

Table S1. Manufacture characteristics of the studied varieties of Spanish sheep cheese.

		I-CLM	T-CLM	I-CL	T-CL
Production location		Castilla-La-Mancha (Central Spain)	Castilla-La-Mancha (Central Spain)	Castilla y León (north-western Spain)	Castilla y León (north-western Spain)
Manufacture		In large enterprises, according to PDO Manchego cheese	In local small enterprises according to traditional manufacture of ewe’s milk cheese	In large enterprises, according to Castellano cheese quality mark	In local small enterprises according to traditional manufacture of ewe’s milk cheese
Commercial designation		Manchego cheese PDO	Traditional Manchego sheep cheese	Castellano sheep cheese	Traditional Castellano sheep cheese
Sheep breed		Manchega	Manchega, Merina and Talaverana	Castellana and Churra	Castellana and Churra
Milk Pre-treatment		Pasteurised	Raw	Raw	Raw
Starter Culture		Homo-fermentative mesophilic LAB	Homo-fermentative mesophilic LAB	Homo-fermentative mesophilic LAB	Homo-fermentative mesophilic LAB
Rennet		Recombinant Chymosin	Calf commercial dried rennet	Recombinant Chymosin	Lamb commercial natural rennet
Coagulation	T (°C)	30-32	30-32	32	28-32
	Time (min)	45	40-45	35-40	30-45
Cutting Curd	Grain size (mm)	Continuous automated process	Semi-continuous process	Continuous automated process	Semi-continuous process
		5-10	5-10	5-8	5-10
Mild stirring		Continuous automated process	Discontinuous process	Continuous automated process	Discontinuous process
Pre-drainage of whey		Continuous automated process (mild stirred and pumped whey)	Manual (whey drainage by soft pressing)	Semi-continuous processes (mild stirred and pumped whey)	Manual (whey drainage by soft pressing)
Scalding	T (°C)	36-40	34-38	35-38	35-40
	Time (min)	30-35	30-40	40	30-40
Pre-pressing	Continuous automated process (previous pressing depending on mold size)		Manual (in curdling vats)	Continuous automated process (in curdling vats)	Manual (in curdling vats)
	T (°C)	30-32	30-32	30-32	30-32
	Time (min)	35	30	30	30
Moulding		Automatic	Manual	Manual	Manual
Pressing	Time (h)	Through pneumatic press	Through pneumatic press	Through pneumatic press	Through pneumatic press
		4	10-12	10-12	10
Unmoulding		Automated	Manual	Automated	Manual
Salting	By immersion in sodium chloride (20 g/100 mL)		By immersion in sodium chloride (23 g/100 ml)	By immersion in sodium chloride (20-22 g/100 mL)	By immersion in sodium chloride (20-21 g/100 mL)
	T (°C)	10	10-15	10	10-15
	Time (min)	20-24	20-24	24-30	28-32
Ripening	In chambers with automated control of temperature and RH		In chambers with automated control of temperature and RH	In chambers with automated control of temperature and RH	In chambers under natural conditions
	T (°C)	8-10	10	10	10-12
	RH (%)	80	75-80	75-80	75-80
	Time (days)	60 days for pieces bigger than 1.5 kg Semi-cured: 60-90 days Cured: 180 days			

I-CLM = pieces produced in an industry in Castilla-La-Mancha region; T-CLM = pieces manufactured according to an artisanal/traditional procedure also in Castilla-La-Mancha; I-CL = pieces produced in a large industry in Castilla y León; T-CL = manufactured according to an artisanal/traditional procedure also in Castilla y León. PDO = protected designation of origin. LAB = lactic acid bacteria. T (°C) = temperature; RH = relative humidity (%).

Table S2. Values of the physicochemical features (pH, a_w , DM, WC, Ash, Fat, and Protein contents) of the four considered Spanish sheep cheese varieties at different ripening times.

