DESIGN OF AN INDIGENOUS STARTER FOR THE PRODUCTION OF ROCAMADOUR, A FRENCH PDO CHEESE

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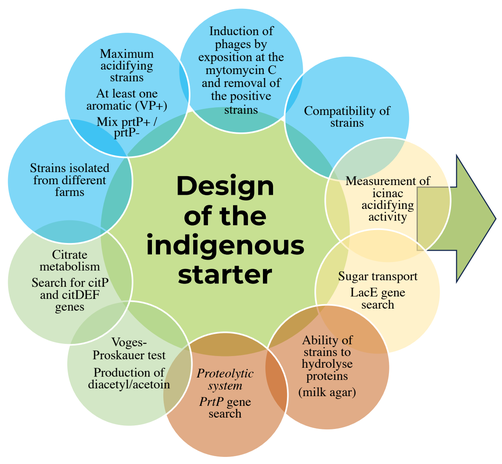
CONTEXT

Raw milk cheeses owe their typicity to the milk's native microflora. However, a decrease in lactic acid bacteria in raw milk has resulted in the use of industrial starters. This practice led to the standardization of cheeses and impacted raw milk cheeses such as PDOs. To restore this natural diversity, the use of indigenous starters presents an interesting alternative and strengthens the connection between the PDO cheese, its terroir and its microbial heritage.

RESULT - I

Three strains of *Lactococcus lactis* were selected to constitute an indigenous starter



Strains	V_{max} (UpH/h)	Final pH	*lacE*	Hydrolysis of casein	*prtP*	VP Test	*citDEF*/ *citP*	Prophage
EIP13D	0.204	4.59	+	+	+	++	-	-
EIP20B	0.216	4.54	+	+	+	-	-	-
EIP07A	0.066	5.88	+	-	-	+	-	-

Table 1. Phenotypic and genetic properties of the selected strains. Twenty-four strains of *Lactococcus lactis* isolated from raw goat's milk from the Rocamadour PDO area were characterized. Strains were selected based on genetic and phenotypic capabilities in addition to strains' compatibility (*Couderc* et *al*., 2022).

RESULT - II

Cheeses produced with the selected indigenous starter met the expected specifications of the Rocamadour PDO label

	Fresh curd (J0)		Drained Cheese (J1)		Mature cheese (J6)	
	Industrial starter (n.3)	**Indigenous** starter (n.3)	**Industrial** starter (n.3)	**Indigenous** starter (n.3)	**Industrial** starter (n.3)	**Indigenous** starter (n.3)
Dry matter (g/100g)	$38.28^a \pm 2.49$	$40.88^a \pm 3.20$	$36.79^a \pm 1.70$	$37.99^a \pm 0.26$	$38.24^a \pm 2.63$	$38.75^a \pm 1.03$
Fat (g/100g)	$19.83^a \pm 1.45$	$21.70^a \pm 1.65$	$18.37^a \pm 1.62$	$19.03^a \pm 0.71$	$19.83^a \pm 2.59$	$20.63^a \pm 1.26$
pH	$4.38^a \pm 0.03$	$4.25^a \pm 0.09$	$4.45^a \pm 0.05$	$4.33^a \pm 0.06$	$4.72^a \pm 0.28$	$4.72^a \pm 0.28$
MFFB (%)	$76.97^a \pm 1.79$	$75.47^a \pm 2.46$	$77.43^a \pm 0.81$	$76.60^a \pm 0.46$	$77.03^a \pm 1.00$	$77.17^a \pm 0.23$
Fat / Dry (%)	$51.80^a \pm 1.05$	$53.07^a \pm 0.15$	$49.87^a \pm 2.29$	$50.10^a \pm 1.55$	$51.70^a \pm 3.48$	$53.23^a \pm 1.90$

Table 2. Physical-chemical properties of cheeses at three stages of the fermentation process (fresh curd, drained cheese and ripened cheese). Data are mean ± standard deviation (n=3); The letter (a) indicates no significant statistical differences (Kruskal-Wallis's test with p-value < 0.05) between the industrial starter (CHN19, CHR Hansen) and the selected indigenous starter.

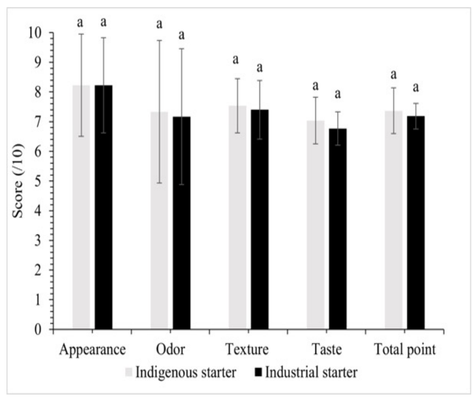


Figure 1. Sensory analysis of cheeses carried out by the official Rocamadour PDO cheese tasting committee (p-value < 0.05).

