

**Table S1.** Summary of the general data of papers evaluating the effect of different sources of Se supplementation on ruminants.

Species	Dose <sup>1</sup>	Duration <sup>2</sup>	Results	Ref.
Holstein dairy cows (milk yield 26.2±0.5 kg; DIM 63±3.0 days; parity 2.5±0.3; BW 625±18.2 kg)	0.15 mg SeY 0.30 mg SeY 0.45 mg SeY	45 days with 30 days of adaptation and 15 days of sampling.	<p>↑ Total VFA and molar proportion of propionate.</p> <p>↓ Rumen pH, NH<sub>3</sub>-N concentration, and acetate to propionate ratio.</p> <p>↑ Digestibility of DM, OM, CP, EE, NDF, and ADF.</p>	[1]
Lactating dairy cows (milk yield 33.2±2.3 kg/day; DIM 114.8±9.6; parity 3.4±1.1, BW 647±16.2 kg)	4.8 mg RPSS*	105 days with 15 days of adaptation and 90 days of data collection.	<p>↑ Total VFA and molar proportion of propionate.</p> <p>↓ Rumen pH, NH<sub>3</sub>-N, molar proportion of butyrate, and acetate to propionate ratio.</p> <p>↑ Digestibility of DM, non-fibre carbohydrates, NDF, and ADF.</p> <p>↑ Xylanase, protease, α-amylase, and pectinase.</p> <p>↑ Total bacteria, total anaerobic fungi, total protozoa, Ruminococcus albus, Ruminococcus flavefaciens, Butyrivibrio fibrisolvens, and Ruminobacter amylophilus.</p> <p>↓ Prevotella ruminicola.</p>	[2]
Lactating dairy cows (milk yields 28.9 ± 1.5 kg/d; DIM 153 ± 18 d)	0.3 mg SS 0.1 mg HMSeBA 0.3 mg HMSeBA 0.5 mg HMSeBA	The experiment lasted for 70 days, with a pretrial period of 14 days	<p>↑ Total VFA, molar proportions of propionate and butyrate.</p> <p>↓ Rumen pH, NH<sub>3</sub>-N concentration, and acetate to propionate ratio.</p> <p>↑ Digestibility of DM, OM, CP, NDF, and ADF.</p>	[3]
Lactating dairy cows (milk yield 35.3± 2.8 kg/day; DIM	0.3 mg SS. 0.1 mg CSS 0.2 mg CSS 0.3 mg CSS	The experiment lasted for 110 days with 20 days of adaptation and	<p>↑ Total VFA, molar proportions of propionate.</p> <p>↓ Rumen pH, NH<sub>3</sub>-N concentration, the molar proportions of butyrate, and</p>	[4]

103 ± 11.2;  
parity 3.1 ±  
0.98, BW 642  
± 17.6 kg)

90 days of  
sample  
collection.

acetate to propionate ratio.

↑ Digestibility of DM, OM, CP,  
EE, NDF, and ADF.

↑ Activity of carboxymethyl-  
cellulase, cellobiase, xylanase,  
α-amylase, and protease.

↑ Total bacteria, total  
anaerobic fungi, total  
protozoa, and Ruminococcus  
albus, Ruminococcus  
flavefaciens, Fibrobacter  
succinogenes Butyrivibrio  
fibrisolvens, and  
Ruminobacter amylophilus.

↓ Prevotella ruminicola.

No change in total  
methanogens.

Se had no effect on the  
digestibility of DM, OM, CP,  
EE, NDF, and non-fibrous  
carbohydrates.

[5]

Primiparous and  
multiparous  
Holstein  
cows (milk  
yield  
27.6±1.6 kg,  
DIM 116±9  
days; BW  
582.8±51.8  
kg & milk  
yield  
36.2±2.0 kg,  
DIM 98±58  
days; BW  
617.8±56.9  
kg )

15 g Se\*

The experiment  
lasted 80 days,  
with four  
experimental  
periods of 20  
days with 14  
days of  
adaptation and  
6 days of  
sampling.

