Effects of graded levels of Tetracin® on physico-chemical and sensory properties of broiler meat

*Akinwumi, A. O., Odunsi, A. A., Omojola, A. B., Olatoye, I. O., Akande, T. O. and Olawuyi, B. S.

1Animal Products and Processing Unit, Department of Animal Nutrition and Biotechnology, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria.

2Meat Science Laboratory, Department Animal Science, University of Ibadan, Ibadan, Oyo State, Nigeria.

3Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Ibadan, Nigeria.

4Department of Animal Science, Obafemi Awolowo University, Ife, Osun State, Nigeria.

*Corresponding author: aoakinwumi@lautech.edu.ng; yimika2akin@yahoo.com; +2348029455394

Tetracin® (a feed grade veterinary antibiotic) was administered at 0, 50, 100, 150 and 200mg/kg to conventional starter and finisher feed for broilers for a period of six weeks before the breast meat were analyzed for physical, chemical and organoleptic properties. One hundred and fifty (2 weeks old) broiler chicks were randomly divided into 10 birds per replicate with 3 replicates per treatment. At the end of the feeding trial, 6 birds per treatment were slaughtered, defeathered, eviscerated and dressed. The breasts cuts were however subjected to laboratory analyses. No statistically significant (P>0.05) differences were observed in drip loss, chilling loss, shear force, ash and moisture contents of broiler meat across the treatment groups. However, the cooking loss and thermal loss progressively increased (P<0.05) with the corresponding increase in Tetracin®. Similarly, WHC was also significantly (P<0.05) influenced with increased inclusion of Tetracin®. Crude protein increased (P<0.05) but ether extract was reduced with inclusion of Tetracin®. Meat without antibiotics was highly rated (P<0.05) for flavour, juiciness and tenderness while colour and general acceptability were not significantly (P>0.05) influenced with or without Tetracin®. Conclusively, the inclusion of Tetracin® improved the chemical properties of broiler meat but the physical properties (cooking loss and WHC), flavour, juiciness and tenderness of the meat were compromised especially when administered above 100mg/kg feed.

Keywords: Tetracin®; antibiotics; Physical; chemical; sensory properties; broilers

Introduction

Antibiotics are among the most widely used veterinary drugs in poultry industry (Simon and Baxter, 2006). They are used for poultry birds not only to treat (Olatoye and Ehinmowo, 2009), and protect (Nisha, 2008) the birds from different diseases, but also to promote growth of the birds (Geidam et al., 2009), to improve feed conversion ratio (FCR), to increase weight gain and to maximize economic returns from the
The use of antibiotics has facilitated the efficient production of poultry allowing the consumers to purchase at reasonable cost, high quality meat and eggs (Donoghue, 2003). Despite these benefits ascribed to the use of antibiotics, there is a negative side to its use. Aamer et al. (2000) and Akinwumi et al. (2013a) reported that abuse of antibiotic occurs when they are: used unnecessarily, over prescribed, employed in wrong combination, changed quickly over to other drugs, used persistently, given in inadequate dosage, given through self medication, used for preventive purposes, and used unauthorized. Due to the above-mentioned practices, antibiotic residues accumulate in various body tissues like muscles, liver and kidney and eggs of birds (Akinwumi et al., 2013a).

There are environmental and human health risks that are associated with these residues which ranged from direct to indirect toxicity on consumers exhibiting allergic reactions to indirect problems through the generation of resistant strains of pathogenic bacteria and the residual contamination of manures used in crop production (Dubois et al., 2001). To ensure consumer safety worldwide, regulatory authorities have set MRL's (Maximum Residual Limit) for several veterinary drugs (Zeina et al., 2013). These MRL's are expected to regulate the maximum permitted levels of the drug residue for each antibiotic that is considered safely acceptable in food of animal origin (Akinwumi et al., 2013a). Hughes and Heritage (2004) reported other beneficial effects of antibiotics on product quality, such as decreased fat, increased meat protein, as well as indirect benefits such as a reduction in the amount and cost of feed needed which consequently results in profit maximization. Since continuous administration of antibiotics at sub-therapeutic regime has been documented to influence the protein and fat content of meat, other meat quality properties may also be influenced by the administration of antibiotics. This study was therefore aimed at determining the effect of a feed-grade antibiotic (Tetracin®) on physico-chemical and sensory properties of broiler meat.

