Prevalence and risk factors associated to the incorrect application of the anabolic implant in intensive cattle feedlots in Sinaloa, México

Molina-Gámez, Gamaliel1; Portillo-Loera, Jesús J.1; Félix-Bernal, José A.1; Robles-Estrada, Juan C.1; Rodríguez-Millán, J.1; Sánchez-Pérez, Jaime N.1; Vasquez-Sarabia, Fredy1; Montero-Pardo, Arnulfo1; Dávila-Ramos, Horacio1*

* Correspondence: davila-ramos@uas.edu.mx

ABSTRACT
Objective: To determine the prevalence and the risk factors associated to the incorrect application of the anabolic implant in intensive cattle feedlots.

Design/Methodology/Approach: An observational study was conducted in which 888 cattle ears were evaluated from five livestock feedlots. The criteria of the condition of the anabolic implant were: correct and incorrect (Encapsulated, Abscessed, In cartilage, Poorly placed, Bunched, Partial and Missing.). The results were evaluated through the chi-squared test and logistic regression, the alpha level established was 0.05.

Results: A prevalence of 64.30% incorrectly applied anabolic implants was observed. At least 50% of the cattle from the feedlots evaluated presented failures in the application of the implant. Encapsulated and poorly implants represented 91.6% (51.4 and 40.2%, respectively) of the total incorrect conditions. The risk of a bovine presenting an incorrect condition increased 1.8 times more when the feedlot has more than 4000 cattle (P<0.001) and 4.2 times more when they are females (P<0.001); the season of the year was not a risk factor (P>0.17).

Study Limitation/Implications: The incorrect application of anabolic implants derives in failures that compromise their absorption and integration into the organism, which is why more studies are suggested to determine the economic impact that this can cause.

Findings/Conclusions: The prevalence of the failures in anabolic implants is high, and, therefore, the productive and economic benefits that favor the application of this productive technology are not being obtained, in addition to there being determinant risk factors.

Keywords: Cattle, growth promoters, anabolic implant, condition.
INTRODUCTION

Anabolic steroids are substances that increase the retention of nutrients from food by the animal’s organism; in particular, they increase the retention of protein and non-protein nitrogen, and its later transformation into protein, specifically in the skeletal muscle of ruminants (Palermo, 1998). The use of anabolic implants as growth promoters is a routine practice in the intensive production of beef, and it has been estimated that a higher proportion than 95% of cattle in confinement in northwestern Mexico are implanted (Cáñez et al., 1985). This practice has the purpose of improving the productive yield and food efficiency, thus reducing the production costs; concerning this, it has been informed that in comparison to non-implanted livestock, the daily weight gain increases (5-18%) and the dietary efficiency improves (5-10%) (Duckett et al., 1996; Mader, 1998). The anabolic implant must be placed in the posterior part of the ear, via subcutaneous in the middle third, between the two longitudinal cartilaginous ribs (Mader, 1998). However, an incorrect application of the implant can cause different conditions (encapsulated, abscessed, in cartilage, poorly placed, bunched, partial and missing), which has been called “failure of the anabolic implant” (Barajas et al., 2010; Berry et al., 2000; Folmer et al., 2009), causing double loss, first the investment in the implant and second the loss of productive benefits (Barajas et al., 2010). In this regard, failures have been reported in the absorption of the implant from 2.65% (Folmer et al., 2009) to 95.5% (Zollers et al., 2002), which is reflected in an estimated economic loss of $15.1 USD to $22.50 USD per animal (Anderson and Botts, 2002; Barajas et al., 2010), as a reflection of the loss of calculated productive yield in 0.077 kg day\(^{-1}\) of reduction in weight gain of the carcass (Mader, 1998). Therefore, it becomes necessary to perform studies to evaluate the technique of anabolic implants in confined beef cattle. Because of this, the purpose of this research was to determine the prevalence and the risk factors associated to the incorrect application of the anabolic implant in intensive feedlot cattle.

MATERIALS AND METHODS

Location of the study area and generalities of the sampling

The research was conducted in two Federal Inspection Type Meat Processors; this type of establishments are regulated by the norms NOM-194-SSA1-2004 corresponding to Products and Services, which indicate the sanitary specifications in the establishments devoted to the sacrifice and skinning of animals for supply, storage, transport and retail.

Sanitary specifications of products and the norm NOM-033-SAG/ZOO-2014 indicate the method to slaughter domestic and wild animals, located in the municipality of Culiacán, Sinaloa, Mexico (24° 2’ 4.92” N to 25° 16’ 33.6” N) (INEGI, 2020). To determine the condition of the anabolic implant of cattle when finalizing the fattening, n = 888 ears were inspected. The cattle evaluated came from five production units, three of which had more than N = 4000 bovines and were considered as large feedlots, and two with inventory of less than N = 4000 bovines which were considered as small feedlots. Four fattening production units are located in the municipality of Culiacán and one in the municipality of Guasave, Sinaloa. Twenty-three (23) cattle feedlots were inspected, where the origin and sex of the bovines were identified. In the period when the evaluations were performed, the season
was determined according to the monthly average temperature, winter (<29 °C) and summer (≥29 °C), obtained from the meteorological station of the Center for Research in Feed and Development (Centro de Investigación en Alimentación y Desarrollo, CIAD, 2019) located approximately 4.2 km from the meat processors.

