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Animal Production Science

Supplementary Material

The effects of *Alnus viridis* encroachment in mountain pastures on the growth performance, carcass and meat quality of Dexter cattle and Engadine sheep

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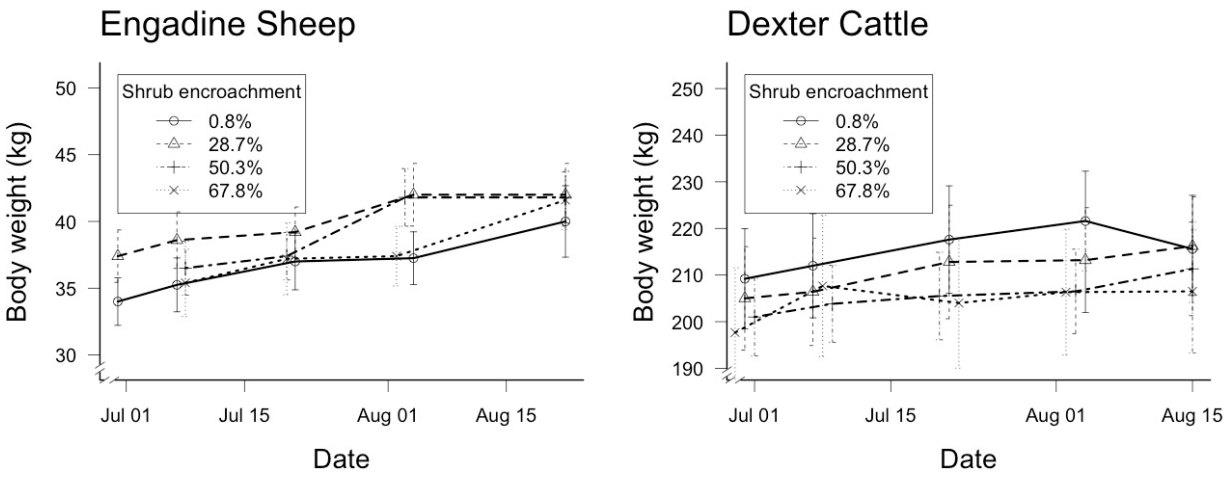

Supplementary Figure S1. Development of the body weight of the Dexter cattle (*n* = 5 to 6 per encroachment level) and the Engadine sheep (*n* = 5 per shrub encroachment level) during the experimental grazing period (error bars reflect standard error).

Supplementary Table S1. Muscle fibre characteristics of the *M. longissimus thoracis* of Dexter cattle and Engadine sheep grazing pastures with increasing shrub encroachment level.

Trait	Shrub encroachment (% of area) (E)					*P*-value		
Animal species (S)	0.8	28.7	50.3	67.8	s.e.m.	S	E	S×E
Average number of fibres counted (n)					15.8	<0.001	0.37	0.76
Dexter cattle	187	169	165	191				
Engadine sheep	389	316	320	334				
Mean fibre cross sectional area (μm^2)								
All					118.8	<0.001	0.27	0.75
Dexter cattle	1482	1725	1760	1568				
Engadine sheep	904	1023	1109	1117				
Type I					51.5	<0.001	0.077	0.81
Dexter cattle	1010	1302	1400	1230				
Engadine sheep	693	871	876	868				
Type IIa					89.2	<0.001	0.39	0.37
Dexter cattle	1851	2081	2084	1777				
Engadine sheep	879	895	1034	1030				
Type IIx/IIb					62.6	0.003	0.51	0.88
Dexter cattle	1584	1792	1794	1696				
Engadine sheep	1141	1303	1418	1455				
Fibre number (% of total fibres)								
Type I					3.07	<0.001	0.62	0.065
Dexter cattle	24.7	27.7	24.7	30.1				
Engadine sheep	13.9	8.9	12.0	10.3				
Type IIa					2.56	<0.001	0.64	0.083
Dexter cattle	41.2	38.6	45.5	40.2				
Engadine sheep	47.8	56.6	50.6	57.1				
Type IIx/IIb					1.03	0.058	0.41	0.67
Dexter cattle	34.1	33.7	29.8	29.7				
Engadine sheep	38.3	34.6	37.5	32.6				
Fibre area (% of total area)								
Type I					1.05	<0.001	0.30	0.0275
Dexter cattle	15.9	19.8	18.2	23.1				
Engadine sheep	9.9	7.4	8.9	7.6				
Type IIa					1.04	0.83	0.92	0.12
Dexter cattle	47.7	44.1	50.6	44.1				
Engadine sheep	42.8	48.5	44.0	49.0				
Type IIx/IIb					1.33	<0.001	0.70	0.55
Dexter cattle	33.9	33.3	28.6	30.8				
Engadine sheep	42.8	42.3	44.5	39.3				