	RT* (days)	I-CLM [#]		T-CLM		I-CL		T-CL	
pH	2	5.69±0.04	a α	5.58±0.03	a β	5.26±0.03	ab γ	5.18±0.06	a γ
	9	5.66±0.06	a α	5.19±0.06	b γ	5.33±0.04	a β	5.06±0.05	b γ
	30	5.44±0.02	b α	5.14±0.05	b $\beta\gamma$	5.22±0.03	b β	5.07±0.02	b γ
	90	5.48±0.01	b α	5.20±0.02	b β	5.23±0.01	b β	5.11±0.02	ab γ
	180	5.49±0.02	b α	5.13±0.01	b γ	5.30±0.01	ab β	5.11±0.04	ab γ
a_w	2	0.952±0.001	a γ	0.961±0.001	a α	0.957±0.002	a β	0.964±0.003	a α
	9	0.951±0.002	a α	0.954±0.002	ab α	0.952±0.001	a α	0.945±0.008	b β
	30	0.942±0.007	b α	0.946±0.003	bc α	0.946±0.003	b α	0.929±0.001	c β
	90	0.936±0.002	bc α	0.942±0.007	c α	0.911±0.009	c γ	0.926±0.002	c β
	180	0.933±0.003	c α	0.904±0.002	d β	0.897±0.009	d γ	0.891±0.002	d γ
DM (% w/w of cheese)	2	50.85±0.177	d β	51.92±2.638	c α	50.82±0.493	c β	52.91±0.258	d α
	9	51.59±0.718	d β	53.61±1.446	c α	52.49±1.047	c β	54.73±0.746	c α
	30	58.06±0.389	c β	57.07±0.854	b γ	60.33±1.726	b α	58.38±0.413	b β
	90	63.00±0.994	b $\alpha\beta$	60.88±1.038	a β	65.97±0.506	a α	61.56±0.783	a β
	180	67.70±0.835	a α	62.51±1.810	a β	66.19±0.485	a α	63.09±0.732	a β
WC (%)	2	49.15±0.176	a α	48.07±2.638	a β	49.17±0.493	a α	47.08±0.257	a β
	9	48.41±0.717	a α	46.38±3.866	a β	47.50±1.046	a α	45.27±0.746	b β
	30	41.94±0.389	b β	42.99±0.854	b α	39.66±1.726	b γ	41.61±0.413	c β
	90	36.99±0.994	c $\alpha\beta$	39.11±1.038	c α	34.02±0.505	c β	38.44±0.783	d α
	180	33.29±0.835	d β	37.48±1.810	c α	33.81±0.484	c β	36.90±0.732	d α
Ash (% w/w of DM)	2	6.01±0.09	c β	6.33±0.24	b β	7.56±0.34	b α	6.93±0.47	b α
	9	6.11±0.13	c β	6.67±0.19	b β	7.71±0.48	b α	7.06±0.27	b α
	30	6.17±0.06	bc β	6.57±0.51	b $\alpha\beta$	7.39±0.72	b α	6.99±0.27	b α
	90	6.49±0.29	b β	6.69±0.18	b β	7.65±0.12	b α	6.95±0.55	b β
	180	8.38±0.27	a α	7.33±0.46	a β	8.40±0.23	a α	8.01±0.22	a $\alpha\beta$
Fat (% w/w of DM)	2	50.3±2.15	a β	54.4±2.89	a $\alpha\beta$	55.3±0.78	a α	55.2±1.32	a α
	9	51.9±1.60	a α	53.9±1.27	a α	54.6±1.48	a α	54.4±1.09	a α
	30	51.9±0.72	a β	53.9±1.31	a $\alpha\beta$	54.1±1.17	a α	54.1±1.31	a α
	90	50.7±0.43	a β	52.3±3.70	a $\alpha\beta$	55.1±1.24	a α	54.6±3.32	a α
	180	52.1±0.89	a β	52.8±1.61	a $\alpha\beta$	54.3±1.06	a α	54.1±1.21	a α
Protein (%, w/w of DM)	2	35.8±1.94	a α	33.7±0.92	b α	33.2±0.56	a $\alpha\beta$	32.0±1.29	b $\alpha\beta$
	9	36.7±1.89	a α	33.0±1.04	b β	34.6±1.12	a $\alpha\beta$	33.1±0.83	ab β
	30	36.9±0.99	a α	33.6±0.54	b β	34.2±1.37	a $\alpha\beta$	33.9±0.74	a β
	90	36.2±3.26	a $\alpha\beta$	37.3±1.53	a α	33.9±1.04	a β	34.4±1.01	a β
	180	37.2±0.89	a α	37.8±1.44	a α	34.5±1.48	a β	35.0±0.86	a β

a, b, c, d...: Different letter within a column for the same physicochemical characteristic indicates statistically significant differences ($p < 0.05$) related to ripening time.

