



Influence of ornithine formation by starter cultures on the CO₂ production and quality of Gruyère type model cheese

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Introduction



Emmentaler AOP

Mechanism and control of eye formation in cheese

Guggisberg et al. (2015)

IDF Cheese Science & Technology, 11 – 13 April 2016



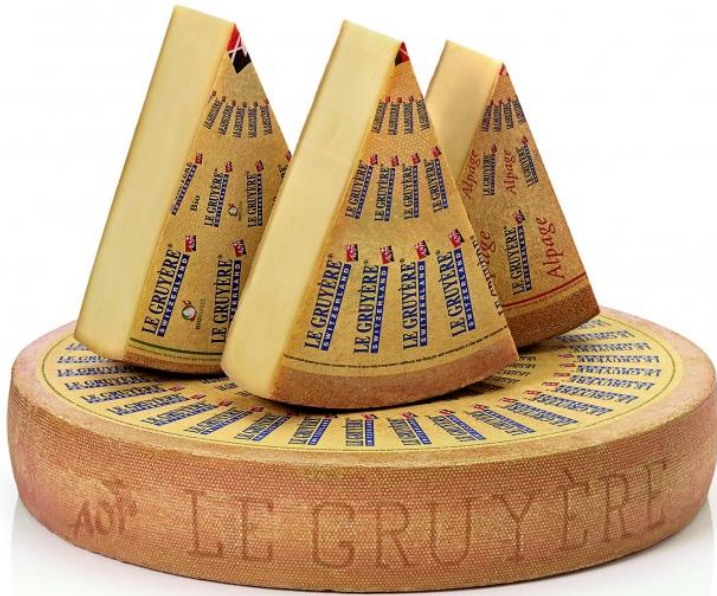
Appenzeller®

Swiss Tilsiter





CO₂ production undesired



Le Gruyère AOP



Sbrinz AOP

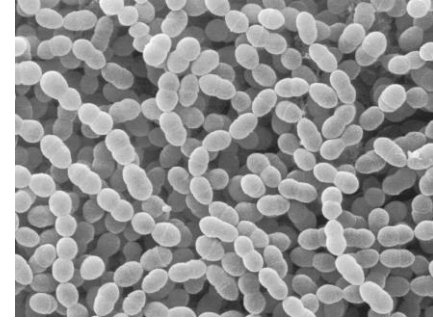
☞ Gas source: Homofermentative lactic acid bacteria (LAB)?

Contribution of Agroscope starters?

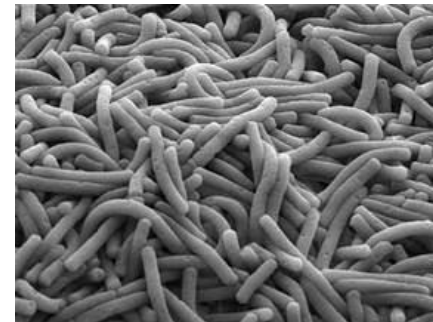


CO₂ formation by lactic acid bacteria

- Heterofermentative sugar fermentation
- Fermentation of citrate
- Decarboxylation of amino acids to biogenic amines
- Fermentation of lactate
- Arginine Deiminase Pathway (ADI)
 - ☞ Genome analyses of *Lb. delbrueckii* and *Lc. lactis*
 - ☞ Genes for the ADI pathway
 - ☞ Simple test: Ornithine formation!



