Oleoresins from chili pepper and turmeric can substitute for salinomycin in broilers

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SHORT COMMUNICATION

Oleoresins from chili pepper and turmeric can substitute for salinomycin in broilers

Oleoresinas de pimiento y cúrcuma pueden reemplazar la salinomicina en pollos de engorde

Oleoresinas de pimenta chilli e cúrcuma podem substituir a salinomicina em frangos de corte

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Abstract

Background: Coccidiosis has the greatest economic impact when compared to other diseases in poultry production. In addition, chemotherapeutic growth promoters have been substituted for other alternative strategies. Objective: To evaluate the effect of oleoresins from chili pepper (Capsicum annuum) and turmeric (Curcuma longa L.) on the performance, survival rate, and the Productive Efficiency Index of broilers from 1 to 21d challenged by Eimeria sp. Methods: A total of 700 male 1-day-old chicks (Cobb 500) were assigned in a completely randomized design with four treatments: (1) negative control diet, without anticoccidial agent or growth promoters; (2) control diet+0.05% of salinomycin; (3) negative control diet+100g/ton; and (4)+140g/ton of test product (Curcuma longa L. plus Capsicum annuum oleoresins) and challenged by Eimeria sp. Results: There were similar results for body weight, weight gain, feed conversion and Productive Efficiency Index between broilers fed a diet containing anticoccidial chemotherapeutics and diets containing oleoresins. In addition, there was no difference in the feed intake and survival rate between the dietary treatments. Conclusion: Broilers fed diets supplemented with chili pepper and turmeric oleoresins presented similar results for body weight, weight gain, feed conversion, and Productive Efficiency Index to broilers fed a diet supplemented with chemotherapeutic anticoccidials from 1 to 21d without affecting the animal feed intake nor the animal survival rate.

Keywords: antibiotics replacement; broiler; chili pepper; coccidiosis challenge; oleoresins; performance; poultry production; turmeric.

Resumen

Antecedentes: El impacto económico generado por la coccidiosis en el sector avícola es mayor en relación a otras enfermedades. Además de eso, promotores de crecimiento quimioterapéuticos han sido reemplazados por estrategias alternativas. Objetivo: Evaluar el efecto de oleorresinas de pimiento (Capsicum annuum) y cúrcuma (Curcuma longa L.) sobre el desempeño zootécnico, tasa de supervivencia y el Índice de Eficiencia Productiva en pollos de engorde con Eimeria sp. Métodos: Fueron utilizados 700 pollos machos (Cobb500) de 1 día de edad, distribuidos en un diseño completamente al azar en cuatro tratamientos: (1) dieta control negativo, sin agentes anticoccidianos, ni promotores de crecimiento; (2) dieta control+0,05% de salinomicina; (3) dieta control negativa+100g/ton; y (4)+140g/ton del producto a evaluar (oleoresina de Curcuma longa L. y Capsicum annuum). Resultados: Se presentaron resultados similares en relación al peso corporal, ganancia de peso, conversión alimenticia e Índice de Eficiencia Productiva, en los tratamientos con dietas que contenían
anticoccidianos quimioterapéutico y dietas con oleorresinas. Además de esto, no se observaron
diferencias en el consumo de la ración y su tasa de supervivencia entre los tratamientos
dietarios. **Conclusión:** Pollos de engorde bajo una ración suplementada con oleorresinas de
pimiento y cúrcuma presentan resultados similares para el peso corporal, ganancia de peso,
conversión alimenticia e Índice de Eficiencia Productiva, en comparación a pollos de engorde
alimentados con dietas suplementadas con anticoccidianos quimioterapéuticos de 1 a 21d, sin
afectar el consumo de ración ni la viabilidad de los animales.

**Palabras clave:** azafrán; desafío con coccidiosis; desempeño; pollos de engorde; oleorresinas;
pimiento; producción de aves; reemplazo de antibióticos.

