

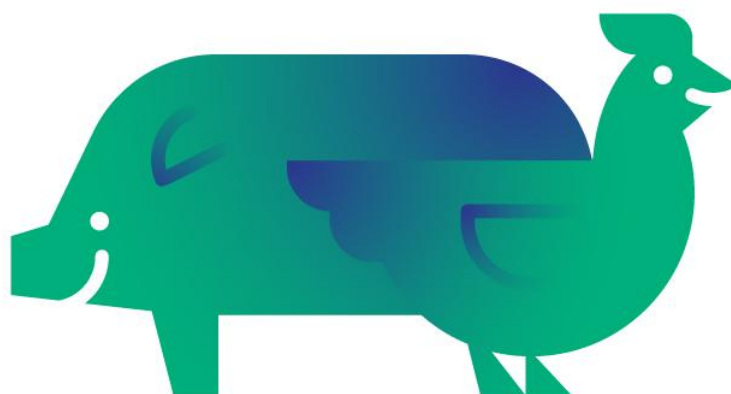
国际科技创新合作重点专项

EU Research and Innovation - Horizon 2020

减少抗菌药物用量的畜禽健康养殖与动物福利综合技术与示范

HealthyLivestock: Tackling Antimicrobial Resistance through
Improved Livestock Health & Welfare

研究论文汇编



HealthyLivestock

健康畜禽

前言

本汇编收集了“国际科技创新合作重点专项——减少抗菌药物用量的畜禽健康养殖与动物福利综合技术与示范”（简称“动物福利与减抗”项目）的科研论文。动物福利与减抗项目旨在不影响动物生产能力的前提下，通过提升动物健康和福利，减少抗生素的使用和残留，解决抗生素耐药性问题，并促进中欧先进技术的交流与融合。本汇编围绕“动物福利与减抗养殖”的主题，共分为福利养殖技术、健康与营养技术、智能检测与诊断技术、中兽药技术及农产品监测技术及畜禽养殖减抗趋势这6个章节，包括中文论文24篇，英文论文19篇，共43篇论文。这些论文是项目团队的科研成果结晶，以期为相关领域的研究提供借鉴和参考。

中国农业国际合作促进会动物福利国际合作分会

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论文

1. 福利养殖技术

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6	Effects of Eggshell Temperature Pattern during Incubation on Primary Immune Organ Development and Broiler Immune Response in Later Life	<i>Poultry Science</i>
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9	Farm Characteristics Affecting Antibiotic Consumption in Pig Farms in England	<i>Porcine Health Management</i>

2020年《农产品质量与安全》

生猪福利养殖系统的研究进展

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摘要: 随着现代养猪产业的规模化发展, 较为完善的福利养殖评分体系及有效的智能化监测系统的研发, 对提高动物福利水平, 保障畜产品品质与质量安全具有重要意义。本文重点研究了世界各国及相关组织现行福利评价标准, 我国国内实际生猪养殖福利水平, 分析了相关研究中的福利评价方法以及相应的监测设备方法等。

2023年《中国畜牧兽医》

母猪的母性行为及其影响因素研究进展

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摘要: 母猪繁殖性能的选育增加了产仔数, 但产后5天仔猪甚至断奶前仔猪死亡率高仍然是生产中面对的问题。母猪母性行为的好坏对仔猪的存活、生长发育及福利都有着重要的影响, 从而影响养殖效益, 因此对母猪母性行为的研究具有重要意义。母猪的母性行为主要包括产前筑窝、产后哺乳、抚育和护仔等行为。母猪母性行为的实施通过神经和激素的共同作用和调节, 并且也会受到遗传、环境等多种因素的影响。随着育种目标的调整及动物福利的重视, 母猪的母性行为被越来越多的学者关注研究。本文对母猪母性行为的概念、行为产生机制、影响因素等方面的国内外研究进展进行了综述, 并对未来的研究方向和内容进行了展望, 为提高母猪母性行为研究提供理论基础和研究思路。

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A Comparison of the Behavior, Physiology, and Offspring Resilience of Gestating Sows When Raised in a Group Housing System and Individual Stalls

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Abstract: Being in a confined environment causes chronic stress in gestating sows, which is detrimental for sow health, welfare and, consequently, offspring physiology. This study assessed the health and welfare of gestating sows housed in a group housing system compared to individual gestation stalls. After pregnancy was confirmed, experimental sows were divided randomly into two groups: the group housing system (GS), with the electronic sow feeding (ESF) system; or individual stall (IS). The behavior of sows housed in the GS or IS was then compared; throughout pregnancy, GS sows displayed more exploratory behavior, less vacuum chewing, and less sitting behavior ($p < 0.05$). IS sows showed higher stress hormone levels than GS sows. In particular, at 41 days of gestation, the concentration of the adrenocorticotrophic hormone (ACTH) and adrenaline (A) in IS sows was significantly higher than that of GS sows, and the A level of IS sows remained significantly higher at 71 days of gestation ($p < 0.01$). The lipopolysaccharide (LPS) test was carried out in the weaned piglets of the studied sows. Compared with the offspring of gestating sows housed in GS (PG) or IS (PS), PG experienced a shorter period of high temperature and showed a quicker return to the normal state ($p < 0.05$). Additionally, their lower levels of stress hormone ($p < 0.01$) suggest that PG did not suffer from as much stress as PS. These findings suggested that gestating sows housed in GS were more able to carry out their natural behaviors and, therefore, had lower levels of stress and improved welfare. In addition, PG also showed better disease resistance and resilience. These results will provide a research basis for the welfare and breeding of gestating sows.

Effects of On-farm and Traditional Hatching on Welfare, Health, and Performance of Broiler Chickens

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Abstract: In on-farm hatching systems, eggs that have been incubated for 18 D are transported to the broiler farm. After hatching around day 21, the chicks have immediate access to feed and water. By contrast, traditionally hatched chicks are in early life exposed to dust and pathogens in the hatcher, handling procedures, and transport and remain without feed and water until they have arrived on the farm 1 to 3 D after hatching. We compared welfare and performance of onfarm hatched (OH) and traditionally hatched control (C) Ross 308 broiler chickens from day 0 to 40, housed under semicommercial conditions. The experiment included 3 production cycles in 4 rooms, with each room containing 1 OH and 1 C pen with 1,150 chickens in each pen. Per cycle, C and OH chicks were from the same batch of eggs of 1 parent stock flock. Day-old chick quality was worse for OH than C chickens (hock and navel score; $P < 0.05$). On-farm hatched chickens were heavier than C chickens until day 21 of age ($P < 0.05$). Total mortality was significantly lower in OH compared with C pens ($P < 0.05$). A tendency for lower footpad dermatitis scores was found in OH pens compared with C pens ($P < 0.10$), probably because of the dryer litter in OH than C pens ($P < 0.05$). No differences between treatments were found in gait, hock burn, cleanliness, and injury scores, and no or only minor, short lasting differences were found in pathology and intestinal histology. In conclusion, the present study showed that on-farm hatching may be beneficial for broiler welfare, as it reduced total mortality and resulted in dryer litter which is known to be beneficial for reducing footpad dermatitis.

Comparative Assessment of General Behaviour and Fear-related Responses in Hatchery-hatched and On-farm Hatched Broiler Chickens

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Abstract: Traditionally, broiler chickens hatch in the hatchery and they are usually not provided with feed and water until placement at the farm. This can have negative effects on their health and welfare. Therefore, alternative systems providing early nutrition, for instance by hatching eggs in a poultry house (on-farm hatching) are increasingly being used in practice. However, information on the behaviour and welfare of on-farm hatched chickens in relation to hatchery-hatched chickens is very limited. This study aims to gain basic knowledge of the behaviour of on-farm hatched chickens (OH) by comparing them to a control group (C) hatched in the hatchery. In addition, fear-related responses were assessed as indicators of chicken welfare. About 13,800 chickens per treatment group were reared in three consecutive batches in eight floor pens under semi-commercial conditions. Direct behavioural observations and three different fear tests, i.e. a novel environment, a human approach and a novel object test, were carried out between two and 36 days of age. Except for ‘disturbance behaviour’ (i.e. pushing or overrunning another chicken), which was more often performed by the OH chickens ($F_{1,3} = 35.10$, $P < 0.05$), no effect of treatment was found on general behaviour. In contrast, nearly all observed behaviours were affected by the chickens’ age ($F_{4,24} = 4.02–41.81$, $P < 0.05$). In the fear tests, most variables, for instance average latency of chickens touching a human and

the number of chickens in the vicinity of a novel object, differed between the treatments ($P < 0.05$) with OH chickens being more fearful and less active. The present results indicate that the hatching system (hatchery-hatching vs. on-farm hatching) seems to have limited effects on broiler chicken activity and general behaviours. In test situations, however, hatchery-hatched chickens showed more active and less fearful responses compared to on-farm hatched chickens. The underlying causes for these differences in response to more challenging situations remain to be investigated further, as these may be related to a higher intrinsic motivation to search for food or more exposure to humans or objects in the hatchery in C chickens as compared to OH chickens, but also to differences in coping style or development of cognitive abilities between the treatment groups.

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Effects of Eggshell Temperature Pattern during Incubation on Primary Immune Organ Development and Broiler Immune Response in Later Life

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Abstract: Eggshell temperature (EST) during incubation greatly affects embryo development, chick quality at hatch, and subsequently various broiler physiological systems. Until now, a constant EST of 37.8°C seems optimal. Data on effects of EST patterns on immune organ development and subsequent broiler immune response are, however, scarce. A higher EST of 38.9°C in week 2 and/or a lower EST of 36.7°C in week 3 of incubation potentially positively affect embryo immune organ development and broiler immune response post hatch. Broiler eggs ($n = 468$) were incubated at 4 different EST patterns ($n = 117$ eggs/treatment) from week 2 of incubation onward.

Week 1 (embryonic age (E)0 < E7) EST was 37.8°C for all eggs. Week 2 (E7 < E14) EST was either 37.8°C (Control) or 38.9°C (Higher), and week 3 (E14 - /hatch) EST was either Control or 36.7°C (Lower). At hatch, histology of bursal follicles and jejunum villi and crypts were determined as well as heterophil to lymphocyte ratio (H:L) (n = 49). Posthatch, both sexes were grown in 8 pens/treatment for 6 wk (n = 320). Natural antibodies (NAb) were determined at day 14, 22, and slaughter (day 41 or 42) as an indicator of immunocompetence and response to a Newcastle disease (NCD) vaccination was determined by antibody levels at day 22 and slaughter (n = 128). Results showed no interaction EST week 2 × EST week 3, except for jejunum histology. Higher EST in week 2 resulted in lower cell density within bursal follicles (P = 0.02) and a tendency for lower H:L (P = 0.07) at hatch, and higher NCD titers at slaughter (P = 0.02) than Control EST. Lower EST in week 3 resulted at hatch in higher cell density within bursal follicles, higher H:L (both P < 0.05), and a tendency for a higher posthatch mortality rate than control EST (P = 0.10). In conclusion, higher EST in week 2 during incubation may benefit embryonic immune organ development and posthatch broiler immunocompetence, while lower EST in week 3 showed opposite indications.