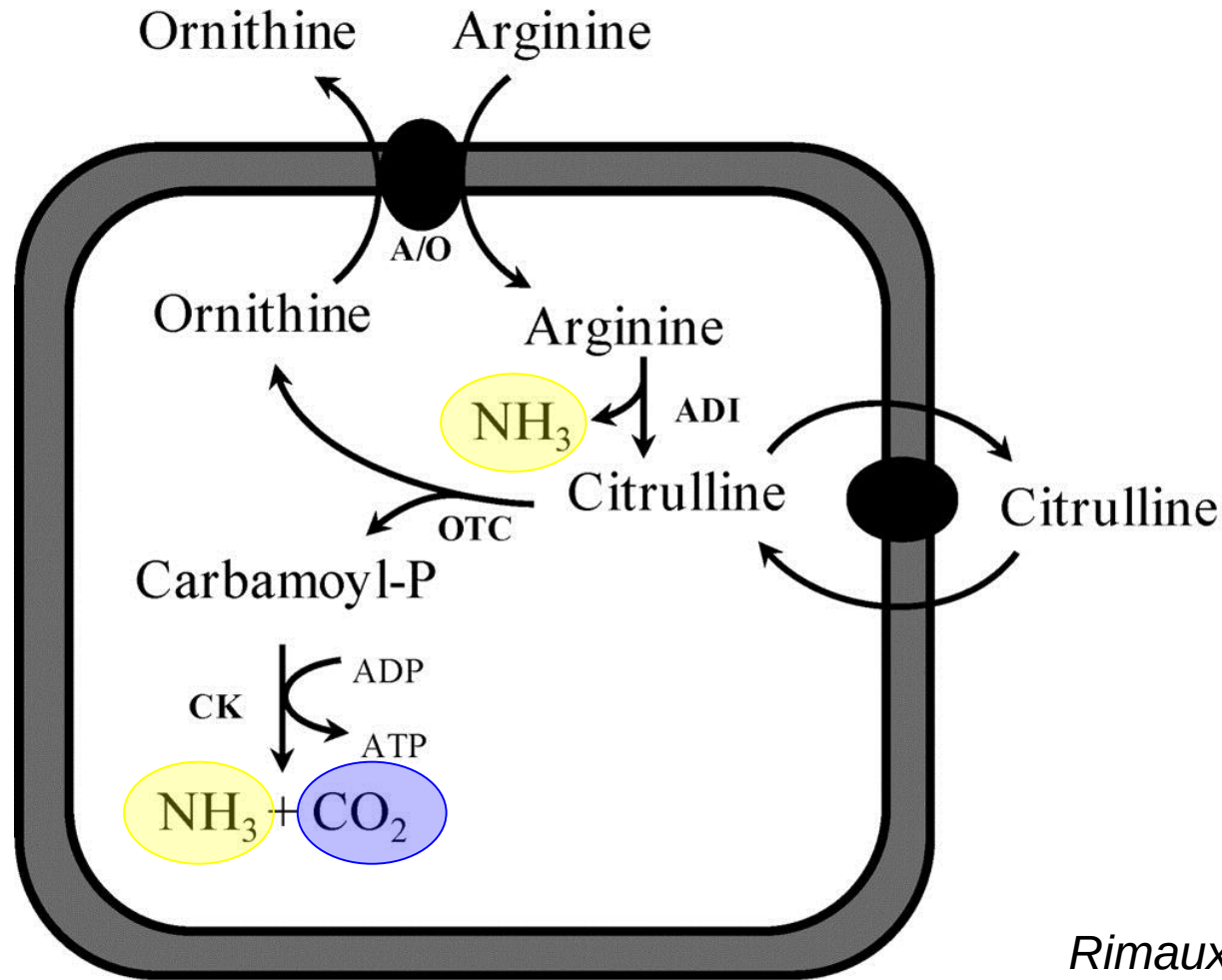
Str. thermophilus



Lb. delbrueckii



The arginine deiminase pathway

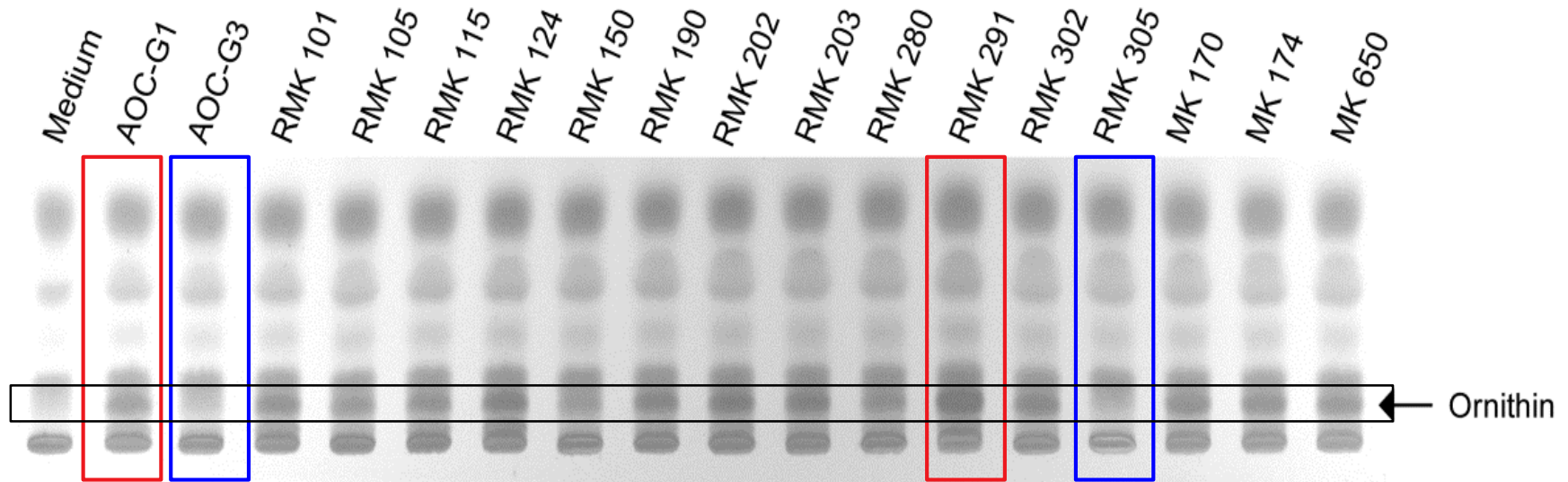


Rimaux et al. (2012)



Selection of starters I

1. Incubation of the Agroscope starter cultures in a medium containing arginine
2. Separation of the culture supernatants on thin-layer plates
3. Optical intensity of ornithine-bands → Selection





Selection of starters II

Weak ornithine formation

Strong ornithine formation

AOP-G3	RMK 305	AOP-G1	RMK 291
thermophilic mixed culture	thermophilic mixed culture	thermophilic mixed culture	thermophilic mixed culture
<i>Lb. delbrueckii</i> subsp. <i>lactis</i> , <i>S. thermophilus</i> , <i>Lb. helveticus</i>	<i>Lb. delbrueckii</i> subsp. <i>lactis</i> , <i>S. thermophilus</i>	<i>Lb. delbrueckii</i> subsp. <i>lactis</i> , <i>S. thermophilus</i> , <i>Lb. helveticus</i>	<i>Lb. delbrueckii</i> subsp. <i>lactis</i> , <i>S. thermophilus</i>
Gruyère AOP	Sbrinz	Gruyère AOP	Gruyère, semi-hard cheeses, alpine cheeses

