

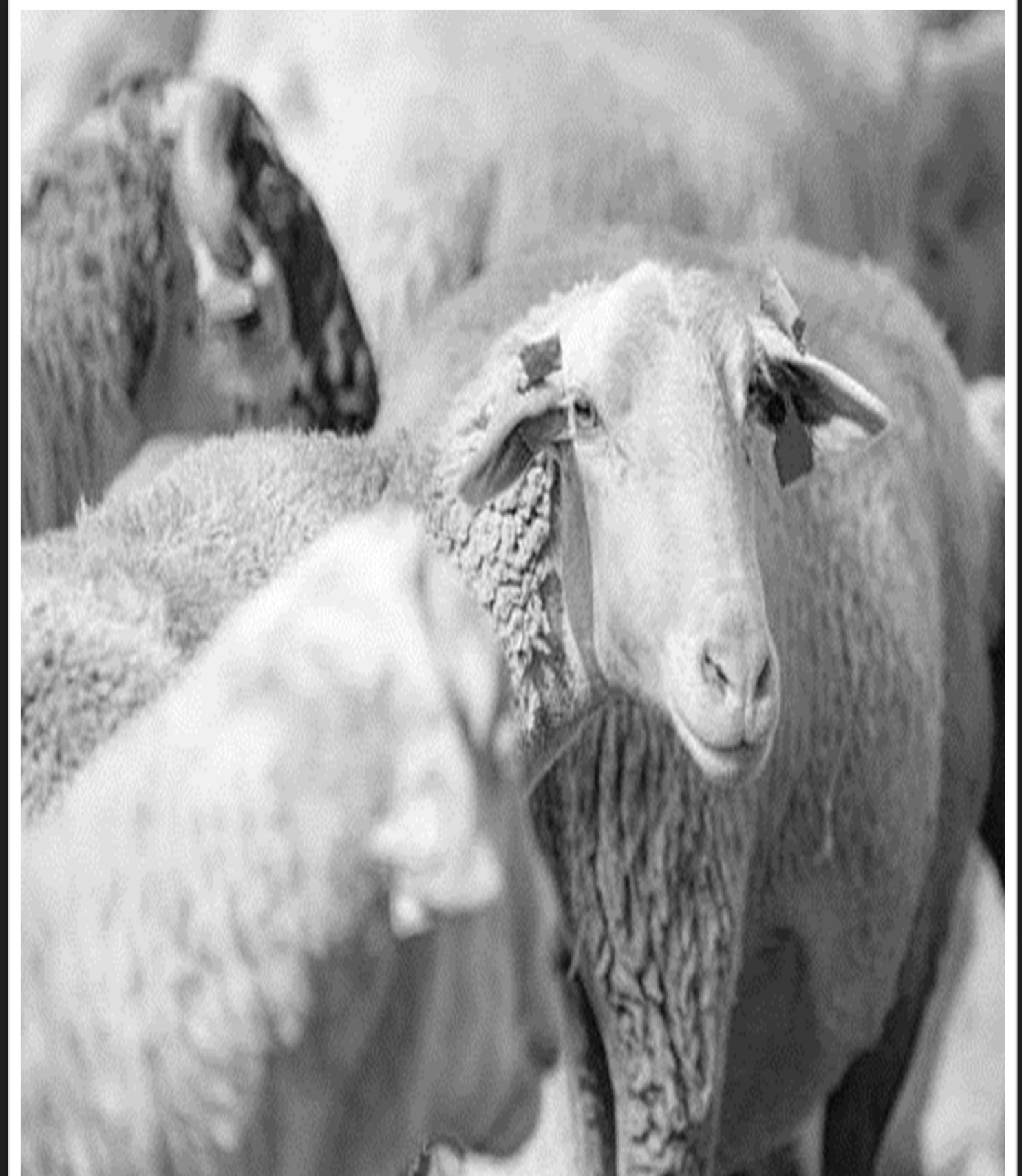
IN VITRO NUTRITIONAL INTERVENTIONS TO ENHANCE RUMEN FERMENTATION DURING POST-WEANING PROCESS IN LAMBS.

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Summary

1. Introduction
2. Material and Methods
3. Results
4. Conclusions



Introduction



Commercial dairy farms

- Newborns separated from their mothers after birth
- Artificial reared and early weaning programs.

Consequences: metabolic, physiologic and microbiologically underdeveloped rumen (protozoa).

Crucial:

- Accelerate rumen microbial development
- Promote intake and rumen fermentation
- Prevent digestive disorders
- Ensure optimal performance in later stages of life.

Traditionally have been used **antibiotic therapies**.

An EU-wide ban on the use of antibiotics as growth promoters in animal feed enters into effect on January 1, 2006.



Identifying natural feed additives capable of concurrently modulating the rumen microbiota and enhance performance, gut health and function pre- and post-weaning.

Possible solutions: phytochemicals, fatty acids, oleins, allicin, live yeast and pectins. Different fractions of colostum (not presented).

Phytochemicals (essential oils, saponins and tanins)

- **Modulate and stablish the intestinal microbiota** while decreased the microbial presence of specific pathogens.
- Trigger **proliferation of immune cells** (cytokine modulation).

Belanche et al. (2020): **Comercial plant extract blend improved milk yield and feed efficiency**, as well as **decreased methane production**.

Wang et al. (2019): **Saponins** at 9 g/calf per day promoted higher abundance of *Bacteroidetes* and *Firmicutes* which resulted in more favorable for **rumen development and improved the breakdown of structural polysaccharides** in growing calves.

Wang et al. (2019): **Tannins ameliorated the morphological damage in the jejunum** by increasing the villus height and crypt depth, **activated the antioxidative pathway and intestinal barrier**.



Fatty acids (FA)

Medium-chain FA (lauric acid and coconut oil):

- Improved rumen papillary development and fermentation.
- **Antimicrobial properties** against methanogens, bacteria and protozoa.

Long-chain FA (derived of fish oils and algae):
immunomodulatory properties.

Oleins

- Vegetable oils contains **fat sources** which maintenance **energy, growth performance, gastrointestinal development and immunity** in suckling ruminants.



Allicin

Antimicrobial, antioxidant and anti-inflammatory properties.

Zhong et al. (2019): Commercial garlic powder increased **lambs' average daily gain, feed digestion and rumen fermentation**, as well as **reduced ammonia nitrogen concentration**.

