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- Chatur, Y.A., Brahmabhatt, M.N., Modi, S., Nayak, J.B., 2014. Fluoroquinolone resistance and detection of topoisomerase gene mutation in *Campylobacter jejuni* isolated from animal and human sources. *Int. J. Curr. Microbiol. App. Sci.*, 3, 773–783.
- Cover, T.L., Perez-Perez, G.I., Blaser, M.J., 1990. Evaluation of cytotoxic activity in fecal filtrates from patients with *Campylobacter jejuni* or *Campylobacter coli* enteritis. *FEMS Microbiol. Lett.*, 70, 301–304.
- de Souza, E.L., de Barros, J.C., de Oliveira, C.E.V., da Conceição, M. L., 2010. Influence of Origanum vulgare L. essential oil on enterotoxin production, membrane permeability and surface characteristics of *Staphylococcus aureus*. *Inter. J. Food Microbiol.*, 137, 308–311.
- Dramé, O., Leclair, D., Parnley, E.J., Deckert, A., Ouattara, B., Daignault, D., Ravel, A., 2020. Antimicrobial resistance of *Campylobacter* in broiler chicken along the food chain in Canada. *Foodborne Pathog. Dis.*, 17, 512–520.
- Elbaz, A.M., Ashmawy, E.S., Salama, A.A., Abdel-Moneim, A.M.E., Badri, F.B., Thabet, H. A., 2022. Effects of garlic and lemon essential oils on performance, digestibility, plasma metabolite, and intestinal health in broilers under environmental heat stress. *BMC Vet. Res.*, 18, 1–12.
- Elraheem Elayed, M.S.A., Tarabees, R., Shehata, A.A., Harb, O.H.A., Sabry, A., 2019. Virulence Repertoire and Antimicrobial Resistance of *Campylobacter jejuni* and *Campylobacter coli* Isolated from Some Poultry Farms in Menoufia Governorate, Egypt. *Pak. Vet. J.*, 39, 2.
- EFSA (European Food Safety Authority), 2012. The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2010. *EFSA J.*, 10, 2597.
- Ewert, D.L., Barger, J.O., Tidson, C.S., 1979. Local antibody response in chickens: analysis of antibody synthesis to Newcastle disease virus by solid-phase radioimmunoassay and immunofluorescence with class-specific antibody for chicken immunoglobulins. *Infect. Immun.*, 24, 657–675.
- Facciola, A., Riso, R., Antunovic, E., Visic, G., Delia, S.A., Laganà, P., 2017. *Campylobacter*: from microbiology to prevention. *J. Prev. Med. Hyg.*, 58, E79.
- Fadaly, E., 2016. Zoonotic concern of *Campylobacter jejuni* in raw and ready-to-eat barbecue chickens along with Egyptian handlers and consumers via molecular and immunofluorescent characterization. *Arab J. Sci. Technol.*, 8, 392.
- Fonseca, B.B., Ferreira Júnior, A., dos Santos, J.P., Coelho, L.R., Rossi, D.A., Melo, R.T., Mendonça, E.P., Araújo, T.G., Alves, R.N., Fagundes, M.E., 2016. *Campylobacter jejuni* Increases Transcribed IL-1 B and Causes Morphometric Changes in the Ileal Enterocytes of Chickens. *Braz. J. Poul. Sci.*, 18, 63–68.
- Frost, J.A., Oza, A.N., Thwaites, R.T., Rowe, B., 1998. Serotyping scheme for *Campylobacter jejuni* and *Campylobacter coli* based on direct agglutination of heat-stable antigens. *J. Clin. Microbiol.*, 36, 335–339.
- Gahlan Youseef, A., Ibrahim, A. I., Sayed, A., Sobhy, M., 2017. Occurrence of *Campylobacter* species in chickens by multiplex polymerase chain reaction. *Assiut Vet. Med. J.*, 63, 66–72.
- Gharbi, M., Béchouati, A., Hamrouni, S., Arfaoui, A., Maaroufi, A., 2017. Persistence of *Campylobacter* spp. in Poultry Flocks after Disinfection, Virulence, and Antimicrobial Resistance Traits of Recovered Isolates. *Antibiotics*, 12, 890.
- Ghoneim, N.H., Abdel-Moein, K. A.A., Barakat, A.M.A.K., Hegazi, A.G., Abd El-razek, K.A. E., Sadek, S. A. S., 2020. Isolation and molecular characterization of *Campylobacter jejuni* from chicken and human stool samples in Egypt. *Food Sci. Technol.*, 19, 195–202.
