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Phenolic Compounds of Aqueous and Methanol Extracts of Hypsizygus tessellatus (brown and white var.) and Flammulina velutipes caps: Antioxidant and Antiproliferative Activities (Article)

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Abstract

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Since the World Health Organization has suggested the exploration of natural products for cancer management owing to the side effects of chemotherapy and irradiation on humans and breast cancer accounts for the highest number of cancer related deaths globally, this study has examined antiproliferative effects of the aqueous and methanol extracts of Hypsizygus tessellatus (brown and white var.) and Flammulina velutipes caps against two breast cancer cell lines. The antioxidant and antiproliferative activities of these mushroom extracts were evaluated in vitro using chemical-based (for antioxidant activity) and cell (for antiproliferative activity) approaches. Furthermore, the phytochemical composition of the mushroom extracts were identified using mass spectroscopy (UPLC-QTOF/MS). The obtained results showed aqueous extracts of F. velutipes (Enoki) and white H. tessellatus (Bunapi shimeji) caps to possess higher antiodixant activities against DPPH (IC_{50} = 0.202 and 0.573 mg/mL, respectively), and H_2O_2 (IC_{50} = 0.622 and 0.745 mg/mL, respectively) compared tothe methanol extracts. Aqueous extracts of the mushrooms also showed better ferric reducing antioxidant power (FRAP) values against ferric ions compared to the methanol extracts. Finally, the mushroom extracts showed good antiproliferative activities against human breast cancer cell lines. These findings suggest the presence of phytochemicals with antiproliferative and antioxidant acrtivities in the mushroom extracts studied. © 2020, Springer Science+Business Media, LLC, part of Springer Nature.

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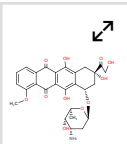
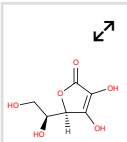

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(2018) Food Chemistry

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		water extract of Flammulina velutipes, Enoki, mushroom, caps, dry, Malaysia, Pahang, Kuantan, pulverized	methanol extract of Hypsizygus tessellatus, Bunapi shimeji, mushroom, white, caps, dry, Malaysia, Pahang, Kuantan, pulverized	water extract of Hypsizygus tessellatus, Bunapi shimeji, mushroom, white, caps, dry, Malaysia, Pahang, Kuantan, pulverized	methanol extract of Hypsizygus tessellatus, Buna shimeji, mushroom, brown, caps, dry, Malaysia, Pahang, Kuantan, pulverized

Author keywords

antioxidant | antiproliferative | F. Velutipes | H. tessellatus | phytochemicals

Indexed keywords

EMTREE drug terms: alkaloid | astilbin | bavachinin | buddlenoid a | corylifolinin | corylin | doxorubicin | ferric ion | flavonoid | isoetin | isoxanthohumol | kakuol | kuraridinol | kushenol a | kushenol k | kushenol m | kuwanon s | licochalcone A | lupinifolin | methanol | nelumboroside a | pelargonidin 3 glucoside | phenol derivative | quercetin 3 oglucuronide 6 methylester | sanggenon k | saponin | smiglanin | steroid | tangeritin | unclassified drug | unindexed drug

EMTREE medical terms: antineoplastic activity | antioxidant activity | antiproliferative activity | aqueous solution | Article | breast cancer cell line | DPPH radical scavenging assay | drug synthesis | ferric reducing antioxidant power assay | Flammulina velutipes | human | human cell | Hypsizygus | Hypsizygus tessellatus | in vitro study | mass spectrometry | nonhuman | phytochemistry | ultra performance liquid chromatography

Chemicals and CAS Registry Numbers:

astilbin, 11027-89-7, 29838-66-2, 29838-67-3, 30375-17-8; doxorubicin, 23214-92-8, 25316-40-9; ferric ion, 20074-52-6; licochalcone A, 58749-22-7; methanol, 67-56-1; saponin, 8047-15-2

Manufacturers:

Drug manufacturer:

kuantan, Malaysia

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Universiti Malaysia Pahang	RDU160156,PGRS1703102	

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References (57)

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1 Sangdee, K., Buranrat, B., Naksuwankul, K., Jaihan, P., Sangdee, A.

