

# Abstracts

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infection but became more generalized throughout the affected enterocytes as the infection progressed and mitochondria appeared to decrease ( $P < 0.04$ ) in numbers and condense into tight clumps. The nitration mirrored the progression from d 1 to d 3 to d 6 after infection of the parasites down the villus to the crypts, with the nuclei of both the trophozoites and the schizonts showing evidence of strong generalized protein nitration ( $P < 0.01$ ; detected with anti-nitrotyrosine antibody) and membrane disruption. The data suggest that post-translational mitochondrial autonation of Complex V P-loop may participate in cellular responses to coccidiosis.

**Key Words:** *Eimeria*, mitochondria, protein nitration  
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**030 Ovicidal effect of the fruit and leaf of *Caesalpinia coriaria* against *Haemonchus contortus* and *Haemonchus placei*.** A. Olmedo-Juarez<sup>1</sup>, R. Rojo Rubio<sup>2</sup>, P. Mendoza-de Gives<sup>3</sup>, J. F. Vázquez-Armijo<sup>2</sup>, B. Albarran-Portillo<sup>2</sup>, and C. Garcia-Hernandez<sup>2</sup>, <sup>1</sup>Centro Nacional de Investigación Disciplinaria en Parasitología Veterinaria, INIFAP, Cuernavaca, Mexico, <sup>2</sup>Universidad Autónoma del Estado del Mexico, Temascaltepec, Mexico, <sup>3</sup>Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Jiutepec, Mexico.

The effect of hydroalcoholic extracts of fruits and leaves from *Caesalpinia coriaria* on the egg hatching inhibition of *Haemonchus contortus* and *Haemonchus placei* was evaluated. The tested concentrations were 25.0, 12.5, 6.2, 3.1, and 1.5 mg/mL; likewise, a 4% methanol solution and albendazole were used as negative and positive controls, respectively. The results were analyzed under a  $2 \times 2 \times 6$  factorial arrangement of treatments under a completely randomized design, and for the mean comparison, Tukey's test was used. The mean ( $LC_{50}$ ) and maximum ( $LC_{90}$ ) lethal concentrations were estimated with Probit analysis of SAS. The hydroalcoholic leaf extract as well as the fruit extract had ovicidal activity (Table 030;  $P < 0.05$ ), inhibiting hatching in around 100% with the concentration of 25.0 mg/mL. The fruit extract had better egg hatching inhibition ( $P < 0.001$ ) in *H. contortus* and *H. placei* than the leaf extract. The  $LC_{50}$  for the fruit extract were 1.63 and 3.91 mg/mL and for the leaf were 3.98 and 11.68 mg/mL for *H. contortus* and *H. placei*, respectively. The main compounds contained in both extracts were tannins, flavonoids, gallic acid, and ethyl gallate. It is concluded that the hydroalcoholic extracts from mature fruits and leaves of *C. coriaria* have the ability of inhibit the egg hatching of *H. contortus* and *H. placei*.

**Key Words:** *Caesalpinia coriaria*, *Haemonchus*, secondary compounds  
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**Table 030.** Percentage of egg hatching inhibition in 2 species of gastrointestinal nematodes exposed to a hydroalcoholic extract of mature fruits and leaves of *Caesalpinia coriaria*

Extract	Concentration, mg/mL	Egg hatching inhibition, %	
		Nematode	
		<i>Haemonchus contortus</i>	<i>Haemonchus placei</i>
Fruit	25.00	100 <sup>a</sup>	100 <sup>a</sup>
	12.50	100 <sup>a</sup>	100 <sup>a</sup>
	6.25	99.5 <sup>a</sup>	92.75 <sup>a</sup>
	3.15	89.25 <sup>a</sup>	33.75 <sup>cd</sup>
	1.56	58.75 <sup>b</sup>	17.75 <sup>e</sup>
	0.00	3.25 <sup>fg</sup>	2.75 <sup>s</sup>
Leaf	25.00	95.25 <sup>a</sup>	92.50 <sup>a</sup>
	12.50	90.00 <sup>a</sup>	60.75 <sup>b</sup>
	6.25	60.00 <sup>b</sup>	22.75 <sup>de</sup>
	3.15	40.75 <sup>c</sup>	19.75 <sup>de</sup>
	1.56	27.50 <sup>cd</sup>	16.25 <sup>efg</sup>
	0.00	3.25 <sup>fg</sup>	2.75 <sup>s</sup>
Albendazole	10.00	100 <sup>a</sup>	100 <sup>a</sup>
Extract			<0.0001
Nematode			<0.0001
Concentration			<0.0001
Extract × nematode			0.8977
Extract × concentration			<0.0001
Extract × nematode × concentration			<0.0001
SEM			0.10