**Materials and methods**

A six week experiment was conducted with one hundred and fifty (150) 2 week old (Anak strain) broiler chicks that were randomly assigned to 5 experimental treatments (3 replicates of 10 birds each) representing 5 levels of veterinary antibiotic Tetracin®. Tetracin® is a tetracycline based antibiotics bought at a local veterinary store in Ogbomoso and was administered at 0, 50, 100, 150 and 200mg/kg of feed to represent T1 (control), T2, T3, T4 and T5 respectively.

At the expiration of the feeding trial, six (6) birds per treatment were slaughtered. Selected birds were fasted for 8 hours prior to slaughter, and bled for 90 seconds from a single cut that severed the carotid artery and jugular vein. After...
bleeding, birds were scalded, defeathered and eviscerated and dressed as described by Abdullah et al. (2010). The breast meat was however subjected to physico-chemical and sensory analyses with their methodologies as follow;

**Water Holding Capacity**

Water holding capacity (WHC) of the samples was determined by the filter press method as modified by Suzuki et al., (1991). Intact meat samples from the primal cuts were weighed, placed between equal sized filter papers (10.1x10.1cm$^2$) and pressed between two plexi-glasses using a vice for one minute. The meat samples were removed and oven dried at 105°C for 24 hours to determine the moisture content. The amount of water released from the sample was measured as the area of the filter paper wetted by pressing, relative to the area of pressed sample using a compensatory planimeter. Thus water holding capacity was calculated as follows:

$$WHC = \frac{100 - (Ar-Am) \times 9.49 \times 100}{Wm \times Mo}$$

Where,
- $Ar$ = Area of water released from meat ($cm^2$)
- $Am$ = Area of meat sample ($cm^2$),
- $Wm$ = weight of meat sample (mg)
- $Mo$ = Moisture content of the meat (%),

and '9.49' is a constant.

**Cooking Loss**

This was determined according to the procedure by Honikel (1998) and Malgorzata et al. (2005). The samples were wrapped individually in heat resistant polythene bags and immersed in water inside a water bath at a temperature of 80°C for 20 minutes. After cooking, the meat samples were allowed to equilibrate to room temperature. The meat samples were reweighed and cooking loss was calculated as the percentage change in weight after cooking.

**Thermal Shortening**

The length of the meat was measured and placed in a heat resistant polythene bag immersed in already boiling water and allowed to cook for 20 minutes using water bath at 80°C. The length of each sample was recorded after cooking. The percent change in length of meat was taken as the thermal loss (Honikel, 1998; Malgorzata et al., 2005).

**Chilling Loss**

Meat samples were chilled for 24 hours according to the method of King et al., (2003). The chilling loss was determined as difference between the warm carcass weight and chilled weight expressed as percent of warm carcass weight as described by Awosanya and Okubanjo (1993).

**Cold Shortening**

This was determined by measuring the length of meat before and after chilling (King et al., 2003). The percentage change in the length of meat was referred to the cold shortening.

**Shear force**

Weighed meat samples (approx 10g) were wrapped in a thermo-resistant polyethylene bags and cooked in a pre-heated pressure cooking pot for 20 minutes to an internal temperature of
80°C (Malgorzata et al., 2005). The meat samples were removed and allowed to equilibrate to room temperature (27°C) before removing 1.25cm diameter cores parallel to muscle fibre orientation with a coring device (Qiaofen and Da-Wen, 2005). They were shared at three locations with Warner-Bratzler V-notch blade shearing instrument. Shear force determined in this way expressed the tenderness of the meat after cooking.

**Proximate composition**

The proximate analysis of meat samples was done by the method described by AOAC (2000) to get the moisture content, crude protein, ether extract and ash.

**Organoleptic Properties**

This was conducted using a 10 member semi-trained panelists according to the procedures of AMSA (1995). Meat preparation was done using a wet cooking method. The samples were wrapped in impervious polythene pouches which could not be destroyed by cooking process. In the process, the meat samples were cooked in boiling water for 20 minutes using water bath with no spices added to the meat. The meat was then served to 10 member taste panels drawn from students and staff in the Department of Animal Nutrition and Biotechnology, Ladoke Akintola University of Technology, Ogbomoso. The trained panelists evaluated the samples for colour, flavour, juiciness, tenderness and general acceptability. The assessment was based on a 9 point hedonic scale. The score was arranged in a descending order, the maximum score 9 was given to extremely like condition while the lowest score 1 was for the poorest condition.

**Statistical analysis**

All data obtained were processed and subjected to analysis of variance (ANOVA) using statistical analysis software (SAS, 1999). Significantly different means were separated using Duncan's multiple Range (DMR) test.