Brangus  
cattle (BW  
395 ± 15 kg)

2 mg SS

The experiment  
lasted for 101  
days.

Se had no effect on ruminal  
pH and VFA composition.

[6]

Crossbred  
beef calves  
(BW 250 kg;  
6-7 months  
of age)and  
Holstein

1 mg SS  
1 mg SeY

The experiment  
lasted for 112  
days.

Se had no effects on the  
digestibility including DM,  
OM, CP, NDF and energy.

[7]

heifers (BW 250 kg; 7-17 months of age)				
Holstein dairy calves (BW = 83 ± 2.1 kg; 63 ± 3.4 days of age)	0.3 mg SS	The experiment lasted 86 days with 16 days of adaptation and 70 days of sampling.	<p>↑ Total VFA and molar proportion of propionate.</p> <p>↓ Rumen pH and acetate to propionate ratio.</p> <p>No change in NH<sub>3</sub>-N</p> <p>↑ Digestibility of DM, OM, CP, NDF, and ADF.</p> <p>↑ Xylanase, protease, α-amylase, and pectinase.</p> <p>↑ Total bacteria, total anaerobic fungi, total protozoa, total methanogens, Ruminococcus albus, Ruminococcus flavefaciens, Fibrobacter succinogenes, and Butyrivibrio fibrisolvens.</p> <p>↓ Ruminobacter amylophilus.</p> <p>↑ Urinary excretion of allantoin and total purine derivatives.</p> <p>No effect on uric acid.</p>	[8]
Holstein calves (3–4 weeks of age)	SeY concentration in the basal diet changed according to starter consumption, ranging from 0.095 mg SeY# (first 5 weeks) to 0.128 mg SeY# (last 5 weeks).	The experiment lasted for 105 days.	Se had no effect on the DM digestibility.	[9]
Holstein dairy bulls (averaging 13 months of age and 312 ± 7.8 kg of	0.1 mg SS 0.3 mg SS 0.5 mg SS	25 days with 15 days of adaptation and 10 days of sampling.	<p>↑ Total VFA and propionate production.</p> <p>↓ Rumen pH, NH<sub>3</sub>-N concentration, and acetate to propionate ratio.</p> <p>↑ Digestibility of DM, OM,</p>	[10]

BW)

CP, EE, NDF, and ADF.

↑ Activity of cellobiase, xylanase, pectinase,  $\alpha$ -amylase, and protease.

↑ Total bacteria, total anaerobic fungi, total protozoa and Ruminococcus albus, Ruminococcus flavefaciens, Fibrobacter succinogenes, Butyrivibrio fibrisolvens, and Ruminobacter amylophilus.

↓ Total methanogens, and Prevotella ruminicola.

↑ Urinary excretion of allantoin and total purine derivatives.

No effect on uric acid.

↑ Total VFA, molar proportions of propionate.

↓ Rumen pH, molar proportion of acetate, and acetate to propionate ratio.

↑ Digestibility of DM, OM, CP, EE, NDF, and ADF as well as Se concentration in serum.

No effects on ruminal NH<sub>3</sub>-N concentration.

↑ Molar proportion of propionate and ruminal microbial protein synthesis.

No change in pH, TVFA, VFA, and acetate to propionate ratio.

↓ NH<sub>3</sub>-N concentration and acetate to propionate ratio.

↑ Urinary excretion of allantoin and total purine derivatives.

No effect on uric acid.

Holstein  
bulls (BW =  
424.6 ± 7.6  
kg; 14 ± 1.2  
months of  
age)

0.3 mg SS  
0.3 mg CSS

The experiment  
lasted for 80  
days with 20  
days of  
adaptation and  
60 days of  
sample  
collection.

[11]

Simmental  
Steers (BW  
430±20; 2.5  
years of age)

7.5 mg SeY\*  
15 mg SeY\*  
22.5 mg SeY\*

21 days with 11  
days of  
adaptation and  
10 days of  
sampling.