<sup>a-g</sup>Means within the same column and row with different letters statistically differ ( $P < 0.05$ ).

**031 In vitro evaluation of the antimicrobial activity of several short- and medium-chain fatty acid salts and their combinations.** C. Sol<sup>1</sup>, J. M. Oddo<sup>1</sup>, M. Puyalto<sup>1</sup>, A. Carvajal<sup>2</sup>, M. Gómez<sup>2</sup>, S. Costillas<sup>2</sup>, J. J. Mallo<sup>1</sup>, and P. Rubio<sup>2</sup>, <sup>1</sup>NOREL S.A., Madrid, Spain, <sup>2</sup>Universidad de León – grupo DIGESPORC, León, Spain.

Organic acid salts are feed additives used as alternatives to antibiotics for health and growth promotion in animal production. The aim of this study was to investigate the minimum inhibitory concentration (MIC) of organic acid salts against *Salmonella enterica* subsp. *enterica* (7 strains), *Escherichia coli* (9 strains), and *Clostridium perfringens* (6 strains). The products tested were sodium butyrate (BUT), sodium heptanoate (HEP), sodium salt of coconut fatty acid distillate (DIC), and their combinations BUT + DIC (1:1 ratio) and HEP + DIC (1:1 ratio). For each product and each strain, MIC was determined in triplicate using a broth microdilution method at pH 4.8 and 6, and the value that inhibits 50% of the tested isolates was determined ( $MIC_{50}$ ). The results at pH 4.8 of  $MIC_{50}$  against *E. coli* showed that HEP was the most effective (32 ppm) followed by HEP + DIC (128 ppm), BUT (512 ppm), and BUT + DIC (1,024 ppm); DIC could not solubilize at more than 5,000 ppm. Regarding to *Salmonella*, HEP was also the most effective (32 ppm) followed by HEP + DIC and BUT (256 ppm) and DIC and BUT + DIC (512 ppm). *Clostridium*

*perfringens* was unable to grow at pH 4.8. The results at pH 6 of MIC<sub>50</sub> against *E. coli* showed that HEP was again the most effective (3,125 ppm) followed by HEP + DIC (3,500 ppm) and BUT (62,500 ppm). Sodium salt of coconut fatty acid distillate could not solubilize at more than 5,000 ppm and BUT + DIC could not solubilize at more than 9,000 ppm. Regarding to *Salmonella* at pH 6, HEP was also the most effective (1,562 ppm) followed by BUT (125,000 ppm); however, DIC, BUT + DIC, and HEP + DIC could not solubilize at more than 5,000, 9,000, and 14,000 ppm, respectively. Finally, the results against *C. perfringens* showed that DIC was the most effective (15.4 ppm) followed by HEP + DIC (21.5 ppm), BUT + DIC (27.6 ppm), HEP (1,562 ppm), and BUT (31,250 ppm). In summary, the results showed that HEP was the most effective against Gram-negative bacteria, whereas DIC was the most effective against Gram-positive bacteria. The combination HEP + DIC showed an increased effect of DIC against *Salmonella* and also an increased effect of HEP against *C. perfringens*. The combination of BUT with DIC potentiated the effect of BUT against *C. perfringens*. Further studies would be required to better understand these interactions as well as in vivo studies to demonstrate the effects on microbial populations.

