (2002). Bioactivity of alkylamides isolated from *Echinacea purpurea* (L.) Moench. Phytomedicine 9, 249–253. <https://doi.org/10.1078/0944-7113-00105>

Committee on herbal medicinal products (HMPC) (2007). Community list entry on *Echinacea purpurea* (L.) Moench, herba recens. [Community list entry Echinaceae purpureae \(L.\) Moench, herba recens \(europa.eu\)](#)

Currier, N., 2000. Natural killer cells from aging mice treated with extracts from *Echinacea purpurea* are quantitatively and functionally rejuvenated. Exp. Gerontol. 35, 627–639. [https://doi.org/10.1016/S0531-5565\(00\)00106-6](https://doi.org/10.1016/S0531-5565(00)00106-6)

Currier, N.L., Miller, S.C. (2002). The Effect of Immunization with Killed Tumor Cells, with/Without Feeding of *Echinacea purpurea* in an Erythroleukemic Mouse Model. J. Altern. Complement. Med. 8, 49–58. <https://doi.org/10.1089/107555302753507177>

Cuzzolin, L., Francini-Pesenti, F., Verlato, G., Joppi, M., Baldelli, P., Benoni, G. (2010). Use of herbal products among 392 Italian pregnant women: focus on pregnancy outcome. Pharmacoepidemiol. Drug Saf. 19, 1151–1158. <https://doi.org/10.1002/pds.2040>

Dabbou, S., Rotolo, L., Kovitvadhi, A., Bergagna, S., Dezzutto, D., Barbero, R., Rubiolo, P., Schiavone, A., De Marco, M., Helal, A.N., Zoccarato, I., Gasco, L.

(2016). Rabbit dietary supplementation with pale purple coneflower. 1. Effects on the reproductive performance and immune parameters of does. *Animal* 10, 1101–1109. <https://doi.org/10.1017/S1751731115002979>

Dapas, B., Dall'Acqua, S., Bulla, R., Agostinis, C., Perissutti, B., Invernizzi, S., Grassi, G., Voinovich, D. (2014). Immunomodulation mediated by a herbal syrup containing a standardized *Echinacea* root extract: A pilot study in healthy human subjects on cytokine gene expression. *Phytomedicine* 21, 1406–1410. <https://doi.org/10.1016/j.phymed.2014.04.034>

De Fougères, A.R., Baines, M.G. (1987). Modulation of the natural killer cell activity in pregnant mice alters the spontaneous abortion rate. *J. Reprod. Immunol.* 11, 147–153. [https://doi.org/10.1016/0165-0378\(87\)90018-0](https://doi.org/10.1016/0165-0378(87)90018-0)

Di Lorenzo, C., Ceschi, A., Kupferschmidt, H., Lüde, S., De Souza Nascimento, E., Dos Santos, A., Colombo, F., Frigerio, G., Nørby, K., Plumb, J., Finglas, P., Restani, P. (2015). Adverse effects of plant food supplements and botanical preparations: a systematic review with critical evaluation of causality. *Br. J. Clin. Pharmacol.* 79, 578–592. <https://doi.org/10.1111/bcp.12519>

EMA (2012): Assessment report on *Echinacea angustifolia* DC., radix. EMA/HMPC/688212/2008. [Assessment report on Echinacea angustifolia DC., radix \(europa.eu\)](https://www.ema.europa.eu/assessments/assessment-report-on-echinacea-angustifolia-dc-radix)

EMA (2014): Assessment report on *Echinacea purpurea* (L.) Moench., herba recens. EMA/HMPC/557979/2013. [Assessment report on Echinacea purpurea \(L.\) Moench., herba recens \(europa.eu\)](https://www.ema.europa.eu/assessments/assessment-report-on-echinacea-purpurea-l-moench-herba-recens)

EMA (2018): Assessment report on *Echinacea pallida* (Nutt.) Nutt., radix. EMA/HMPC/737379/2017. [Assessment report on Echinacea pallida \(Nutt.\) Nutt., radix \(europa.eu\)](https://www.ema.europa.eu/assessments/assessment-report-on-echinacea-pallida-nutt-nutt-radix)

EMA monograph (2012): Community herbal monograph on *Echinacea angustifolia* DC., radix. EMA/HMPC/688216/2008. [Community herbal monograph on Echinacea angustifolia DC., radix \(europa.eu\)](https://www.ema.europa.eu/assessments/community-herbal-monograph-on-echinacea-angustifolia-dc-radix)

