

Response of early and late lactation dairy cows to diets differing in levels of human edible ingredients

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Background and Aim

- Increasing competition between humans and livestock for feed resources.
- Dairy sector relies on significant quantities of 'human-edible' (HE) feeds.
- Increasing pressure to make more use of low human-edible "by-product" feeds in dairy cow diets.
- Expected that there are greater opportunities to make use of low human-edible feeds in diets of late lactation cows compared to early lactation cows.

Aim

- To assess the impact of reducing the quantity of human-edible ingredients in the concentrates of early and late lactation dairy cows offered a grass silage based diet.

Materials and Methods

- 40 dairy cows used in a 2-period (4 weeks duration) changeover design study
- 2x2 factorial design:
 - 2 lactation stages
 - 20 early lactation (EL): 65 days calved
 - 20 late lactation (LL): 220 days calved
 - 2 concentrate types
 - High in human-edible ingredients (HE)
 - Low in human-edible ingredients (IN)
- Ration comprised grass silage plus concentrate (60:40 on a dry matter (DM) basis)

Assessing Human Edible Fractions (Wilkinson, 2011)

- Each component of the concentrate/diet assigned a value describing its Human Edible Fraction (HEF).
- Values derived from Council for Agricultural Science and Technology (1999).
 - Forage, minerals and vitamins: value of **0**
 - Cereal by-products, oilseed meals and other by-products: value of **0.2**
 - Cereals, soyabean meal and pulse grains: value of **0.8**
- A weighted HEF was produced for each concentrate
- Value used to calculate human edible feed conversion rate (eFCR)

Assessing Human Edible Fractions (Ertl et al., 2015)

- Estimates for HEF for individual feedstuff derived from literature on food processing or food usage
- HEF value applied for Gross Energy and Crude Protein to each feed
- Further revisions to HEF applied according to degree of nutrient extraction: eg for soyabean meal

	HEF	
	CP	GE
Low	0.50	0.42
Medium	0.71	0.54
High	0.92	0.65

- 'Medium' values used to calculate Net Food Production (NFP) in this study

Ingredient Composition of Treatment Concentrates (% fresh weight)

	Low human-edible concentrate (IN)	High human-edible concentrate (HE)
Barley	--	12.0
Wheat	--	10.5
Maize	--	10.0
Soyabean meal	--	20.5
Soya hulls	11.5	9.0
Unmolassed sugar beet pulp	19.8	15.5
Distillers dark grains (maize)	8.5	--
Rapeseed meal	20.0	--
Wheat feed	16.0	8.0
Maize gluten	16.0	8.5
Molasses	3.0	3.0
Minerals and vitamins	3.0	3.0
Protected fat	2.2	--

Calculated Human Edible Fractions of Treatment Concentrates

	Low human-edible (IN)	High human-edible (HE)
Wilkinson (2011)		
HEF	0.18	0.51
Ertl et al. (2015)		
HEF Crude Protein (medium)	0.15	0.41
HEF Gross Energy (medium)	0.10	0.37

Measurements

- Feed intake, milk yield, milk composition and liveweight
- Rumen fermentation and nutrient digestibility
- Feed utilization coefficients
 - Feed Conversion Rate (FCR) = energy corrected milk (ECM) yield/ DM intake
 - Nitrogen Use Efficiency (NUE) = milk N output/ total N input
 - Human Edible Feed Conversion Ratio (eFCR for energy and protein) = human-edible output/ human-edible input
 - Net Food Production (NFP for energy and protein) = human-edible output – human-edible input

RESULTS



Chemical composition of silage and experimental concentrates

	Grass silage	Low human-edible concentrate (IN)	High human-edible concentrate (HE)
Oven DM (g/kg)	250	917	907
Crude protein (g/kg DM)	158	197	204
NDF (g/kg DM)	520	373	257
Starch (g/kg DM)	--	69	227
Predicted ME (MJ/kg DM)	10.9	12.4	12.5

