== Errata ==

THE RUMINANT NUTRITION SYSTEM

VOLUME II — TABLES OF EQUATIONS AND CODING

First Edition

March 25, 2024

Fixed Equations 1, 2, and 3 in the Table 4.2.9 Ruminal volatile fatty acids: calcVFA()

Fixed Footnote in the Table 4.2.9 Ruminal volatile fatty acids: calcVFA()

Fixed Equations 33, 34, and 35 in the Table 4.2.17 Total digestible nutrients, and gross, digestible, and metabolizable energies: calcTDN()

4.2.9 Ruminal volatile fatty acids: calcVFA()

#	Variable[(1)]	Description[(2)]	Equation
1:	*fracA4*	VFA	$\frac{NFCBactA4_f}{NFCBactA1_f + NFCBactA2_f + NFCBactA3_f + NFCBactA4_f + NFCBactB1_f + NFCBactB2_f}$
2:	*fracB1*	VFA	$\frac{NFCBactB1_f}{NFCBactA1_f + NFCBactA2_f + NFCBactA3_f + NFCBactA4_f + NFCBactB1_f + NFCBactB2_f}$
3:	*fracB2*	VFA	$\frac{NFCBactB2_f}{NFCBactA1_f + NFCBactA2_f + NFCBactA3_f + NFCBactA4_f + NFCBactB1_f + NFCBactB2_f}$
4:	$AcidA4_f$	VFA	$Max[0, (1-0.344) * RDCA4_f - (1-0.044) * NFCBactA4_f + (AmmoniaN_{NFC,f} + 6.25 * AminoN_{NFC,f}) * fracA4]$
5:	$AcidB1_f$	VFA	$Max[0, (1-0.344) * RDCB1_f - (1-0.044) * NFCBactB1_f + (AmmoniaN_{NFC,f} + 6.25 * AminoN_{NFC,f}) * fracB1]$
6:	$AcidB2_f$	VFA	$Max[0, (1-0.344) * RDCB2_f - (1-0.044) * NFCBactB2_f + (AmmoniaN_{NFC,f} + 6.25 * AminoN_{NFC,f}) * fracB2]$
7:	$AcidB3_f$	VFA	$Max[0, (1-0.54) * RDCB3_f - (1-0.044) * FCBactB3_f + AmmoniaN_{FC,f}]$
8:	$f_{Lactate}^{A4}$	VFA	$Max[0, 2.4444 - 0.3075 * pH]$
9:	$f_{Lactate}^{B1}$	VFA	$Max[0, 3.2989 - 0.4744 * pH]$
10:	$f_{Lactate}^{B2}$	VFA	0
11:	$f_{Lactate}^{B3}$	VFA	$Max[0, 2.4278 - 0.3532 * pH]$
12:	$f_{Butyrate}^{A4}$	VFA	$Max[0, 0.5733 - 0.0585 * pH]$
13:	$f_{Butyrate}^{B1}$	VFA	$Max[0, 0.7359 - 0.0921 * pH]$
14:	$f_{Butyrate}^{B2}$	VFA	$Max[0, 0.3621 - 0.0504 * pH]$
15:	$f_{Butyrate}^{B3}$	VFA	$Max[0, 5015 - 0.0631 * pH]$