Antibacterial and anti-breast cancer cell line activities of sanghuangporus sp.1 extracts (Open Access)

(2017) *Tropical Journal of Pharmaceutical Research*, 16 (3), pp. 613-620. Cited 7 times.
https://www.tjpr.org/admin/12389900798187/2017_16_3_16.pdf
doi: 10.4314/tjpr.v16i3.16

View at Publisher

2 Alara, O.R., Abdurahman, N.H., Ukaegbu, C.I., Azhari, N.H.

Vernonia cinerea leaves as the source of phenolic compounds, antioxidants, and anti-diabetic activity using microwave-assisted extraction technique

(2018) *Industrial Crops and Products*, 122, pp. 533-544. Cited 33 times.
www.elsevier.com/inca/publications/store/5/2/2/8/2/5
doi: 10.1016/j.indcrop.2018.06.034

View at Publisher

3 Steer, P., Millgård, J., Sarabi, D.M., Basu, S., Vessby, B., Kahan, T., Edner, M., (...), Lind, L.

Cardiac and vascular structure and function are related to lipid peroxidation and metabolism

(2002) *Lipids*, 37 (3), pp. 231-236. Cited 46 times.
http://www.springerlink.com/content/0024-4201
doi: 10.1007/s11745-002-0885-3

View at Publisher

4 Bouayed, J., Bohn, T.

Exogenous antioxidants - Double-edged swords in cellular redox state: Health beneficial effects at physiologic doses versus deleterious effects at high doses (Open Access)

(2010) *Oxidative Medicine and Cellular Longevity*, 3 (4), pp. 228-237. Cited 486 times.
http://www.landesbioscience.com/journals/oximed/article/BouayedOXCL3-4.pdf
doi: 10.4161/oxim.3.4.12858

View at Publisher

5 Pandey, K.B., Rizvi, S.I.

Plant polyphenols as dietary antioxidants in human health and disease (Open Access)

(2009) *Oxidative Medicine and Cellular Longevity*, 2 (5), pp. 270-278. Cited 1798 times.
http://www.landesbioscience.com/journals/oximed/article/PandeyOMCL2-5.pdf
doi: 10.4161/oxim.2.5.9498

View at Publisher

6 Khan, H., Jawad, M., Kamal, M.A., Baldi, A., Xiao, J., Nabavi, S.M., Daglia, M.

Evidence and prospective of plant derived flavonoids as antiplatelet agents: Strong candidates to be drugs of future

(2018) *Food and Chemical Toxicology*, 119, pp. 355-367. Cited 25 times.
www.elsevier.com/locate/foodchemtox
doi: 10.1016/j.fct.2018.02.014

View at Publisher

7 Liu, K., Xiao, X., Wang, J., Chen, C.-Y.O., Hu, H.
Polyphenolic composition and antioxidant, antiproliferative, and antimicrobial activities of mushroom Inonotus sanghuang (Open Access)

(2017) *LWT - Food Science and Technology*, 82, pp. 154-161. Cited 25 times.
http://www.elsevier.com/inca/publications/store/6/2/2/9/1/0/index.htt
doi: 10.1016/j.lwt.2017.04.041

View at Publisher

8 Chandel, N.S., Tuveson, D.A.
The promise and perils of antioxidants for cancer patients

(2014) *New England Journal of Medicine*, 371 (2), pp. 177-178. Cited 103 times.
http://www.nejm.org/doi/pdf/10.1056/NEJMcibr1405701
doi: 10.1056/NEJMcibr1405701

View at Publisher

9 Conklin, K.A.
Dietary antioxidants during cancer chemotherapy: Impact on chemotherapeutic effectiveness and development of side effects