<http://www.agroscope.admin.ch/kulturen/>





Experimental cheese production

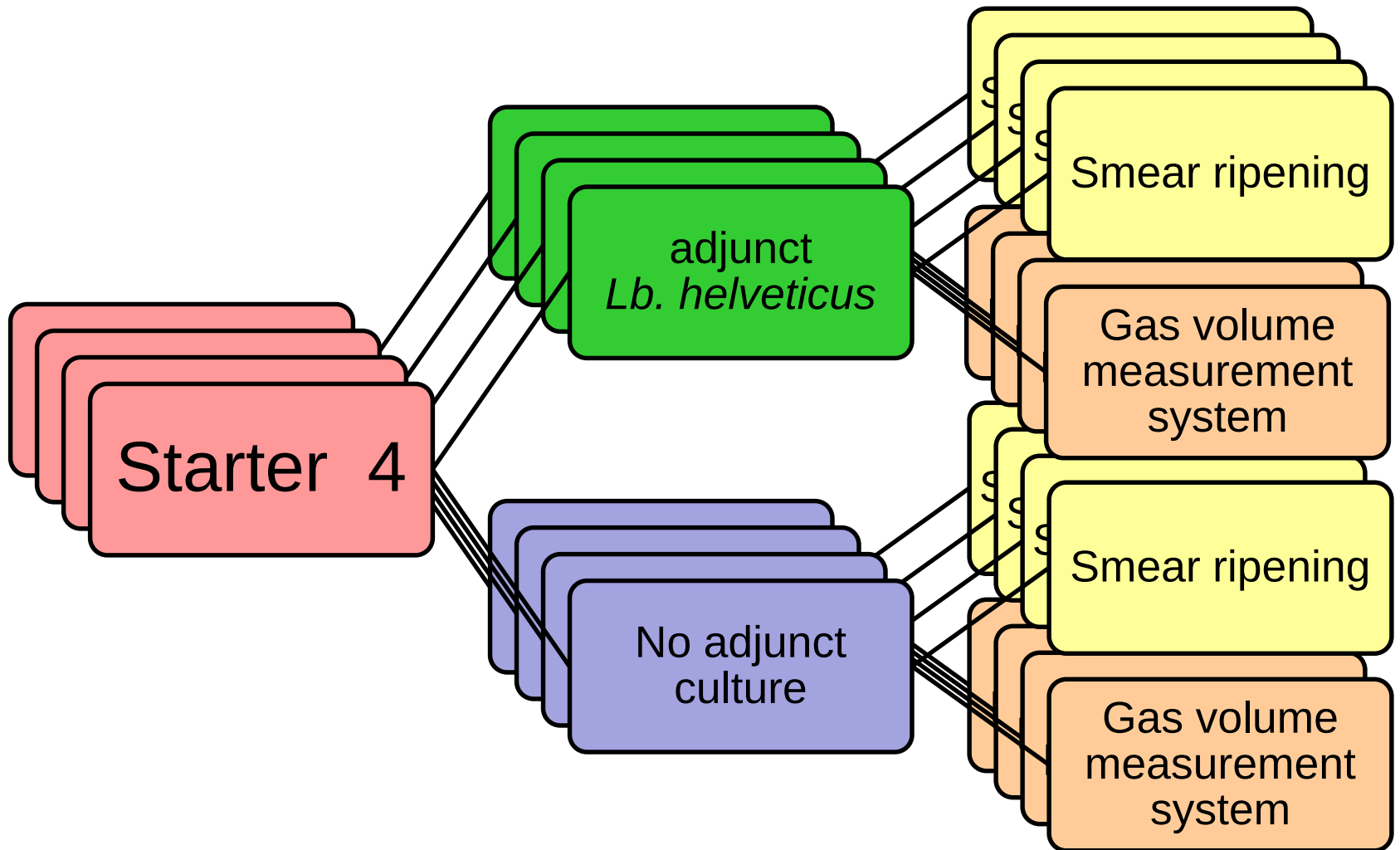
- Gruyère-type cheeses from raw milk
- 2 experiments
- 5 production days
- 8 cheeses per day
- 40 cheeses in total



Aim:
To study the influence of ornithine formation by starter cultures on cheese quality



Experimental design





Gas volume measurement system





Results

- Means of the smear ripened cheeses and of the cheeses ripened in the gas monitor system
- N = 10 per starter
- 6 months ripening time
- Smear-ripened cheeses:

water ↓

lactate ↓

pH-value ↑

volatile carboxylic acids ↑

proteolysis into depth ↑

gas monitor

smear





Cheese composition

👉 No relevant differences in the content of lactate, water and volatile carboxylic acids (VCA) between the tested cultures.