Supplementary Table S2. Muscle fibre characteristics of the *M. biceps femoris* of Dexter cattle and Engadine sheep grazing pastures with increasing shrub encroachment level.

Trait	Shrub encroachment (% of area) (E)					*P*-value		
Animal species (S)	0.8	28.7	50.3	67.8	s.e.m.	S	E	S×E
Average number of fibres counted (n)					13.0	<0.001	0.17	0.029
Dexter cattle	146	167	153	174				
Engadine sheep	330	336	282	251				
Mean fibre cross sectional area (μm^2)								
All					115.8	<0.001	0.21	0.22
Dexter cattle	1862	1757	1950	1662				
Engadine sheep	1155	1087	1349	1369				
Type I					76.8	<0.001	0.18	0.49
Dexter cattle	2269	1853	2012	1920				
Engadine sheep	1274	1082	1313	1356				
Type IIa					60.1	<0.001	0.12	0.063
Dexter cattle	1663	1741	1868	1419				
Engadine sheep	1017	1016	1286	1282				
Type IIx/IIb					60.2	<0.001	0.13	0.55
Dexter cattle	1654	1676	1970	1646				
Engadine sheep	1175	1162	1448	1468				
Fibre number (% of total fibres)								
Type I					5.27	<0.001	0.95	0.36
Dexter cattle	50.6	51.7	47.5	51.9				
Engadine sheep	20.2	21.9	26.8	22.7				
Type IIa					3.12	<0.001	0.86	0.59
Dexter cattle	21.0	24.6	23.9	23.2				
Engadine sheep	44.8	39.4	31.6	36.8				
Type IIx/IIb					2.57	0.003	0.90	0.86
Dexter cattle	28.4	23.8	28.7	24.9				
Engadine sheep	35.1	38.7	41.6	40.5				
Fibre area (% of total area)								
Type I					2.65	<0.001	0.74	0.23
Dexter cattle	56.4	52.9	47.3	54.9				
Engadine sheep	21.8	20.9	25.4	21.8				
Type IIa					2.04	<0.001	0.89	0.48
Dexter cattle	17.0	22.8	22.3	18.9				
Engadine sheep	40.0	36.0	28.8	33.7				
Type IIx/IIb					2.06	<0.001	0.74	0.86
Dexter cattle	24.3	21.6	27.2	23.1				
Engadine sheep	34.1	38.7	42.2	41.5				

Supplementary Table S3. Physicochemical quality of the *Longissimus thoracis* aged for 21 days of Dexter cattle and Engadine sheep grazing pastures with increasing shrub encroachment level.