(2000) *Nutrition and Cancer*, 37 (1), pp. 1-18. Cited 355 times.
http://www.tandfonline.com/toc/hnuc20/current
doi: 10.1207/S15327914NC3701_1

View at Publisher

10 (2018)
US Breast Cancer Statistics Reports

11 Boroomand, N., Sadat-Hosseini, M., Moghbeli, M., Farajpour, M.
Phytochemical components, total phenol and mineral contents and antioxidant activity of six major medicinal plants from Rayen, Iran

(2018) *Natural Product Research*, 32 (5), pp. 564-567. Cited 11 times.
www.tandf.co.uk/journals/titles/14786419.asp
doi: 10.1080/14786419.2017.1315579

View at Publisher

12 Khan, M., Arahman, M.M.
Sardar
(2016) , *Asian Pac. J. Trop. Biomed.*, 6, pp. 410-417.

13 Jayakumar, T., Thomas, P.A., Sheu, J.R., Geraldine, P.
In-vitro and in-vivo antioxidant effects of the oyster mushroom Pleurotus ostreatus

(2011) *Food Research International*, 44 (4), pp. 851-861. Cited 63 times.
doi: 10.1016/j.foodres.2011.03.015

View at Publisher

14 Mau, J.-L., Chang, C.-N., Huang, S.-J., Chen, C.-C.
Antioxidant properties of methanolic extracts from Grifola frondosa, Morchella esculenta and Termitomyces albuminosus mycelia

(2004) *Food Chemistry*, 87 (1), pp. 111-118. Cited 231 times.
doi: 10.1016/j.foodchem.2003.10.026

View at Publisher

15 Yang, S., Jin, L., Ren, X., Lu, J., Meng, Q.
Optimization of fermentation process of Cordyceps militaris and antitumor activities of polysaccharides in vitro (Open Access)

(2014) *Journal of Food and Drug Analysis*, 22 (4), pp. 468-476. Cited 33 times.
http://www.elsevier.com/journals/journal-of-food-and-drug-analysis/1021-9498#
doi: 10.1016/j.jfda.2014.01.028

View at Publisher

16 Iwalokun, D.K., Ausen, B.U.A.
Otunba
(2007) *J. Biotechnol.*, 6, pp. 1732-1739.

17 Ukaegbu, C.I., Shah, S.R., Hamid, H.A., Normaiza, Z., Alara, O.R.
Extracts of Hypsizygus tessellatus (white var.) caps inhibited MCF-7 and MDA-MB-231 cell lines proliferation

(2019) *Journal of Food Measurement and Characterization*, 13 (1), pp. 368-382.
http://rd.springer.com/journal/11694
doi: 10.1007/s11694-018-9952-8

View at Publisher

18 Shah, S.R., Ukaegbu, C.I., Hamid, H.A., Alara, O.R.
Evaluation of antioxidant and antibacterial activities of the stems of Flammulina velutipes and Hypsizygus tessellatus (white and brown var.) extracted with different solvents

(2018) *Journal of Food Measurement and Characterization*, 12 (3), pp. 1947-1961. Cited 13 times.
http://rd.springer.com/journal/11694
doi: 10.1007/s11694-018-9810-8

View at Publisher

19 Muhammad, S., Allah, R., Masood, S.
(2017) *J. Food Biochem.*, 42.

20 Khandelwal, K.
(2008) *Practical Pharmacognosy:Techniques and Experiments*. Cited 850 times.
19, Pune, Nirali Prakashan

21 Avni, H., Annamaria, G., Giangiacomo, B.
Eur. Food Res. Technol,10.1007/s00217–018–3046–z

22 Odeja, O., Ogwuche, C., Elemike, E.
Clin. Phytosci., 2

23 Vijayalakshmi, M., Ruckmani, K.
Ferric reducing anti-oxidant power assay in plant extract (Open Access)

(2016) *Bangladesh Journal of Pharmacology*, 11 (3), pp. 570-572. Cited 22 times.
http://www.banglajol.info/bd/index.php/BJP/article/download/27663/18611
doi: 10.3329/bjp.v11i3.27663

View at Publisher

24 Mftah, A., Alhassan, F.H., Al-Qubaisi, M.S., Zowalaty, M.E.E., Webster, T.J., Sh-Eldin, M., Rasedee, A., (...), Rashid, S.S.