- Gumus, R., Ercan, N., Imik, H., 2017. The effect of thyme essential oil (*Thymus vulgaris*) added to quail diets on performance, some blood parameters, and the antioxidant metabolism of the serum and liver tissues. *Braz. J. Poul. Sci.*, 19, 297–304.
- Hafez, A.A., Younis, G., El-Shorbagy, M.M., Awad, A., 2018. Prevalence, cytotoxicity and antibiotic susceptibility of *Campylobacter* species recovered from retail chicken meat (Mansoura, Egypt. *Afri. J. Microbiol. Res.*, 12, 501–507.
- Han, X., Guan, X., Zeng, H., Li, J., Huang, X., Wen, Y., Zhao, Q., Huang, X., Yan, Q., Huang, Y., 2019. Prevalence, antimicrobial resistance profiles and virulence-associated genes of thermophilic *Campylobacter* spp. isolated from ducks in a Chinese slaughterhouse. *Food Control*, 104, 157–166.
- Hassan, F.A.M., Awad, A., 2017. Impact of thyme powder (*Thymus vulgaris* L.) supplementation on gene expression profiles of cytokines and economic efficiency of broiler diets. *Environ. Sci. Pollut. Res.*, 24, 15816–15826.
- Humphrey, T., O'Brien, S., Madsen, M., 2007. *Campylobacters* as zoonotic pathogens: a food production perspective. *Inter. J. Food Microbiol.*, 117, 237–257.
- Ibrahim, D., Ismail, T.A., Khalifa, E., Abd El-Kader, S.A., Mohamed, D.I., Mohamed, D.T., Shahin, S.E., Abd El-Hamid, M. I., 2021. Supplementing garlic nanohydrogel optimized growth, gastrointestinal integrity and economics and ameliorated necrotic enteritis in broiler chickens using a *Clostridium perfringens* challenge model. *Animals*, 11, 2027.
- Kelly, C., Gundogdu, O., Pircalabioru, G., Cean, A., Scates, P., Linton, M., Pinkerton, L., Magowan, E., Stef, L., Simiz, E., 2017. The in vitro and in vivo effect of carvacrol in preventing *Campylobacter* infection, colonization and in improving productivity of chicken broilers. *Foodborne Pathog. Dis.*, 14, 341–349.
- Khan, R. U., Naz, S., Nikousefat, Z., Tufarelli, V., Laudadio, V., 2012. *Thymus vulgaris*: alternative to antibiotics in poultry feed. *World's Poul. Sci. J.*, 68, 401–408.
- Latimer, K. S., 2011. Duncan and Prasse's veterinary laboratory medicine: clinical pathology. John Wiley & Sons.
- Li, L., Chen, X., Zhang, K., Tian, G., Ding, X., Bai, S., Zeng, Q., 2023. Effects of Thymol and Carvacrol Eutectic on Growth Performance, Serum Biochemical Parameters, and Intestinal Health in Broiler Chickens. *Animals*, 13, 2242.
- Liu, S.D., Song, M.H., Yun, W., Lee, J.H., Kim, H.B., Cho, J.H., 2019. Effect of carvacrol essential oils on immune response and inflammation-related genes expression in broilers challenged by lipopolysaccharide. *Poul. Sci.*, 98, 2026–2033.
- Luna, A., Lábague, M. C., Fernández, M. E., Zygañlo, J. A., Marín, R. H., 2018. Effects of feeding thymol and isoeugenol on plasma triglycerides and cholesterol levels in Japanese quail. *JAPS: J. Anim. Plant Sci.*, 28, 1.
- Ma, L., Wang, Y., Shen, J., Zhang, Q., Wu, C., 2014. Tracking *Campylobacter* contamination along a broiler chicken production chain from the farm level to retail in China. *Inter. J. Food Microbiol.*, 181, 77–84.
- Mansour, E.S., Shawky, N.A., Salh El Deen, M., 2021. Clinicopathological changes associated with *Campylobacter jejuni* infection in broilers. *Benha Vet. Med. J.*, 40, 11–15.
- Micciche, A., Rothrock Jr, M.J., Yang, Y., Ricke, S.C., 2019. Essential oils as an intervention strategy to reduce *Campylobacter* in poultry production: a review. *Front. Microbiol.*, 10, 1058.
- Moustafa, N., Aziza, A., Orma, O., Ibrahim, T., 2020. Effect of supplementation of broiler diets with essential oils on growth performance, antioxidant status, and general health. *Mansoura Vet. Med. J.*, 21, 14–20.