EMA monograph (2014): European Union herbal monograph on *Echinacea purpurea* (L.) Moench, herba recens. (EMA/HMPC/104945/2006. [European Union herbal monograph on Echinacea purpurea \(L.\) Moench, herba recens \(europa.eu\)](https://www.ema.europa.eu/assessments/european-union-herbal-monograph-on-echinacea-purpurea-l-moench-herba-recens)

EMA monograph (2017): European Union herbal monograph on *Echinacea purpurea* (L.) Moench, radix. EMA/HMPC/577784/2008. [European Union herbal monograph on Echinacea purpurea \(L.\) Moench, radix \(europa.eu\)](https://www.ema.europa.eu/assessments/european-union-herbal-monograph-on-echinacea-purpurea-l-moench-radix)

[monograph on Echinacea purpurea \(L.\) Moench, radix \(europa.eu\)](#)

EMA monograph (2018): European Union herbal monograph on *Echinacea pallida* (Nutt.) Nutt., radix. (EMA/HMPC/332350/2008. [European Union herbal monograph on Echinacea pallida \(Nutt.\) Nutt., radix \(europa.eu\)](#))

Espinosa-Paredes, D.A., Cornejo-Garrido, J., Moreno-Eutimio, M.A., Martínez-Rodríguez, O.P., Jaramillo-Flores, M.E., Ordaz-Pichardo, C. (2021). *Echinacea Angustifolia* DC Extract Induces Apoptosis and Cell Cycle Arrest and Synergizes with Paclitaxel in the MDA-MB-231 and MCF-7 Human Breast Cancer Cell Lines. Nutr. Cancer 73, 2287–2305. <https://doi.org/10.1080/01635581.2020.1817956>

Filipiak-Szok, A., Kurzawa, M., Szłyk, E. (2015). Determination of toxic metals by ICP-MS in Asiatic and European medicinal plants and dietary supplements. J. Trace Elem. Med. Biol. 30, 54–58. <https://doi.org/10.1016/j.jtemb.2014.10.008>

Fonseca, F.N., Papanicolaou, G., Lin, H., Lau, C.B.S., Kennelly, E.J., Cassileth, B.R., Cunningham-Rundles, S. (2014). *Echinacea purpurea* (L.) Moench modulates human T-cell cytokine response. Int. Immunopharmacol. 19, 94–102. <https://doi.org/10.1016/j.intimp.2013.12.019>

Fusco, D., Liu, X., Savage, C., Taur, Y., Xiao, W., Kennelly, E., Yuan, J., Cassileth, B., Salvatore, M., Papanicolaou, G.A. (2010). *Echinacea purpurea* aerial extract alters course of influenza infection in mice. Vaccine 28, 3956–3962. <https://doi.org/10.1016/j.vaccine.2010.03.047>

Gallo, M., Sarkar, M., Au, W., Pietrzak, K., Comas, B., Smith, M., Jaeger, T.V., Einarson, A., Koren, G. (2000). Pregnancy Outcome Following Gestational Exposure to *Echinacea*: A Prospective Controlled Study. Arch. Intern. Med. 160, 3141.: [Pregnancy Outcome Following Gestational Exposure to Echinacea: A Prospective Controlled Study | Complementary and Alternative Medicine | JAMA Internal Medicine | JAMA Network](#)

Gan, X.-H., Zhang, L., Heber, D., Bonavida, B. (2003). Mechanism of activation of human peripheral blood NK cells at the single cell level by *Echinacea* water soluble extracts: recruitment of lymphocyte–target conjugates and killer cells and activation of programming for lysis. Int. Immunopharmacol. 3, 811–824. [https://doi.org/10.1016/S1567-5769\(02\)00298-9](https://doi.org/10.1016/S1567-5769(02)00298-9)

Gendron, R.L., Baines, M.G. (1988). Infiltrating decidual natural killer cells are associated with spontaneous abortion in mice. Cell. Immunol. 113, 261–267. [https://doi.org/10.1016/0008-8749\(88\)90025-1](https://doi.org/10.1016/0008-8749(88)90025-1)

George, L., Ioannis, E., Radostina, T., Antonios, M. (2006). Severe thrombotic thrombocytopenic purpura (TTP) induced or exacerbated by the immunostimulatory herb *Echinacea*. Am. J. Hematol. 81, 224–224.