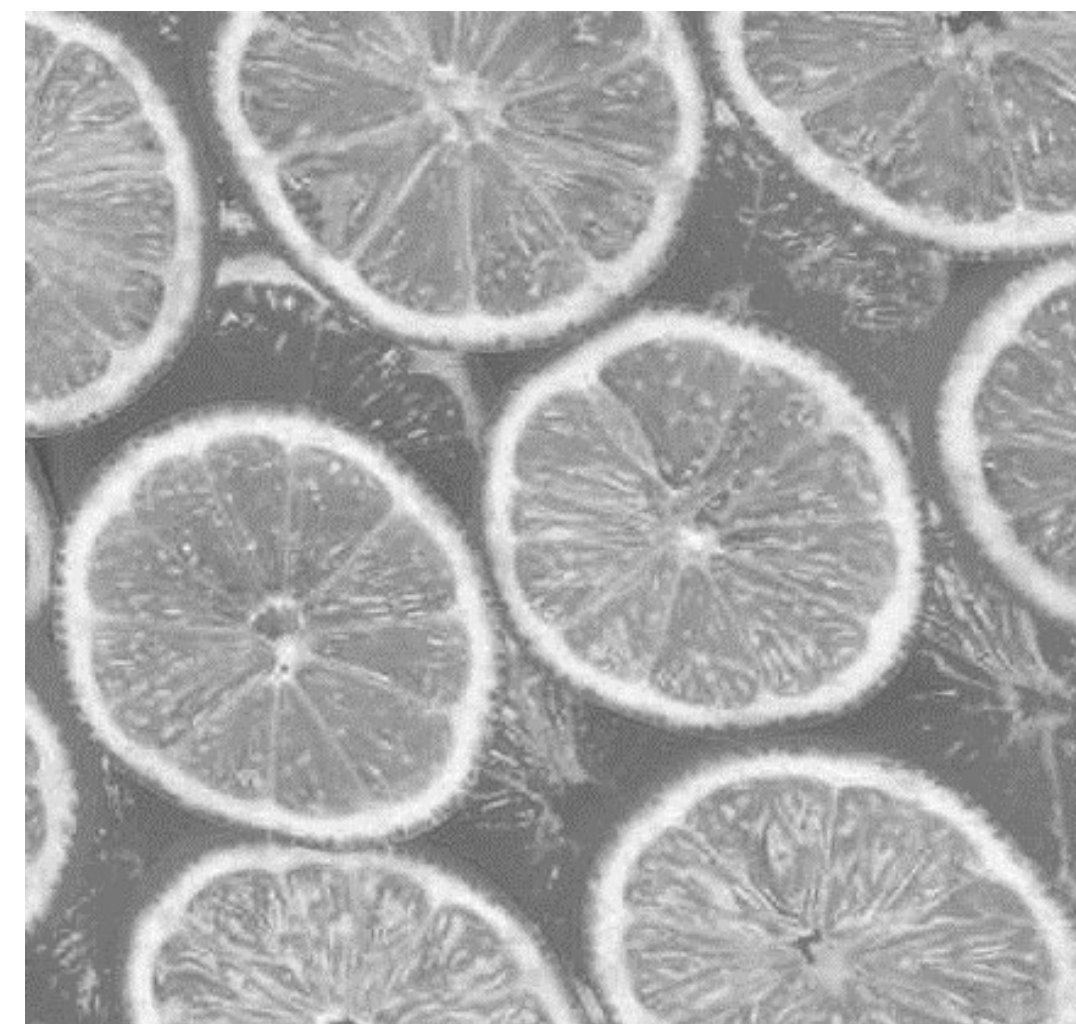
Live yeast

- Accelerate the **establishment of functional microbial communities in the rumen**.
- Reduce ruminal ammonia N and fecal pathogenic bacteria.



Pectins

- Pectin methylesterases are cell wall enzymes which **interact with rumen microbiota** such as *Butyrivibrio* and *Prevotella* which **improve fiber, protein and carbohydrate degradation**.
- **Enhance the intestinal immune barrier**, strengthening the mucus layer epithelial integrity, as well as by modulating macrophage and dendritic cell responses.
- Proanthocyanidins in pectin bind with proteins and **reduce activity of microbial enzymes and growth rate of proteolytic bacteria, lessen ammonia nitrogen** and boost assimilation of dietary amino acid by ruminant.





- High concentrate diets
 - Very low pH
- Absence of protozoa
etc



Hypothesis

Weaning and post-weaning period in ruminants might be **optimize by natural feed additives**.

Objectives

- 01.** To asses the impact of twelve natural feed additives aiming to identify the **most effective *in vitro***.
- 02.** To determine the **optimal dosage for enhancing rumen fermentation and intestinal health** through an *in vitro* approaches (batch culture and Caco-2 cell lines).

Material and Methods

Comercial feed additives evaluated



- **Essential oils blends:**
 - *Agolin Ruminant (Agolin)*,
 - *Biopracid EiM (Fatro Ibérica)*,
 - *Rumi G (CCPA)*.
- **Allicin** (*Zooalium*).
- **Saponins** (*Silvafeed MultiSap*).
- **Tannins** (*Silvafeed ByPro*).
- **Fatty acids:**
 - Medium-chain FA (lauric acid),
 - Long-chain FA (halibut liver oil).
- **Oleins:**
 - Saturated (*Riosa S.A*),
 - Polyunsaturated oleins (*Riosa S.A*).
- **Live yeast** (*Lallemand Animal Nutrition*).
- **Pectins** (*Silvafeed Pectin*).