RESULT - III

The indigenous starter provides a different sensory signature

Descriptors	Fisher's Test	*p*-value
Velvety skin	4.619	**0.010**
Colour ivory/cream to yellow	0.425	0.737
Total odor	0.454	0.716
Balanced odor	0.601	0.620
Real goat odor	0.903	0.453
Real fermentations odors	0.626	0.604
Creamy	2.636	0.070
Fondant	6.135	**0.003**
Sticky	1.191	0.332
Grainy	4.206	**0.015**
Homogeneity between skin and heart	9.299	**0.000**
Balanced flavour	0.537	0.661
Sour/pungent	0.164	0.920
Bitter	4.339	**0.013**
Salty	0.914	0.447
Persistent taste	2.482	0.082
Off-aftertaste	0.983	0.415

Values in bold correspond to discriminating descriptors (p-value < 0.05).

Table 3. Sensory analysis of cheeses carried out by a trained panel using 17 descriptor. ANOVA of a product effect for each descriptor.

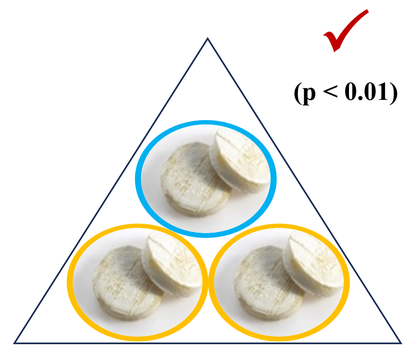


Figure 2. A triangle test by a trained panel significantly discriminates the products from industrial or indigenous starters.

RESULT - IV

Rocamadour PDO cheeses were composed mainly of *Lactococcus lactis* (relative abundance > 96,50 % in all samples) and *Geotrichum candidum* (> 99,30 %) but the two types of starter were differentiated by the sub-dominant bacterial ecosystem

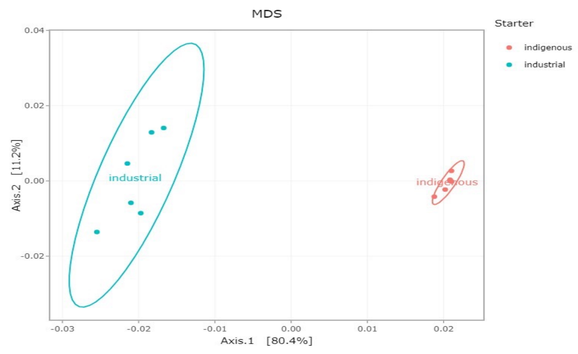


Figure 3A. β-diversity (Bray Curtis index) 16S rRNA cheese core

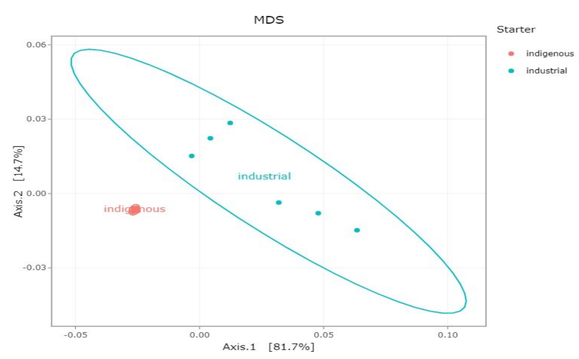


Figure 3B. β-diversity (Bray Curtis index) 16S rRNA cheese skin

CONCLUSION

The indigenous starter, composed of strains well adapted to the production of Rocamadour cheese, has been successfully tested and could be an alternative to the use of industrial starters by strengthening the links with the terroir.

METHODOLOGY

The indigenous starter was used to produce cheeses at "Les Fermiers du Rocamadour". These cheeses were then compared to other ones produced with the industrial starter usually used for Rocamadour production (CHN19, CHR Hansen).

- Physicochemical analysis on D0 (fresh curd), D1 (drained cheese), or D6 (ripened cheese) were conducted (Table 2) (*Couderc* et *al*., 2022).
- Sensorial analysis was realized by an expert panel of Rocamadour PDO cheese (Figure 1) or an external trained panel (Figure 2 & Table 3) (*Couderc* et *al*., 2022).
- Profiling of bacterial communities based on 16S rRNA and ITS2 amplicon sequencing were studied as follows: Libraries generated with V3-V4 regions for 16S rRNA and ITS3 tagmix1 and ITS4ngs regions for ITS2 (*Tedersoo* et *al*., 2015); 2x300 bp paired-end sequencing - Illumina MiSeq; Data processing: DADA2 and FROGS pipeline and phyloseq (Figure 3A, 3B)

REFERENCES

Couderc et *al*. IJFM 2022 379:109837 - *Tedersoo* et *al. Mycokeys* 2015 10:1-43

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