



# Evaluation of the Lipolytic and Antioxidant Activities of Different Strains of Coagulase-negative *Staphylococci* in Fermented Sausages

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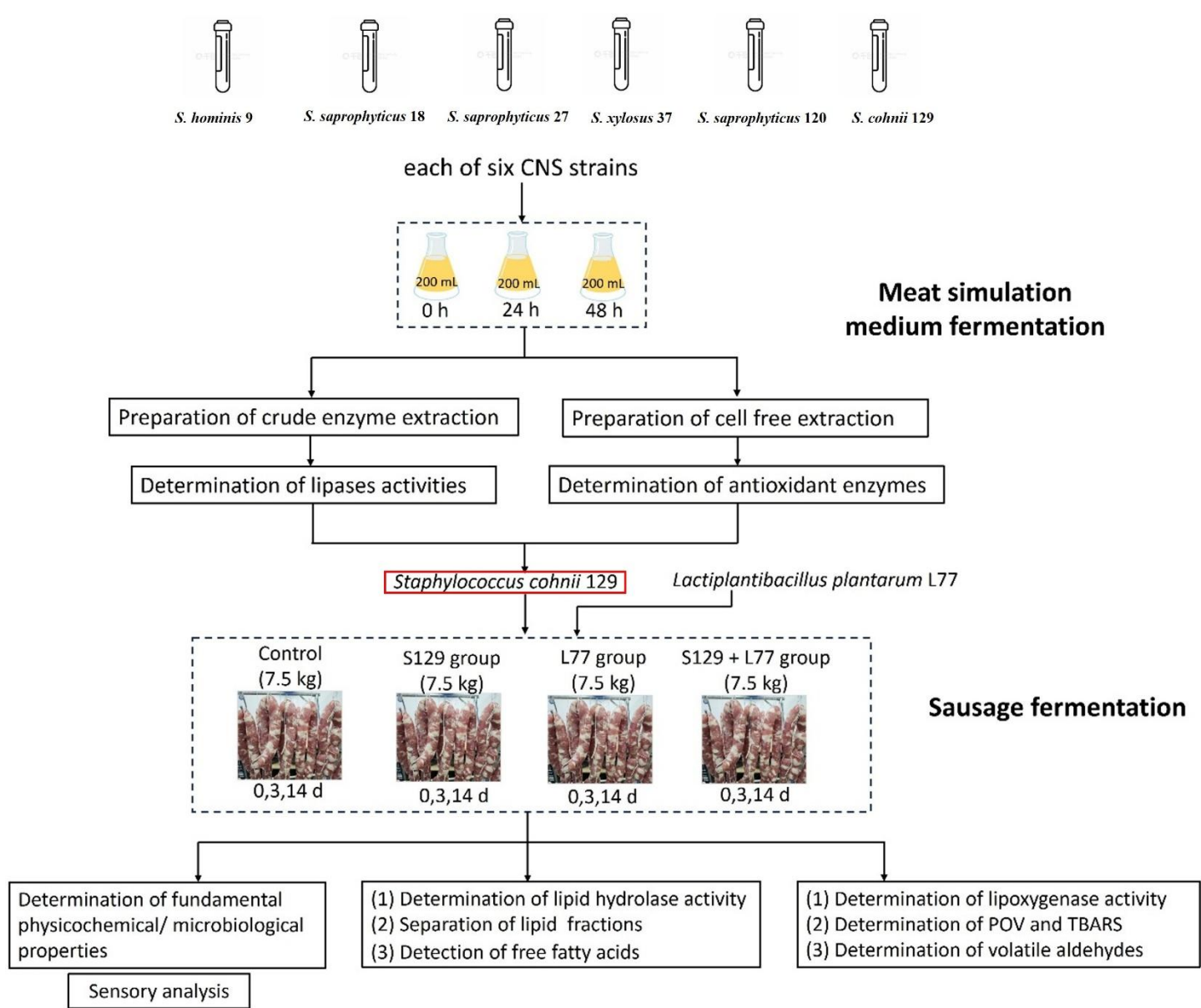
## Introduction

- Recent studies have indicated that coagulase negative staphylococci (CNS) are not only predominant but also exhibit greater biodiversity compared to lactic acid bacteria in fermented sausages.
- Moderate lipid oxidation can produce appropriate levels of small aldehydes, ketones, and carboxylic acids, thereby enhancing the flavor of meat products. Conversely, excessive lipid oxidation results in the formation of large quantities of volatile compounds, associated with off-flavors and undesirable taste.
- Currently, there is limited knowledge regarding the precise enzyme activities associated with lipid hydrolysis and oxidation of CNS strains and the effects of them on sausage fermentation.

