# Growth and Carcass Characteristics of Pigs Fed Bt and Non-Bt Corn and Harvested at US and European Market Weights

## A.S. Leaflet R1953

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**Summary and Implications**

The *Bt* corn expresses a gene derived from *Bacillus thuringiensis* that encodes for proteins that kill the European corn borer. It is of interest to investigate whether the *Bt* gene influences the feed intake and carcass quality of livestock fed *Bt* corn. In this study, 64 pigs were divided into treatment groups and fed diets containing *Bt* corn or an isogenic control corn to compare growth performance and carcass characteristics. Carcass characteristic comparisons were made between U.S. (240 lb) and European (185 lb) average market weights by dividing the pigs into different harvest dates. Findings demonstrate that feeding *Bt* corn to growing-finishing pigs has no detrimental effects on their growth performance or carcass composition. Market weight comparisons suggest that traits desired by consumers are not different between pigs harvested at U.S. and European market weights. Findings suggest that feeding *Bt* corn to pigs poses no negative effects in their growth performance or carcass characteristics.

**Introduction**

*Bacillus thuringiensis (Bt)* expresses a gene that encodes for crystal-like proteins that kill a specific group of insects. This gene has been introduced in corn as an alternative to spraying insecticides for the control of an economically important pest, the European corn borer. In 2002, it was estimated that 34% of the corn planted in the United States was biotechnology-derived, of which 22% were of the *Bt* variety. A large portion of the total production of corn is consumed by farm animals and the increasing cultivation of genetically modified plants opens new questions to animal agriculturists. For instance, it is not well documented as to whether the carcass quality of livestock fed *Bt* crops is altered. In the current study, feed intake and carcass measures of pigs fed *Bt* corn were analyzed to determine if the *Bt* gene had any effect on growth performance or carcass characteristics.

**Materials and Methods**

Sixty-four Yorkshire pigs (32 barrows and 32 gilts, average initial BW = 140 lb and 130 lb, respectively) were divided into 16 pens (4 pigs per pen) and assigned to dietary treatments based on size and gender, to provide the same animal profile between treatments. Each pen was assigned to either a diet with *Bt* corn or a diet with the isogenic control corn. All diets contained chromic oxide in order to determine nutrient digestibilities. Pigs were weighed weekly. Fecal and urine samples were collected weekly for digestibility analyses. Feed samples from each diet were collected for proximate analyses.

Half of the pigs in each dietary treatment group (*Bt*, Non-*Bt*) were harvested at average European market weight (185lb). The other half was harvested at average U.S. market weight (240 lb). Carcass measurements (weight, pH, temperature) were recorded at the time of slaughter. Backfat and loin eye area were measured 24 hours post-slaughter. Loin samples were collected for meat quality attributes including color, drip loss, shear force, and proximate analyses.

Data were analyzed using SAS statistical package (SAS Institute, Inc, Cary, NC, USA). Statements of statistical significance were based upon $P<0.05$.

**Results and Discussion**

*Animal Performance*

There is no significant difference in average daily gain ($P=0.61$) between pigs fed non-*Bt* and *Bt* corn diets for both market weight groups (Table 1). However, feed efficiency (feed consumed/ lb gain in weight) was greater in pigs fed the *Bt* corn diets ($P=0.002$). Feed efficiency was not different for pigs grown to the European market weight compared to those raised to a U.S. market weight. An interaction between corn fed and market weight was observed ($P=.04$) due to improved feed efficiency in gilts fed the *Bt* corn and raised to a U.S. market weight while gilts raised to a European market weight had greater feed efficiency when fed the non-*Bt* corn.

Barrows in both the U.S. and European groups had a higher initial body weight, final body weight, and average daily gain (Table 1). However, the gilts converted feed to gain more efficiently (gilts =3.13 lb feed per lb weight gain vs. barrows = 3.38; $P<0.001$).

