Calculation of Nutrient Requirement for Cattle and buffaloes (Factorial Method)

I Nutrient requirement for maintenance

(a) Energy requirement

(i) NEm (Kcal/day) = **80 $W^{0.75}$**

(ii) MEm (Kcal/day) = **133 $W^{0.75}$**

(iii) DEm (Kcal/day) = **155 $W^{0.75}$**

(iv) TDN (g/day) = **35.2 $W^{0.75}$**

Where, **W** = Body weight; **$W^{0.75}$** = Metabolic body size; **NEm** = Net energy for maintenance; **MEm** = Metabolizable energy for maintenance; **DEm** = Digestible energy for maintenance; **TDN** = Total digestible nutrients

For solving W0.75 = 3 times multiplication i.e. WxWxW (BWxBWxBW) then 2 times under root of the product of multiplication

(b) Protein requirement

$$\textbf{TP}\ (\text{g/day}) = \frac{(\text{EUN} + \text{S1 or S2} + \text{MFN}) \times 6.25}{\text{BV}}$$

Where, **TP** = Truly digestible protein

S_1 = Nitrogen loss through the sloughed off skin cells,

(S_1 is used in case of cattle, its estimated value = 0.02 g /kg $W^{0.75}$ or 0.02 $W^{0.75}$ g

S_2 = Loss of nitrogen and fleece/ hair

(S_2 is used in case of sheep/ goat, estimated value = 0.6 to 1 g/kg $W^{0.75}$ or 0.6 – 1 $W^{0.75}$ g/d

EUN = Endogenous urinary nitrogen = 0.146 $W^{0.75}$ g/day

BV = Biological value of protein = 70% for cattle, 65% for sheep and goat

MFN = Metabolic faecal nitrogen = 5 g N/kg DMI

DCP (g/day) = TP – (MFN× 6.25)

$$\textbf{DCP}\ (\text{g/day}) = \left[\frac{(\text{EUN+ S1 or S2 +MFN})}{\text{BV}} - \text{MFN}\right] \times 6.25$$

II Nutrient requirement for growth

(a) Energy requirement

$$\textbf{MEg}\ (\text{Kcal/day}) = \frac{\text{NEm (Kcal/day)} + (\text{Weight gain /day} \times \text{Energy content of gain})}{\text{Efficiency of utilization of ME for growth}}$$

(Weight gain/day× Energy content of gain) = Energy deposited in tissues (Tissue gained)

(b) Protein requirement

$$\textbf{DCP (g/day)} = \left[\frac{(EUN + G + MFN)}{BV} - MFN\right] \times 6.25$$

EUN (Endogenous urinary nitrogen) $= 0.146\ W^{0.75}$ g
MFN (Metabolic faecal nitrogen) = 5 g /kg DMI
G (nitrogen storage) = Weight gain/day × Protein/ (N) content of gain
BV = Biological value of protein

III Nutrient requirement for lactation

(a) Energy requirement

$$\textbf{ME}_l \text{ (Kcal/day)} = \frac{\text{NEm + Energy in milk produced}}{\text{Efficiency of utilization of dietary ME for milk}}$$

ME_l = Metabolizable energy for lactation
Efficiency of utilization of dietary ME for milk production = 62%

Energy value of milk can be calculated by following formula:-

EV of Milk (Kcal/day) = 304.8+114.1F, Where F = % fat content in milk

(b) Protein requirement

$$\textbf{DCP (g/day)} = \text{Maintenance requirement of Protein} + \frac{\text{Total CP content of milk}}{BV}$$

Protein content of milk can be calculated by following formula:-

Protein (g/Kg) = 21.7 +0.31 F, where **F** = g fat /kg of milk

Problem 1(a) Calculate NE, ME, DE and TDN requirement for maintenance of a cow weighing 400kg

(b) Calculate protein requirement (TP and DCP) for the same animal when DMI is 2% of BW

Solution: **(a) Energy requirement**

(i) **NEm (Kcal/day)** $= 80W^{0.75}$

$= 80 \times (400)^{0.75}$

$= 80 \times \sqrt{}\sqrt{}(400)^3$

$= 80 \times \sqrt{}\sqrt{}(400x400x400)$

$= 80 \times \sqrt{}\sqrt{}64000000$

$= 80 \times \sqrt{}8000$

$= 80 \times 89.44$ Means an animal of 400kg BW have 89.44 kg metabolic body weight

