

2016 年由 pubmed 蒐集香菇功能性研究

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1. [Antitumor Activity of Extracts from Medicinal Basidiomycetes Mushrooms.](#)

Vetchinkina E, Shirokov A, Bucharskaya A, Navolokin N, Prilepskii A, Burov A, Maslyakova G, Nikitina VE.

Int J Med Mushrooms. 2016;18(11):955-964.

藥用擔子菌菇萃取物的抗癌活性

Abstract

Aqueous extracts from the vegetative submerged mycelia of cultivated Basidiomycetes *Ganoderma lucidum*, *Lentinus edodes*, and *Grifola frondosa*, as well as from the fruiting bodies of *G. lucidum*, were found to have antitumor activity. The antitumor effect of the mycelial extracts from all 3 fungal species was ascertained in vivo in rats with implanted kidney cancer. Dystrophic changes in tumor cells and tumor necrosis (up to 90%) were noted. In vitro cytotoxicity studies of the A549 human lung adenocarcinoma cell line and HEP-2 human laryngeal epidermoid carcinoma cells showed that the extracts from the *G. lucidum* fruiting bodies and from the *L. edodes* vegetative mycelium were the most effective. The animals' immune systems were activated, and the fungal extracts displayed no toxicity when administered orally.

摘要

來自培養的擔子菌的液態培養的菌絲體的靈芝，香菇和舞菇以及靈芝的子實體水萃取物發現具有抗癌活性。將具有植入的腎癌細胞的大鼠中在體內確定來自，確認3種菇菌類的菌絲體萃取物具有抗腫瘤作用。值得一提會導致腫瘤細胞的營養不良和腫瘤壞死的變化（高達90%）。A549人肺腺癌細胞和HEP-2人類喉癌表皮樣癌細胞以體外細胞毒性研究表明，來自靈芝子實體和來自香菇液態培養

菌絲體的萃取物是最有效的。菇類萃取物口服給動物時，他們免疫系統是被活化且沒有顯示出毒性。

2. [A polysaccharide from *Lentinus edodes* inhibits human colon cancer cell proliferation and suppresses tumor growth in athymic nude mice.](#)

Wang J, Li W, Huang X, Liu Y, Li Q, Zheng Z, Wang K.

Oncotarget. 2016 Nov 21.

香菇的多醣抑制人結腸癌細胞增殖並抑制無胸腺裸鼠的腫瘤生長

Abstract

The antitumor effect of Lentinan is thought rely on the activation of immune responses; however, little is known about whether Lentinan also directly attacks cancer cells. We therefore investigated the direct antitumor activity of SLNT (a water-extracted polysaccharide from *Lentinus edodes*) and its probable mechanism. We showed that SLNT significantly inhibited proliferation of HT-29 colon cancer cells and suppressed tumor growth in nude mice. Annexin V-FITC/PI, DAPI, AO/EB and H&E staining assays all showed that SLNT induced cell apoptosis both in vitro and in vivo. SLNT induced apoptosis by activating Caspase-3 via both intrinsic and extrinsic pathways, which presented as the activation of Caspases-9 and -8, upregulation of cytochrome c and the Bax/Bcl-2 ratio, downregulation of NF- κ B, and overproduction of ROS and TNF- α in vitro and in vivo. Pretreatment with the caspase-3 inhibitor Ac-DEVD-CHO or antioxidant NAC blocked SLNT-induced apoptosis. These findings suggest that SLNT exerts direct antitumor effects by inducing cell apoptosis via ROS-mediated intrinsic and TNF- α -mediated extrinsic pathways. SLNT may thus represent a useful candidate for colon cancer prevention and treatment.

摘要

香菇聚醣的抗腫瘤作用被認為是依藉免疫反應活化系統;然而,很少

知道香菇聚醣是否也直接攻擊癌細胞。因此,我們研究了 SLNT

(來自香菇的水萃取多醣)的直接抗腫瘤活性及其可能的機制。我

們顯示 SLNT 顯著抑制 HT-29 結腸癌細胞的增殖並抑制裸鼠的腫瘤

生長。 Annexin V-FITC / PI, DAPI, AO / EB 和 H&E 染色測定均

顯示 SLNT 在體外和體內誘導細胞凋亡。SLNT 通過激活 Caspase-3 通過內部和外部途徑誘導細胞凋亡，其表現為 Caspase-9 和-8 的激活，細胞色素 c 的上調和 Bax / Bcl-2 比率，NF- κ B 的下調和過量產生 ROS 和 TNF- α 在體外和體內。用 caspase-3 抑制劑 Ac-DEVD-CHO 或抗氧化劑 NAC 預處理阻斷 SLNT 誘導的細胞凋亡。這些研究結果表示 SLNT 通過誘導細胞凋亡通過 ROS 介導的內在和腫瘤壞死因子- α 介導的外在途徑發揮直接的抗腫瘤作用。因此，SLNT 可代表結腸癌預防和治療的有用候選物。

3. Investigating the Effect of Tissue Size on Mycelial Growth of Seven Mushroom Species by Using a Novel Device for Precise Tissue Isolation.

Liu SR, Zhang WR, Chen AP, Kuang YB.

Indian J Microbiol. 2016 Dec;56(4):516-521.

使用新型裝置用於精確組織分離來研究組織大小對七種蘑菇物種的菌絲生長的影響

Abstract

Tissue isolation from mushrooms is frequently practiced by both researchers and growers to isolate new and improved strains. In the present study, we designed a simple and convenient device for precise tissue isolation and therefore investigated the effect of tissue size on mycelial growth of seven mushroom species. The developed device consists of a cutting needle and a transfer needle. The cutting needle was used to obtain circular tissue plugs having a height up to 3 mm and variable diameters (2-5 mm) from mushroom fruit bodies. The transfer needle was a stainless steel round rod (1.5 mm in diameter) with a blade-like end. It can be used for collecting mushroom tissue when the cutting needle fails to extract it. With the aid of these devices, precise tissue isolation was achieved. Plate cultures demonstrated that tissue size had little effect on mycelium extension for *Lentinula edodes* (the winter shiitake), *Hypsizygus marmoreus*, and *Agrocybe aegerita*, but influenced the aerobic mycelium density. For *Pleurotus ostreatus*, *Pleurotus eryngii*, and *Volvariella volvacea*, large tissue plugs produced faster mycelial growth and higher aerobic mycelium density compared with small ones. On the contrary, small plugs from the tissue of the flower shiitake and *Agaricus bisporus* favored mycelial growth. The present study revealed that the preferable tissue size for mycelial growth varies among mushroom species, and the developed device is expected to greatly facilitate the isolation of new and improved mushroom strains.