## Objectives

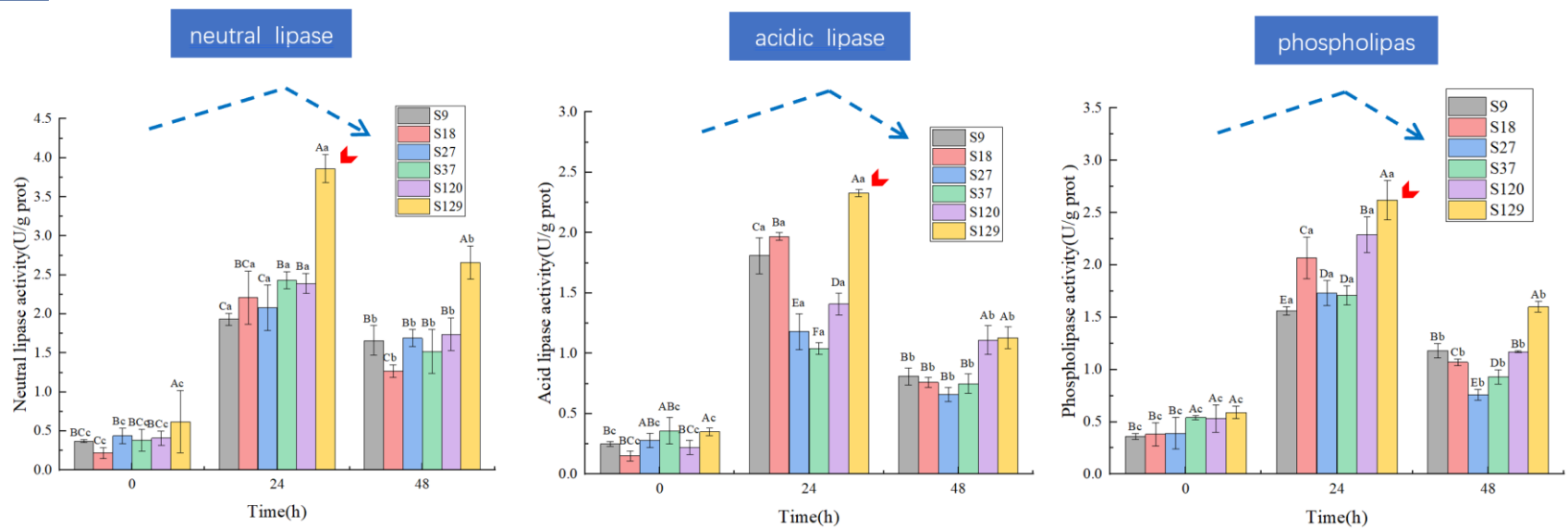
In our previous study, we identified some CNS strains with remarkable lipolytic activity on tributyrin-containing agar and CAT activity in gas release tests, from Chinese spontaneously fermented meat products. In this study, we would like to evaluate the lipid hydrolase and antioxidant enzyme activities of six CNS strains in a meat simulation medium firstly, then examine the effects of the selected strain on lipid hydrolysis and oxidation in fermented sausage.

