An investigation of a reported case of white striping in broilers

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Primary Audience: Consumers, Plant Managers, Researchers, Scientists, Veterinarians

SUMMARY

Market reports of white striping in broiler breast fillets have been increasing, which has generated concerns in the broiler meat industry regarding negative effects on consumer acceptance. This study was conducted to macro- and microscopically characterize the condition of white striping at varying degrees of severity on Cobb 500 broiler breast fillets slaughtered at 42 d of age. Carcasses of 2,512 broilers presenting white striping were slaughtered and macroscopically classified according to the degree of severity of the striations as moderate or severe; further histological microscopic evaluation demonstrated degenerative myopathy in both moderate and severe cases, but 75% of those breast fillets were classified as moderate. Typically, the samples classified macroscopically as moderate showed microscopic necrosis only (65.17%) or moderate multifocal necrosis (9.83%), whereas those classified as severe showed diffuse and strong necrosis (25.00%). The proliferation of connective tissue was not observed for either of the degrees of white striping investigated, characterizing this profile as an acute occurrence.

Key words: broiler breast fillet, histopathology, muscle fiber, white striping

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DESCRIPTION OF PROBLEM

Brazil is the third largest producer of broilers in the world and the greatest exporter of their meat, producing 12,645 million tons in 2012 [1]. Aviculture allows rapid genetic evolution with a focus on improving the muscular yield [2]. Genetic selection of broiler chickens has been continuous in recent decades, which has led to tremendous improvements in live performance as well as in broiler meat yields. The proportion of breast muscles is a much greater proportion of body mass now (around 3.5 times) when compared with birds that have not gone through any selection for growth since 1950 [3]. Still, genetic selection targeting increases in breast meat yield has been continuous to the present.

Processing plants have been reporting increasing numbers of chicken breast fillets with varying degrees of white striations, which are seen in parallel to muscle fibers, a condition been referred as breast white striping [4]. This condition has also been directly associated with broiler age, as well as BW, and is represented by muscular dystrophy of unknown etiology [5–7].

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Breast white striping often starts in the cranial part of the fillet near the wing attachment point. As the condition worsens (e.g., with increased BW) the stripes become visible throughout the fillet (length of muscle fibers) and can become wider in appearance [6]. Upon histological examination, the striped areas of the fillet are characterized by an increase in fat cells and connective tissue, along with muscle fiber degeneration. Some authors suggest that it is likely that fat and connective tissue infiltrate the areas where fiber degeneration occurs [4, 8, 9].

The severity of this condition can be classified based on its visual aspect. A basic classification system is to rank the fillets as normal, moderate (MOD), or severe (SEV) based on the severity of this condition [10]. The current study was conducted with breast fillets obtained from broilers being processed in a single shift in a Brazilian processing plant. Its main objective was to characterize, macro- and microscopically, the condition of white striping at varying degrees of severity on Cobb 500 broiler breast fillets slaughtered at 42 d of age.

MATERIALS AND METHODS

Male Cobb 500 broiler chickens, 42 d of age, were obtained during a single shift in a processing plant located in southern Brazil. Average BW of processed broilers was 3.2 ± 0.2 kg. From a total of 25,520 birds processed, 2,512 presented with variable degrees of breast white striping (9.84%) and were collected for further evaluation.

A macroscopic classification of the breast fillets (n = 2,512) was performed according to their degree of severity based on the criteria described by Kuttappan et al. [10] as MOD and SEV. Fillets classified as MOD generally exhibited stripes of <1 mm in thickness, easily visible on the fillet surface, whereas fillets classified as SEV exhibited white lines parallel in the muscle fibers having thickness >1

Figure 1. Broiler breast muscle (pectoralis major), with a firm and diffuse consistency, exhibiting a degree of white striping classified as severe. Color version available in the online PDF.
mm, which were easily observed on the surface (Figure 1) [6, 10].

To characterize microscopically the condition of white striping classified as MOD and SEV, breast muscle samples (pectoralis major) were collected after the dripping stage of the slaughter process, cut along the direction of muscle fibers, fixed in buffered 10% formalin, and sent to the Veterinary Pathology Sector of the Federal University of Rio Grande do Sul for histopathological examination. The muscle portions were taken from the ventral (skin-side) and dorsal (bone-side) surfaces of the cranial region of breast fillets of 40 birds (n = 20 for MOD and SEV). The samples were cut into sections approximately 5 mm thick, dehydrated with ethanol in increasing concentrations, diaphanized, and included in paraffin. Two muscle sections were collected from each muscle. The blocks were then cut [11] into serial sections of 3 μm in thickness and stained with hematoxylin-eosin to determine the frequency of histopathological characteristics as myopathic lesions and Masson’s trichrome, the latter being used to analyze the proliferation of connective tissue. Four slides for each muscle sections were examined under a light microscope [12].

The data were analyzed using ANOVA performed considering the degrees of white stripping [13]. The mean scores were estimated for each degree of white striping (MOD and SEV) and for each histopathological characteristic (necrosis only, moderate multifocal necrosis, and diffuse and strong necrosis). Significant differences were calculated using Tukey’s Honestly Significant Difference test (P < 0.05). Individual birds were considered as the experimental unit for the entire analysis.