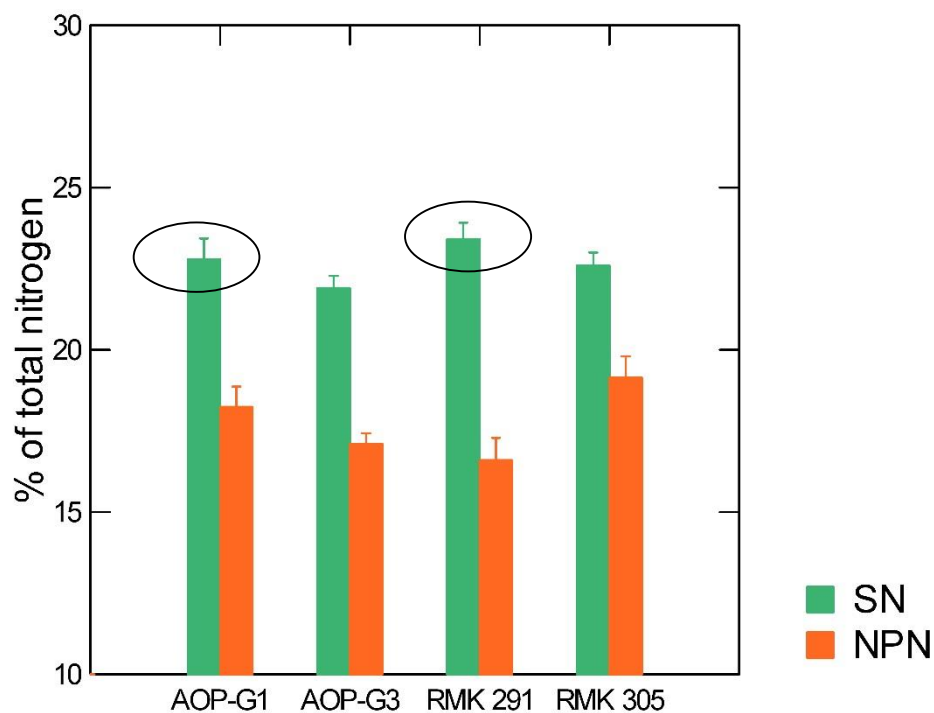
	lactate (mmol/kg)	water (gl/kg)	VCA (mmol/kg)
AOP-G3	142	339	5.20
RMK 305	142	343	5.38
AOP-G1	141	338	5.34
RMK 291	145	342	5.22