16:	$f_{A:P}^{A4}$	VFA	$Max[0, -1.3209 + 0.468 * pH]$
17:	$f_{A:P}^{B1}$	VFA	$Max[0, 5.6265 - 0.627 * pH]$
18:	$f_{A:P}^{B2}$	VFA	$Max[0, 2.5186 + 0.5643 * pH]$
19:	$f_{A:P}^{B3}$	VFA	$Max[0, -0.2662 + 0.3267 * pH]$
20:	$Lact_f^{A4}$	VFA	$f_{Lactate}^{A4} * AcidA4_f$
21:	$Lact_f^{B1}$	VFA	$f_{Lactate}^{B1} * AcidB1_f$
22:	$Lact_f^{B2}$	VFA	$f_{Lactate}^{B2} * AcidB2_f$
23:	$Lact_f^{B3}$	VFA	$f_{Lactate}^{B3} * AcidB3_f$
24:	But_f^{A4}	VFA	$f_{Butyrate}^{A4} * (AcidA4_f - Lact_f^{A4})$
25:	But_f^{B1}	VFA	$f_{Butyrate}^{B1} * (AcidB1_f - Lact_f^{B1})$
26:	But_f^{B2}	VFA	$f_{Butyrate}^{B2} * (AcidB2_f - Lact_f^{B2})$
27:	But_f^{B3}	VFA	$f_{Butyrate}^{B3} * (AcidB3_f - Lact_f^{B3})$
28:	$Prop_f^{A4}$	VFA	$\frac{(1 - f_{Butyrate}^{A4}) * (AcidA4_f - Lact_f^{A4})}{1 + f_{A:P}^{A4}}$
29:	$Prop_f^{B1}$	VFA	$\frac{(1 - f_{Butyrate}^{B1}) * (AcidB1_f - Lact_f^{B1})}{1 + f_{A:P}^{B1}}$
30:	$Prop_f^{B2}$	VFA	$\frac{(1 - f_{Butyrate}^{B2}) * (AcidB2_f - Lact_f^{B2})}{1 + f_{A:P}^{B2}}$
31:	$Prop_f^{B3}$	VFA	$\frac{(1 - f_{Butyrate}^{B3}) * (AcidB3_f - Lact_f^{B3})}{1 + f_{A:P}^{B3}}$
32:	Ac_f^{A4}	VFA	$f_{A:P}^{A4} * Prop_f^{A4}$
33:	Ac_f^{B1}	VFA	$f_{A:P}^{B1} * Prop_f^{B1}$
34:	Ac_f^{B2}	VFA	$f_{A:P}^{B2} * Prop_f^{B2}$
35:	Ac_f^{B3}	VFA	$f_{A:P}^{B3} * Prop_f^{B3}$
36:	$Ac_{Ru,f}$	VFA	$Ac_f^{A4} + Ac_f^{B1} + Ac_f^{B2} + Ac_f^{B3}$
37:	$Prop_{Ru,f}$	VFA	$Prop_f^{Glycerol} + Prop_f^{A4} + Prop_f^{B1} + Prop_f^{B2} + Prop_f^{B3}$
38:	$But_{Ru,f}$	VFA	$But_f^{A4} + But_f^{B1} + But_f^{B2} + But_f^{B3}$
39:	$Lact_{Ru,f}$	VFA	$Lact_f^{A4} + Lact_f^{B1} + Lact_f^{B2} + Lact_f^{B3}$
40:	$fracP^{A4}$	CH_4	$\frac{\frac{\sum_{j=1}^{nf} Prop_f^{A4}}{74}}{\frac{\sum_{f=1}^{nf} Ac_f^{A4}}{60} + \frac{\sum_{f=1}^{nf} Prop_f^{A4}}{74} + \frac{\sum_{f=1}^{nf} But_f^{A4}}{88}}$