摘要

從研究者和種植者經常實施與蘑菇的組織分離，給予分離出新的和改良的菌株。在本研究中，我們設計了一個簡單，方便的設備精確組織分離，因此探討組織大小對七個蘑菇菌種菌絲生長的影響。開

發的裝置由切割針和轉移針組成。切割針用於獲得高度達 3mm 並且來自菇類子實體的可變直徑（2-5mm）的圓形組織插塞。轉移針是具有刀片狀端部的不銹鋼圓棒（直徑 1.5mm）。它可用於收集菇類組織，當切割針無法萃取它。借助於這些裝置，實現了精確的組織隔離。平板培養確認，組織大小對香菇菌絲體，鴻喜菇和茶樹菇的菌絲體生長幾乎沒有影響，但影響有氧菌絲體密度。對於平菇和草菇，大的組織比小塊組織產生更快的菌絲體生長和更高的有氧菌絲體密度。相反，來自花香菇和雙孢菇的組織的小塊組織有利於菌絲體生長。本研究揭示，菌絲體生長的優選組織大小對在菇類具有種間差異，並且開發的裝置預期極大地促進新的和改進的菇類菌株的分離。

4. [Oral administration of *Lentinus edodes* \$\beta\$ -glucans ameliorates DSS-induced ulcerative colitis in mice via MAPK-Elk-1 and MAPK-PPAR \$\gamma\$ pathways.](#)

Shi L, Lin Q, Yang T, Nie Y, Li X, Liu B, Shen J, Liang Y, Tang Y, Luo F.

Food Funct. 2016 Nov 9;7(11):4614-4627

口服給予 β -葡聚糖將改善以 MAPK-Elk-1 和 MAPK-PPAR γ 途徑改善

小鼠中的 DSS 誘導的潰瘍性結腸炎

Abstract

To evaluate the anti-inflammatory effect of β -glucans from *Lentinus edodes*, and its molecular mechanism, the dextran sulfate sodium salt (DSS) induced colitis model of mice and the LPS-stimulated RAW264.7 cell inflammation model were used in this study. 40 ICR male mice were randomly divided into 4 groups: Control, DSS (DSS treated only), DSS + low- β Gs (500 mg kg⁻¹ d⁻¹) and DSS + high- β Gs (1000 mg kg⁻¹ d⁻¹). The body weight of the mice with *Lentinus edodes* β -glucan supplementation increased significantly compared to the DSS group and the disease activity index (DAI) was improved in both β G-treated groups. Compared with the DSS group, histopathological analysis showed that the infiltration of inflammatory cells of both β G-treated groups decreased significantly in colonic tissues. Furthermore, oral administration of β -glucans decreases the concentration of malondialdehyde (MDA) and myeloperoxidase (MPO) and inhibits the expression of iNOS and several inflammatory factors: TNF- α , IL-1 β and IL-6 as well as nitric oxide (NO) of the colonic tissues. The mitogen-activated protein kinase (MAPK) pathway is closely related to the expression of pro-inflammatory factors. In the DSS-induced colitis model and the LPS-stimulated RAW264.7 cell model, β Gs inhibited the expression of pro-inflammatory factors and blocked the phosphorylation of JNK/ERK1/2 and p38; β Gs also suppress the phosphorylation of Elk-1 at Ser84 and the phosphorylation of PPAR γ at Ser112. Altogether, these results suggest that *Lentinus edodes* β Gs could inhibit the DSS-induced ulcerative colitis and decrease inflammatory factor expressions. The molecular mechanism may be involved in suppressing MAPK signaling and inactivation of Elk-1 and activation of PPAR γ .

摘要

為了評估來自香菇的 β -葡聚糖(β Gs)的抗炎效果及其分子機制，本研究中使用硫酸葡聚糖鈉鹽 (DSS) 誘導的小鼠結腸炎模型和脂多醣

體(LPS)刺激的 RAW264.7 細胞炎症模型。將 40 隻 ICR 雄性小鼠隨機分為 4 組：對照，DSS (僅 DSS 處理)，DSS +低-βGs (500mg kg⁻¹ d⁻¹) 和 DSS +高-βG (1000mg kg⁻¹ d⁻¹)。與 DSS 組相比，給予具有香菇 β-葡聚糖的小鼠的體重顯著增加，並且兩個 βG-處理組都改善了疾病活動指數 (DAI)。與 DSS 組相比，組織病理學分析顯示兩個 βG 治療組的炎症細胞浸潤在結腸組織中顯著降低。此外，β-葡聚糖的口服給藥降低了丙二醛 (MDA) 和髓質過氧化物酶 (MPO) 的濃度，並抑制 iNOS 和幾種炎症因子的表達：TNF-α，IL-1β 和 IL-6 以及一氧化氮) 的結腸組織。有絲分裂原活化蛋白激酶 (MAPK) 通路與促炎因子的表達密切相關。在 DSS 誘導的結腸炎模型和 LPS 刺激的 RAW264.7 細胞模型中，βGs 抑制促炎因子的表現並阻斷 JNK / ERK1 / 2 和 p38 的磷酸化; βGs 也抑制 Ser84 處的 Elk-1 的磷酸化和 Ser112 處的 PPARγ 的磷酸化。總之，這些結果表示香菇 βGs 可以抑制 DSS 誘導的潰瘍性結腸炎和減少炎症因子表現。分子機制可能參與抑制 MAPK 信號和減小活化 Elk-1 和活化 PPARγ。

5. Biosynthesis of nanoparticles of metals and metalloids by basidiomycetes.
Preparation of gold nanoparticles by using purified fungal phenol oxidases.

Vetchinkina EP, Loshchinina EA, Vodolazov IR, Kursky VF, Dykman LA, Nikitina VE.

Appl Microbiol Biotechnol. 2016 Oct 7.

