Does feeding dairy cows with “ecological” diets improve the conversion of human-edible nutrient from feeds into milk?

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Introduction

Ruminants can convert feeds unsuitable and unpalatable for humans into milk, and thereby play a key role in food security. Milk production efficiency is usually calculated as the ratio between nutrients secreted in milk and nutrient intake, but this metric does not address concerns about human/livestock feed competition. Feeding animals with resources not suitable for human consumption, such as by-products and grass from marginal land unsuited for crop production, is referred to as producing livestock on “ecological leftovers” (**ECO**; Garnett, 2009).

Objective

Our objective was to evaluate effects of diets composed of ECO ingredients on dairy cattle productivity. In addition, we sought to estimate human-edible (**HE**) nutrient recovery rate (HE inputs vs. milk nutrients) in different scenarios: thrift (all potentially HE ingredients counted as such), choice (ingredients rarely consumed by humans considered not HE), and land use (land used for alfalfa production could be used to grow corn and soybeans for direct human consumption).

Materials and Methods

Two experiments were carried out at the Dairy Teaching and Research Center of Kansas State University. In experiment 1, twelve dairy cows after peak lactation were randomly assigned to treatment sequence in a crossover design. Treatments were a conventional diet (**CON1**) or a diet with 95% by-product feeds (**ECO1**). In experiment 2, twelve second lactation dairy cows were assigned to a 3×3 Latin square design experiment with the following treatments: 1) a conventional diet for lactating cows (**CON2**), 2) a diet comprised entirely of ECO feedstuffs (**ECO2**); and 3) ECO2 with top-dressed rumen-protected lysine and methionine (**ECO2-AA**). Metabolizable energy (ME) content of feeds and milk were calculated based on Atwater calorie factors: 4 kcal/g of starch or sugar, 9 kcal/g of fat, and 4 kcal/g of protein. To account for amino acid recovery, we estimated the HE digestible amino acid inputs and outputs using the feed total amino acid content and standardized ileal digestibility values from the National Research Council (2012). A recovery value of 1 would indicate that for every HE unit (either MJ or protein) the cow consumes, she would produce 1 HE unit in milk.

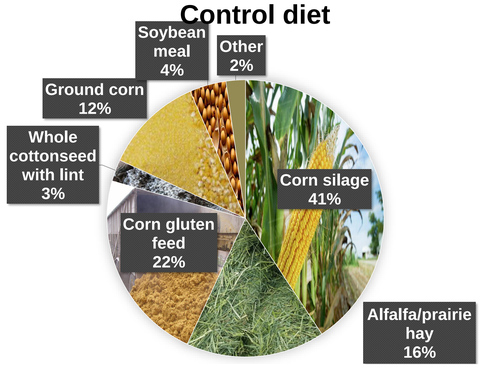
References

Garnett, T. (2009). Livestock-related greenhouse gas emissions: impacts and options for policy makers. Environ. Sci. Policy 12, 491–503. doi:10.1016/J.ENVSCI.2009.01.006.

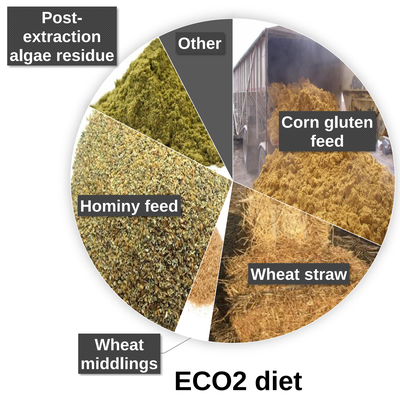
NRC (2012). Nutrient Requirements of Swine. Washington, D.C.: National Academies Press doi:10.17226/13298.