**Resumen**

**Antecedentes:** O impacto económico da coccidiose é o maior quando comparado a outras
doenças na produção avícola. Além disso, promotores de crescimento quimioterápicos tem sido
substituídos por estratégias alternativas. **Objetivo:** Avaliar o efeito das oleoresinas da pimenta
Chilli (**Capsicum annuum**) e açafrão-da-terra (**Curcuma longa** L.) no desempenho zootécnico,
taxa de sobrevivência e Índice de Eficiência Produtiva de frangos de corte de 1 a 21d desafiados
por *Eimeria* sp. **Métodos:** Foram utilizados 700 pintos de 1d, machos (Cobb500) distribuídos
em delineamento inteiramente casualizado, em quatro tratamentos: (1) dieta controle negativo,
sem agente anticoccidiano ou promotores de crescimento; (2) dieta controle+0,05% de
salinomicina; (3) dieta controle negativa+100g/ton; e (4)+140g/ton de produto teste (oleoresina
de *Curcuma longa* L. mais *Capsicum annuum*) e desafiados por *Eimeria* sp. **Resultados:** Houve
resultados similares para peso, ganho de peso, conversão alimentar e Índice de Eficiência
Produtiva entre frangos alimentados com dietas contendo anticoccidiano quimioterápico e dietas
contendo oleoresinas. Além disso, não houve diferença para consumo de ração e a taxa de
sobrevivência entre os tratamentos dietéticos. **Conclusão:** Frangos de corte alimentados com
dietas suplementadas com oleoresinas de pimenta chili e açafrão-da-terra apresentaram
resultados similares para peso, ganho de peso, conversão alimentar e Índice de Eficiência
Produtiva que frangos de corte alimentados com dietas suplementadas com anticoccidianos
quimioterápicos de 1 a 21d, sem afetar o consumo de ração e a taxa de sobrevivência dos
animais.

**Palavras-chave:** açafrão-da-terra; desafio com coccidiose; desempenho; frango; oleoresinas;
pimenta chili; produção avícola; substituição de antibióticos.

**Introduction**

Coccidiosis is one of the most common and damaging diseases in broiler production, mainly
because of serious losses to the industry attributed to the increase in drug costs and lower animal performance (Drăgan et al., 2014; Tanweer et al., 2014).

In general, anticoccidial agents, such as ionophores, monensin, lasalocid, and salinomycin are used for strategic control and treatment, and have been used for more than 40 years (Chapman, 1997; Jenkins et al., 2010). However, unregulated use causes a loss of efficiency because of protozoa resistance (Löhren et al., 2009; Kheirabadi et al., 2014).

In addition, the use of chemical antimicrobials as growth promoters has been banned in many countries due to its linkage with antimicrobial resistance and meat residuals (Bajpai et al., 2012). Thus, there is an increased search for alternative feed additives that can substitute chemical antimicrobials.

Plant extracts, such as chili pepper (Capsicum annuum) and turmeric (Curcuma longa L.), have been gaining recognition in the area because of the comparable effects to those of antimicrobials, which are called chemotherapeutics due to their antioxidative status improvement, antibiotic and anti-inflammatory effects (Majolo et al., 2014; Araújo et al., 2015). Studies suggest that phytogenic supplements can improve the animal’s antioxidative status by removing free radicals and influencing the animal’s defence system, sustaining the intestinal integrity during coccidial infection due to the protection of infected tissue against oxidative stress damage, and so reducing the negative impacts of coccidiosis (Allen and Fetterer, 2002).

Studies show positive effects on zootechnical performance, intestinal lesions and pro-inflammatory cytokines of broilers challenged by Eimeria sp. and Clostridium sp. and fed capsaicin and thymol supplemented diets (Lee et al., 2013; Kim et al., 2015). Thus, the objective of this study was to evaluate the effect of oleoresins from chili pepper (Capsicum annuum) and turmeric (Curcuma longa L.) on the performance, survival rate, and the Productive Efficiency Index of broilers from 1 to 21d challenged by Eimeria sp.