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Day-old Chicken Quality and Performance of Broiler Chickens from 3 Different Hatching Systems

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Abstract: In on-farm hatching systems, eggs are transported at d 18 of incubation to the broiler farm, where chickens have immediate access to feed and water after hatching. In hatchery-fed systems, newly hatched chickens have immediate access to feed and water in the hatchery and are transported to the farm thereafter. Conventionally hatched chickens can remain without access to feed and water up to 72 h after hatching until placement on the farm. The current study compared day-old chicken quality, performance, and slaughter yield of broiler chickens that were on-farm hatched (OH), hatchery-fed (HF), or conventionally hatchery-hatched (HH). The experiment was performed in 6 rooms in 1 house. Each room contained 2 duplicate pens with approximately 1,155 chickens per pen; 2 rooms with each 2 duplicate pens were assigned to 1 treatment. The experiment was repeated during 3 consecutive production cycles. Chickens originated from young parent stock flocks. Results showed that HF and OH chickens were heavier and longer than HH chickens at day (D) 1. Relative weight of stomach and intestines were highest for OH chickens. The OH chickens had worse day-old chicken quality in terms of navel condition and red hocks than HH and HF chickens. Treatments did not differ in first wk and total mortality. From D0 until slaughter age, body weight was highest for OH, followed by HF and HH. Furthermore, carcass weight at slaughter age (D40) was highest for OH chickens, followed by HF and HH chickens. Breast fillets showed a higher incidence of white striping and wooden breast in HF and OH chickens compared with HH chickens. In conclusion, the current study showed that both OH and HF chickens of young parent flocks had better growth performance, which could explain the higher prevalence of breast myopathies, compared with HH. The worse day-old chicken quality for OH compared with HH and HF does not seem to affect first wk mortality and later life performance.

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Effects of Hatching System on the Welfare of Broiler Chickens in Early and Later Life

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Abstract: Broiler chicks usually hatch in the hatchery without access to feed and water until placement at the farm. This can affect their health and welfare negatively. Therefore, alternative strategies have been developed, for instance providing chicks with early nutrition in the hatchery or hatching eggs directly on-farm. However, information on the physical and mental welfare of chicks hatched in these systems compared to conventionally hatched chicks is limited. The aim of this study was to investigate the effects of alternative hatching systems on the welfare of broiler chickens in early and later life. A system comparison was performed with chickens that hatched conventionally in a hatchery (HH), in a system which provided light, feed, and water in a hatcher (hatchery-fed, HF), or on-farm (on-farm hatched, OH, where feed and water were available and transport of day-old chicks from the hatchery to the farm was not necessary). Chickens were reared in 3 batches, in 12 floor pens per batch (approximately 1,155 animals per pen), with a total of 12 replicates per treatment. Animal-based welfare indicators were assessed following standard protocols: plumage cleanliness, footpad dermatitis (FPD), hock burn, skin lesions (all at day 21 and 35 of age), and gait score (day 35). Furthermore, a set of behavioral tests was carried out: novel environment (day 1 and 21), tonic immobility, novel object, and avoidance distance test (day 4 and 35). Plumage cleanliness, hock burn, and skin lesions were affected by age but not by hatching system, with older broilers scoring worse than younger ones ($P < 0.05$). An effect of hatching system was only found for FPD, with the highest prevalence in HH chickens, followed by HF and OH chickens ($P < 0.05$). All responses measured in the behavioral tests were affected by age but not by hatching system. In later life, chickens were significantly less fearful than during the first days of life. The results indicate that conventionally hatched chickens scored significantly worse for FPD, whereas,

in general, hatching system seemed to have minor effects on other broiler welfare indicators.

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Farm Characteristics Affecting Antibiotic Consumption in Pig Farms in England

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Abstract:

Background: Pig production has been highlighted as one of the highest users of antibiotics amongst livestock, with several studies suggesting a variety of approaches to antibiotic reduction. We aimed to investigate links between antibiotic use (defined as total amount of critically (CIA) and non-critically important antibiotics, and as mg per kg of pig on farm), production stages present on farm (Breeder–Finisher, Nursery–Finisher, and Finisher), and pig farm characteristics using farm data collected through national recording systems in Great Britain for 2017 & 2018. Providing enrichment within pig pens may reduce the need for antibiotics by enhancing both pig welfare and resilience to infection; this was one of the hypotheses addressed by this paper.

Results: The amount of antibiotic used, expressed as mg/kg, reduced between 2017 and 2018 for Breeder–Finisher farms, but not for Nursery–Finisher or Finisher farms. Breeder–Finisher farms were more likely to use CIA compared with other production stages. Larger farms were more likely to use CIA, but farm size had no effect on mg/kg of antibiotic used. As the proportion of pens containing straw increased, the total use of antibiotics decreased for Breeder–Finisher, but not for Nursery–Finisher or Finisher farms. As the proportion of pens containing straw increased, the

probability of using CIAs also decreased. Farms with a higher proportion of finisher pens with an outdoor space had a lower use of non-critical antibiotics and lower probability of use of CIA. Farms with a higher proportion of pens with automatically controlled natural ventilation (ACNV) had lower total use of antibiotics, although ACNV had no effect on the probability of using CIA.

Conclusions: We quantified the influence of farm characteristics on the consumption of antibiotics in pig farms in England. Our findings support the hypothesis that farm characteristics have an influence on antibiotic use within a system and suggest that this reflects the balance of effects on both animal resilience and disease challenge. Consistent with our hypothesis, provision of straw was associated with reduced antibiotic use. We also demonstrate the value of using secondary databases, although further structural improvements are required to facilitate effective database combination and ensure maximum information benefits can be realised.

2. 健康与营养技术

序号	论文名称	刊物
1	益生菌对肉鸡生长性能及缓解 LPS 引起的肝脏炎症的研究	《畜牧与兽医》
2	添加益生菌和苜蓿草粉对肉鸡生长性能和肠道菌群组成的影响	《畜牧与兽医》
3	复合益生菌对肉仔鸡小肠形态和盲肠微生物菌群的影响	《南京农业大学学报》
4	金霉素和乳果糖 - 凝结芽孢杆菌合生素对断奶仔猪相对生长速率和粪便代谢产物的影响	《动物营养学报》

5	乳果糖和凝结芽孢杆菌合生素对断奶仔猪生长性能、养分表观消化率和血液指标的影响	《动物营养学报》
6	发酵酒糟麸皮混合物对肉鸡生长性能、屠宰性能及免疫器官指数的影响	《中国家禽》
7	Hepatic Inflammatory Response to Exogenous LPS Challenge is Exacerbated in Broilers with Fatty Liver Disease	<i>Animals</i>
8	Dietary γ-Aminobutyric Acid Supplementation Inhibits High-Fat Diet-Induced Hepatic Steatosis via Modulating Gut Microbiota in Broilers	<i>Microorganisms</i>
9	Effect of High-copper Diet on Transference of BlaCTX-M Genes among Escherichia coli Strains in Rats' Intestine	<i>Frontiers in Veterinary Science</i>

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https://xueshu.baidu.com/usercenter/paper/show?paperid=1m4g06b07x4504a0gc0r0j107s263850&site=xueshu_se

益生菌对肉鸡生长性能及缓解LPS引起的肝脏炎症的研究

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摘要: 脂多糖(LPS)是革兰阴性菌细胞壁的主要成分, 常被用于模拟革兰阴性菌所致的感染, 诱导机体炎症反应。益生菌能提高机体的免疫力, 改善动物健康和福利。然而, 目前有关益生菌对家禽细菌感染的防治效果的研究尚未见报道。试验选用40只1日龄罗斯308白羽肉鸡, 随机分为2组: 对照组(CON1)和益生菌组(Pb), Pb组鸡的饮水中添加益生菌(0.05 g/只), 连续饲喂2周, 按正常标准饲养。29日龄时进行LPS注射处理, 分别将CON和Pb组随机分为2组, 即生理盐水注射(CON2)、LPS注射组(LPS)、Pb+生理盐水组(Pb)、Pb+LPS注射组(Pb+LPS), 注射后2 h采集血液和肝脏组织待测。结果显示, 与对照组相比, 益生菌可降低肉鸡的采食量及料重比($P<0.01$); LPS可显著增加肝脏, 脾脏重及器官指数($P<0.05$), 但显著降低法氏囊重及器官指数($P<0.05$)。血液生化指标分析显示, 益生菌可以缓解LPS导致的谷丙转氨酶(ALT)升高($P<0.05$), 并降低谷草转氨酶(AST)及肌酸激酶(CK)的水平($P<0.05$)。实时荧光定量PCR显示, LPS处理可激活肝脏中LPS-TLR4-NF- κ B信号通路且上调下游基因IL-6、IL-1 β 、IFN- γ 及IL-10的表达($P<0.05$)。与LPS组和Pb组相比, Pb+LPS组抑炎细胞因子IFN- γ 、IL-10基因的表达显著上调($P<0.05$)。此外, LPS能显著上调肝脏C-反应蛋白(CRP)mRNA的表达($P<0.01$)。研究表明, 益生菌能提高肉鸡的生长性能, 参与机体免疫调节, 并对LPS引起的肝脏炎症反应有一定的缓解作用。这些结果为益生菌防治细菌感染提供了参考。

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<https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CJFD&filename=XMYS2020090>

