

**Table S1.** Descriptive statistics of live weight (kg), live weight gain (kg), average daily gain (g/d), average daily feed intake (kg/d), total feed intake (kg), and feed efficiency by Experimental Group (Control – CON and Treatment -TRT).

	Study Day	Group CON			Group TRT			P value <sub>F</sub>
		Mean (SD)	Median (Q1, Q3)	Min, Max	Mean (SD)	Median (Q1, Q3)	Min, Max	
<b>Live weight (kg)</b>	-3	39.71 (6.97)	41.00 (35.30, 43.70)	22.20, 53.20	42.16 (6.26)	40.90 (38.70, 45.10)	30.60, 53.80	0.30
	14	42.73 (7.34)	42.00(38.2, 47.20)	25.00, 55.80	45.12 (6.37)	44.00 (41.85, 50.00)	36.20, 58.00	0.31
	28	48.73 (8.79)	48.20 (42.55, 53.95)	31.80, 65.20	52.04 (6.06)	51.40 (48.65, 53.70)	42.00, 64.80	0.18
	42	57.13 (10.58)	55.90 (49.20, 65.30)	37.00, 73.40	61.38 (8.42)	60.40 (56.80, 66.00)	42.400, 81.00	0.09
	56	69.18 (13.37)	68.90 (61.40, 79.30)	41.80, 91.60	75.01 (9.66)	74.10 (70.60, 77.80)	53.400, 101.00	0.02
<b>Average daily gain (g/d)</b>	-3 to 14	180 (150)	160 (120, 260)	-90, 520	170 (150)	180 (50, 280)	-110, 460	0.96
	15 to 28	430 (250)	450 (250, 620)	-70, 830	490 (190)	500 (370, 650)	130, 760	0.33
	29 to 42	600 (290)	690 (370, 830)	-10, 1010	670 (250)	680 (490, 850)	30, 1240	0.34
	43 to 56	860 (310)	870 (770, 1060)	170, 1440	970 (210)	960 (820, 1100)	600, 1430	0.11
	-3 to 56	500 (180)	520 (380, 620)	180, 840	570 (90)	540 (500, 610)	450, 820	0.14
<b>Total feed intake(kg)</b>	-3 to 56	42.73 (17.54)	42.84 (33.40, 51.00)	15.56, 88.30	46.59 (12.19)	45.60 (38.96, 52.40)	26.97, 70.44	0.34
<b>Feed efficiency §</b>	-3 to 56	1.46 (0.49)	1.34 (1.18, 1.48)	0.84, 3.18	1.44 (0.33)	1.44 (1.19, 1.70)	0.90, 2.00	0.62

Key: SD - Standard Deviation, Q1 & Q3 - First and Third Quartiles, Min - Minimum, Max - Maximum

§Average Feed intake kg : Average daily gain kg

F P values mean estimates. P values are interaction term p values derived from a mixed effects regression model of each measured outcome variable over the study period. Model fitted with calf as random effect with random intercepts and an autoregressive correlation structure for the residuals.

**Table S2.** Descriptive statistics of live weight, feed intake and body measurements of animals randomly selected from each Experimental Group (Control – CON and Treatment -TRT) for postmortem and histopathology investigation. .

Variable	Group CON (n = 3)			Group TRT (n = 3)			P values <sup>‡</sup>
	Mean (SD)	Median (Q1, Q3)	Min, Max	Mean (SD)	Median (Q1, Q3)	Min, Max	
Age at post-mortem (days)	63 (4)	64 (62, 65)	59, 66	62 (3)	61 (60, 63)	59, 65	0.66
Initial live weight (kg)	46 (7)	43 (42, 48)	41, 53	49 (5)	49 (47, 52)	44, 54	0.28
Live weight at post-mortem (kg)	77 (12)	73 (71, 82)	68, 91	84 (6)	85 (81, 87)	77, 89	0.51
Total live weight gain (kg)	32 (6)	30 (29, 34)	27, 38	35 (2)	36 (34, 36)	33, 36	0.51
Average daily gain (kg/d)	0.49 (0.86)	0.48 (0.47, 0.52)	0.46, 0.58	0.56 (0.79)	0.59 (0.57, 0.57)	0.55, 0.55	0.51
Total feed intake (kg) <sup>§§</sup>	51 (19)	41 (39, 57)	38, 73	51 (1)	51 (50, 52)	49, 52	0.51
Hip Height (cm)	93(2)	92 (91, 94)	91, 95	95 (2)	95 (94, 96)	93, 97	0.18
Hip Width (cm)	21 (1)	20 (20, 21)	20, 22	22 (1)	22 (21, 22)	21, 22	0.28
Heart Girth (cm)	103 (7)	105 (100, 107)	95, 109	102 (2)	103 (102, 104)	100, 104	0.51