<https://doi.org/10.1002/ajh.20531>

Goel, V., Chang, C., Slama, J.V., Barton, R., Bauer, R., Gahler, R., Basu, T.K. (2002). *Echinacea* stimulates macrophage function in the lung and spleen of normal rats. J. Nutr. Biochem. 13, 487–492. [https://doi.org/10.1016/S0955-2863\(02\)00190-0](https://doi.org/10.1016/S0955-2863(02)00190-0)

Gorski, J. (2004). The effect of echinacea (*Echinacea purpurea* root) on cytochrome P450 activity *in vivo*. Clin. Pharmacol. Ther. 75, 89–100.

<https://doi.org/10.1016/j.clpt.2003.09.013>

Gurley, B., Gardner, S., Hubbard, M., Williams, D., Gentry, W., Carrier, J., Khan, I., Edwards, D., Shah, A. (2004). *In vivo* assessment of botanical supplementation on human cytochrome P450 phenotypes: *Citrus aurantium*, *Echinacea purpurea*, milk thistle, and saw palmetto. Clin. Pharmacol. Ther. 76, 428–440.

<https://doi.org/10.1016/j.clpt.2004.07.007>

Gurley, B.J., Swain, A., Hubbard, M.A., Williams, D.K., Barone, G., Hartsfield, F., Tong, Y., Carrier, D.J., Cheboyina, S., Battu, S.K. (2008). Clinical assessment of CYP2D6-mediated herb-drug interactions in humans: Effects of milk thistle, black cohosh, goldenseal, kava kava, St. John's wort, and *Echinacea*. Mol. Nutr. Food Res. 52, 755–763. <https://doi.org/10.1002/mnfr.200600300>

Hall, H.G., Griffiths, D.L., McKenna, L.G. (2011). The use of complementary and alternative medicine by pregnant women: A literature review. Midwifery 27, 817–824. <https://doi.org/10.1016/j.midw.2010.08.007>

Hansen, T.S., Nilsen, O.G. (2009). *Echinacea purpurea* and P-glycoprotein drug transport in Caco-2 cells. Phytother. Res. 23, 86–91.

<https://doi.org/10.1002/ptr.2563>

Heitmann, K., Havnen, G.C., Holst, L., Nordeng, H. (2016). Pregnancy outcomes after prenatal exposure to *Echinacea*: the Norwegian Mother and Child Cohort Study. Eur. J. Clin. Pharmacol. 72, 623–630. [Pregnancy outcomes after prenatal exposure to echinacea: the Norwegian Mother and Child Cohort Study | European Journal of Clinical Pharmacology](https://doi.org/10.1007/s00228-016-2000-0)

Hellum, B.H., Hu, Z., Nilsen, O.G. (2007). The Induction of CYP1A2, CYP2D6 and CYP3A4 by Six Trade Herbal Products in Cultured Primary Human Hepatocytes.

Basic Clin. Pharmacol. Toxicol. 100, 23–30. <https://doi.org/10.1111/j.1742-7843.2007.00011.x>

Hellum, B.H., Nilsen, O.G. (2007). The *in vitro* Inhibitory Potential of Trade Herbal Products on Human CYP2D6-Mediated Metabolism and the Influence of Ethanol. Basic Clin. Pharmacol. Toxicol. 101, 350–358. <https://doi.org/10.1111/j.1742-7843.2007.00121.x>

HMR 2012: The Human Medicines Regulations 2012. [The Human Medicines Regulations 2012 \(legislation.gov.uk\)](#)

Holst, L., Wright, D., Haavik, S., Nordeng, H. (2011). Safety and efficacy of herbal remedies in obstetrics—review and clinical implications. *Midwifery* 27, 80–86.
<https://doi.org/10.1016/j.midw.2009.05.010>

Hudson, J., Vimalanathan, S., Kang, L., Amiguet, V.T., Livesey, J., Arnason, J.T. (2005). Characterization of Antiviral Activities in *Echinacea* Root Preparations. Pharm. Biol. 43, 790–796. <https://doi.org/10.1080/13880200500408491>

Hudson, J.B. (2012). Applications of the Phytomedicine *Echinacea purpurea* (Purple Coneflower) in Infectious Diseases. J. Biomed. Biotechnol. 1-16.
<https://doi.org/10.1155/2012/769896>

