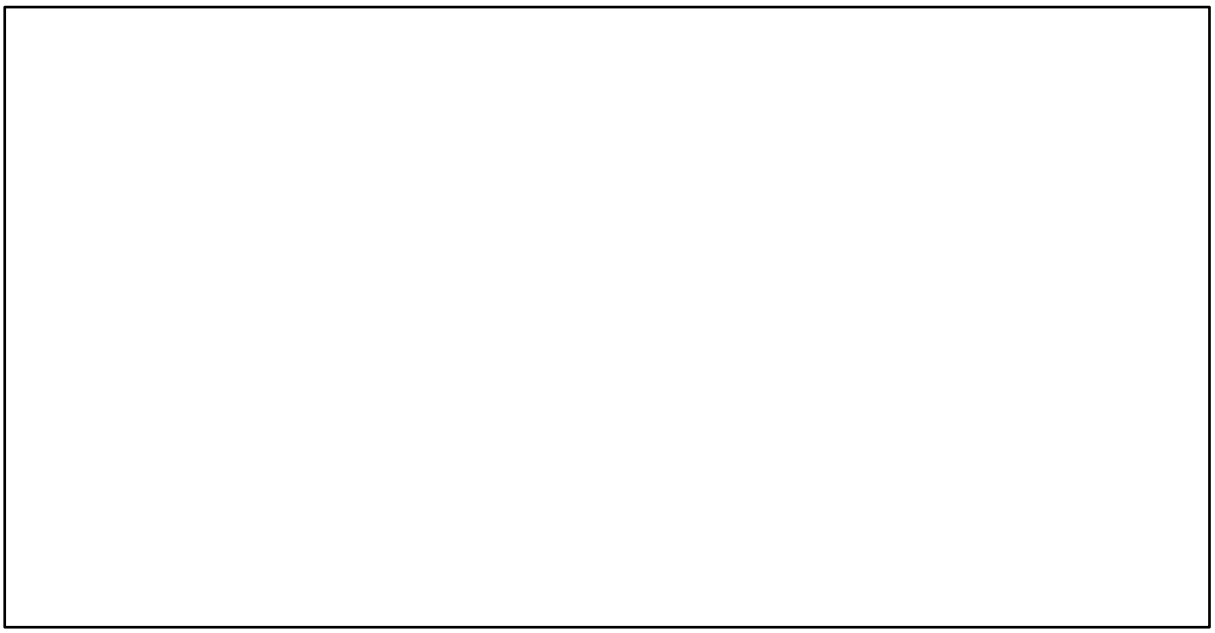
Activity of Syringic Acid on HT-29 cells revealed that Syringic acid exhibits therapeutic effects on colorectal cancer [37]. There are also reports that Syringic acid has the potential to induce cytotoxicity in the human hepatoma HepG2 cell line through reactive oxygen species-mediated mechanisms [38]. Syringic acid exerted inhibitory effects on the proliferation, invasion, and migration of glioblastoma cells by suppressing the expression of matrix metalloproteinases, ultimately promoting apoptosis [39].

Antimicrobial activity: Phenolic compounds, both natural and synthetic, are being explored for their potential use in food preservation, pharmaceuticals, and other applications where antimicrobial properties are desirable. The antimicrobial activity of phenolic compounds can vary depending on factors such as the specific compound, concentration, and the type of microorganism targeted. Syringic acid has also been investigated for its potential antimicrobial properties. The phenolic structure of syringic acid (SA) imparts antimicrobial activity against a variety of microorganisms. Studies have indicated that SA, extracted from diverse mushroom species, exhibits antibacterial effects against both Gram-negative and Gram-positive bacteria. Research investigating the antimicrobial potential of syringic acid against *Cronobacter sakazakii* demonstrated its ability to impede bacterial growth. This effect was accompanied by disruptions in cell membrane functionality, evidenced by a decrease in intracellular ATP concentration, a reduction in intracellular pH, hyperpolarization of the cell membrane, and alterations in cellular morphology. These results suggest that syringic acid holds promise for development as a natural preservative to manage *Cronobacter sakazakii* in food products, thereby aiding in the prevention of related infections [40]. Syringic acid possesses the capability to combat biofilms formed by methicillin-resistant *S. epidermidis* bacterial strains. Combined with antibiotics, it can potentially reduce the prevalence of nosocomial infections [41].