[12]

Cannulated Tabapuã steers (BW = $398 \pm 28.7$ kg)	5 g SeY*	The experiment lasted 105 days, with 5 experimental periods of 21 days with 14 days of adaptation and 7 days of sampling.	<p>↓ Urinary excretion of uric acid derivative.</p> <p>No effect on allantoin.</p> <p>No effects on rumen fermentation (total VFA, VFA composition, acetate to propionate ratio, pH, and NH<sub>3</sub>), protozoa number, and digestibility.</p>	[13]
buffalo (Bubalus bubalis) heifers (BW = $239 \pm 16.46$ kg; 18–36 months of age)	0.2 mg SS	The experiment lasted for 120 days.	Se had no effect on the digestibility of DM, CP, EE, CF, and NFE.	[14]
Male buffalo calves (BW = $112 \pm 7.69$ kg; 8–9 months of age)	0.3 mg SS	The experiment lasted for 86 days.	↑ Digestibility of ADF and cellulose.	[15]
Male buffalo calves (BW = $75 \pm 2.2$ kg; 10–12 months of age)	0.3 mg Se	The experiment lasted for 196 days.	Se had no effect on the digestibility of DM, OM, CP, EE, NDF, ADF, cellulose, and hemicellulose as well nitrogen balance.	[16]
Ossimi pregnant ewes (BW = $50.77 \pm 2.29$ kg; 2.5 years; at 4–6 weeks of late-gestation)	0.2 mg SS.	126 days (4 – 6 weeks of late-gestation until the end of suckling period (3 months)).	↑ Digestibility of DM, OM, CP, EE, CF, NDF, and NFE as well as Nutritive value digestible crude protein and total digestible nutrients.	[17]
Sheep (Dorset sheep × Small Tail Han × Tan sheep; BW	4 g SeY (4 mg Se) 4 g SeNps (4 mg Se)	25 days with 15 days of adaptation and 10 days of sampling.	<p>↑ Total VFA and propionate production.</p> <p>↓ Rumen pH, NH<sub>3</sub>-N concentration, and acetate to propionate ratio.</p>	[18]

43.32±4.8 kg)

↑ Digestibility of DM, OM, CP, EE, NDF, and ADF.

↑ Urinary excretion of allantoin and purine derivatives.

No effect on uric acid, xanthine and hypoxanthine

Hu sheep (BW = 27.95 ± 0.27 kg; 6 months of age)	0.3 mg SS	The experiment lasted for 70 days with 10 days of preliminary trial and 60-day formal experiment.	↑ Total VFA, the concentration of acetate and propionate.	[19]
	0.3 mg SeY		↓ Ruminal NH <sub>3</sub> -N concentration.	
	0.5 mg SeY		↑ Digestibility of CP, EE, NDF, and ADF.	
Sheep [F1 hybrid, Hu × Small Tailed Han, (BW = 27.46 ± 0.99 kg; 6 months)]	3 µg SeY	The experiment lasted for 36 days.	↑ Digestibility DM and ADF.	[20]
	6 µg SeY		↑ GE, DE, and ME intakes.	
	9 µg SeY		↓ CH <sub>4</sub> output as a proportion of GE, DE, and ME intakes.	
	12 µg SeY		↑ The N intake, faecal N, urine N, digestible N, and retained N.	
Sheep of the Valashka breed (18 months of age)	0.53 mg SS	The experiment lasted for 84 days.	↑ Activities of gamma-glutamyl transferase, glutamate dehydrogenase and aspartate amino transferase in the rumen fluid.	[21]
	0.46 mg SeY			
Ossimi lambs (BW = 29.25 ± 2.02 kg; 4 months of age).	0.30 mg SS	The experiment lasted for 122 days.	↑ Digestibility of DM, OM, CP, EE, CF, NDF, and NFE as well as nutritive value digestible crude protein and total digestible nutrients.	[22]
	0.30 mg SeY			
	0.30 mg SeNps.			
Crossbred Slovak Valashka lambs (4 months of age)	0.31 mg SS. 0.31 mg SeY.	The experiment lasted for 153 days.	↑ <i>Dasytricha ruminantium</i> , <i>Ophryoscolex caudatus</i> (f. <i>tricornatus</i> ), <i>Polyplastron multivesiculatum</i> , and <i>Diploplastron affine</i> .	[23]
Lambs.	0.3 mg SS#	The experiment lasted for 70	↑ Total VFA and molar proportion of acetate,	[24]