$=$ **7155.41 Kcal/d**

(ii) **MEm (Kcal/day)** $=133\ W^{0.75}$

$=133 \times 89.44$ **Note:** Follow calculation step by step as followed in calculation of NEm

$=$ **11895.52 Kcal/d**

(iii) **DEm (Kcal/day)** $= 155\ W^{0.75}$ **Note:** Follow calculation step by step as followed in calculation of NEm

$=155 \times 89.44$

$=$ **13863.2 Kcal/d**

(iv) **TDN (g/day)** $= 35.2\ W^{0.75}$ **Note:** Follow calculation step by step as followed in calculation of NEm

$= 35.2 \times 89.44$

$=$ **3148.29 g/day**

(b) Protein requirement

(i) **TP (g/d)** $= \frac{(EUN+S_1+MFN)}{B.V.} \times 6.25$

EUN $= 0.146$ g/kg $W^{0.75}$

$= 0.146 \times 89.44$

$=13.06$ g

S1 $= 0.02$g/ kg $W^{0.75}$

$= 0.02 \times 89.44$

$= 1.79$g

DMI $= 2$ % of body weight

$=2 \times 400/100$

$= 8$kg

MFN $= 5$g/kg DMI

= 5×8
= 40 g

TP = $\frac{[13.06+1.79+40]}{70\%} \times 6.25$

= $\frac{54.85\times6.25}{70\%}$

=342.81×100/70
= 34281.25/70
= **489.73 g/day**

(ii) **DCP (g/day)** = TP - (MFN×6.25)
= 489.73 - (40×6.25)
= 489.73 – (250)
= **239.73 g/day**

Ans.1.a (i) **NEm** = 7155.4 Kcal/day
(ii) **MEm** = 11895.52 (Kcal/day)
(iii) **DEm** = 13863.2 (Kcal/day)
(iv) **TDN** = 3148.29 g/day
b. (i) **TP** = 489.73 g/day
(ii) **DCP** = 239.73 g/day

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Problem 2 (a) Calculate the ME requirement for growth of 200kg bull steer (i) gaining @ 100 g/day (ii) energy content of gain is 1.5 Kcal/g of gain (iii) The efficiency of utilization of dietary ME energy is 70% .

(b) Calculate the protein requirement for the same animal (i) the nitrogen content of gain is 2.5% and (ii) DMI is 2.5 % of B.wt**.**

Solution: **(a) MEg** (kcal/d) = $\frac{\text{NEm (Kcal /day) + (wt gain /day} \times \text{energy content of gain)}}{\text{Efficiency of utilization of dietary ME for growth}}$

NEm (Kcal/day) $= 80 \times W^{0.75}$
$= 80 \times (200)^{0.75}$
$= 80 \times \sqrt{}\sqrt{}200\times200\times200$
$= 80 \times \sqrt{}\sqrt{}\ 8000000$
$= 80\times \sqrt{}2828.4271$
$= 80\times 53.18$

NEm (Kcal/day) $= 4254.64$

Wt gain /day = 100 g
Energy content of gain = 1.5 Kcal/g
Efficiency of utilization of MEg = 70 %

MEg (Kcal/d) $= \frac{4254.64 + (100\times1.5)}{70\ \%}$ 100

$= \frac{4404.64}{70\ \%}$ or 0.7 $= 4404.64 \times \frac{100}{70}$

$=$ **6292 Kcal/day**

(b) DCP (g/day) $= \left[\frac{(EUN+ G +MFN)}{BV\ \%} - MFN\right] \times 6.25$

G = Nitrogen storage = (weight gain/day) × protein/ (N_2) content of gain
$= 100\times2.5$
$= 2.5g$

EUN $= 0.146$ g/kg $W^{0.75}$, W= 200kg
$= 0.146\times W^{0.75}$
$= 0.146 \times (200)^{0.75}$
$= 0.146 \times \sqrt{}\sqrt{}200\times200\times200$
$= 0.146 \times \sqrt{}\sqrt{}\ 8000000$
$= 0.146 \times \sqrt{}2828.4271$
$= 0.146 \times 53.18$
$=$ **7.764 g**

