Supplementary Material

# Supplementary Figures and Tables

**Table 1.** Ingredients, chemical composition, and fatty acid profile of the diets.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Dietary Treatment** | |  |  |
| **Ingredients (%)** | **Control** | **Grape pomace** | **Sun-dried grape pomace** | **Hay** |
| Corn | 14.70 | 11.15 |  |  |
| Wheat middlings | 14.50 | 10.00 |  |  |
| Flaked maize | 14.00 | 10.00 |  |  |
| Soybean meal (45%) | 13.50 | 12.00 |  |  |
| Barley | 7.00 | 5.00 |  |  |
| Soybean seeds | 7.00 | 7.00 |  |  |
| Corn gluten meal | 7.00 | 6.00 |  |  |
| Wheat flour shorts | 6.54 | 4.00 |  |  |
| Alfalfa | 3.00 | 3.00 |  |  |
| Flaked faba bean | 3.00 | 3.00 |  |  |
| Molasses | 2.90 | 2.00 |  |  |
| Sun-dried Grape Pomace | 0.00 | 20.00 |  |  |
| Soybean oil | 0.50 | -- |  |  |
| Grapeseed oil | -- | 0.50 |  |  |
| Carob | 1.00 | 1.00 |  |  |
| Bentonite | 1.00 | 1.00 |  |  |
| Calcium carbonate | 2.80 | 2.80 |  |  |
| Dicalcium phosphate | 1.00 | 1.00 |  |  |
| Sodium chloride | 0.40 | 0.40 |  |  |
| Mineral-Vitamin Supplement | 0.16 | 0.16 |  |  |
| Forage Units/Kg DM | 1.09 | 1.01 | 0.90 | 0.41 |
| **Chemical composition (% on DM basis)** |  |  |  |  |
| Moisture | 8.80 | 8.20 | 9.00 | 14.77 |
| Crude protein | 17.03 | 17.06 | 12.76 | 10.25 |
| Total lipid | 4.92 | 4.73 | 7.73 | 1.18 |
| Neutral detergent fiber (NDF) | 29.04 | 28.97 | 40.74 | 60.38 |
| Acid detergent fiber (ADF) | 15.14 | 17.08 | 39.09 | 37.43 |
| ADL | 2.43 | 2.11 | 19.87 | 9.31 |
| Ash | 10.44 | 10.21 | 9.13 | 9.05 |
| Total Carbohydrates | 10.98 | 13.87 | 22.68 | 34.59 |
| N-free extract | 9.20 | 5.26 | -- | 48.93 |
| Gross Energy (MJ/kg) | 10.55 | 10.67 | 8.00 | 11.25 |
| Total phenolics (g of gallic acid equivalent/kg DM) | -- | 103.99 | 243.38 |  |
| Total tannins (g of gallic acid equivalent/kg DM) | -- | 61.20 | 143.04 | -- |
| Proanthocyanidins (g of cyaniding chloride equivalent/kg DM) | -- | 25.70 | 64.91 | -- |
| **Fatty acid profile (%FA methyl esters)** |  |  |  |  |
| C16:0 (Palmitic) | 19.53 | 16.08 | 10.03 | 13.45 |
| C18:0 (Stearic) | 2.32 | 1.91 | 2.04 | 3.03 |
| C18:1 n-9 (Oleic) | 19.71 | 17.78 | 15.39 | 12.13 |
| C18:2 n-6 (Linoleic) | 52.46 | 59.17 | 72.14 | 31.00 |
| C18:3 n-6 (γ-linolenic) | 1.41 | 1.22 | 0.19 |  |
| C18:3 n-3 (α-linolenic) | 4.94 | 2.73 | 0.22 | 0.01 |