		days.	propionate, and butyrate.	
			↓ Rumen pH.	
			↑ Total protozoa and percentage of <i>Diplodinium</i> and <i>Ophryoscolex caudatum</i> .	
Corriedale Lambs ( BW 30.4 ± 2.6 kg)	0.35 mg SS 0.35 mg SeY	The experiment lasted for 35 days.	↑ Total VFA, acetate, propionate, iso-butyrate, and iso-valerate production. No change in acetate to propionate ratio.	[25]
Male lambs of valaška breed 4 months of age.	0.3 mg SeY	The experiment lasted for 91 days.	↑ Activities of alkaline phosphatase and glutamate dehydrogenase in ruminal fluid.	[26]
Cross-bred (Suffolk × Dorset) male lambs (BW = 43.2 ± 2.1 kg; 11 months of age)	0.3 mg SS 0.6 mg SS 0.9 mg SS	14 days with 10 days of adaptation and 4 days of sampling.	↑ Digestibility of OM, starch, NDF, feed N, microbial, and N efficiency. No changes in VFA, acetate to propionate ratio, ruminal pH, and NH <sub>3</sub> -N concentration. No change in protozoa, bacteria as well as CH <sub>4</sub> production.	[27]
Male lambs (BW = 24.68 ± 2.89 kg; 8-9 months of age)	0.15 mg SS 0.15 mg Se as Jevsel-101	The experiment lasted for 90 days including a 6 days metabolism trial.	↑ N retention. Se had no effect on the digestibility of DM, OM, CP, EE, NDF, and hemicellulose.	[28]
Male lambs (BW 35.6±2.6 kg; 4–5 month of age)	0.20 mg SS 0.40 mg SS 0.20 mg SeY 0.40 mg SeY	1st experiment 70 days 2nd experiment 14 days	↑ Digestibility of DM, OM, CP, NDF, and ADF.	[29]
Male lambs (BW 25 ± 0.90 kg; 8–9 months of age)	0.15 mg SS 0.30 mg SS.	Experiment lasted for 90 days including a 6-day metabolism trial.	No effect on rumen digestibility.	[30]
Male sheep (Dorset)	0.3 g SeNps (0.3 mg Se)	20 days with 10 days of	↑ Total VFA and propionate production.	[31]

sheep×Small Tail Han×Tan sheep; BW 42.5±3.2 kg)	3 g SeNps (3 mg Se) 6 g SeNps (6 mg Se)	adaptation and 10 days of sampling.	<p>↓ Rumen pH, NH<sub>3</sub>-N concentration, and acetate to propionate ratio.</p> <p>↑ Digestibility of DM, OM, CP, EE, NDF, and ADF.</p> <p>↑ Urinary excretion of allantoin and total purine derivatives. No effect on uric acid, xanthine and hypoxanthine</p>	
Male Tibetan sheep (Oula breed; BW 31.0 ± 0.64 kg; 1-year old)	0.2 mg SeY. 0.4 mg SeY. 0.8 mg SeY.	The experiment lasted for 35 days with 28 days of adaptation and 37 days of sample collection.	<p>↑ Digestibility of EE, NDF, and ADF as well as improving Se digestibility, excretion, and balances. [32]</p> <p>↑ Nitrogen intake and nitrogen absorption.</p>	
Rams (BW = 31.0 ± 0.64 kg)	0.223 mg SeY 0.423 mg SeY 0.823 mg SeY	The experiment lasted for 35 days with 7 days of adaptation and 28 days of sample collection.	<p>↑ Total VFA, molar proportions of propionate, butyrate, and rumen NH<sub>3</sub>-N concentration. [33]</p> <p>↓ Acetate to propionate ratio.</p> <p>The relative abundance of Synergistetes decreased with SeY additive level. There is no difference in relative abundance (%) of bacterial phyla among treatments except the phylum of Synergistetes which increased in low Se group compared with the control group. At the family level, analysis revealed that Lachnospiraceae increased in high Se group compared with the other groups. At the genus level, Carnobacterium and Dysgonomonas increased in medium Se compared with the other groups. Lachnospiraceae XPB1014</p>	