Hepatoprotective effects: Syringic acid has been investigated for its hepatoprotective effects, indicating its potential to safeguard the liver from various insults and damage. Syringic acid could effectively hinder the activation of cultured hepatic stellate cells, which are pivotal contributors to liver fibrogenesis. The administration of Syringic acid demonstrated the capacity to mitigate hepatic fibrosis in the context of chronic liver injury [42]. The investigation into the impact of Syringic acid (SA) on acetaminophen (APAP)-induced hepatotoxicity in rats demonstrated that Syringic acid effectively reduced lipid peroxidation markers while enhancing the activity of enzymatic antioxidants in the liver. These results show that Syringic acid significantly protects against APAP-induced hepatic injury in rats [43]. Syringic acid exhibits hepatoprotective effects against hepatic encephalopathy by alleviating hepatotoxicity biomarkers. It exhibits antioxidant and anti-inflammatory characteristics, as well as effectively controlling hyperammonemia [44]. Cirrhosis and hepatocellular carcinoma stand as the leading causes of mortality in individuals with diabetes. Reports indicate that Syringic acid can potentially alleviate hepatic damage caused by chronic hyperglycemia in Wistar rats [17]. Syringic Acid (SA) exhibited robust hepatoprotective effects against depletion of endogenous antioxidant enzymes induced by Methyl cellosolve (MECE). It also hindered MECE-induced cytosolic Nrf2 activation and the inhibition of antioxidant response element (ARE)-dependent genes in rats [45]. Reports show that SA can effectively inhibit



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supplements may offer additional health benefits due to the synergistic effects of other compounds in those foods.

Abbreviations: APAP- Acetaminophen, ARE-antioxidant response element, CAD-cinnamyl alcohol dehydrogenase, CCR- cinnamoyl-CoA reductase, C4H-Cinnamate 4-hydroxylase, C5H- Coniferaldehyde 5-hydroxylase, CAT-catalase, DPPH- 2,2-diphenyl-1-picrylhydrazyl radicals, DTM- Deltamethrin, GPx-Glutathione peroxidase, GRD- Glutathione reductase, LPS- lipopolysaccharides NF-κB -nuclear factor-kappa B, OGD/R- oxygen-glucose deprivation/reoxygenation, PAL-phenylalanine ammonia-lyase, SA-Syringic acid, SOD-Superoxide dismutase

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REFERENCES

1. Zhang Y-J, Gan R-Y, Li S, et al: Antioxidant Phytochemicals for the Prevention and Treatment of Chronic Diseases. Molecules 2015, 20:21138–21156. DOI: https://doi.org/10.3390/molecules201219753
2. Soumya SN, Soumya NPP, Mondal S, Mini S.: Menthol confers neuroprotection through Nrf2/ARE pathway in diabetic encephalopathy. Bioact Compd Heal Dis 2023, 6:108. DOI: https://doi.org/10.31989/bchd.v6i6.1113
3. Martirosyan D, Ekblad M: Functional foods classification system: exemplifying through analysis of bioactive compounds. Funct Food 2022, Sci 2:94. DOI: https://doi.org/10.31989/ffs.v2i4.919
4. Martirosyan DM, Singh J: A new definition of functional food by FFC: What makes a new definition unique? Funct Foods 2015, Heal Dis 5:209–223. DOI: https://doi.org/10.31989/ffhd.v5i6.183
5. Martirosyan D, Lampert T, Lee M: A comprehensive review on the role of food bioactive compounds in functional food science. Funct Food Sci 2022, 2:64. DOI: https://doi.org/10.31989/ffs.v2i3.906
6. Soumya NPP, Mini S, Sivan SK, Mondal S: Bioactive compounds in functional food and their role as therapeutics. Bioact Compd Heal Dis 2021, 4:24–39. DOI: https://doi.org/10.31989/bchd.v4i3.786
7. Augustiniene E, Kutraite I, Valanciene E, et al: Transcription factor-based biosensors for detection of naturally occurring phenolic acids. N Biotechnol 2023, 78:1–12. DOI: https://doi.org/10.1016/j.nbt.2023.09.004
8. Lorigooini Z, Jamshidi-kia F, Hosseini Z: Chapter 4 - Analysis of aromatic acids (phenolic acids and hydroxycinnamic acids). In: Sanches Silva A, Nabavi SF, Saeedi M, Nabavi SM (eds) Recent Advances in Natural Products Analysis. Elsevier; 2020: pp 199–219 DOI: http://dx.doi.org/10.1016/B978-0-12-816455-6.00004-4
9. Stevenson DE, Hurst RD: Polyphenolic phytochemicals--just antioxidants or much more? Cell Mol Life Sci 2007, 64:2900–2916. DOI: https://doi.org/10.1007/s00018-007-7237-1
10. Kumar N, Goel N: Phenolic acids: Natural versatile molecules with promising therapeutic applications. Biotechnol reports (Amsterdam, Netherlands) 2019, 24: e00370. DOI: https://doi.org/10.1016/j.btre.2019.e00370
11. Bartel I, Mandryk I, Horbańczuk JO, et al: Nutraceutical Properties of Syringic Acid in Civilization Diseases—Review. Nutrients 2024,16. DOI: https://doi.org/10.3390/nu16010010
12. R. Giménez Martínez H. López García De La Serrana MVMMNAMOHCCV, Martínez MCL: Study of Vanillin,