Physicochemical properties, cytotoxicity, and antimicrobial activity of sulphated zirconia nanoparticles (Open Access)

(2015) *International Journal of Nanomedicine*, 10, pp. 765-774. Cited 15 times.
http://www.dovepress.com/getfile.php?fileID=23328
doi: 10.2147/IJN.S66058

View at Publisher

25 Hamid, A., Roziasyahira, M., Mashitah, M.
(2016) *Food Chem. Toxicol.*, 108, pp. 451-457. Cited 2 times.

26 Danladi, S., Wan-Azemin, A., Sani, Y.N., Mohd, K.S., Mahadeva Rao, U.S., Mansor, S.M., Dharmaraj, S.

Phytochemical screening, antioxidant potential and cytotoxic activity of melastoma malabathricum linn. from different locations

(2015) *International Journal of Pharmacy and Pharmaceutical Sciences*, 7 (7), pp. 408-413. Cited 3 times.
http://innovareacademics.in/journals/index.php/ijpps/article/download/5673/pdf_972

27 Visht, S., Chaturvedi, S.
(2012) *Curr. Pharm. Res.*, 2.

28 Dar, B.N., Sharma, S., Nayik, G.A.

Effect of storage period on physiochemical, total phenolic content and antioxidant properties of bran enriched snacks

(2016) *Journal of Food Measurement and Characterization*, 10 (4), pp. 755-761. Cited 13 times.
http://rd.springer.com/journal/11694
doi: 10.1007/s11694-016-9360-x

View at Publisher

29 Cushnie, T.P.T., Cushnie, B., Lamb, A.J.

Alkaloids: An overview of their antibacterial, antibiotic-enhancing and antivirulence activities

(2014) *International Journal of Antimicrobial Agents*, 44 (5), pp. 377-386. Cited 211 times.
www.elsevier.com/locate/ijantimicag
doi: 10.1016/j.ijantimicag.2014.06.001

View at Publisher

30 Ireneusz, S., Roman, P., Maciej, S.
(2017) *Nat. Prod. Res.*, 32, pp. 605-609.

31 Ding, X., Hou, Y., Hou, W.

Structure feature and antitumor activity of a novel polysaccharide isolated from Lactarius deliciosus Gray

(2012) *Carbohydrate Polymers*, 89 (2), pp. 397-402. Cited 47 times.
doi: 10.1016/j.carbpol.2012.03.020

View at Publisher

32 Zou, W., Zhou, H., Hu, J., Zhang, L., Tang, Q., Wen, X., Xiao, Z., (...), Wang, W.
Rhizoma Smilacis Glabrae inhibits pathogen-induced upper genital tract inflammation in rats through suppression of NF-κB pathway

(2017) *Journal of Ethnopharmacology*, 202, pp. 103-113. Cited 9 times.
www.elsevier.com/locate/jethpharm
doi: 10.1016/j.jep.2017.02.034

View at Publisher

33 Bilal, A., Usman, A., Muhammad, A.A.
(2014) *Bangladesh J. Pharmacol.*, 9, pp. 545-550.

34 Di, T.-T., Ruan, Z.-T., Zhao, J.-X., Wang, Y., Liu, X., Wang, Y., Li, P.
Astilbin inhibits Th17 cell differentiation and ameliorates imiquimod-induced psoriasis-like skin lesions in BALB/c mice via Jak3/Stat3 signaling pathway
(Open Access)