			<p>group increased in the high Se group compared with the other treatments.</p> <p>Prevotella 1 was higher in control and medium Se than those in the low Se.</p> <p>Rikenellaceae RC9 gut group increased in the low Se compared with in the control group.</p> <p>Hafnia-Obesumbacterium was lower in the high Se group than the other Se groups.</p> <p>Furthermore, Tax4fun metagenome analysis indicated that carbohydrate and other amino acid-related gene activities and metabolic pathways were overexpressed in the rumen microbiota of SeY-supplemented sheep.</p>	
Crossbred wethers.	1 mg SS®	The experiment lasted for 183 days.	<p>↑ Molar proportion of acetic and isovaleric acid.</p> <p>↓ Molar proportion of butyrate.</p>	[34]
Iranian native goats (BW = 46 ± 8 kg; 41 ± 9 months)	0.3 mg SS* 0.3 mg SeMet*	The experiment lasted for 45 days.	<p>↑ Digestibility of Crude fat.</p> <p>↑ Total nitrogen production, total N production/intake N, and total N production/digestible N.</p> <p>↓ Urinary nitrogen, urine N/intake N, and urine N/digestible N.</p> <p>↑ Production energy/ ME intake</p> <p>↓ Urinary energy/ME intake and maintenance energy/ME intake</p>	[35]
Liaoning Cashmere goats (BW	1 mg SS.	The experiment lasted for 45	No effects on nutrient digestibility, nitrogen balance, and nitrogen	[36]

38.0 ± 2.94 kg; 2-year-old)		days.	retention.	
Crossbred goats (BW 9.93-10.71 kg; 110-130 days of age).	0.3 mg SeY#	The experiment lasted for a period of 56 days.	↑ Total VFA and molar proportion of propionate. ↓ Rumen pH. ↑ Glutathione peroxidase activity in ruminal epithelium of goats.	[37]
Cross-bred goats (BW = 10.5 kg ;4 months of age)	0.3 mg SeY#	The experiment lasted for 56 days.	↑ Digestibility of DM, CP, EE, and crude fiber. ↑ Weights of rumen, duodenum, colon, and large intestine.	[38]
Male cross breed goats (BW 10.5 kg; 4 months of age)	0.3 mg SeY#	The experiment lasted for a period of 56 days.	↑ Total VFA and molar concentrations of propionate. ↓ pH of colonic digesta. ↑ weight of colon and GSH-Px activity in colonic mucosa of goat.	[39]

1: Selenium (Se) supplementation per kg of dry matter; 2: Supplementation period (days); DIM: days in milk; ↑: Increase; ↓: Decrease; \*: mg per animal per day; #: mg per kg of diet; ¶: mg per kg of BW per day; VFA: Volatile fatty acids; SeY: Se yeast; ®: mg per animal per week.; DM: Dry matter; OM: Organic matter; CP: Crude protein; EE: Ether extract; NDF: Neutral detergent fiber; and ADF: Acid detergent fiber; NFE: Nitrogen free extract; CF: Crude fibre; GE: Gross energy; DE: Digestive energy; ME: Metabolic energy; SeNps: Se nanoparticles; RPSS: Rumen-protected sodium selenite; SS: sodium selenite; SSA: sodium selenate; HMSeBA: hydroxy-analog of selenomethionine; CSS: Coated sodium selenite; SeMet: Selenomethionine; #: The used Se species is not defined; \*: Organic Se.

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