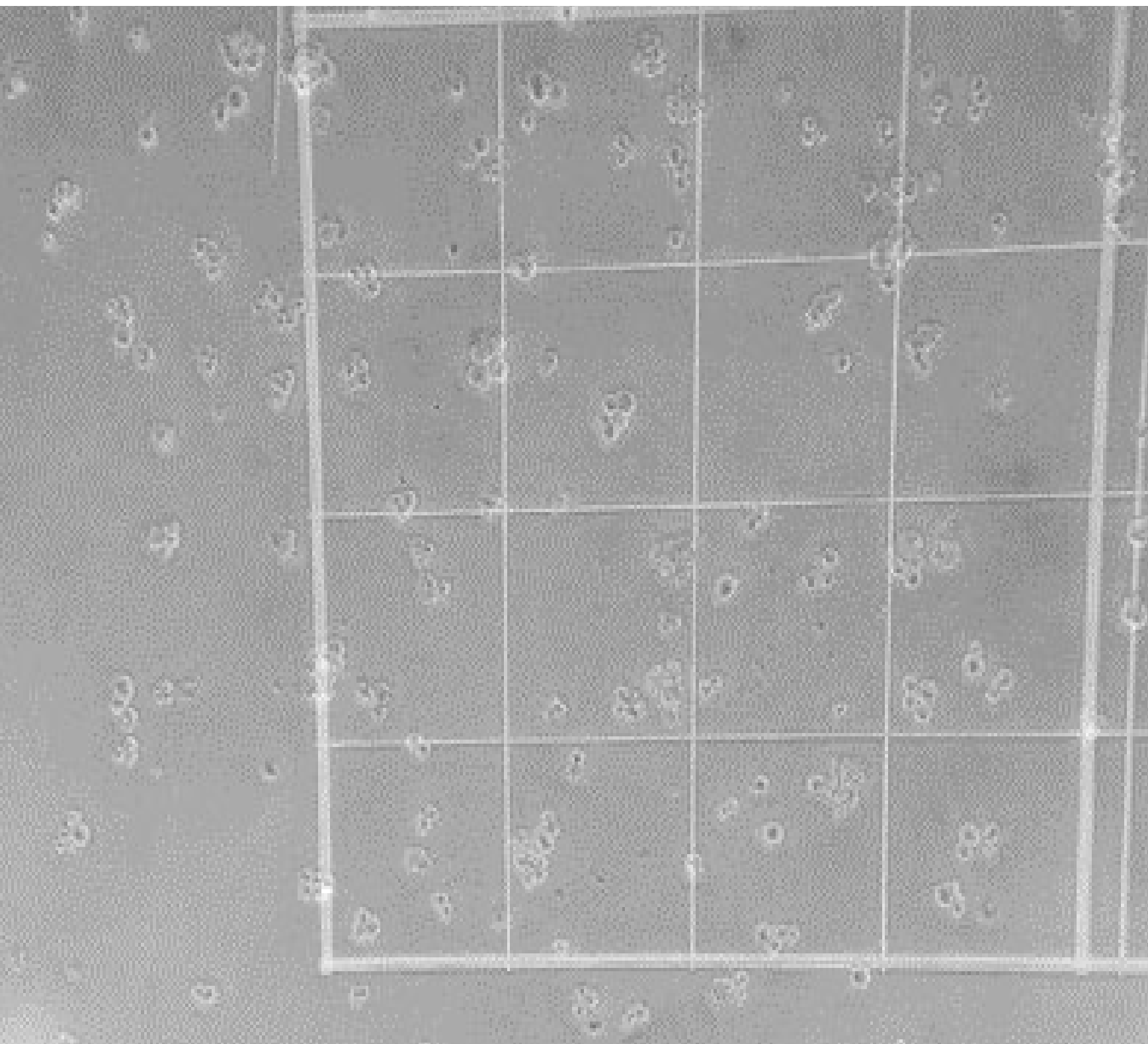
Dose-response: **0, 100, 300, and 600 mg/L.**

In vitro batch fermentations



- **Ruminal fluid:** four Assaf lambs which were artificial reared.
- Diet: 92% **concentrate diets** and 8% barley straw (based previous *in vivo* measurements).
- **Incubation:** 39°C, 24 h.
- **Measurements:**
 - Gas production (3, 6, 12 and 24 h),
 - Methane production (3 and 24 h),
 - Rumen fermentation (24 h)
 - pH
 - VFA
 - Ammonia

Cell culture and viability



- **Caco-2 cells** grown at 37°C with 5% CO₂ during 7 days and incubated with additives during 24 h.
- **Viability of cells and cytotoxicity:** Mitochondrial dehydrogenase activity.



Results

- Ruminal pH remained around 5.7.
- Absence on ruminal protozoa.

Essential oils

Coriander seed oil, eugenol, geranyl acetate, and geraniol.

Table 1. Effects of **Agolin Ruminant** (*Agolin*) on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.72	5.71	5.73	0.025	ns	ns	ns
NH ₃ -N (mg/dL)	37.5	36.9	37.1	36.6	0.383	ns	ns	ns
Total VFA ¹ (mmol/L)	139	136	133	129	4.76	ns	ns	ns
Acetate (%)	38.2	39.1	38.8	38.9	0.510	ns	ns	ns
Propionate (%)	43.7	43.0	43.1	42.8	0.446	ns	ns	ns
Butyrate (%)	11.6	11.8	11.9	12.0	0.148	ns	ns	ns
BCFA ² (%)	2.07	2.13	2.15	2.18	0.082	ns	ns	ns
Acetate:propionate ratio	0.876	0.913	0.901	0.913	0.021	ns	ns	ns
Total gas production (ml)	103	103	105	105	1.63	ns	ns	ns
Total CH ₄ , mL	2.33	2.32	2.32	2.39	0.09	ns	ns	ns
CH ₄ /VFA, mmol	15.0	15.3	15.9	16.6	0.953	ns	ns	ns
Caco-2 cell viability, %	100	106	100	104	2.43	ns	ns	ns

¹Total VFA, Total volatile fatty acids; ²BCFA, branched chain fatty acids.

Essential oils

Cinnamon bark,
oregano and
capsicum oleoresin.

Table 2. Effects of **Biopracid EiM** (*Fatro Ibérica*) on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.71	5.71	5.72	0.026	ns	ns	ns
NH ₃ -N (mg/dL)	31.2	29.5	29.8	28.6	0.587	T	ns	ns
Total VFA ¹ (mmol/L)	139	132	127	134	6.69	ns	ns	ns
Acetate (%)	38.2	39.1	38.0	40.0	0.729	ns	ns	ns
Propionate (%)	43.7	42.9	43.6	42.4	0.432	ns	ns	ns
Butyrate (%)	11.6	11.8	12.1	11.6	0.232	ns	ns	ns
BCFA ² (%)	2.07	2.10	2.13	2.05	0.090	ns	ns	ns
Acetate:propionate ratio	0.876	0.918	0.872	0.946	0.027	ns	ns	ns
Total gas production (ml)	103	99	97	100	1.27	T	**	**
Total CH ₄ , mL	2.33	2.20	2.23	2.29	0.074	ns	ns	ns
CH ₄ /VFA, mmol	15.0	14.9	16.0	15.6	0.942	ns	ns	ns
Caco-2 cell viability, %	100	106	106	110	3.87	ns	ns	ns

¹Total VFA, Total volatile fatty acids; ²BCFA, branched chain fatty acids.

Essential oils

Tumeric, thymol and yeast cell wall components.

Table 3. Effects of **Rumi G (CCPA)** on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.72	5.72	5.71	0.025	ns	ns	ns
NH ₃ -N (mg/dL)	31.2	30.9	31.3	31.7	0.628	ns	ns	ns
Total VFA ¹ (mmol/L)	139	135	128	135	6.69	ns	ns	ns
Acetate (%)	38.2	39.8	39.0	36.9	0.648	T	ns	ns
Propionate (%)	43.7 ^{ab}	42.5 ^b	42.9 ^{ab}	44.2 ^a	0.361	*	ns	T
Butyrate (%)	11.6	11.6	11.8	12.3	0.201	ns	ns	ns
BCFA ² (%)	2.07	2.14	2.18	2.22	0.087	ns	ns	ns
Acetate:propionate ratio	0.876	0.940	0.910	0.836	0.023	T	ns	ns
Total gas production (ml)	103	102	102	103	1.40	ns	ns	ns
Total CH ₄ , mL	2.33	2.34	2.44	2.39	0.076	ns	ns	ns
CH ₄ /VFA, mmol	15.0	15.5	17.2	16.2	0.836	ns	ns	ns
Caco-2 cell viability, %	100 ^b	113 ^a	107 ^{ab}	100 ^b	2.64	ns	ns	ns

¹Total VFA, Total volatile fatty acids; ²BCFA, branched chain fatty acids.

