



Assessment of *Nigella sativa* extract as a potential antibiotic alternative feed supplement for weaned swine



B.T. Petrujkić¹, R.C. Beier², H. He², K.J. Genovese², C.L. Swaggerty², M.E. Hume², T.L. Crippen², R.B. Harvey², R.C. Anderson², & D.J. Nisbet²

¹ Faculty of Veterinary Medicine, University of Belgrade, Serbia

² Southern Plains Agricultural Research Center, Agricultural Research Service, USDA, College Station, TX, USA

Abstract

New technologies are needed to help livestock producers maintain health and wellbeing of their animals while minimizing risks of disseminating antimicrobial resistant bacteria to humans or animals. *Nigella sativa* (NS) is a plant containing bioactive constituents such as thymoquinone. Extracts of NS enhance immune function, improve performance and reduce enteropathogen colonization in poultry and small ruminants but studies with swine are lacking. Presently, we assessed the effect of NS extracts on intestinal carriage of wildtype *Escherichia coli* and *Campylobacter* and a challenge strain of *Salmonella* Typhimurium orally inoculated (10^9 colony forming units, CFU) into newly weaned piglets 6 to 18 h before initiation of treatment. In study one, treatments were administered via gavage of an aqueous NS extract at doses equivalent to 0, 0.15 or 0.45% diet dry matter ($n = 6$ pigs/treatment). In study two, equivalent doses were administered via supplementation of the pigs' daily ration ($n = 6$ pens/treatment). Analysis of bacterial populations in gut samples collected 26 and 42 h after initiation of treatment in study one and 9 days after treatment in study two revealed tendencies of linear effects ($P < 0.09$) of treatment on *E. coli*, with populations recovered from NS extract-treated pigs being 0.7 to 1.8 log units lower than those recovered from jejunal, cecal and rectal contents of controls (which ranged from 6.05 to 8.10 \log_{10} CFU/g). Gut populations of *Campylobacter* and Typhimurium were unaffected ($P > 0.10$) by NS treatment in both studies. Feed intake and weight gain over the 9 days of study two were unaffected by treatment ($P > 0.10$), averaging 2.85 ± 0.67 and 1.28 ± 0.70 kg, respectively, but feed efficiency was improved linearly ($P < 0.05$), achieving 0.28 ± 0.21 , 0.46 ± 0.11 and 0.54 ± 0.16 kg body weight gain/kg dry matter intake in 0, 0.15 and 0.45% NS-treated pens, respectively.

Introduction and Objectives

- ☀ Livestock producers are under increasing pressure to reduce their use of antibiotics to control disease and enhance production because of the concern of public health officials and the general public that such use of antibiotics may contribute to the emergence and proliferation of antibiotic resistant bacteria, and thus diminish the effectiveness of antibiotics used to treat medically important diseases in humans.
- ☀ There is a critical need for new, environmentally compatible technologies to help eliminate pathogens from food animals during on-farm rearing.
- ☀ An attractive plant source has been identified called *Nigella sativa*, which is native to Asia, and parts of the Mideast and is known to contain a variety of derivatives active against bacteria.
- ☀ *Nigella sativa* has been shown to be biologically active, exhibiting antimicrobial, anti-inflammatory, antioxidant, gastroprotective, and anticancer activities.
- ☀ The antimicrobial, anti-inflammatory and gastroprotective activities of *Nigella sativa* seeds and extracts have been demonstrated in poultry by reductions in ileal and excreta concentrations of *E. coli* as well as in Baladi goats.
- ☀ But until now very little research, if any, has been done with *Nigella sativa* seeds or extracts in swine rearing and production.
- ☀ The objective of this work was to study the effect of *Nigella sativa* on swine performance and colonization of wildtype generic *E. coli* and *Campylobacter* and the challenge strain of *Salmonella* Typhimurium.
- ☀ Also, determine if *Nigella sativa* could be a potential feed additive for swine.