**Evaluation of the condition of the anabolic implant**

When starting the inspection of the implant’s condition, the ear implanted was removed from each bovine, and later dissected with a scalpel blade number 23; the criteria of the condition of the anabolic implant were classified as: 1-correct, 2-incorrect (encapsulated, abscessed, in cartilage, poorly placed, bunched, partial and missing), capturing at the end a photograph of each inspection as evidence. The criterion to assign the condition of the anabolic implant was: correct when the anabolic implant is degraded and liberated into the blood stream; encapsulated when there was a fibrous capsule that covered the anabolic implant and it was found without degradation; abscessed when there was purulent content; in cartilage when it was incrusted in the ear’s cartilage; poorly when it was positioned outside the middle third, close to another anabolic implant, identification earrings, orifices or notches; bunched when it was bound together in the same site; partial when there were less pellets than those that there ought to be, even if they were in degradation process or not; and missing when it was not applied or lost (Barajas et al., 2010; Berry et al., 2000; Folmer et al., 2009).

**Statistical analysis**

All the ears that presented at least one inadequate condition of the anabolic implant and were identified as incorrect were included. The prevalence was calculated as number of incorrect implants/number of ears evaluated × 100. A graph was made to understand the order of presentation of failures in the implant. The association between the time of the year, sex of the animal, and size of the feedlot with the condition of the implant was analyzed with the Chi-squared test. To estimate the odds ratio, a logistic regression analysis was conducted with the LOGISTIC procedure from SAS (SAS, 2002), for the sex variable the procedure used was univariate analysis for 474 observations, while for the feedlot size and time of the year it was multivariate analysis, where there were 888 observations. The alpha level established was 0.05.

**RESULTS AND DISCUSSION**

**Prevalence of the conditions of the anabolic implants**

A prevalence of 64.30% (IC 95% 61.01-67.59) of incorrect anabolic implants was observed. Folmer et al. (2009) observed failures of 2.65% when sanitary measures were applied at the time of placing the implant; likewise, Anderson & Botts (2002) observed 5.75% in the fault of the implant when contaminating the site at the time of placing the implant and using an implant with an antibiotic pellet (Tylosin tartrate), and therefore the high prevalence in our study can be attributed to the implantation technique. Our findings differ from what was reported by Berry et al. (2000) and Barajas et al. (2010), from 20 to
32.98%, respectivamente, aunque es inferior a la reportada por Zollers et al. (2002) de 94.1% de falta del implanto.

La Tabla 1 muestra la prevalencia de la falta del implanto anabólico en cada lot de ganado, que presentó prevalencia superior a 50% de implantos anabólicos incorrectos.

Cuando determinando la prevalencia de los criterios de la condición de implante anabólico (n=369), las condiciones encapsuladas y mal representadas 91.6% (51.4 y 40.2%) respectivamente (Figura 1).

Durante la implantación, las bacterias presentes en el sitio (auricula) son inevitablemente introducidas bajo la piel, un proceso inflamatorio se inicia en el día uno en la zona periférica y el organismo busca inhibir esta infección; el implanto anabólico es considerado un cuerpo extraño y en el día siete se encapsula como el organismo intenta aislarlo para minimizar su impacto; por día quince un revestimiento de tejido conectivo fibroso se forma, que será degradado por macrófagos y la absorción del implanto anabólico en la corriente sanguínea comenzará, la espesor del revestimiento dependerá del volumen de bacterias presentes en el sitio de implantación (Loughin, 2004); esto causa que el implanto no degrade, por lo que medidas sanitarias se han establecido para disminuir la carga patogénica (Lancaster, 2009). De igual manera, en un implanto mal colocado (cerca de la base de la oreja), el irrigado es menor y esto afecta la absorción (Goodall, 1955). Parrott et al. (1985) indican que con el estrés de aplicación en el centro de la oreja, el porcentaje de pérdidas se reduce de 29 a 14% cuando se aplica en el centro de la oreja, ya que

### Tabla 1. Prevalencia de la condición del implanto anabólico en lotes de ganado.

<table>
<thead>
<tr>
<th>Lote</th>
<th>Incorrect ( % )</th>
<th>Correct ( % )</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lote 1</td>
<td>106 (84.80 %)</td>
<td>19 (15.20 %)</td>
<td>125</td>
</tr>
<tr>
<td>Lote 2</td>
<td>235 (58.89 %)</td>
<td>164 (41.10 %)</td>
<td>399</td>
</tr>
<tr>
<td>Lote 3</td>
<td>99 (97.05 %)</td>
<td>3 (2.94 %)</td>
<td>102</td>
</tr>
<tr>
<td>Lote 4</td>
<td>105 (49.52 %)</td>
<td>107 (50.47 %)</td>
<td>212</td>
</tr>
<tr>
<td>Lote 5</td>
<td>26 (52 %)</td>
<td>24 (48 %)</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>571</td>
<td>317</td>
<td>888</td>
</tr>
</tbody>
</table>