Proteolysis

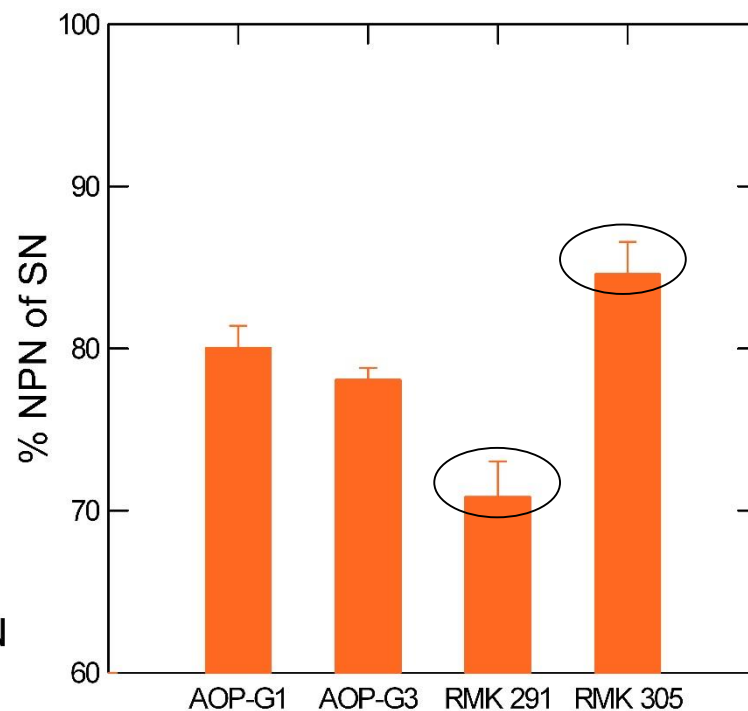
Primary proteolysis

Ornithine-forming starters ↑



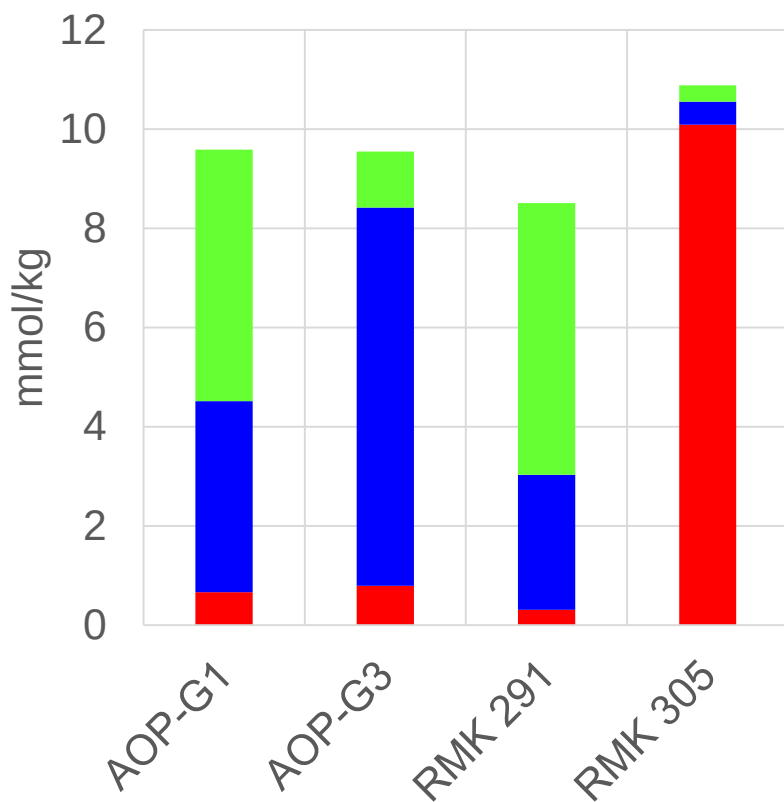
Secondary proteolysis

RMK 305 ↑ and RMK 291 ↓





Ornithine formation



Ornithine formation

- AOP-G1 and RMK 291 ↑
- AOP-G3 and RMK 305 ↓

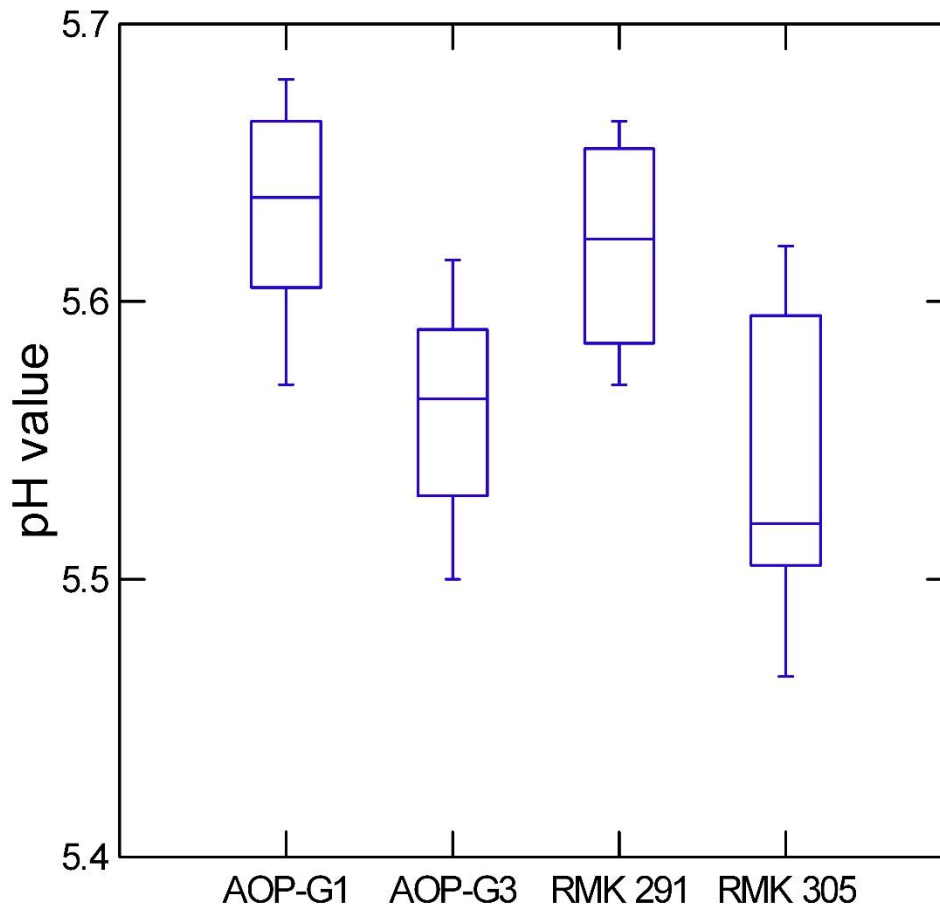
Arginine degradation

- AOP-G1, RMK 291, AOP-G3 ↑
- RMK 305 ↓

Ornithine (■) Citrulline (■) Arginine (■)



