Meat quality characteristics of broilers fed with soybean oil by-products added to diets

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RESUMO – O presente estudo objetivou a utilização de óleo de soja, óleo ácido de soja e glicerina como fontes de energia na dieta de frangos de corte na performance (consumo individual, ganho de peso e conversão alimentar) e qualidade de carne (pH, perda cor cocção, perda por descongelamento e b*). De acordo com os resultados, os animais suplementados com 4% de glicerina apresentaram menor performance quando comparados com os demais, sem distinção entre os tratamentos para os parâmetros de qualidade de carne. Entretanto, para os valores de a*, obteve-se uma diferença significativa no tratamento com inclusão de glicerina 4%, o qual apresentou menores valores de vermelho que podem estar associados com a baixa concentração de carotenóides. A glicerina associada com o óleo de soja possui bons resultados, porém, se utilizada individualmente, afeta negativamente os parâmetros de performance e qualidade de carne.

ABSTRACT – The present study aimed considering the use of soybean oil, soybean acid oil and glicerin as energy sources for the feeding of broilers on performance (individual consumption, body weight gain and feed conversion) and meat quality (pH, cooking and dripping losses and color [L*, a* and b*]). According to the results, the animals fed glicerin 4% presented lower performance than other treatments and there was not distinction between treatments for the parameters of meat quality. However, for a* values, there was a significant difference in the treatment with the inclusion of glicerin 4% that had the lowest values of red and can be associated with a lower concentration of carotenoids. Glycerin has proven to have a good use when associated with soybean oil, but when used individually, glicerin affected negatively the parameters of performance and meat quality.

PALAVRAS-CHAVE: frangos de corte; glicerina; óleo de soja; qualidade de carne.

KEYWORDS: broilers; glycerin; meat quality; soybean oil.
INTRODUCTION

Supplementing poultry diets with fat sources to increase the energy content is a common practice in poultry industry (Pekel et al., 2013). The knowledge of the nutritional value of foods is of great importance in formulating rations that meet the requirements of animal species correctly. In poultry production, it is essential information to the energy content of foods to provide adequate amounts of energy to the birds, according to category of each phase (Junqueira et al., 2005).

In view of the increasing demand for nutrients and energy of fast-growing modern broilers, supplementation of broiler diets with different sources of fat that are concentrated sources of energy has become a common practice. In addition to their high-energy content, dietary fat supplementation considerably improves the digestibility of most of the other nutrients due to increased contact between nutrients and enzymes in the gut (Latshaw, 2008; Pekel et al., 2012).

Fats are major suppliers of readily available energy and essential fatty acids. These, because they contain more energy than carbohydrates, are used in rations to increase energy density. Their addition promotes a beneficial effect on performance of chickens, often having a superior biological value than the expected. This extra caloric benefit or effect usually reflects improvements in the rate of growth in the use of ration nutrients and on the content of metabolizable energy (Wiseman and Salvador, 1991).

Despite these benefits, it is known that, depending on the type of offered fat in the diet of the birds, there are some changes in composition of fatty acids in meat, changing properties such as texture, succulence, flavor, aroma and color. These are the main organoleptic characteristics responsible by the meat acceptance by the consumer. So, it is evident the importance of studies of the physicochemical characteristics of chicken meat from animals whose feeds differ energy sources, as well as its quality during commercialization (Pino, 2005).

One of the energy sources more used to broiler fed is soybean bran, however the use of acid soybean oil and glycerin, industrial subproducts of soybean oil, have proved to be useful alternatives to achieve lower costs production, without sacrificing performance and carcass quality of the birds.

This study aimed to examine the use of different oils as energy sources in the diet of broilers on performance characteristics and meat quality.

MATERIALS AND METHODS

Birds and housing

The experiment was carried out at Federal University of Rio Grande do Sul experimental facilities located in Porto Alegre, RS. A total of 520 one-day-old male broilers Cobb X Cobb 500 were used. All birds were weighed at the beginning of the experiment to determine their medium weight and distributed in boxes in groups of 25 animals each, 4 boxes per treatment. The initial temperature was 32°C decreasing 1°C every two days until reaching 22°C on day 13. The birds and feed were weighed weekly to determine individual consumption, body weight gain and feed conversion.