α , β , γ ...: Different letter within a row indicates statistically significant differences ($p < 0.05$) related to the cheese variety.

*RT = ripening time (days); DM = dry matter (%); WC = water content (%; 100-DM).

[#]Cheese variety (I-CLM, T-CLM, I-CL, and T-CL) according to Table S1.

Table S3. Regression parameters of the linear models between MRI parameters and physicochemical and texture parameters.

			I-CLM ^a			T-CLM			I-CL			T-CL		
			Coefficient	SD ^b	<i>p</i> -value	Coefficient	SD	<i>p</i> -value	Coefficient	SD	<i>p</i> -value	Coefficient	SD	<i>p</i> -value
RT (days) ^c	<i>T</i> ₁	Intercept	15.03	0.4060	0.0001	19.90	0.8927	0.0001	18.05	1.2064	0.0001	15.42	0.5245	0.0001
		Slope	-0.034	0.0010	0.0001	-0.042	0.0020	0.0001	-0.029	0.0020	0.0001	-0.021	0.0009	0.0001
	<i>T</i> ₂	Intercept	12.59	0.7771	0.0001	10.62	0.4847	0.0001	-5.762	0.1870	0.0001	-0.320	0.2463	0.1995
		Slope	-0.235	0.0161	0.0001	-0.275	0.0132	0.0001	0.133	0.0036	0.0001	0.090	0.0063	0.0001
<i>a_w</i>	<i>T</i> ₁	Intercept	0.880	0.0078	0.0001	0.733	0.0238	0.0001	0.705	0.0547	0.0001	0.752	0.0175	0.0001
		Slope	0.000	0.0000	0.0001	0.000	0.0001	0.0001	0.000	0.0001	0.0003	0.000	0.0000	0.0001
	<i>T</i> ₂	Intercept	0.898	0.0088	0.0001	0.828	0.0105	0.0001	1.034	0.0170	0.0001	0.984	0.0035	0.0001
		Slope	0.001	0.0002	0.0001	0.003	0.0003	0.0001	-0.002	0.0003	0.0001	-0.001	0.0001	0.0001
WC (%) ^d	<i>T</i> ₁	Intercept	-8.146	4.8019	0.1009	-5.426	5.2999	0.3147	-32.07	12.3685	0.0150	11.36	2.0336	0.0001
		Slope	0.125	0.0119	0.0001	0.106	0.0116	0.0001	0.123	0.0209	0.0001	0.052	0.0034	0.0001
	<i>T</i> ₂	Intercept	7.164	6.2550	0.2618	20.54	3.4713	0.0001	74.17	2.5022	0.0001	49.61	0.9112	0.0001