Essential oils

Tumeric, thymol and yeast cell wall components.

Table 3. Effects of **Rumi G (CCPA)** on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.72	5.72	5.71	0.025	ns	ns	ns
NH ₃ -N (mg/dL)	31.2	30.9	31.3	31.7	0.628	ns	ns	ns
Total VFA ¹ (mmol/L)	139	135	128	135	6.69	ns	ns	ns
Acetate (%)	38.2	39.8	39.0	36.9	0.648	T	ns	ns
Propionate (%)	43.7 ^{ab}	42.5 ^b	42.9 ^{ab}	44.2 ^a	0.361	ns	ns	ns
Butyrate (%)	11.6	11.6	11.8	12.3	0.201	ns	ns	ns
BCFA ² (%)	2.07	2.14	2.18	2.22	0.087	ns	ns	ns
Acetate:propionate ratio	0.876	0.940	0.910	0.836	0.023	ns	ns	ns
Total gas production (ml)	103	102	102	103	1.40	ns	ns	ns
Total CH ₄ , mL	2.33	2.34	2.44	2.39	0.076	ns	ns	ns
CH ₄ /VFA, mmol	15.0	15.5	17.2	16.2	0.836	ns	ns	*
Caco-2 cell viability, %	100 ^b	113 ^a	107 ^{ab}	100 ^b	2.64	ns	ns	*

¹Total VFA, Total volatile fatty acids; ²BCVFA, branched chain fatty acids.

Essential oils

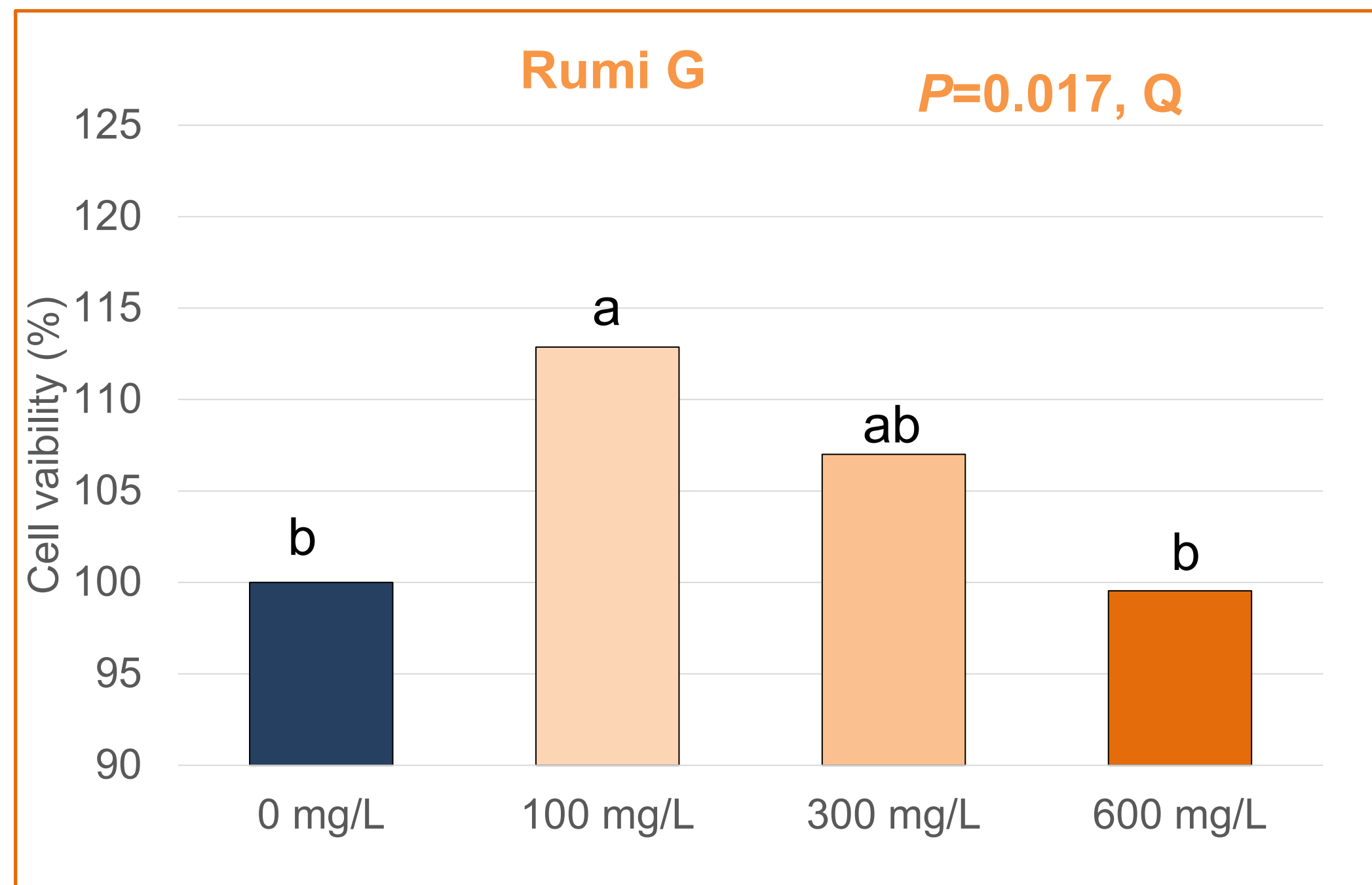


Figure 1. Caco-2 cell viability with Rumi G.

Table 4. Effects of **Allicin** (*Zooalium*) on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.70	5.71	5.70	0.024	ns	ns	ns
NH ₃ -N (mg/dL)	31.2	29.8	30.8	31.0	0.595	ns	ns	ns
Total VFA ¹ (mmol/L)	139	129	134	135	6.71	ns	ns	ns
Acetate (%)	38.2	37.4	38.6	38.3	0.709	ns	ns	ns
Propionate (%)	43.7	43.9	43.2	43.1	0.387	ns	ns	ns
Butyrate (%)	11.6	12.3	11.9	12.2	0.254	ns	ns	ns
BCFA ² (%)	2.07	2.15	2.15	2.17	0.094	ns	ns	ns
Acetate:propionate ratio	0.876	0.852	0.896	0.889	0.025	ns	ns	ns
Total gas production (ml)	103	99.1	102	103	1.19	ns	ns	T
Total CH ₄ , mL	2.33	2.23	2.24	2.26	0.120	ns	ns	ns
CH ₄ /VFA, mmol	15.0	15.9	15.4	15.5	1.28	ns	ns	ns
Caco-2 cell viability, %	100	102	105	112	3.14	ns	*	ns

¹Total VFA, Total volatile fatty acids; ²BCFA, branched chain fatty acids.