**Table 2.** Growth performances and slaughtering data of young bulls in relation to the diet (D) and genotype (G).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diet | Control | | | Grape pomace | | | SEM 1 | Effects | | |
| **Genotype** | L**×**P | M**×**P | P | L**×**P | M**×**P | P | D | G | D × G |
| Initial weight (kg) | 395.50 C | 360.00 D | 340.00 D | 394.00 C | 361.00 D | 337.00 D | 20.951 | n.s. | \*\* | \* |
| Duration of the trial (d) | 141.00 D | 218.00 Cd | 267.00 Cc | 148.00 D | 229.00 Cd | 272.00 Cc | 6.542 | n.s. | \*\* | \* |
| Slaughter weight (kg) | 612.50 | 604.00 | 608.00 | 624.50 | 617.00 | 615.00 | 33.471 | n.s. | n.s. | n.s. |
| Average daily gain (g/d) | 1539.00 C | 1119.30 Dc | 1003.75 Dd | 1557.43 C | 1117.90 Dc | 1022.06 Dd | 97.656 | n.s. | \*\* | \* |
| Feed Intake (kg/d) | 8.48 BD | 11.68 Cc | 10.88 Bd | 10.72 Ad | 11.81 c | 11.54 Ac | 0.348 | \*\* | \*\* | \*\* |
| Feed conversion rate | 8.65 Bd | 9.08 Bcd | 9.79 Bc | 10.27 Ad | 11.60 Acd | 12.00 Ac | 0.044 | \*\* | \*\* | \*\* |
| Hot carcass weight (kg) | 380.55 C | 357.19 D | 359.66 D | 397.71 C | 361.20 D | 366.70 D | 1.254 | n.s. | \*\* | \*\* |
| Cold carcass weight (kg) | 371.85 C | 349.78 D | 352.40 D | 388.13 C | 353.05 D | 358.91 D | 1.313 | n.s. | \*\* | \*\* |
| Drip loss (%) | 2.29 | 2.08 | 2.02 | 2.41 | 2.26 | 2.12 | 0.040 | n.s. | n.s. | n.s. |
| Hot dressing percentage (%) | 62.13 C | 59.14 D | 59.15 D | 63.69 C | 58.54 D | 59.63 D | 1.247 | n.s. | \*\* | \* |
| Cold dressing percentage (%) | 60.71 C | 57.91 D | 57.96 D | 62.15 C | 57.22 D | 58.36 D | 1.372 | n.s. | \*\* | \* |
| Carcass conformation grade | U | R | R | U | R | R | -- | n.s. | n.s. | n.s. |
| Subcutaneous fat development | 3 | 2+ | 2- | 3 | 2+ | 2- | -- | n.s. | n.s. | n.s. |

1 SEM: standard error of means. Differences between diets within each genotype: A, B, *p* < 0.01. Differences between genotypes within the diet: C, D, *p* < 0.01; C, d: *p* < 0.05. Significance of effects: n.s.: not significant; \*\*: *p* < 0.01; \*: *p* < 0.05.

**Table 3.** Dissection data (%) of the righthalf carcass of young bulls in relation to the diet (D) and genotype (G).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diet | Control | | | Grape pomace | | | SEM 1 | Effects | | |
| Genotype | L × P | M × P | P | L × P | M × P | P | D | G | D × G |
| Right-side weight (kg) | 186.15 c | 174.64 d | 176.28 d | 194.09 c | 176.46 d | 179.37 d | 1.073 | n.s. | \* | \* |
| Round | 30.71 | 28.77 | 26.13 | 32.09 | 27.87 | 27.60 | 0.841 | n.s. | n.s. | n.s. |
| Shoulder clod | 11.92 | 11.21 | 10.05 | 11.64 | 11.28 | 11.07 | 0.067 | n.s. | n.s. | n.s. |
| Rib + Loin | 8.84 | 8.95 | 8.60 | 8.66 | 8.65 | 7.23 | 0.081 | n.s. | n.s. | n.s. |
| Steaks | 15.23 c | 15.77 c | 13.47 d | 14.73 c | 14.07 c | 13.65 d | 0.798 | n.s. | \* | n.s. |
| Neck with bone | 7.82 | 7.65 | 8.55 | 7.93 | 7.44 | 7.04 | 0.063 | n.s. | n.s. | n.s. |
| Belly | 6.33 | 6.35 | 6.50 | 6.55 | 6.68 | 6.12 | 0.071 | n.s. | n.s. | n.s. |
| Brisket | 16.06 | 15.99 | 16.94 | 15.33 | 14.89 | 15.07 | 0.056 | n.s. | n.s. | n.s. |
| 12th rib fat thickness (cm) | 5.6 c | 4.9 cd | 3.8 d | 5.8 c | 5.0 cd | 4.1d | 0.015 | n.s. | \* | n.s. |
| Rib-eye area (cm2) | 54.68 c | 51.82 cd | 36.87 d | 55.37 c | 52.06 cd | 38.34 d | 1.241 | n.s. | \* | n.s. |

1 SEM: standard error of means. Differences between genotypes within the diet: c, d: *p* < 0.05. Significance of effects: n.s.: not significant; \*: *p* < 0.05