		Slope	0.726	0.1294	0.0001	0.617	0.0949	0.0001	-0.648	0.0478	0.0001	-0.215	0.0232	0.0001
Hardness (N)	<i>T</i> ₁	Intercept	81.30	7.2964	0.0001	84.61	10.285	0.0001	77.06	8.2174	0.0001	80.47	4.7258	0.0001
		Slope	-0.128	0.0182	0.0001	-0.130	0.0225	0.0001	-0.095	0.0138	0.0001	-0.096	0.0079	0.0001
	<i>T</i> ₂	Intercept	72.60	6.9519	0.0001	63.90	4.2113	0.0001	0.833	3.2176	0.7967	12.14	2.1592	0.0001
		Slope	-0.882	0.1440	0.0001	-1.060	0.1145	0.0001	0.381	0.0616	0.0001	0.323	0.0555	0.0001
Adhesiveness (N×s)	<i>T</i> ₁	Intercept	-0.473	0.0692	0.0001	-1.650	0.1111	0.0001	-0.3272	0.0498	0.0001	-1.0976	0.0886	0.0001
		Slope	0.001	0.0002	0.0001	0.003	0.0002	0.0001	0.0004	0.0001	0.0001	0.0015	0.0001	0.0001
	<i>T</i> ₂	Intercept	-0.406	0.0647	0.0001	-0.818	0.0829	0.0001	0.0438	0.0160	0.0085	-0.0001	0.0364	0.9977
		Slope	0.005	0.0013	0.0002	0.018	0.0023	0.0001	-0.0022	0.0003	0.0001	-0.0053	0.0009	0.0001
Springiness (m) ^e	<i>T</i> ₁	Intercept	4.8800	0.2957	0.0001	8.7200	0.6383	0.0001	5.4800	0.7527	0.0001	7.0800	0.4625	0.0001
		Slope	-0.0092	0.0007	0.0001	-0.0144	0.0014	0.0001	-0.0073	0.0013	0.0001	-0.0065	0.0008	0.0001
	<i>T</i> ₂	Intercept	4.0100	0.3521	0.0001	5.4300	0.3618	0.0001	-0.4916	0.2710	0.0753	2.1600	0.1275	0.0001
		Slope	-0.0582	0.0073	0.0001	-0.0893	0.0098	0.0001	0.0321	0.0052	0.0001	0.0299	0.0033	0.0001
Cohesiveness	<i>T</i> ₁	Intercept	-0.423	0.1076	0.0003	-1.377	0.1070	0.0001	-1.207	0.1972	0.0001	-0.229	0.0302	0.0001
		Slope	0.002	0.0003	0.0001	0.004	0.0002	0.0001	0.003	0.0003	0.0001	0.001	0.0001	0.0001
	<i>T</i> ₂	Intercept	-0.166	0.1193	0.1697	-0.487	0.0528	0.0001	1.159	0.0551	0.0001	0.315	0.0150	0.0001
		Slope	0.014	0.0025	0.0001	0.027	0.0014	0.0001	-0.014	0.0011	0.0001	-0.003	0.0004	0.0001