#	Variable[(1)]	Description[(2)]	Equation
41:	$fracP^{B1}$	CH_4	$\frac{\frac{\sum_{j=1}^{nf} Prop_f^{B1}}{74}}{\frac{\sum_{f=1}^{nf} Ac_f^{B1}}{60}+\frac{\sum_{f=1}^{nf} Prop_f^{B1}}{74}+\frac{\sum_{f=1}^{nf} But_f^{B1}}{88}}$
42:	$fracP^{B2}$	CH_4	$\frac{\frac{\sum_{j=1}^{nf} Prop_f^{B2}}{74}}{\frac{\sum_{f=1}^{nf} Ac_f^{B2}}{60}+\frac{\sum_{f=1}^{nf} Prop_f^{B2}}{74}+\frac{\sum_{f=1}^{nf} But_f^{B2}}{88}}$
43:	$fracP^{B3}$	CH_4	$\frac{\frac{\sum_{j=1}^{nf} Prop_f^{B3}}{74}}{\frac{\sum_{f=1}^{nf} Ac_f^{B3}}{60}+\frac{\sum_{f=1}^{nf} Prop_f^{B3}}{74}+\frac{\sum_{f=1}^{nf} But_f^{B3}}{88}}$
44:	$CH4Y^{A4}$	CH_4	$Max\left[0,\left(\frac{1}{2*fracP^{A4}}-\frac{3}{4}\right)*\frac{16}{74}\right]$
45:	$CH4Y^{B1}$	CH_4	$Max\left[0,\left(\frac{1}{2*fracP^{B1}}-\frac{3}{4}\right)*\frac{16}{74}\right]$
46:	$CH4Y^{B2}$	CH_4	$Max\left[0,\left(\frac{1}{2*fracP^{B2}}-\frac{3}{4}\right)*\frac{16}{74}\right]$
47:	$CH4Y^{B3}$	CH_4	$Max\left[0,\left(\frac{1}{2*fracP^{B3}}-\frac{3}{4}\right)*\frac{16}{74}\right]$
48:	$CH4_f^{A4}$	CH_4	$CH4Y^{A4}*Prop_f^{A4}$
49:	$CH4_f^{B1}$	CH_4	$CH4Y^{B1}*Prop_f^{B1}$
50:	$CH4_f^{B2}$	CH_4	$CH4Y^{B2}*Prop_f^{B2}$
51:	$CH4_f^{B3}$	CH_4	$CH4Y^{B3}*Prop_f^{B3}$
52:	$CH4_f$	CH_4	$CH4_f^{A4}+CH4_f^{B1}+CH4_f^{B2}+CH4_f^{B3}$
53:	Yg_{me}	lactate	$If[pH<5.07,0,-1.176+0.232*pH]$
54:	m_{me}	lactate	$-2.779+0.664*pH$
55:	u_{me}	lactate	$If\left[pH<4.18\ or\ pH>7.33,0,If[pH\geq 4.18\ and\ pH\leq 6.07,-3.631+1.255*pH-0.0925*pH^2,-6.906+2.636*pH-0.2311*pH^2]\right]$
56:	Y_{me}	lactate	$\frac{1}{\frac{m_{me}}{u_{me}}+\frac{1}{Yg_{me}}}$
57:	kd^L	lactate	$(u_{me}+m_{me}*Yg_{me})*24*100$
58:	f_{Lu}	lactate	$(1+10^{pH-3.86})^{-1}$
59:	ka^L	lactate	$\left(\frac{Ar}{Vr}\right)*\left(0.00405*f_{Lu}+0.00139*(1-f_{Lu})\right)*100$
60:	$Lact_{Ru+Diet,f}$	lactate	$Lact_{Ru,f}+Lact_{Diet,f}$
61:	RDL_f	lactate	$Lact_{Ru+Diet,f}*\left(\frac{kd^L}{kd^L+24*kp_{Liquid}+ka^L}\right)$
62:	$Bact_{me,f}$	lactate	RDL_F*Y_{me}
63:	$f_{Acetate}^L$	lactate	$If\left[4\leq pH\leq 5.65,1.035-0.154*pH,If[5.65<pH\leq 8,-1.089+0.222*pH,0]\right]$
64:	$f_{Propionate}^L$	lactate	$If\left[4\leq pH\leq 6,1.568-0.206*pH,If[6<pH\leq 8,-1.408+0.29*pH,0]\right]$
65:	$f_{Butyrate}^L$	lactate	$If\left[4.4\leq pH\leq 5.5,-1.181+0.27*pH,If[5.5<pH\leq 7,1.316-0.184*pH,0]\right]$
66:	VFA_f^L	lactate	$RDL_f*\frac{1-0.856*Bact_{me,f}}{1+f_{Acetate}^L*\frac{44}{60}}$
67:	Ac_f^L	lactate	$VFA_f^L*f_{Acetate}^L$
68:	$Prop_f^L$	lactate	$VFA_f^L*f_{Propionate}^L$
69:	But_f^L	lactate	$VFA_f^L*f_{Butyrate}^L$
70:	f_{Au}	[VFA]	$(1+10^{pH-4.76})^{-1}$
71:	f_{Pu}	[VFA]	$(1+10^{pH-4.87})^{-1}$
72:	f_{Bu}	[VFA]	$(1+10^{pH-4.81})^{-1}$
73:	ka^A	[VFA]	$\left(\frac{Ar}{Vr}\right)*\left(0.48*f_{Au}+0.12*(1-f_{Au})\right)*100$
74:	ka^P	[VFA]	$\left(\frac{Ar}{Vr}\right)*\left(0.67*f_{Pu}+0.21*(1-f_{Bu})\right)*100$
75:	Ka^B	[VFA]	$\left(\frac{Ar}{Vr}\right)*\left(1.43*f_{Bu}+0.15*(1-f_{Bu})\right)*100$
76:	$Ac_{Ru+Diet,f}$	[VFA]	$Ac_{Ru,f}+Ac_f^L+Ac_{Diet,f}$