擔子菌的金屬和類金屬納米顆粒的生合成。製備金納米顆粒可為純化的真菌酚氧化酶

Abstract

The work shows the ability of cultured Basidiomycetes of different taxonomic groups-Lentinus edodes, Pleurotus ostreatus, Ganoderma lucidum, and Grifola frondosa-to recover gold, silver, selenium, and silicon, to elemental state with nanoparticles formation. It examines the effect of these metal and metalloid compounds on the parameters of growth and accumulation of biomass; the optimal cultivation conditions and concentrations of the studied ion-containing compounds for recovery of nanoparticles have been identified. Using the techniques of transmission electron microscopy, dynamic light scattering, X-ray fluorescence and X-ray phase analysis, the degrees of oxidation of the bio-reduced elements, the ζ -potential of colloidal solutions uniformity, size, shape, and location of the nanoparticles in the culture fluid, as well as on the surface and the inside of filamentous hyphae have been determined. The study has found the part played by homogeneous chromatographically pure fungal phenol-oxidizing enzymes (laccases, tyrosinases, and Mn-peroxidases) in the recovery mechanism with formation of electrostatically stabilized colloidal solutions. A hypothetical mechanism of gold(III) reduction from HAuCl_4 to gold(0) by phenol oxidases with gold nanoparticles formation of different shapes and sizes has been introduced.

摘要

這項工作顯示了不同分類組 - 香菇，平菇，靈芝和舞菇培養的擔子菌的能力，使用金，銀，硒和矽，到納米形成的元素狀態。分析這些金屬和類金屬化合物對生物質生長和積累參數的影響;已經確定了用於回收納米顆粒的所研究的含離子化合物的最佳培養條件和濃

度。使用透射電子顯微鏡，動態光散射，X 射線熒光和 X 射線相分析的技術，生物還原元件的氧化程度，膠體溶液的 ζ -電勢均勻性，尺寸，形狀和納米顆粒的位置在培養液中，以及在絲狀菌絲的表面和內部。該研究發現，在形成靜電穩定的膠體溶液的恢復機制中，通過均質層析純化真菌酚氧化酶（漆酶，酪氨酸酶和 Mn-過氧化物酶）回收膠質溶液是靜電穩定。我們的假設機制通過酚氧化酶用金納米顆粒形成不同形狀和大小的金（III）從 HAuCl_4 還原為金（0）。

6. Effect of Tree Species on Enzyme Secretion by the Shiitake Medicinal Mushroom, *Lentinus edodes* (Agaricomycetes).

Plotnikov EV, Glukhova LB, Sokolyanskaya LO, Karnachuk OV, Solioz M. Int J Med Mushrooms. 2016;18(7):637-44.

樹種對藥用香菇分泌酶的影響

Abstract

We compared cold and hot wood extracts of 3 endemic Siberian trees-namely, *Prunus padus* (bird cherry), *Populus tremula* (aspen), and *Betula* sp. (birch)-on biomass production and laccase and peroxidase secretion in submerged cultures by the medicinal mushroom *Lentinus edodes*. Of the conditions tested, only hot *Prunus* extracts stimulated biomass production, whereas all extracts stimulated laccase and peroxidase secretion, albeit to different extents. A large, differential stimulation of manganese peroxidase was observed by hot *Prunus* extracts. The results highlight important differences between tree species in the stimulation of biomass and enzyme production by *L. edodes* and point to potentially interesting stimulatory factors present in hot *Prunus* extracts. These findings are of relevance in the use of *L. edodes* for medicinal or biotechnological applications.

摘要

我們比較了 3 種地方性西伯利亞樹木的冷和熱木材樹種萃取物，歐洲稠李 (*Prunus padus*)，楊樹楊 (*Populus tremula*) (白楊) 和樺樹 (*Betula* sp.) -以香菇栽培樹種分析其生物質量產生和漆酶和過氧化物酶分泌能力。在測試的條件中，只有歐洲稠李熱萃取物刺激生物質量產生，而所有萃取物刺激漆酶和過氧化物酶分泌，雖然不同程度。通過歐洲稠李熱萃取物觀察到錳過氧化物酶的大差別被刺激而分泌。結果顯示樹種在生物質量的刺激下產生大量和酶分泌量的有顯著差異，指出潛在有趣的刺激因子存在於歐洲稠李熱萃取物。這些發現與用於藥物香菇作為藥用或生物技術有價值性。

7. [Mushroom Extracts Decrease Bone Resorption and Improve Bone Formation.](#)

Erjavec I, Brkljacic J, Vukicevic S, Jakopovic B, Jakopovich I.

Int J Med Mushrooms. 2016;18(7):559-69.

菇類萃取物可減少骨質再吸收和改善骨質形成

Abstract

Mushroom extracts have shown promising effects in the treatment of cancer and various chronic diseases. Osteoporosis is considered one of the most widespread chronic diseases, for which currently available therapies show mixed results. In this research we investigated the in vitro effects of water extracts of the culinary-medicinal mushrooms *Trametes versicolor*, *Grifola frondosa*, *Lentinus edodes*, and *Pleurotus ostreatus* on a MC3T3-E1 mouse osteoblast-like cell line, primary rat osteoblasts, and primary rat osteoclasts. In an animal osteoporosis model, rats were ovariectomized and then fed 2 mushroom blends of *G. frondosa* and *L. edodes* for 42 days. Bone loss was monitored using densitometry (dual-energy X-ray absorptiometry) and micro computed tomography. In the concentration test, mushroom extracts showed no toxic effect on MC3T3-E1 cells; a dose of 24 µg/mL showed the most proliferative effect. Mushroom extracts of *T. versicolor*, *G. frondosa*, and *L. edodes* inhibited osteoclast activity, whereas the extract of *L. edodes* increased osteoblast mineralization and the production of osteocalcin, a specific osteoblastic marker. In animals, mushroom extracts did not prevent trabecular bone loss in the long bones. However, we show for the first time that the treatment with a combination of extracts from *L. edodes* and *G. frondosa* significantly reduced trabecular bone loss at the lumbar spine. Inhibitory properties of extracts from *L. edodes* on osteoclasts and the promotion of osteoblasts in vitro, together with the potential to decrease lumbar spine bone loss in an animal osteoporosis model, indicate that medicinal mushroom extracts can be considered as a preventive treatment and/or a supplement to pharmacotherapy to enhance its effectiveness and ameliorate its harmful side effects.