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添加益生菌和苜蓿草粉对肉鸡生长性能和肠道菌群组成的影响

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摘要: 旨在探索饲料中添加益生菌和苜蓿草粉对肉鸡生长性能及肠道菌群组成的影响。试验选取144只1日龄青脚麻鸡分为3组, 即对照组、益生菌组和苜蓿组, 每组6个重复, 每个重复8只鸡。益生菌组肉鸡于2日龄以每天60 mg/只的剂量饮水饲喂益生菌; 苜蓿组肉鸡于22日龄在饲料中添加4%苜蓿, 饲喂3周。试验期间记录肉鸡采食量, 并分别于第8、15、22、35、44日龄时称重; 于44日龄时屠宰采集肠内容物和黏膜上皮组织, 观察十二指肠上皮形态结构, 采用实时荧光定量PCR检测肠道紧密连接、营养素转运等相关基因的表达, 16S高通量测序法检测盲肠内容物微生物的组成。生产性能结果: 与对照组相比, 益生菌组和苜蓿组肉鸡平均日增重升高, 36~44日龄时, 料重比有降低趋势, 但差异均不显著($P>0.05$); 实时荧光定量PCR结果显示: 和对照组相比, 早期益生菌处理显著升高肉鸡十二指肠Occludin基因mRNA的表达水平($P>0.05$); 高通量测序结果: 和对照组相比, 益生菌和苜蓿处理提高了肉鸡盲肠细菌多样性和拟杆菌门/厚壁菌门细菌丰度比值, 益生菌组肉鸡盲肠狄氏副拟杆菌属的丰度相比对照组和苜蓿组显著升高($P>0.05$), 乳酸杆菌属等有益菌的丰度也有一定程度升高, 但差异不显著($P>0.05$)。研究表明, 早期益生菌处理和苜蓿处理均可提高肉鸡的生长性能, 肉鸡生长性能的提高可能与肠道菌群多样性的提高以及拟杆菌和乳酸杆菌等有益菌在肠道的定植有关。

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复合益生菌对肉仔鸡小肠形态和盲肠微生物菌群的影响

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摘要: [目的]本试验旨在研究早期饲喂复合益生菌对肉仔鸡盲肠微生物组成、小肠上皮组织结构及紧密连接相关基因表达的影响。[方法]将144只1日龄健康青脚麻鸡随机分为3组, 分别为对照组(CON)、低剂量($50 \text{ mg} \cdot \text{d}^{-1}$)

益生菌组(LP)和高剂量($100 \text{ mg} \cdot \text{d}^{-1}$)益生菌组(HP), 每组6个重复, 每个重复8只鸡, 从1日龄开始饮水中添加益生菌, 试验期为2周。试验期间记录采食量和体重, 于第14日龄采集小肠上皮组织, 检测其形态结构及紧密连接相关基因表达, 16S rRNA测序分析盲肠内容物微生物组成。[结果]试验期间HP组肉鸡体重高于对照组, 但差异不显著($P>0.05$)。与对照组相比,HP组肉鸡1~7日龄平均日采食量显著降低($P<0.05$), 但7~14日龄平均日采食量有升高的趋势($P>0.05$); HP组肉鸡1~7日龄料重比极显著低于CON组($P<0.01$)。LP组与CON组之间以上指标均无显著差异($P>0.05$)。与CON组相比, 添加益生菌显著降低隐窝深度, 增加绒毛高度及绒毛高度与隐窝深度的比值; HP组回肠和盲肠上皮闭锁小带蛋白1基因(ZO 1)和回肠上皮闭合蛋白基因(OCLN)表达显著上调($P<0.05$); LP组盲肠上皮黏蛋白2基因(MUC 2)表达显著上调($P<0.05$)。16S rRNA高通量测序结果表明, 与CON组相比, 早期饲喂复合益生菌对肉鸡盲肠内容物中细菌多样性无显著影响($P>0.05$), 但LP组盲肠中Sellimonas和Intestinimonas属的丰度显著增加($P<0.05$), HP组Akkermansiaceae科的丰度极显著增加($P<0.01$)。[结论]早期饲喂复合益生菌对肉仔鸡盲肠内容物中细菌多样性无显著影响, 但可升高某些有益菌的定殖丰度; 上调小肠上皮组织中紧密连接相关基因的表达, 促进绒毛生长, 从而潜在影响肉鸡早期和后期的生长性能。

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金霉素和乳果糖 – 凝结芽孢杆菌合生素对断奶仔猪相对生长速率和粪便代谢产物的影响

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摘要: 本试验旨在研究金霉素和乳果糖-凝结芽孢杆菌合生素对断奶仔猪相对生长速率及粪便代谢产物的影响。选取18头健康且体重相近的27~28日龄“杜×长×大”阉公猪, 初始体重(9.08 ± 0.59)kg, 随机分为3组, 每组6个重复, 每个重复1头猪。对照组(CTR组)饲喂基础无抗饲料, 抗生素组(ANT组)饲喂基础无抗饲料+75 mg/kg金霉素, 合生素组(SYN组)饲喂基础无抗饲料+乳果糖-凝结芽孢杆菌合生素(10 g/kg乳果糖+ 2×10^9 CFU/kg凝结芽孢杆菌)。试验期为29 d。试验期间每周记录体重, 并对第29天粪便样品进行代谢组学与短链脂肪酸(SCFAs)检测。结果表明: 1) 第1~4周, 3组相对生长速率(RGR)存在显著的趋势($P=0.052$); 其中SYN组比CTR组高6.00%, ANT组比CTR组高7.08%, 而ANT组比SYN组高1.01%。2) 粪便代谢组学结果显示, 与CTR组相比, ANT组和SYN组均能显著影响有机酸和胺类物质的含量($P<0.05$); 其中, 除L-吡啶甲酸和吡多胺含量均显著提高($P<0.05$)外, 无其他共有差异代谢产物。与ANT组相比, SYN组亚油酸、反异油酸、所有顺式(6, 9, 12)-亚油酸、D-乳糖、环己胺、烟酸、腺嘌呤和N6, N6, N6-三甲基-L-赖氨酸含量显著提高($P<0.05$), 5-氨基戊酸、D-半乳糖醛酸和2-氧己二酸含量显著降低($P<0.05$)。3) KEGG通路富集结果显示, 与CTR组相比, SYN组和ANT组均显著影响赖氨酸降解通路($P<0.05$); 此外, ANT组还显著影响苯丙氨酸代谢、维生素消化吸收、精氨酸和脯氨酸代谢3条通路($P<0.05$); SYN组则影响半乳糖代谢、味觉转导、碳水化合物消化吸收、ABC转运蛋白、色氨酸代谢、淀粉和蔗糖代谢共6条通路($P<0.05$)。与ANT组相比, SYN组显著影响赖氨酸降解、亚油酸代谢、ABC转运蛋白和不饱和脂肪酸生物合成共4条通路($P<0.05$)。4) 3组之间SCFAs浓度无显著差异($P>0.05$), 但SYN组丙酸比例显著低于ANT组($P<0.05$)。5) 相关性分析结果显示, 断奶仔猪RGR与粪便代谢产物D-半乳糖醛酸、环己胺和甘露糖含量呈显著相关($P<0.05$)。综上所述, 无抗饲料中添加乳果糖-凝结芽孢杆菌合生素可通过粪便中赖氨酸降解、半乳糖代谢、淀粉和蔗糖、碳水化合物消化吸收等代谢通路影响仔猪的生长和代谢。与CTR组相比, 乳果糖-凝结芽孢杆菌合生素不仅具有和金霉素相似的促生长效果, 还能部分影响粪便中与金霉素相同的代谢产物和代谢通路。此外, 乳果糖-凝结芽孢杆菌合生素影响粪便中代谢产物的种类和代谢通路比金霉素更加广泛。

乳果糖和凝结芽孢杆菌合生素对断奶仔猪生长性能、养分表观消化率和血液指标的影响

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摘要: 本试验旨在研究乳果糖和凝结芽孢杆菌合生素对断奶仔猪生长性能、养分表观消化率和血液指标的影响。选取24头27~28日龄健康“杜×长×大”三元杂交断奶阉公猪, 初始体重为(9.09±0.12) kg, 随机分为对照组(n=12)、试验I组(n=6)和试验II组(n=6)。对照组饲喂基础饲粮(不含抗生素), 试验I组饲喂基础饲粮+75mg/kg的金霉素, 试验II组饲喂基础饲粮+乳果糖和凝结芽孢杆菌合生素(10 g/kg的乳果糖和 2×10^9 CFU/kg的凝结芽孢杆菌)。试验期29d。结果表明: 1) 第1天、第15天和第29天, 3组之间体重均无显著差异($P>0.05$)。第1~2周, 3组之间平均日增重(ADG)和平均日采食量(ADFI)无显著差异($P>0.05$); 试验II组的料重比(F/G)显著低于对照组($P<0.05$), 且与试验I组无显著差异($P>0.05$)。第3~4周和第1~4周, 3组之间ADG、ADFI和F/G均无显著差异($P>0.05$)。2) 第3~4周, 试验I组和试验II组的腹泻率显著低于对照组($P<0.05$), 且试验I组和试验II组之间无显著差异($P>0.05$); 第1~2周和第1~4周, 3组之间腹泻率无显著差异($P>0.05$)。3) 试验I组和试验II组的总能和粗脂肪的表观消化率高于对照组($P<0.05$), 且试验I组和试验II组之间无显著差异($P>0.05$); 试验I组的粗蛋白质表观消化率高于对照组($P<0.05$), 但试验II组与其他2组无显著差异($P>0.05$)。4) 3组之间血液常规指标均无显著差异($P>0.05$)。试验I组和试验II组的血清总胆红素含量显著低于对照组($P<0.05$), 且试验I组和试验II组之间无显著差异($P>0.05$)。综上所述, 在无抗饲粮中添加乳果糖和凝结芽孢杆菌合生素可降低断奶仔猪腹泻率, 提高总能和粗脂肪表观消化率, 降低血清总胆红素含量, 并降低F/G。

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<https://kns.cnki.net/kcms/detail//32.1222.S.20230227.0904.006.html>

发酵酒糟麸皮混合物对肉鸡生长性能、屠宰性能及免疫器官指数的影响

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摘要: 试验旨在研究发酵酒糟麸皮混合物对肉鸡生长性能、屠宰性能及免疫器官指数的影响。试验采用植物乳杆菌、枯草芽孢杆菌和酿酒酵母菌组成的混合菌或在混合菌中添加纤维素酶和木聚糖酶发酵酒糟麸皮混合物制备多菌混合发酵物或菌酶协同发酵物。300只1日龄肉鸡随机分为3组, 每组5个重复, 每个重复20只鸡, 对照组饲喂基础日粮, 试验 I 组与试验 II 组在各阶段基础日粮中分别添加1%、2%、4%多菌混合发酵物或菌酶协同发酵物。结果显示: 酒糟麸皮混合物发酵后酸溶蛋白显著提升 ($P<0.05$), 中性洗涤纤维显著降低 ($P<0.05$), 呕吐毒素显著降低 ($P<0.05$)。试验 II 组肉鸡41日龄体重较对照组显著提升 ($P<0.05$)。试验组肉鸡30~41日龄段日采食量及1~41日龄段日采食量和日增重较对照组显著提升 ($P<0.05$)。试验 II 组脾脏指数具有提高趋势 ($0.05\leq P<0.10$)。结果表明: 多菌混合或菌酶协同发酵可提升酒糟麸皮混合物营养价值, 发酵酒糟麸皮混合物可改善肉鸡生长性能, 维持肉鸡屠宰性能, 提高免疫器官指数, 且菌酶协同发酵效果及发酵物应用效果较好。

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Hepatic Inflammatory Response to Exogenous LPS Challenge is Exacerbated in Broilers with Fatty Liver Disease

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Abstract: This study aimed to examine hepatic function and inflammatory response in broilers with fatty livers, following acute lipopolysaccharide (LPS) challenge. One-day-old Lihua yellow broilers were fed a basal diet. Broilers were divided into four groups: control (CON), corticosterone treatment (CORT), LPS treatment (LPS), and LPS and CORT treatment (LPS&CORT). Results show that CORT induced an increase in plasma and liver triglycerides (TGs), which were accompanied by severe hepatic steatosis. The LPS group showed hepatocyte necrosis with inflammatory cell infiltration. Total liver damage score in the LPS&CORT group was significantly higher than that in the LPS group ($p < 0.05$). Activity levels of plasma alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were similar in the CON and CORT groups, but higher in the LPS group. Gene expression upregulation of the proinflammatory cytokines (NF- κ B, IL-1 β , IL-6, IFN- γ , and iNOS) was also noted in the LPS group ($p < 0.05$). In particular, LPS injection exacerbated the gene expression of these proinflammatory cytokines, even when accompanied by CORT injections ($p < 0.05$). In summary, our results indicate that broilers suffering from fatty liver disease are more susceptible to the negative effects of LPS, showing inflammatory response activation and more severe damages to the liver.