DMI $= 2.5\%$

=200×2.5/100
= **5kg**

MFN = 5g/kg DMI
= 5×5
= **25 g**

DCP $= \left[\frac{(7.76+2.5+25)}{70\% \text{ or } 0.7} - 25\right] \times 6.25$

$= \left[\frac{(35.26)}{70\% \text{ or } 0.7} - 25\right] \times 6.25$

= [(50.77) - 25] x 6.25
= [25.37] x6.25
= 158.56 g/day

Answer: (a) MEg = 6292 Kcal/day
(b) DCP = 158.56 g/day

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Problem 3: Calculate the ME and DCP requirement for a lactating cow weighing 400 kg, producing 10kg milk with 4% fat daily the DMI is 2.5% of B.wt. **(**Efficiency of ME utilization for milk is 62%**).**

(a) Calculation of ME requirement:

$$\mathbf{ME_L}\ (\text{Kcal/day}) = \frac{\text{NEm + Energy in milk produced}}{\text{Efficiency of utilization of dietary ME for milk}}$$

(i) ME requirement for maintenance:

NEm (Kcal/day) $= 80 \times W^{0.75}$

$= 80 \times (400)^{0.75}$

$= 80 \times \sqrt{\sqrt{400 \times 400 \times 400}}$

$= 80 \times \sqrt{\sqrt{64000000}}$

$= 80 \times \sqrt{8000}$

$= 80 \times 89.44$

NEm (Kcal/day) = 7155.42

(ii) ME requirement for milk production:

Energy value of milk (Kcal/kg) $= 304.8 + 114.1F$

$= 304.8 + 114.1 \times 4$

$= 761.2$

Energy value for 10 kg of milk (Kcal) $= 761.2 \times 10$

$= 7612$ Kcal

Efficiency of utilization of dietary ME for milk is 62%

$$= \frac{7155.42 + 7612}{0.62}$$

Total ME (maintenance+ milk production) requirement (Kcal/d) = 23818.42

(b) Calculation of DCP requirement:

$$\mathbf{DCP\ (g/day)} = \frac{[\text{Maintenance requirement of protein + Total CP content of milk}]}{\text{BV}}$$

(i) DCP for maintenance (g/d) $= \frac{[(\text{EUN} + \text{S1} + \text{MFN}) - \text{MFN}]}{\text{BV}} \times 6.25$

Calculation of EUN (g) $= 0.146 \times W^{0.75}$

$= 0.146 \times (400)^{0.75}$

$= 0.146 \times \sqrt{\sqrt{400 \times 400 \times 400}}$

$= 0.146 \times \sqrt{\sqrt{64000000}}$

$= 0.146 \times \sqrt{8000}$

$= 0.146 \times 89.44$

$= 13.06$g

Calculation of S1(g) $= 0.02W0.75$

$= 0.02 \times 89.44$

$= 1.79$ g

Calculation of DMI = 2.5% BW

$$= \frac{400 \times 2.5}{100}$$

= 10kg

Calculation of MFN (g) = 5g/kg DMI

= 5×10

= 50 g

DCP (g/d) for maintenance $= \left[\frac{(13.06+1.79+50)}{0.7} - 50\right] \times 6.25$

= [(64.85/0.7) -50] ×6.25

= [92.64 - 50] ×6.25

= [42.64] x 6.25

= **266.592 g/day**

(ii) DCP for milk production

Protein content of milk can be calculated by following formula-

Protein (g/kg) = 21.7 +0.31×40

Where, F = g fat /kg of milk (4g×10kg=40g)

= 34.1 (g/kg)

Total protein in milk produced (10 kg) = 34.1×10

=341 g

DCP requirement for milk production = $\frac{341}{0.7}$ = 487 g

Total DCP (maintenance+ Milk production) = 266.592+ 487 = 753.59 g/day

Answer: The requirements of the given animal will be

ME = 23818.42 Kcal/day

and DCP =753.59 g/day