*Carcass Characteristics*

There were no significant differences between non-*Bt* and *Bt* corn fed groups with regard to hot carcass weight, loin eye area, 1st, 10th, last rib and last lumbar vertebrae fat (Table 2). Pigs raised to the European market weight had a lighter hot carcass weight (132 vs. 173 lb), smaller loin eye area (4.88 vs. 6.17 sq. inches), less 10th rib, last rib and last lumbar vertebrae fat (Table 2). First rib fat was not different between market weight groups (P=.08). Across both market weight groups, loin eye area was larger for gilts than barrows (P=0.006). Gilts in both market weight groups were leaner compared to barrows as indicated by the 10th, last rib and the last lumbar vertebrae backfat (P= <0.0001, 0.014 and <0.0001, respectively; Table 2). No significant interactions were observed.

Warner-Bratzler shear force values (tenderness) were not different between pigs fed the two corn sources, between barrows or gilts, or between groups harvested at the two market weights (Table 3). Similarly, Hunter color 'L' and 'a' values were not affected by the main effects. However, Hunter color 'b' values were greater in pigs fed the control corn (11.71 vs. 11.31; P=.02), for gilts (11.79 vs. 11.23; P=.002) and for pigs harvested at the European market weight (11.77 vs. 11.26; P=.005; Table 3). No significant main effect differences were observed for drip loss, 1-hour or 6-hour pH measures. Samples from gilts had a greater 24-hour pH value compared to barrows and pigs in the U.S. market weight group had greater 24-hour pH values than those in the European market weight group (Table 3). Temperature differences are best explained by potential differences in harvest floor temperature over the four harvest dates (Table 3).

Findings demonstrate that feeding *Bt* corn to growing-finishing pigs has no detrimental effects on their growth performance or carcass composition. Market weight comparisons suggest that traits desired by consumers are not different between pigs harvested at U.S. and European market weights.

Results for nutrient digestibility and carcass quality are still being analyzed at the time of writing.

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**Table 1. Growth and performance of pigs grown to U.S. (240 lb) and European (185 lb) market weights.**

| | Treatment groups | | | | P-values | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Non-Bt corn, barrows* | *Bt corn, barrows* | *Non-Bt corn, gilts* | *Bt corn, gilts* | *Treatment* | *Sex* | *Market weight* | *Treatment x sex* | *Treatment x market weight* |
| **Starting weight, lb** | | | | | 0.53 | <0.0001 | <0.0001 | 0.83 | 0.62 |
| U.S. (240 lb) | 150.2 | 150 | 135 | 139.6 | | | | | |
| European (185 lb) | 127.8 | 129.6 | 123.9 | 122.5 | | | | | |
| **Final weight, lb** | | | | | 0.75 | 0.0002 | <0.0001 | 0.96 | 0.52 |
| U.S. (240 lb) | 251.8 | 252.9 | 227.8 | 219 | | | | | |
| European (185 lb) | 189.2 | 186 | 181.6 | 187.5 | | | | | |
| **Days on feed** | | | | | - | - | - | - | - |
| U.S. (240 lb) | 51 | 51 | 53 | 53 | | | | | |
| European (185 lb) | 37 | 37 | 39 | 39 | | | | | |
| **Average daily gain** | | | | | 0.53 | 0.006 | 0.002 | 0.88 | 0.33 |
| U.S. (240 lb) | 1.99 | 2.02 | 1.75 | 1.5 | | | | | |
| European (185 lb) | 1.67 | 1.52 | 1.48 | 1.67 | | | | | |
| **Feed efficiency** | | | | | 0.002 | <0.0001 | 1.0 | 0.94 | 0.04 |
| U.S. (240 lb) | 3.31 | 3.34 | 3.01 | 3.36 | | | | | |
| European (185 lb) | 3.34 | 3.54 | 3.14 | 3.01 | | | | | |