**Material and methods**

**Ethical considerations**

All procedures and protocols were approved by the Ethical Committee for the Use of Animals of the School of Veterinary Medicine and Animal Science, Universidade de São Paulo, in accordance with the Arouca Law (No. 11,794 of October 8, 2008).

**Housing and husbandry**
A total of 700 1-day-old chicks (Cobb 500) obtained from a local commercial hatchery were used. The food was provided by tubular feeders, and water was supplied in pendular drinking troughs arranged in the centre of the floorpens.

The pens measured 180x220 cm, covered by pine wood shavings, and the density and ambient temperature were in accordance with the linage manual (Cobb Vantress, 2012).

**Experimental design**

The 1-day-old chicks were distributed into four experimental treatments, a corn and soybean meal-based diet being formulated to meet the nutritional requirements of male chicks from 1-21 days (Rostagno et al., 2011): (1) the negative control diet was free of anticoccidial agents and growth promoters (Table 1); (2) the positive control (PC) diet was supplemented with 0.05% of salinomycin (Coxistac® 12%, Phibro Brazil Animal Health Corporation; Guarulhos, São Paulo, Brazil; (3) one negative control diet plus 100 g/ton of the test product (NC+10%); and (4) one negative control diet plus 140 g/ton of the test product (NC+14%), totalling four treatments with seven replicates of 25 animals each.

**Table 1.** Composition and nutritional levels of the experimental diet.

<table>
<thead>
<tr>
<th></th>
<th>NC</th>
<th>PC</th>
<th>NC+10%</th>
<th>NC+14%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>62.80</td>
<td>62.80</td>
<td>62.80</td>
<td>62.80</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>32.75</td>
<td>32.75</td>
<td>32.75</td>
<td>32.75</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>1.77</td>
<td>1.77</td>
<td>1.77</td>
<td>1.77</td>
</tr>
<tr>
<td>Soybean oil</td>
<td>0.76</td>
<td>0.76</td>
<td>0.76</td>
<td>0.76</td>
</tr>
<tr>
<td>Inert</td>
<td>0.06</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.82</td>
<td>0.82</td>
<td>0.82</td>
<td>0.82</td>
</tr>
<tr>
<td>Salt</td>
<td>0.43</td>
<td>0.43</td>
<td>0.43</td>
<td>0.43</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.22</td>
<td>0.22</td>
<td>0.22</td>
<td>0.22</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Threonine</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Premix Vit/Min**</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Test product</td>
<td>-</td>
<td>-</td>
<td>0.008</td>
<td>0.015</td>
</tr>
<tr>
<td>Salinomycin*</td>
<td>-</td>
<td>0.05</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Calculated levels**

<p>| ME (kcal/kg) | 2928.26 | 2928.26 | 2928.26 | 2928.26 |</p>
<table>
<thead>
<tr>
<th></th>
<th>19.8</th>
<th>19.8</th>
<th>19.8</th>
<th>19.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Na (%)</td>
<td>0.19</td>
<td>0.19</td>
<td>0.19</td>
<td>0.19</td>
</tr>
<tr>
<td>aP (%)</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>Ca (%)</td>
<td>0.84</td>
<td>0.84</td>
<td>0.84</td>
<td>0.84</td>
</tr>
<tr>
<td>Lys (%)</td>
<td>1.12</td>
<td>1.12</td>
<td>1.12</td>
<td>1.12</td>
</tr>
<tr>
<td>Threeo (%)</td>
<td>0.72</td>
<td>0.72</td>
<td>0.72</td>
<td>0.72</td>
</tr>
<tr>
<td>Met+Cys (%)</td>
<td>0.77</td>
<td>0.77</td>
<td>0.77</td>
<td>0.77</td>
</tr>
</tbody>
</table>

NC = negative control diet; PC = Positive control diet (0.05% of salinomycin); NC+10% = negative control diet plus 0.008% of test product; NC+14% = negative control diet plus 0.015% of test product; **Premix mineral vitamin without anticoccidial or growth promoters. Nutritional vitamin/mineral level per kg of diet from 1 to 21d of age: pantothenic acid: 12 mg; folic acid: 1.25 mg; biotin: 0.06 mg; niacin: 35 mg; thiamine: 1.5 mg; vit. A: 10000 IU; pyridoxine (B6): 3mg; riboflavin (B2): 6.5 mg; cobalamin (B12): 20 mg; vit. D3: 3000 IU; vit. E: 25 IU; vit. K3: 2 mg; Cu: 9.5 mg; Fe: 40 mg; I: 1.1 mg; Mn: 70 mg; Se: 0.33 mg; Zn: 60 mg.