- Naeim, H., El-Hawiet, A., Abdel Rahman, R.A., Hussein, A., El Demellawy, M. A., Embaby, A. M., 2020. Antibacterial activity of Centaurea pumilio L. root and aerial part extracts against some multidrug resistant bacteria. *BMC Complement. Med. Ther.*, 20, 1–13.
- NRC, 1994. Nutrient Requirements of Poultry. Washington, D. C.: National Academies Press; 1994.
- Otigbu, A.C., Clarke, A.M., Fri, J., Akanbi, E.O., Njom, H.A., 2018. Antibiotic sensitivity profiling and virulence potential of *Campylobacter jejuni* isolates from estuarine water in the Eastern Cape Province, South Africa. *Inter. J. Environ. Res. Public Health*, 15, 925.
- Penner, J.L., 1988. The genus *Campylobacter*: a decade of progress. *Clin. Microbiol. Rev.*, 1, 157–172.
- Persson, S., Olsen, K.E.P., 2005. Multiplex PCR for identification of *Campylobacter coli* and *Campylobacter jejuni* from pure cultures and directly on stool samples. *J. Med. Microbiol.*, 54, 1043–1047.
- Premarathne, J.M., Anuar, A.S., Thung, T.Y., Satharasinghe, D.A., Jambari, N.N., Abdul-Mutalib, N.A., Huat, J.T.Y., Basri, D.F., Rukayadi, Y., Nakaguchi, Y., 2017. Prevalence and antibiotic resistance against tetracycline in *Campylobacter jejuni* and *C. coli* in cattle and beef meat from Selangor, Malaysia. *Front. Microbiol.*, 8, 2254.
- Raeisi, M., Khoshbakhtr, R., Ghaemi, E.A., Bayani, M., Hashemi, M., Seyedghasemi, N.S., Shirzad-Aski, H., 2017. Antimicrobial resistance and virulence-associated genes of *Campylobacter* spp. isolated from raw milk, fish, poultry, and red meat. *Microb. Drug Resist.*, 23, 925–933.
- Ramires, T., de Oliveira, M.G., Kleinubing, N.R., de Fátima Rauber Würfel, S., Mata, M.M., Iglesias, M.A., Lopes, G.V., Dellagostin, O.A., da Silva, W. P., 2020. Genetic diversity, antimicrobial resistance, and virulence genes of thermophilic *Campylobacter* isolated from broiler production chain. *Braz. J. Microbiol.*, 51, 2021–2032.
- Reid, W.D.K., Close, A.J., Humphrey, S., Chaloner, G., Lacharme-Lora, L., Rothwell, L., Kaiser, P., Williams, N.J., Humphrey, T.J., Wigley, P., 2016. Cytokine responses in birds challenged with the human food-borne pathogen *Campylobacter jejuni* implies a Th17 response. *Royal Soc. Open Sci.*, 3, 150541.
- Saadat Shad, H., Mazhari, M., Esmailpour, O., Khosravinia, H., 2016. Effects of thymol and carvacrol on productive performance, antioxidant enzyme activity and certain blood metabolites in heat stressed broilers. *Iranian Journal of Applied Animal Science*, 6, 195–202.
- Sheppard, S.K., Dallas, J.F., Strachan, N.J.C., MacRae, M., McCarthy, N.D., Wilson, D.J., Gormley, F.J., Falush, D., Ogden, I.D., Maiden, M.C.J., 2009. *Campylobacter* genotyping to determine the source of human infection. *Clin. Infect. Dis.*, 48, 1072–1078.
- Smith, C.K., AbuOun, M., Cawthraw, S.A., Humphrey, T.J., Rothwell, L., Kaiser, P., Barrow, P.A., Jones, M.A., 2008. *Campylobacter* colonization of the chicken induces a proinflammatory response in mucosal tissues. *FEMS Immunol. Med. Microbiol.*, 54, 114–121.
- Stef, L., Julean, C., Cean, A., Mot, D., Stef, D. S., Simiz, E., Simiz, F., Pet, I., Marcu, A., Corcionivoschi, N., 2016. Evaluation of the administration effects of probiotics against *Campylobacter jejuni* on the immune system of broiler chickens. *Scientific Papers: Animal Science & Biotechnologies/Lucrări Stiintifice: Zootehnie Si Biotehnologii*, 49, 1.
- Szczepanska, B., Andrzejewska, M., Spica, D., Klawe, J.J., 2017. Prevalence and antimicrobial resistance of *Campylobacter jejuni* and *Campylobacter coli* isolated from children and environmental sources in urban and suburban areas. *BMC Microbiol.*, 17, 1–9.