Trait	Shrub encroachment (% of area) (E)					*P*-value		
Animal species (S)	0.8	28.7	50.3	67.8	s.e.m.	S	E	S×E
$pH_{24h\ post\ mortem}$					0.029	0.83	0.79	0.66
Dexter cattle	5.85	5.69	5.82	5.72				
Engadine sheep	5.73	5.78	5.76	5.74				
L*					0.3	<0.001	0.36	0.54
Dexter cattle	37	38	34	34				
Engadine sheep	36	38	34	34				
a*					0.4	<0.001	0.86	0.49
Dexter cattle	24	24	21	21				
Engadine sheep	26	25	21	21				
b*					0.30	<0.001	0.45	0.86
Dexter cattle	4.2	4.9	1.9	1.9				
Engadine sheep	4.6	5.6	1.8	2.3				
Drip loss (%)					0.067	0.070	0.61	0.13
Dexter cattle	1.25	1.47	1.40	1.47				
Engadine sheep	1.85	1.46	1.92	1.35				
Cooking loss (%)					0.67	0.097	0.17	0.47
Dexter cattle	26.4	28.1	30.0	27.8				
Engadine sheep	22.1	26.6	26.0	28.6				
Shear force (N)					2.26	<0.001	0.87	0.88
Dexter cattle	64.7	66.4	67.9	63.4				
Engadine sheep	39.4	41.0	40.1	40.8				
Composition (g/100 g meat)								
Moisture					0.18	0.90	0.99	0.59
Dexter cattle	73.4	73.8	73.1	73.5				
Engadine sheep	73.6	73.1	73.9	73.4				
Protein					0.12	0.33	0.59	0.87
Dexter cattle	22.2	21.6	21.6	21.6				
Engadine sheep	21.7	21.4	21.3	21.7				
Fat					0.136	0.32	0.46	0.98
Dexter cattle	2.47	2.67	2.10	2.33				
Engadine sheep	2.95	2.95	2.38	2.45				
Total ash					0.039	0.002	0.32	0.12
Dexter cattle	1.31	1.08	1.30	1.21				
Engadine sheep	1.25	1.43	1.51	1.58				

Supplementary Table S4. Physicochemical quality of the *Biceps femoris* aged for 21 days of Dexter cattle and Engadine sheep grazing pastures with increasing shrub encroachment level.

Trait	Shrub encroachment (% of area) (E)					*P*-value		
Animal species (S)	0.8	28.7	50.3	67.8	s.e.m.	S	E	S×E
$pH_{24h\ post\ mortem}$					0.026	0.37	0.16	0.60
Dexter cattle	5.79	5.62	5.66	5.83				
Engadine sheep	5.87	5.75	5.75	5.76				
L*					0.4	<0.001	0.87	0.62
Dexter cattle	37	36	32	33				
Engadine sheep	36	37	32	33				
a*					1.1	0.19	0.36	0.20
Dexter cattle	24	22	22	23				
Engadine sheep	33	22	22	23				
b*					0.18	<0.001	0.39	0.13
Dexter cattle	4.3	4.1	1.7	2.4				
Engadine sheep	3.2	3.5	2.1	2.4				
Drip loss (%)					0.069	<0.001	0.84	0.85
Dexter cattle	1.88	1.85	1.71	1.63				
Engadine sheep	1.24	1.27	1.32	1.24				
Cooking loss (%)					0.28	0.012	0.88	0.42
Dexter cattle	30.4	31.1	29.5	30.5				
Engadine sheep	29.4	28.4	29.2	28.6				
Shear force (N)					1.18	0.001	0.95	0.73
Dexter cattle	37.6	36.6	39.5	40.9				
Engadine sheep	34.2	32.4	29.5	31.5				
Composition (g/100 g meat)								
Moisture					0.17	0.051	0.81	0.47
Dexter cattle	74.6	75.1	74.6	75.3				
Engadine sheep	74.6	73.6	74.4	74.3				
Protein					0.17	<0.001	0.63	0.18
Dexter cattle	20.8	19.9	20.2	19.8				
Engadine sheep	21.6	21.8	21.9	22.0				
Fat					0.147	0.18	0.61	0.85
Dexter cattle	3.22	2.91	2.40	2.49				
Engadine sheep	2.42	2.32	2.33	2.17				
Total ash					0.040	0.085	0.28	0.88
Dexter cattle	1.50	1.56	1.70	1.63				
Engadine sheep	1.45	1.32	1.57	1.51				

Supplementary Table S5. Fatty acid profile of the lipids (g/100 g total fatty acid methyl esters) of the *M. longissimus dorsi* of Dexter cattle and Engadine sheep grazing pastures with increasing shrub encroachment level.