## Experimental design

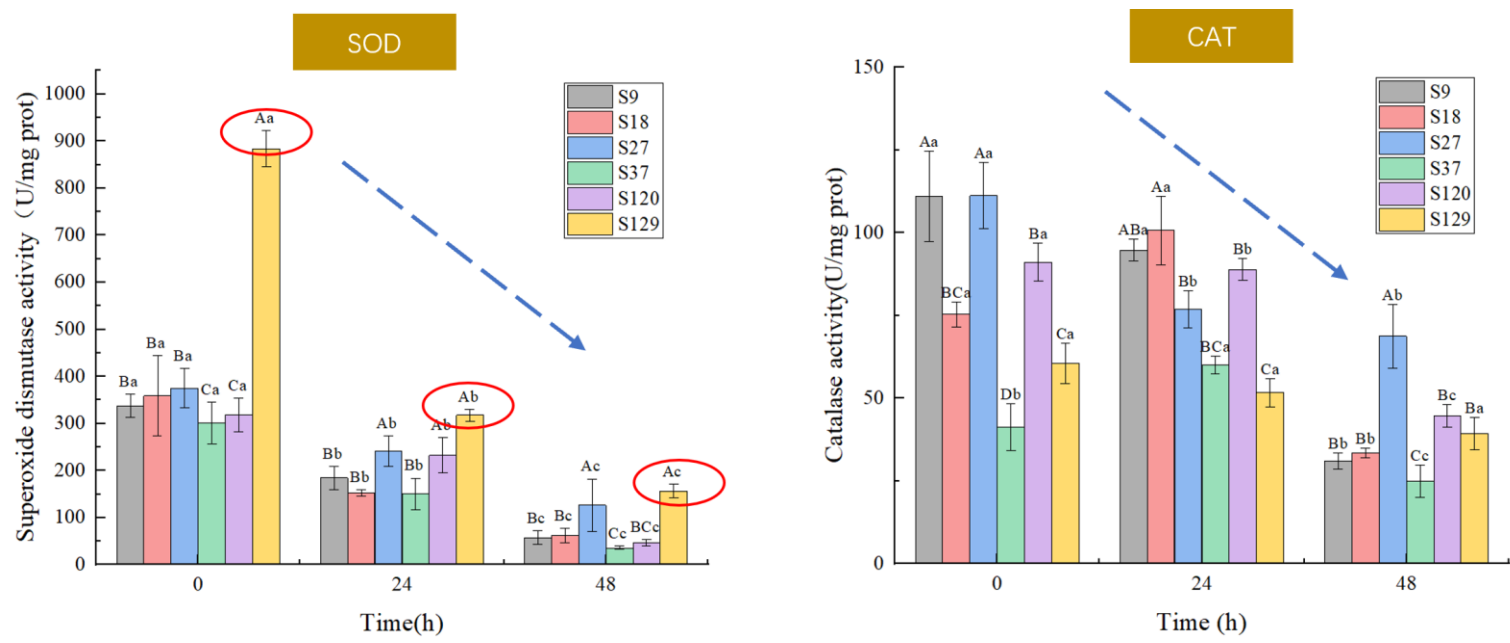


## Results

### 1 Enzyme activities of six CNS strains



Effect of strain and fermentation time on the lipid hydrolase activity



Effect of strain and fermentation time on the antioxidant enzyme activity

Above all, *S. cohnii* 129 exhibited remarkable lipid hydrolase activity and SOD activity. Hence, *S. cohnii* 129 was selected as the optimal strain to ferment sausage either alone (S129) or in combination with *Lactiplantibacillus plantarum* 77 (S129+L77), with a blank group as the control.