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Dietary γ -Aminobutyric Acid Supplementation Inhibits High-Fat Diet-Induced Hepatic Steatosis via Modulating Gut Microbiota in Broilers

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Abstract: The present study aims to investigate the effect of γ -aminobutyric acid (GABA) on liver lipid metabolism and on AA broilers. Broilers were divided into three groups and fed with lowfat diets, high-fat diets, and high-fat diets supplemented with GABA. Results showed that GABA supplementation decreased the level of triglyceride (TG) in the serum and liver of broilers fed high-fat diets, accompanied by up-regulated mRNA expression of genes related to lipolysis and β -oxidation in the liver ($p < 0.05$). Furthermore, GABA supplementation increased liver antioxidant capacity, accompanied by up-regulated mRNA expression of antioxidant genes ($p < 0.05$). 16S rRNA gene sequencing showed that GABA improved high-fat diet-induced dysbiosis of gut microbiota, increased the relative abundance of Bacteroidetes phylum and *Barnesiella* genus, and decreased the relative abundance of Firmicutes phylum and *Ruminococcus_torques_group* and *Romboutsia* genus ($p < 0.05$). Moreover, GABA supplementation promoted the production of propionic acid and butyric acid in cecal contents. Correlation analysis further suggested the ratio of Firmicutes/Bacteroidetes negatively correlated with hepatic TG content, and positively correlated with cecal short chain fatty acids content ($r > 0.6$, $p < 0.01$). Together, these data suggest that GABA supplementation can inhibit hepatic TG deposition and steatosis via regulating gut microbiota in broilers.

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Effect of High-copper Diet on Transference of BlaCTX–M Genes among Escherichia coli Strains in Rats' Intestine

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Abstract: Both ceftiofur (CTO) and high copper are widely utilized in animal production in China, and the occurrence of CTX-M-carrying *Escherichia coli* in food-producing animals is increasing. There are some specific associations between in-feed highlevel copper and antibiotic resistance, but research in Gram-negative bacteria such as *E. coli* remains scarce. This study aimed to evaluate the effect of high-copper diet on the horizontal transfer of blaCTX-M-1 among *E. coli*. A total of 32 male SPF rats aged 21 days were randomly assigned to the following four groups: control (6 mg/kg in-feed copper, C⁻), high copper (240 mg/kg in-feed copper, H⁻), CTO (6 mg/kg in-feed copper with oral CTO administration, C⁺), and high copper plus CTO (240 mg/kg in-feed copper with oral CTO administration, H⁺). All rats were orally inoculated with an *E. coli* strain harboring a conjugative plasmid carrying blaCTX-M-1, and the C⁺ and H⁺ groups were given 10 mg/kg of body weight (BW) CTO hydrochloride at 26, 27, and 28 days, while the C⁻ and H⁻ groups were given salad oil at the same dose. Fecal samples collected at different time points were used for the enumeration of *E. coli* on Mac plates or for molecular analysis using PCR, pulsed-field gel electrophoresis (PFGE), S1-PFGE, and Southern-blot hybridization. The results showed that the number of the blaCTX-M-1 gene in the H⁻ group was higher and that the loss speed of this gene was slower compared with the C⁻ group. After administration of CTO, the counts of cefotaxime-resistant *E. coli* were significantly higher in the C⁺ group than that in the corresponding control group (C⁺ vs. C⁻; H⁺ vs. H⁻). In the in vitro test, the results showed that the transfer rates of the conjugation induced by the H⁻ (12 mmol/L) group were significantly higher than that of low copper (2 mmol/L) group. The indigenous sensitive isolates, which were homologous to the blaCTX-M-positive isolates of rat feces, were found by PFGE. The further analysis of S1-PFGE and Southern-blot hybridization confirmed that the blaCTX-M-1 gene in new transconjugants was derived from the inoculated strain. Taken together, high-copper diet facilitates the horizontal transfer and maintenance of the resistant genes in the intestine of rats, although the effects of antibiotics on bacterial resistance appearance and maintenance are more obvious.

3. 智能监测与诊断技术

序号	论文名称	刊物
1	基于音频技术的肉鸡采食量检测方法研究	《华南农业大学学报》
2	基于 Kinect 的哺乳期母猪姿态识别算法的研究	《南京农业大学学报》
3	基于深层卷积神经网络的初生仔猪目标实时检测方法	《农业机械学报》
4	基于红外热成像的白羽肉鸡体温检测方法	《农业机械学报》
5	基于音频技术的白羽肉鸡咳嗽识别算法研究	《南京农业大学学报》
6	基于机器视觉的断奶仔猪腹泻自动识别方法	《南京农业大学学报》
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16	Automatic Recognition of Feeding and Foraging Behaviour in Pigs Using Deep Learning	<i>Biosystems Engineering</i>

17	Automated Recognition of Postures and Drinking Behaviour for the Detection of Compromised Health in Pigs	<i>Scientific Reports</i>
18	Early Detection of Diarrhea in Weaned Piglets From Individual Feed, Water and Weighing Data	<i>Frontiers in Animal Science</i>

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基于音频技术的肉鸡采食量检测方法研究

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摘要: 【目的】通过研究肉鸡采食音频提出一种基于音频技术的肉鸡采食量检测方法, 以摆脱目前我国肉鸡采食量数据主要是人工测量群体采食量的现状, 为准确获取肉鸡采食量信息提供技术支持。【方法】录音笔采集到的采食音频经分帧加窗、端点检测等预处理后, 将有效声音片段提取出来, 依托不同声音的功率谱密度曲线差异, 使用单分类支持向量机 (OC-SVM) 对提取出的有效声音片段进行分类识别。利用音频技术检测肉鸡进食时的啄食次数, 分析确定啄食次数与采食量的关系, 利用啄食次数与采食量的高相关性计算肉鸡采食量。【结果】利用音频技术检测的肉鸡啄食次数与采食量高度相关, 决定系数 (R^2)=0.982 5。啄食次数计算正确率为 94.58%, 采食量计算正确率为91.37%。【结论】该方法可用于肉鸡采食量测定。

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基于Kinect 的哺乳期母猪姿态识别算法的研究

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摘要: 【目的】哺乳期母猪的姿态是其母性的外在表现, 为监测母猪在哺乳期的哺乳行为, 提出了一种基于Kinect的无接触式母猪姿态识别算法。【方法】使用 Kinect 2.0采集位于限位栏内哺乳期小梅山母猪的深度数据。先通过姿态预分类将母猪的姿态分为站姿与卧姿, 而后针对卧姿, 使用基于 DBSCAN (density-based spatial clustering of applications with noise) 密度 聚类算法计算母猪高度信息的簇数, 通过比较簇的个数将卧姿分为侧卧与趴卧; 针对站姿, 使用基于脊背线提取的识别算 法, 将脊背线分成前后2段, 通过比较前后2段脊背线的平均高度将站姿分为站立与坐立。【结果】比较人眼观察结果与算法识别结果, 该算法识别站立、坐立的准确率分别为 94.3%、92.6%, 趴卧识别准确率为 84.2%, 侧卧姿态为 93.7%。【结论】提出了一种无接触式的哺乳期母猪姿态识别算法, 为母猪哺乳能力的评判与健康状况的分析提供了技术支持。

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基于深层卷积神经网络的初生仔猪目标实时检测方法

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摘要: 针对初生仔猪目标较小、分娩栏内光线变化复杂、仔猪粘连和硬性遮挡现象较为严重等问题, 提出一种基于深层卷积神经网络的初生仔猪目标识别方法。将分类和定位合并为一个任务, 以整幅图像为兴趣域,

利用特征金字塔网络(Feature pyramid network, FPN) 算法定位识别仔猪目标; 对比了不同通道数数据集以及不同迭代次数对模型效果的影响; 该方法支持图像批量处理、视频与监控录像的实时检测和检测结果多样化储存。实验结果表明: 在数据集总量相同时, 同时包含夜间单通道和白天3通道的数据集, 在迭代20000次时接近模型最优值。模型在验证集和测试集上的精确率分别为95.76%和93.84%, 召回率分别为95.47%和94.88%, 对分辨率为500像素×375像素的图像检测速度为53.19 f/s, 对清晰度为720P的视频检测速度为22f/s, 可满足实时检测的要求, 对全天候多干扰场景表现出良好的泛化能力。

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基于红外热成像的白羽肉鸡体温检测方法

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摘要: 为了快速、准确地检测肉鸡体温, 提出了一种红外热成像技术和深度学习相结合的肉鸡体温检测方法。以卷积神经网络为基础, 建立肉鸡头部和腿部的感兴趣区域(Region of interest, ROI)识别模型, 提取肉鸡头部和腿部的最高温度, 结合环境温度、相对湿度和光照强度, 分别构建了基于多元线性回归和基于BP神经网络的肉鸡翅下体温反演模型。试验结果表明, 基于深度卷积神经网络(Convolutional neural networks, CNNs)的感兴趣区域识别模型在测试集上的查准率和查全率分别为96.77%和100%, 基于多元线性回归和BP(Back propagation)神经网络的反演模型平均相对误差分别为 0.33%和0.29%。基于BP神经网络的肉鸡翅下温度反演模型具有更高的准确性, 可准确检测肉鸡体温。