#	Variable[(1)]	Description[(2)]	Equation
77:	$Prop_{Ru+Diet,f}$	[VFA]	$Prop_{Ru,f} + Prop_f^L + Prop_{Diet,f}$
78:	$But_{Ru+Diet,f}$	[VFA]	$But_{Ru,f} + But_f^L + But_{Diet,f}$
79:	*[Lact]*	[VFA]	$\frac{\sum_{f=1}^{nf} Lact_{Ru+Diet,f} * 1000}{\left(0.01 * kd^L + 0.01 * 24 * kp_{Liquid} + 0.01 * ka^L\right) * Vr * 90}$
80:	*[Ac]*	[VFA]	$\frac{\sum_{f=1}^{nf} Ac_{Ru+Diet,f} * 1000}{\left(0.01 * 24 * kp_{Liquid} + 0.01 * ka^A\right) * Vr * 60}$
81:	*[Prop]*	[VFA]	$\frac{\sum_{f=1}^{nf} Prop_{Ru+Diet,f} * 1000}{\left(0.01 * 24 * kp_{Liquid} + 0.01 * ka^P\right) * Vr * 74}$
82:	*[But}*	[VFA]	$\frac{\sum_{f=1}^{nf} But_{Ru+Diet,f} * 1000}{\left(0.01 * 24 * kp_{Liquid} + 0.01 * ka^B\right) * Vr * 88}$
83:	*Ds*	buffering	$Max[100, -177.2 + 0.01638 * (0.001 * DMI) + 4.766 * peNDF]$
84:	*EatSa*	buffering	$3.2 * DMI$
85:	*RumSa*	buffering	$255 * (0.005085 * NDF + 0.174)$
86:	*RestSa*	buffering	$6 * DMI * \left(1 - (0.005085 * NDF + 0.174)\right)$
86:	*Saliva*	buffering	$Max[Ds, EatSa + RumSa + RestSa]$
87:	*[Saliva]*	buffering	$\frac{Saliva}{1000 * Vr * 0.01 * 24 * kp_{Liquid}}$
88:	$Saliva_{BC}$	buffering	$-33.3 + \frac{165.8}{1 + 10^{pH-6.4}}$
89:	*[NDF]*	buffering	$\frac{\sum_{f=1}^{nf}\left(\frac{1000 * RDCB3_f}{24 * 0.01 * kp_{Forage}}\right)}{1000 * Vr}$
90:	NDF_{pHc}	buffering	$2.388 + 0.00078 * CECNDF$
91:	NDF_{BC}	buffering	$-0.004 + 0.3 * e^{-(pH-NDF_{pHc})}$
92:	Ru_{BC}	buffering	$[Saliva] * Saliva_{BC} + [NDF] * NDF_{BC}$
93:	$Ru_{Acidity}$	buffering	$[Ac] * (1 - f_{Au}) + [Prop] * (1 - f_{Pu}) + [But] * (1 - f_{Bu}) + [Lact] * (1 - f_{Lu})$
94:	*pH*	buffering	$7.2 - 0.01 * ([Ac] + [Prop] + [But]) + 0.0015 * [Lact]$

