Animal Journal- Supplementary material

Meat quality of farmed red deer fed a balanced diet: effects of supplementation with copper bolus on different muscles

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Short title: Cu supplementation and meat quality of farmed deer

**Supplementary Table S1** *Statistical model codes for quality characteristics, chemical composition and mineral content of meat from red deer yearling males1*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Intercept | | | *R*2 | Adjusted *R*2 |
| Dependent variable |  | RMSE | F-value | *P*-value |
| pH at 24 h *post mortem* |  | 6.6 | 211.9 | \*\*\* | 0.283 | 0.185 |
| *Meat colour* |  |  |  |  |  |  |
| Lightness (*L\**) |  | 484.9 | 39.1 | \*\*\* | 0.143 | 0.026 |
| Redness (*a\**) |  | 5.8 | 1.2 | Ns | 0.298 | 0.202 |
| Yellowness (*b*\*) |  | 11.8 | 4.4 | \* | 0.233 | 0.129 |
| Chroma (*c*\*) |  | 18.7 | 4.4 | \* | 0.368 | 0.282 |
| Hue angle (*H*º) |  | 0.12 | 11.0 | \*\* | 0.014 | -0.120 |
| *Chemical composition (%)* |  |  |  |  |  |  |
| Moisture |  | 1006 8 | 1766 4 | \*\*\* | 0.549 | 0.488 |
| Protein |  | 90.1 | 270.6 | \*\*\* | 0.610 | 0.557 |
| Intramuscular fat |  | 1.8 | 4.4 | 0.05 | 0.109 | -0.018 |
| Ash |  | 0.69 | 33.2 | \*\*\* | 0.261 | 0.160 |
| Cholesterol (mg/100 g sample) |  | 603.4 | 20.6 | \*\*\* | 0.383 | 0.299 |
| Mineral content |  |  |  |  |  |  |
| Calcium (mg/kg) |  | 5.30 | 43.9 | \*\*\* | 0.298 | 0.202 |
| Potassium (mg/kg) |  | 7882 3 | 57.6 | \*\*\* | 0.195 | 0.085 |
| Magnesium (mg/kg) |  | 87.2 | 14.4 | \*\*\* | 0.297 | 0.201 |
| Sodium (mg/kg) |  | 1318 0 | 34.0 | \*\*\* | 0.050 | -0.079 |
| Phosphorus (mg/kg) |  | 5880 6 | 157.0 | \*\*\* | 0.328 | 0.237 |
| Copper (mg/kg) |  | 0.009 | 6.2 | \* | 0.094 | -0.030 |
| Iron (mg/kg) |  | 0.49 | 19.9 | \*\*\* | 0.144 | 0.027 |
| Manganese (µg/100 g) |  | 140.3 | 3.2 | 0.09 | 0.163 | 0.049 |
| Zinc (mg/kg) |  | 0.77 | 14.9 | \*\*\* | 0.599 | 0.545 |

1 The experimental unit was the sample (*n* = 10 and 16 for Cu bolus supplemented and control groups, respectively and *n* = 13 for *Sternocephalicus* and *Rectus Abdominis* muscles).

The *P*-values are indicated by \*, \*\* and \*\*\* for *P* < 0.05, *P* < 0.01 and *P* < 0.001, respectively.