Allicin

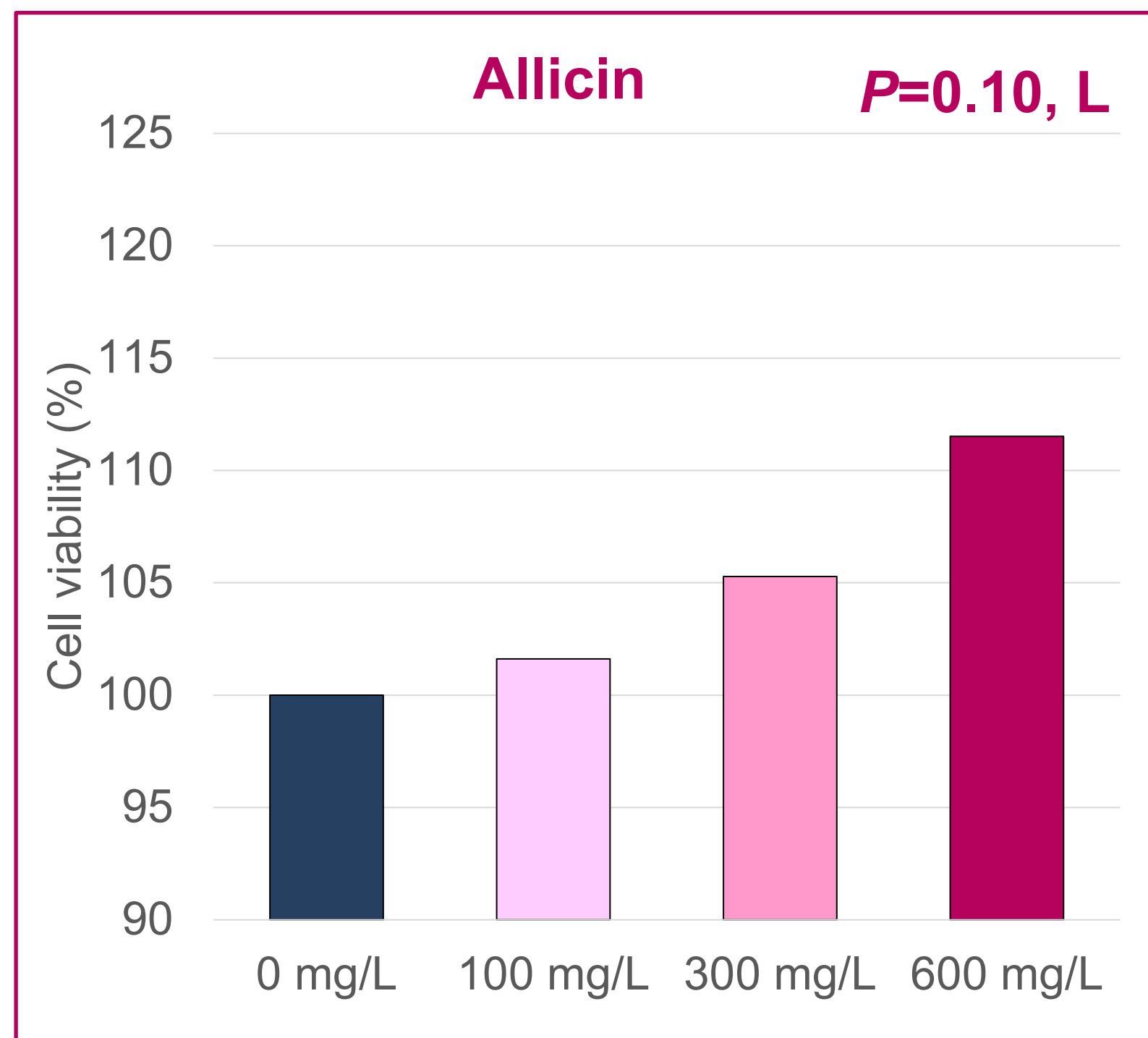


Figure 2. Caco-2 cell viability with Allicin.

Mixture of botanical extract

Table 5. Effects of **Saponins** (*Silvafeed MultiSap*) on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.71	5.71	5.71	0.026	ns	ns	ns
NH ₃ -N (mg/dL)	31.2 ^{ab}	31.7 ^a	31.1 ^{ab}	29.6 ^b	0.442	*	ns	ns
Total VFA ¹ (mmol/L)	139	139	134	140	8.47	ns	ns	ns
Acetate (%)	38.2	38.4	39.0	37.7	1.03	ns	ns	ns
Propionate (%)	43.7	43.2	42.8	43.8	0.713	ns	ns	ns
Butyrate (%)	11.6	12.0	11.9	12.1	0.209	ns	ns	ns
Valerate (%)	4.40	4.20	4.15	4.18	0.162	ns	ns	ns
BCFA ² (%)	2.07	2.24	2.17	2.22	0.064	ns	ns	ns
Acetate:propionate ratio	0.876	0.891	0.921	0.871	0.040	ns	ns	ns
Total gas production (ml)	103	103	103	102	0.871	ns	ns	ns
Total CH ₄ , mL	2.33	2.36	2.38	2.46	0.090	ns	ns	ns
CH ₄ /VFA, mmol	15.0	15.6	16.0	14.8	1.17	ns	ns	ns
Caco-2 cell viability, %	100 ^b	107 ^{ab}	111 ^{ab}	120 ^a	4.01	*	**	ns

¹Total VFA, Total volatile fatty acids; ²BCFA, branched chain fatty acids.