The product tested consisted of 4% oleoresin of chili pepper (Capsicum annuum) and 4% of oleoresin of turmeric (Curcuma longa L.).

At 7d-old, the chicks were infected by oral inoculation using an attenuated live commercial vaccine containing E. tenella, E. acervulina, E. maxima (5x10^6), and E. necatrix (1x10^6) (1ml/bird; Livacox® Q, Biopharm, Prague, Czech Republic).

Data collection

At 21 d of age, the birds and the feed leftovers were weighed in a mobile digital scale (e= 0.050) to assess weight gain (WG), feed intake (FI), feed conversion (FC), and the Productive Efficiency Index (PEI). The PEI was obtained by the Equation 1, described below:

\[ PEI = \left( \frac{\text{Body weight gain(kg)}}{\text{number of days}} \right) \times \frac{\text{Survival rate(%)}}{10} \]

Statistical analysis

The data were analyzed using the Statistical Analysis System (SAS Institute, 2009), version 9.2, by the GLM procedure. The data were submitted to analysis of variance, and the means were compared by the Tukey test at 5% significance level.

Results
There were similar results for the FBW, WG, FC and PEI of broilers fed both the diet containing anticoccidial chemotherapeutics and diets containing oleoresins (Table 2; p<0.05). However, broilers fed without any feed additive supplement presented lower BW, FI, FC and PEI when compared to the supplemented diets. In addition, there was no difference of the feed intake and survival rate between the dietary treatments.

**Table 2.** Final body weight (FBW), weight gain (WG), feed intake (FI), feed conversion (FC), Productive Efficiency Index (PEI), and survival rate of broilers from 1 to 21d fed diets supplemented or not with essential oils.

<table>
<thead>
<tr>
<th></th>
<th>NC</th>
<th>PC</th>
<th>NC+10%</th>
<th>NC+14%</th>
<th>CV</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial body weight (g)</td>
<td>51.71</td>
<td>51.57</td>
<td>51.43</td>
<td>51.43</td>
<td>1.14</td>
<td>0.777</td>
</tr>
<tr>
<td>FWB (g)</td>
<td>942.00</td>
<td>1016.02</td>
<td>1015.86</td>
<td>1004.3</td>
<td>3.82</td>
<td>0.004*</td>
</tr>
<tr>
<td>WG (g)</td>
<td>890.28</td>
<td>964.42</td>
<td>964.42</td>
<td>952.71</td>
<td>4.04</td>
<td>0.004*</td>
</tr>
<tr>
<td>FI (g)</td>
<td>1359.14</td>
<td>1373.87</td>
<td>1403.36</td>
<td>1363.63</td>
<td>4.72</td>
<td>0.612</td>
</tr>
<tr>
<td>FC (g:g)</td>
<td>1.53</td>
<td>1.42</td>
<td>1.45</td>
<td>1.43</td>
<td>4.84</td>
<td>0.039*</td>
</tr>
<tr>
<td>PEI</td>
<td>265.53</td>
<td>306.46</td>
<td>298.95</td>
<td>299.42</td>
<td>8.45</td>
<td>0.027*</td>
</tr>
<tr>
<td>Livability (%)</td>
<td>100</td>
<td>98.85</td>
<td>98.85</td>
<td>98.28</td>
<td>1.53</td>
<td>0.336</td>
</tr>
</tbody>
</table>

a, b p<0.05 (Tukey test); SEM= standard error of the mean; NC = negative control, free of anticoccidial agent and growth promoter; PC = positive control, diet with anticoccidial agent (salinomycin) and growth promoter; NC+10% = negative control+10% of test product (4% *Capsicum annuum* and 4% of *Curcuma longa* L. oleoresins); CN+14% = negative control+14% of test product. WG = weight gain; FI = Feed intake; FC = Feed conversion; PEI = Productive Efficiency Index; FWB = final body weight.