**Table 4.** Physical parameters and MDA concentration of *Longissimus lumborum* muscle of young bulls in relation to the diet (D), genotype (G) and storage time (T).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diet | Day | Control | | | Grape pomace | | | SEM 1 | Effects | | | | | |
| **Genotype** |  | L × P | M × P | P | L × P | M × P | P | D | G | T | D × G | G x T | D x T |
| pH | 1 | 6.49 | 6.48 | 6.33 | 6.49 | 6.59 | 6.58 | 0.404 | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. |
|  | 9 | 5.85 | 5.78 | 6.03 | 5.92 | 5.87 | 5.79 |
|  | 14 | 5.45 | 5.39 | 5.71 | 5.56 | 5.39 | 5.46 |
| L\* | 3 | 28.59 be | 28.70 be | 29.95 be | 32.42 a | 32.31 a | 33.65 a | 2.467 | \* | n.s. | \* | n.s. | n.s. | n.s. |
|  | 9 | 28.06 bef | 28.21 bef | 29.43 bef | 32.04 a | 31.94 a | 33.27 a |
|  | 14 | 27.64 bf | 27.72 bf | 29.01 bf | 31.87 a | 31.65 a | 32.81 a |
| a\* | 3 | 10.50 f | 11.23 | 10.69 f | 11.40 | 10.00 | 10.95 f | 2.302 | n.s. | n.s. | \* | n.s. | n.s. | n.s. |
|  | 9 | 11.36 ef | 11.86 | 11.07 ef | 11.74 | 10.62 | 11.57 ef |
|  | 14 | 11.98 e | 12.13 | 11.98 e | 12.34 | 11.03 | 12.07 e |
| b\* | 3 | 8.10 | 8.45 | 7.39 | 8.35 | 7.20 | 7.77 | 1.146 | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. |
|  | 9 | 8.19 | 8.67 | 7.74 | 8.61 | 7.58 | 8.13 |
|  | 14 | 8.41 | 8.88 | 8.01 | 8.97 | 7.94 | 8.47 |
| WBS raw | 3 | 2.50 d | 2.55 d | 3.50 ce | 2.60 d | 2.62 d | 3.05 ce | 0.153 | n.s. | \* | \* | n.s. | n.s. | n.s. |
|  | 9 | 2.22 d | 2.18 d | 3.04 cef | 2.36 d | 2.36 d | 2.67 cef |
|  | 14 | 1.98 d | 1.87 d | 2.79 cf | 2.01 cd | 1.89 d | 2.13 cf |
| WBS cooked | 3 | 6.30 de | 6.45 de | 7.70 c | 6.90 d | 6.75 d | 7.75 c | 0.504 | n.s. | \* | \* | n.s. | n.s. | n.s. |
|  | 9 | 5.89 def | 5.97 def | 7.32 c | 6.41 d | 6.01 d | 7.24 c |
|  | 14 | 4.74 df | 4.81 df | 6.84 c | 5.97 d | 5.84 d | 6.91 c |
| Cooking loss (%) | 3 | 25.09 | 26.17 | 26.70 | 25.01 | 26.66 | 26.95 | 1.148 | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. |
| 9 | 25.00 | 26.03 | 26.53 | 24.78 | 26.37 | 26.58 |
| 14 | 24.31 | 25.61 | 26.45 | 24.62 | 26.03 | 26.34 |
| MDA (mg/kg of meat) | 3 | 0.14 af | 0.13 af | 0.12 af | 0.09 b | 0.08 b | 0.07 b | 0.203 |  |  |  |  |  |  |
| 9 | 0.23 aef | 0.22 aef | 0.22 aef | 0.12 b | 0.11 b | 0.10 b | \* | n.s. | \* | n.s. | n.s. | n.s. |
| 14 | 0.39 ae | 0.38 ae | 0.37 ae | 0.19 b | 0.18 b | 0.17 b |  |  |  |  |  |  |

1 SEM: standard error of means. L\*, Lightness; a\*, redness; b\* yellowness; WBS, Warner–Bratzler shear force; MDA, malondialdehyde. Differences between diets within each genotype: a, b, *p* < 0.05; differences between genotypes within the diet: c, d: *p* < 0.05; differences between storage times: e, f: *p* < 0.05. Significance of effects: n.s.: not significant; \*: *p* < 0.05.