## References

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## 2 Sausage fermentation

### Lipid hydrolysis

diglyceride: μmol/g, others: g/100 g						
Indexes	Time (d)	Control	L77	S129	S129+L77	P <sub>Two</sub>
neutral lipids	0	46.50 <sup>c</sup>	43.52 <sup>c</sup>	45.50 <sup>c</sup>	45.19 <sup>c</sup>	2.44
	3	65.53 <sup>a</sup>	61.29 <sup>a</sup>	64.53 <sup>a</sup>	63.11 <sup>a</sup>	2.93
	14	60.36 <sup>b</sup>	59.50 <sup>b</sup>	62.19 <sup>b</sup>	59.51 <sup>b</sup>	2.19
	0	9.36 <sup>Ca</sup>	9.50 <sup>Ba</sup>	10.50 <sup>Ca</sup>	9.33 <sup>Ba</sup>	1.53
phospholipid	3	4.25 <sup>Cb</sup>	4.50 <sup>Bb</sup>	3.51 <sup>Dc</sup>	6.53 <sup>Ab</sup>	1.02
	14	3.98 <sup>Cc</sup>	4.16 <sup>Bc</sup>	4.29 <sup>Bc</sup>	3.50 <sup>Dc</sup>	1.17
	0	170.42 <sup>Aa</sup>	157.66 <sup>Ba</sup>	170.84 <sup>Aa</sup>	163.74 <sup>ABa</sup>	3.08
	3	151.96 <sup>Bb</sup>	166.94 <sup>Aa</sup>	166.02 <sup>Ab</sup>	148.11 <sup>Bb</sup>	2.34
diglyceride	14	149.29 <sup>BCb</sup>	157.01 <sup>ABa</sup>	163.95 <sup>Aa</sup>	146.28 <sup>Bb</sup>	3.89
	0	0.75 <sup>c</sup>	0.72 <sup>c</sup>	0.74 <sup>c</sup>	0.77 <sup>c</sup>	0.11
	3	0.91 <sup>Cb</sup>	1.33 <sup>Bb</sup>	1.49 <sup>Ab</sup>	1.51 <sup>Ab</sup>	0.26
	14	2.58 <sup>c</sup>	2.67 <sup>Ca</sup>	4.29 <sup>Aa</sup>	3.65 <sup>Ba</sup>	0.12
monoglyceride	0	2.88 <sup>ABc</sup>	1.38 <sup>Cc</sup>	2.53 <sup>Bc</sup>	2.99 <sup>Ac</sup>	0.22
	3	2.90 <sup>Cb</sup>	2.49 <sup>Db</sup>	3.87 <sup>Bb</sup>	4.35 <sup>Ab</sup>	0.19
	14	3.52 <sup>Bb</sup>	5.04 <sup>Ba</sup>	4.77 <sup>Ca</sup>	5.87 <sup>Aa</sup>	0.08
	0	6.63 <sup>Cb</sup>	9.20 <sup>Ac</sup>	9.39 <sup>Ac</sup>	8.57 <sup>Bc</sup>	0.89
free glycerol	3	19.03 <sup>Ba</sup>	22.57 <sup>Ab</sup>	13.11 <sup>Db</sup>	17.47 <sup>Cb</sup>	1.25
	14	20.30 <sup>Ba</sup>	24.47 <sup>Ca</sup>	33.68 <sup>Aa</sup>	30.72 <sup>Ba</sup>	1.52
	0	2.88 <sup>ABc</sup>	1.38 <sup>Cc</sup>	2.53 <sup>Bc</sup>	2.99 <sup>Ac</sup>	0.22
	3	2.90 <sup>Cb</sup>	2.49 <sup>Db</sup>	3.87 <sup>Bb</sup>	4.35 <sup>Ab</sup>	0.19
total fatty acids	14	3.52 <sup>Bb</sup>	5.04 <sup>Ba</sup>	4.77 <sup>Ca</sup>	5.87 <sup>Aa</sup>	0.08
	0	6.63 <sup>Cb</sup>	9.20 <sup>Ac</sup>	9.39 <sup>Ac</sup>	8.57 <sup>Bc</sup>	0.89
	3	19.03 <sup>Ba</sup>	22.57 <sup>Ab</sup>	13.11 <sup>Db</sup>	17.47 <sup>Cb</sup>	1.25
	14	20.30 <sup>Ba</sup>	24.47 <sup>Ca</sup>	33.68 <sup>Aa</sup>	30.72 <sup>Ba</sup>	1.52

Total FFA: g/100g, others: mg/100 g						
Indexes	Time (d)	Control	L77	S129	S129+L77	P <sub>Two</sub>
SFA subtotal [10]	0	3165.62 <sup>Dc</sup>	4228.00 <sup>Bc</sup>	3487.92 <sup>Cc</sup>	4359.86 <sup>Ac</sup>	23.87
	3	8585.43 <sup>Bb</sup>	9488.47 <sup>Ab</sup>	5921.33 <sup>Bb</sup>	7663.13 <sup>Cb</sup>	63.86
	14	8890.00 <sup>Ba</sup>	10645.08 <sup>Ca</sup>	13418.40 <sup>Aa</sup>	12953.87 <sup>Ba</sup>	61.96
	0	3568.72 <sup>ABc</sup>	3568.70 <sup>Ac</sup>	3487.86 <sup>Bc</sup>	3051.23 <sup>Bc</sup>	20.75
MUFA subtotal [9]	3	7482.87 <sup>Bb</sup>	9469.00 <sup>Ab</sup>	5219.84 <sup>Bb</sup>	7035.41 <sup>Cb</sup>	73.24
	14	7869.54 <sup>Ba</sup>	9612.06 <sup>Ca</sup>	13765.43 <sup>Aa</sup>	12679.11 <sup>Ba</sup>	146.26
	0	1004.93 <sup>Bc</sup>	1407.36 <sup>Ac</sup>	1413.72 <sup>Ac</sup>	1161.23 <sup>Bc</sup>	23.16
	3	2961.22 <sup>Bb</sup>	3612.67 <sup>Ab</sup>	1967.35 <sup>Db</sup>	2769.13 <sup>Cb</sup>	27.21
PUFA subtotal [10]	14	3541.91 <sup>Ba</sup>	4208.86 <sup>Ca</sup>	6491.34 <sup>Aa</sup>	5087.30 <sup>Ba</sup>	60.88
	0	6.63 <sup>Cb</sup>	9.20 <sup>Ac</sup>	9.39 <sup>Ac</sup>	8.57 <sup>Bc</sup>	0.89
	3	19.03 <sup>Ba</sup>	22.57 <sup>Ab</sup>	13.11 <sup>Db</sup>	17.47 <sup>Cb</sup>	1.25
	14	20.30 <sup>Ba</sup>	24.47 <sup>Ca</sup>	33.68 <sup>Aa</sup>	30.72 <sup>Ba</sup>	1.52
Total FFA [29]	0	0.317	0.333	0.405	0.266	
	3	0.345	0.381	0.332	0.361	
	14	0.398	0.395	0.488	0.393	
	0	0.317	0.333	0.405	0.266	
PUFA/SFA	3	0.345	0.381	0.332	0.361	
	14	0.398	0.395	0.488	0.393	