2019年11月 《南京农业大学学报》

<http://kns.cnki.net/kcms/detail/32.1148.S.20191108.1751.012.html>

基于音频技术的白羽肉鸡咳嗽识别算法研究

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摘要: 【目的】咳嗽是肉鸡呼吸道发病初期的主要症状, 为实现肉鸡呼吸道疾病非接触式监测, 本研究提出一种肉鸡咳嗽声识别算法。【方法】利用网络拾音器采集白羽肉鸡咳嗽及其它声音数据, 选用 MMSE 谱减法对其进行滤波去噪; 经预处理后人工截取肉鸡咳嗽样本与噪声样本; 提取样本 WMFCC 特征, 构建 GMM-HMM 模型, 训练并调整优化咳嗽识别模型。【结果】将算法识别结果与人工分类结果比较, 肉鸡咳嗽识别算法的平均准确率为 95%。【结论】本文提出的一种用于识别肉鸡咳嗽声音的算法, 能为肉鸡呼吸道疾病的早期自动预警提供技术支持。

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基于机器视觉的断奶仔猪腹泻自动识别方法

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摘要: [目的]断奶仔猪腹泻严重影响养猪业的经济效益, 本试验基于机器视觉技术提出一种排泄姿态与异常粪便结合的断奶仔猪腹泻检测方法以实现断奶仔猪腹泻的快速、准确检测。[方法]以深层卷积神经网络(convolutional neural networks, CNN)为基础构建腹泻检测分类模型, 实现仔猪身份、姿态与异常粪便的一体化识别, 对比不同迭代次数对模型效果的影响, 选取最优模型; 提出时空信息融合判定法, 从时间序列先后和空间距离远近两方面, 关联最优模型

识别出的目标姿态与病便,实现断奶仔猪腹泻的视频检测。[结果]在训练迭代25 000次时接近模型最优值,对姿态、病便等目标识别的平均精度均值和召回率分别为95.75%和89.13%;基于时空信息融合方法的断奶仔猪腹泻视频检测识别准确率和召回率分别为97.92%和95.92%。[结论]深层卷积神经网络分类模型结合时空信息融合判定法为断奶仔猪腹泻自动识别提供了有力的技术支撑。

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基于CenterNet搭配优化DeepSORT算法的断奶仔猪目标跟踪方法研究

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摘要: [目的] 断奶仔猪是生猪养殖业中的重点关注对象, 群养环境下的仔猪精准跟踪是分析仔猪个体行为、监测仔猪个体健康的基础。本文提出1种基于深度学习的断奶仔猪目标跟踪方法。[方法] 利用基于中心点的CenterNet检测算法设计断奶仔猪目标检测模型, 对DeepSORT算法的检测部分进行优化; 训练优化跟踪过程中提取仔猪目标外观特征的模型, 结合卡尔曼滤波和匈牙利匹配算法, 改进重识别环节, 实现具有深度关联度量的断奶仔猪目标实时检测与跟踪。[结果] 算法测试结果表明, 断奶仔猪目标检测模型的平均精度均值和召回率分别为99.0%和78.6%, 多目标跟踪精度MOTA和MOTP指标分别为96.8%和81.8%。[结论] 本文所提方法改善了因断奶仔猪外表高度相似性以及黏连遮挡情况导致跟踪困难的问题, 可在群养环境中精准跟踪断奶仔猪个体, 算法为后续仔猪个体行为分析研究提供技术支撑。

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基于实例分割的白羽肉鸡体质量估测方法

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摘要: 针对白羽肉鸡体质量测量自动化水平低、易造成肉鸡应激的问题, 提出一种结合深度学习的非接触式白羽肉鸡体质量估测方法。利用Mask R-CNN和YOLOACT(You only look at coefficients) 两种实例分割算法获取白羽肉鸡位置与覆盖掩膜, 并进行效果对比; 采用自适应掩膜随机提取白羽肉鸡身体部分边缘点, 并作为观测点进行椭圆拟合, 映射白羽肉鸡背部像素投影面积; 通过双变量相关性分析验证白羽肉鸡背部投影面积与体质量间的显著相关性, 根据白羽肉鸡背部投影面积与背部像素投影面积的线性比例关系, 按照最小二乘原则建立白羽肉鸡背部像素投影面积与体质量间的线性回归模型。试验表明, 单只鸡体质量估测中以Mask R-CNN进行特征提取的体质量估测平均准确率为97.23%, 以YOLOACT进行特征提取的体质量估测平均准确率为97.49%, 群鸡场景中体质量估测最低准确率为90.50%。

2022年1月 《南京农业大学学报》

<https://kns.cnki.net/kcms/detail/32.1148.S.20220124.1915.012.html>

信息感知技术在畜禽养殖中的研究进展

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摘要: 信息化是畜禽养殖业发展的必然趋势,对养殖过程中环境和生长等信息的有效监测,有助于实现低成本、高效率和高收益的生产过程。智能信息感知技术的应用,满足了规模化养殖条件下海量信息的自动化监测需求,为解放生产力、实现节本增效提供了技术支持。本文阐述了信息感知技术对畜禽养殖过程中环境监控、畜禽关键生长信息感知和畜禽疾病预警的主要研究方法,包括传感器技术、图像处理技术、音频处理技术、热红外技术等;分析了当前主流方法应用于该领域的准确性、有效性与泛化性;总结了信息感知技术在畜禽养殖业中未来的研究重点,并对其未来发展方向做出展望。

2022年2月 《农业机械学报》

<https://kns.cnki.net/kcms/detail/11.1964.S.20220224.1021.008.html>

基于深度神经网络的猪咳嗽声识别方法

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摘要: 猪只呼吸道疾病易传染,影响猪的养殖生产效率,咳嗽是呼吸道疾病的显著症状之一,为识别猪只咳嗽声提出了一种基于深度神经网络的识别方法。对声音信号进行谱减法去噪和双门限端点检测后分别提取梅山猪咳嗽及喷嚏、鸣叫、呼噜声的滤波器组(Log_filter bank, logFbank)和梅尔频率倒谱系数(Mel frequency cepstral coefficients, MFCC)特征,每种特征与其一阶及二阶方差组合作为卷积神经网络(Convolutional neural networks, CNNs)和深层前馈序列记忆神经网络(Deep feed forward sequential memory networks, DFSMN)咳嗽声识别模型的输入,进行多分类训练。对比不同特征提取方法及不同迭代次数对模型效果的影响。实验结果表明,以MFCC作为特征输入的CNNs模型效果较优,测试集上咳嗽声识别精确率为97%,召回率为96%,F1值为98%,总体识别准确率为96.71%。表明该模型是有效可行的,可为生猪福利养殖中猪咳嗽声识别提供技术支持。

2022年2月 《农业机械学报》

<https://kns.cnki.net/kcms/detail/11.1964.S.20220224.1245.027.html>

基于EfficientDet的围产期母猪姿态识别与分析

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摘要: 围产期母猪母性行为直接影响仔猪的成活率, 母猪姿态是其母性行为 and 筑巢行为的重要表现。针对目前对围产期母猪姿态转化主要依靠人工巡检, 费时耗力且主观性强等问题, 采集了24头母猪的视频数据并对数据进行预处理, 利用EfficientDet网络对产床内母猪图像进行深层次特征提取, 实现了母猪站、坐、胸卧、侧卧姿态及其侧卧方向(乳房面向仔猪保温箱、乳房背对仔猪保温箱)的准确识别。结果表明: 该算法识别平均精度均值(mAP) 达 93.97%, 对图像的检测速度达 26.2 f/s, 对视频的检测速度达 10.66 f/s。通过对母猪产前及产后 24h 的姿态进行分析, 母猪产前表现出显著的筑巢行为, 姿态转变频率显著提高 ($P < 0.05$); 母猪产后侧卧时间显著增加, 母猪侧卧时长与仔猪窝均重呈正相关关系; 根据母猪侧卧方向的偏好性进行分组比较, 母猪偏向于将乳房面向保温箱侧卧的小组, 仔猪断奶成活率更高。

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An Automatic Ear Base Temperature Extraction Method for Top View Piglet Thermal Image

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Abstract: Ear bases are considered the thermal windows of a piglet. Temperature variation in piglet ear bases can be used as the indicator of a piglet's health status. However, piglet skin temperatures in thermal windows in the existing research are obtained manually from infrared thermal images captured by a thermography. This has put an obstacle at the automatic identification of piglets with health disorder. An algorithm was proposed in this paper to extract ear base temperature automatically from top view piglet thermal images. Firstly, a SVM (Support Vector Machine) classifier was trained to identify piglet head part. Then, two ear base points were located based on the shape feature of the head part contour. Finally, two maximum temperatures inside the two circles centered by ear base points were extracted as the ear base temperatures. The proposed algorithm was implemented in Matlab® (R2016a) and applied to 100 testing images. The extracted ear base temperatures were compared with those extracted manually by using Fluke SmartView 3.14 (FLUKE Systems). Comparison results showed that for left and right ear base respectively, 97% and 98% of the testing images had an error within 0.4°C. Ear base temperatures with such accuracy provided a foundation for the automatic identification of sick piglets.

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Recognition and Classification of Broiler Droppings Based on Deep Convolutional Neural Network

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Abstract: Digestive diseases are one of the common broiler diseases that significantly affect production and animal welfare in broiler breeding. Droppings examination and observation are the most precise techniques to detect the occurrence of digestive disease infections in birds. This study proposes an automated broiler digestive disease detector based on a deep Convolutional Neural Network model to classify fine-grained abnormal broiler droppings images as normal and abnormal (shape, color, water content, and shape&water). Droppings images were collected from 10,000 25-35-day-old Ross broiler birds reared in multilayer cages with automatic droppings conveyor belts. For comparative purposes, Faster R-CNN and YOLO-V3 deep Convolutional Neural Networks were developed. The performance of YOLO-V3 was improved by optimizing the anchor box. Faster R-CNN achieved 99.1% recall and 93.3% mean average precision, while YOLO-V3 achieved 88.7% recall and 84.3% mean average precision on the testing data set. The proposed detector can provide technical support for the detection of digestive diseases in broiler production by automatically and nonintrusively recognizing and classifying chicken droppings.

