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吡咯喹啉醌对脂肪肝蛋鸡肝损伤的保护作用机制

赵芹[1], 张海军[1], 武书庚[1], 岳洪源[1], 王晶[1], 齐广海[1], 孙琳琳[2]

1. 中国农业科学院饲料研究所, 农业部饲料生物技术重点开放实验室, 北京 100081;
2. 上海医学生命科学研究中心有限公司, 上海 200032

Protective Mechanisms of Dietary Pyrroloquinoline Quinine on Fatty Liver Laying Hens

ZHAO Qin[1], ZHANG Haijun[1], WU Shugeng[1], YUE Hongyuan[1], WANG Jing[1], QI Guanghai[1], SUN Linlin[2]

1. Key Laboratory of Feed Biotechnology of Ministry of Agricultural, Feed Research Institute, The Chinese Academy of Agricultural Science, Beijing 100081, China;
2. Shanghai Medical Life Science Research Center Co., Ltd., Shanghai 200032, China

摘要 本试验旨在研究吡咯喹啉醌（PQQ）防治蛋鸡脂肪肝综合征的作用机制。选用29周龄海兰褐蛋鸡288只，随机分为4组，每组6个重复，每个重复12只鸡。Ⅰ组为对照组，饲喂基础饲粮（代谢能11.03 MJ/kg，粗蛋白质16.2%）；Ⅱ组为病理模型组，饲喂高能低蛋白质饲粮（代谢能12.75 MJ/kg，粗蛋白质13.0%）；Ⅲ和Ⅳ组分别在Ⅱ组的高能低蛋白质饲粮基础上添加0.08和0.16 mg/kg的PQQ。试验期4周。结果表明：1）与Ⅰ组相比，Ⅱ组高能低蛋白质饲粮成功诱导了蛋鸡脂肪肝试验模型，表现为肝细胞弥散性脂肪变性，肝脏中甘油三酯、总胆固醇含量显著升高（$P<0.05$），血浆谷丙转氨酶活性显著升高（$P<0.05$）；2）饲粮PQQ可显著抑制高能低蛋白质饲粮引起的肝脏中甘油三酯和总胆固醇含量及血浆中谷丙转氨酶活性的升高（$P<0.05$），达到与对照组相当的水平；3）饲粮PQQ可显著抑制高能低蛋白质饲粮引起的肝脏中超氧化物歧化酶活性降低和丙二醛含量升高（$P<0.05$）；4）饲粮PQQ可显著抑制高能低蛋白质饲粮引起的蛋鸡肝脏线粒体相对含量减少（$P<0.05$），抑制柠檬酸脱氢酶和细胞色素C氧化酶活性降低（$P<0.05$）；5）饲粮PQQ可阻止采食高能低蛋白质饲粮的蛋鸡发生脂肪肝，维持与正常对照组相当的水平，不同剂量PQQ之间未见显著差异（$P>0.05$）。由此可见，饲粮PQQ可通过改善蛋鸡肝脏线粒体功能、调节脂质代谢和抗氧化功能预防蛋鸡脂肪肝综合征。

