Bar Diamond, Inc.™

In-Situ Digestion Models

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BDF* or NDF Fraction and Residue Analysis

Feedstuff

2mm ground feed sample, weight, nitrogen, fat, NDF, BDF & ash

Laboratory Only

200 Mesh Filter Fraction

Hot Water Soluble (S)	Hot Water Insoluble (IS) = D + U

50µ Pore Dacron Bag Fractions washing machine water rinsed

Water Rinse (A) = S + Dl +Ul	Water Retained (B) = Dp + Up

Laboratory and Rumen Digestion

50µ Pore Dacron Bag Fractions NDF or BDF digestion in bag

Rinse = S + Dl + Dp + Ul + Up	Retained = Dp + Up

2mm ground feed sample, weight, nitrogen & ash

*** BDF (Bar Diamond Fiber) Rohwer, Unpublished 2013**

BarData™ *In-situ* Model Feedstuff Fraction Assumptions

- The hot water soluble fraction (S) is the material passing through 200 mesh filter. It is assumed to be soluble and immediately degradable upon entry into the rumen. Rate of degradation of S (Kd) is 1.0.
- The material retained on 200 mesh filter is the insoluble fraction (IS) is the material that is removed from the rumen at either the liquid passage rate (Kl) and the particle passage rate (Kp) depending on particle size. IS less than ~50µ moves with liquid phase and IS greater than moves with the particle phase.
- IS fraction comprises degradable insoluble material (D) as well are un-degradable material (U).
- D fraction degrades over time in the rumen at a rate (Kd) determined from the residues retained in 50µ pore bags following rumen incubation over time. The residue containing bags are digested with NDF or BDF* solution to remove microbial contamination from the fibrous feed residues.
- All of S and a portion of both D and U will "wash out" with a water rinse from a 50µ pore rumen incubation bag and is the (A) fraction. The "retained" in the bag following a water rinse is the (B) fraction and is composed of D and U particles greater than 50µ.
- D and U in A is removed from the rumen at the liquid passage rate (Kl). D removed at the Kl rate is D liquid (Dl) fraction. U removed at the Kl rate is U liquid (Ul) fraction.
- D and U in B is removed from the rumen at the particle passage rate (Kp). D removed at the Kp rate is D particle (Dp) fraction. U removed at the Kp rate is U particle (Up) fraction.
- The ratio of Ul:Dl and Up:Dp are assumed to be the same as U:D
- Up is the amount of NDF or BDF* digested residue predicted as the exponent of the intercept of the regression of the log B (DpUp) vs hours in the rumen.

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Determination of Un-degraded particle fraction (Up)

50µ pore Dacron bags containing residues following 0, 8, 24, 48 and 96 hour rumen incubations are water rinsed in a washing machine and subjected to BDF* or NDF digestions to remove non-fiber materials including microbial contamination. Four separate rumen incubations are done for each time point.

The log of the residues post BDF* or NDF digestions vs time point are regressed through the intercept. The exponent of the intercept is interpreted as the un-degraded particle (Up) for the individual feedstuff tested. The effect of the individual rumen incubation run is not considered in the determination of Up.

The Up for dry matter, organic matter, fiber and nitrogen are determined.

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Determination of Degradation Rate (Kd) of the potentially degradable particle fraction (Dp)

The bag residue weights used in the determination of the Up are corrected by removing the Up yielding the Dp of the residue or the amount of potentially degraded particle remaining in the bag.

The log of the adjusted residues vs time point are regressed through the origin (zero intercept). The Kd or rate of degradation of the Dp is the slope of this regression. Kd for dry matter, organic matter, fiber and nitrogen are determined for each feedstuff by individual rumen incubation.

BarData™ *In-situ* Model Rate of Passage Assumptions

Kp = particle fraction passage rate, Kl = liquid fraction passage rate

- Seo, et al. J. Dairy Sci. 89:2327-2342 (2006) tested the NRC 2001 particle passage rate equations from the *Nutrient Requirements of Dairy Cattle* concluded the empirical Kp equations were suitable for prediction passage rate in lactating dairy cows.
- The empirical Kp equations Dairy Requirements NRC 2001 for concentrate, dry forage and wet forage were converted to reflect dry matter intake per unit of body weight (DMI), concentrate per unit of dry matter CONC) and in the case of dry forage, neutral detergent fiber per unit of dry matter (NDF) as input variables (Llewellyn and Rohwer, 2013, unpublished data).

    - **Kp concentrate = 0.03205 + (1.325 * DMI) – (0.023 * CONC)**
    - **Kp wet forage = 0.02948 + (0.655 * DMI)**
    - **Kp dry forage = 0.04542 + (0.485 * DMI) – (0.006 * CONC) - (0.006 * NDF)**

- An empirical Kp equation for mixed rations utilizing the Conc% and the calculated Kp from the dry forage equation and the calculated Kp from the concentrate equation was developed (Llewellyn and Rohwer, 2013, unpublished data).

    - **Kp mixed ration = ((1-CONC) * Kp as dry forage) + (CONC * Kp as concentrate)**

- The Kl empirical equation for liquid fraction passage rate from CNCPS version 5.0, 2003, Cornell University was converted to reflect dry matter intake per unit of body weight (DMI) (Llewellyn and Rohwer, 2013, unpublished data).