**Results**

The effect of inclusion of graded levels of Tetracin® on the physical properties of broiler chicken is presented in Table 1. The thermal and cooking losses and WHC were influenced (P<0.05) with the increasing levels of the antibiotics. The values for both thermal and cooking loses increased (P<0.05) progressively with the corresponding increase in the inclusion level of Tetracin® while a reverse (P<0.05) trend was observed in WHC. Drip loss, chilling loss and shear force were not significantly (P<0.05) different across the treatment groups. The means obtained however ranged from 3.40 - 3.70% in the drip loss, 5.32 – 3.70% for chilling loss and 2.01 – 2.34kg for shear force.

The inclusion of Tetracin® significantly (P<0.05) influenced both the crude protein and ether extract in an opposite direction. The CP progressively (P<0.05) increased with the increase in the inclusion levels. However, no significance was obtained from the ash content and the moisture content of the broilers chicken. The values ranged
Table 1: Effect of graded levels of Tetracin® on physical properties of broiler meat

<table>
<thead>
<tr>
<th>Parameter</th>
<th>T1 (0mg/kg)</th>
<th>T2 (50mg/kg)</th>
<th>T3 (100mg/kg)</th>
<th>T4 (150mg/kg)</th>
<th>T5 (200mg/kg)</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal loss</td>
<td>10.13b</td>
<td>10.28b</td>
<td>10.47b</td>
<td>10.39b</td>
<td>13.21a</td>
<td>0.23</td>
</tr>
<tr>
<td>Cooking loss</td>
<td>18.27c</td>
<td>16.20c</td>
<td>21.35c</td>
<td>23.23b</td>
<td>27.88a</td>
<td>1.21</td>
</tr>
<tr>
<td>WHC</td>
<td>81.62a</td>
<td>83.00a</td>
<td>77.54ab</td>
<td>76.80ab</td>
<td>71.98b</td>
<td>2.03</td>
</tr>
<tr>
<td>Drip loss</td>
<td>3.42</td>
<td>3.54</td>
<td>3.40</td>
<td>3.70</td>
<td>3.63</td>
<td>0.07</td>
</tr>
<tr>
<td>Chilling loss</td>
<td>5.45</td>
<td>5.38</td>
<td>5.48</td>
<td>5.32</td>
<td>5.59</td>
<td>0.15</td>
</tr>
<tr>
<td>Shear force</td>
<td>2.01</td>
<td>2.29</td>
<td>2.34</td>
<td>2.33</td>
<td>2.10</td>
<td>0.04</td>
</tr>
</tbody>
</table>

a,b,c: Means along the same row with different superscripts differ significantly (P<0.05)

Table 2: Effect of graded levels of Tetracin® on chemical properties of broiler meat

<table>
<thead>
<tr>
<th>Parameter</th>
<th>T1 (0mg/kg)</th>
<th>T2 (50mg/kg)</th>
<th>T3 (100mg/kg)</th>
<th>T4 (150mg/kg)</th>
<th>T5 (200mg/kg)</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein</td>
<td>17.66c</td>
<td>18.34b</td>
<td>20.66c</td>
<td>21.12a</td>
<td>21.23a</td>
<td>2.11</td>
</tr>
<tr>
<td>Ether Extract</td>
<td>8.02a</td>
<td>7.31ab</td>
<td>6.02b</td>
<td>5.11b</td>
<td>5.24b</td>
<td>0.21</td>
</tr>
<tr>
<td>Ash</td>
<td>1.02</td>
<td>1.05</td>
<td>1.02</td>
<td>1.17</td>
<td>1.17</td>
<td>0.05</td>
</tr>
<tr>
<td>Moisture</td>
<td>70.83</td>
<td>70.94</td>
<td>69.81</td>
<td>70.16</td>
<td>69.99</td>
<td>0.53</td>
</tr>
</tbody>
</table>

a,b,c: Means along the same row with different superscripts differ significantly (P<0.05)

from 1.02 – 1.17% and 69.81 – 70.94% for ash content and moisture content. The results of the evaluation panel for the main effect of the inclusion levels of Tetracin® on the broiler chicken are shown in Table 3. The colour ratings were not significantly different (P>0.05) from each other with or without the antibiotic. The panelists gave the highest (P<0.05) flavor, juiciness and tenderness ratings to the meat from the control diet (T1 0mg/kg) while the least value was found in T5. For both eating quality parameters (flavour and tenderness), the rating for broiler meat from T2, T3 and T4 were similar (P>0.05). No significant difference was however observed in the rating of the general acceptability of the chicken samples.

