Chapter 5
Feeding Applications of Corn Fermented Protein Co-Products in Dairy and Beef Cattle Diets

Introduction

The use of corn fermented protein (CFP) co-products in beef and dairy cattle diets has not been extensively evaluated but energy and protein digestibility values have been determined, and positive results have been reported when feeding CFP to growing beef calves and lactating dairy cows. The following sections summarize dry matter (DM), crude protein (CP), and neutral detergent fiber (NDF) degradability, along with metabolizable energy (ME), net energy (NE), amino acid and fatty acid profiles of some CFP sources.

Nutrient Profile of Corn Fermented Protein Co-Products for Beef and Dairy Cattle

Nutritional composition

An *in vitro* digestibility study was conducted to compare the degradability of DM, NDF, and CP of one source of CFP (A+ Pro), a source of hydrolyzed yeast (Ultramax), a HP-DDG source, and two common sources of conventional DDGS (Palowski et al., 2021). The hydrolyzed yeast had comparable DM degradability to the two DDGS sources, which were greater than for the CFP and HP-DDG sources evaluated (**Table 1**). Degradability of NDF of the hydrolyzed yeast and CFP sources was less than in HP-DDG and DDGS sources, and it was actually negative for the hydrolyzed yeast due to fine particle size and loss through filter bags during incubation. Ruminal degradable and undegradable protein was similar among corn co-products. Estimated intestinal degradable protein and total digestible dietary protein was similar among all co-products except for hydrolyzed yeast which was the lowest. Additional nutritional analyses and sample variation has been conducted for CFP (NexPro) to include other carbohydrates, minerals, fatty acids, and amino acids (**Table 2**).

Table 1. Ruminant NDF degradability, in vitro total dry matter degradability, ruminal protein degradation, and intestinal protein degradation of corn co-products (adapted from Palowski et al., 2021)

Measure, %	CFP A+ Pro	Hydrolyzed Yeast Ultramax*	HP-DDG	DDGS Dakota Gold	DDGS Absolute Energy
NDF degradability[1]	24	-8	53	62	79
Degradable NDF	4	-1	24	16	30
Undegradable NDF	14	7	21	10	8
In vitro total DM degradability[2]	86	93	79	90	92
Ruminal undegradable protein	57	52	59	55	56
Estimated intestinal degradable protein	74	52	80	68	77
Ruminal degradable protein[3]	43	48	41	45	44
Intestinally absorbable dietary protein[4]	43	27	47	38	43

Total digestible dietary protein[5]	85	75	88	82	87

[1]Neutral detergent fiber degradability determined after a 48-hour incubation.
[2]In vitro dry matter degradability determined after a 48-hour incubation.
[3]Ruminal degradable protein = 100 – ruminal undegradable protein.
[4]Intestinally absorbable dietary protein = ruminal undegradable protein × estimated intestinal degradable protein.
[5]Total digestible dietary protein = ruminal degradable protein + intestinally absorbable dietary protein.
*Negative degradability values were likely due to small particle size of this co-product which resulted in loss of product through the filter bags during incubation.

Table 2. Nutrient composition and variability of a source of corn fermented protein (NexPro) from 10 samples obtained from the same production facility (Fairmont, NE; adapted from unpublished data from the University of Nebraska provided with permission from POET)

Measure, % of dry matter	**Mean ± Standard Deviation**
Dry matter	92.1 ± 2.57
Crude protein	53.6 ± 1.13
Soluble protein	4.52 ± 0.82
Neutral detergent-insoluble crude protein	5.00 ± 2.22
Acid detergent-insoluble crude protein	3.73 ± 1.46
aNDF (determined using α-amylase and sodium sulfite)	31.2 ± 3.53
Acid detergent fiber	19.2 ± 2.43
Lignin	1.96 ± 0.76
Sugar	1.25 ± 0.39
Starch	1.47 ± 0.28
Ether extract	5.81 ± 0.46
Minerals	
Ash, %	3.47 ± 0.37
Ca, %	0.03 ± 0.01
P, %	0.72 ± 0.16
Mg, %	0.22 ± 0.08
K, %	0.52 ± 0.26
S, %	0.71 ± 0.10
Na, %	0.12 ± 0.03
Cl, %	0.08 ± 0.01
Fe, mg/kg	120 ± 12.9
Mn, mg/kg	16.7 ± 7.51
Zn, mg/kg	116 ± 67.8
Cu, mg/kg	3.80 ± 0.98
Fatty acids, % of dry matter	
Total fatty acids	7.17 ± 0.50
C14:0	0.01 ± 0.005
C16:0	1.24 ± 0.09
C16:1	0.01 ± 0.003
C17:0	0.01 ± 0.003
C18:0	0.17 ± 0.01
C18:1ω9	1.63 ± 0.16