Huntley, A.L., Thompson Coon, J., Ernst, E. (2005). The Safety of Herbal Medicinal Products Derived from *Echinacea* Species: A Systematic Review. Drug Saf. 28, 387–400. [The Safety of Herbal Medicinal Products Derived from Echinacea Species | Drug Safety](#)

Husain, I., Dale, O.R., Martin, K., Gurley, B.J., Adams, S.J., Avula, B., Chittiboyina, A.G., Khan, I.A., Khan, S.I. (2023). Screening of medicinal plants for possible herb-drug interactions through modulating nuclear receptors, drug-metabolizing enzymes and transporters. *J. Ethnopharmacol.* 301, 115822.
<https://doi.org/10.1016/j.jep.2022.115822>

Jacobsson, I., Jönsson, A.K., Gerdén, B., Hägg, S. (2009). Spontaneously reported adverse reactions in association with complementary and alternative medicine substances in Sweden. *Pharmacoepidemiol. Drug Saf.* 18, 1039–1047.
<https://doi.org/10.1002/pds.1818>

Jawad, M., Schoop, R., Suter, A., Klein, P., Eccles, R. (2012). Safety and Efficacy Profile of *Echinacea purpurea* to Prevent Common Cold Episodes: A Randomized, Double-Blind, Placebo-Controlled Trial. *Evid. Based Complement. Alternat. Med.*

2012, 1–7. <https://doi.org/10.1155/2012/841315>

Jeong, J.-S., Kim, J.-W., Kim, J.-H., Chung, E.-H., Lee, D.-R., Choi, B.-K., Ko, J.-W., Kim, T.-W. (2024). Oral toxicity and genotoxicity assessment of standardized *Echinacea purpurea* (L.) extract and the pharmacokinetic profile of its active ingredient chicoric acid. *Toxicol. Res.* 40, 457–472. [Oral toxicity and genotoxicity assessment of standardized Echinacea purpurea \(L.\) extract and the pharmacokinetic profile of its active ingredient chicoric acid | Toxicological Research](#)

Kemp, D.E., Franco, K.N. (2002). Possible leukopenia associated with long-term use of *Echinacea*. *J. Am. Board Fam. Pract.* 15, 417.

Khaksary Mahabady, M., Ranjbar, R., Arzi, A., Papahn, A.A., Najafzadeh, H. (2006). A comparison study of effects of *Echinacea* extract and levamisole on phenytoin-induced cleft palate in mice. *Regul. Toxicol. Pharmacol.* 46, 163–166. <https://doi.org/10.1016/j.yrtph.2006.06.005>

Kocaman, O., Hulagu, S., Senturk, O. (2008). *Echinacea*-induced severe acute hepatitis with features of cholestatic autoimmune hepatitis. *Eur. J. Intern. Med.* 19, 148. [Echinacea-induced severe acute hepatitis with features of cholestatic autoimmune hepatitis - European Journal of Internal Medicine](#)

Kovitvadhi, A., Gai, F., Dabbou, S., Ferrocino, I., Rotolo, L., Falzone, M., Vignolini, C., Gennero, M.S., Bergagna, S., Dezzutto, D., Barbero, R., Nebbia, P., Rosati, S., Cocolin, L., Zoccarato, I., Gasco, L. (2016). Rabbit dietary supplementation with pale purple coneflower. 2. Effects on the performances, bacterial community, blood parameters and immunity of growing rabbits. *Animal* 10, 1110–1117. <https://doi.org/10.1017/S1751731115002980>

Lee, A.N., Werth, V.P. (2004). Activation of Autoimmunity Following Use of Immunostimulatory Herbal Supplements. *Arch. Dermatol.* 140. [Activation of Autoimmunity Following Use of Immunostimulatory Herbal Supplements | Complementary and Alternative Medicine | JAMA Dermatology | JAMA Network](#)

Lee Soon, S., Crawford, R.I. (2001). Recurrent erythema nodosum associated with *Echinacea* herbal therapy. *J. Am. Acad. Dermatol.* 44, 298–299. [Recurrent erythema nodosum associated with echinacea herbal therapy - Journal of the American Academy of Dermatology](#)

Lenk, W. (1989). Akute Toxizität von verschiedenen Polysacchariden *Echinacea purpurea* an der Maus. [Acute toxicity of various polysaccharides from *Echinacea purpurea* in mice.]

purpurea in the mouse.]. *Zeitschrift fur Phytotherapie*, 10, pp.49-51.