Experimental Diets

Diets were categorized and it was used three phases: initial (0-21 days), growth (21-32 days) and final (32-39 days), being prepared in a 400kg horizontal mixer and provided in mash form. Five treatments were used for this experimental and the diets were based on soybean oil (SO), acid soybean oil (ASO) and glycerin (GLY) at different percentages of fat, as shown in Table I.
Table I. Description of the experimental treatments related to sources and percentages of fat in the diets of broilers throughout the phases (initial, growth and final).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>SO %</th>
<th>ASO %</th>
<th>GLY %</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>T4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>T5</td>
<td>4</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

T1: SO 4 %; T2: ASO 4 %; T3: GLI 4 %; T4: SO 4 % + ASO 4 %; T5: SO % + GLY 4 %.

SO %: Percentage of soybean oil presented in the treatment; ASO %: Percentage of acid soybean oil presented in the treatment; GLY %: Percentage of glycerin presented in the treatment.

Data collection

At 39 days old, six animals per box (n = 120) were slaughtered at UFRGS Pilot Plant (Aviário de Ensino e Pesquisa) after 8 hours of water fasting, and the slaughter steps were: electronarcosis stunning, bleeding, scalding at 60°C, defathering, evisceration and cooling. The carcasses were cooled by immersion in ice until the internal temperature of 4°C, measured from an insertion thermometer in the center of the Pectoralis major muscle at 2 cm depth. Muscle samples of Pectoralis major and supra-coracoideus were collected, and it was performed quality assessments by laboratory analysis at Centro de Ensino, Pesquisa e Tecnologia de Carmes (CEPETEC/ UFRGS) as described below.

Laboratory analyzes

Meat quality characteristic were evaluated by pH, cooking (CL) and dripping losses (DL) and color. Muscle pH was measured with insertion pH meter in the center of Pectoralis major 24h post-mortem (Young et al., 2004).

To evaluate de cooking loss (CL) based on the methodology described by Chrystall et al. (1994), samples of Pectoralis major and supra-coracoideus were wrapped in plastic bags of film resistant to heat and baked in a water bath at a temperature of 80°C until the temperature of 72°C at the innermost point of the cut (about 60 min.). The plastic bags containing the samples were sealed and the set of four enclosures was immersed in water for cooking, aiming at standardizing baking. The temperature was monitored using thermometer inside the equipment. After 60 minutes of cooking, the plastic bags were removed from the vat, opened and the meat cuts of cooked breasts were placed on plastic trays where they remained for 50 minutes until the samples reached an internal temperature of 45 ± 2°C in which it was possible to manipulate them. Thereafter, each sample was placed on disposable plastic dishes and were weighed again. Weight loss was determined by recording the difference in weights of the samples before and after cooking.

Analyses of cooking loss were made by difference in weight. Before freezing, the samples were weighed and, after the freezing period, were thawed and re-weighed. The difference between the two weights was regarded as the weight loss by thawing the sample, therefore loss of yield of the cutting.

The color measurements were based on the International Commission of Illumination (CIE, 1976) system color profile of lightness (L*), redness (a*), and yellowness (b*) performed by a reflectance colorimeter (Minolta Chroma Meter CR-400). Pectoralis major and supra-coracoideus were measured with three replicates per point, in three different regions of the upper and lower surface of the muscle.
Experimental delineation and statistical analysis

It was performed an analysis of variance considering a Completely Randomized Delineation (CCD) with 5 treatments. All variables were analyzed with a significance level (P < 0.05), using the SPSS 18 statistical program.

RESULTS AND DISCUSSION

The results of animal performance are shown in Table II. According to values, significant differences were found in parameters body weight gain (BWG), individual consumption (CONS) and feed conversion (FC) of broilers fed with diets of inclusions of different oils.