**Table 5.** Chemical composition of *Longissimus lumborum* muscle of young bulls in relation to the diet (D) and genotype (G).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diet | Control | | | Grape pomace | | | SEM 1 | Effects | | |
| **Genotype** | L × P | M × P | P | L × P | M × P | P | D | G | D × G |
| Moisture | 72.28 | 72.67 | 71.35 | 72.04 | 71.10 | 70.05 | 0.977 | n.s. | n.s. | n.s. |
| Protein | 23.40 | 23.83 | 22.60 | 22.75 | 23.90 | 23.62 | 0.991 | n.s. | n.s. | n.s. |
| Fat | 2.86 | 2.21 | 3.23 | 3.79 | 3.06 | 3.50 | 1.386 | n.s. | n.s. | n.s. |
| Ash | 1.06 | 0.90 | 1.44 | 1.02 | 0.97 | 0.93 | 0.110 | n.s. | n.s. | n.s. |
| N-free extract | 0.40 | 0.39 | 1.38 | 0.40 | 0.97 | 1.90 | 0.530 | n.s. | n.s. | n.s. |

## 1 SEM: standard error of means. Significance of effects: n.s.: not significant.

**Table 6.** Fatty acids composition of *Longissimus lumborum* muscle of young bulls in relation to the diet (D) and genotype (G).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diet | Control | | | Grape pomace | | | SEM 1 | Effects | | |
| **Genotype** | L × P | M × P | P | L × P | M × P | P | D | G | D × G |
| C14:0 (Myristic) | 5.75 | 5.20 | 5.70 | 4.55 | 4.40 | 4.65 | 0.329 | n.s. | n.s. | n.s. |
| C15:0 (Pentadecylic) | 0.65 | 0.70 | 0.70 | 0.65 | 0.55 | 0.60 | 0.062 | n.s. | n.s. | n.s. |
| C16:0 (Palmitic) | 29.65 a | 28.95 a | 28.45 a | 25.95 b | 26.00 b | 26.00 b | 0.707 | \* | n.s. | n.s. |
| C17:0 | 1.40 | 1.10 | 1.45 | 1.20 | 1.00 | 1.05 | 0.173 | n.s. | n.s. | n.s. |
| C18:0 (Stearic) | 15.50 | 15.95 | 15.1 | 16.95 | 16.05 | 15.75 | 1.054 | n.s. | n.s. | n.s. |
| C20:0 | 0.30 | 0.30 | 0.40 | 0.30 | 0.35 | 0.25 | 0.062 | n.s. | n.s. | n.s. |
| C22:0 | 0.55 | 0.60 | 0.50 | 0.40 | 0.50 | 0.55 | 0.041 | n.s. | n.s. | n.s. |
| Total SFA2 | 53.80 a | 52.80 a | 52.30 a | 50.00 b | 48.85 b | 48.85 b | 0.496 | \* | n.s. | n.s. |
| C 14:1 | 1.00 | 1.15 | 1.35 | 1.07 | 1.43 | 1.35 | 0.187 | n.s. | n.s. | n.s. |
| C 15:1 | 0.25 | 0.30 | 0.30 | 0.25 | 0.25 | 0.35 | 0.047 | n.s. | n.s. | n.s. |
| C 16:1 | 4.40 | 4.30 | 4.40 | 4.05 | 4.05 | 4.25 | 0.855 | n.s. | n.s. | n.s. |
| C 17:1 | 1.30 | 1.25 | 1.40 | 1.37 | 1.43 | 1.40 | 0.135 | n.s. | n.s. | n.s. |
| C18:1 n-7 (cis-vaccenic acid) | 1.45 | 1.40 | 1.75 | 1.35 | 1.65 | 1.60 | 0.211 | n.s. | n.s. | n.s. |
| C18:l n-9 (Oleic) | 25.3 | 26.41 | 26.95 | 25.55 | 25.8 | 25.6 | 1.202 | n.s. | n.s. | n.s. |
| C20:l n-9 (Eicosanoic) | 0.05 | 0.15 | 0.10 | 0.10 | 0.10 | 0.15 | 0.041 | n.s. | n.s. | n.s. |
| C 22:1 n-9 | 0.25 | 0.05 | 0.10 | 0.15 | 0.10 | 0.20 | 0.078 | n.s. | n.s. | n.s. |
| Total MUFA3 | 34.00 a | 35.01 a | 36.35 a | 33.89 b | 34.81 b | 34.90 b | 0.502 | \* | n.s. | n.s. |
| Total CLA | 1.70 b | 1.75 b | 1.65 b | 2.60 a | 2.95 a | 3.05 a | 0.249 | \* | n.s. | n.s. |
| C18:2 n-6 (linoleic) | 9.40 B | 9.95 B | 9.40 B | 14.05 A | 13.80 A | 13.70 A | 0.252 | \*\* | n.s. | \* |
| C18:3 n-3 (α-linolenic) | 0.45 | 0.39 | 0.48 | 0.51 | 0.65 | 0.48 | 0.041 | n.s. | n.s. | n.s. |
| C18:3 n-6 (γ -linolenic) | 0.15 | 0.15 | 0.15 | 0.10 | 0.10 | 0.10 | 0.041 | n.s. | n.s. | n.s. |
| C20:2 n-6 | 0.25 | 0.20 | 0.30 | 0.3 | 0.25 | 0.35 | 0.041 | n.s. | n.s. | n.s. |
| C 20:3n-6 | 0.35 | 0.20 | 0.15 | 0.15 | 0.20 | 0.35 | 0.183 | n.s. | n.s. | n.s. |
| C20:4 n-6 ARA | 0.20 | 0.25 | 0.10 | 0.20 | 0.10 | 0.25 | 0.033 | n.s. | n.s. | n.s. |
| C22:5 n-3 (docosapentaenoic, DPA) | 0.10 | 0.10 | 0.10 | 0.10 | 0.05 | 0.10 | 0.024 | n.s. | n.s. | n.s. |
| Total PUFA4 | 11.60 B | 11.79 B | 11.33 B | 15.91 A | 16.00 A | 16.18 A | 0.365 | \*\* | n.s. | \* |
| Total n-65 | 10.15 B | 10.50 B | 10.00 B | 14.60 A | 14.35 A | 14.50 A | 0.271 | \*\* | n.s. | \* |
| Total n-36 | 0.75 | 0.74 | 0.68 | 0.81 | 0.80 | 0.83 | 0.033 | n.s. | n.s. | n.s. |
| n-6/n-3 | 13.53 B | 14.19 B | 14.71 B | 18.02 A | 17.94 A | 17.47 A | 8.593 | \*\* | n.s. | \* |
| AI (Atherogenic Index) | 0.97 | 0.95 | 0.95 | 1.06 | 0.87 | 0.97 | 0.047 | n.s. | n.s. | n.s. |
| TI (Thrombogenic Index) | 1.87 | 1.81 | 1.75 | 2.24 | 1.83 | 1.70 | 0.042 | n.s. | n.s. | n.s. |