Methodology

- ☀ In two animal studies a total of 72 three-week old piglets (36 per study) were assigned to either the Control ($n = 12$) Group, or the 1X treatment ($n = 12$) or the 3X treatment ($n = 12$) Groups. Each study group consisted of six replicate pens with two animals in each pen. All animal handling and care was in accordance with the ACUC USDA protocol # 2016016.
- ☀ All animals were fed a diet that met or exceeded the requirements set by the National Research Council.
- ☀ In study one *Nigella sativa* extract was given via oral gavage 6 and 18 h after challenge with *Salmonella* Typhimurium oral gavage, which was preceded by a five day adjusting period on control feed. The Control Group was gavaged with 6 mL of distilled water, while the 1X Group received 6 mL of 10% and the 3X Group received 6 mL of 30% *Nigella sativa* extract, which was 0.6 and 1.8 g of dry *Nigella sativa* extract per animal, respectfully. One half of the animals from each group were harvested at 26 h ($n = 18$) and the other half was harvested at 42 h ($n = 18$) after *Salmonella* Typhimurium oral gavage challenge, and were subjected to microbiology analysis.
- ☀ In study two *Nigella sativa* extract was supplied in the feed and given *ad libitum* beginning on the first day of the study at a rate of 0.15% (1X Group) or 0.45% (3X Group) of the dry matter diet. Animals were orally challenged with *Salmonella* Typhimurium nine days later and harvested at 42 h following the oral challenge and then subjected to microbiology analysis.