摘要

菇類萃取物在癌症和各種慢性疾病的治療中顯示出有希望的效果。

骨質疏鬆被認為是最普遍的慢性疾病之一，對於該疾病，目前可用的治療是採用混合治療。在本研究中，我們研究用 MC3T3-E1 小鼠

成骨細胞樣細胞系、原代培養大鼠成骨細胞和原代培養大鼠破骨細胞。藥用雲芝、舞菇、香菇和平菇的水萃取物的細胞體外效應。在動物骨質疏鬆症模型中，將大鼠切除卵巢，然後餵食 2 個菇類舞菇、香菇研磨混合物 42 天。使用光密度測定法（雙能 X 射線吸光度法）和微計算機斷層攝影監測骨損失。在濃度試驗中，菇類萃取物對 MC3T3-E1 細胞沒有毒性作用；24 μ g/ mL 的劑量顯示出最大的增殖效應。雲芝、舞菇和香菇萃取物可抑制破骨細胞活性，而香菇萃取物增加成骨細胞礦化和骨鈣素（一種特定的成骨細胞標記物）的產生。在動物中，菇類萃取物不能防止長骨中的骨小梁流失。然而，我們第一次顯示用來自香菇和舞菇的萃取物的組合的處理顯著減少腰椎的骨小梁損失。體外細胞試驗香菇萃取物對破骨細胞是抑制和促進是成骨細胞，在動物骨質疏鬆症模型中減少腰椎骨流失的潛力，藥用菇類萃取物可以被認為是預防性處理和/或補充藥物療法以提高其有效性和改善其有害的副作用。

8. Role of the NO Synthase System in Response to Abiotic Stress Factors for Basidiomycetes *Lentinula edodes* and *Grifola frondosa*.

Loshchinina EA, Nikitina VE.

Mikrobiologiya. 2016 Mar-Apr;85(2):154-61. Russian.

一氧化氮合成酶系統角色對香菇和舞菇之非生物不利因子反應

Abstract

Effect of stressors (unfavorable pH and temperature or carbon and nitrogen limitation) on the synthesis of the components of the NO synthase signaling system was studied in submerged cultures of xylotrophic basidiomycetes *Lentinula edodes* and *Grifola frondosa*. Marker compounds of the NO synthase signaling system were found in both cultures. A simultaneous increase of the concentrations of NO and citrulline in the culture liquid of the basidiomycetes grown at superoptimal pH and in nitrogen-limited medium indicates the activation of the NO synthase signaling system under such stress conditions.

摘要

液態培養香菇與舞菇的培養物中來研究不利物（不利的 pH 和溫度或碳和氮限制）對 NO 合成酶訊息傳導系統成分的合成的影響。分析兩種培養物中 NO 合成酶訊息傳導系統的標記化合物。在最適 pH 和在氮限制培養基中生長的擔子菌的培養液中 NO 和瓜氨酸的濃度的同時增加表示在這樣的不利條件下 NO 合成酶訊息傳導系統是被活化。

9. [Lentianan protects pancreatic \$\beta\$ cells from STZ-induced damage.](#)

Zhang Y, Mei H, Shan W, Shi L, Chang X, Zhu Y, Chen F, Han X.

J Cell Mol Med. 2016 Oct;20(10):1803-12.

香菇聚醣可保護胰腺 β 細胞免受 STZ 誘導的損傷

Abstract

Pancreatic β -cell death or dysfunction mediated by oxidative stress underlies the development and progression of diabetes mellitus (DM). In this study, we evaluated the effect of lentianan (LNT), an active ingredient purified from the bodies of *Lentinus edodes*, on pancreatic β -cell apoptosis and dysfunction caused by streptozotocin (STZ) and the possible mechanisms implicated. The rat insulinoma cell line INS-1 were pre-treated with the indicated concentration of LNT for 30 min. and then incubated for 24 hrs with or without 0.5 mM STZ. We found that STZ treatment causes apoptosis of INS-1 cells by enhancement of intracellular reactive oxygen species (ROS) accumulation, inducible nitric oxide synthase (iNOS) expression and nitric oxide release and activation of the c-jun N-terminal kinase (JNK) and p38 mitogen-activated protein kinase (MAPK) signalling pathways. However, LNT significantly increased cell viability and effectively attenuated STZ-induced ROS production, iNOS expression and nitric oxide release and the activation of JNK and p38 MAPK in a dose-dependent manner in vitro. Moreover, LNT dose-dependently prevented STZ-induced inhibition of insulin synthesis by blocking the activation of nuclear factor kappa beta and increasing the level of Pdx-1 in INS-1 cells. Together these findings suggest that LNT could protect against pancreatic β -cell apoptosis and dysfunction caused by STZ and therefore may be a potential pharmacological agent for preventing pancreatic β -cell damage caused by oxidative stress associated with diabetes.

摘要

由氧化反應會誘導的胰腺 β -細胞死亡或功能障礙是糖尿病

(DM) 的發展和進展的基礎。在這項研究中，我們評估了香菇

聚醣 (LNT)，一種活性成分從香菇子實體中純化對胰腺 β -細胞

凋亡和鏈球菌素 (STZ) 引起的功能障礙和相關的可能機制的影

響。大鼠胰島瘤細胞系 INS-1 用指定濃度的 LNT 預處理 30 分鐘。然後在有或沒有 0.5mM STZ 的情況下培養 24 小時。我們發現 STZ 治療通過增強細胞內活性氧 (ROS) 積累，誘導型一氧化氮合酶 (iNOS) 表現和一氧化氮釋放和 c-jun N 末端激酶 (JNK) 的活化而引起 INS-1 細胞的凋亡和 p38 有絲分裂原活化蛋白激酶 (MAPK) 訊息路徑。然而，LNT 顯著增加細胞活力，並在體外以劑量依賴相關性方式有效減弱 STZ 誘導的 ROS 產生，iNOS 表達和一氧化氮釋放以及 JNK 和 p38 MAPK 的活化。此外，LNT 劑量相關性地阻止 STZ 誘導的胰島素合成的抑制，通過阻斷核因子 κ B 的活化和增加 INS-1 細胞中 Pdx-1 的含量。這些研究結果表示 LNT 可以保護免受由 STZ 引起的胰腺 β -細胞凋亡和功能障礙，因此可以用於預防由與糖尿病相關的氧化反應引起的胰腺 β -細胞損傷的潛在藥物。

10. Anti-tumor effect of β -glucan from *Lentinus edodes* and the underlying mechanism.

Xu H, Zou S, Xu X, Zhang L.