(1) ***[Ac]*** is the concentration of acetate in the rumen, mM (mol/m^3); ***[But]*** is the concentration of butyrate in the rumen, mM (mol/m^3); ***[Lact]*** is the concentration of lactate in the rumen, mM (mol/m^3); ***[NDF]*** is the NDF concentration, g/L; ***[Prop]*** is the concentration of propionate in the rumen, mM (mol/m^3); ***[Saliva]*** is saliva concentration, L/L; $\boldsymbol{Ac^{A4,B1,B2,B3}}$ is the amount of acetate produced from the fermentation of each carbohydrate substrate (A4, B1, B2, and B3), g/d; ***AcidA4*** is the volatile fatty acids and lactic acids produced from carbohydrate A4 (sugars), g/d; ***AcidB1*** is the volatile fatty acids and lactic acids produced from carbohydrate B1 (starch), g/d; ***AcidB2*** is the volatile fatty acids and lactic acids produced from carbohydrate B2 (pectin), g/d; ***AcidB3*** is the volatile fatty acids and lactic acids produced from carbohydrate B3 (available neutral detergent fiber) g/d; $\boldsymbol{Ac^L}$ is the acetate produced from the ruminal fermentation of lactate, g/d; $\boldsymbol{Ac_{Ru}}$ is the amount of acetate produced from the fermentation of carbohydrates, g/d; $\boldsymbol{Ac_{Ru+Diet}}$ is the amount of acetate produced from the fermentation of carbohydrates plus acetate from the diet, g/d; $\boldsymbol{AminoN_{NFC}}$ is the amino-N uptake by the nonfiber carbohydrate degrading bacteria, g/d; $\boldsymbol{AmmoniaN_{FC}}$ is the ammonia-N uptake by the fiber carbohydrate degrading bacteria, g/d; $\boldsymbol{AmmoniaN_{NFC}}$ is the ammonia-N uptake by the nonfiber carbohydrate degrading bacteria, g/d; ***Ar*** is rumen surface area, m^2; $\boldsymbol{Bact_{me}}$ is the *Megasphaera elsdenii* growth rate from ruminally degraded lactate, g/d; $\boldsymbol{But^{A4,B1,B2,B3}}$ is the amount of butyrate produced from the fermentation of each carbohydrate substrate (A4, B1, B2, and B3), g/d; $\boldsymbol{But^L}$ is the butyrate produced from the ruminal fermentation of lactate, g/d; $\boldsymbol{But_{Ru}}$ is the amount of butyrate produced from the fermentation of carbohydrates, g/d; $\boldsymbol{But_{Ru+Diet}}$ is the amount of butyrate produced from the fermentation of carbohydrates plus butyrate from the diet, g/d; ***CECNDF*** is the cation exchange capacity of cell wall (i.e., NDF) (default is 500), mmol/kg NDF; ***CH4*** is the total methane production from the fermentation of carbohydrates, g/d; $\boldsymbol{CH4^{A4,B1,B2,B3}}$ is the methane production for each carbohydrate substrate (A4, B1, B2, B3), g/d; $\boldsymbol{CH4Y^{A4,B1,B2,B3}}$ is the methane yield for each carbohydrate substrate (A4, B1, B2, B3), g/g; ***DMI*** is dry matter intake, kg/d; *Ds* is empirical saliva production, L/d; ***EatSa*** is eating saliva production, L/d; ***f*** is the fth feed in the diet; $\boldsymbol{f^L_{Acetate,Propionate,Butyrate}}$ is the mass fraction of ruminally degraded lactate yielding acetate, propionate, and butyrate, g/g; $\boldsymbol{f^{A4,B1,B2,B3}_{Lactate,Butyrate,A:P}}$ is the mass fraction of carbohydrate substrates (A4, B1, B2, and B3) yielding lactate, butyrate, or acetate-to-propionate ratio (A:P), g/g; $\boldsymbol{f_{Au}}$ is the fraction of undissociated form of acetic acid; $\boldsymbol{f_{Bu}}$ is the fraction of undissociated form of butyric acid; $\boldsymbol{f_{Lu}}$ is the fraction of undissociated form of lactic acid; $\boldsymbol{f_{Pu}}$ is the fraction of undissociated form of propionic acid; ***fracA4*** is the proportion of nonfiber carbohydrate A4 (sugar)-degrading bacteria, g/g; ***fracB1*** is the proportion of nonfiber carbohydrate B1 (starch)-degrading bacteria, g/g; ***fracB2*** is the proportion of nonfiber carbohydrate B2 (pectin)-degrading bacteria, g/g; $\boldsymbol{fracP^{A4,B1,B2,B3}}$ is the molar proportion of propionate to volatile fatty acids (i.e., acetate, propionate, and butyrate) for each carbohydrate substrate (A4, B1, B2, B3), g/g; $\boldsymbol{ka^A}$ is the fractional absorption rate of acetate, %/d; $\boldsymbol{ka^B}$ is the fractional absorption rate of butyrate, %/d; $\boldsymbol{ka^L}$ is the fractional absorption rate of lactate, %/d; $\boldsymbol{ka^P}$ is the fractional absorption rate of propionate, %/d; $\boldsymbol{kd^L}$ is fractional degradation rate of lactate, %/d; $\boldsymbol{Lact^{A4,B1,B2,B3}}$ is the amount of lactate produced from the fermentation of each carbohydrate substrate (A4, B1, B2, and B3), g/d; $\boldsymbol{Lact_{Ru}}$ is the amount of lactate produced from the ruminal fermentation of carbohydrates, g/d; $\boldsymbol{Lact_{Ru+Diet}}$ is the amount of lactate produced from the ruminal fermentation of carbohydrates plus lactate from the diet, g/d; ***NDF*** is the concentration of neutral detergent fiber, %DM; $\boldsymbol{NDF_{BC}}$ is the buffering capacity of the cell wall (i.e., NDF), mEq/g NDF; $\boldsymbol{NDF_{pHc}}$ is the reference ruminal