^a Cheese variety (I-CLM, T-CLM, I-CL, and T-CL) according to Table S1.^b SD = standard deviation; ^c RT = ripening time; ^d WC = water content; ^e Values of Intercept and Slope for Springiness are ×10³.

Table S4. Simple linear regression analysis of ripening time, water content and a_w with Apparent Diffusion Coefficient (ADC) of the four varieties of Spanish ewe's milk cheese.

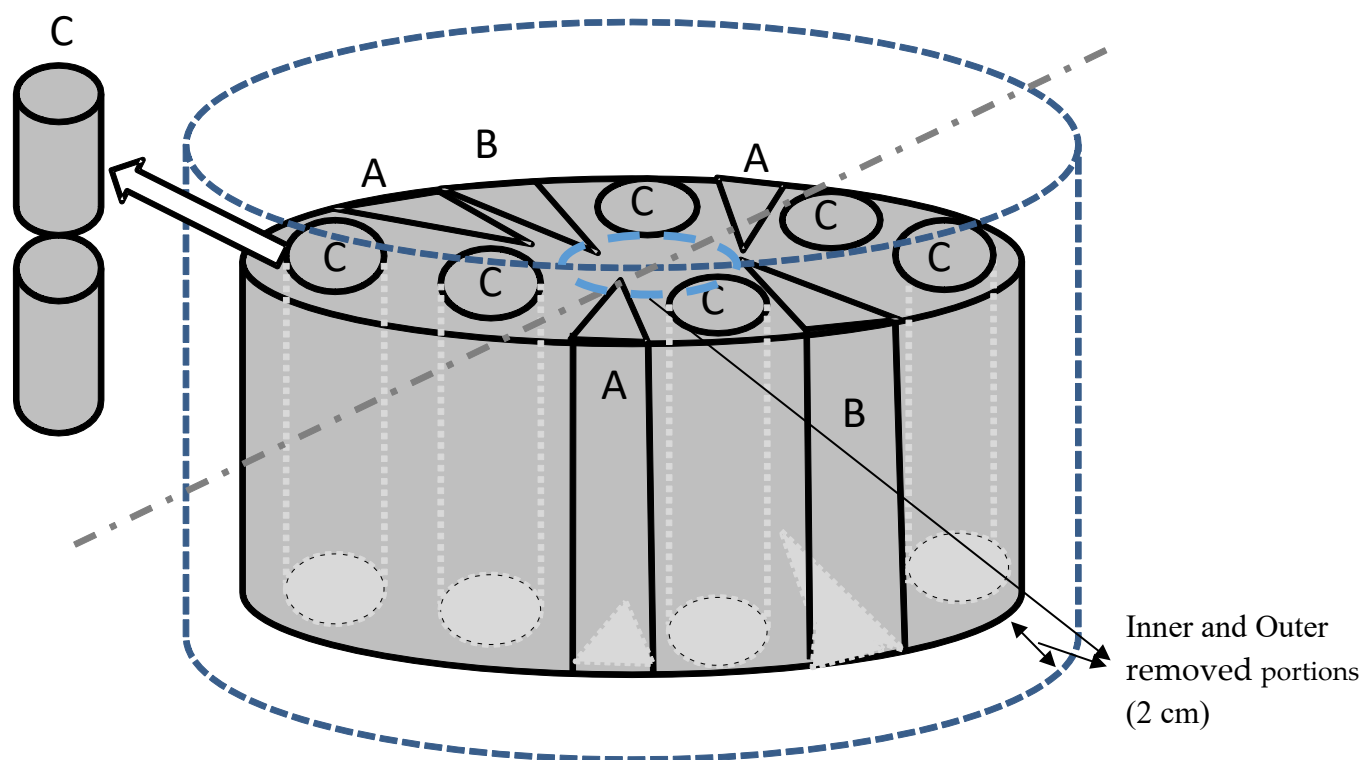
Dependent variable	Cheese variety ^a and Independent variables		Regression equation coefficients	p -value ^b	R ²	SE ^c
RT (days)	I-CLM	Intercept	149.46	0.0001	0.44***	50.67
		Slope	-137.21	0.0001		
	T-CLM	Intercept	187.31	0.0001	0.49***	48.39
		Slope	-193.01	0.0001		
	I-CL	Intercept	139.33	0.0001	0.42***	51.76
		Slope	-131.17	0.0001		
	T-CL	Intercept	200.14	0.0001	0.54***	46.29
		Slope	-187.41	0.0001		
WC (%)	I-CLM	Intercept	31.43	0.0001	0.73**	3.660
		Slope	16.07	0.0010		
	T-CLM	Intercept	32.93	0.0001	0.47*	3.400
		Slope	16.02	0.0050		
	I-CL	Intercept	28.74	0.0001	0.69**	4.330
		Slope	18.96	0.0001		
	T-CL	Intercept	32.88	0.0001	0.58**	2.720
		Slope	12.25	0.0010		
a_w	I-CLM	Intercept	0.93	0.0001	0.67**	0.005
		Slope	0.02	0.0002		
	T-CLM	Intercept	0.90	0.0001	0.42*	0.020
		Slope	0.06	0.0300		
	I-CL	Intercept	0.90	0.0001	0.46*	0.020
		Slope	0.06	0.0060		
	T-CL	Intercept	0.87	0.0001	0.58**	0.020
		Slope	0.08	0.0010		

^a Cheese variety (I-CLM, T-CLM, I-CL and T-CL) according to Table S1.

^b *** $p < 0.0001$; ** $p < 0.001$; * $p < 0.01$.