**Supplementary Table S2** *Statistical model codes for* *fatty acid profile (mg/g of fat) of red deer yearling males1*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Intercept | | | *R*2 | Adjusted *R*2 |
| Dependent variable |  | RMSE | F-value | *P*-value |
| C10:0 |  | 0.000 | 1.6 | Ns | 0.104 | -0.018 |
| C12:0 |  | 0.001 | 0.41 | Ns | 0.299 | 0.203 |
| C13:0 |  | 0.000 | 2.5 | Ns | 0.202 | 0.093 |
| C14:0 |  | 2.8 | 5.7 | \* | 0.174 | 0.062 |
| C14:1n‒5 |  | 0.27 | 0.67 | Ns | 0.306 | 0.211 |
| C15:0 |  | 0.14 | 25.9 | \*\*\* | 0.222 | 0.116 |
| C15:1n‒5 |  | 0.003 | 7.3 | \* | 0.324 | 0.231 |
| C16:0 |  | 180.7 | 76.1 | \*\*\* | 0.311 | 0.217 |
| C16:1n‒7 |  | 24.0 | 4.2 | 0.05 | 0.288 | 0.191 |
| C17:0 |  | 0.11 | 43.9 | \*\*\* | 0.197 | 0.088 |
| C17:1n‒7 |  | 0.07 | 22.0 | \*\*\* | 0.153 | 0.038 |
| C18:0 |  | 17.3 | 13.6 | \*\*\* | 0.224 | 0.118 |
| C18:1n‒7 |  | 2.4 | 4.8 | \* | 0.165 | 0.051 |
| C18:1n‒9 |  | 40.2 | 34.6 | \*\*\* | 0.106 | -0.015 |
| *9t-*C18:1 |  | 0.009 | 6.1 | \* | 0.175 | 0.062 |
| *11t-*C18:1 |  | 2.1 | 4.2 | 0.05 | 0.038 | -0.093 |
| C18:2n‒6 |  | 39.2 | 7.5 | \* | 0.319 | 0.226 |
| *9c,11t*-C18:2 |  | 2.1-5 | 0.002 | Ns | 0.082 | -0.043 |
| C18:3n‒3 |  | 0.06 | 24.4 | \*\*\* | 0.413 | 0.333 |
| C18:3n‒6 |  | 0.001 | 4.5 | \* | 0.231 | 0.127 |
| C20:0 |  | 9.1-5 | 4.2 | 0.05 | 0.562 | 0.502 |
| C20:1n‒9 |  | 0.002 | 8.8 | \*\* | 0.045 | -0.085 |
| C20:2n‒6 |  | 0.001 | 3.0 | Ns | 0.441 | 0.364 |
| C20:3n‒3 |  | 1.5-5 | 0.14 | Ns | 0.038 | -0.093 |
| C20:3n‒6 |  | 0.03 | 7.2 | \* | 0.376 | 0.291 |
| C20:4n‒6 |  | 3.5 | 4.6 | \* | 0.493 | 0.423 |
| C20:5n‒3 |  | 0.006 | 3.2 | 0.09 | 0.165 | 0.051 |
| C21:0 |  | 0.000 | 1.4 | Ns | 0.201 | 0.092 |
| C22:0 |  | 0.002 | 3.0 | Ns | 0.435 | 0.358 |
| C22:1n‒9 |  | 2.7-5 | 0.45 | Ns | 0.196 | 0.086 |
| C22:5n‒3 |  | 0.04 | 2.9 | Ns | 0.518 | 0.452 |
| C22:6n‒3 |  | 0.001 | 0.76 | Ns | 0.399 | 0.317 |
| C23:0 |  | 0.002 | 2.1 | Ns | 0.379 | 0.294 |
| C24:0 |  | 5.7-6 | 0.11 | Ns | 0.232 | 0.127 |
| SFA2 |  | 403.1 | 73.3 | \*\*\* | 0.083 | -0.043 |
| MUFA3 |  | 232.2 | 14.9 | \*\*\* | 0.202 | 0.093 |
| PUFA4 |  | 79.7 | 7.0 | \* | 0.386 | 0.303 |
| PUFA/SFA |  | 0.04 | 5.2 | \*\* | 0.396 | 0.313 |
| ∑ n‒6 |  | 70.3 | 6.9 | \* | 0.375 | 0.290 |
| ∑ n‒3 |  | 0.30 | 5.8 | \* | 0.421 | 0.342 |
| n‒6/n‒3 |  | 43.8 | 37.8 | \*\*\* | 0.048 | -0.082 |
| NV5 |  | 0.23 | 10.8 | \*\* | 0.536 | 0.472 |
| h/H6 |  | 0.18 | 13.3 | \*\*\* | 0.489 | 0.419 |
| IA7 |  | 0.14 | 12.8 | \*\* | 0.196 | 0.086 |
| IT8 |  | 0.39 | 23.2 | \*\*\* | 0.170 | 0.057 |

1 The experimental unit was the sample (*n* = 10 and 16 for Cu bolus supplemented and control groups, respectively and *n* = 13 for *Sternocephalicus* and *Rectus Abdominis* muscles).

2 Saturated fatty acids.

3 Monounsaturated fatty acids.

4 Polyunsaturated fatty acids.

5 Nutritional value = Σ(C12:0+C14:0+C16:0)/Σ(C18:1n‒9+C18:2n‒6).

6 Hypocholesterolemic/hypercholesterolemic ratio = [Σ(C18:1n‒9+C18:1n‒7+C18:2n‒6+C18:3n‒3+C20:3n‒6+C20:4n‒6)/Σ(C14:0+C16:0)].

7 Index of atherogenicity = [C12:0+(4\*C14:0)+C16:0]/[(∑MUFA)+(∑PUFA)].

8 Index of thrombogenicity = [C14:0+C16:0+C18:0]/[(0.5\*∑MUFA)+(0.5\*n‒6)+(3\*n‒3)+(n‒3/n‒6)].

The *P*-values are indicated by \*, \*\* and \*\*\* for *P* < 0.05, *P* < 0.01 and *P* < 0.001, respectively.

