



Figure S1 Parmigiano Reggiano manufacture process and ripening conditions adopted at the cheese factories involved in this study.

Table S1. Free amino acid (FAA) composition (g/100 g FAA) of Parmigiano-Reggiano cheeses ripened up to 50 months. Results are expressed as mean \pm standard deviation.

Ripening time (months)	Asp	Thr	Ser	Asn	Glu	Gln	Gly	Ala	Cit	Val	Met	Ile	Leu	Tyr	Phe	Gaba	Om	Lys	His	Arg	Pro
12	3.86 \pm 0.03	3.52 \pm 0.05	6.01 \pm 0.05	4.05 \pm 0.03	17.04 \pm 0.26	0.81 \pm 0.04	2.25 \pm 0.03	2.62 \pm 0.03	3.31 \pm 0.05	7.33 \pm 0.05	2.32 \pm 0.06	6.26 \pm 0.26	8.52 \pm 0.12	3.6 \pm 0.19	4.96 \pm 0.08	0 \pm 0	0.9 \pm 0.02	10.3 \pm 0.05	2.66 \pm 0.04	0.67 \pm 0.01	9 \pm 0.16
18	4.44 \pm 0.56	2.99 \pm 0.06	6.36 \pm 0.12	3.33 \pm 0.44	16.76 \pm 0.33	0.4 \pm 0.04	2.64 \pm 0.11	2.84 \pm 0.05	3.37 \pm 0.17	7.56 \pm 0.22	2.33 \pm 0.06	6.46 \pm 0.12	8.18 \pm 0.18	3.37 \pm 0.14	4.67 \pm 0.23	0.2 \pm 0.22	0.96 \pm 0.08	10.68 \pm 0.17	2.77 \pm 0.14	0.24 \pm 0.27	9.44 \pm 0.20
24	4.2 \pm 0.42	3.8 \pm 0.07	6.92 \pm 0.06	3.83 \pm 0.36	16.16 \pm 0.42	0.15 \pm 0.16	2.16 \pm 0.03	2.69 \pm 0.04	0.85 \pm 0.08	7.67 \pm 0.18	2.37 \pm 0.06	6.38 \pm 0.09	7.99 \pm 0.27	3.32 \pm 0.25	4.47 \pm 0.13	0.53 \pm 0.24	0.16 \pm 0.06	10.36 \pm 0.16	2.86 \pm 0.02	3.65 \pm 0.39	9.46 \pm 0.27
30	4.18 \pm 0.1	2.2 \pm 0.11	7.12 \pm 0.28	3.83 \pm 0.06	16.6 \pm 0.49	0.07 \pm 0.07	3.28 \pm 0.15	2.89 \pm 0.09	2.47 \pm 0.15	7.73 \pm 0.24	2.65 \pm 0.26	6.69 \pm 0.39	8.43 \pm 0.44	2.78 \pm 1.09	4.68 \pm 0.07	0 \pm 0	1.52 \pm 0.03	10.63 \pm 0.62	2.31 \pm 0.04	0 \pm 0	9.96 \pm 0.30
40	4.8 \pm 0.24	3.74 \pm 0.06	7.53 \pm 0.05	3.52 \pm 0.03	16.7 \pm 0.1	0 \pm 0	2.26 \pm 0.07	2.71 \pm 0.02	2.3 \pm 0.75	7.63 \pm 0.22	2.28 \pm 0.14	6.3 \pm 0.13	7.72 \pm 0.65	2.88 \pm 0.36	4.63 \pm 0.06	0.1 \pm 0.11	0.34 \pm 0.07	10.48 \pm 0.13	2.61 \pm 0.05	2.06 \pm 1.12	9.42 \pm 0.21
50	7.11 \pm 0.11	2.77 \pm 0.07	7.48 \pm 0.20	0.73 \pm 0.02	16.16 \pm 0.5	0 \pm 0	2.71 \pm 0.09	2.75 \pm 0.06	2.11 \pm 0.02	7.55 \pm 0.11	2.83 \pm 0.37	7.21 \pm 0.72	9.01 \pm 0.39	2.96 \pm 0.16	4.46 \pm 0.16	0.64 \pm 0.15	1.81 \pm 0.09	10.13 \pm 0.34	2.24 \pm 0.05	0 \pm 0	9.36 \pm 0.32

Table S2. Number of tyrosine crystals and spots counted on a surface of 100 cm² in Parmigiano-Reggiano cheeses ripened up to 50 months.

Ripening time (months)	Tyrosine crystals	Spots
12	92	0
18	42	182
24	53	415
30	98	332
40	55	277
50	59	590

Table S3. Correlation coefficients between compositional, rheological and chemical parameters. The asterisks indicate the significance levels (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$).

	Moisture	Fat	Protein	MNFS	Hardness	FAA	$\alpha 1$ - $1/\alpha 1$	$\Sigma\gamma/\Sigma\beta$	Number of fat globules	Porosity	Butanoic acid	Hexanoic acid	Heptanoic acid	Octanoic acid	Total VOCs
Moisture	1.000														
Fat	-0.782	1.000													
Protein	-0.089	-0.534	1.000												
MNFS	0.929*	-0.498	-0.445	1.000											
Hardness	-0.950**	0.651	0.197	-0.931*	1.000										
FAA	-0.890*	0.769	-0.102	-0.773	0.939*	1.000									
$\alpha 1$ - $1/\alpha 1$	0.837	-0.755	0.126	0.708	-0.904*	-0.980**	1.000								
$\Sigma\gamma/\Sigma\beta$	-0.963**	0.655	0.219	-0.950**	0.972**	0.866*	-0.803	1.000							
Number of fat globules	0.672	-0.674	0.197	0.526	-0.744	-0.877*	0.945*	-0.588	1.000						
Porosity	-0.891*	0.768	-0.105	-0.775	0.916*	0.988***	-0.956**	0.840	-0.867*	1.000					
Butanoic acid	-0.952**	0.701	0.108	-0.908*	0.934*	0.858*	-0.767	0.981**	-0.530	0.844*	1.000				
Hexanoic acid	-0.952**	0.756	0.040	-0.875*	0.932*	0.863*	-0.794	0.979**	-0.565	0.832*	0.987**	1.000			
Heptanoic acid	-0.762	0.611	-0.036	-0.687	0.875*	0.873*	-0.845	0.858*	-0.652	0.801	0.848	0.880*	1.000		
Octanoic acid	-0.518	0.012	0.526	-0.700	0.634	0.518	-0.390	0.636	-0.194	0.544	0.658	0.546	0.535	1.000	
Total VOCs	-0.954**	0.753	0.046	-0.881*	0.938*	0.870*	-0.801	0.981**	-0.574	0.840*	0.988***	1.000***	0.882*	0.556	1.000