The feed conversion was improved by the positive control treatment when compared to the negative control. However, the supplemented treatments presented averages similar to the positive and negative control groups.

**Discussion**

Some studies suggest that the zootechnical performance and immunological response are improved in broilers submitted to diets supplemented with turmeric and capsicum in challenge conditions (Lee *et al.*, 2010a, b, 2013; Kim *et al.*, 2015).

The performance results corroborate those of Kim *et al.* (2015), who found similar results for weight gain among animals that were challenged by *Eimeria sp./Clostridium sp.* and submitted to diets supplemented with *Curcuma Longa* L. Furthermore, the authors observed that diets
supplemented with *Capsicum* sp. and *Curcuma longa* L. derivatives reduced the negative effects on body weight caused by intestinal lesions resulting from necrotic enteritis.

Previous studies suggest that macrophages mRNA and spleen cells proliferation increase in birds submitted to *Curcuma longa* L. in comparison to the control group (Lee *et al*., 2010a). In addition, studies observed a decrease in intestinal pro-inflammatory cytokines in birds fed a diet supplemented with *Capsicum* sp. oleoresins and challenged by necrotic enteritis. The results demonstrated an increase in weight gain and a low *E. acervulina* fecundation rate and reduction in negative disease effects (Lee *et al*., 2010b).

Thus, it is possible that the essential oil compounds had an immunomodular role in the immune profile of the birds, directly reflected in the performance of the animals. Based on the performance results, it is possible to suggest that there was a synergistic effect between chili pepper oleoresin (which contains capsaicin as the main active compound) and turmeric oleoresin (which contains thymol as the main active compound), promoting body weight and weight gain similar to the anticoccidial chemotherapeutics used in diets for broiler chickens from 1 to 21d, while not affecting the feed intake or feed conversion.

It is possible that the supplementation of vegetable oil compounds in critical stages of development, demonstrated by coccidiosis exposure, minimizes the energy expenditure of the immune system, thus utilizing the absorbed nutrients for other functions, such as growth (Bento *et al*., 2013). The scientific literature information about the effects of plant extracts or oleoresins on dietary metabolized energy absorption and body weight gain is inconsistent. However, it has been reported that the plant compounds can stabilise the poultry digestive functions (Pirgozliev *et al*., 2018).

In conclusion, broilers fed diets supplemented with chili pepper and turmeric oleoresins presented results for body weight, weight gain, feed conversion and Productive Efficiency Index similar to broilers fed a diet supplemented with chemotherapeutic anticoccidials from 1 to 21d. In addition, the dietary inclusion of 4% oleoresins from chili pepper and turmeric can be a potential substitute for chemotherapeutic antimicrobials like salinomycin, as demonstrated in the present study.

**Declarations**

**Acknowledgements**

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Conflicts of interest
The authors declare they have no conflicts of interest with regard to the work presented in this
report.

Author contribution
Maria Estela Gaglianone Moro, Cristiane Soares da Silva Araújo and Lúcio Francelino Araújo
were responsible for the study design. Rafael Araújo Nacimento, Viviane Borba Ferrari, Luís
Vinicius Sanfelice, Paulo Henrique Pelissari, Yasmin Gonçalves de Almeida Sartore, Mariana
Llaque Cuadros and Jose Antonio Rivera Ulloa were involved in the experiment conduction and
data collection. Viviane Borba Ferrari and Rafael Araújo Nacimento carried out the statistical
analysis. Rafael Araújo Nacimento and Lúcio Francelino Araújo drafted the manuscript. All
authors read and approved the final manuscript.

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Atividade antimicrobiana do óleo

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