**Table 2. Carcass characteristics of pigs harvested at U.S. (240 lb) and European (185 lb) market weights.**

| | Treatment groups | | | | P-values | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Non-Bt corn, barrows* | *Bt corn, barrows* | *Non-Bt corn, gilts* | *Bt corn, gilts* | *Treatment* | *Sex* | *Market weight* | *Treatment x sex* | *Treatment x market weight* |
| **Hot carcass weight, lb** | | | | | 0.29 | 0.001 | <0.0001 | 0.55 | 0.53 |
| U.S. weight | 186.3 | 182.4 | 165.4 | 158.7 | | | | | |
| European weight | 135.0 | 128.5 | 130.4 | 134.1 | | | | | |
| **Loin Eye Area, inches$^2$** | | | | | 0.51 | 0.006 | <0.0001 | 0.68 | 0.72 |
| U.S. weight | 6.09 | 6.34 | 6.02 | 6.24 | | | | | |
| European weight | 4.26 | 4.12 | 5.43 | 5.71 | | | | | |
| **1$^{st}$ rib fat, inches** | | | | | 0.92 | 0.157 | 0.08 | 0.97 | 0.72 |
| U.S. weight | 1.31 | 1.32 | 1.18 | 1.19 | | | | | |
| European weight | 1.18 | 1.16 | 1.17 | 1.15 | | | | | |
| **10$^{th}$ rib fat, inches** | | | | | 0.52 | <0.0001 | 0.0008 | 0.97 | 0.81 |
| U.S. weight | 0.92 | 0.95 | 0.58 | 0.59 | | | | | |
| European weight | 0.64 | 0.68 | 0.51 | 0.56 | | | | | |
| **Last rib fat, inches** | | | | | 0.78 | 0.014 | 0.004 | 0.15 | 1.0 |
| U.S. weight | 0.89 | 0.82 | 0.68 | 0.72 | | | | | |
| European weight | 0.72 | 0.63 | 0.58 | 0.64 | | | | | |
| **Last Lumbar Vertebrae fat, inches** | | | | | 0.86 | <0.0001 | 0.0006 | 0.55 | 0.75 |
| U.S. weight | 0.88 | 0.84 | 0.60 | 0.68 | | | | | |
| European weight | 0.68 | 0.68 | 0.50 | 0.49 | | | | | |

**Table 3. Effect of non-Bt and Bt corn diets on tenderness, loin color values, percentage drip loss and carcass pH and temperature of pigs harvested at U.S (240 lb) and European (185 lb) market weights.**

| | Diet | | Sex | | Market weight | | Diet | Sex | Market weight |
|---|---|---|---|---|---|---|---|---|---|
| | *Non-Bt corn diet* | *Bt corn diet* | *Barrows* | *Gilts* | *U.S.* | *European* | *P-value* | *P-value* | *P-value* |
| **Warner-Bratzler shear force, kg** | 5.66 | 5.48 | 5.43 | 5.71 | 5.39 | 5.75 | 0.35 | 0.168 | 0.08 |
| **Hunter color values** | | | | | | | | | |
| L value | 52.20 | 51.52 | 51.94 | 51.78 | 52.27 | 51.45 | 0.39 | 0.84 | 0.29 |
| a value | 6.79 | 6.45 | 6.48 | 6.77 | 6.43 | 6.81 | 0.09 | 0.15 | 0.06 |
| b value | 11.71 | 11.31 | 11.23 | 11.79 | 11.26 | 11.77 | 0.02 | 0.002 | 0.005 |
| **Drip loss, %** | 6.32 | 5.54 | 5.93 | 5.93 | 5.84 | 6.01 | 0.06 | 0.99 | 0.68 |
| **pH values** | | | | | | | | | |
| 1-hour | 6.00 | 6.02 | 6.07 | 5.96 | 6.02 | 6.00 | 0.78 | 0.14 | 0.78 |
| 6-hour | 5.56 | 5.61 | 5.60 | 5.57 | 5.61 | 5.57 | 0.24 | 0.47 | 0.40 |
| 24-hour | 5.43 | 5.41 | 5.35 | 5.49 | 5.46 | 5.37 | 0.65 | 0.0001 | 0.02 |
| **Temperature** | | | | | | | | | |
| 1-hour | 31.92 | 31.92 | 32.99 | 30.86 | 32.54 | 31.31 | 0.96 | <.0001 | 0.004 |
| 6-hour | 9.41 | 9.98 | 10.41 | 8.98 | 11.52 | 7.87 | 0.18 | .0012 | <.0001 |
| 24-hour | 2.08 | 2.07 | 2.68 | 1.48 | 1.02 | 3.14 | 0.97 | <.0001 | <.0001 |