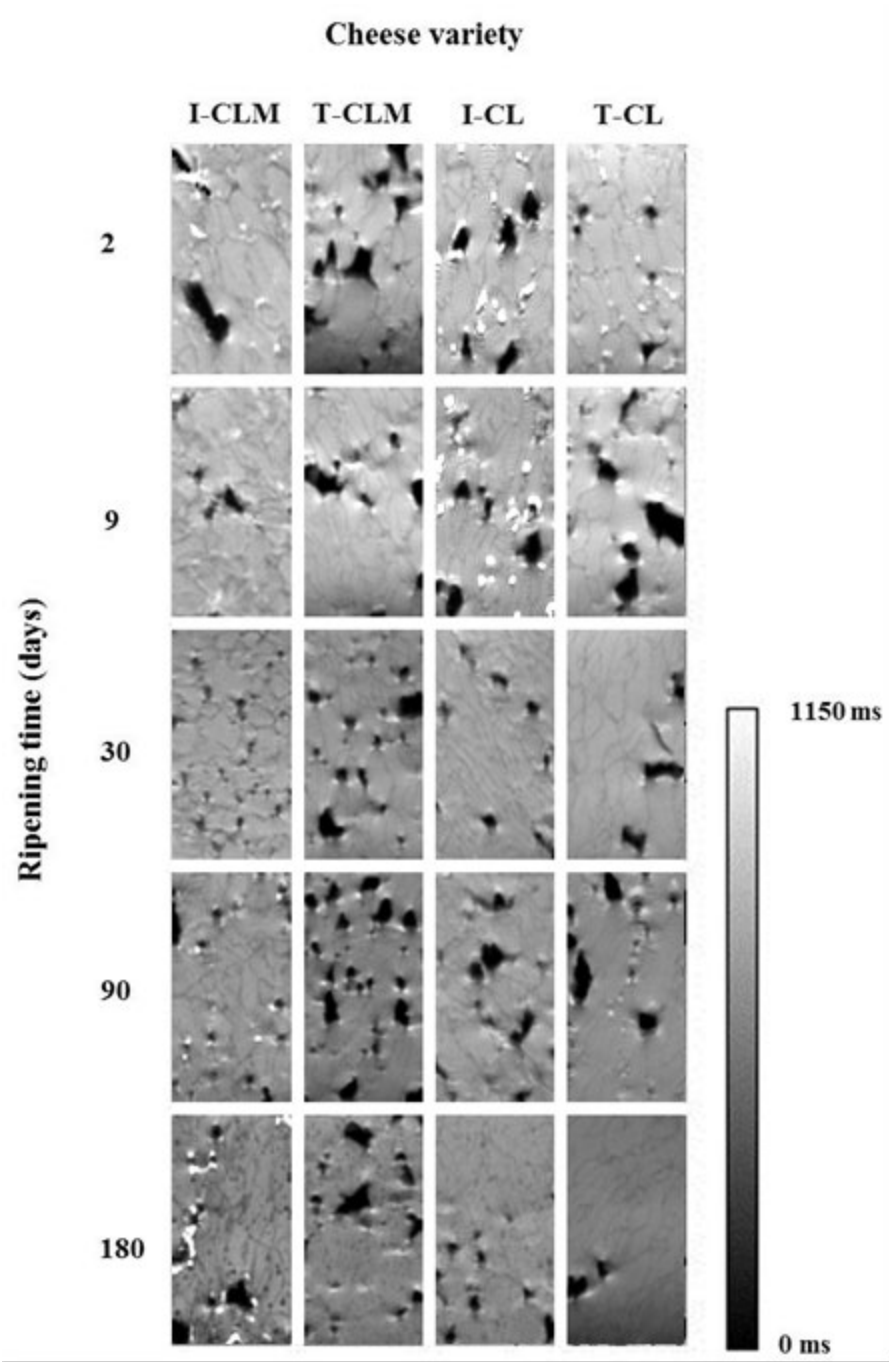
^c SE = standard error of the estimate; R² = coefficient of determination.