Trait	Shrub encroachment (% of area) (E)					*P*-value		
Animal species (S)	0.8	28.7	50.3	67.8	s.e.m.	S	E	S×E
C8:0					0.0008	0.83	0.64	0.81
Dexter Cattle	0.014	0.013	0.013	0.011				
Engadine sheep	0.013	0.016	0.012	0.011				
C10:0					0.0058	<0.001	0.328	0.21
Dexter Cattle	0.046	0.046	0.049	0.046				
Engadine sheep	0.111	0.104	0.110	0.133				
C12:0					0.0074	<0.001	0.63	0.40
Dexter Cattle	0.085	0.078	0.085	0.080				
Engadine sheep	0.125	0.135	0.127	0.175				
C14:0					0.098	0.003	0.77	0.67
Dexter Cattle	2.61	2.63	2.75	2.63				
Engadine sheep	1.91	1.99	2.01	2.48				
C15:1					0.0039	0.167	0.94	0.99
Dexter Cattle	0.181	0.178	0.173	0.184				
Engadine sheep	0.169	0.165	0.167	0.169				
C16:0					0.46	<0.001	0.74	0.66
Dexter Cattle	23.9	24.6	24.9	24.3				
Engadine sheep	19.9	19.5	20.3	21.6				
∑ 16:1[A]					0.163	<0.001	0.54	0.82
Dexter cattle	3.98	3.9	3.68	3.46				
Engadine sheep	2.07	1.95	1.92	1.93				
C17:0					0.051	<0.001	0.11	0.46
Dexter cattle	1.55	1.35	1.58	1.76				
Engadine sheep	1.83	1.90	2.06	2.00				
C17:1					0.0120	0.16	0.086	0.70
Dexter cattle	0.723	0.703	0.661	0.612				
Engadine sheep	0.645	0.658	0.641	0.610				
C18:0					0.44	<0.001	0.29	0.65
Dexter cattle	14.7	15.5	15.3	16.1				
Engadine sheep	19.0	19.3	20.9	20.2				
C18:1 *c*9					0.46	0.007	0.13	0.69
Dexter cattle	32.6	32.5	32.4	29.6				
Engadine sheep	30.0	30.4	28.4	28.3				
C18:1 *t*11					0.121	<0.001	0.76	0.22
Dexter cattle	1.48	1.29	1.57	1.60				
Engadine sheep	2.68	2.90	2.80	2.25				
Further C18:1 isomers[B]					0.046	0.12	0.62	0.14
Dexter cattle	2.41	2.42	2.32	2.32				
Engadine sheep	2.47	2.25	2.61	2.69				
C18:2 *n*-6					0.291	0.001	0.25	0.95
Dexter cattle	4.67	4.31	4.70	5.65				
Engadine sheep	5.98	6.30	6.80	7.64				
C18:2 *c*9*t*11					0.0006	0.14	0.072	0.25
Dexter cattle	0.011	0.015	0.012	0.009				
Engadine sheep	0.017	0.014	0.013	0.011				

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Supplementary Table S5. continued.