Sci Rep. 2016 Jun 29;6:28802

香菇的 β -葡聚糖的抗腫瘤作用和機制

Abstract

β -Glucans are well known for its various bioactivities, but the underlying mechanism has not been fully understood. This study focuses on the anti-tumor effect and the potential mechanism of a branched β -(1, 3)-glucan (LNT) extracted from *Lentinus edodes*. The in vivo data indicated that LNT showed a profound inhibition ratio of \sim 75% against S-180 tumor growth, even significantly higher than the positive control of Cytoxan (\sim 54%). Interestingly, LNT sharply promoted immune cells accumulation into tumors accompanied by cell apoptosis and inhibition of cell proliferation during tumor development. Furthermore, LNT not only up-regulated expressions of the tumor suppressor p53, cell cycle arrestin p21 and pro-apoptotic proteins of Bax and caspase 3/9, but also down-regulated PARP1 and anti-apoptotic protein Bcl-2 expressions in tumor tissues. It was first found that LNT initiated p53-dependent signaling pathway to suppress cell proliferation in vitro, and the caspase-dependent pathway to induce cell apoptosis in vivo. The underlying anti-tumor mechanism was proposed that LNT activated immune responses to induce cell apoptosis through caspase 3-dependent signaling pathway and to inhibit cell proliferation possibly via p53-dependent signaling pathway in vivo. Besides, LNT inhibited angiogenesis by suppressing VEGF expression, leading to slow progression of tumors.

摘要

β -葡聚糖在各種生物活性而眾所周知，但其基本機制尚未完全了

解。本研究的重點是從香菇萃取的支鏈 β -(1,3)-葡聚糖

(LNT) 的抗腫瘤效果和機制。動物體內研究資料顯示 LNT 顯

示對於 S-180 腫瘤生長的 \sim 75% 的顯著抑制率，甚至顯著高於環

磷酰胺的陽性對照 (\sim 54%)。有趣的是，LNT 可促進免疫細胞

積累到腫瘤伴隨細胞凋亡和抑制腫瘤發展期間的細胞增殖。此外，LNT 不僅在上路徑調控腫瘤抑制基因 p53，細胞週期抑制蛋白 p21 和 Bax 和 caspase 3/9 的促凋亡蛋白的表達，且下路徑調控腫瘤組織中的 PARP1 和抗凋亡蛋白 Bcl-2 表現。它首次發現 LNT 啟動 p53 信息傳遞路徑，以體外抑制細胞增殖，和 caspase 傳遞路徑誘導體內細胞凋亡。基本的抗腫瘤機制提出 LNT 活化免疫反應，通過 caspase 3 信息傳遞路徑誘導細胞凋亡，並可能通過體內 p53 信息傳遞路徑抑制細胞增殖。此外，LNT 經由抑制 VEGF 表現抑制血管生成，導致腫瘤的緩慢進展。

11. Polysaccharide from *Lentinus edodes* combined with oxaliplatin possesses the synergy and attenuation effect in hepatocellular carcinoma.

Zhang Y, Li Q, Wang J, Cheng F, Huang X, Cheng Y, Wang K.

Cancer Lett. 2016 Jul 28;377(2):117-25.

香菇的多醣與奧沙利鉑聯合在肝細胞癌中具有協同作用和減毒作用

Abstract

Despite the great progress in the treatment of hepatocellular carcinoma, combination chemotherapy is still the main choice of treatment for patients with unresectable metastatic or recurrent hepatocellular cancer. Lentinan, which has been used as an immunomodulator in the treatment of cancer, possesses anti-tumor activities. However, the mechanisms by which Lentinan inhibits hepatocellular carcinoma remain unknown. Our study showed that Lentinan has a significantly synergistic anti-tumor effect with oxaliplatin against HepG2 cells in vitro and in H22 tumor-bearing mice through the mitochondria pathway and for the inhibition of NF- κ B, Stat3 and survivin signaling. Moreover, Lentinan moderated side effects induced by oxaliplatin. These findings suggested that Lentinan may be an ideal agent for the combination therapy of oxaliplatin against hepatocellular carcinoma.

摘要

儘管在治療肝細胞癌方面取得了巨大進展，但聯合化療仍然是運用在不能切除的轉移性或復發性肝細胞癌患者的主要選擇。在癌症治療中用作免疫調節劑的香菇素具有抗腫瘤活性。香菇聚醣抑制肝細胞癌的機制仍然未知。我們的研究顯示，香菇聚醣與奧沙利鉑 oxaliplatin 對 HepG2 細胞體外和 H22 荷瘤小鼠經由粒線體途徑和抑制 NF- κ B，Stat3 和存活素信息具有顯著協同抗腫瘤作用。此外，香菇聚醣可以緩解因奧沙利鉑誘導的副作用。這

些發現表示，香菇聚醣可能是奧沙利鉑與肝細胞癌聯合治療的理想藥物。

12. Lentinan mitigates therarubicin-induced myelosuppression by activating bone marrow-derived macrophages in an MAPK/NF- κ B-dependent manner.

Liu Q, Dong L, Li H, Yuan J, Peng Y, Dai S.

Oncol Rep. 2016 Jul;36(1):315-23.

香菇聚醣經由以 MAPK / NF- κ B 依賴性方式活化骨髓來源的巨噬細胞來緩解吡柔比星誘導的骨髓抑制

Abstract

Bone marrow (BM) suppression (also known as myelosuppression) is the most common and most severe side-effect of therarubicin (THP) and thereby limits the clinical application of this anticancer agent. Lentinan (LNT), a glucan extracted from dried shiitake mushrooms (*Lentinula edodes*), exhibits a variety of pharmacological activities. The objectives of the present study were to determine the effect of LNT on the myelosuppression of THP-treated mice and to examine the pharmacological mechanism of these effects. In vivo experiments indicated that non-cytotoxic levels of LNT strongly increased blood myeloperoxidase (MPO) activity; improved BM structural injuries; increased the numbers of leukocytes and neutrophils in the blood and BM; elevated the blood levels of granulocyte colony-stimulating factor (G-CSF), granulocyte-macrophage colony-stimulating factor (GM-CSF) and macrophage colony-stimulating factor (M-CSF); and reduced the self-healing period in THP-treated mice. In vitro experiments indicated that LNT increased the viability of BM-derived macrophages (BMDMs) in a time- and dose-dependent manner without toxic side-effects and markedly increased the release of G-CSF, GM-CSF and M-CSF by BMDMs. Further analyses revealed that LNT activated the NF- κ B and MAPK signalling pathways and promoted the nuclear import of p65 and that BAY 11-7082 (a specific inhibitor of NF- κ B) suppressed the release of G-CSF, GM-CSF and M-CSF. Furthermore, we found that U0126, SB203580 and SP600125 (specific inhibitors of ERK, p38 and JNK, respectively) markedly inhibited the IKK/I κ B/NF- κ B-dependent release of G-CSF, GM-CSF and M-CSF. In conclusion, LNT induces the production of G-CSF, GM-CSF and M-CSF by activating the MAPK/NF- κ B signalling pathway in BM cells, thereby mitigating THP-induced myelosuppression.