Syringaldehyde and Gallic Acid Content in Oak Wood and Wine Spirit Mixtures: Influence of Heat Treatment and Chip Size. J Wine Res 2001, 12:175–182.
DOI: https://doi.org/10.1080/09571260120106811

13. Kuriyama I, Nakajima Y, Nishida H, et al.: Inhibitory effects of low molecular weight polyphenolics from Inonotus obliquus on human DNA topoisomerase activity and cancer cell proliferation. Mol Med Rep 2013, 8:535–542
DOI: https://doi.org/10.3892/mmr.2013.1547
14. Stanikunaite R, Khan SI, Trappe JM, Ross SA: Cyclooxygenase-2 inhibitory and antioxidant compounds from the truffle Elaphomyces granulatus. Phyther Res An Int J Devoted to Pharmacol Toxicol Eval Nat Prod Deriv 2009, 23:575–578
DOI: https://doi.org/10.1002/ptr.2698
15. Abarca-Vargas R, Petricevich VL: Bougainvillea Genus: A Review on Phytochemistry, Pharmacology, and Toxicology. Evid Based Complement Alternat Med 2018, 9070927.
DOI: https://doi.org/10.1155/2018/9070927
16. Adeyi OE, Somade OT, Ajayi BO, et al.: Syringic acid demonstrates better anti-apoptotic, anti-inflammatory, and antioxidative effects than ascorbic acid via maintenance of the endogenous antioxidants and downregulation of pro-inflammatory and apoptotic markers in DMN-induced hepatotoxicity in. Biochem Biophys reports 2023, 33:101428.
DOI: https://doi.org/10.1016/j.bbrep.2023.101428
17. Mirza AC, Panchal SS, Allam AA, et al.: Syringic Acid Ameliorates Cardiac, Hepatic, Renal and Neuronal Damage Induced by Chronic Hyperglycaemia in Wistar Rats: A Behavioural, Biochemical and Histological Analysis. Molecules 2022, 27:6722
DOI: https://doi.org/10.3390/molecules27196722
18. Mishra V, Jana AK, Jana MM, Gupta A: Improvement of selective lignin degradation in fungal pretreatment of sweet sorghum bagasse using synergistic CuSO4-syringic acid supplements. J Environ Manage 2017, 193:558–566.
DOI: https://doi.org/10.1016/j.jenvman.2017.02.057
19. Brauer GM, Stansbury JW: Materials Science Cements Containing Syringic Acid Esters- o-Ethoxybenzoic Acid and Zinc Oxide. J Dent Res 1984, 63:137–140.
DOI: https://doi.org/10.1177/00220345840630020801
20. Karamać M, Kosińska A, Pegg RB: Comparison of radical-scavenging activities for selected phenolic acids. Polish Journal of Food and Nutritional Sciences 2005, 55(2):165-170
http://journal.pan.olsztyn.pl/Issue-2-2005,6554
21. Tohge T, R Fernie A: An overview of compounds derived from the shikimate and phenylpropanoid pathways and their medicinal importance. Mini Rev Med Chem 2017, 17:1013–1027
DOI: https://doi.org/10.2174/1389557516666160624123425
22. Srinivasulu C, Ramgopal M, Ramanjaneyulu G, et al: Syringic acid (SA) – A Review of Its Occurrence, Biosynthesis, Pharmacological and Industrial Importance. Biomed Pharmacother 2018, 108:547–557.
DOI: https://doi.org/10.1016/j.biopha.2018.09.069
23. Sofowora A, Ogunbodede E, Onayade A: The role and place of medicinal plants in the strategies for disease prevention. African J Tradit Complement Altern Med AJTCAM 2013, 10:210–229. DOI: https://doi.org/10.4314/ajtcam.v10i5.2
24. Ham JR, Lee H-I, Choi R-Y, et al: Anti-steatotic and anti-inflammatory roles of syringic acid in high-fat diet-induced obese mice. Food & Funct 2016, 7:689–697
DOI: https://doi.org/10.1039/c5fo01329a
25. Abaza M-S, Al-Attiyah R, Bhardwaj R, et al: Syringic acid from Tamarix aucheriana possesses antimitogenic and chemo-sensitizing activities in human colorectal cancer cells. Pharm Biol 2013, 51:1110–1124.
DOI: https://doi.org/10.3109/13880209.2013.781194
26. Muthukumaran J, Srinivasan S, Venkatesan RS, et al: Syringic acid, a novel natural phenolic acid, normalizes hyperglycemia with special reference to glycoprotein components in experimental diabetic rats. J Acute Dis 2013, 2:304–309.
DOI: https://doi.org/10.1016/s2221-6189(13)60149-3
27. Güven M, Aras AB, Topalo\uglu N, et al: The protective effect of syringic acid on ischemia injury in rat brain. Turkish J Med Sci 2015, 45:233–240
DOI: https://doi.org/10.3906/sag-1402-71
28. Cikman O, Soylemez O, Ozkan OF, et al: Antioxidant Activity of Syringic Acid Prevents Oxidative Stress in l-arginine-Induced Acute Pancreatitis: An Experimental Study on Rats. Int Surg 2015, 100:891–896.
DOI: https://doi.org/10.9738/INTSURG-D-14-00170.1
29. Srivastava N, Srivastava A, Srivastava S, et al.: HPTLC-densitometric determination and kinetic studies on antioxidant potential of monomeric phenolic acids (MPAs) from Bergenia species. RSC Adv 2014, 4:52647–52657
DOI: https://doi.org/10.1039/C4RA09330E
30. Li Y, Zhang L, Wang X, et al: Effect of Syringic acid on antioxidant biomarkers and associated inflammatory markers in mice model of asthma. Drug Dev Res 2019, 80:253–261.
DOI: https://doi.org/https://doi.org/10.1002/ddr.21487