Key: SD - Standard Deviation, Q1 & Q3 - First and Third Quartiles, Min - Minimum, Max - Maximum

<sup>§§</sup> Feed intake from grain only.

<sup>‡</sup> P values derived from *Kruskal-Wallis* chi-squared test and were adjusted (Bonferroni) for multiple comparisons. The null hypothesis is that data distribution is homogenous. P values  $\leq 0.05$  reject the null hypothesis.

**Table S3.** Descriptive statistics of gastrointestinal tracts organs weights (g) of animals randomly selected from each Experimental group (Control – CON and Treatment -TRT) for postmortem and histopathology investigation.

Organ	Group CON (n = 3)			Group TRT (n = 3)			P value <sup>‡</sup>
	Mean (SD)	Median (Q1, Q3)	Min, Max	Mean (SD)	Median (Q1, Q3)	Min, Max	
Rumen pH	6 (0.89)	5.7 (5.5, 6.35)	5.3, 7.0	5.6 (0.1)	5.6 (5.55, 5.65)	5.5, 5.7	0.66
Weight with digesta (g)							
Rumen	8403 (1443)	8510 (7710, 9150)	6910, 9790	8370 (1164)	8690 (7885, 9015)	7080, 9340	0.82
Abomasum	1620 (652)	1940 (1405, 1995)	870, 2050	1390 (450)	1640 (1255, 1650)	870, 1660	0.38
Omasum	590 (291)	700 (480, 755)	260, 810	760 (221)	840 (675, 885)	510, 930	0.28
Reticulum	590 (324)	530 (415, 735)	300, 940	760 (243)	720 (630, 870)	540, 1020	0.28
Duodenum	33 (5)	30 (30, 35)	30, 40	87 (64)	50 (50, 105)	50, 160	0.04
Jejunum	3590 (922)	3220 (3065, 3930)	2910, 4640	4243.33 (134)	4300 (4195, 4320)	4090, 4340	0.51
Ileum	37 (15)	40 (30, 45)	20, 50	30 (17)	40 (25, 40)	10, 40	0.48

<b>Caecum</b>	730 (147)	810 (685, 815)	560, 820	607 (380)	730 (455, 820)	180, 910	0.83
<b>Colon</b>	1077 (352)	1030 (890, 1240)	750, 1450	1367 (279)	1310 (1215, 1490)	1120, 1670	0.28
<b>Weight without digesta (g)</b>							
<b>Rumen</b>	1460 (191)	1560 (1400, 1570)	1240, 1580	1427 (84)	1470 (1400, 1475)	1330, 1480	0.51
<b>Abomasum</b>	390 (17)	400 (385, 400)	370, 400	450 (53)	430 (420, 470)	410, 510	<b>0.05</b>
<b>Omasum</b>	413.33 (146)	460 (355, 495)	250, 530	417 (32)	430 (405, 435)	380, 440	0.51
<b>Reticulum</b>	257 (31)	250 (240, 270)	230, 290	357 (47)	340 (330, 375)	320, 410	<b>0.05</b>
<b>Duodenum</b>	33 (6)	30 (30, 35)	30, 40	73 (58)	40 (40, 90)	40, 140	0.09
<b>Jejunum</b>	2050 (579)	1930 (1735, 2305)	1540, 2680	2643 (464)	2540 (2390, 2845)	2240, 3150	0.27
<b>Ileum</b>	33 (12)	40 (30, 40)	20, 40	30 (17)	40 (25, 40)	10, 40	0.79
<b>Caecum</b>	227 (49)	250 (210, 255)	170, 260	197 (97)	220 (155, 250)	90, 280	0.82
<b>Colon</b>	510 (132)	560 (460, 585)	360, 610	677 (84)	650 (630, 710)	610, 770	0.07