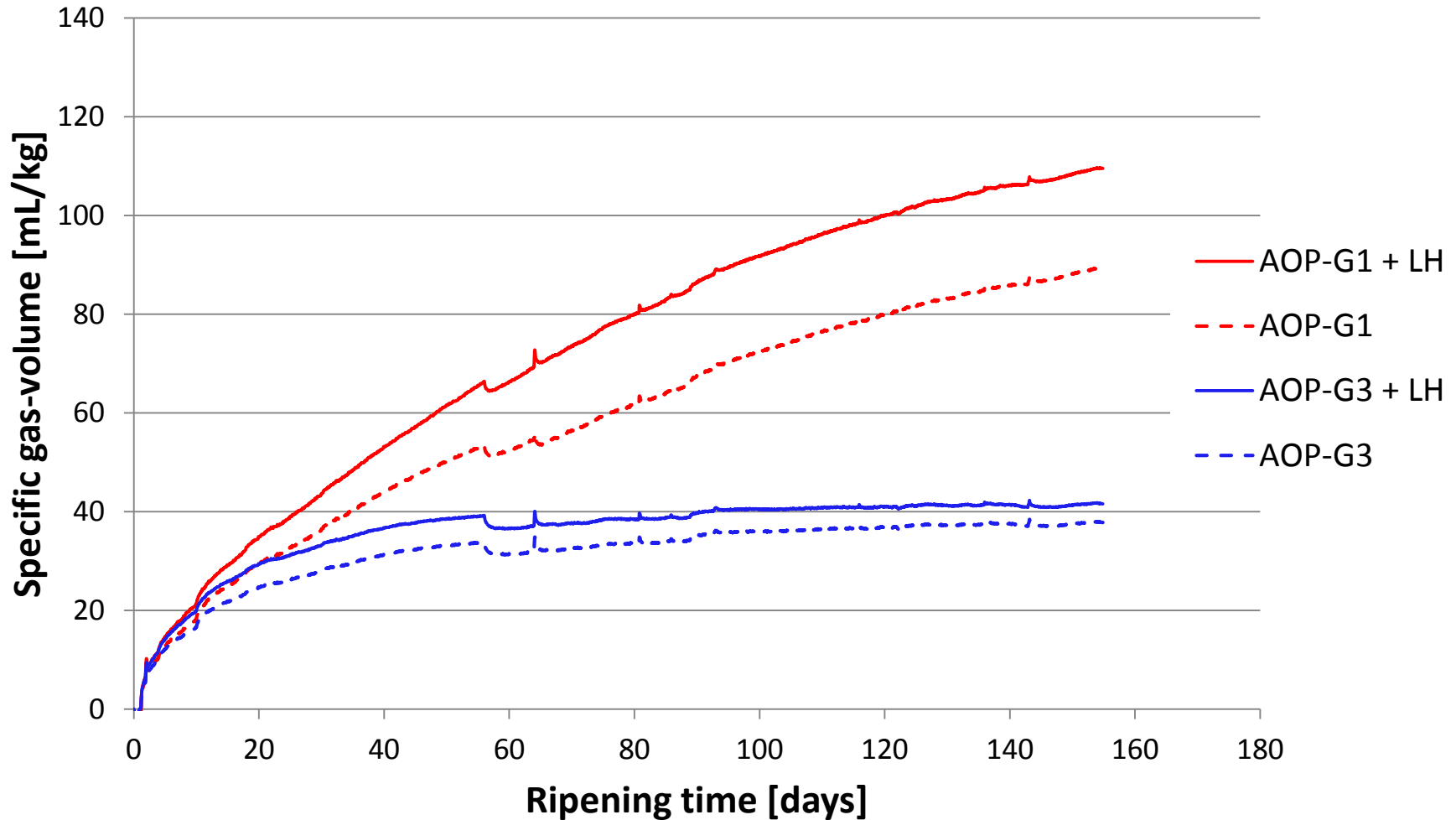
Effect on pH value in cheese



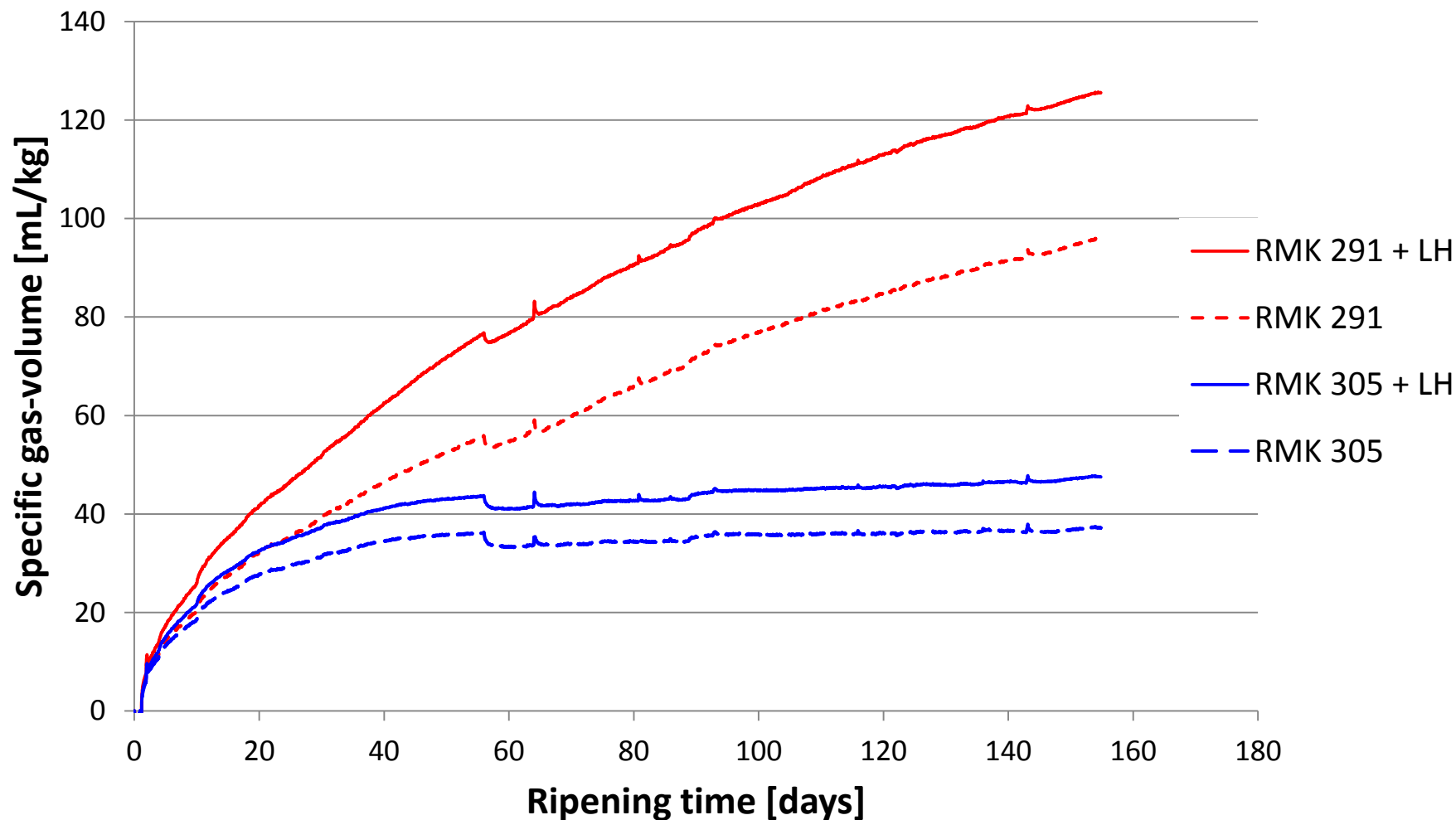
pH value