31. Vo Q V, Bay M Van, Nam PC, et al: Theoretical and Experimental Studies of the Antioxidant and Antinitrosant Activity of Syringic Acid. J Org Chem 2020, 85:15514–15520. DOI: https://doi.org/10.1021/acs.joc.0c02258
32. Somade OT, Oyinloye BE, Ajiboye BO, Osukoya OA: Syringic acid demonstrates an anti-inflammatory effect via modulation of the NF-κB-iNOS-COX-2 and JAK-STAT signaling pathways in methyl cellosolve-induced hepato-testicular inflammation in rats. Biochem Biophys reports 2023, 34:101484. DOI: https://doi.org/10.1016/j.bbrep.2023.101484
33. Xiang S, Xiao J: Protective effects of syringic acid on inflammation, apoptosis and intestinal barrier function in Caco-2 cells following oxygen-glucose deprivation/reoxygenation-induced injury. Exp Ther Med 2022, 23:66. DOI: https://doi.org/10.3892/etm.2021.10989
34. Pei J, Velu P, Zareian M, et al: Effects of Syringic Acid on Apoptosis, Inflammation, and AKT/mTOR Signaling Pathway in Gastric Cancer Cells. Front Nutr 2021, 8:788929. DOI: https://doi.org/10.3389/fnut.2021.788929
35. Mihanfar A, Darband SG, Sadighparvar S, et al: In vitro and in vivo anticancer effects of syringic acid on colorectal cancer: Possible mechanistic view. Chem Biol Interact 2021, 337:109337. DOI: https://doi.org/10.1016/j.cbi.2020.109337
36. Lavanya M, Srinivasan P, Padmini R: Unveiling the Anticancer Effect of Syringic Acid and Its Derivatives in Hepatocellular Carcinoma. Int J App Pharm 2023, 15:114–124 DOI: https://doi.org/10.22159/ijap.2023v15i4.47773
37. Burul F, Altunlu Ö, Okkay IF, et al Investigation of the Antitumoral Activity of Syringic Acid on HT-29 Cells: An In Vitro Study. Recent Trends Pharmacol 1:123–130
38. Gheena S, Ezhilarasan D: Syringic acid triggers reactive oxygen species-mediated cytotoxicity in HepG2 cells. Hum \& Exp Toxicol 2019, 38:694–702. DOI: https://doi.org/10.1177/0960327119839173
39. Li D, Luo D, Hu S, et al: Syringic Acid Suppressed Proliferation, Invasion, and Migration via Inhibition of Matrix Metalloproteinases Expression on Glioblastoma Cells by Promoting Apoptosis. Curr Pharm Biotechnol 2023, 24:310–316. DOI: https://doi.org/10.2174/1389201023666220513100129
40. Shi C, Sun Y, Zheng Z, et al.: Antimicrobial activity of syringic acid against Cronobacter sakazakii and its effect on cell membrane. Food Chem 2016, 197:100–106. DOI: https://doi.org/10.1016/j.foodchem.2015.10.100