Li, Y., Wang, Y., Wu, Y., Wang, B., Chen, X., Xu, X., Chen, H., Li, W., Xu, Xiaogang, (2017). *Echinacea purpurea* extracts promote murine dendritic cell maturation by activation of JNK, p38 MAPK and NF- κ B pathways. *Dev. Comp. Immunol.* 73, 21–26. <https://doi.org/10.1016/j.dci.2017.03.002>

Maass, N., Bauer, J., Paulicks, B.R., Böhmer, B.M., Roth-Maier, D.A. (2005). Efficiency of *Echinacea purpurea* on performance and immune status in pigs. *J. Anim. Physiol. Anim. Nutr.* 89, 244–252. <https://doi.org/10.1111/j.1439-0396.2005.00501.x>

Mahajan, D., Sharma, N. R., Kancharla, S., Kolli, P., Tripathy, A., Sharma, A. K., Singh, S., Kumar, S., Mohanty, A. K., & Jena, M. K. (2022). Role of Natural Killer Cells during Pregnancy and Related Complications. *Biomolecules*, 12(1), 68. <https://doi.org/10.3390/biom12010068>

Maskatia, Z.K., Baker, K. (2010). Hypereosinophilia Associated with *Echinacea* Use: *South. Med. J.* 103, 1173–1174. <https://doi.org/10.1097/smj.0b013e3181f1ed8b>

Matthias, A., Merika, H., Addison, R., Bone, K., Lehmann, R. (2008). Bioavailability of *Echinacea* alkylamides in human breast milk. *Planta Med.* 74, s-0028-1083939. <https://doi.org/10.1055/s-0028-1083939>

Melchart D, Linde K, Worku F, Sarkady L, Holzmann M, Jurcic K, Wagner H (1995). Results of five randomized studies on the immunomodulatory activity of preparations of *Echinacea*. *J Altern Complement Med.* Summer;1(2):145-60. [doi: 10.1089/acm.1995.1.145](https://doi.org/10.1089/acm.1995.1.145). PMID: 9395611.

Melchart, D. (1998). *Echinacea* Root Extracts for the Prevention of Upper Respiratory Tract Infections: A Double-blind, Placebo-Controlled Randomized Trial. *Arch. Fam. Med.* 7, 541–545. <https://doi.org/10.1001/archfami.7.6.541>

Mengs, U., Clare, C.B., Poiley, J.A. (1991). Toxicity of *Echinacea purpurea*. Acute, subacute and genotoxicity studies. *Arzneimittelforschung.* 41, 1076–1081.

Merali, S., Binns, S., Paulin-Levasseur, M., Ficker, C., Smith, M., Baum, B., Brovelli, E., Arnason, J.T. (2003). Antifungal and Anti-inflammatory Activity of the Genus *Echinacea*. *Pharm. Biol.* 41, 412–420. <https://doi.org/10.1076/phbi.41.6.412.17828>

Modarai, M., Gertsch, J., Suter, A., Heinrich, M., Kortenkamp, A. (2010). Cytochrome P450 inhibitory action of *Echinacea* preparations differs widely and co-varies with alkylamide content. J. Pharm. Pharmacol. 59, 567–573.
<https://doi.org/10.1211/jpp.59.4.0012>

Mrozikiewicz, P.M., Bogacz, A., Karasiewicz, M., Mikołajczak, P.L., Ozarowski, M., Seremak-Mrozikiewicz, A., Czerny, B., Bobkiewicz-Kozłowska, T., Grzeskowiak, E.(2010). The effect of standardized *Echinacea purpurea* extract on rat cytochrome P450 expression level. Phytomedicine 17, 830–833.
<https://doi.org/10.1016/j.phymed.2010.02.007>

Mullins, R.J. (1998). *Echinacea*-associated anaphylaxis. Med. J. Aust. 168, 170–171. <https://doi.org/10.5694/j.1326-5377.1998.tb126773.x>

Mullins, R.J., Heddle, R. (2002). Adverse reactions associated with *Echinacea*: the Australian experience. Ann. Allergy. Asthma. Immunol. 88, 42–51.
[https://doi.org/10.1016/S1081-1206\(10\)63591-0](https://doi.org/10.1016/S1081-1206(10)63591-0)

Nordeng, H., Bayne, K., Havnen, G.C., Paulsen, B.S. (2011). Use of herbal drugs during pregnancy among 600 Norwegian women in relation to concurrent use of conventional drugs and pregnancy outcome. Complement. Ther. Clin. Pract. 17, 147–151. <https://doi.org/10.1016/j.ctcp.2010.09.002>