    - **Kl liquid fraction = 0.04413 + (191 * DMI)**

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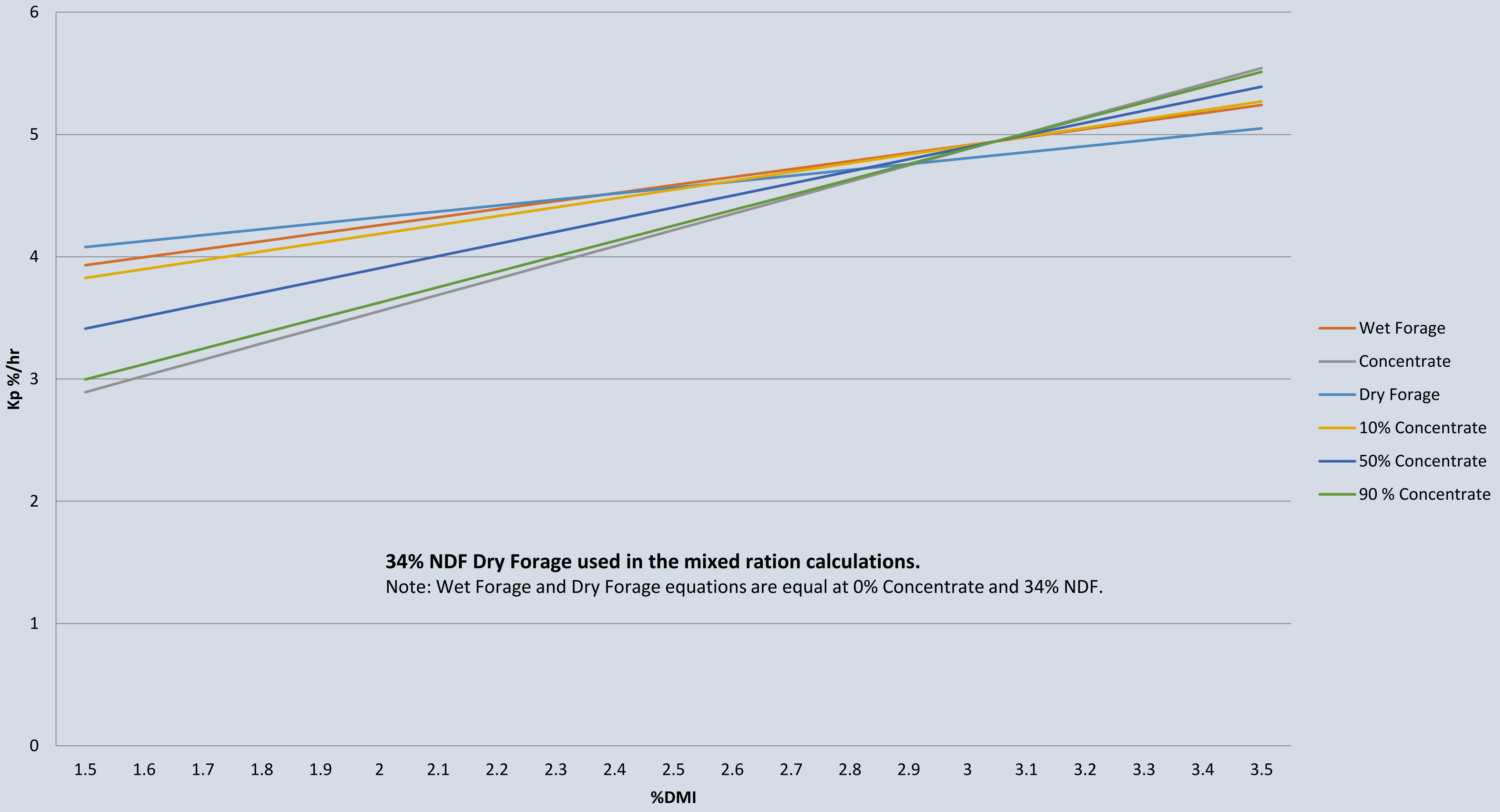
BarData™ *In-situ* Model Kp particle fraction passage rates

(Llewellyn and Rohwer, 2013, unpublished data)



BarData™ *In-situ* Extent of Digestion Models

Models using both liquid and particle fraction passage rates (Kl & Kp)

S+Dl+Dp	=	**S + { Dl * [Kd / (Kl +Kd)] } + {Dp * [Kd / (Kd +Kp)] }**	*Eq. 9 Dhanoa et al., J Animal Sci. 1999 77:3385-3391*	**Preferred**
S+adjDl+Dp	=	**S + { Dl * [Kd / ((0.5*Kl) + (0.5*Kp) +Kd)] } + {Dp * [Kd / (Kd +Kp)] }**	*Eq. 10 Dhanoa et al., J Animal Sci. 1999 77:3385-3391*	**Good**

Models using particle fraction passage rates (Kp) only

Ave S&D	=	**(Pooled S&D + Split S&D) / 2**	*Llewellyn and Rohwer, 2013, unpublished data*	**Good**
Pooled S&D	=	**(S + D) * [Kd / (Kd +Kp)]**	*Eq. 11 Dhanoa et al., J Animal Sci. 1999 77:3385-3391*	**Ok**
Split S&D	=	**S + { D * [Kd / (Kd +Kp)] }**	*Llewellyn and Rohwer, 2013, unpublished data*	**Ok**
Pooled A&B	=	**(A + BpCp – Cp) * [Kd / (Kd +Kp)]**	*Eq. 2 Dhanoa et al., J Animal Sci. 1999 77:3385-3391*	**Poor**
Split A&B	=	**A + { (BpCp – Cp) * [Kd / (Kd +Kp)] }**	*Eq. 4 Dhanoa et al., J Animal Sci. 1999 77:3385-3391*	**Poor**
Ave A&B	=	**(Pooled A&B + Split A&B) / 2**	*Llewellyn and Rohwer, 2013, unpublished data*	**Poor**