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A Machine Vision System for Early Detection and Prediction of Sick Birds: A Broiler Chicken Model

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Abstract: The occurrence of poultry diseases not only affects farm production economics but also leads to poor poultry welfare, food safety concerns, and zoonotic infections. Therefore, timely detection of these diseases is of paramount importance in poultry production. This study proposes a machine vision-based monitoring system for broiler chicken as they walk through a test area. Data were collected from two groups of broilers; control group and treatment group (inoculated intramuscularly with virulent Newcastle disease virus) housed in fully isolated chambers for comparative monitoring. The broilers were monitored by video surveillance for data labelling and depth camera for the automated health status classifier development. Feature variables were extracted based on 2D posture shape descriptors (circle variance, elongation, convexity, complexity, and eccentricity) and mobility feature (walk speed). A statistical analysis of the feature variables established that all investigated features were statistically significant ($p < 0.05$) with time after challenge in the treatment group. The earliest possible infection detection time was on the 4th day based on circle variance and elongation, and the 6th day based on eccentricity and walk speed. However, convexity and complexity could not provide early detection. Two sets of classifiers were then developed based on only the posture shape descriptors, and on all the feature variables, The Support Vector Machine (RBF-SVM) outperformed all the other models with an accuracy of 0.975 and 0.978 respectively. The proposed system can serve as an automatic broiler monitoring system by providing an early warning and prediction of an occurrence of disease continuously and non-intrusively.

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A Novel Method for Broiler Abnormal Sound Detection Using WMFCC and HMM

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Abstract: Broilers produce abnormal sounds such as cough and snore when they suffer from respiratory diseases. The aim of this research work was to develop a method for broiler abnormal sound detection. The sounds were recorded in a broiler house for one week (24/7). There were 20 thousand white feather broilers reared on the floor in a building. Results showed that the developed recognition algorithm, using wavelet transform Mel frequency cepstrum coefficients (WMFCCs), correlation distance Fisher criterion (CDF), and hidden Markov model (HMM), provided an average accuracy, precision, recall, and F1 of 93.8%, 94.4%, 94.1%, and 94.2%, respectively, for broiler sound samples. The results indicate that sound analysis can be used in broiler respiratory assessment in a commercial broiler farm.

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Automatic Recognition of Feeding and Foraging Behaviour in Pigs Using Deep Learning

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Abstract: Automated, vision-based early warning systems have been developed to detect behavioural changes in groups of pigs to monitor their health and welfare status. In commercial settings, automatic recording of feeding behaviour remains a challenge

due to problems of variation in illumination, occlusions and similar appearance of different pigs. Additionally, such systems, which rely on pig tracking, often overestimate the actual time spent feeding, due to the inability to identify and/or exclude non-nutritive visits (NNV) to the feeding area. To tackle these problems, we have developed a robust, deep learning-based feeding detection method that (a) does not rely on pig tracking and (b) is capable of distinguishing between feeding and NNV for a group of pigs. We first validated our method using video footage from a commercial pig farm, under a variety of settings. We demonstrate the ability of this automated method to identify feeding and NNV behaviour with high accuracy ($99.4\% \pm 0.6\%$). We then tested the method's ability to detect changes in feeding and NNV behaviours during a planned period of food restriction. We found that the method was able to automatically quantify the expected changes in both feeding and NNV behaviours. Our method is capable of monitoring robustly and accurately the feeding behaviour of groups of commercially housed pigs, without the need for additional sensors or individual marking. This has great potential for application in the early detection of health and welfare challenges of commercial pigs.

2020 *Scientific Reports* Volume 10

<https://doi.org/10.1038/s41598-020-70688-6>

Automated Recognition of Postures and Drinking Behaviour for the Detection of Compromised Health in Pigs

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Abstract: Changes in pig behaviours are a useful aid in detecting early signs of compromised health and welfare. In commercial settings, automatic detection of pig behaviours through visual imaging remains a challenge due to farm demanding conditions, e.g., occlusion of one pig from another. Here, two deep learning-based detector methods were developed to identify pig postures and drinking behaviours of

group-housed pigs. We first tested the system ability to detect changes in these measures at group-level during routine management. We then demonstrated the ability of our automated methods to identify behaviours of individual animals with a mean average precision of 0.989 ± 0.009 , under a variety of settings. When the pig feeding regime was disrupted, we automatically detected the expected deviations from the daily feeding routine in standing, lateral lying and drinking behaviours. These experiments demonstrate that the method is capable of robustly and accurately monitoring individual pig behaviours under commercial conditions, without the need for additional sensors or individual pig identification, hence providing a scalable technology to improve the health and well-being of farm animals. The method has the potential to transform how livestock are monitored and address issues in livestock farming, such as targeted treatment of individuals with medication.

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Early Detection of Diarrhea in Weaned Piglets From Individual Feed, Water and Weighing Data

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Abstract: This study analyzed individual water and feed consumption related to weight of weaned piglets and their link to diarrhea. Data were collected from 15 batches of 102 piglets each, using specific automata (connected feeders, connected drinkers, automatic weighing stations, RFID ear tags). Analyses were carried out every week on the 138 healthy animals compared by weight category. The average feed consumption had no significant difference between weight categories (light, medium, heavy pigs) whatever the week and was close to 4% of the live weight. For the average water consumption according to weight, it was close to 10%. There was no significant difference between weight groups, except at the end of the period,

where the variability of one heavy pig was so high that its own water consumption caused significant difference when compared with the light group. But these overall stable averages do not highlight the high intra-individual variabilities, which was around 40% for both water and feed data at the beginning of trial. At the end, it was almost 16% for feed consumption and 25% for water. The comparison between healthy and diarrheic piglets showed no statistical difference for average water consumption on the day of the first clinical signs and even 1 and 2 days before. In contrast, the average feed consumption had a very significant difference ($P \leq 0.001$) for days 5–7 after the weaning and a significant difference for day 8 ($P \leq 0.05$). Differences were also significant for data 24 and 48 h before first clinical signs. This means either that diarrheic piglets decrease their feed consumption the first days after weaning or that it is because they eat less that they become diarrheic. So, the hypothesis was that feed consumption could be an interesting indicator to detect early sick animals. Nevertheless, despite this difference, machine learning methods failed in detecting individually diarrheic animals from water and feed consumption related to weight, because of considerable individual variability. To improve these results, one solution could be to collect other data from new sensors like automatic measurement of body temperature or location of piglets in the pen by image analysis.

4. 中兽药技术

序号	论文名称	刊物
1	常山散对靶动物鸡的安全性试验	《中国兽医科学》
2	中兽药复方组合与抗生素防治肉鸡 呼吸道疾病的协同效应	《中国畜牧兽医》

3	参姜止痢合剂治疗仔猪黄痢的临床疗效评价	《中国动物传染病学报》
4	Combined Effect of Shegandilong Granule and Doxycycline on Immune Responses and Protection Against Avian Infectious Bronchitis Virus in Broilers	<i>Frontiers in Veterinary Science</i>
5	Huang Bai Jian Pi Decoction Alleviates Diarrhea and Represses Inflammatory Injury via PI3K/Akt/NF-KB Pathway: In Vivo and in Vitro Studies	<i>Journal of Ethnopharmacology</i>

2020年7月 《中国兽医科学》

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常山散对靶动物鸡的安全性试验

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摘要: 为评价常山散对靶动物鸡的安全性, 将80只岭南黄羽肉鸡随机分为4组, 每组20只。常山散按推荐剂量的1倍 (0.1 g/kg)、3倍 (0.3 g/kg) 和5倍 (0.5 g/kg) 进行给药, 连用7d, 同时设置空白对照组。试验期间每日观察记录鸡的精神、采食、饮水、粪便等外观表现, 测定给药7d后和休药7d后血常规指标、血液生化指标、脏器系数, 并进行肝肾病理学观察。结果显示, 常山散各剂量组鸡的临床状态、饮食和粪便均正常。与空白对照组比较, 给药7d后, 常山散1倍和3倍剂量组鸡血常规指标、血液生化指标和脏器系数均无显著性变化 ($P > 0.05$), 解剖

各脏器未发现肉眼可见病变；5倍剂量组的肝和肾出现轻度肿胀和淤血，肝系数显著降低 ($P < 0.05$)。休药7d后，除5倍剂量组鸡丙氨酸氨基转移酶显著降低外 ($P < 0.05$)，其他各项指标均无显著性变化 ($P > 0.05$)。空白对照组鸡临床表现和各项检测指标均正常。结果表明，常山散按1倍和3倍推荐剂量给药对靶动物鸡无毒副作用，临床使用安全。

2020年 《中国畜牧兽医》 第47卷 第3期

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中兽药复方组合与抗生素防治肉鸡呼吸道疾病的协同效应

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摘要: 为探讨中兽药复方组合与抗生素防治肉鸡呼吸道疾病的协同效应, 本研究在规模化鸡场两栋鸡舍内分别随机选取100只3日龄白羽肉鸡, 分为两组 (I 组和 II 组): I 组饮水添加抗生素, II 组在添加抗生素基础上的不同阶段分别饲喂中兽药玉屏风口服液 (3 ~ 7 d)、射干地龙颗粒 (10 ~ 16 d)、双黄连口服液 (22 ~ 25 d)、麻杏石甘口服液 (27 ~ 31 d)。分别于8日龄免疫鸡传染性支气管炎活疫苗、新城疫-传染性支气管炎二联活疫苗和新城疫-禽流感二联灭活疫苗, 免疫后1、7、14、21、28 d采集血清和气管组织, 检测新城疫、禽流感 (H9)、传染性支气管炎疫苗的抗体水平, 观察气管组织病理变化, 计算免疫器官指数和平均日增重。结果显示, II 组的成活率较 I 组提高了1.23%, II 组末体重与平均日增重极显著高于 I 组 ($P < 0.01$), 分别提高了561.25和16.63 g/d; II 组病鸡呼吸道症状较 I 组轻, 病程短, 肝脏和心脏无明显病变, 脾脏指数在36 d 显著高于 I 组 ($P < 0.05$)。免疫后21 d, II 组新城疫、传染性支气管炎和禽流感 (H9) 疫苗的抗体水平达到最高, 显著高于 I 组 ($P < 0.05$); 免疫后28 d, II 组新城疫抗体水平极显著高于 I 组 ($P < 0.01$)。综上所述, 4种清热解毒

、止咳平喘、清肝利胆的中兽药复方组合使用与抗生素促生长和预防肉鸡呼吸道疾病具有协同效应。

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参姜止痢合剂治疗仔猪黄痢的临床疗效评价

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摘要: 为验证参姜止痢合剂治疗仔猪黄痢的临床疗效, 从兰州周边养猪场搜集疑似病例, 经流行病学调查、临床症状观察作出初步诊断, 通过实验室细菌学检查进行确诊后, 采用参姜止痢合剂进行治疗, 观察给药后病猪精神状态、饮食和腹泻情况, 采用普通血平板培养基和大肠杆菌显色培养基测定给药前后仔猪粪便中大肠杆菌的数量。结果显示, 用药治疗后的仔猪精神状态明显好转或恢复正常, 病猪粪便中大肠杆菌数量明显减少, 3个养猪场(景泰县王德香养猪场、甘肃蟾慕农业科技有限责任公司和永登县苗中俊养猪场)的黄痢治愈率分别为 87.6%、89.1%和 84.1%。结果提示, 参姜止痢合剂治疗仔猪黄痢效果较好, 为今后研发新药提供了试验依据。