pH, mmol/kg NDF; ***nf*** is number of feeds; ***NFCBactA1*** is nonfiber carbohydrate A1 (volatile fatty acids)-degrading bacteria, g/d; ***NFCBactA2*** is nonfiber carbohydrate A2 (lactate)-degrading bacteria, g/d; ***NFCBactA3*** is nonfiber carbohydrate A3 (other organic acids)-degrading bacteria, g/d; ***NFCBactA4*** is nonfiber carbohydrate A4 (sugars)-degrading bacteria, g/d; ***NFCBactB1*** is nonfiber carbohydrate B1 (starch)-degrading bacteria, g/d; ***NFCBactB2*** is nonfiber carbohydrate B2 (pectin)-degrading bacteria, g/d; ***peNDF*** is the concentration of physically effective neutral detergent fiber, % DM; ***pH*** is ruminal pH; $Prop^{A4,B1,B2,B3}$ is the amount of propionate produced from the fermentation of each carbohydrate substrate (A4, B1, B2, and B3), g/d; $Prop^{Glyc}$ is the propionate produced from the ruminal fermentation of lypolized glycerol, g/d; $Prop^{L}$ is the propionate produced from the ruminal fermentation of lactate, g/d; $Prop_{Ru}$ is the amount of propionate produced from the fermentation of glycerol and carbohydrates, g/d; $Prop_{Ru+Diet}$ is the amount of propionate produced from the fermentation of glycerol and carbohydrates plus propionate from the diet, g/d; **RDCA4** is ruminally degraded carbohydrate A4 (sugars), g/d; **RDCB1** is ruminally degraded carbohydrate B1 (starch), g/d; **RDCB2** is ruminally degraded carbohydrate B2 (pectin), g/d; **RDCB3** is ruminally degraded carbohydrate B3 (available neutral detergent fiber), g/d; ***RDL*** is ruminally degraded lactate, g/d; ***RestSa*** is resting saliva production, L/d; $Ru_{Acidity}$ is the total acidity in the rumen, mEq/L; ***RumSa*** is rumination saliva production, L/d; ***Saliva*** is saliva production, L/d $Saliva_{BC}$ is the buffering capacity of the saliva, mEq/L; VFA^{L} is the volatile fatty acids produced from the ruminal fermentation of lactate, g/d; and ***Vr*** is rumen volume, m^3.