Ondrizek, R.R., Chan, P.J., Patton, W.C., King, A. (1999). Inhibition of Human Sperm Motility by Specific Herbs Used in Alternative Medicine. J. Assist. Reprod. Genet. 16, 87–91. <https://doi.org/10.1023/A:1022568823262>

Penzak, S.R., Robertson, S.M., Hunt, J.D., Chairez, C., Malati, C.Y., Alfaro, R.M., Stevenson, J.M., Kovacs, J.A. (2010). *Echinacea purpurea* Significantly Induces Cytochrome P450 3A Activity but Does Not Alter Lopinavir-Ritonavir Exposure in Healthy Subjects. Pharmacother. J. Hum. Pharmacol. Drug Ther. 30, 797–805.
<https://doi.org/10.1592/phco.30.8.797>

Perri D, Dugoua JJ, Mills E, Koren G. (2006): Safety and efficacy of *Echinacea* (*Echinacea angustifolia*, *E. purpurea* and *E. pallida*) during pregnancy and lactation. Can J Clin Pharmacol, 13(3): e262-267.

Pilarska, G., Twarużek, M., Altyń, I. (2022). The Presence of Molds and Their Secondary Metabolites in Purple Coneflower-Based Dietary Supplements (*Echinacea purpurea* (L.) Moench). Toxins 14, 607.
<https://doi.org/10.3390/toxins14090607>

Pleschka, S., Stein, M., Schoop, R., Hudson, J.B. (2009). Anti-viral properties and mode of action of standardized *Echinacea purpurea* extract against highly pathogenic avian Influenza virus (H5N1, H7N7) and swine-origin H1N1 (S-OIV). Virol. J. 6, 197. <https://doi.org/10.1186/1743-422X-6-197>

Raman, P., Patino, L.C., Nair, M.G. (2004). Evaluation of Metal and Microbial Contamination in Botanical Supplements. J. Agric. Food Chem. 52, 7822–7827. <https://doi.org/10.1021/jf049150>

Raner, G.M., Cornelious, S., Moulick, K., Wang, Y., Mortenson, A., Cech, N.B. (2007). Effects of herbal products and their constituents on human cytochrome P4502E1 activity. Food Chem. Toxicol. 45, 2359–2365. <https://doi.org/10.1016/j.fct.2007.06.012>

Rininger, J.A., Kickner, S., Chigurupati, P., McLean, A., Franck, Z. (2002). Immunopharmacological activity of *Echinacea* preparations following simulated digestion on murine macrophages and human peripheral blood mononuclear cells. J. Leukoc. Biol. 68, 503–510. <https://doi.org/10.1189/jlb.68.4.503>

[Roberts, C.; Steer, T.; Maplethorpe, N.; Cox, L.; Meadows, S.; Page, P.; Nicholson, S.; Swan, G. \(2018\) National Diet and Nutrition Survey Results from Years 7 and 8 \(combined\) of the Rolling Programme \(2014/2015 – 2015/2016\) National Diet and Nutrition Survey \(publishing.service.gov.uk\)](https://www.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681112/national-diet-and-nutrition-survey-results-from-years-7-and-8-combined-2014-2015-2015-2016.pdf)

Rondanelli, M., Miccono, A., Lamburghini, S., Avanzato, I., Riva, A., Allegrini, P., Faliva, M.A., Peroni, G., Nichetti, M., Perna, S. (2018). Self-Care for Common Colds: The Pivotal Role of Vitamin D, Vitamin C, Zinc, and *Echinacea* in Three Main Immune Interactive Clusters (Physical Barriers, Innate and Adaptive Immunity) Involved during an Episode of Common Colds—Practical Advice on Dosages and on the Time to Take These Nutrients/Botanicals in order to Prevent or Treat Common Colds. Evid. Based Complement. Alternat. Med. 2018, 1–36. <https://doi.org/10.1155/2018/5813095>

Schapowal, A., Klein, P., Johnston, S.L. (2015). *Echinacea* Reduces the Risk of Recurrent Respiratory Tract Infections and Complications: A Meta-Analysis of Randomized Controlled Trials. Adv. Ther. 32, 187–200. <https://doi.org/10.1007/s12325-015-0194-4>

See, D.M., Broumand, N., Sahl, L., Tilles, J.G. (1997). *In vitro* effects of *Echinacea* and ginseng on natural killer and antibody-dependent cell cytotoxicity in healthy subjects and chronic fatigue syndrome or acquired immunodeficiency syndrome patients. Immunopharmacology 35, 229–235. <https://doi.org/10.1016/S0162->

Sharma, M., Anderson, S.A., Schoop, R., Hudson, J.B. (2009). Induction of multiple pro-inflammatory cytokines by respiratory viruses and reversal by standardized *Echinacea*, a potent antiviral herbal extract. *Antiviral Res.* 83, 165–170.