C18:2ω6	3.87 ± 0.30
C18:3ω3	0.15 ± 0.01
C20:0	0.02 ± 0.005
C20:1ω9	0.02 ± 0.005
C22:0	0.01 ± <0.001
C24:0	0.02 ± 0.005
C24:1	0.01 ± 0.007
Amino acids, % dry matter	
Arg	2.29 ± 0.13
His	1.39 ± 0.08
Ile	1.83 ± 0.17
Leu	6.53 ± 0.34
Lys	1.99 ± 0.13
Met	1.34 ± 0.09
Phe	2.81 ± 0.13
Thr	2.26 ± 0.10
Trp	0.62 ± 0.03
Val	3.51 ± 0.24
Total indispensable amino acids	12.7 ± 0.56
Ala	3.86 ± 0.16
Asp	3.96 ± 0.15
Cys	1.23 ± 0.07
Glu	9.37 ± 0.43
Gly	2.11 ± 0.09
Pro	4.89 ± 0.29
Ser	3.00 ± 0.13
Tyr	2.33 ± 0.10
Total dispensable amino acids	30.8 ± 1.26
Total amino acids	55.3 ± 0.10

Summary of Corn Fermented Protein Feeding Trials with Lactating Dairy Cows

Lactating Jersey cows were fed diets containing corn silage (40%), alfalfa hay (18.1%), ground corn (14.3%), soybean meal (2.66%), soybean hulls (8.61%), fat (3%), urea (0.64%), vitamins and minerals, with increasing inclusion rates (0, 2.64, 5.36, and 8.0%) of CFP (NexPro) to replace non-enzymatically browned soybean meal. This resulted in a slight decrease in CP content (16.14 to 16.06%) and an increase in total fatty acid concentration of the diets because CFP had a higher lipid content than nonenzymatically browned soybean meal. There were no differences in oxygen consumption, or carbon dioxide and methane production with increasing dietary levels of CFP (**Table 3**). However, there was a quadratic effect on respiratory quotient, which is the volume of carbon dioxide released over the volume of oxygen absorbed during respiration, as dietary CFP levels increased. There was also a quadratic trend for DM intake, and a linear trend for increased milk yield as diet inclusion rates of CFP increased (**Table 4**). In addition, there were significant linear increases in energy corrected milk (ECM) production, ECM per dry matter intake, milk fat concentration and yield, and milk lactose concentration and yield as diet inclusion levels of CFP increased (**Table 4**). However, although no differences were observed for milk protein concentration, and milk urea nitrogen, there was a linear trend for increased milk protein yield as cows consumed greater amounts of CFP. These results indicate that feeding up to 8.0% CFP of diet dry matter to lactating dairy cows results in improvements in milk production, composition, and energy utilization efficiency.

Table 3. Oxygen consumption, carbon dioxide and methane production, respiratory quotient, and energy utilization of lactating Jersey cows fed increasing amounts of CFP (NexPro; adapted from unpublished data from the University of Nebraska provided with permission from POET)

Measure	0% CFP	2.64% CFP	5.36% CFP	8% CFP
Gases, L/d				
O_2 consumption	4,892	4,674	4,779	4,770
CO_2 production	4,995	4,861	4,984	4,869
CH_4 production	436	403	413	402
Respiratory quotient[b]	1.02	1.04	1.04	1.02
Energy, Mcal/kg DM				
GE[a]	4.25	4.26	4.28	4.31
DE	2.81	2.84	2.83	2.83
ME	2.48	2.54	2.54	2.53
NE_L	1.60	1.72	1.76	1.72
Energy efficiencies				
ME:DE	0.88	0.90	0.90	0.89
NE_L:ME[a]	0.65	0.68	0.69	0.68

[a] Linear effect ($P < 0.05$) of dietary CFP inclusion rate.