Key: SD - Standard Deviation, Q1 & Q3 - First and Third Quartiles, Min - Minimum, Max - Maximum

‡P values derived from *Kruskal-Wallis* chi-squared test and were adjusted (Bonferroni) for multiple comparisons. The null hypothesis is that data distribution is homogenous. P values ≤0.05 reject the null hypothesis.

**Table S4.** Descriptive statistics of gastrointestinal tracts organs lengths (mm) of animals randomly selected from each Experimental group (Control – CON and Treatment -TRT) for postmortem and histopathology investigation. .

Organ	Group CON (n = 3)			Group TRT (n = 3)			P value ‡
	Mean (SD)	Median (Q1, Q3)	Min, Max	Mean (SD)	Median (Q1, Q3)	Min, Max	
<b>Jejunum</b>	142 (70)	160 (112, 181)	65, 202	506 (636)	148 (139, 694)	130, 1240	0.51
<b>Ileum</b>	20317 (2218)	21070 (19440, 21560)	17820, 22060	91243 (68892)	121300 (66860, 130600)	12430, 140000	0.51
<b>Caecum</b>	188 (83)	165 (142, 222)	120, 280	151 (14)	155 (145, 158)	135, 162	0.28
<b>Colon</b>	767 (225)	820 (670, 890)	520, 960	530 (269)	680 (450, 685)	220, 690	0.82

Key: SD - Standard Deviation, Q1 & Q3 - First and Third Quartiles, Min - Minimum, Max - Maximum

‡P values derived from *Kruskal-Wallis* chi-squared test and were adjusted (Bonferroni) for multiple comparisons. The null hypothesis is that data distribution is homogenous. P values ≤0.05 reject the null hypothesis.

**Table S5.** Descriptive statistics of organ tissue fold density<sup>€</sup> and length of animals randomly selected from each Experimental group (Control – CON and Treatment -TRT) for postmortem and histopathology investigation. .

Variable	Group CON (n = 3)			Group TRT (n = 3)			P value <sup>‡</sup>
	Mean (SD)	Median (Q1, Q3)	Min, Max	Mean (SD)	Median (Q1, Q3)	Min, Max	
<b>Tissue fold density</b>	1.5 (0.5)	2.0 (1.0, 2.0)	1.0, 2.0	2.1 (0.8)	2.0 (2.0, 3.0)	1.0, 3.0	0.09
<b>Tissue fold length</b>	1.3 (0.5)	1.0 (1.0, 2.0)	1.0, 2.0	1.8 (0.8)	2.0 (1.0, 2.0)	1.0, 3.0	0.03

Key: SD - Standard Deviation, Q1 & Q3 - First and Third Quartiles, Min - Minimum, Max – Maximum

<sup>€</sup> Fold density grading scheme used: Grade 1 = minimal findings; Grade 2 Moderate findings; Grade 3 Marked findings.

<sup>‡</sup> P values derived from *Kruskal-Wallis* chi-squared test and were adjusted (Bonferroni) for multiple comparisons. The null hypothesis is that data distribution is homogenous between the Groups. P values  $\leq 0.05$  reject the null hypothesis.

**Table S6.** Organ histopathology microscopic villi length (mm) and width (mm) histopathological measurement animals randomly selected from Control (CON) and Treatment (TRT) for postmortem and histopathology investigation. .