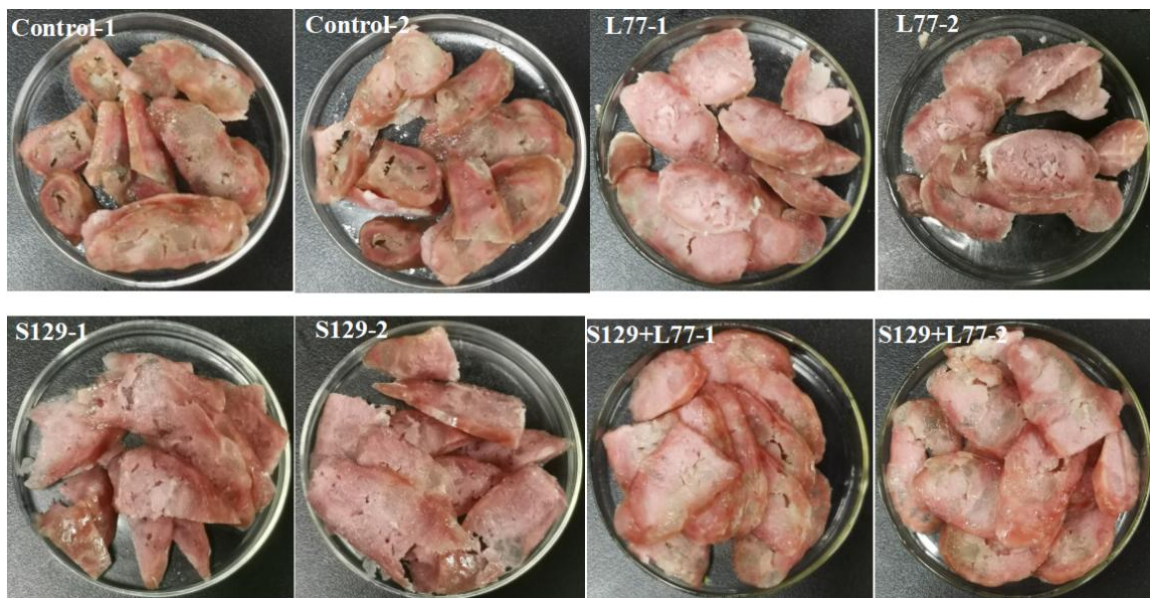
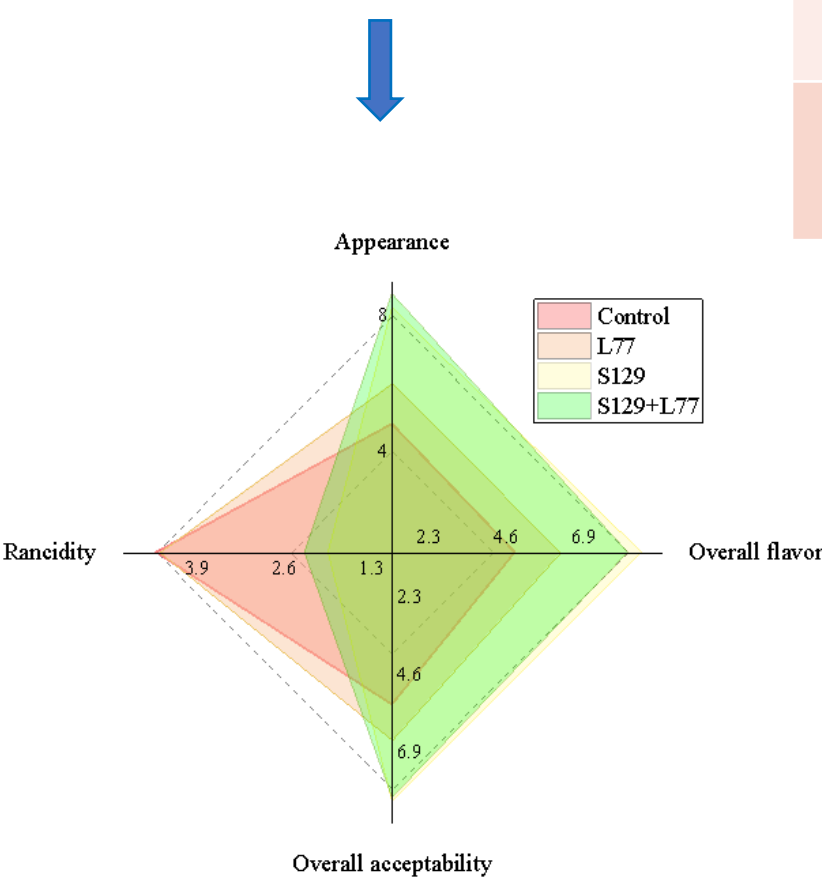
Lipase activities and the concentrations of lipid hydrolysis products, including monoglyceride, free glycerol, and free fatty acids, were higher in both S129 and S129+L77 than in the control.