[b] Quadratic effect ($P < 0.05$) of dietary CFP inclusion rate.

Table 4. Dry matter intake, milk production and composition, water intake, and body condition scores pf lactating Jersey cows fed increasing amounts of CFP (NexPro; adapted from unpublished data from the University of Nebraska provided with permission from POET)

Measure	0% CFP	2.64% CFP	5.36% CFP	8% CFP
Dry matter intake[d], kg/d	19.2	19.9	20.7	19.9
Milk yield[b], kg/d	27.8	28.6	29.8	29.0
Energy corrected milk[1,a], kg/d	34.3	35.7	37.3	37.4
Energy corrected milk/dry matter intake[a]	1.80	1.81	1.81	1.89
Milk protein, %	3.35	3.43	3.40	3.40
Milk protein[b], kg/d	0.93	0.98	1.01	0.99
Milk fat[a], %	5.05	5.18	5.15	5.47
Milk fat[a], kg/d	1.40	1.46	1.53	1.58
Lactose[a], %	4.86	4.89	4.90	4.93
Lactose[a], kg/d	1.35	1.40	1.46	1.43
Milk urea nitrogen, mg/dL	12.9	13.0	12.8	13.5

Free water intake[b,d], L/d	79.0	90.6	84.7	80.9
Body weight, kg	436	440	440	439
Body condition score	3.05	3.04	3.16	3.04

[1]Energy corrected milk = 0.327 × milk yield (kg) + 12.95 × fat (kg) + 7.20 × true protein (kg).
[a] Linear effect ($P < 0.05$) of dietary CFP inclusion rate.
[b] Linear trend ($P < 0.1$) of dietary CFP inclusion rate.
[c] Quadratic effect ($P < 0.05$) of dietary CFP inclusion rate.
[d] Quadratic trend ($P < 0.1$) of dietary CFP inclusion rate.

Summary of Corn Fermented Protein Feeding Trials with Growing Beef Cattle

Wiseman et al. (2020) conducted a growth performance study using 250 kg crossbred steers to compare the effects of supplementing CFP (NexPro), SoyPass (non-enzymatically browned soybean meal), and soybean meal at increasing dietary levels (0, 4.5, 9, 13.5, and 18%) as protein supplements in corn silage-based diets. Compared with feeding the control diet, steers fed 18% SoyPass, CFP, and soybean meal had 56, 42, and 32% improvement in ADG, respectively, and 33, 26, and 23% improvement in feed:gain, respectively. These results indicate that growth performance was improved by supplementing CFP, SoyPass, and soybean meal in corn silage-based diets for growth feedlot steers, and the greater improvements were observed when feeding CFP and SoyPass compared with soybean meal which suggests that CFP and SoyPass have similar but greater ruminal undegradable protein content than soybean meal.

Conclusions

Corn fermented protein is an excellent rumen undegradable protein and energy source for lactating dairy cows, where feeding up to 8.0% CFP of diet dry matter can improve milk production, milk composition, and energy utilization efficiency. In growing beef cattle diets, growth performance can be improved by supplementing CFP, SoyPass, and soybean meal in corn silage-based diets for growth feedlot steers, with greater improvements achieved by feeding CFP and SoyPass compared with soybean meal, which suggests that these ingredients have similar but greater ruminal undegradable protein content than soybean meal.

References

Kononoff, P.J. Feed characterization and studying the effects of a novel corn milling co-product (NexPro) on milk production, composition and nitrogen and energy utilization in lactating dairy cows. Unpublished study with permission for use granted by POET.

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