(2016) *International Immunopharmacology*, 32, pp. 32-38. Cited 46 times.
www.elsevier.com/locate/intimp
doi: 10.1016/j.intimp.2015.12.035

View at Publisher

35 Guotam, B., Dilip, G., Rajiv, R.
(2013) *Brazilian J. Pharmacogn.*, 23, pp. 559-575.

36 Chen, K.-H., Weng, M.-S., Lin, J.-K.
Tangeretin suppresses IL-1β-induced cyclooxygenase (COX)-2 expression through inhibition of p38 MAPK, JNK, and AKT activation in human lung carcinoma cells

(2007) *Biochemical Pharmacology*, 73 (2), pp. 215-227. Cited 115 times.
doi: 10.1016/j.bcp.2006.09.018

View at Publisher

37 Morley, K.L., Ferguson, P.J., Koropatnick, J.
Tangeretin and nobiletin induce G1 cell cycle arrest but not apoptosis in human breast and colon cancer cells

(2007) *Cancer Letters*, 251 (1), pp. 168-178. Cited 157 times.
doi: 10.1016/j.canlet.2006.11.016

View at Publisher

38 Kumara, M., Shylajab, M., Nazeemc, P., Dev, J.
Drugs, 6,10.4172/2329–6631.1000167

39 Wu, Z., Shi, J., Yang, S.
The effect of pyrogallic acid on growth, oxidative stress, and gene expression in Cylindrospermopsis raciborskii (Cyanobacteria)

(2013) *Ecotoxicology*, 22 (2), pp. 271-278. Cited 19 times.
doi: 10.1007/s10646-012-1023-z

View at Publisher

40 Qiaoping, X.W., Haiyan, L., Sun, Z.
Sci. Rep

41 Xirui, X.H., Jiacheng, F., Huang, L.
(2015) *J. Ethnopharmacol.*, 172, pp. 10-29.

42 Alam, M.N., Bristi, N.J., Rafiquzzaman, M.
Review on in vivo and in vitro methods evaluation of antioxidant activity (Open Access)

(2013) *Saudi Pharmaceutical Journal*, 21 (2), pp. 143-152. Cited 603 times.
doi: 10.1016/j.jsps.2012.05.002

View at Publisher

43 Baratzadeh, M.-H., Asoodeh, A., Chamani, J.
Antioxidant peptides obtained from goose egg white proteins by enzymatic hydrolysis

(2013) *International Journal of Food Science and Technology*, 48 (8), pp. 1603-1609. Cited 13 times.
doi: 10.1111/ijfs.12130

View at Publisher

44 Hamid, H.A., Ramli, A.N.M., Zamri, N., Yusoff, M.M.
UPLC-QTOF/MS-based phenolic profiling of Melastomaceae, their antioxidant activity and cytotoxic effects against human breast cancer cell MDA-MB-231

(2018) *Food Chemistry*, 265, pp. 253-259. Cited 8 times.
www.elsevier.com/locate/foodchem
doi: 10.1016/j.foodchem.2018.05.033

View at Publisher

45 Ukaegbu, C., Shah, S., Hamid, A.
(2018) *Beni-Suef Univ. J. Basic Appl. Sci.*, 7, pp. 675-682. Cited 4 times.

46 Vijayalakshmi, M., Ruckmani, K.
Ferric reducing anti-oxidant power assay in plant extract (Open Access)

(2016) *Bangladesh Journal of Pharmacology*, 11 (3), pp. 570-572. Cited 22 times.
http://www.banglajol.info/bd/index.php/BJP/article/download/27663/18611
doi: 10.3329/bjp.v11i3.27663

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47 Ukaegbu, C.I., Shah, S.R., Hamid, H.A., Normaiza, Z., Alara, O.R.
Extracts of Hypsizygus tessellatus (white var.) caps inhibited MCF-7 and MDA-MB-231 cell lines proliferation