**Supplementary Table S3** *Statistical model codes for* *amino acid (AA) content of meat (mg/100 g of sample) of red deer yearling males1*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Intercept | | | *R*2 | Adjusted *R*2 |
| Dependent variable |  | RMSE | F-value | *P*-value |
| *Essential* |  |  |  |  |  |  |
| Histidine |  | 101 726 | 19.2 | \*\*\* | 0.162 | 0.048 |
| Isoleucine |  | 210 525 | 18.9 | \*\*\* | 0.027 | -0.106 |
| Leucine |  | 663 427 | 21.0 | \*\*\* | 0.017 | -0.117 |
| Lysine |  | 748 073 | 18.8 | \*\*\* | 0.027 | -0.106 |
| Methionine |  | 1 007 | 0.25 | Ns | 0.122 | 0.003 |
| Phenylalanine |  | 117 783 | 13.1 | \*\* | 0.062 | -0.066 |
| Threonine |  | 241 138 | 17.5 | \*\*\* | 0.034 | -0.098 |
| Valine |  | 257 162 | 22.0 | \*\*\* | 0.030 | -0.102 |
| Tyrosine |  | 51 504 | 8.5 | \*\* | 0.269 | 0.169 |
| Cysteine |  | 7 093 | 7.9 | \*\* | 0.034 | -0.098 |
| Total essentials |  | 22 924905 | 21.2 | \*\*\* | 0.024 | -0.109 |
| *Non-essential* |  |  |  |  |  |  |
| Arginine |  | 917 177 | 15.7 | \*\*\* | 0.068 | -0.059 |
| Alanine |  | 498 809 | 26.1 | \*\*\* | 0.087 | -0.038 |
| Aspartic acid |  | 792 684 | 23.0 | \*\*\* | 0.009 | -0.126 |
| Glutamic acid |  | 2118 793 | 20.0 | \*\*\* | 0.019 | -0.115 |
| Glycine |  | 334 069 | 18.7 | \*\*\* | 0.235 | 0.131 |
| Proline |  | 280 567 | 32.5 | \*\*\* | 0.240 | 0.137 |
| Serine |  | 128 879 | 19.7 | \*\*\* | 0.039 | -0.093 |
| Total non-essentials |  | 2464 2528 | 25.9 | \*\*\* | 0.046 | -0.084 |
| Total AA |  | 9423 5779 | 24.0 | \*\*\* | 0.023 | -0.110 |
| Essential/non-essential |  | 0.18 | 223.9 | \*\*\* | 0.391 | 0.308 |

1 The experimental unit was the sample (*n* = 10 and 16 for Cu bolus supplemented and control groups, respectively and *n* = 13 for *Sternocephalicus* and *Rectus Abdominis* muscles).

The *P*-values are indicated by \*\* and \*\*\* for *P* < 0.01 and *P* < 0.001, respectively.

**Supplementary Table S4** *Statistical model codes for mineral content of liver from red deer*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Intercept | | | *R*2 | Adjusted *R*2 |
| Dependent variable |  | RMSE | F-value | *P*-value |
| *Macromineral content (g/100 g)* |  |  |  |  |  |  |
| Calcium |  | 4.9-8 | 0.44 | Ns | 0.528 | 0.434 |
| Potassium |  | 0.006 | 20.1 | \*\*\* | 0.030 | -0.163 |
| Magnesium |  | 1.7-5 | 124.4 | \*\*\* | 0.441 | 0.301 |
| Sodium |  | 0.000 | 15.7 | \*\* | 0.430 | 0.316 |
| Phosphorus |  | 0.010 | 7.8 | \* | 0.174 | 0.009 |
| Sulphur |  | 0.004 | 22.3 | \*\*\* | 0.176 | 0.011 |
| *Trace mineral content (mg/kg)* |  |  |  |  |  |  |
| Aluminium |  | 0.064 | 0.98 | Ns | 0.344 | 0.212 |
| Bismuth |  | 0.002 | 14.5 | \*\* | 0.593 | 0.503 |
| Boron |  | 0.002 | 9.3 | \* | 0.474 | 0.369 |
| Cadmium |  | 9.1-6 | 1.0 | Ns | 0.215 | 0.058 |
| Cobalt |  | 0.001 | 6.8 | \* | 0.192 | 0.031 |
| Chrome |  | 0.000 | 1.8 | Ns | 0.056 | -0.133 |
| Copper |  | 604.0 | 3.1 | Ns | 0.027 | -0.168 |
| Iron |  | 341.6 | 1.1 | Ns | 0.063 | -0.124 |
| Lithium |  | 0.009 | 5.0 | 0.05 | 0.341 | 0.209 |
| Manganese |  | 3.1 | 26.8 | \*\*\* | 0.164 | -0.003 |
| Molybdenum |  | 0.23 | 12.3 | \*\* | 0.013 | -0.184 |
| Nickel |  | 9.6-5 | 4.2 | 0.07 | 0.472 | 0.366 |
| Lead |  | 1.3-5 | 0.045 | Ns | 0.615 | 0.538 |
| Rubidium |  | 2.7 | 2.0 | Ns | 0.006 | -0.193 |
| Selenium |  | 0.012 | 6.0 | \* | 0.118 | -0.058 |
| Strontium |  | 0.000 | 1.8 | \* | 0.492 | 0.390 |
| Titanium |  | 6.5-5 | 1.3 | \* | 0.423 | 0.307 |
| Thallium |  | 0.13 | 45.2 | \*\*\* | 0.498 | 0.373 |
| Zinc |  | 254.8 | 10.5 | \*\* | 0.050 | -0.140 |

The *P*-values are indicated by \*, \*\* and \*\*\* for *P* < 0.05, *P* < 0.01 and *P* < 0.001, respectively.