Saponins

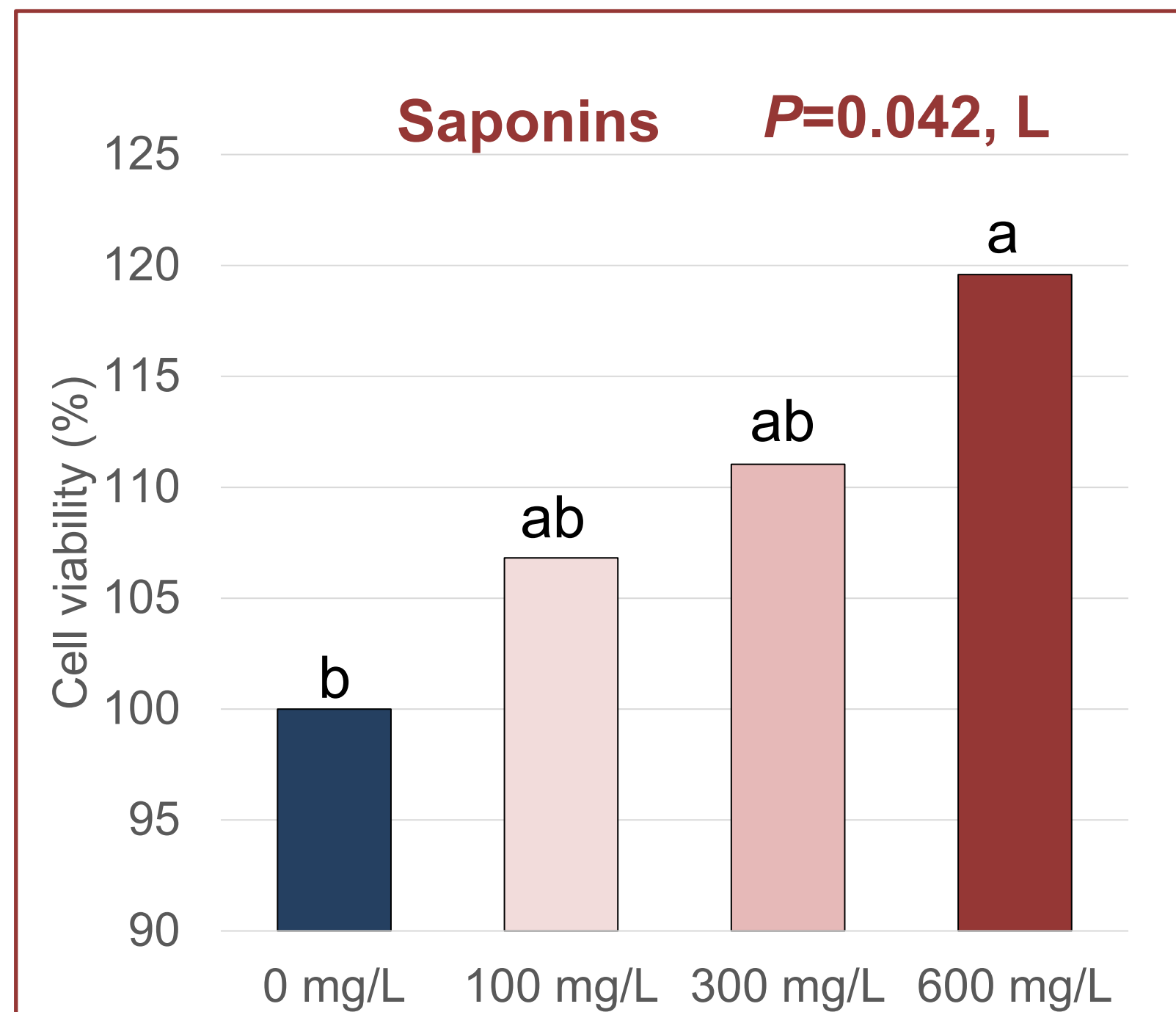


Figure 3. Caco-2 cell viability with Saponins.

Tannins

Quebracho and chesnut tannins.

Table 6. Effects of **tannins** (*Silvafeed ByPro*) on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.71	5.70	5.67	0.031	ns	ns	ns
NH ₃ -N (mg/dL)	31.2 ^a	29.3 ^a	26.1 ^b	22.7 ^c	0.444	***	ns	ns
Total VFA ¹ (mmol/L)	139	129	130	124	4.59	ns	ns	ns
Acetate (%)	38.2	37.9	39.5	40.3	1.07	ns	ns	ns
Propionate (%)	43.7	43.5	42.7	42.4	0.604	ns	ns	ns
Butyrate (%)	11.6	12.2	11.8	11.7	0.333	ns	ns	ns
BCFA ² (%)	2.07	2.15	1.95	1.72	0.097	T	ns	ns
Acetate:propionate ratio	0.876	0.871	0.934	0.952	0.041	ns	ns	ns
Total gas production (ml)	103	103.83	101.97	99.07	1.24	ns	ns	ns
Total CH ₄ , mL	2.33	2.48	2.31	2.16	0.093	ns	ns	ns
CH ₄ /VFA, mmol	15.0	17.4	15.9	15.7	0.673	ns	ns	ns
Caco-2 cell viability, %	100	106	97	96	4.27	ns	ns	ns

¹Total VFA, Total volatile fatty acids; ²BCVFA, branched chain fatty acids.

Fatty acids

Table 7. Effects of medium-chain FA (lauric acid) on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.71	5.70	5.71	0.051	ns	ns	ns
NH ₃ -N (mg/dL)	31.2	32.2	31.6	31.0	1.09	ns	ns	ns
Total VFA ¹ (mmol/L)	139	136	149	144	1.99	ns	ns	ns
Acetate (%)	38.2	39.4	38.2	38.5	1.13	ns	ns	ns
Propionate (%)	43.7	42.6	43.4	43.2	0.746	ns	ns	T
Butyrate (%)	11.6	11.7	12.1	12.0	0.408	ns	ns	ns
BCFA ² (%)	2.07	2.15	2.20	2.21	0.086	ns	ns	ns
Acetate:propionate ratio	0.875	0.929	0.882	0.890	0.041	ns	ns	ns
Total gas production (ml)	102	101	102	100	2.72	ns	ns	ns
Total CH ₄ , mL	2.33	2.19	2.37	2.24	0.219	ns	ns	ns
CH ₄ /VFA, mmol	15.0	14.8	14.9	14.6	1.31	ns	ns	ns
Caco-2 cell viability, %	100	100	97	112	4.94	ns	ns	ns

¹Total VFA, Total volatile fatty acids; ²BCVFA, branched chain fatty acids.

Fatty acids

Table 8. Effects of long-chain FA (halibut liver oil) on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.75	5.74	5.74	0.028	ns	ns	ns
NH ₃ -N (mg/dL)	31.2	31.2	30.9	31.2	0.339	ns	ns	ns
Total VFA ¹ (mmol/L)	139	141	137	133	8.44	ns	ns	ns
Acetate (%)	38.2	37.8	38.6	38.8	0.700	ns	ns	ns
Propionate (%)	43.7	43.7	43.4	43.1	0.416	ns	ns	ns
Butyrate (%)	11.6	11.9	11.7	11.8	0.245	ns	ns	ns
BCFA ² (%)	2.07	2.26	2.18	2.15	0.082	ns	ns	ns
Acetate:propionate ratio	0.876	0.869	0.890	0.905	0.024	ns	ns	ns
Total gas production (ml)	102	101	99	102	1.76	ns	ns	ns
Total CH ₄ , mL	2.33	2.19	2.17	2.21	0.104	ns	ns	ns
CH ₄ /VFA, mmol	15.0	14.5	14.6	14.8	1.34	ns	ns	ns
Caco-2 cell viability, %	100	110	115	96	5.37	ns	ns	ns

¹Total VFA, Total volatile fatty acids; ²BCVFA, branched chain fatty acids.