摘要

骨髓 (BM) 抑制 (也稱為骨髓抑制) 是吡柔比星 therarubicin

(THP) 的最常見和最嚴重的副作用，而被限制該抗癌劑的臨床應用。香菇 (Lentinan) (LNT) 是從乾燥的香菇提取的葡聚糖，表現出多種藥理活性。本研究的目的是確定 LNT 對 THP 處理的小鼠的骨髓抑制的作用並檢查這些作用的藥理學機制。體內實驗表明非細胞毒性含量的 LNT 強烈增加血液髓質過氧化物酶 (MPO) 活性;改善 BM 結構損傷;增加血液和 BM 中的白血球細胞和嗜中性顆粒細胞的數量;提高顆粒性白血球細胞集落刺激因子 (G-CSF)，粒細胞 - 巨噬細胞集落刺激因子 (GM-CSF) 和巨噬細胞集落刺激因子 (M-CSF) 的血液水平;並降低 THP 治療小鼠的自愈期。體外實驗表明 LNT 以時間和劑量相關性方式增加 BM 衍生的巨噬細胞 (BMDM) 的存活力，沒有毒性副作用，並且顯著增加 BMDM 的 G-CSF，GM-CSF 和 M-CSF 的釋放。進一步的分析表明，LNT 激活 NF- κ B 和 MAPK 信號通路並促進 p65 的細胞核進入，並且 BAY 11-7082 (NF- κ B 的特異性抑製劑) 抑制 G-CSF，GM-CSF 和 M-CSF。此外，我們發現 U0126，SB203580 和 SP600125 (分別為 ERK，p38 和 JNK 的特異性抑製劑) 顯著抑制 G-CSF，GM-CSF 和 M-CSF 的 IKK /I κ B/ NF- κ B 釋放。總之，LNT 通過活化 BM 細胞中的 MAPK / NF- κ B 信號途徑，從而減輕 THP 誘導的骨髓抑制，誘導 G-CSF，GM-CSF 和

M-CSF 的產生。

13. [Effects of indoor and outdoor cultivation conditions on ¹³⁷Cs concentrations in cultivated mushrooms produced after the Fukushima Daiichi Nuclear Power Plant accident.](#)

Tagami K, Uchida S, Ishii N.

J Sci Food Agric. 2017 Jan;97(2):600-605.

福島第一核電站事故後生產的栽培香菇中室內和室外栽培條件對¹³⁷Cs 濃度的影響

Abstract

BACKGROUND:

Radiocesium (¹³⁴Cs and ¹³⁷Cs) in mushrooms has been a matter of public concern after the accident at Fukushima Daiichi Nuclear Power Plant. To minimize the internal dose by ingestion of cultivated mushrooms, the Japanese government set a guideline level with respect to the radiocesium concentration in bed-logs and mushroom beds; however, the effects of indoor and outdoor cultivation methods on radiocesium concentrations in cultivated mushrooms were not clear.

RESULTS:

The effects of indoor and outdoor cultivation on the radiocesium concentrations in mushroom were examined using published food monitoring data. ¹³⁷Cs concentration data in *Lentinula edodes* from the Aizu area in Fukushima Prefecture and seven prefectures outside Fukushima were used for the analysis. No statistically significant ¹³⁷Cs concentration differences were found between these two cultivation methods. Using detected ¹³⁷Cs data in shiitake, the geometric means from each prefecture were less than one-quarter of the standard limit (100 Bq kg⁻¹) for total radiocesium under both cultivation conditions.

CONCLUSION:

It was suspected that re-suspended radiocesium might have been taken up by mushrooms or that radiocesium might have been absorbed into the mushrooms from the soil in the outdoor cultures. However, neither effect was significant for cultivated mushrooms in the areas examined.

摘要

背景：

在福島第一核電站事故發生後，香菇中的鈯（ ^{134}Cs 和 ^{137}Cs ）一直是公眾關注的問題。為了通過攝取栽培的香菇來使內部劑量最小化，日本政府針對栽培床和香菇床中的放射性鈯濃度設定含量標準；然而，室內和室外栽培方法對栽培香菇中放射性鈯濃度的影響不清楚。

結果：

使用公佈的食品監測數據檢查室內和室外栽培對蘑菇的放射性鈯濃度的影響。來自福島縣的 Aizu 地區和福島縣以外的 7 個縣的香菇中的 ^{137}Cs 濃度數據用於分析。在這兩種培養方法之間沒有發現統計學上顯著的 ^{137}Cs 濃度差異。使用檢測到的 ^{137}Cs 數據，在兩種栽培條件下，每個縣的幾何平均值小於總鐳的標準限值（ 100 Bq kg^{-1} ）的四分之一。

結論：

質疑放射性鈯可能已被福島植栽香菇吸收，或放射性鈯可能已從戶外培養物中的土壤吸收到香菇中。然而，對於此研究區域中的栽培的蘑菇，兩種效果都不顯著。

14. Extracts from *Lentinula edodes* (Shiitake) Edible Mushrooms Enriched with Vitamin D Exert an Anti-Inflammatory Hepatoprotective Effect.

Drori A, Shabat Y, Ben Ya'acov A, Danay O, Levanon D, Zolotarov L, Ilan Y. J Med Food. 2016 Apr;19(4):383-9.