(2019) *Journal of Food Measurement and Characterization*, 13 (1), pp. 368-382.
http://rd.springer.com/journal/11694
doi: 10.1007/s11694-018-9952-8

View at Publisher

48 Hodzic, Z., Pasalic, H., Memisevic, A., Srabovic, M., Saletovic, M., Poljakovic, M.
The influence of total phenols content on antioxidant capacity in the whole grain extracts

(2009) *European Journal of Scientific Research*, 28 (3), pp. 471-477. Cited 87 times.
http://www.eurojournals.com/ejsr_28_3_13.pdf

49 Schafer, F.Q., Buettner, G.R.
Redox environment of the cell as viewed through the redox state of the glutathione disulfide/glutathione couple

(2001) *Free Radical Biology and Medicine*, 30 (11), pp. 1191-1212. Cited 3172 times.
doi: 10.1016/S0891-5849(01)00480-4

View at Publisher

50 Moure, A., Franco, D., Sineiro, J., Domínguez, H., Núez, M.J., Lema, J.M.
Antioxidant activity of extracts from Gevuina avellana and Rosa rubiginosa defatted seeds

(2001) *Food Research International*, 34 (2-3), pp. 103-109. Cited 54 times.
doi: 10.1016/S0963-9969(00)00136-8

View at Publisher

51 Bazzaz, E.J., Khayat, B.S.F., Emamic, M.H.
(2011) *Sci. Asia*, 7, pp. 327-334.

52 Serban, C., Anca, M., Marius, R.
(2015) *Int. J. Cancer Res. Treat.*, 35, pp. 3147-3154.

53 Forbes-Hernández, T.Y., Giampieri, F., Gasparrini, M., Mazzoni, L., Quiles, J.L., Alvarez-Suarez, J.M., Battino, M.
The effects of bioactive compounds from plant foods on mitochondrial function: A focus on apoptotic mechanisms

(2014) *Food and Chemical Toxicology*, 68, pp. 154-182. Cited 134 times.
www.elsevier.com/locate/foodchemtox
doi: 10.1016/j.fct.2014.03.017

View at Publisher

54 Niestroy, J., Barbara, A., Herbst, K., Rode, S., van Liempt, M., Roos, P.H.
Single and concerted effects of benzo[a]pyrene and flavonoids on the AhR and Nrf2-pathway in the human colon carcinoma cell line Caco-2

(2011) *Toxicology in Vitro*, 25 (3), pp. 671-683. Cited 56 times.
doi: 10.1016/j.tiv.2011.01.008

View at Publisher

55 Youn, H., Jeong, J.-C., Jeong, Y.S., Kim, E.-J., Um, S.-J.
Quercetin potentiates apoptosis by inhibiting nuclear factor-kappaB signaling in H460 lung cancer cells (Open Access)

(2013) *Biological and Pharmaceutical Bulletin*, 36 (6), pp. 944-951. Cited 44 times.
https://www.jstage.jst.go.jp/article/bpb/36/6/36_b12-01004/_pdf
doi: 10.1248/bpb.b12-01004

View at Publisher

56 Kim, D.-H., Han, K.-H., Song, K.-Y., Lee, K.-H., Jo, S.Y., Lee, S.-W., Yoon, T.J.
Activation of innate immunity by Lepiota procera enhances antitumor activity

(2010) *Korean Journal of Pharmacognosy*, 41 (2), pp. 115-121. Cited 3 times.
http://img.kisti.re.kr/soc_img/society//kspmc/HKSOBF/2010/v41n2/HKSOBF_2010_v41n2_115.pdf

57 Xu, T., Beelman, R.B., Lambert, J.D.

The cancer preventive effects of edible mushrooms

(2012) *Anti-Cancer Agents in Medicinal Chemistry*, 12 (10), pp. 1255-1263. Cited 43 times.
doi: 10.2174/187152012803833017

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