关键词： 吡咯喹啉醌 蛋鸡脂肪肝综合征 高能低蛋白质饲粮 脂质代谢 线粒体

Abstract： This experiment was conducted to investigate the protective mechanisms of dietary pyrroloquinoline quinine (PQQ) on laying hens with fatty liver syndrome. Two hundred and eighty eight Hy-Line brown laying hens aged 29 weeks were randomly divided into 4 groups with 6 replicates per group and 12 hens per replicate. Hens in group Ⅰ (control group) were fed a basal diet (ME 11.03 MJ/kg; CP 16.2%), hens in group Ⅱ (pathological model control group) were fed a high-energy low-protein diet (ME 12.75 MJ/kg; CP 13.0%), and hens in groups Ⅲ and Ⅳ were fed the high-energy low-protein diet (the same as group Ⅱ) supplemented with 0.08 or 0.16 mg/kg PQQ, respectively. The experiment lasted for 4 weeks. The results showed as follows: 1) compared with the control group, high-energy low-protein diet in group Ⅱ successfully induced experimental fatty liver model; there were large quantity of fat degeneration in livers from pathological model control; the contents of triglyceride and total cholesterol in liver, and the plasma alanine aminotransferase activity in group Ⅱ were significantly increased ($P<0.05$). 2) Dietary PQQ strikely suppressed the elevation of contents of triglyceride and total cholesterol in liver, and the plasma alanine aminotransferase activity caused by high-energy low-protein diet ($P<0.05$), to the same levels as normal control. 3) Dietary PQQ significantly prevented the decrease of superoxide dismutase activity, and the increase of malondialdehyde content induced by high-energy low-protein diet ($P<0.05$). 4) Dietary PQQ significantly inhibited the decrease of mitochondrial relative content and the activities of citrate synthase and cytochrome C oxidase induced by high-energy low-protein diet ($P<0.05$). In conclusion, dietary PQQ can prevent the fatty liver syndrome induced by high-energy low-protein diets by improving mitochondrial function, and regulating the lipid metabolism and anti-oxidative activities in the liver.

Keywords： pyrroloquinoline quinine, laying hen fatty liver syndrome, lipid metabolism, anti-oxidation, mitochondria

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通讯作者 武书庚，副研究员，硕士生导师，E-mail：wushugeng@caas.cn；齐广海，研究员，博士生导师，E-mail：qiguanghai@caas.cn Email: wushugeng@caas.cn; qiguanghai@caas.cn

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[1] PESSAYRE D.Role of mitochondria in non-alcoholic fatty liver disease[J].Journal of Gastroenterology and Hepatology, 2007, 22(1):S20-S27.

[2] 闵向荣, 赵永芳.PQQ对四氯化碳和乙醇引起大鼠肝损伤的保护作用[J].武汉大学学报, 2001(6):757-760.

[3] 徐磊, 张海军, 武书庚, 等.吡咯喹啉醌对蛋鸡生产性能、蛋品质及抗氧化功能的影响[J].动物营养学报, 2011, 23(8):1370-1377.

[4] STITES T E, STORMS D, BAUERLY K, et al.Pyrroloquinoline quinone modulates mitochondrial quantity and function in mice[J].The Journal of Nutrition, 2006, 136(2):390-396.

[5] FOLCH J, LEES M, SLOANE G H.A simple method for the isolation and purification of total lipides from animal tissues[J].The Journal of Biological Chemistry, 1957, 226(1):497-509.

[6] 郭小权, 曹华斌, 胡国良, 等.高能量低蛋白质日粮中添加生物素对蛋鸡脂类代谢的影响[J].中国兽医学报, 2012, 32(5):754-758.

[7] STEINBERG F M, GERSHWIN M E, BUCKER R B, et al.Dietary Pyrroloquinoline quinone:growth and immune response in BALB/c mice[J].The Journal of Nutrition, 1994, 124(5):744-753.

[8] BAUERLY K, HARRIS C, CHOWANADISAI W, et al.Altering pyrroloquinoline quinone nutritional status modulates mitochondrial, lipid, and energy metabolism in rats[J].PLoS One, 2011, 6(7):e21779.

[9] 徐磊.日粮中添加吡咯喹啉醌对产蛋鸡生产性能和抗氧化机能的影响[D].硕士学位论文.北京:中国农业科学院, 2011:27-29.

[10] 郭小权, 胡国良, 曹华斌, 等.高能低蛋白日粮致脂肪肝出血综合征鸡抗氧化能力和肝损伤的研究[J].中国兽医学报, 2010, 30(6):829-832.

[11] OLIVEIRA C P M S, COELHO A M M, BARBEIRO H V, et al.Liver mitochondrial dysfunction and oxidative stress in the pathogenesis of experimental nonalcoholic fatty liver disease[J].Brazilian Journal of Medical and Biological Research, 2006, 39(2):189-194.

