**Digestibility contributes to between-animal variation in feed efficiency in beef cows**

A. De La Torre1, D. Andueza1, G. Renand2, R. Baumont 1, G. Cantalapiedra-Hijar1, and P. Nozière1

*1Université Clermont Auvergne, INRA, VetAgro Sup, UMR Herbivores, F-63122 Saint-Genès-Champanelle, France*

*2INRA - AgroParisTech, UMR 1313 Génétique Animale et Biologie Intégrative, F-78352 Jouy-en-Josas, France*

**Table S1** Mean pre-experimental efficiency, feed intake and body weight of the High- and Low-residual feed intake (RFI) heifers selected for use in this experiment.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |
|  | All heifers |  | RFI group |  |  |
| Measurement | Mean | SD |  | Low-RFI1 | High-RFI2 | SEM | *P*-value |
| *n=69* |  |  | *n*=7 | *n*=8 |  |  |
|  RFI, kg DM/d | 0 | 1.00 |  | -0.73 | 1.02 | 0.28 | 0.006 |
|  DMI3, kg/d | 7.91 | 1.27 |  | 7.61 | 9.15 | 0.41 | 0.016 |
|  ADG4, g/d | 971 | 229 |  | 931 | 1002 | 66 | 0.31 |
|  BW5, kg | 525 | 54 |  | 543 | 556 | 19 | 0.24 |

1Low-RFI is efficient cows and 2High-RFI is inefficient

3DMI corresponds to the dry matter intake expressed in kg/day

4ADG corresponds to the average daily gain expressed in g/day

5BW corresponds to the mean body weight of beef heifer during the period of RFI measurements

**Table S2** Effects of residual feed intake (RFI) phenotype and diet on rumen fermentation variables measured in cows

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Hay |  | WPMS1 |  |  | P-values |
| Measurements | Low-RFI2 | High-RFI3 |  | Low-RFI2 | High-RFI3 |  | SEM | RFI | Diet | RFI x Diet |
| Mean pH | 6.86 | 7.15 |  | 6.99 | 7.04 |  | 0.09 | 0.09 | 0.92 | 0.20 |
| N-NH3, mmol/L | 5.95 | 5.53 |  | 11.79 | 10.13 |  | 0.91 | 0.48 | 0.002 | 0.63 |
| Total VFA, mmol/L4 | 125.99 | 113.40 |  | 86.64 | 93.91 |  | 7.56 | 0.73 | 0.0017 | 0.20 |
| VFA molar proportions, mol/100 mol total VFA |  |  |  |  |  |  |  |  |  |  |
|  Acetate | 71.58 | 64.40 |  | 44.81 | 46.32 |  | 4.05 | 0.49 | <0.0001 | 0.30 |
|  Propionate | 13.45 | 11.93 |  | 11.31 | 13.55 |  | 0.97 | 0.73 | 0.78 | 0.06 |
|  Iso-butyrate | 0.53 | 0.52 |  | 0.68 | 0.66 |  | 0.05 | 0.77 | 0.009 | 0.93 |
|  Butyrate | 8.42 | 7.73 |  | 6.95 | 8.26 |  | 0.93 | 0.76 | 0.60 | 0.27 |
|  Iso-valerate | 0.66 | 0.65 |  | 1.08 | 1.13 |  | 0.12 | 0.90 | 0.003 | 0.83 |
|  Valerate | 0.65 | 0.57 |  | 0.77 | 1.20 |  | 0.13 | 0.21 | 0.007 | 0.05 |
|  Caproate | 0.20 | 0.16 |  | 0.13 | 0.23 |  | 0.03 | 0.44 | 0.99 | 0.07 |
|  Acetate:propionate | 5.32 | 5.41 |  | 4.01 | 3.49 |  | 0.17 | 0.23 | <0.0001 | 0.08 |

1WPMS corresponds to the whole-plant maize silage and concentrate diet

2Low-RFI is efficient

3High-RFI is inefficient

4total VFA: total volatile fatty acid: acetate + propionate + iso-butyrate + butyrate + iso-valerate + valerate + caproate