Trait	Shrub encroachment (% of area) (E)					*P*-value		
Animal species (S)	0.8	28.7	50.3	67.8	s.e.m.	S	E	S×E
C18:2 *t*11*c15.*					0.0180	<0.001	0.40	0.40
Dexter cattle	0.294	0.28	0.267	0.301				
Engadine sheep	0.343	0.372	0.42	0.493				
C18:3 *n*-3					0.131	<0.001	0.39	0.79
Dexter cattle	1.93	1.99	1.90	2.17				
Engadine sheep	2.90	3.33	3.34	3.55				
Further C18:3 isomers[C]					0.293	0.001	0.25	0.95
Dexter cattle	4.63	4.29	4.68	5.62				
Engadine sheep	5.93	6.27	6.76	7.63				
C20:3 *n*-3					0.0018	0.006	0.51	0.73
Dexter cattle	0.045	0.039	0.035	0.039				
Engadine sheep	0.049	0.047	0.047	0.054				
C20:4 *n*-6					0.090	0.78	0.45	0.91
Dexter cattle	1.40	1.19	1.35	1.75				
Engadine sheep	1.32	1.45	1.47	1.67				
C20:5 *n*-3					0.0613	0.14	0.34	0.74
Dexter cattle	0.795	0.753	0.756	1.090				
Engadine sheep	0.868	0.967	1.150	1.150				
C22:4 *n*-6					0.0009	0.049	0.30	0.89
Dexter cattle	0.010	0.013	0.014	0.013				
Engadine sheep	0.013	0.016	0.020	0.016				
C22:5 *n*-3					0.0485	0.78	0.67	0.92
Dexter cattle	0.917	0.917	0.876	1.060				
Engadine sheep	0.846	0.834	0.970	1.000				
C22:6 *n*-3					0.0193	<0.001	0.84	0.91
Dexter cattle	0.108	0.117	0.117	0.151				
Engadine sheep	0.3	0.312	0.337	0.319				
∑ SFA					0.37	0.77	0.99	0.68
Dexter cattle	43.9	45.3	44.7	44.9				
Engadine sheep	45.8	44.4	45.2	44.6				
∑ MUFA					0.56	<0.001	0.10	0.80
Dexter cattle	42.2	41.8	41.5	38.4				
Engadine sheep	38.2	38.6	36.7	36.1				
∑ PUFA					0.62	0.005	0.36	0.94
Dexter cattle	11.2	10.5	11	13.4				
Engadine sheep	13.6	14.5	15.4	16.6				
∑ *n*-3					0.231	0.001	0.45	0.86
Dexter cattle	4.02	4.06	3.92	4.81				
Engadine sheep	5.04	5.57	5.94	6.16				
n-6:*n*-3, x:1					0.0115	0.017	0.19	0.75
Dexter cattle	0.621	0.676	0.606	0.605				
Engadine sheep	0.679	0.705	0.694	0.639				

[A]Include C16:1 *c*7, C16:1 *c*9, C16:1 *t*9.

[B]Include C18:1 *t*6-12, C18:1 *c*10-13, C18:1 *c*15.

[C]Include C18:3 *n*-6, C18:3 *2n6c.*

MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SFA, saturated fatty acids.

Supplementary Table S6. Fatty acid profile of the lipids (g/100 g total fatty acid methyl esters) of the perirenal fat tissue of Dexter cattle and Engadine sheep grazing pastures with increasing shrub encroachment level.[A]

Trait	Shrub encroachment (% of area) (E)					*P*-value		
Animal species (S)	0.8	28.7	50.3	67.8	s.e.m.	S	E	S×E
C8:0					0.0009	<0.001	0.49	0.57
Dexter Cattle	0.008	0.010	0.008	0.008				
Engadine sheep	0.020	0.017	0.016	0.017				
C10:0					0.0066	<0.001	0.11	0.12
Dexter Cattle	0.048	0.047	0.044	0.046				
Engadine sheep	0.148	0.103	0.095	0.110				
C12:0					0.0115	0.79	0.42	0.82
Dexter Cattle	0.178	0.145	0.18	0.157				
Engadine sheep	0.206	0.125	0.173	0.193				
C14:0					0.216	<0.001	0.65	0.75
Dexter Cattle	4.91	4.55	5.00	4.42				
Engadine sheep	3.30	2.44	2.87	3.19				
C15:1					0.0074	0.047	0.97	0.23
Dexter Cattle	0.347	0.312	0.34	0.357				
Engadine sheep	0.299	0.335	0.303	0.301				
C16:0					0.718	<0.001	0.23	0.61
Dexter Cattle	26.6	26.0	27.3	25.0				
Engadine sheep	19.8	17.8	18.1	17.7				
∑ 16:1					0.088	<0.001	0.16	0.79
Dexter cattle	3.03	3.09	2.87	2.69				
Engadine sheep	2.2	2.04	1.93	1.93				
C17:0					0.037	<0.001	0.87	0.40
Dexter cattle	1.71	1.66	1.63	1.73				
Engadine sheep	1.86	2.06	2.01	1.94				
C18:0					0.96	<0.001	0.051	0.53
Dexter cattle	23.8	24.5	24.9	27.2				
Engadine sheep	29.9	34.7	35.6	37.0				
C18:1 *c*9					0.62	<0.001	0.68	0.67
Dexter cattle	25.9	27.4	24.8	25.4				
Engadine sheep	22.4	20.5	20.3	21.1				
C18:1 *t*11					0.210	<0.001	0.97	0.51
Dexter cattle	1.83	1.56	1.88	2.03				
Engadine sheep	3.98	3.98	3.81	3.17				
Further C18:1 isomers					0.200	<0.001	0.72	0.51
Dexter cattle	3.68	3.47	3.58	3.59				
Engadine sheep	5.31	5.73	5.34	4.50				
C18:2 *n*-6					0.118	<0.001	0.66	0.98
Dexter cattle	1.31	1.15	1.19	1.14				
Engadine sheep	2.69	2.54	2.47	2.52				
C18:2 *c9t*11					0.0195	0.83	0.57	0.42
Dexter cattle	0.416	0.472	0.439	0.446				
Engadine sheep	0.504	0.496	0.456	0.339				
C18:2 *t*11*c*15					0.0364	<0.001	0.15	0.083
Dexter cattle	0.515	0.451	0.483	0.503				
Engadine sheep	0.938	0.828	0.611	0.551				