Ornithine forming starters ↑

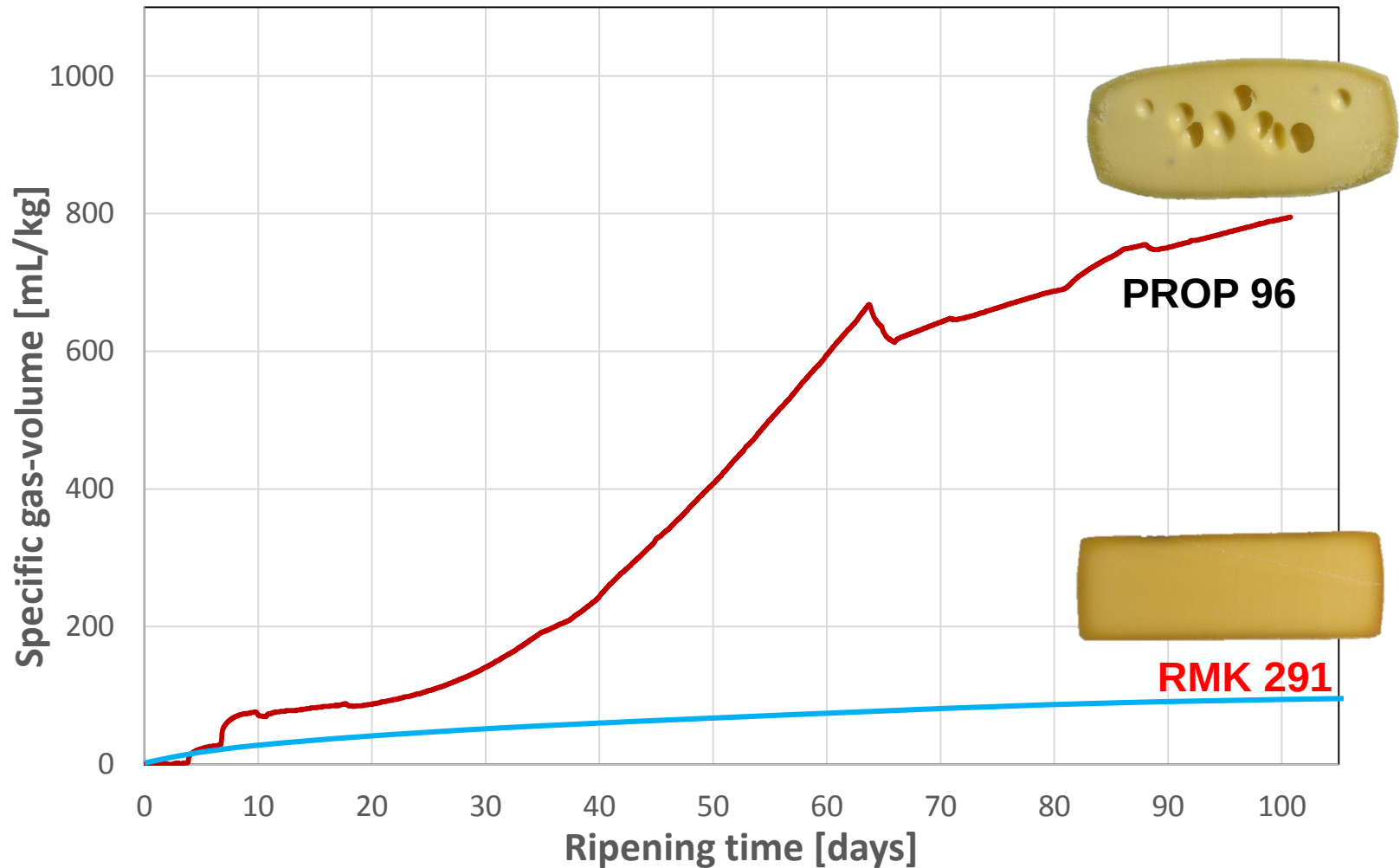
Effect on gas formation (gas monitor)



Effect on gas formation (gas monitor)