**Table S3** Effects of residual feed intake (RFI) phenotype and diet on time budget of feeding and physical behaviors measured in cows

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Hay |  | WPMS1 |  |  | P-values |
| Measurement | Low-RFI2 (n=7) | High-RFI3 (n=8) |  | Low-RFI2 (n=7) | High-RFI3 (n=8) |  | SEM | RFI  | diet | RFI x Diet |
| Feeding behaviors |  |
|  Mastication, min/d | 844 | 784 |  | 590 | 638 | 42.0 | 0.909 | 0.004 | 0.219 |
|  Ingestion, min/d | 328 | 276 |  | 216 | 224 | 21.9 | 0.374 | 0.016 | 0.256 |
|  Rumination, min/d | 513 | 508 |  | 395 | 420 | 27.4 | 0.764 | 0.015 | 0.633 |
|  Eating rate, kg/min | 0.027 | 0.035 |  | 0.060 | 0.059 | 0.004 | 0.486 | 0.011 | 0.399 |
| Physical behaviors |  |  |  |  |  |  |  |  |  |
|  Standing time, min/d | 629 | 637 |  | 517 | 532 | 50.9 | 0. 857 | 0.005 | 0.921 |
|  Lying time, min/d | 811 | 803 |  | 923 | 908 | 50.8 | 0.866 | 0.005 | 0.928 |

1WPMS corresponds to the whole-plant maize silage and concentrate diet

2Low-RFI is efficient

3High-RFI is inefficient

*Supplementary Material S1: Rumen fermentation traits.* In periods 2 (hay diet) and 4 (whole-plant maize silage, WPMS diet), rumen fluid (100 mL) was sampled by suction through a pipe inserted in a ventral sac just before the morning feed on the 1st day following the week of digestibility measurement (week 3). The pH was determined using a digital pH meter (VWR, model pH100, series no. JC00572) and samples were immediately strained through an 800-µm-pore nylon monofilament fabric. An aliquot of rumen filtrate (0.8 mL) was transferred to a microcentrifuge tube containing 0.5 mL of a deproteinizing solution (2% [wt/vol] metaphosphoric acid and 0.4% [wt/vol] crotonic acid), cooled at 4°C for at least 2 h and stored at -20 °C until determination of volatile fatty acid (VFA) content by gas liquid chromatography using crotonic acid as an internal standard. Another 1 mL aliquot of rumen filtrate was transferred to a microcentrifuge tube containing 0.1 mL of 5% orthophosphoric acid and stored at -20°C for ammonia (NH3-N) analysis by colorimetry on an Infinity M200 spectrophotometer (Tecan, Austria, GmbH, Grödig, Austria) using the phenol-hypochlorite method.

*Supplementary Material S2: Measurements of feeding and physical behaviors*. The Rumiwatch® system (RWS, Itin+Hoch, Liestal Switzerland) was used to record continuous feeding activities as eating and ruminating time and also the time spent in lying, standing or walking position (Zehner *et al.,* 2012). As the cows were in individual stalls, the standing position was defined as the activity of the cow in the upright position when it did not walk. This RWS device included a noseband pressure sensor attached to the head of the cow by a halter and a three directional accelerometer that functions as a pedometer attached to the right hind foot. Feeding and physical activities were recorded individually over week 3 of each period in 8 divergent residual feed intake (RFI) cows (4 High-RFI and 4 Low-RFI in periods 1 and 3, the other 8 RFI-cows in periods 2 and 4). The raw data was collected at 10 Hz frequency and saved on an SD-memory card situated in the halter and in the pedometer. The cows were equipped with the RWS device in the middle of week 2 and, at the end of week 3, the devices were removed and connected to a computer for data transfer via a USB cable. The data were then downloaded using the RWS converter firmware version 0.7.3.11 and the output resolution for data analysis was the minute. The data were not pre-processed or filtered in any other way.