[2] Equations 1 to 39 have the calculations for volatile fatty acids, Equations 40 to 52 have the calculations for methane, Equations 53 to 57 have the calculation for *Megasphaera elsdenii* converting lactate to volatile fatty acids. Figure 4.4 depicts the impact of ruminal pH on maintenance coefficient, maximum yield, fractional growth rate, and yield of three groups of bacteria.

In Figure 4.4, the physically effective neutral detergent fiber (peNDF) that is correlated to the ruminal pH is shown in the X-axis. The ruminal pH is not altered by peNDF when it is above 24.5 %DM. Additionally,

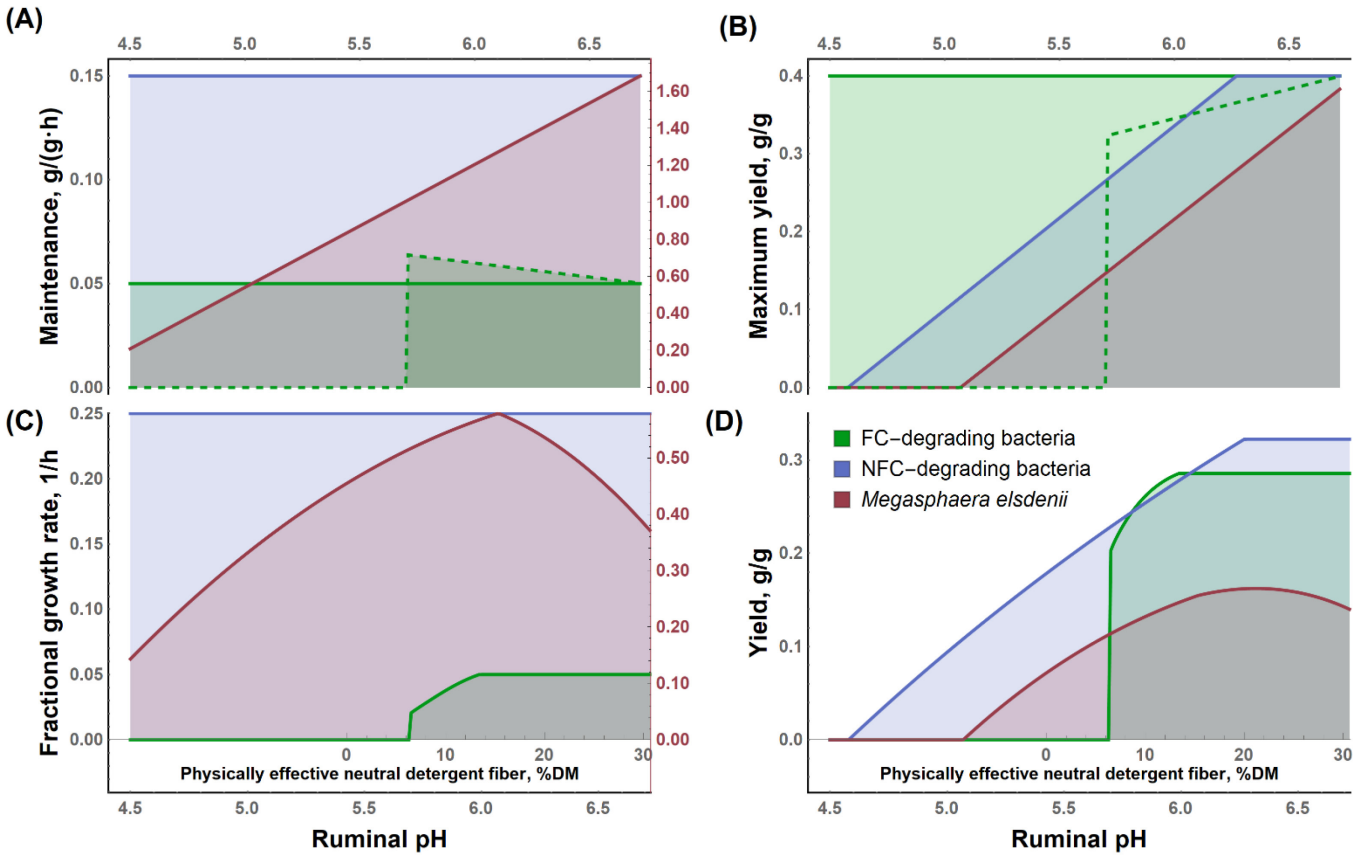

Figure 4.4. Bacteria growth submodels for fiber- and nonfiber-carbohydrate-degrading bacteria (green and blue, respectively) and *Megasphaera elsdenii* (red) showing the impact of ruminal pH on their (A) maintenance coefficient, (B) maximum yield, (C) fractional growth rate, and (D) effective yield. For panels A and C, *Megasphaera elsdenii*'s maintenance coefficient and fractional growth rate are shown in the second Y-axis. The fractional growth rate for fiber- and nonfiber-carbohydrate-degrading bacteria was assumed 5 and 25 %/h, respectively. The dashed lines represent potential impact of ruminal pH on specific coefficients (see text for additional information).