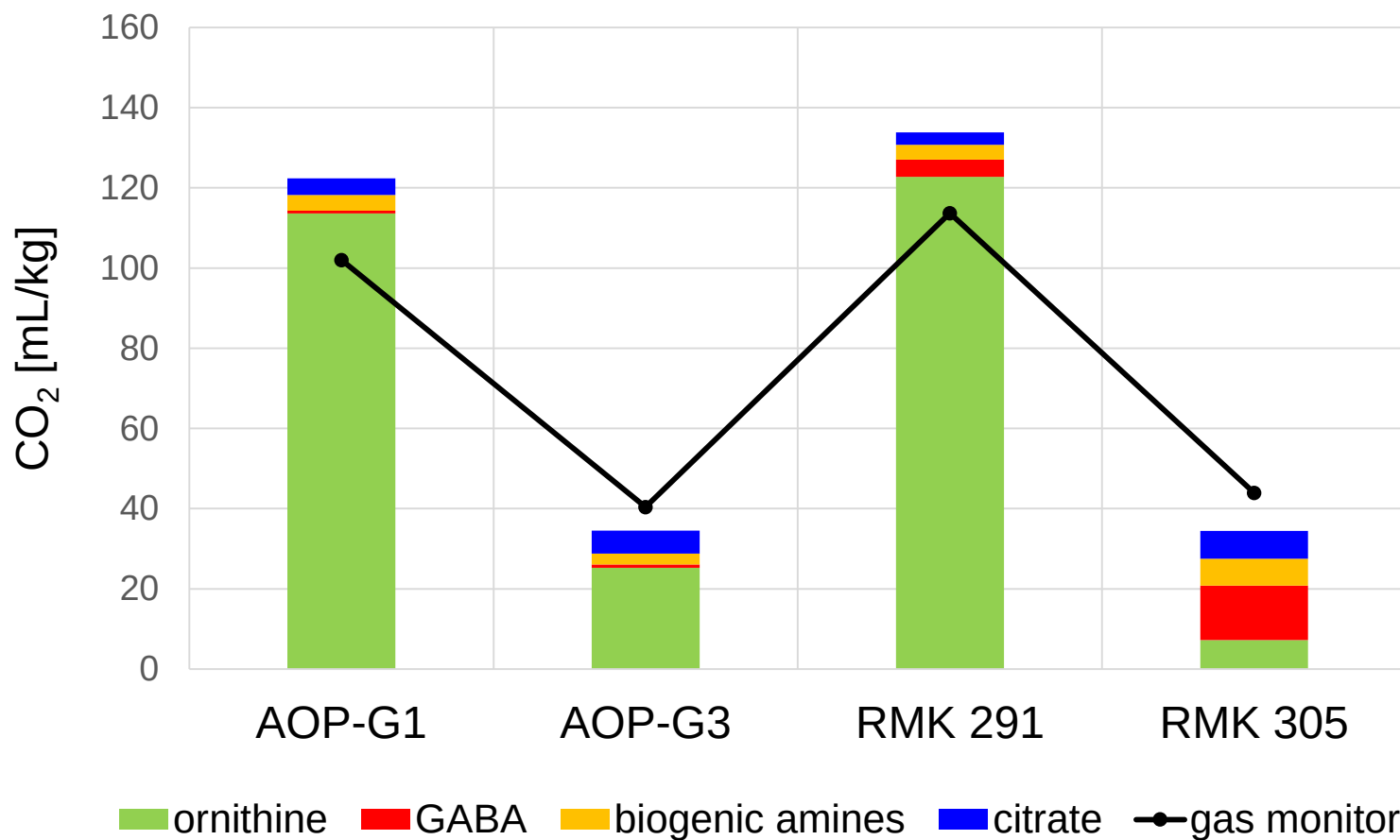


In comparison with Swiss-type cheese



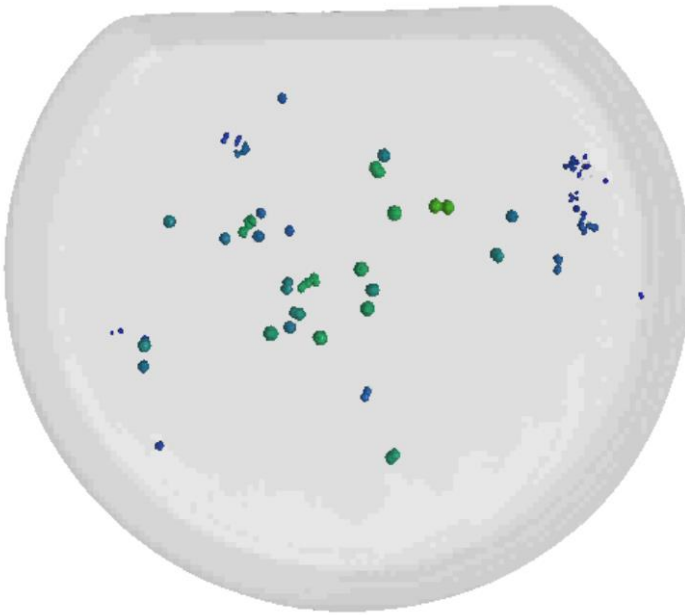


Sources of CO₂



⇒ Ornithine (and γ -aminobutyric acid)

Eye formation in Gruyère-type cheese



with AOP-G1



with AOP-G3



Summary

Weak ornithine formation

Cheeses with AOP-G3

- SN ↓
- pH ↓
- CO₂ ↓

Cheeses with RMK 305

- SN ↓
- NPN ↑
- pH ↓
- CO₂ ↓

Strong ornithine formation

Cheeses with AOP-G1

- SN ↑
- pH ↑
- CO₂ ↑

Cheeses with RMK 291

- SN ↑
- NPN ↓
- pH ↑
- CO₂ ↑

Lb. helveticus?



Conclusion

The ability to form ornithine has to be considered when selecting a starter culture.

👉 Reason

The ornithine formation by starters has an impact on

- pH-value
- ripening and
- eye formation in cheese.





Thank you for your attention

**Walter Bisig, Dominik Guggisberg,
Ernst Jakob, Daniel Wechsler, Stefan Irmeler**