**Key Words:** minimum inhibitory concentration, organic acid salts  
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### 032 Antibacterial activity of different essential oils and their combinations against relevant enteric pathogenic bacteria.

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Essential oils (EO) and their components are being increasingly used in animal feeds for their antibacterial properties. However, in-feed concentrations are usually lower than the effective antibacterial concentrations reported by in vitro assays. Therefore, it is important to study the most efficient EO and synergistic combinations to improve their effectiveness as feed additives. The objective of this study was to test the in vitro antibacterial activity of 3 EO (clove, oregano, and black pepper) and 3 isolated EO components (cinnamaldehyde, thymol, and carvacrol) both individually and in combinations against a collection of reference and field strains of *Escherichia coli*, *Salmonella enterica* subsp. *enterica*, and *Clostridium perfringens*. The minimum inhibitory concentrations (MIC) were studied in triplicate using a broth microdilution method at pH 6. First, MIC of the 6 individual products were determined, whereas in a second step, 11 combinations of the individual products were evaluated. The results indicated that all the individual products, except black pepper, showed antimicrobial activity against all Gram-positive and Gram-negative tested bacterial strains. Minimum inhibitory concentrations that

inhibit 50% of the isolates (MIC<sub>50</sub>) ranged from 300 to 600 mg/L for *E. coli*, 300 to 600 mg/L for *Salmonella*, and 300 to 1,200 mg/L for *C. perfringens*. Carvacrol showed the best antibacterial activity, with a MIC<sub>50</sub> of 300 mg/L against all 3 bacteria, followed by cinnamaldehyde, with a MIC<sub>50</sub> of 600 mg/L against *E. coli* and *Salmonella* and a MIC<sub>50</sub> of 300 mg/L against *C. perfringens*. Most of the combinations showed an increased antibacterial activity compared with their individual components, with a MIC<sub>50</sub> range from 150 to 300 mg/L for all tested strains of the 3 bacterial species. The combination of cinnamaldehyde, thymol, carvacrol, and clove EO showed the best antibacterial results, with a MIC<sub>50</sub> of 150 mg/L against all 3 bacteria, followed by the combination of cinnamaldehyde and carvacrol, with a MIC<sub>50</sub> of 150 mg/L for *E. coli* and *C. perfringens* and a MIC<sub>50</sub> of 300 mg/L for *Salmonella*. The results of this study confirm that the antibacterial activity of some EO and their components can be increased by their use in combination. Further studies are needed to better understand these interactions as well as in vivo studies to show their effects on microbial populations.

**Key Words:** combinations, essential oils, minimum inhibitory concentration  
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### 033 Survey of mycotoxins in 2016 United States corn.

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Mycotoxins, toxic secondary metabolites produced by common molds infecting grains and forages, can contaminate feed ingredients. The negative effects on livestock are dependent on the level, type, and duration of exposure as well as the age, species, and general health status of the animal. The current study's objective was to determine the occurrence and potential risk of mycotoxins to livestock species in the 2016 U.S. corn crop in comparison with the previous year. In total, 318 corn samples from 25 states (2015 harvest) and 387 corn samples from 26 states (2016 harvest) were submitted for analysis as part of the annual Biomin PROcheck Mycotoxin Survey. Samples were analyzed by liquid chromatography tandem mass spectrometry for the presence of mycotoxins from 6 major mycotoxin groups: type B trichothecenes including deoxynivalenol (DON), fumonisins (FUM), zearalenone (ZEN), aflatoxins (Afla), type A trichothecenes including T-2 toxin (T-2), and ochratoxin A (OTA). A summary of the results is provided in Table 033. Individual toxin levels and co-occurrence from each year were compared using nonparametric tests (GraphPad Prism). In the 2016 sample pool, 90% of the corn samples had least one mycotoxin detected. Compared with 2015 corn, 2016 corn had higher contamination levels of DON and FUM ( $P < 0.001$ ). Additionally, co-occurrence of more than one mycotoxin increased from 2015 to 2016 (46 vs. 67%;  $P < 0.001$ ). Toxins produced by *Fusarium* fungal species (DON,