Table II. Values of body weight gain (BWG, kg), individual consumption (CONS, kg) and feed conversion (FC) of broilers fed with diets* of inclusions of different oils

<table>
<thead>
<tr>
<th>Treatments*</th>
<th>BWG (kg)</th>
<th>CONS (kg)</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO (Control)</td>
<td>2.923 a</td>
<td>4.401 b</td>
<td>1.506 b</td>
</tr>
<tr>
<td>ASO 4 %</td>
<td>2.888 a</td>
<td>4.436 ab</td>
<td>1.536 b</td>
</tr>
<tr>
<td>GLY 4 %</td>
<td>2.778 b</td>
<td>4.604 a</td>
<td>1.658 a</td>
</tr>
<tr>
<td>ASO 4 % + OS</td>
<td>2.885 a</td>
<td>4.337 b</td>
<td>1.503 b</td>
</tr>
<tr>
<td>GLY 4 % + OS</td>
<td>2.918 a</td>
<td>4.372 b</td>
<td>1.498 b</td>
</tr>
<tr>
<td>Average</td>
<td>2.879</td>
<td>4.430</td>
<td>1.540</td>
</tr>
</tbody>
</table>

ab - different lowercase in the same column differ statistically from each other (p < 0.05) by Tukey test (5%). SEM: Standard Error Mean.

*SO: Soybean oil; ASO: acid soybean oil; GLY: Glycerin; ASO + SO 4 % and GLY + SO 4 % are supplemented diets with SO to be isoenergetic compared to control treatment.

Treatment with the inclusion of only glycerin oil (GLY 4 %) was inferior performance compared to the other treatments, whose average weight gain (kg), individual consumption (kg) and feed conversion were, respectively, 2,778, 4,604 and 1,658. Based on the exposed, the animals of this study had higher ratio consumption when fed with GLY 4 % compared to those who received treatments SO, ASO 4 % + SO and GLY 4 % + SO in order to satisfy their daily energy needs.

The values of pH, color (L*, a* and b*), cooking loss (CL) and dripping loss (DL) for breast meat cuts of chickens analyzed are explicit in Table III.

Table III. Values of pH, color (L*, a* and b*), cooking loss (CL) and dripping loss (DL) of Pectoralis major and supracoracoideus muscles of chickens fed with inclusion of different oils in the diets*.

<table>
<thead>
<tr>
<th>Treatments*</th>
<th>pH</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>CL %</th>
<th>DL %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO (Control)</td>
<td>5.86</td>
<td>60.18</td>
<td>14.01 ab</td>
<td>7.95</td>
<td>14.31</td>
<td>11.98 ab</td>
</tr>
<tr>
<td>ASO 4 %</td>
<td>5.84</td>
<td>58.91</td>
<td>14.67 ab</td>
<td>9.51</td>
<td>14.71</td>
<td>12.13 b</td>
</tr>
<tr>
<td>GLY 4 %</td>
<td>5.90</td>
<td>61.77</td>
<td>12.66 b</td>
<td>8.07</td>
<td>15.06</td>
<td>14.43 a</td>
</tr>
<tr>
<td>ASO 4 % + OS</td>
<td>5.83</td>
<td>57.81</td>
<td>14.85 a</td>
<td>9.34</td>
<td>14.95</td>
<td>11.60 ab</td>
</tr>
<tr>
<td>GLY 4 % + OS</td>
<td>5.86</td>
<td>57.06</td>
<td>15.57 a</td>
<td>9.23</td>
<td>15.66</td>
<td>12.20 ab</td>
</tr>
<tr>
<td>Average</td>
<td>5.86</td>
<td>59.14</td>
<td>14.35</td>
<td>8.82</td>
<td>14.94</td>
<td>12.47</td>
</tr>
<tr>
<td>SEM</td>
<td>0.04</td>
<td>1.76</td>
<td>0.55</td>
<td>0.60</td>
<td>0.77</td>
<td>0.75</td>
</tr>
<tr>
<td>P</td>
<td>0.6427</td>
<td>0.3410</td>
<td>0.0060</td>
<td>0.1861</td>
<td>0.7973</td>
<td>0.0771</td>
</tr>
</tbody>
</table>
Different lowercase in the same column differ statistically from each other \( (p < 0.05) \) by Tukey test, AB - Different capitalization in the same column differ statistically from each other \( (p < 0.10) \) by Tukey test. SEM: Standard Error Mean.