DM Intakes (kg/cow/day)

	Early lactation (EL)		Late lactation (LL)			P-value	
	IN	HE	IN	HE	SED	Lact	Conc
Silage intake	12.5	12.6	11.8	12.1	0.25	0.032	0.133
Concentrate intake	8.7	8.5	8.3	8.2	0.16	0.052	0.187
Total DM intake	21.2	21.2	20.1	20.3	0.42	0.039	0.653

No lactation stage x concentrate type interaction ($P > 0.05$)

Milk production

	Early lactation (EL)		Late lactation (LL)			P-value	
	IN	HE	IN	HE	SED	Lact	Conc
Milk yield (kg/day)	34.5	34.4	26.1	26.1	1.05	<0.001	0.833
Milk fat (g/kg)	42.8	43.3	47.6	49.6	1.04	<0.001	0.011
Milk protein (g/kg)	29.4	30.6	35.6	36.3	0.52	<0.001	<0.001
ECM yield (kg/day)	34.7	35.0	29.1	29.8	1.16	<0.001	0.408
Liveweight (kg)	624	634	647	646	10.2	0.188	0.082

No lactation stage x concentrate type interaction ($P>0.05$)

Rumen fermentation

	Early lactation		Late lactation			P-value		
	IN	HE	IN	HE	SED	Lact	Conc	Lact x Conc
pH	6.1	6.2	6.2	6.2	0.11	0.306	0.624	0.965
Ammonia (mmol/l)	16.0 ^b	10.6 ^a	12.5 ^a	13.4 ^{ab}	1.50	0.293	0.021	0.002
(Acetate+butyrate): propionate	3.68 ^a	3.81 ^a	3.78 ^a	4.27 ^b	0.110	0.004	<0.001	0.015

Digestibility

	Early lactation (EL)		Late lactation (LL)			P-value	
	IN	HE	IN	HE	SED	Lact	Conc
Dry Matter	0.76	0.78	0.75	0.77	0.011	0.484	0.017
Organic Matter	0.79	0.83	0.79	0.80	0.008	0.587	0.005
Gross Energy	0.76	0.78	0.76	0.78	0.009	0.591	0.014

No lactation stage x concentrate type interaction ($P > 0.05$)

Feed utilization coefficients

	Early lactation (EL)		Late lactation (LL)			P-value	
	IN	HE	IN	HE	SED	Lact	Conc
Feed conversion rate (FCR)	1.63	1.66	1.47	1.45	0.049	<0.001	0.457
Nitrogen use efficiency (NUE)	0.29	0.28	0.27	0.27	0.009	0.119	0.399
Human edible feed conversion rate (eFCR) Wilkinson (2011)							
Energy	3.31	1.27	2.70	1.09	0.094	<0.001	0.001
Protein	3.01	1.20	2.91	1.12	0.086	0.207	<0.001
Net Food Production (NFP) Ertl et al. (2015)							
Energy (MJ/day)	90	51	73	37	3.5	<0.001	<0.001
Protein (g/day)	740	339	669	264	34.3	0.027	<0.001

No lactation stage x concentrate type
interaction ($P>0.05$)

Conclusions

- Early lactation cows had greater DM intakes, milk yields and lower milk fat and protein concentrations.
- Concentrate type had no impact on DM intake or milk yield. However milk fat and protein concentration was greater with concentrates high in human-edible ingredients.
- No interaction between stage of lactation and concentrate type for DM intake and milk production
- Reducing the quantity of human-edible ingredients in the concentrate with a grass silage based diet :
 - Had no impact on total feed conversion rate (FCR) and nitrogen use efficiency (NUE)
 - Increased human edible feed efficiency (eFCR) and Net Food Production (NFP)

Acknowledgements

- Financial assistance from the Department of Agriculture, Environment and Rural Affairs for Northern Ireland (DAERA) is gratefully acknowledged