Organ	Group CON			Group TRT			P valu e ‡
	Mean (SD)	Median (Q1,Q3)	Min, Max	Mean (SD)	Median Q3)	(Q1, Min, Max	
Villi Length (mm)							
Rumen	1.46 (0.79)	1.31 (0.78,1.90)	0.05,3.32	1.69 (0.90)	1.54 (1.10, 2.02)	0.11, 4.37	0.28
Atrium							
Rumen	1.31 (0.39)	1.33 (1.04, 1.53)	0.45, 2.17	1.75 (0.67)	1.69 (1.28, 2.27)	0.42, 3.24	0.04
Ventral Sac							
Rumen	1.59 (1.02)	1.28 (0.76, 1.98)	0.51, 4.27	1.35(0.77)	1.33 (0.64, 1.89)	0.04, 4.44	0.23
Blind Sac							
Omasum	4.25 (4.59)	1.85 (1.28, 4.83)	0.81,17.36	6.33(9.52)	1.84 (0.80, 8.62)	0.12,40.73	0.28
Reticulum	3.04 (2.35)	3.34 (0.85, 4.28)	0.43,9.15	2.29 (1.89)	1.60 (0.84, 3.21)	0.44, 7.55	0.32
Duodenu	0.66 (0.22)	0.57 (0.47,0.84)	0.38, 1.13	0.75 (0.28)	0.66 (0.57,0.90)	0.12, 1.43	0.23
m							
Jejunum - Proximal	0.86 (0.28)	0.80 (0.72, 0.98)	0.46, 1.79	1.16 (0.50)	1.26 (0.67,1.50)	0.31, 2.18	0.32
Jejunum - Middle	1.32 (0.35)	1.37 (0.98, 1.63)	0.65, 1.89	0.87 (0.22)	0.84 (0.72, 0.94)	0.34, 1.61	0.03
Jejunum - Distal	0.71 (0.18)	0.73 (0.64,0.84)	0.33, 1.12	0.83 (0.21)	0.85 (0.73, 0.99)	0.09, 1.44	0.13
Ileum	0.62 (0.12)	0.60 (0.55, 0.67)	0.33, 1.10	0.80 (0.18)	0.80 (0.72, 0.91)	0.05, 1.13	0.00
Colon	0.47 (0.06)	0.48 (0.45, 0.52)	0.27, 0.56	0.52 (0.11)	0.50 (0.46, 0.60)	0.33, 0.75	0.48
Caecum	0.51 (0.10)	0.52 (0.41, 0.58)	0.29, 0.78	0.53 (0.14)	0.49 (0.43, 0.63)	0.28, 0.82	0.38
Abomasu	0.55 (0.32)	0.44 (0.34, 0.60)	0.20, 1.40	0.59 (0.21)	0.49 (0.43, 0.72)	0.36, 1.08	0.36
m							
Villi Width (mm)							
Rumen	0.28 (0.07)	0.28 (0.22,0.32)	0.17, 0.47	0.37 (0.27)	0.31 (0.13, 0.57)	0.05, 0.98	0.31
Atrium							
Rumen	0.22 (0.11)	0.23 (0.14,0.29)	0.02, 0.54	0.37 (0.12)	0.37 (0.26, 0.46)	0.15, 0.62	0.06
Ventral Sac							
Rumen	0.24 (0.14)	0.20 (0.16, 0.30)	0.07, 0.78	0.34 (0.15)	0.31 (0.23, 0.43)	0.07, 0.70	0.23
Blind Sac							
Omasum	0.66 (0.18)	0.68 (0.53,0.79)	0.11, 1.02	0.42, (0.14)	0.40 (0.34, 0.47)	0.13, 1.01	0.02
Reticulum	0.43 (0.18)	0.35 (0.29, 0.59)	0.17, 0.85	0.43 (0.29)	0.34 (0.19, 0.57)	0.10, 1.45	0.23
Duodenu	0.05 (0.01)	0.05 (0.04, 0.06)	0.02, 0.08	0.06 (0.0)	0.05 (0.04, 0.08)	0.02, 0.12	0.17
m							
Jejunum - Proximal	0.05 (0.02)	0.05 (0.04, 0.06)	0.03, 0.10	0.08 (0.12)	0.06 (0.05, 0.07)	0.03, 0.82	0.37
Jejunum - Middle	0.04 (0.01)	0.04 (0.03, 0.05)	0.01, 0.08	0.51 (0.65)	0.09 (0.06, 1.19)	0.04, 1.97	0.20