- Szott, V., Reichelt, B., Alter, T., Friese, A., Roessler, U., 2020. In vivo efficacy of carvacrol on *Campylobacter jejuni* prevalence in broiler chickens during an entire fattening period. *Eur. J. Microbiol. Immunol.*, 10, 131–138.
- Szymanski, C.M., Gaynor, E.C., 2012. How a sugary bug gets through the day: recent developments in understanding fundamental processes impacting *Campylobacter jejuni* pathogenesis. *Gut Microbes*, 3, 135–144.
- Thibault, A., Fravallo, P., Yergeau, É., Arsenault, J., Lahaye, L., Letellier, A., 2015. Chicken caecal microbiome modifications induced by *Campylobacter jejuni* colonization and by a non-antibiotic feed additive. *PLoS One*, 10, e0131978.
- Tall, M.A., Weiser, G., Allison, R.W., Campbell, T.W., 2012. Veterinary hematology and clinical chemistry. John Wiley and Sons.
- Tiwari, M., Dwivedi, J.N., Kakkur, P., 2010. Suppression of oxidative stress and pro-inflammatory mediators by Cymbopogon citratus D. Stapf extract in lipopolysaccharide stimulated mouse alveolar macrophages. *Food Chem. Toxicol.*, 48, 2913–2919.
- Tresse, O., Alvarez-Ordóñez, A., Connerton, I.F., 2017. Editorial: About the Foodborne Pathogen *Campylobacter*. *Front. Microbiol.*, 8, 1908.
- Upadhyay, A., Anand, K., Wagley, R., Upadhyaya, I., Shrestha, S., Donoghue, A. M., Donoghue, D. J., 2017. Trans-cinnamaldehyde, carvacrol, and eugenol reduce *Campylobacter jejuni* colonization factors and expression of virulence genes in vitro. *Front. Microbiol.*, 8, 713.
- Vandamme, P., Gevers, G., & Debruyne, J. (2008). Taxonomy of the Family *Campylobacteraceae*. In I. Nachamkin, C. M. Szymanski, & M. J. Blaser (Eds.), *Campylobacter* (3rd ed., pp. 3–25). Washington: American Society for Microbiology.
- Walker, L.J., Wallace, R.L., Smith, R., Ham, J., Saputra, T., Symes, S., Stylianopoulos, A., Polkinghorne, B.G., Kirk, M., & Glass, G. (2019). Prevalence of *Campylobacter coli* and *Campylobacter jejuni* in retail chicken, beef, lamb, and pork products in three Australian states. *J. Food Prot.*, 82, 2126–2134.
- Wieczorek, K., Kania, I., Osek, J., 2013. Prevalence and antimicrobial resistance of *Campylobacter* spp. isolated from poultry carcasses in Poland. *J. Food Prot.*, 76, 1451–1455.
- Wieczorek, K., Szewczyk, R., Osek, J., 2012. Prevalence, antimicrobial resistance, and molecular characterization of *Campylobacter jejuni* and *C. coli* isolated from retail raw meat in Poland. *Veter. Med.*, 57, 6.
- Wright, G. D., 2019. Unlocking the potential of natural products in drug discovery. *Microb. Biotechnol.*, 12, 55–57.
- Yang, Y., Ashworth, A.J., Willett, C., Cook, K., Upadhyay, A., O'Brien, P., Mackey, S., DeBruyn, J.M., Moore Jr, P.A., 2019. Review of antibiotic resistance, ecology, dissemination, and mitigation in US broiler poultry systems. *Front. Microbiol.*, 10, 2639.
- Young, K.T., Davis, L.M., DiRita, V.J., 2007. *Campylobacter jejuni*: molecular biology and pathogenesis. *Nature Rev. Microbiol.*, 5, 665–679.
- Youssef, I.M. I., Männer, K., Zentek, J., 2021. Effect of essential oils or saponins on colonization on productive performance, intestinal morphology and digestive enzymes' activity of broiler chickens. *J. Anim. Physiol. Anim. Nutri.*, 105, 99–107.
- Zhai, H., Liu, H., Wang, S., Wu, J., Kluentner, A.-M., 2018. Potential of essential oils for poultry and pigs. *Anim. Nutr.*, 4, 179–186.
- Zheng, J., Meng, J., Zhao, S., Singh, R., Song, W., 2006. Adherence to and invasion of human intestinal epithelial cells by *Campylobacter jejuni* and *Campylobacter coli* isolates from retail meat products. *J. Food Prot.*, 69, 768–774.