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Supplementary Table S6. continued.

Trait	Shrub encroachment (% of area) (E)					*P*-value		
Animal species (S)	0.8	28.7	50.3	67.8	s.e.m.	S	E	S×E
C18:3 *n*-3					0.0952	<0.001	0.12	0.38
Dexter cattle	0.862	0.765	0.772	0.705				
Engadine sheep	2.010	2.030	1.710	1.630				
Further C18:3 isomers					0.099	<0.001	0.57	0.97
Dexter cattle	1.26	1.17	1.15	1.15				
Engadine sheep	2.46	2.28	2.22	2.28				
C20:3 *n*-3					0.0014	0.067	0.53	0.72
Dexter cattle	0.036	0.035	0.031	0.028				
Engadine sheep	0.040	0.036	0.037	0.038				
C20:4 *n*-6					0.0025	0.075	0.093	0.33
Dexter cattle	0.0401	0.037	0.034	0.030				
Engadine sheep	0.061	0.035	0.038	0.043				
C20:5 *n*-3					0.0035	<0.001	0.55	0.89
Dexter cattle	0.0612	0.054	0.051	0.049				
Engadine sheep	0.020	0.020	0.016	0.018				
C22:4 *n*-6					0.0020	0.17	0.36	0.57
Dexter cattle	0.031	0.029	0.028	0.027				
Engadine sheep	0.047	0.032	0.031	0.029				
∑ SFA					0.46	0.75	0.084	0.58
Dexter cattle	58.7	58.1	60.4	59.9				
Engadine sheep	56.4	58.4	60.1	61.2				
∑ MUFA					0.51	0.007	0.27	0.74
Dexter cattle	36.1	37.1	34.7	35.2				
Engadine sheep	35	33.3	32.2	31.5				
∑ PUFA					0.256	<0.001	0.19	0.49
Dexter cattle	3.71	3.38	3.43	3.33				
Engadine sheep	6.95	6.52	5.90	5.65				
∑ *n*-3					0.099	<0.001	0.093	0.47
Dexter cattle	1.11	0.97	0.99	0.91				
Engadine sheep	2.34	2.22	1.94	1.86				
n-6:*n*-3, x:1					0.0129	0.007	0.067	0.37
Dexter cattle	0.695	0.68	0.679	0.649				
Engadine sheep	0.783	0.797	0.709	0.666				

[A]For explanations see footnote of Supplementary Table S6. Data to C17:1, C22:5 *n*-3 and C22:6 *n*-3 are displayed in Figure 2.