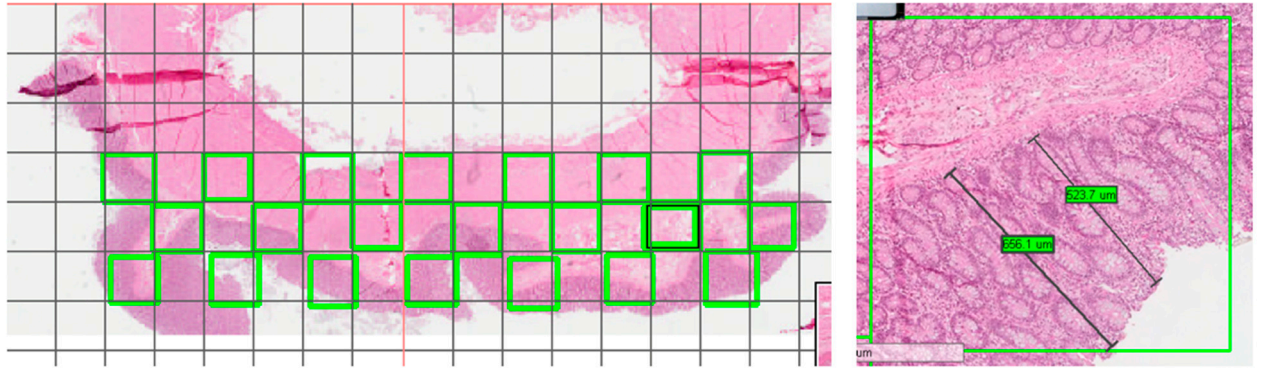
Jejunum - Distal	0.06 (0.03)	0.06 (0.04, 0.08)	0.02, 0.18	0.07 (0.10)	0.06 (0.05, 0.07)	0.03, 0.83	0.38
<b>Ileum</b>	0.10 (0.15)	0.07 (0.05, 0.10)	0.03, 0.90	0.08 (0.05)	0.06 (0.05, 0.10)	0.03, 0.25	0.45
<b>Colon</b>	<b>0.07 (0.07)</b>	<b>0.06 (0.04, 0.07)</b>	<b>0.02, 0.55</b>	<b>0.09 (0.10)</b>	<b>0.08 (0.06, 0.09)</b>	<b>0.03, 0.83</b>	<b>0.02</b>
<b>Caecum</b>	<b>0.05 (0.02)</b>	<b>0.05 (0.04, 0.07)</b>	<b>0.03, 0.09</b>	<b>0.07 (0.02)</b>	<b>0.07 (0.05, 0.08)</b>	<b>0.03, 0.11</b>	<b>0.07</b>

‡ P values derived from *Kruskal-Wallis* chi-squared test and were adjusted (Bonferroni) for multiple comparisons. The null hypothesis is that data distribution is homogenous between the Groups. P values  $\leq 0.05$  reject the null hypothesis.

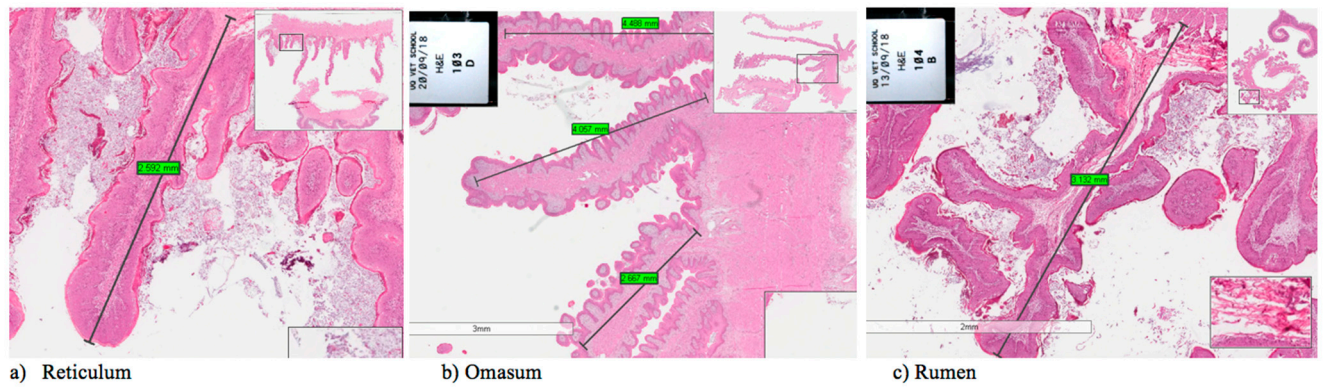
**Table S7.** Organ histopathology microscopic villi surface area ( $\mu\text{m}$ ) of animals randomly selected from each Experimental group (Control – CON and Treatment -TRT) for postmortem and histopathology investigation. .