Table 3: Effect of graded levels of Tetracin® on sensory properties of broiler meat

<table>
<thead>
<tr>
<th>Parameter</th>
<th>T1 (0mg/kg)</th>
<th>T2 (50mg/kg)</th>
<th>T3 (100mg/kg)</th>
<th>T4 (150mg/kg)</th>
<th>T5 (200mg/kg)</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>6.56</td>
<td>6.22</td>
<td>6.20</td>
<td>6.51</td>
<td>6.20</td>
<td>0.24</td>
</tr>
<tr>
<td>Flavour</td>
<td>5.75a</td>
<td>5.28ab</td>
<td>5.30ab</td>
<td>5.39ab</td>
<td>4.80b</td>
<td>0.17</td>
</tr>
<tr>
<td>Juiciness</td>
<td>7.38a</td>
<td>6.90ab</td>
<td>6.80ab</td>
<td>6.87ab</td>
<td>5.67b</td>
<td>0.20</td>
</tr>
<tr>
<td>Tenderness</td>
<td>6.49a</td>
<td>6.39ab</td>
<td>6.40a</td>
<td>5.63ab</td>
<td>4.45b</td>
<td>0.31</td>
</tr>
<tr>
<td>General</td>
<td>7.42</td>
<td>7.30</td>
<td>7.28</td>
<td>7.30</td>
<td>7.31</td>
<td>0.34</td>
</tr>
</tbody>
</table>

a,b,c: Means along the same row with different superscripts differ significantly (P<0.05)

Discussion

The higher cooking loss found with the inclusion of the feed grade antibiotics was similar to the work of Costa et al. (2007) using sub-therapeutic tylosin. In poultry, the muscle fiber increases with age and fast-growing chickens have larger fiber diameter than slow-growing ones (Klosowska et al., 1993; Dransfield and Sosnicki, 1999) It has
also been confirmed that muscle meat composed of large fibre diameter is less cohesive and has a lesser compact structure than meat with smaller fibres (Dransfield and Sosnicki, 1999; Akinwumi et al., 2012). It is also reasonable to assume that this large-fibre meat will have a lower water-holding capacity, given that the space within and between its myofibrils will be bigger (Costa et al., 2007). This has proven why more cooking loss was reported with the antibiotic supplemented chickens that grew faster than the control.

Fakolade (2007) stated that cooking loss depends on raw meat qualities and is of interest because it is expected to explain part of the variation of juiciness. It is also of great economic importance because higher cooking loss gives an expectation of loss. Similar reason was responsible for the lower WHC reported since both cooking loss and WHC were inversely proportional to each other which were clearly shown with the results. Lower WHC indicates losses in the nutritive value through exudates that are released and result in drier and tougher meat (Dabes, 2001; Akinwumi et al., 2013b). The report is in line with those of Latif et al. (1998) and Berri et al., (2005) who earlier reported lower WHC values in fast growing bird to the slow growing ones.

In addition to the loss of saleble weight, purge loss also entails the loss of a significant amount of protein (Offer and Knight, 1988). With the high losses reported with the meat with antibiotics residues in this study, the nutritive values of such meat would have been lost.

This study revealed that the inclusion of the feed grade antibiotics had no effect on the shear force, drip loss and the chilling loss. The result for the drip loss was similar to the finding of Costa et al. (2007) in a similar study but the shear force was significantly influenced. They however stated that since the primary factors of production (breed, age, and nutritional status), pre-slaughtering and slaughtering conditions and subsequent storage (Honickel, 1998; Berri, 2000; Fletcher, 2002) that influenced drip loss and others are controlled, one should not expect any statistical significance, which was indeed the case here.