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Combined Effect of Shegandilong Granule and Doxycycline on Immune Responses and Protection Against Avian Infectious Bronchitis Virus in Broilers

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Abstract: Infectious bronchitis (IB) causes significant economic losses to commercial chicken farms due to the failures of vaccine immunization or incomplete protection. In this study, we evaluated the combination effect of Shegandilong (SGDL) granule (a traditional Chinese veterinary medicine) and doxycycline on the prevention of IBV infection and injury in the respiratory tract in broilers. A total of 126, 7-day-old broilers were randomly divided into four groups after vaccination. Group I served as a control. Broilers in Group II were given doxycycline, and Group III was given SGDL granule through drinking water. Broilers in Group IV were given SGDL granule and doxycycline by drinking water. Broilers in all groups were challenged with IBV through intraocular and intranasal routes at day 28. Results showed that the anti-IBV antibody level was higher in group IV compared with the level in other groups. Immunohistochemistry and ELISA results showed that an increase of immunoglobulin A (IgA) was observed in the trachea with the maximum level observed at day 14. In addition, SGDL granule + doxycycline effectively inhibited IBV replication and stopped IBV propagation from the trachea to the lung; modulated the mRNA expressions of IL-1 β , IL-6, TNF- α , and IFN- γ ; and extenuated the histopathology lesions in trachea and lung. These data imply that a combination of SGDL granule and doxycycline is effective in preventing IBV infection and respiratory tract injury in broilers.

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Huang Bai Jian Pi Decoction Alleviates Diarrhea and Represses Inflammatory Injury via PI3K/Akt/NF-KB Pathway: In Vivo and in Vitro Studies

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Ethnopharmacological relevance: Huang Bai Jian Pi (HBJP) decoction, a Chinese herbal formula based on the Pulsatilla decoction (PD) and Si Junzi decoction, is efficacy to treat clinical diarrhea in calves.

Abstract:

Aim of the study: The mechanism of HBJP decoction to treat calf diarrhea remains unclear. This study was to investigate the therapeutic effect and anti-inflammatory mechanism of HBJP decoction on diarrhea in rats. **Materials and methods:** Thirty-six Sprague Dawley rats were randomly divided into control group, model group, PD group and three treated groups with HBJP decoction. The diarrheal model in rats was established by multiple factors including high-sugar and fat diet, high temperature and dampness environment, biological pathogenic factors. The diarrheal animals were treated with HBJP decoction or PD for 5 days. The inflammatory model of the intestinal epithelioid cell line 6 (IEC-6) was induced by TNF- α . The clinical symptoms, blood routine and biochemistry parameters, histopathology of main organs were detected. The proteins associated with PI3K/Akt/ NF- κ B pathway and the expression levels of cytokines associated with inflammation were detected in vivo and in vitro by Western blot and ELISA.

Results: The model rats showed obvious diarrheal symptoms, and the obvious systemic inflammatory response accompanied with abnormal change in blood routine, biochemistry parameters and histopathology. HBJP decoction alleviated obviously the clinical symptoms, and pathological changes of the liver, colon and lung, and abnormal blood routine and biochemistry indexes in rats. The expression of P-PI3K,

P-Akt, P-NF-kB, IL-1, IL-6 was significantly increased, and the expression of IL-10 was markedly decreased in diarrheal rats and IEC-6 with inflammation. HBJP decoction significantly inhibited the PI3K/AKT/NF- kB signal pathway and adjusted the expression of these inflammatory cytokines.

Conclusions: The finding suggested that HBJP decoction alleviate the inflammation in diarrhea through inhibiting the PI3K/Akt/NF- kB signal pathway, which provides scientific evidences for the clinical application of HBJP decoction in diarrhea.

5. 农产品检测技术

序号	论文名称	刊物
1	利用稳定同位素进行农产品溯源研究进展	《核农学报》
2	代谢组学技术在肉品鉴别中的应用进展	《农产品质量与安全》
3	Rapid Simultaneous Determination of 160 Drugs in Urine and Blood of Livestock and Poultry by Ultra-high-performance Liquid Chromatography-tandem Mass Spectrometry	<i>Journal of Chromatography A</i>

4	Simultaneous Determination of Multi-class Antibiotics and Steroid Hormones Drugs in Livestock and Poultry Faeces Using Liquid Chromatography–Quadrupole Time-of-flight Mass Spectrometry	<i>Food Additives & Contaminants: Part A</i>
5	Huang Bai Jian Pi Decoction Alleviates Diarrhea and Represses Inflammatory Injury via PI3K/Akt/NF-KB Pathway: In Vivo and in Vitro Studies	<i>Journal of Ethnopharmacology</i>
6	Rapid On-site Detection of Salmonella pullorum Based on Lateral Flow Nucleic Acid Assay Combined with Recombinase Polymerase Amplification Reaction	<i>Poultry Science</i>
7	Meat Differentiation Between Pasture-fed and Concentrate-fed Sheep/Goats by Liquid Chromatography Quadrupole Time-of-flight Mass Spectrometry Combined with Metabolomic and Lipidomic Profiling	<i>Meat Science</i>
8	Effect of Bacterial Resistance of Escherichia coli From Swine in Large-Scale Pig Farms in Beijing	<i>Frontiers in Microbiology</i>
9	Synergistic Interaction Between Paired Combinations of Natural Antimicrobials Against Poultry-Borne Pathogens	<i>Frontiers in Microbiology</i>
欧方论文		

10	Analysis of Antimicrobials in Muscle and Drinking Water in Terms of Reducing the Need of Antimicrobial Use by Increasing the Health and Welfare of Pig and Broiler	<i>Antibiotics</i>
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2021年3月 《核农学报》

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利用稳定同位素进行农产品溯源研究进展

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摘要: 随着消费者对农产品质量与安全要求的提高,农产品溯源保持着良好的发展态势。稳定同位素在农产品研究中应用广泛,主要包括农产品产地溯源、真伪鉴别等。在产地溯源方面,研究较多的是牛肉、羊肉、牛奶、葡萄酒、蜂蜜、水产品、茶叶、谷物等农产品。一直以来,缩小溯源区域范围是产地溯源的难点和重点。稳定同位素技术与矿物元素技术、氨基酸技术、脂肪酸技术相结合是缩小溯源区域范围的最佳方法。在农产品真伪鉴别方面,农产品掺杂掺假形式多样、手段复杂,消费者难以辨别。在农产品加工过程中稳定同位素分馏方面,研究已经展开,且逐步深入。本文综述了2015—2020年稳定同位素在农产品产地溯源、真伪鉴别以及加工过程中的分馏研究进展,阐述了稳定同位素与其他技术结合进行农产品溯源区域范围的研究,并对利用稳定同位素进行农产品溯源研究予以总结和展望。

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代谢组学技术在肉品鉴别中的应用进展

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摘要: 当前肉品掺假已成为全球范围内备受关注的问题, 需要准确可靠的分析方法来监测和鉴别肉品的真实性, 从而确保肉品质量。代谢组学技术凭借其高灵敏性、高通量和稳健性等特点可以有效克服传统鉴别方法的局限性, 已被广泛应用于肉品鉴别相关分析中。本文介绍了代谢组学的整体研究流程, 对代谢组学在肉品鉴别方面的研究现状与进展进行综述, 以期代谢组学在肉产品质量控制等方面的进一步研究提供理论依据。

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Rapid Simultaneous Determination of 160 Drugs in Urine and Blood of Livestock and Poultry by Ultra-high-performance Liquid Chromatography-tandem Mass Spectrometry

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Abstract: In order to address the specific question of food safety in livestock and poultry, it is imperative to monitor veterinary drugs at every moment in the process of livestock and poultry breeding. Thus, multi-residue analysis of a wide variety of drugs using ultra-high-performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) has become a tool of critical significance, especially for veterinary drug monitoring programs. A total of 160 compounds,

belonging to 17 different families of veterinary drugs, were investigated in the urine and blood of livestock and poultry. Drug samples were extracted using a slightly acidic acetonitrile solution. The QuEChERS (quick, easy, cheap, effective, rugged, and safe) preparation method, combined with dispersive solid phase extraction (d-SPE) was compared with the approach of solid phase extraction (SPE). In the end, the QuEChERS extraction procedure was selected to reduce matrix effects and efficiently extract target veterinary drugs, and d-SPE was applied as a cleanup step. Electrospray ionization coupled with positive dynamic multiple reaction monitoring (dMRM) was utilized for the analysis of 160 different drugs in a single chromatographic run of 24 min. The efficiency of this method was evaluated using 7 matrices (pig blood, cattle blood, sheep blood, chicken blood, pig urine, cattle urine, and sheep urine). Good linearity was obtained for the analytes in a concentration range of 1–100 ng/mL, with correlation coefficients higher than 0.990. Most of the 160 drugs studied gave estimated limits of detection (LOQs) of 1 ng/mL, with some LOQs reaching as much as 5 ng/mL. The mean recoveries at four spike-in levels of 1, 5, 10, and 50 ng/mL, ranged from 60% to 120%. The intra-day precision measurements had coefficients of variation ($n = 6$) <15%, and the inter-day precision measurements were below 25%. Our method was applied in real samples and proved to be adequate for routine analysis. The proposed method proved to be simple, rapid and reliable for monitoring 160 drugs in the urine and blood of livestock and poultry, and can also be used for food safety monitoring.

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Simultaneous Determination of Multi-class Antibiotics and Steroid Hormones Drugs in Livestock and Poultry Faeces Using Liquid Chromatography–Quadrupole Time-of-flight Mass Spectrometry

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Abstract: A method for simultaneous determination of multi-class antibiotics and steroid hormone analysis in faeces of livestock and poultry was developed using liquid chromatography–quadrupole time-of-flight mass spectrometry (LC-QTOF MS). An in-house database was built for 156 detected drugs using Personal Compound Database Library software (PCDL) including compound name, monoisotopic mass, chemical formula, RT, chemical structure and three CID MS/MS spectra. The linearity result showed that all the drugs exhibited good linearity with determination coefficients (R^2) higher than 0.99. The drug recoveries and their RSDs for all three faeces samples (pig, cattle and chicken) were tested and 81, 96 and 92 drugs were chosen for analysis in pig, cattle and chicken faeces, respectively. Further validation showed that 73 veterinary drugs in all three kinds of faeces samples can be quantified in one analytical run. This work shows that qualitative and quantitative analysis using LC-QTOF MS represents a simple, sensitive, low-cost and high-throughput methodology in routine laboratory analyses.