Oleins

Table 9. Effects of **polyunsaturated olein** (*Riosa S.A.*) on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.71	5.72	5.72	0.026	ns	ns	ns
NH ₃ -N (mg/dL)	31.2	30.0	30.1	30.1	0.591	ns	ns	ns
Total VFA ¹ (mmol/L)	139	124	133	114	8.50	ns	ns	ns
Acetate (%)	38.2	38.6	38.8	38.5	0.939	ns	ns	ns
Propionate (%)	43.7	43.1	43.1	43.1	0.557	ns	ns	ns
Butyrate (%)	11.6	12.0	11.9	12.0	0.322	ns	ns	ns
BCFA ² (%)	2.07	2.10	2.11	2.13	0.082	ns	ns	ns
Acetate:propionate ratio	0.876	0.894	0.899	0.898	0.033	ns	ns	ns
Total gas production (ml)	103	99	99	103	1.24	T	***	***
Total CH ₄ , mL	2.33	2.08	2.18	2.33	0.107	ns	**	*
CH ₄ /VFA, mmol	15.0	15.6	15.2	18.3	1.21	ns	ns	ns
Caco-2 cell viability, %	100	107	118	102	4.95	ns	ns	*

¹Total VFA, Total volatile fatty acids; ²BCVFA, branched chain fatty acids.

AL polyunsaturated

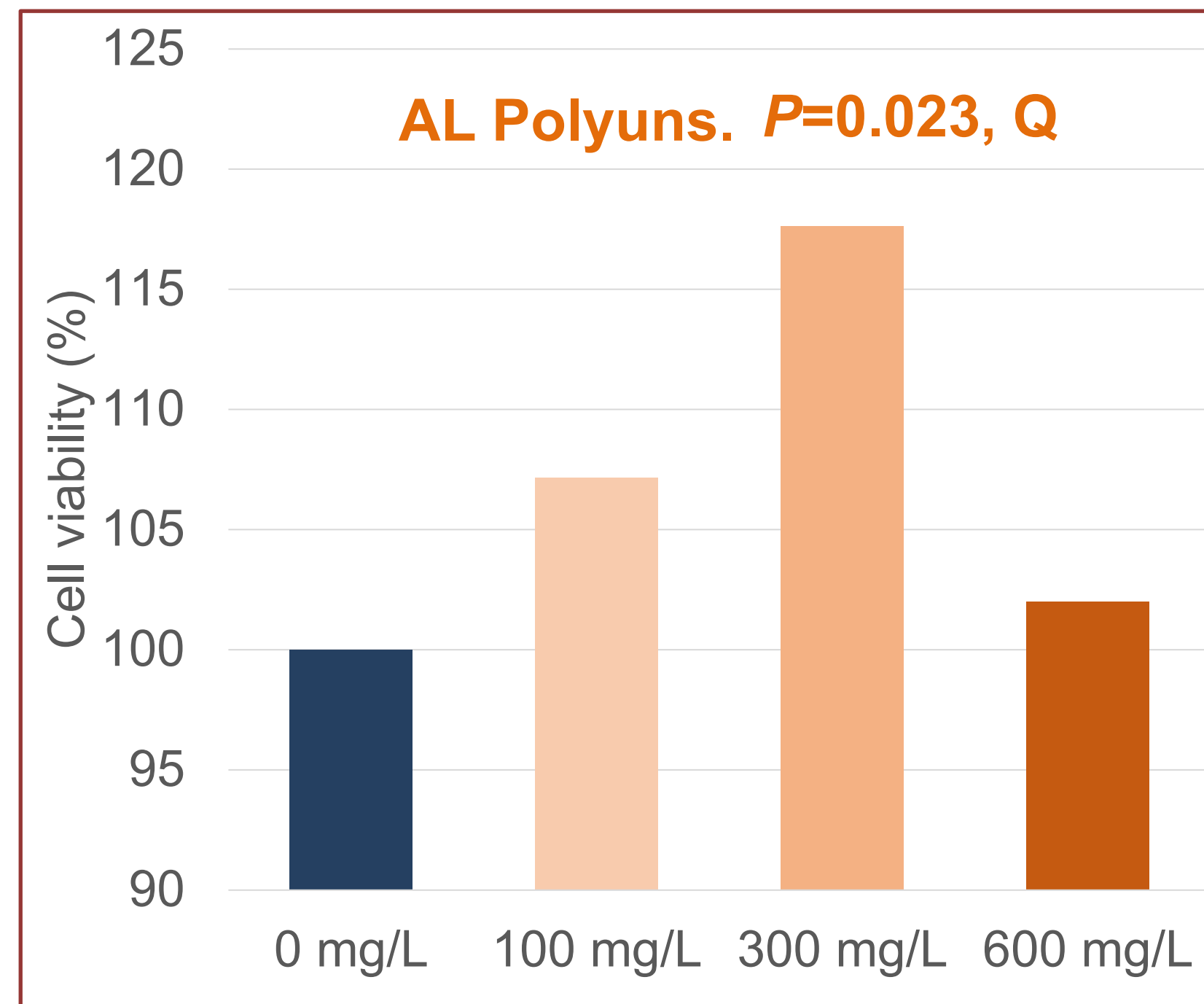


Figure 4. Caco-2 cell viability with AL polyunsaturated.

Oleins

Table 10. Effects of **saturated oleins** (*Riosa S.A.*) on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.72	5.72	5.72	0.025	ns	ns	ns
NH ₃ -N (mg/dL)	31.2	31.1	31.3	31.20	0.469	ns	ns	ns
Total VFA ¹ (mmol/L)	139	134	136	131	5.92	ns	ns	ns
Acetate (%)	38.2	39.4	39.1	38.9	0.365	ns	ns	ns
Propionate (%)	43.7	42.6	42.6	42.8	0.307	T	***	**
Butyrate (%)	11.6	11.7	11.9	12.0	0.122	ns	ns	ns
BCFA ² (%)	2.07	2.17	2.17	2.18	0.082	ns	ns	ns
Acetate:propionate ratio	0.876	0.928	0.922	0.910	0.015	ns	ns	ns
Total gas production (ml)	103	102	101	100	1.30	ns	ns	ns
Total CH ₄ , mL	2.33	2.16	2.22	2.30	0.112	ns	ns	ns
CH ₄ /VFA, mmol	15.0	14.7	14.9	16.1	0.854	ns	ns	ns
Caco-2 cell viability, %	100	102	111	120	6.53	ns	*	ns

¹Total VFA, Total volatile fatty acids; ²BCVFA, branched chain fatty acids.