Organs	Group CON			Group TRT			P values ‡
	Mean (SD)	Median (Q1,Q3)	Min ,Max	Mean(SD )	Median (Q1,Q3)	Min ,Max	
Villi surface area (µm)							
Rumen atrium	0.81 (0.71)	0.52 (0.35, 1.04)	0.17, 3.53	0.95 (1.07)	0.59 (0.37, 1.02)	0.10, 6.57	0.23
Rumen ventral Sac	0.54 (0.49)	0.39 (0.22, 0.66)	0.11, 2.63	0.94 (0.82)	0.70 (0.45, 1.24)	0.15, 4.19	0.12
Rumen blind Sac	1.21 (0.94)	1.01 (0.38, 1.79)	0.11, 3.27	0.67 (0.64)	0.44 (0.32, 0.74)	0.10, 3.32	0.18
Omasum	8.13 (7.25)	4.62 (3.02, 11.49)	0.49, 35.64	6.85 (6.12)	5.15 (2.05, 8.90)	0.04, 24.02	0.26
Reticulum	1.90 (2.39)	0.83 (0.33, 2.15)	0.11, 9.12	1.93 (1.99)	1.32 (0.64, 2.95)	0.11, 13.64	0.26
Duodenum	0.38 (0.13)	0.39 (0.29, 0.45)	0.12, 0.68	0.50 (0.21)	0.47 (0.36, 0.69)	0.10, 0.87	0.08
Jejunum - proximal	0.53 (0.21)	0.50 (0.36, 0.74)	0.10, 0.98	0.48 (0.22)	0.43 (0.33, 0.60)	0.05, 0.98	0.33
Jejunum - middle	0.50 (0.21)	0.50 (0.32, 0.62)	0.14, 0.94	0.42 (0.17)	0.40 (0.33, 0.50)	0.13, 0.97	0.09
Jejunum - distal	0.40 (0.22)	0.43 (0.19,0.58)	0.10,0.95	0.55 (0.24)	0.55 (0.37, 0.71)	0.10, 1.09	0.29
Ileum	0.49 (0.20)	0.54 (0.40, 0.60)	0.11, 0.88	0.48 (0.20)	0.44 (0.35, 0.63)	0.11, 0.93	0.28
Colon	0.29 (0.14)	0.27 (0.22, 0.32)	0.13, 0.96	0.32 (0.15)	0.29 (0.21, 0.39)	0.12, 0.95	0.35
Caecum	0.34 (0.16)	0.32 (0.24, 0.40)	0.11, 0.95	0.37 (0.15)	0.35 (0.25, 0.46)	0.17, 0.78	0.15
Abomasum	0.32 (0.11)	0.28 (0.25, 0.36)	0.18, 0.67	0.37 (0.17)	0.31 (0.23, 0.49)	0.12, 0.84	0.25

‡ P values derived from *Kruskal-Wallis* chi-squared test and were adjusted (Bonferroni) for multiple comparisons. The null hypothesis is that data distribution is homogenous between the Groups. P values  $\leq 0.05$  reject the null hypothesis.



**Figure S1.** An example of area selection for linear measurement forestomach (reticulum, rumen, omasum). The linear measurements were obtained through measurement of all intact villi as shown in Figure S2



**Figure S2.** Linear measurements of forestomach example.