**Figura 1.** Incorrect conditions of the anabolic implants n=369: Enc=Encapsulated, PP=Poorly placed, Bun=Bunched, Par=Partial, Abs=Abscessed, Mis=Missing, Cart=In cartilage.
the skin is less relaxed and firmer which ensures that the anabolic implant is not displaced to the incision zone and lost, and close to other implants, earrings or blood vessels, where irrigation can be interrupted; however, the formation of new blood vessels and capillaries towards surrounding tissues (angiogenesis) takes place (Lancaster, 2009); thus, it is possible that absorption is favored.

In cattle with the incorrect condition of the implant, 151 ears (40.92%) presented one failures condition and 147 ears (39.83%) presented 2 conditions (Table 2).

**Risk factors**

When determining association between size of the feedlot, time of the year, and sex with the incorrect condition of the anabolic implants, the three factors were associated (P≤0.05) (Table 3).

When the size of the feedlot and the time of the year were included in the logistic regression model, only the size of the feedlot was determined to be a risk factor (P<0.05). Likewise, the sex was also estimated as a risk factor (Table 4).

The risk for a bovine to present an incorrect condition of the anabolic implant when the size of the feedlot was larger than N=4000 cattle is 1.8 times higher (P<0.05). This result

<table>
<thead>
<tr>
<th>Number of incorrect conditions</th>
<th>Number of ears</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>151</td>
<td>40.92</td>
</tr>
<tr>
<td>2</td>
<td>147</td>
<td>39.83</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>3.52</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0.27</td>
</tr>
</tbody>
</table>

**Table 2.** Prevalence of the number of incorrect conditions per ear inspected.

<table>
<thead>
<tr>
<th>Condition of the anabolic implant</th>
<th>Total</th>
<th>P&lt;sup&gt;3&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorrect&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small&lt;sup&gt;4&lt;/sup&gt;</td>
<td>43 (4.84 %)</td>
<td>132 (14.86 %)</td>
</tr>
<tr>
<td>Large&lt;sup&gt;5&lt;/sup&gt;</td>
<td>274 (30.86 %)</td>
<td>439 (49.44 %)</td>
</tr>
<tr>
<td>Total</td>
<td>317 (35.70 %)</td>
<td>571 (64.30 %)</td>
</tr>
</tbody>
</table>

| Sex<sup>6</sup>                   |       |               |
| Female                           | 59 (12.45 %) | 215 (45.36 %) | 274 (57.81 %) | <0.0001 |
| Male                             | 108 (22.78 %) | 92 (19.41 %) | 200 (42.19 %) |       |
| Total                            | 167 (35.23 %) | 307 (64.77 %) | 474 (100 %) |       |

| Time of the year                  |       |               |
| Winter<sup>7</sup>                | 126 (14.19 %) | 266 (29.95 %) | 392 (44.14 %) | <0.0493 |
| Summer<sup>8</sup>                | 191 (21.51 %) | 305 (34.35 %) | 496 (55.86 %) |       |
| Total                            | 317 (35.70 %) | 571 (64.30 %) | 888 (100 %) |       |

<sup>1,2</sup> Correct=the anabolic implant was absorbed, Incorrect=the anabolic implant was not absorbed.

<sup>3</sup> Probability values of the chi-square statistic.

<sup>4,5</sup> Small= <4000 animals, Large= ≥ 4000 animals.

<sup>6</sup> n=474.

<sup>7,8</sup> Winter= <29 °C, Summer= ≥ 29 °C.
is attributed to the human factor that is related to the management of the animals, so that with more animals in the inventory of a livestock farm there is more work and workers can be tired and reduce the efficiency of implantation, which is why it is recommended that there be a substitute worker available.

Authors like Elanco (2017) and Brsci et al. (2018) indicated that when decreasing the number of animals in charge of a worker, the deficiencies in the operative management of the feedlot are reduced in up to 3.5%. Likewise, the analysis showed that the females had 4.2 more risk of presenting incorrect anabolic implants ($P < 0.05$). These results agree with those found by Anderson and Botts (2002), who reported that the females presented 3% more probability of implantation failures compared to the males and this is possibly a reflection of the temperament that depends on the sex, which could modify their behavior.

**CONCLUSIONS**

The prevalence of incorrect anabolic implants was 64.30%, and the conditions with highest frequency were encapsulated and poorly. An association between the time of the year, the inventory and the sex with the incorrect condition of anabolic implants was identified. The risk of an animal presenting such a condition increases 1.8 times when the inventory of the livestock feedlot is large and 4.2 times when they are females; therefore, it is important to consider the economic losses that this could generate and to direct more attention to the implantation technique.

**AKNOWLEDGEMENTS**

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