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Rapid On-site Detection of *Salmonella pullorum* Based on Lateral Flow Nucleic Acid Assay Combined with Recombinase Polymerase Amplification Reaction

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Abstract: Caused by *Salmonella pullorum*, pullorosis is a bacterial disease threatening the poultry industry and has been listed as the bacterial disease to be

eliminated by the government. However, antibiotic treatment of pullorosis has become increasingly difficult, resulting in severe influences on the sustainable development of poultry. Abuse of antibiotics may cause global drug-resistant problems. Hence, early diagnosis of young chickens and accurate treatment of sick chickens are urgently needed. Traditional serotyping for Salmonella detection is costly and labor-intensive, whereas other commonly used plate agglutination test methods often cause physical injury of chickens. Therefore, a rapid and nondamaging detection method is of great significance for early diagnosis, which is the key step in accurate medication and elimination of pullorosis. In this study, we propose a novel lateral flow nucleic acid assay(LFNAA) system combining recombinase polymerase amplification (RPA) for the detection of *S. pullorum*. In this method, the DNA of *S. pullorum* strains was quickly amplified by RPA under 37 C, and then, the RPA products were added onto the LFNAA sample pad until the final results could be observed by naked eyes within 3 min. The proposed assay is fast and delivers visible results to naked eyes in field test. The limit of detection for genomic DNA was 5 ! 10²³ ng/mL, indicating high sensitivity. In addition, the proposed LFNAA system is cost-effective, efficient, and nondamaging to chicks in the field test. This system provides technical support for early diagnosis of *S. pullorum* in the poultry and paves a way for future precision medicine to avoid the global drug-resistance issues.

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Meat Differentiation Between Pasture-fed and Concentrate-fed Sheep/Goats by Liquid Chromatography Quadrupole Time-of-flight Mass Spectrometry Combined with Metabolomic and Lipidomic Profiling

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Abstract: Animal feeding method is a crucial factor in influencing meat quality. Consumers would preferentially select meat obtained from pasture-fed animals. In this study, an untargeted metabolomic and lipidomic method based on ultra-performance liquid chromatography quadrupole time-of-flight mass spectrometry (UPLC-Q-TOF/MS) combined with chemometric analysis was utilized to investigate the differences between meat from free-range and intensively-fed sheep/goats. Distinct separation between these two kinds of sheep/goats meat obtained were identified by principal component analysis. Analysis of variance, fold change and orthogonal projection to latent structures discriminant analysis were then conducted to determine specific potential markers. A total of 46 potential markers were selected according to online chemical databases. The support vector machine (SVM) method was used to process the responses of the selected potential markers, and the results of metabolomics and lipidomics from an additional 59 samples revealed the discrimination rate of 89.3% and 98.3%. These findings provided a basis for differentiation of meat from sheep/goats fed in the two methods.

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Effect of Bacterial Resistance of *Escherichia coli* From Swine in Large-Scale Pig Farms in Beijing

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Abstract: With widespread use of antibiotics in the aquaculture industry, bacterial resistance has recently attracted increasing attention. Continuous emergence of multi-resistant bacteria has greatly threatened human and animal health, as well as the quality and safety of livestock products. To control bacterial resistance, the effect of bacterial resistance needs to be well understood. The purpose of this study was to explore the factors influencing *Escherichia coli* (*E. coli*) drug resistance in large-scale pig farms. In this study, 296 strains of *E. coli* isolated and identified from large-scale pig farms in Beijing were used as the research objects. In vitro drug sensitivity tests were used to determine the sensitivity to 10 antibiotics of pig-derived *E. coli*. SPSS logistic regression was employed to analyze the effects of the season, pig type, sampling point (medication type) and sampling location on resistance and multi-drug resistance of *E. coli* from pigs. The degrees of drug resistance to 10 antibiotics of the 296 strains of pig-derived *E. coli* were varied, their resistance rates were between 4.05 and 97.64%, and their multi-drug resistance was appalling, with the highest resistance to six antibiotics being 26.35%. The isolated strains were proven more resistant to tetracyclines, penicillin and chloramphenicol, which are commonly used for disease prevention in pig farms, and less resistant to quinolones and aminoglycosides, which are not used in pig farms. The resistance of the isolated strains in spring and summer was generally higher than that in winter. *E. coli* resistance in piglets, fattening pigs and sows was more serious than that in nursery and sick pigs. The results showed that the season, type of medication and type of pig had an influence on the pig-derived *E. coli* resistance, among which the type of medication was the most influencing factor.

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Synergistic Interaction Between Paired Combinations of Natural Antimicrobials Against Poultry-Borne Pathogens

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Abstract: Natural antimicrobials (NAM) are promising candidates for the successful control of poultry-borne bacteria, carrying potent antimicrobial activity (AMA) against a wide range of multidrug-resistant pathogens. Individual activities of carvacrol, eugenol, trans-cinnamaldehyde, oregano, and thymol, along with the combined activity of paired compounds, were examined using broth microdilution and checkerboard techniques. The characteristic interactions between the compounds were calculated using an improved method, based on combination index (CI) values. The bacteria examined herein were selected due to their known genetic resistance to at least one antibiotic. Our results indicated that thymol was most effective, exhibiting the lowest minimum inhibitory concentration (MIC) value against *Salmonella pullorum*, *Escherichia coli*, and *Klebsiella pneumoniae*, establishing the order of antimicrobial efficacy as: thymol > oregano > carvacrol > trans-cinnamaldehyde > eugenol. In the interaction study, the paired combination of carvacrol and thymol showed synergistic effects and was highly effective in reducing the antibiotic resistance of all the evaluated pathogens. Notably, all CI values were <1.0 in evaluations of *S. pullorum*, indicating the absence of antagonism between eugenol and thymol (or oregano). In *K. pneumoniae*, majority of CI values, which had a few concentration points, were smaller than 1.0, indicating a synergistic effect between eugenol and carvacrol (oregano or thymol), and trans-cinnamaldehyde and carvacrol. In *E. coli*, apart from some concentration points, some CI values were smaller than 1.0, demonstrating a synergistic effect between eugenol and carvacrol, and thymol and carvacrol (eugenol or oregano). It is therefore of great significance to investigate and illuminate the minimal effect concentration of these five components when they are used in combination as feed additives. Moreover, the

improved evaluation method of this study provides a precise and extensive means to assess the synergistic effects of NAM.

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Analysis of Antimicrobials in Muscle and Drinking Water in Terms of Reducing the Need of Antimicrobial Use by Increasing the Health and Welfare of Pig and Broiler

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Abstract: Antimicrobial residues may pose harmful effects on the health of consumers. At the same time, an adequate quality of drinking water for animals is one of the important element to ensure animal welfare and food without antibacterials. The presented study is aimed at estimating the residue levels of antibacterial compounds, such as penicillins, cephalosporin, macrolides, tetracyclines, quinolones, sulphonamides, aminoglycosides, diaminopyrimidines, pleuromutilines and lincosamides in meat and on-farm drinking water samples using liquid chromatography-tandem mass spectrometry (LC-MS/MS), as a

part of a surveillance system on pig and broiler farms within the project Healthy Livestock. A total of 870 samples of muscle from pig and broiler, as well as 229 water samples were analysed for antibiotic residues. Samples were collected from farms in EU countries in two steps, before and after implementation of a tailor-made health plan. In muscle samples, the detected concentrations of doxycycline in the post-intervention step (15.9–70.8 µg/kg) were lower than concentrations in the pre-intervention step (20.6–100 µg/kg). In water samples, doxycycline in an average concentration of 119 µg/L in the pre- and 23.1 µg/L in the post-intervention step, as well as enrofloxacin at concentrations of 170 µg/L in the pre- and 1.72 µg/L in the post-intervention step were quantified. Amoxicillin was only present before intervention. The obtained results confirm the effectiveness of the intervention actions. The concentrations of antibiotics in muscles and water were lower after implementation of a health plan on the farms.

6. 畜禽养殖减抗趋势

序号	论文名称	刊物
1	我国畜禽养殖减抗探索及国外经验启示	《北方牧业》
2	兽用抗生素使用的挑战与对策：国际经验及其启示	《农村动态反映》

2023年第5期 《北方牧业》

<https://kns.cnki.net/kcms2/article/abstract?v=3uoqIhG8C44YLTIOAiTRKu87-SJxoEJu6LL9TJzd50m41rmZflAKnUqsLOXpq2m-ME9sqhp8ZUiL2rQYyd5w33zIVff9FWvE&u niplatform=NZKPT>

我国畜禽养殖减抗探索及国外经验启示

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摘要： 抗生素和其他抗微生物药物是现代医药成功发挥疗效的关键所在，显著改善了人类和动物健康。然而，抗生素的过度使用和误用导致疗效降低，越来越多病原体能够耐受原本用于杀灭病原体的抗微生物药物环境。抗微生物药物耐药性的发展和传播意味着用于预防和治疗人类、动物和植物感染的抗微生物药物可能会失效，现代医学甚至无法治疗轻微感染。目前，全球销售的抗微生物药物中有70%以上用于食用动物。随着全球粮食需求的增加，这种情况预计会恶化。在养殖业滥用抗生素，不仅会给动物性食品的安全带来潜在隐患，也会对人类的健康及生存环境造成危害。因此，对动物合理使用抗生素已经成为食品安全和畜牧业健康发展中一个重要问题。本文通过对中国的兽用抗生素使用现状、国外养殖减抗的经验、畜禽养殖减抗的途径三个方面，对畜禽减抗现状进行综合的分析，以期为国内养殖减抗行动提供参考。

2020年2月《农村动态反映》

兽用抗生素使用的挑战与对策：国际经验及其启示

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摘要：我国畜牧业是细菌耐药性和抗生素排放残留两大问题的主要来源。从学理上来说，对食用动物产品的人和自然生态环境均造成了不利的影响。兽用抗生素主要以亚治疗剂量为主，因其主要通过饲喂添加，并具有促进动物生长、预防疫病的优点，所以又被称为促生长类或饲用抗生素。因其能够满足畜牧业产业化、集约化、低成本的需求，亚治疗剂量抗生素在全球的畜牧业得到大规模地使用。由于长期以来缺少对其负面作用的了解，导致对兽药的管控力度不足，所有的人用抗生素均可以由兽药生产厂商制造并自由使用。甚至硫酸粘菌素这种治疗“超级细菌”的最后的抗生素，在之前也被用于促进动物生长。

国家重点研发计划“政府间国际科技创新合作”重点专项

减少抗菌药物用量的畜禽健康养殖与动物福利综合技术与示范

Tackling Antimicrobial Resistance (AMR) through Improved Livestock Health & Welfare

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