### Lipid oxidation

Indexes	Time (d)	Control	L77	S129	S129+L77	Pooled SEM	P <sub>Two</sub>
LOX (U/g protein)	0	775.13 <sup>Aa</sup>	501.86 <sup>Bca</sup>	479.89 <sup>Ca</sup>	573.63 <sup>Ba</sup>	52.74	
	3	502.80 <sup>Ab</sup>	444.03 <sup>Ba</sup>	388.69 <sup>Ca</sup>	398.64 <sup>Cb</sup>	43.90	<0.001
	14	375.17 <sup>Ab</sup>	95.43 <sup>Cb</sup>	253.98 <sup>Bb</sup>	302.67 <sup>Abb</sup>	40.32	
	0	90.15 <sup>Ab</sup>	60.76 <sup>Ca</sup>	70.07 <sup>Ba</sup>	90.67 <sup>Aa</sup>	10.74	
POV (mg/100 g)	3	100.22 <sup>Ab</sup>	30.36 <sup>Cb</sup>	40.11 <sup>Cb</sup>	60.38 <sup>Bb</sup>	8.91	<0.001
	14	130.68 <sup>Ab</sup>	60.14 <sup>Ca</sup>	70.65 <sup>Ba</sup>	70.69 <sup>Bb</sup>	5.67	
	0	0.10 <sup>Bc</sup>	0.10 <sup>Bc</sup>	0.10 <sup>Bb</sup>	0.13 <sup>Ab</sup>	0.01	
	3	0.19 <sup>Ab</sup>	0.15 <sup>Bb</sup>	0.12 <sup>Bb</sup>	0.13 <sup>Bb</sup>	0.01	<0.001
TBARS (mg/kg)	14	0.40 <sup>Aa</sup>	0.33 <sup>Ba</sup>	0.33 <sup>Ba</sup>	0.30 <sup>Ca</sup>	0.02	
	0	0.317	0.333	0.405	0.266		
	3	0.345	0.381	0.332	0.361		
	14	0.398	0.395	0.488	0.393		

The suppression of lipoxxygenase activity, TBARS, hexanal, and saturated aldehyde production was more pronounced in S129 and S129+L77 compared to the control.

The highest scores for overall flavor and acceptability, and the lowest score for rancid notes, were reported for S129.



## Conclusion

Our findings suggest that *Staphylococcus cohnii* 129, a relatively uncommon CNS strain, has the potential to serve as a functional starter culture, promoting lipid hydrolysis and mitigating lipid peroxidation, ultimately enhancing the overall quality of fermented sausages.

## Acknowledgements

- National Key Research and Development Program from Ministry of Science and Technology of China (2022YFE0120800);
- Sichuan Science and Technology Program (2025ZNSFSC0226)