Results

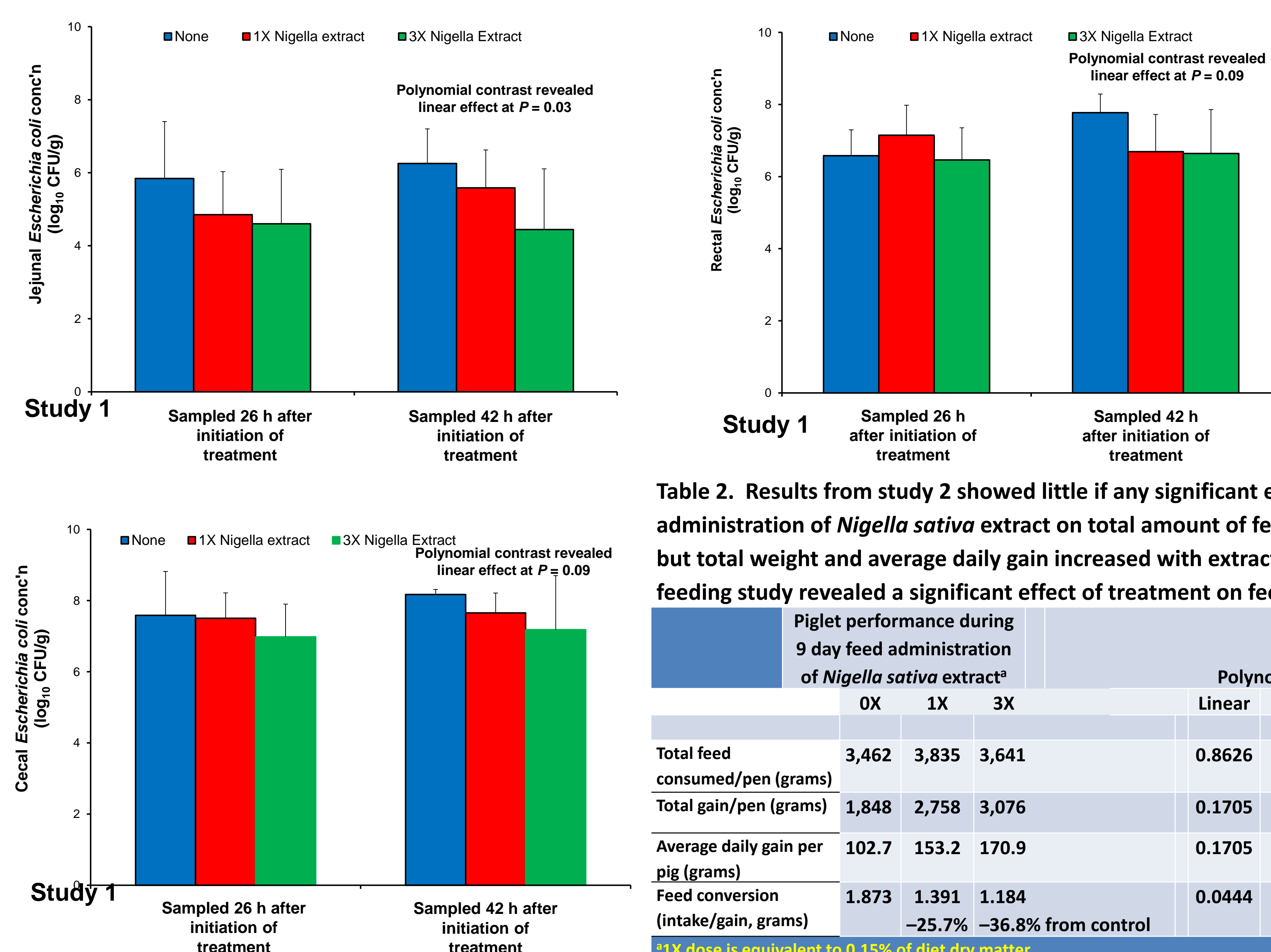


Table 1. Results from study 2 showed significant or nearly significant effect of feed administration of *Nigella sativa* extract on wildtype *E. coli* but not on experimentally inoculated *S. Typhimurium* or wildtype *Campylobacter* species.

	Bacterial concentrations (\log_{10} CFU/g) observed in gut contents collected 42 h after challenge with <i>Salmonella</i> and with 9 day feeding of <i>Nigella sativa</i> extract			Polynomial contrasts		
	0X	1X	3X	Linear	Quadratic	SEM
Wildtype <i>E. coli</i>						
Jejunal	6.05	4.48	4.74	0.0237	0.0083	0.324
Cecal	6.50	5.66	5.60	0.1318	0.2423	0.364
Rectal	6.61	5.89	5.68	0.0188	0.1868	0.246
<i>S. Typhimurium</i>						
Jejunal	1.25	1.00	1.84	0.1238	0.2597	0.312
Cecal	2.34	2.10	2.91	0.2769	0.4254	0.428
Rectal	2.84	2.42	2.55	0.6754	0.4892	0.374
<i>Campylobacter</i> spp.						
Jejunal	2.04	1.55	2.05	0.8009	0.2296	0.323
Cecal	4.04	3.40	3.53	0.3675	0.2527	0.324
Rectal	4.42	4.59	4.17	0.5199	0.5627	0.344

^a1X dose is equivalent to 0.15% of dry matter diet.

Conclusions

- ☀ A significant or nearly significant positive effect on the reduction of wildtype *E. coli* was observed by the *Nigella sativa* extract, but not on wildtype *Campylobacter* or the inoculated *S. Typhimurium*.
- ☀ The three-week old piglets tolerated the *Nigella sativa* extract very well, and appeared to prefer feed containing the extract.
- ☀ The average daily weight gain per piglet tended to increase with increasing quantities of *Nigella sativa* extract in the feed.
- ☀ In like manner, the total weight gain per pen over the time of the experiment tended to increase as the quantity of extract increased in the feed.
- ☀ Finally, A significant improvement in feed conversion was revealed for the duration of the experiment by both the 1X and 3X *Nigella sativa* treatments.

Contact Information:
 Branko T. Petrujkić — petrujki@vet.bg.ac.rs
 Ross C. Beier — ross.beier@ars.usda.gov
 Robin C. Anderson — robin.anderson@ars.usda.gov