1 SEM: standard error of means. Differences between diets within each genotype: A, B, *p* < 0.01; a, b: *p* < 0.05. Significance of effects: n.s.: not significant; \*\*: *p* < 0.01; \*: *p* < 0.05.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Diet | Control | | | Grape pomace | | |
| **Genotype** | L × P | M × P | P | L × P | M × P | P |
| Duration of the finishing period (days) | 141 | 218 | 267 | 148 | 229 | 272 |
| Feed Intake (kg/d/animal) | 8.48 | 11.68 | 10.88 | 10.72 | 11.81 | 11.54 |
| Total feed ingested (kg/animal) | 1195.68 | 2546.24 | 2904.96 | 1586.56 | 2704.49 | 3138.88 |
| Cost of the feed ingested (Cb) (€) | 492.62 | 1049.05 | 1196.84 | 653.66 | 1114.25 | 1293.22 |
| Grape pomace per day (kg/d/animal) | - | - | - | 2.05 | 2.32 | 2.40 |
| Total grape pomace (kg/animal) | - | - | - | 303.99 | 531.28 | 652.80 |
| Cost of grape pomace (Cp) (€) | - | ­ | - | 10.64 | 18.59 | 22.85 |
| Total feed cost (C = Cb+Cp) (€) | 492.62 | 1049.05 | 1196.84 | 664.30 | 1132.84 | 1316.07 |
| Slaughter weight (kg) | 612.50 | 604.00 | 608.00 | 624.50 | 617.00 | 615.00 |
| Income ( B ) (€) | 2450.00 | 2416.00 | 2432.00 | 2498.00 | 2468.00 | 2460.00 |
| Gross Profit (GPRO=B-C) (€) | 1957.38 | 1366.95 | 1235.16 | 1833.70 | 1335.16 | 1143.93 |
| Gross Profit variation rate (%) | - | - | - | 2.00% | -1.66% | 0.46% |
| Efficiency (E=B/C) | 4.876 | 2.962 | 2.258 | 4.883 | 2.760 | 2.239 |
| Efficiency variation rate on genotype basis (%) | - | - | - | 0.14% | -6.83% | -0.85% |

**Table 7**. Feeding costs and economic performances.

## Supplementary Figures

## Figure 1. From left to right: 12th rib steak from Podolian, Podolian x Marchigiana and Podolian x Limousine young bulls.