Figure S1. Cheese sampling



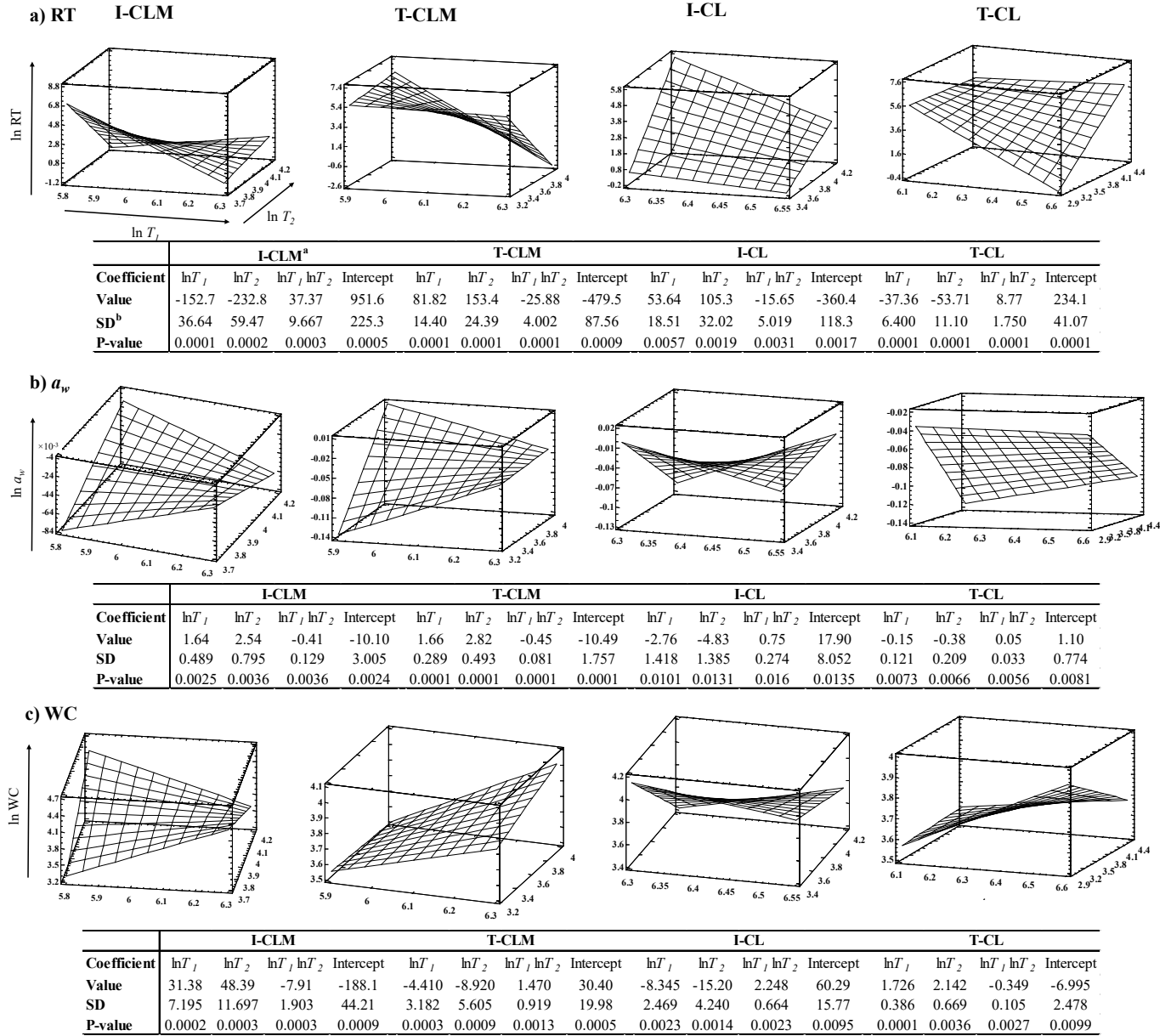
- A: Samples for physicochemical analysis
- B: Samples for Magnetic Resonance Imaging analysis
- C: Samples for textural analysis

Figure S2. Proton Density images of the four varieties of Spanish sheep cheese at different ripening times, used to calculate the hole index.