41. Minich A, Levarski Z, Mikulášová M, et al: Complex Analysis of Vanillin and Syringic Acid as Natural Antimicrobial Agents against Staphylococcus epidermidis Biofilms. Int J Mol 2022, Sci 23. DOI: https://doi.org/10.3390/ijms23031816
42. Itoh A, Isoda K, Kondoh M, et al: Hepatoprotective effect of syringic acid and vanillic acid on CCl4-induced liver injury. Biol Pharm Bull 2010, 33:983–987. DOI: https://doi.org/10.1248/bpb.33.983
43. Ramachandran V, Raja B: Protective effects of syringic acid against acetaminophen-induced hepatic damage in albino rats. J Basic Clin Physiol Pharmacol 2010, 21:369–385. DOI: https://doi.org/10.1515/jbcpp.2010.21.4.369
44. Ferah Okkay I, Okkay U, Gundogdu OL, et al: Syringic acid protects against thioacetamide-induced hepatic encephalopathy: Behavioral, biochemical, and molecular evidence. Neurosci Lett 2022, 769:136385. DOI: https://doi.org/10.1016/j.neulet.2021.136385
45. Somade OT, Oyinloye BE, Ajiboye BO, Osukoya OA: Methyl cellosolve-induced hepatic oxidative stress: The modulatory effect of syringic acid on Nrf2-Keap1-Hmox1-NQO1 signaling pathway in rats. Phytomedicine Plus 2023, 3:100434. DOI: https://doi.org/10.1016/j.phyplu.2023.100434
46. Gheena S, Ezhilarasan D, Shree Harini K, Rajeshkumar S: Syringic acid and silymarin concurrent administration inhibits sodium valproate-induced liver injury in rats. Environ Toxicol 2022, 37:2143–2152 DOI: https://doi.org/10.1002/tox.23557
47. Shahzad S, Mateen S, Naeem SS, et al.: Syringic acid protects from isoproterenol induced cardiotoxicity in rats. Eur J Pharmacol 2019, 849:135–145. DOI: https://doi.org/10.1016/j.ejphar.2019.01.056
48. Sabahi Z, Khoshnoud MJ, Hosseini S, et al: Syringic Acid Attenuates Cardiomyopathy in Streptozotocin-Induced Diabetic Rats. Adv Pharmacol Pharm Sci 2021:5018092. DOI: https://doi.org/10.1155/2021/5018092
49. Ding S, Wang L, Guo L, et al: Syringic acid inhibits apoptosis pathways via downregulation of p38MAPK and JNK signaling pathways in H9c2 cardiomyocytes following hypoxia/reoxygenation injury. Mol Med Rep 2017, 16:2290–2294. DOI: https://doi.org/10.3892/mmr.2017.6845
50. S M, Shaik AH, E MP, et al.: Combined cardio-protective ability of syringic acid and resveratrol against isoproterenol induced cardicardiotoxicityats via attenuating NF-kB and TNF-α pathways. Sci Rep 2020, 10:3426. DOI: https://doi.org/10.1038/s41598-020-59925-0
51. Kumar S, Prahalathan P, Raja B: Syringic acid ameliorates L-NAME-induced hypertension by reducing oxidative stress.