Nutritionally speaking, poultry meat is a valuable source of proteins, and has a relatively low fat content. In that respect, the chemical composition of muscle tissue of major primal cuts is an important element of broiler meat quality (Ristić, 1999; Grashorn and Closterman, 2002; Bogosavljević-Bošković et al., 2003). Thigh muscles have a lower protein content of about 15.50-17.20% (Simeonova, 1999) apart from having more fat. Bogosavljević-Bošković et al., (2003) have also reported 10.6 –15.6% of ether extract. The values reported in this study showed that the inclusion of the feed grade antibiotic increased the crude protein contents of the broilers while the fat was also expectedly reduced. This study corroborated the earlier findings of Hughes and Heritage (2004) that stated that antibiotics in animal
feeds result in a better meat quality with a reduced fat and increased protein contents. Mahmood et al. (2005) observed enhanced the crude protein with reduced fat contents with the use of probiotic and growth promoters. They also noted higher ash content in the control than those fed with growth promoters and probiotics. However, the values reported were different compared to this present study. They reported 28.92-29.09%, 1.50-3.66% and 1.66-2.11% for CP, EE and ash. These variations could be attributed to differences in sampling methods (Omojola and Adeshehinwa, 2006), age, sex, genetic, and environmental factors (Bokkers and Koene, 2003). Myoglobin content is a major factor contributing to meat colour and is dependent on species, muscle, and age of bird. Other intrinsic factors, such as muscle and pH, can also influence meat colour (Fletcher, 2002). However, in the present study, the inclusion of the graded levels of the feed grade antibiotics had no negative influence on the colour of the broiler chicken.

Tenderness has also been identified as the most critical eating quality characteristic, which determines whether consumers are repeat buyers. It is defined as the sensory manifestation of the structure of meat and the manner in which this structure reacts to the force applied during biting and the specific senses involved in eating, (Fanatico et al., 2007). The taste panelists recorded reduced values for the breast meat of the feed grade antibiotics. With the inclusion of the antibiotic, the meat was rated between slightly tough and intermediate while the breast meat from the control diet was rated moderately tender. The diameter of the muscle fiber is positively related to the tenderness of the meat (Fanatico et al., 2007). Extreme hypertrophy of muscle fibers is an indicator of poor meat quality (Rehfeldt et al., 2004), and selection for a more moderate fiber is needed. The panelists rating were however supported by other studies who have reported that meat of slow-growing or older genotypes to be less tender compared with fast-growing (Castellini et al., 2002; Wattanachant et al., 2004; Fanatico et al., 2005) but different from Farmer et al. (1997) who reported that breast meat from slow-growing birds was more tender than meat from fast-growing birds.

The values reported for juiciness by the consumer panel in this study disagree with previous researches in which breast meat from slow-growing birds was considered juicy (Fanatico et al., 2005). This may be explained in part by the size of the breast fillet. Because the fillets from the slow-growing birds are smaller and thinner in dimension, they had relatively more surface area in relation to muscle mass exposed to the air, which likely caused higher drip loss (Fanatico et al., 2005). Since the inclusion of antibiotic in the diet of animals has shown to reduce the fat contents (Hughes and Heritage, 2004) of meat which was also evident in this study, the reduced values observed with the inclusion antibiotic could be...
Effects of Graded levels of Tetracin® on Quality and Sensory Attributes of Broiler Meat

justified. The reduction in the average score in juiciness with the inclusion of the antibiotics could also be linked to the lower WHC and higher cooking loss which have reduced the amount of juice released upon chewing.

Flavour and aroma are also thought to come from materials in fat, which volatilize when heated (Aberle et al., 2001). The panelist reported a similar trend with juiciness with favour as the least value was seen in T5 (200mg/kg) while others with the inclusion of the antibiotic were rated to be intermediate but the flavor of the control was rated to be slightly desirable.

The experience of eating meat does not cause separate impressions of tenderness, juiciness, and flavour, but rather an overall impression (Aberle et al., 2001). No influence was observed by the panelist on the effect of the inclusion of feed-grade antibiotic. It was rated as moderately liked. This means with or without antibiotic, consumer will still like the meat and will be willing to consume it. This is in agreement with Ristic (2003), who reported that production system did not affect overall sensory attributes. Moreover, Omojola et al. (2012) also stated that meat acceptability is mostly based on attractive colour, desirable flavour in the first instance, and on the combined effects of tenderness, juiciness and texture of a particular meat as evaluated by an individual consumer.

In conclusion, the inclusion of Tetracin® truly enhanced the crude protein and expectedly reduced the fat content of the broiler meat. However, the physical properties of the meat were negatively affected with higher loses during cooking and lower WHC. This is an indication of losses in the nutritive value through exudates that are released and resulted in drier and tougher meat as experienced with the sensory analysis.

References


Akinwumi, A. O., Odunsi, A. A., Omojola, A. B. and Shittu, M. D. 2013a. Assessment of antibiotic usage in some selected livestock farms of Oyo


Latif, S., E. Dworschak, A. Lugasi, E.


Ristic, M. 1999. Sensory and chemical


Received: 26th October, 2016
Accepted: 17th March, 2017