香菇的萃提取物富含維生素 D 的可食用菇發揮抗炎性保肝作用

Abstract

Vitamin D has been known for its anti-inflammatory properties. Extracts derived from *Lentinula edodes* (Shiitake) edible mushroom exert an anti-inflammatory effect. These extracts contain high levels of ergosterol, which converts into ergocalciferol (vitamin D₂) following exposure to ultraviolet light, followed by absorption and hydroxylation into the active form 25-hydroxyvitamin D [25(OH)D]. To determine the anti-inflammatory effect of overexpression of vitamin D in edible mushrooms, *L. edodes* mushrooms were exposed to ultraviolet-B light, freeze-dried, followed by measurement of vitamin D₂ contents, in their dry weight. C57B1/6 mice were orally treated with vitamin D₂-enriched or nonenriched mushroom extract prior and during concanavalin A-immune-mediated liver injury. Exposure to ultraviolet light increased vitamin D₂ content in Shiitake edible mushrooms. Following feeding of vitamin D-enriched mushroom extracts to mice with immune-mediated hepatitis, a significant decrease in liver damage was noted. This was shown by a decrease in alanine aminotransferase and aspartate aminotransferase serum levels, a decrease in proportion of mice with severe liver injury, and by improvement in liver histology. These effects were associated with a decrease in serum interferon gamma levels. A synergistic effect was noted between the anti-inflammatory effect of the mushroom extracts and that of vitamin D. Oral administration of vitamin D-enriched *L. edodes* edible mushroom exerts a synergistic anti-inflammatory effect in the immune-mediated hepatitis. The data support its potential use as safe immunomodulatory adjuvant for the treatment of HCV and nonalcoholic steatohepatitis.

摘要

維生素 D 具有抗炎性質而聞名，香菇的萃提取物發揮抗炎效果。這些萃提取物含有高含量的麥角固醇，放在暴露於紫外光後轉化為麥角鈣化醇（維生素 D₂），隨後吸收和羥基化成活性形式的 25-

經基維生素 D [25 (OH) D]。為了確認維生素 D 在食用後中的表現出的抗炎作用，將香菇暴露於紫外線-B 光，冷凍乾燥，然後測量其乾重中的維生素 D₂ 含量。使用刀豆球蛋白 A 免疫誘導造成肝損傷之前和期間，用維生素 D₂ 富集的或非富集的香菇提取物對 C57B1/6 小鼠進行口服治療。暴露於紫外光後可增加香菇食用中的維生素 D₂ 含量，再將富含維生素 D 的香菇萃取物餵養給具有免疫誘導的肝炎的小鼠後，觀察肝損傷的顯著減少。這通過丙氨酸氨基轉移酶和天冬氨酸氨基轉移酶血清水平含量降低，具有嚴重肝損傷的小鼠的比例是降低以及通過肝組織學是有改善。這些效應與血清干擾素 γ 含量降低相關。在香菇萃取物的抗炎作用和維生素 D 的抗炎作用之間作用是有協同效應。口服施用富含維生素 D 的食用香菇在免疫誘導的肝炎中發揮協同抗炎作用。該數據支持其作為用於治療 HCV 和非酒精性脂肪性肝炎的安全免疫調節佐劑的潛在用途。

15. Water-Soluble Compounds from *Lentinula edodes* Influencing the HMG-CoA Reductase Activity and the Expression of Genes Involved in the Cholesterol Metabolism.

Gil-Ramírez A, Caz V, Smiderle FR, Martin-Hernandez R, Largo C, Tabernero M, Marín FR, Iacomini M, Reglero G, Soler-Rivas C.

J Agric Food Chem. 2016 Mar 9;64(9):1910-20.

由香菇的水溶性化合物來影響 HMG-CoA 還原酶活性和參與膽固醇

代謝基因的表現

Abstract

A water extract from *Lentinula edodes* (LWE) showed HMG-CoA reductase inhibitory activity but contained no statins. NMR indicated the presence of water-soluble α - and β -glucans and fucomannogalactans. Fractions containing derivatives of these polysaccharides with molecular weight down to approximately 1 kDa still retained their inhibitory activity. Once digested LWE was applied to Caco2 in transport experiments, no significant effect was noticed on the modulation of cholesterol-related gene expression. But, when the lower compartment of the Caco2 monolayer was applied to HepG2, some genes were modulated (after 24 h). LWE was also administrated to normo- and hypercholesterolemic mice, and no significant lowering of serum cholesterol levels was observed; but reduction of triglycerides in liver was observed. However, LWE supplementation modulated the transcriptional profile of some genes involved in the cholesterol metabolism similarly to simvastatin, suggesting that it could hold potential as a hypolipidemic/hypocholesterolemic extract, although further dose-dependent studies should be carried out.

摘要

香菇水萃取物 (LWE) 發現有 HMG-CoA 還原酶抑制活性，萃取物內含物但不含他汀類藥物。NMR 顯示萃取物有水溶性 α -和 β -葡聚糖和呔喃半乳聚糖，含有分子量低至約 1kDa 的這些多糖衍生物的部份仍保持其抑制活性，被分解的 LWE 在運輸實驗中應用於 Caco2 細胞，對膽固醇相關基因表達的調節沒有顯著的影

響。但是，當 Caco2 單層的下隔室使用 HepG2 細胞時，發現部份基因是被調節改變（24 小時後）。LWE 給予正常和高膽固醇血小鼠，沒有觀察到血清膽固醇含量的顯著降低；但解剖後觀察到肝臟中甘油三酯是減少。然而，給予 LWE 調節參與膽固醇代謝的一些基因的轉錄圖譜類似於辛伐他汀，表示可以作為低血脂/低膽固醇血症的萃取物潛力，但仍需進一步劑量依賴性研究進行。

16. Elm Tree (*Ulmus parvifolia*) Bark Bioprocessed with Mycelia of Shiitake (*Lentinus edodes*) Mushrooms in Liquid Culture: Composition and Mechanism of Protection against Allergic Asthma in Mice.

Kim SP, Lee SJ, Nam SH, Friedman M.

J Agric Food Chem. 2016 Feb 3;64(4):773-84.