BMV saturated

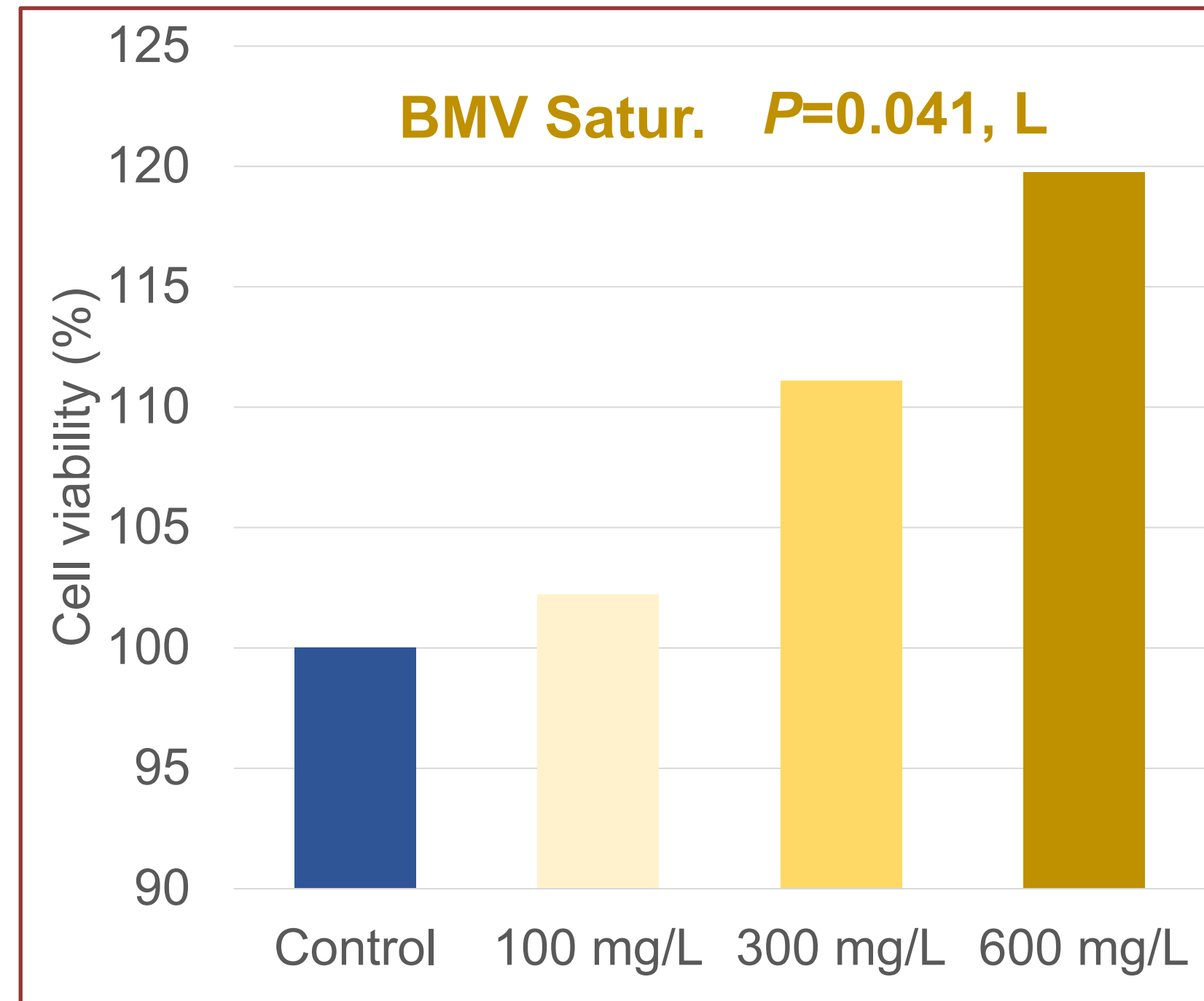


Figure 5. Caco-2 cell viability with BMV saturated.

Table 11. Effects of **live yeast** (*Lallemand Animal Nutrition*) on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.72	5.72	5.72	0.052	ns	ns	ns
NH ₃ -N (mg/dL)	31.2	31.3	31.8	30.4	1.35	ns	ns	ns
Total VFA ¹ (mmol/L)	139	130	135	125	1.38	ns	ns	ns
Acetate (%)	38.2	38.0	39.4	38.3	1.47	ns	ns	ns
Propionate (%)	43.7	43.4	42.4	43.1	0.935	ns	T	ns
Butyrate (%)	11.6	12.1	11.9	12.0	0.393	ns	ns	ns
BCFA ² (%)	2.07	2.22	2.16	2.16	0.083	ns	ns	ns
Acetate:propionate ratio	0.876	0.877	0.932	0.893	0.052	ns	ns	ns
Total gas production (ml)	103	99.8	99.9	99.0	2.42	ns	ns	ns
Total CH ₄ , mL	2.33	2.31	2.22	2.32	0.213	ns	ns	ns
CH ₄ /VFA, mmol	15.0	15.8	15.0	16.6	0.762	ns	ns	ns
Caco-2 cell viability, %	100	109	106	110	6.03	ns	ns	ns

¹Total VFA, Total volatile fatty acids; ²BCVFA, branched chain fatty acids.

Table 12. Effects of **pectins** (*Silvafeed Pectin*) on *in vitro* rumen fermentation.

	Dosage (mg/L)				SEM	P-Value	Lineal	Quadratic
	0	100	300	600				
pH	5.68	5.71	5.70	5.67	0.026	ns	ns	ns
NH ₃ -N (mg/dL)	31.2 ^a	28.5 ^b	29.3 ^b	29.6 ^b	0.335	*	*	*
Total VFA ¹ (mmol/L)	139	136	146	139	7.07	ns	ns	ns
Acetate (%)	38.2	38.6	39.1	39.0	0.891	ns	ns	ns
Propionate (%)	43.7	43.3	43.0	43.1	1.14	ns	ns	ns
Butyrate (%)	11.6	11.9	11.9	11.9	0.296	ns	ns	ns
BCFA ² (%)	2.07	2.08	2.03	2.01	0.099	ns	ns	ns
Acetate:propionate ratio	0.876	0.892	0.910	0.910	0.034	ns	ns	ns
Total gas production (ml)	103	101	103	105	1.15	T	ns	ns
Total CH ₄ , mL	2.33 ^{ab}	2.21 ^b	2.51 ^{ab}	2.62 ^a	0.086	*	*	T
CH ₄ /VFA, mmol	15.0	14.6	15.9	16.8	0.973	ns	ns	ns
Caco-2 cell viability, %	100	104	105	106	3.06	ns	ns	ns

¹Total VFA, Total volatile fatty acids; ²BCVFA, branched chain fatty acids.

Conclusions

1. Several additives (allicin, saponins and oleins) showed positive effects on gut health.
2. **Rumi G at high dosage (600 mg/L)** was the most promising natural feed additive to improve rumen fermentation and enhance intestinal health in young ruminants.
3. However, general results indicated that dietary supplementation with natural feed additives may have **minor effects on the rumen microbial fermentation** during the post-weaning process of artificially reared lambs.
4. The low rumen microbial development, absence on rumen protozoa, and the use of high concentrated feeds which lead to low rumen pH could explain the **difficulty to modulate this microbial ecosystem**.
5. Further research is needed to optimize **post-weaning process in lambs**.

Any Questions?

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