#	Variable[1]	Description[2]	Equation
23:	$[ME]_f$	lactating or dry dairy	$If\left[[EE]_f < 3, 1.01 * \frac{DE_f}{DMI_f} - 0.45, 1.01 * \frac{DE_f}{DMI_f} - 0.45 + 0.0046 * \left([EE]_f - 3\right)\right] * If[\text{Ionophore=True \& Adjust ME=True, 1.023,1}]$
24:		otherwise	$0.82 * \frac{DE_f}{DMI_f} * If[\text{Ionophore=True \& Adjust ME=True, 1.023,1}]$
25:	ME_f		$DMI_f * [ME]_f$
26:	$[NEm]_f$	lactating dairy	$0.644 * [ME]_f$
27:		otherwise	$\left(1.37 * [ME]_f - 0.138 * [ME]_f^2 + 0.0105 * [ME]_f^3 - 1.12\right) * If[\text{Ionophore=True \& Adjust ME=False, 1.12,1}]$
28:	$[NEg]_f$		$1.42 * [ME]_f - 0.174 * [ME]_f^2 + 0.0122 * [ME]_f^3 - 1.65$
29:	$[NEl]_f$		$0.644 * [ME]_f$
30:	NEm_f		$DMI_f * [NEm]_f$
31:	NEg_f		$DMI_f * [NEg]_f$
32:	NEl_f		$DMI_f * [NEl]_f$
33:	k_m		$\frac{\sum_{f=1}^{nf} NEm_f}{\sum_{f=1}^{nf} ME_f}$
34:	k_g		$\frac{\sum_{f=1}^{nf} NEg_f}{\sum_{f=1}^{nf} ME_f}$
35:	k_l		$\frac{\sum_{f=1}^{nf} NEl_f}{\sum_{f=1}^{nf} ME_f}$

[1] ***[ME]*** is the dietary content of metabolizable energy, Mcal/kg; ***[NEg]*** is the dietary content of net energy for growth (also called ***NEga***), Mcal/kg; ***[NEl]*** is the dietary content of net energy for lactation (also called ***NEla***), Mcal/kg; ***[NEm]*** is the dietary content of net energy for maintenance (also called ***NEma***), Mcal/kg; ***aTDCHO*** is the apparent total digestible carbohydrate, g/d; ***aTDEE*** is the apparent total digestible ether extract, g/d; ***aTDN*** is apparent total digestible nutrients, g/d; ***aTDProt*** is the apparent total digestible protein, g/d; ***DECHO*** is the digestible energy from carbohydrates, Mcal/d; ***DEEE*** is the digestible energy from ether extract, Mcal/d; ***DEProt*** is the digestible energy from proteins, Mcal/d; ***f*** is the jth feed; ***GE*** is the gross energy, Mcal/d; k_g is the partial efficiency of utilization of metabolizable energy for net energy for growth, dimensionless; k_l is the partial efficiency of utilization of metabolizable energy for net energy for lactation, dimensionless; k_m is the partial efficiency of utilization of metabolizable energy for net energy for maintenance, dimensionless; ***ME*** is the metabolizable energy, Mcal/d; ***tTDCHO*** is the true total digestible carbohydrate, g/d; ***tTDEE*** is the true total digestible ether extract, g/d; ***tTDN*** is true total digestible nutrients, g/d; and ***tTDProt*** is the true total digestible protein, g/d.

4.2.15 Metabolizable protein: calcMP()

#	Variable[1]	Description	Equation
1:	$MP_{Bact,f}$		$GBProt_f - GBNA_f$
2:	$MP_{Feed,f}$		$GProt_f$
3:	MP_f		$MP_{Bact,f} + MP_{Feed,f}$

[1] ***f*** is the fth feed; ***MP*** is the metabolizable protein, g/d; MP_{Bact} is the metabolizable protein from bacteria, g/d; and MP_{Feed} is the metabolizable protein from feed, g/d.