[12] GONG D, GENG C, JIANG L, et al.Effect of pyrroloquinoline quinone on neuropathic pain following chronic constriction injury of the sciatic nerve in rats[J].European Journal of Pharmacology, 2012, 697(1/2/3):53-58.

[1] 潘瑜, 陈文燕, 林仕梅, 高启平, 罗莉.亚麻油替代鱼油对鲤鱼生长性能、肝胰脏脂质代谢及抗氧化能力的影响[J]. 动物营养学报, 2014,26(2): 420-426

[2] 牛化欣, 雷霁霖, 常杰, 贾玉东, 高淳仁.冰鲜野杂鱼和商品饲料对大菱鲆生长、脂质代谢及抗氧化功能的影响[J]. 动物营养学报, 2013,25(11): 2696-2704

[3] 黄骆镰, 龚凌霄, 刘聪, 吴晓琴, 张英.饲粮中添加竹青素对肉鸡脂质代谢的影响[J]. 动物营养学报, 2013,25(1): 148-155

[4] 张文旭, 李文立.过氧化物酶体增殖剂激活受体γ的结构特征和生物学功能[J]. 动物营养学报, 2012,24(9): 1628-1635

[5] 潘瑜, 毛述宏, 关勇, 林鑫, 林仕梅, 高启平, 罗莉.饲料中不同脂肪源对鲤鱼生长性能、脂质代谢和抗氧化能力的影响 [J]. 动物营养学报, 2012,24(7): 1368-1375

[6] 杨秋霞, 王洪芳, 陈辉, 黄仁录, 王翠菊, 高杨.饲粮中添加黄芪多糖对蛋鸡血清及蛋黄中脂肪性状的影响[J]. 动物营养学报, 2011,23(12): 2143-2148

[7] 蔡教英, 欧阳克蕙, 上官新晨, 徐明生, 刘姚, 王文君, 瞿明仁.脂质代谢组学的研究进展[J]. 动物营养学报, 2011,23(11): 1870-1876

[8] 夏素银, 王成章, 詹发柏, 刘起栓, 陈艳荣, 李海艳.苜蓿草粉和纤维素酶对蛋鸡脂质代谢、抗氧化能力及肠道菌群的影响[J]. 动物营养学报, 2011,23(11): 1991-1999

[9] 徐少辉，武书庚，张海军，齐广海*.饲粮中添加L-肉碱对产蛋鸡生产性能、蛋品质及脂质代谢的影响[J]. 动物营养学报, 2011,23(04): 640-646

[10] 徐少辉，武书庚，张海军，岳洪源，齐广海*.L-肉碱生理作用及其机理的研究进展[J]. 动物营养学报, 2011,23(03): 357-363

[11] 郭小权，胡国良*，曹华斌，张彩英，李浩棠.高能量低蛋白质日粮对蛋鸡载脂蛋白AⅠ和脂质代谢的影响[J]. 动物营养学报, 2010,22(01): 187-193

[12] 李静，井婧，李绍钰，焦玉萍，魏凤仙，王琳燚，孙全友，徐彬.硒和铬对蛋鸡脂质代谢及鸡蛋硒含量的影响[J]. 动物营养学报, 2009,21(04): 540-545

[13] 耿爱莲[1] 李保明[1] 闪于明 袁建敏.辅酶Q10对腹水症敏感肉鸡肝线粒体功能及抗氧化能力的影响[J]. 动物营养学报, 2006,18(02): 86-92

[14] 杜荣,秦健,王俊东.L-肉碱对肉鸡脂质代谢的影响[J]. 动物营养学报, 2005,17(03): 25-28

[15] 谢棒祥,张敏红.生物类黄酮的生理功能及其应用研究进展[J]. 动物营养学报, 2003,15(02): 11-15