榆樹（榆樹）樹皮生物處理的香菇液體培養菌絲體：保護小鼠過敏性哮喘的成分和機制

Abstract

Mushrooms can break down complex plant materials into smaller, more digestible and bioactive compounds. The present study investigated the antiasthma effect of an *Ulmus parvifolia* bark extract bioprocessed in *Lentinus edodes* liquid mycelium culture (BPUBE) against allergic asthma in chicken egg ovalbumin (OVA)-sensitized/challenged mice. BPUBE suppressed total IgE release from U266B1 cells in a dose-dependent manner without cytotoxicity. Inhibitory activity of BPUBE against OVA-specific IgE secretion in bronchoalveolar lavage fluid (BALF) was observed in OVA-sensitized/challenged asthmatic mice. BPUBE also inhibited OVA-specific IgG and IgG1 secretion into serum from the allergic mice, suggesting the restoration of a Th2-biased immune reaction to a Th1/Th2-balanced status, as indicated by the Th1/Th2 as well as regulatory T cell (Treg) cytokine profile changes caused by BPUBE in serum or BALF. Inflammatory cell counts in BALF and lung histology showed that leukocytosis and eosinophilia induced by OVA-sensitization/challenge were inhibited by the oral administration of BPUBE. Amelioration of eosinophil infiltration near the trachea was associated with reduced eotaxin and vascular cell adhesion molecule-1 (VCAM-1) levels. Changes in proinflammatory mediator levels in BALF suggest that BPUBE decreased OVA-sensitization-induced elevation of leukotriene C4 (LTC4) and prostaglandin D2 (PGD2). The finding that asthma-associated biomarker levels of OVA-sensitized/challenged mice were much more inhibited with BPUBE treatment than NPUBE (not-bioprocessed *Ulmus parvifolia* extract) treatment suggested the production of new bioactive compounds by the mushroom mycelia that may be involved in enhancing the observed antiasthmatic properties. The possible relation of the composition determined by proximate analysis and GC/MS to observed bioactivity is discussed. The results suggest that the elm tree (*Ulmus parvifolia*) bark bioprocessed with mycelia of shiitake (*Lentinus edodes*) mushrooms has the potential to prevent and/or treat allergic asthma.

摘要

菇類可以將複雜的植物材料分解成更小，變成更易消化和生物活性的化合物。本研究探討在雞蛋卵白蛋白（OVA）被過敏化的小鼠中，以生物處理的榆樹（*Ulmus parvifolia*）樹皮萃取物對過敏性哮喘，使用香菇液態培養菌絲體培養物（BPUBE）抗哮喘作用。

BPUBE 以劑量相關性方式抑制從 U266B1 細胞的總 IgE 釋放，但沒有細胞毒性。在 OVA 致敏/激發的哮喘小鼠中觀察到支氣管肺泡灌洗液（BALF）中 BPUBE 對 OVA 特異性 IgE 分泌的抑制活性。

BPUBE 也抑制 OVA 特異性 IgG 和 IgG1 分泌到來自過敏小鼠的血清中，表示 Th1 / Th2 平衡狀態恢復 Th2 偏向的免疫反應，如 Th1 / Th2 以及調節性 T 細胞所示 Treg 細胞因子圖譜變化引起的血清或

BALF 中的 BPUBE。BALF 和肺組織學中的炎症細胞計數顯示，經由口服給予 BPUBE 可抑制由 OVA 致敏誘導的白血球細胞增多和嗜

酸性顆粒細胞增多。改善嗜酸性顆粒細胞在氣管附近的浸潤與減少嗜酸性細胞活化趨化因子和血管細胞粘附分子-1（VCAM-1）水

平有關。BALF 中促進發炎介質含量的變化表明 BPUBE 降低 OVA 致敏誘導的白三烯 C4（LTC4）和前列腺素 D2（PGD2）的升高。

與 NPUBE（未生物處理的榆樹萃取物）處理相比，用 BPUBE 處理更多地抑制 OVA 致敏的小鼠的哮喘相關生物標誌物程度的發現，表

示可能參與增強的香菇菌絲體生產新的生物活性化合物觀察到的哮喘性質。討論中經由 GC / MS 確定的組合物與觀察到的生物活性的可能關係。結果表示，榆樹（榆樹）樹皮生物培養介質的香菇具有預防和/或治療過敏性哮喘的潛力。

17. [Antimicrobial and antitumor activities of chitosan from shiitake stipes, compared to commercial chitosan from crab shells.](#)

Chien RC, Yen MT, Mau JL.

Carbohydr Polym. 2016 Mar 15;138:259-64.

香菇的甲殼聚醣的與螃蟹殼的商業品化甲殼聚醣相比較其抗微生物和抗腫瘤活性

Abstract

Chitosan was prepared by alkaline N-deacetylation of chitin obtained from shiitake stipes and crab shells and its antimicrobial and antitumor activities were studied. Chitosan from shiitake stipes and crab shells exhibited excellent antimicrobial activities against eight species of Gram positive and negative pathogenic bacteria with inhibition zones of 11.4-26.8mm at 0.5mg/ml. Among chitosan samples, shiitake chitosan C120 was the most effective with inhibition zones of 16.4-26.8mm at 0.5mg/ml. In addition, shiitake and crab chitosan showed a moderate anti-proliferative effect on IMR 32 and Hep G2 cells. At 5mg/ml, the viability of IMR 32 cells incubated with chitosan was 68.8-85.0% whereas that of Hep G2 cells with chitosan was 60.4-82.9%. Overall, shiitake chitosan showed slightly better antimicrobial and antitumor activities than crab chitosan. Based on the results obtained, shiitake and crab chitosan were strong antimicrobial agents and moderate antitumor agents.

摘要

甲殼聚醣是可由從香菇和螃蟹殼獲得的甲殼多醣，再進行鹼性 N-去乙酰化製備，用來其抗微生物和抗腫瘤活性可以用來研究。由香菇和螃蟹殼的甲殼聚醣對 8 種革蘭氏陽性和陰性病原菌表現出優異的抗菌活性，在 0.5mg / ml 具有 11.4-26.8 mm 的抑制區。在兩種甲殼聚醣樣品中，香菇甲殼聚醣 C120 是最有效的，在 0.5mg / ml 的抑制區為 16.4-26.8 mm。此外，香菇和蟹甲殼聚醣對 IMR 32 和 Hep G2 細胞顯示出適度的抗增殖作用。在 5mg /

ml，與甲殼聚醣孵育的 IMR 32 細胞的存活力為 68.8-85.0%，而具有甲殼聚醣的 Hep G2 細胞的存活力為 60.4-82.9%。總的來說，與螃蟹的甲殼聚醣相比，香菇殼聚醣顯示出更好的抗微生物和抗腫瘤活性。基於所獲得的結果，香菇和螃蟹甲殼聚醣是強抗菌劑和中等抗腫瘤劑。