Cheese varieties (I-CLM, T-CLM, I-CL, and T-CL) according to Table S1

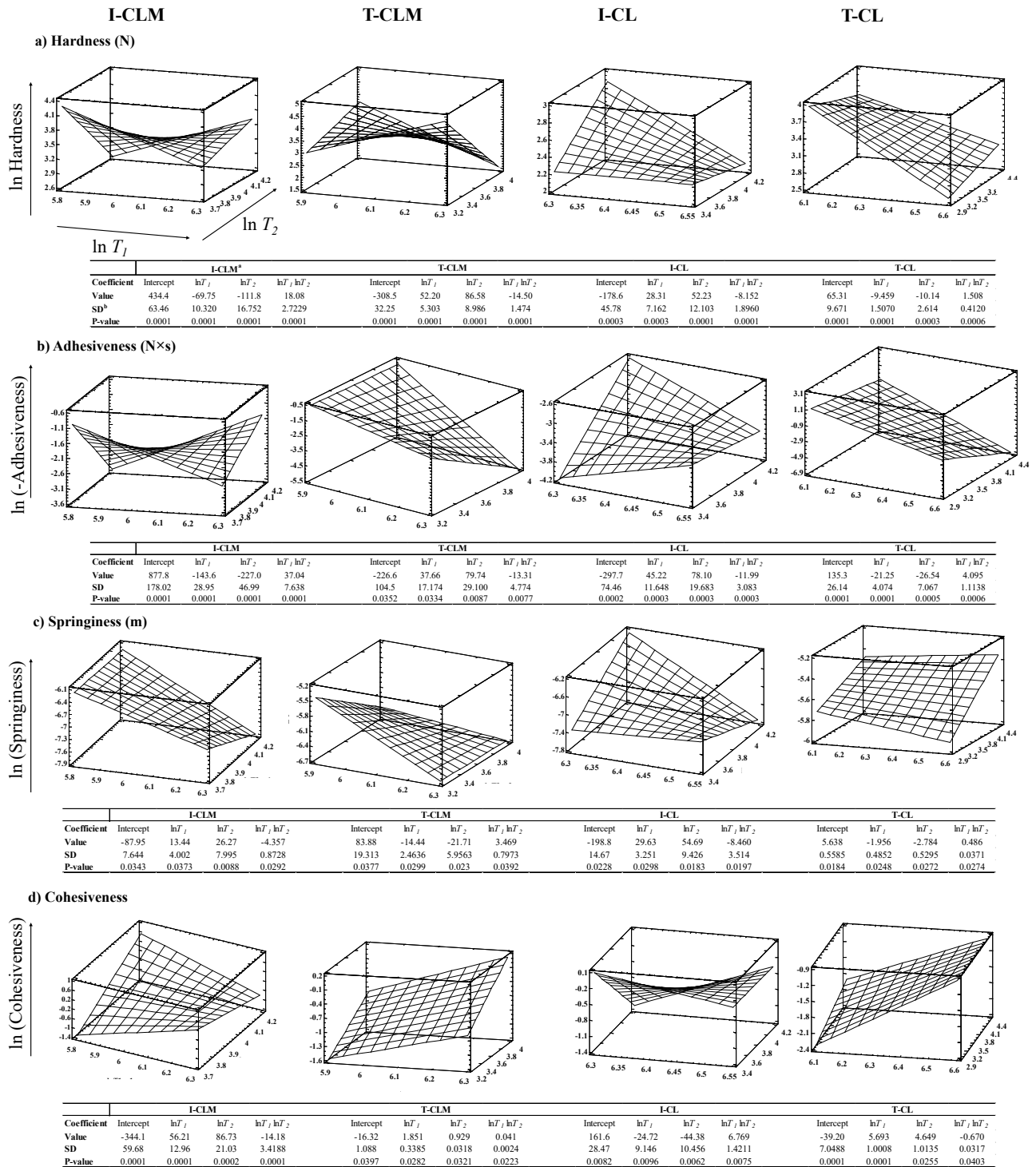
Figure S3. Response surface plot showing the relationship between T_1 and T_2 values (MRI parameters), and physicochemical parameters: a) ripening time, RT (days); b) water activity, a_w ; c) water content, WC (%) of the four varieties of Spanish sheep cheese.



^aCheese variety (I-CLM, T-CLM, I-CL and T-CL) according to Table S1

^bSD = standard deviation

Figure S4. Response surface plot showing the relationship between T_1 and T_2 values (MRI parameters) and texture parameters: a) Hardness (N), b) Adhesiveness (N×s), c) Springiness (m), and d) Cohesiveness, of the four varieties of Spanish sheep cheese.



^aSpanish sheep cheese variety (I-CLM, T-CLM, I-CL and T-CL) according to Table S1

^bSD = standard deviation