Results

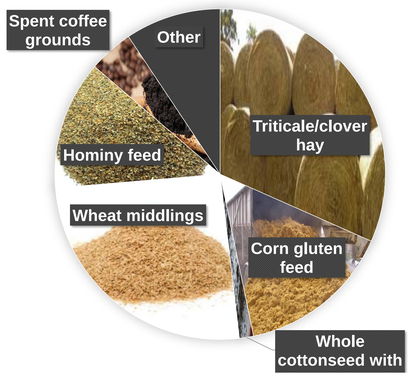
Control diet



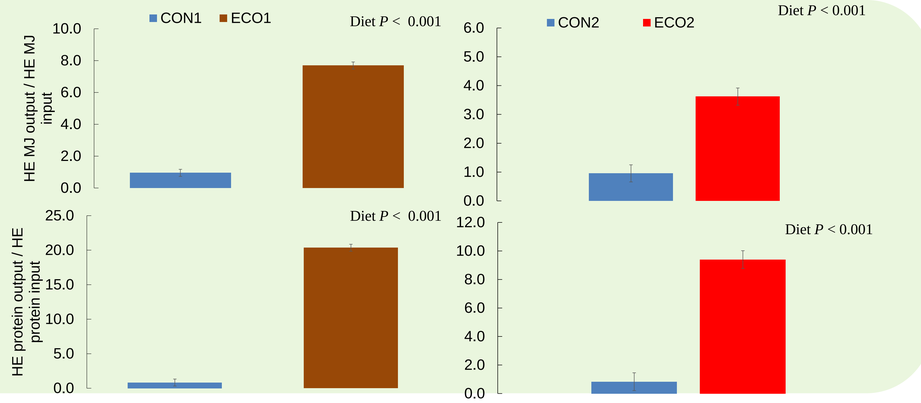
ECO1 diet



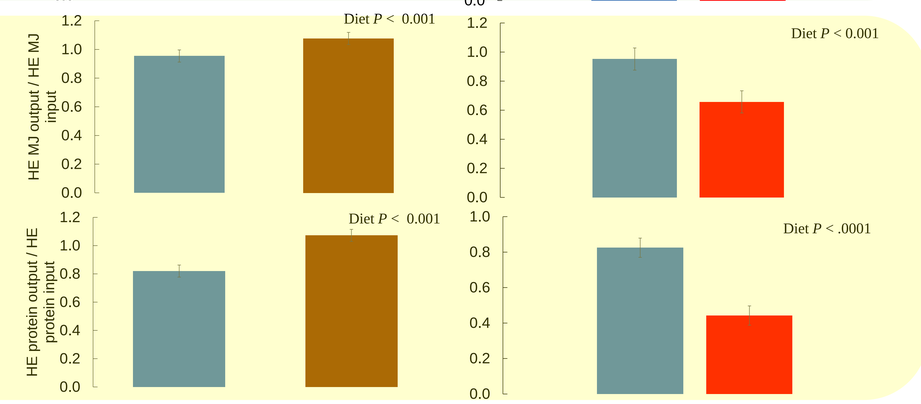
ECO2 diet



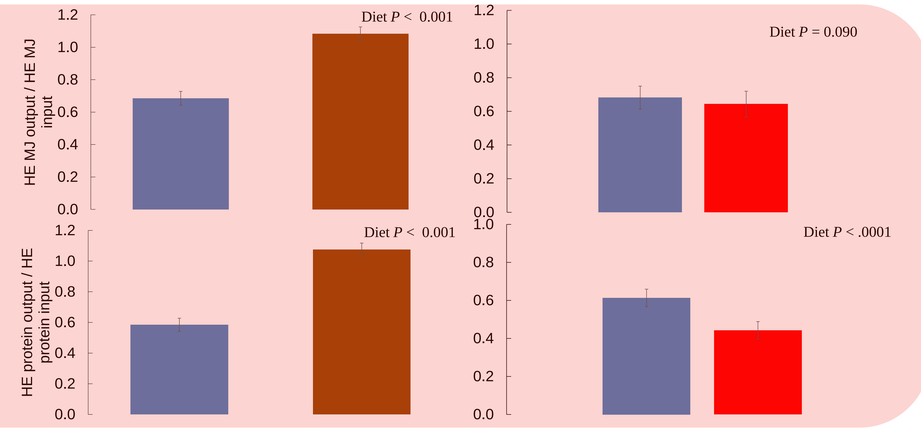
Choice Scenario



Thrift Scenario



Land use Scenario



HE digestible amino acid recovery (g output/g input) in milk of cows fed a conventional diet or an ecological diet. Calculations were made based on the Choice Scenario.

Amino acid	Diet		SEM	*P*-value
	CON1	ECO1		
Arg	0.52	197	6.20	<0.01
His	1.05	363	11.4	<0.01
Ile	1.29	163	5.12	<0.01
Leu	0.97	194	6.09	<0.01
Lys	1.56	471	14.8	<0.01
Met	1.34	145	4.55	<0.01
Phe	0.98	199	6.26	<0.01
Thr	1.28	115	3.60	<0.01
Trp	1.23	176	5.53	<0.01
Val	1.25	66.3	2.08	<0.01
Cys	0.34	19.9	0.63	<0.01
Tyr	1.16	150	4.71	<0.01

Amino acid	Diet		SEM	*P*-value
	CON2	ECO2		
Arg	0.53	87.7	7.47	< 0.01
His	1.16	161	13.8	< 0.01
Ile	1.36	72.3	6.17	< 0.01
Leu	1.14	86.1	7.34	< 0.01
Lys	1.55	209	17.8	< 0.01
Met	1.57	64.4	5.5	< 0.01
Phe	1.07	88.4	7.54	< 0.01
Thr	1.36	50.8	4.34	< 0.01
Trp	1.24	78.2	6.67	< 0.01
Val	1.37	29.5	2.52	< 0.01
Cys	0.40	8.84	0.76	< 0.01
Tyr	1.26	66.6	5.68	< 0.01

***Adding rumen-protected amino acids to the ECO2 diet did not affect either HE nutrient inputs or outputs.

Conclusions

- Dairy cows fed ecological diets may have a net production of HE energy, protein, and essential amino acids.
- The net production of HE nutrients is dependent on assumptions made in calculations.