RESULTS AND DISCUSSION

From a total of 2,512 (9.84% of birds processed) carcasses analyzed, 1,884 (7.38%) macroscopically examined breast fillets (pectoralis major) had white striations classified as MOD and 628 (2.46%) were classified as SEV. Similar results were found by Petracci et al. [14], who reported the total incidence of white-striped breast fillets as 12.0% (8.9 and 3.1% for MOD and SEV, respectively).

In the histopathological evaluation of the breast muscle, degenerative myopathy was observed, characterized as both MOD (Figure 2b) and SEV (Figure 2a), on the bone-side portion by floccular and hyaline (diffuse and accentuated) necrosis of the myofibers, with infiltration of macrophages and a few heterophils. Furthermore, phagocytosis of the remains of the myofibers (indicated by an arrow). Color version available in the online PDF.

In the skin-side region of the breast for both MOD (Figure 3b and 3c) and SEV (Figure 3a) samples, floccular and hyaline diffuse and accentuated necrosis of the myofibers, infiltrate of macrophages, lymphocytes, and a few hetero-
phils were observed. No difference between the ventral and dorsal breast portions was verified. Also, phagocytosis of the remains of the myofibers was observed, showing some degree of regeneration of these myocytes with sarcoplasmic vacuolation.

The samples classified as MOD showed necrosis only (65.17%) or moderate multifocal necrosis (9.83%); however, the samples classified as SEV showed diffuse and strong necrosis (25.00%; Table 1). Staining with Masson’s trichrome did not show the proliferation of connective tissue (Figure 4).

In broilers, selection for growth rate and breast yield has not been shown to affect the type of fiber present in the muscle; however, it causes an increase in the diameter and length of the muscle fibers [15]. Alterations in the type of fibers are mainly caused by muscular dystrophies [16]. Degenerative myopathies similar to those described are found in cases of ionophore poisoning [17–19], intoxication by the toxic plant *Senna occidentalis* [20], or a deficiency in vitamin E or selenium—although in recent studies [21] the authors do not attribute this condition to different levels of these nutrients in the diet of broilers.

To standardize the administration of the feed, the birds in the current study received isoenergetic and isoprotein diets according to the recommendations provided in Brazilian nutritional tables for the feeding of poultry and swine [22]. Thus, the hypothesis of ionophore poisoning, in which the histopathological findings are characterized by muscle tissue with floccular and hyaline necrosis, infiltrate of macrophages, and muscle fibers in the process of regeneration [18, 19, 23], can be discarded.

In agreement with previous studies, the histological sections obtained from the MOD and SEV samples were characterized by myofibrilar degeneration; however, the previously reported atrophy of the fibers was not observed [5, 7]. In addition, data in the literature [5] show that the severity of white striping can increase between the sixth and eighth weeks of processing, suggesting that the occurrence of striping is correlated with age and, consequently, with the weight of the birds at the time of slaughter.

In contrast with data reported in the literature [8] for both degrees of severity, no evidence
of the proliferation of connective tissue in the histological sections stained with Masson’s trichrome was observed. Such proliferation may be found with the advancing age of birds, bearing in mind that the birds of the current study were younger than those described in the literature and considering that, with longer growth and development phases of the bird, a greater tendency exists for the collagen fibers to become progressively larger and stronger [24], assuming the characteristics of chronicity. These characteristics influence the appearance of the product, which may influence consumer acceptance. Kuttappan et al. [10] reported that 50% of consumers consulted (n = 75) would probably not or definitely not buy fillets with any degree of white striping. Based on those data, the condition of white striping is an emerging problem in the poultry industry, which justifies the study of this condition.

Table 1. Frequency (%) of histopathological lesions (hematoxylin and eosin staining) in breast fillets from moderate and severe degrees of white striping (n = 20 for each)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Necrosis only</th>
<th>Necrosis, moderate multifocal</th>
<th>Necrosis, diffuse and strong</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>86.89 (1.637)</td>
<td>13.11 (247)</td>
<td>0 (0)</td>
<td>75 (1.884)</td>
</tr>
<tr>
<td>Severe</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>100.00 (628)</td>
<td>25 (628)</td>
</tr>
<tr>
<td>Total</td>
<td>65.17 (1.637)</td>
<td>9.83 (247)</td>
<td>25.0 (299)</td>
<td>100 (2,512)</td>
</tr>
</tbody>
</table>

A,B Means within each degree of white striping with different letters are significantly different (P < 0.05).

a–c Means within each histopathological characteristic with different letters are significantly different (P < 0.05).

Figure 4. Transverse section of muscle of the lateral part of broiler breast classified with degenerative myopathy without proliferation of connective tissue. Color version available in the online PDF.
CONCLUSIONS AND APPLICATIONS

1. White striping is an emergent problem in broiler production and the related research is recent.
2. Breast meat affected with white striping classified as MOD or SEV showed differences in integrity of muscle fibers, with evidence of myofibrillar degeneration and, in severe cases, moderate multifocal necrosis or diffused and strong necrosis, although proliferation of connective tissue was not evident at 42 d of age.
3. The condition of white striping in the breast muscles of broilers slaughtered at 42 d of age analyzed in the present study can be characterized as a profile of acute occurrence.

REFERENCES AND NOTES

11. Microtome 1 eica RM 2125RT, 1 eica Biosystems Nussloch GmbH, Nussloch, Germany.
12. Microscope 1 eica ICC50 HD, 1 eica Biosystems Nussloch GmbH, Nussloch, Germany.