<https://doi.org/10.1016/j.antiviral.2009.04.009>

Signer, J., Jonsdottir, H.R., Albrich, W.C., Strasser, M., Züst, R., Ryter, S., Ackermann-Gäumann, R., Lenz, N., Siegrist, D., Suter, A., Schoop, R., Engler, O.B. (2020). *In vitro* virucidal activity of Echinaforce®, an *Echinacea purpurea* preparation, against coronaviruses, including common cold coronavirus 229E and SARS-CoV-2. *Viol. J.* 17, 136. <https://doi.org/10.1186/s12985-020-01401-2>

Svedlund, E., Larsson, M., Hägerkvist, R. (2017). Spontaneously Reported Adverse Reactions for Herbal Medicinal Products and Natural Remedies in Sweden 2007–15: Report from the Medical Products Agency. *Drugs - Real World Outcomes* 4, 119–125. <https://doi.org/10.1007/s40801-017-0104-y>

Tournas, V.H. (2009). Microbial contamination of select dietary supplements. *J. Food Saf.* 29, 430–442. <https://doi.org/10.1111/j.1745-4565.2009.00167.x>

Tsai, Y.-L., Chiou, S.-Y., Chan, K.-C., Sung, J.-M., Lin, S.-D. (2012a). Caffeic acid derivatives, total phenols, antioxidant and antimutagenic activities of *Echinacea purpurea* flower extracts. *LWT - Food Sci. Technol.* 46, 169–176. <https://doi.org/10.1016/j.lwt.2011.09.026>

Tsai, Y.-L., Chiu, C.-C., Yi-Fu Chen, J., Chan, K.-C., Lin, S.-D. (2012b). Cytotoxic effects of *Echinacea purpurea* flower extracts and chicoric acid on human colon cancer cells through induction of apoptosis. *J. Ethnopharmacol.* 143, 914–919. <https://doi.org/10.1016/j.jep.2012.08.032>

Upton, R. (Ed.) (2007). *Echinacea purpurea* aerial parts: *Echinacea purpurea* (L.) Moench ; standards of analysis, quality control, and therapeutics, American herbal pharmacopoeia and therapeutic compendium. American Herbal Pharmacopoeia, Scotts Valley, CA.

Vimalanathan, S., Kang, L., Amiguet, V.T., Livesey, J., Arnason, J.T., Hudson, J. (2005). *Echinacea purpurea*. Aerial Parts Contain Multiple Antiviral Compounds. *Pharm. Biol.* 43, 740–745. <https://doi.org/10.1080/13880200500406354>

Vonau, B., Chard, S., Mandalia, S., Wilkinson, D., Barton, S.E. (2001). Does the extract of the plant *Echinacea purpurea* influence the clinical course of recurrent

genital herpes? Int. J. STD AIDS 12, 154–158.

<https://doi.org/10.1258/0956462011916947>

Yale, S.H., Glurich, I. (2005). Analysis of the Inhibitory Potential of Ginkgo biloba, *Echinacea purpurea*, and *Serenoa repens* on the Metabolic Activity of Cytochrome P450 3A4, 2D6, and 2C9. J. Altern. Complement. Med. 11, 433–439.

<https://doi.org/10.1089/acm.2005.11.433>

WHO (1999). Radix echinaceae. In: WHO monographs on selected medicinal plants, Vol. 1, WHO Geneva 1999, Switzerland: 128-135. [WHO monographs on selected medicinal plants](#)

Zhai, Z., Liu, Y., Wu, L., Senchina, D.S., Wurtele, E.S., Murphy, P.A., Kohut, M.L., Cunnick, J.E. (2007). Enhancement of Innate and Adaptive Immune Functions by Multiple Echinacea Species. J. Med. Food 10, 423–434.

<https://doi.org/10.1089/jmf.2006.257>