* SO: Soybean oil; ASO: acid soybean oil; GLY: Glycerin; ASO + SO 4% and GLY + SO 4% are supplemented diets with SO to be isoenergetic compared to control treatment.

Table III shows that the pH values of the samples remained within normality and there wasn’t significant difference among treatments \( (P > 0.05) \). The values of \( L^* \) and \( b^* \) found in this study didn’t show significant differences among treatments \( (P < 0.05) \) (Table III), meaning that there were not differences in light intensity and yellow levels in color of breast cuts evaluated.

On the other hand, the values of \( a^* \) (redness) showed significant differences among treatments. Treatment added only of glycerin had lower incidence of redness \( (a^* = 12.66) \) in Pectoralis major and supracoracoideus muscles of broilers analyzed compared to treatments ASO 4% + SO \( (a^* = 14.85) \) and GLY 4% + SO \( (a^* = 15.57) \).

Regarding the values of cooking loss (CL), no significant differences were found among treatments. According to literature, it can be considered that glycerin uncorrected with soybean oil has a minor quantity of metabolizable energy in comparison to the other treatments (Vieira et al., 2002; Cerrate et al., 2006). The metabolizable energy of glycerol was estimated at 4,320 Kcal.kg\(^{-1}\) by Cerrate et al. (2006) amounting to approximately half the metabolizable energy present in soybean acid oil, 8,114 Kcal.kg\(^{-1}\) (Vieira et al., 2002). The same authors also report that the degummed soybean oil has a metabolizable energy 5% higher than soybean acid oil.

Treatment with highest consumption was responsible for the higher values found in the parameters of feed conversion and reduced weight gain of these animals. Viana et al. (2001) had already observed that broilers fed ad libitum adjust ration consumption according to the energy levels in an attempt to maintain constant energy absorption.

The pH value of meat cuts is an extremely important variable for the food processing industry, as it relates to its quality and shelf life, and it should present values between 5.7 to 5.9. Besides, physicochemical parameters such as color and water retention capacity influence the organoleptic characteristics of the final product and, consequently, consumer acceptance.

Thus, the pH values obtained demonstrate that although the animals had been fed with different compositions of oils did not cause significant variations in the acidity of breast cuts evaluated.

The variable color has great significance because it is closely linked to the acceptability of the product. Consumers usually reject products in which the color is different than expected, therefore this variable can be used to determine the market value of the food (Qiao et al., 2002).

The result of coloring obtained in 4% GLY treatment may be associated with the lowest concentration of carotenoids present in the glycerin oil compared to soybean oil and soybean acid oil (Pardio et al., 2001; Funaro et al., 2014). Large amounts of xanthophylls are found in soybean oils, and soybean acid oil is a rich source of carotenoid pigments (Pardio et al., 2001; Funaro et al., 2014).

When the defrosting process starts, the temperature increases and ice crystals melt, increasing the water activity on the extracellular space. Consequently, the water migrates toward the intracellular space and will be absorbed by the fibers partially dehydrated. If the dripping rate is sufficiently slow, differences in water activity in both compartments is reduced. On the other hand, if the dripping rate is rapid, there may be no reabsorption of water by the fibers, accumulating on the extracellular space and eventually draining as exudate.
CONCLUSION

Glycerin proved to be a good alternative to be used as a partial substitute for soybean oil in the diet of broilers. The use of this oil remained desirable performance characteristics and meat quality when associated with an oil of higher energy value (degummed soybean oil). On the other hand, the same, when used as the sole dietary source of fat, influences in loss of performance and meat quality.

REFERENCES