Naunyn Schmiedebergs Arch Pharmacol 2012, 385:1175–1184 DOI: https://doi.org/10.1007/s00210-012-0802-7

52. Liu G, Zhang B, Hu Q, et al.: Syringic acid mitigates myocardial ischemia reperfusion injury by activating the PI3K/Akt/GSK-3β signaling pathway. Biochem Biophys Res Commun 2020, 531. DOI: https://doi.org/10.1016/j.bbrc.2020.07.047
53. John CM, Arockiasamy S: Syringic acid (4-hydroxy-3,5-dimethoxybenzoic acid) inhibits adipogenesis and promotes lipolysis in 3T3-L1 adipocytes. Nat Prod Res 2020, 34:3432–3436. DOI: https://doi.org/10.1080/14786419.2019.1573820
54. Ogut E, Armagan K, Gül Z: The role of syringic acid as a neuroprotective agent for neurodegenerative disorders and future expectations. Metab Brain Dis 2022, 37:859–880. DOI: https://doi.org/10.1007/s11011-022-00960-3
55. Cao Y, Zhang L, Sun S, et al: Neuroprotective effects of syringic acid against OGD/R-induced injury in cultured hippocampal neuronal cells. Int J Mol Med 2016, 38:567–573. DOI: https://doi.org/10.3892/ijmm.2016.2623
56. Ogut E, Sekerci R, Akcay G, et al: Protective effects of syringic acid on neurobehavioral deficits and hippocampal tissue damages induced by sub-chronic deltamethrin exposure. Neurotoxicol Teratol 2019, 76:106839. DOI: https://doi.org/10.1016/j.ntt.2019.106839
57. Rashedinia M, Alimohammadi M, Shalfroushan N, et al: Neuroprotective Effect of Syringic Acid by Modulation of Oxidative Stress and Mitochondrial Mass in Diabetic Rats. Biomed Res Int 2020:8297984. DOI: https://doi.org/10.1155/2020/8297984
58. Zhao Y, Dang M, Zhang W, et al.: Neuroprotective effects of Syringic acid against aluminium chloride induced oxidative stress mediated neuroinflammation in rat model of Alzheimer's disease. J Funct Foods 2020, 71:104009. DOI: https:// doi.org/10.1016/j.jff.2020.104009
59. Srinivasan S, Muthukumaran J, Muruganathan U, et al: Antihyperglycemic effect of syringic acid on attenuating the key enzymes of carbohydrate metabolism in experimental diabetic rats. Biomed Prev Nutr 2014, 4:595–602. DOI: https://doi.org/10.1016/j.bionut.2014.07.010
60. Sahari S, Saraswathy M: Syringic Acid Alleviates Hyperglycemia by Regulating Hepatic Key Enzymes of Carbohydrate Metabolism in Streptozotocin-induced Diabetic Rats. Asian J Biol Life Sci 2023, 12:66–72. DOI: https://doi.org/10.5530/ajbls.2023.12.10
61. Rashedinia M, Khoshnoud MJ, Fahlyan BK, et al: Syringic Acid: A Potential Natural Compound for the Management of Renal Oxidative Stress and Mitochondrial Biogenesis in Diabetic Rats. Curr Drug Discov Technol 2021, 18:405–413. DOI: https://doi.org/10.2174/1570163817666200211101228
62. Shimsa S, Padmakumari Soumya NP, Mondal S, Mini S: Syringic acid affords antioxidant protection in the pancreas of type 2 diabetic rats. Bioact Compd Heal Dis 2023, 6:13–25. DOI: https://doi.org/10.31989/bchd.v6i2.1061
63. Zabad OM, Samra YA, Eissa LA: Syringic acid ameliorates experimental diabetic nephropathy in rats through its anti-inflammatory, antioxidant and anti-fibrotic effects by suppressing Toll like receptor-4 pathway. In: Metabolism-Clinical and Experimental.2022, pp S1--S2 DOI: http://dx.doi.org/10.1016/j.metabol.2021.154966
64. Sherkhane B, Yerra VG, Sharma A, et al: Nephroprotective potential of syringic acid in experimental diabetic nephropathy: Focus on oxidative stress and autophagy. Indian J Pharmacol 2023, 55:34–42. DOI: https://doi.org/10.4103/ijp.ijp_671_22
65. Liu Y, Fang J, Lei T, et al: Anti-endotoxic effects of syringic acid of Radix Isatidis. J Huazhong Univ Sci Technol Med Sci = Hua zhong ke ji da xue xue bao Yi xue Ying wen ban = Huazhong keji daxue xuebao Yixue Yingdewen ban 2003, 23:206–208. DOI: https://doi.org/10.1007/BF02859960
66. Liu Y, Guo X, Lü Z, Xie W: Study on the pharmacokinetics and bioavailability of syringic acid in rabbits]. Zhong Yao Cai 2003, 26:798–801 https://pubmed.ncbi.nlm.nih.gov/14989061/
67. Liu Y, Sun C, Li W, et al: Preparation and Characterization of Syringic Acid-Loaded TPGS Liposome with Enhanced Oral Bioavailability and In Vivo Antioxidant Efficiency. AAPS PharmSciTech 2019, 20:98. DOI: https://doi.org/10.1208/s12249-019-1290-6