Table S1. Genbank accession number of *S. thermophilus* strains genome and phageome raw data.

Strain isolated in this study	RGP type	Accession number
Moz111	A	JAHBRN000000000
Brie16	A	JAHBRO000000000
Moz86	A	JAHBRP000000000
Moz83	A	JAHBRQ000000000
Rico66	A	JAHDUN000000000
Brie28	A	JAHDUO000000000
Moz76	A	JAHRBD000000000
FDL19	A	JAHRBE000000000
Moz109	B	CP075363
Brie1	B	JAHBRI000000000
Vach57	B	JAHBRJ000000000
Vach60	B	JAHBRK000000000
Rico65	B	JAHBRL000000000
Strac48	B	JAHBRM000000000
Nect1	C	JAHDUP000000000
Scam27	C	JAHDUQ000000000
Strac42	C	JAHDUR000000000
Racle124	C	JAHDUS000000000
Nect13	C	JAHDUT000000000
FDL17	C	JAHRBF000000000
Moz77	E	JAHDUU000000000
Moz74	E	JAHDUV000000000
Roque89	E	JAHRBG000000000
Douc24	E	JAHRBH000000000

Reference strain	Accession number
SMQ301	CP011217.1
ND03	CP002340.1
MN-BM-A01	CP012588.1
EU01	CP047191.1
N4L	LS974444.1
TK-P3A	CP045596.1
STCH_20	MK483556.1
STH_CIRM_1048	LR822033.1
MN-ZLW-002	CP003499.1

Virome	Food Type	Accession number
Brie	Soft cheese	PRJNA731044
Mozzarella B		PRJNA729649
Ricotta		PRJNA731045
Stracciatella		PRJNA731053
Vacherin		PRJNA731055
Semi-soft cheese D	Semi-soft cheese	PRJNA731056
Semi-soft cheese A		PRJNA731057
Blue cheese		PRJNA731046

Table S2. List of primer used in this study.

16S rRNA primer	**Sequence (5' to 3')**			**Reference**
Luc *Fw*	CTTGTTACGACTTCACCC			Corsetti et al. 2004 [1]
Luc *Rv*	TGCCTAATACATGCAAGT			
RGP primer	**Sequence (5' to 3')**	**Product size (bp)**	**RGP type**	**Reference**
RGPpos *Fw*	CAGGTGCAAATGGCCAACTCG	801	Control	Kouwen et al. 2019 [2]
RGPpos *Rv*	CTTGCCATGTTGGGATGAC			
RGPgroup-l *Fw*	GGATGATGGTTCGACGGATAG	631	1 (B)	
RGPgroup-1 *Rv*	CCGCTCTTCCAAAACCATGA			
RGPgroup-2 *Fw*	GTGAAGAGTCAGAAGACGAAT	464	2 (A)	
RGPgroup-2 *Rv*	CAAAGGCCCCGATGGTATT			
RGPgroup-3 *Fw*	GAGGAAGCAACAGATAAACGA	303	3 (D)	
RGPgroup-3 *Rv*	GACCAATTGGTCCACAAAAGT			
RGPgroup-4 *Fw*	CTCCTCGTACTCACCCAC	162	4 (C/E)	
RGPgroup-4 *Rv*	GCACAAGATACAGCTCGTTAC			

Table S3. Number of total filtered reads in virome cheese samples.

Sample name	Total filtered reads
Brie	2,852,252
Mozarella B	3,256,352
Ricotta	2,223,726
Straciatella	3,483,685
Vacherin	4,755,471
Semi-soft cheese D	1,056,334
Semi-soft cheese A	2,409,371
Blue cheese	3,303,896

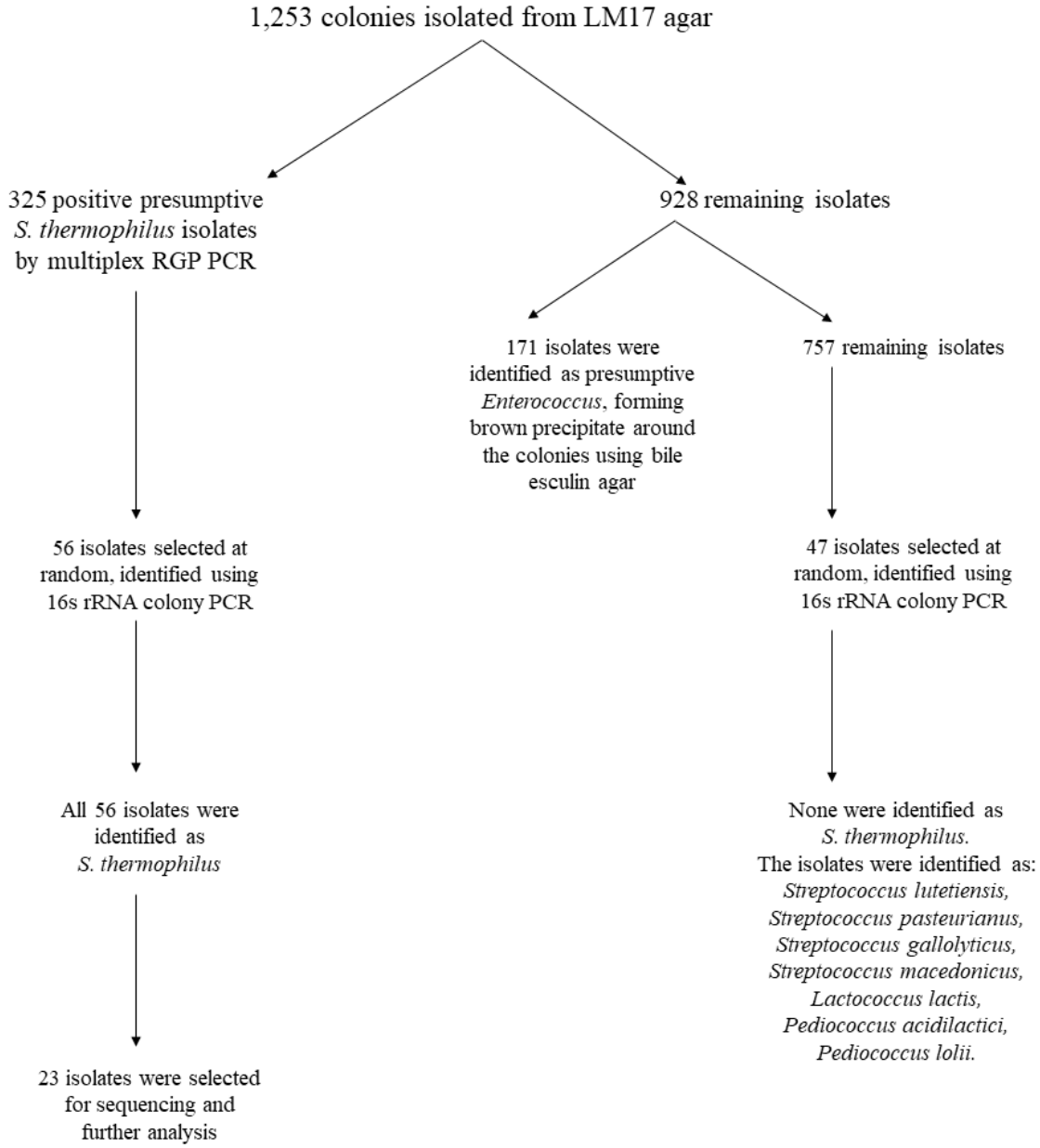

Figure S1. Schematic diagram of *S. thermophilus* screening and isolation performed in this study.

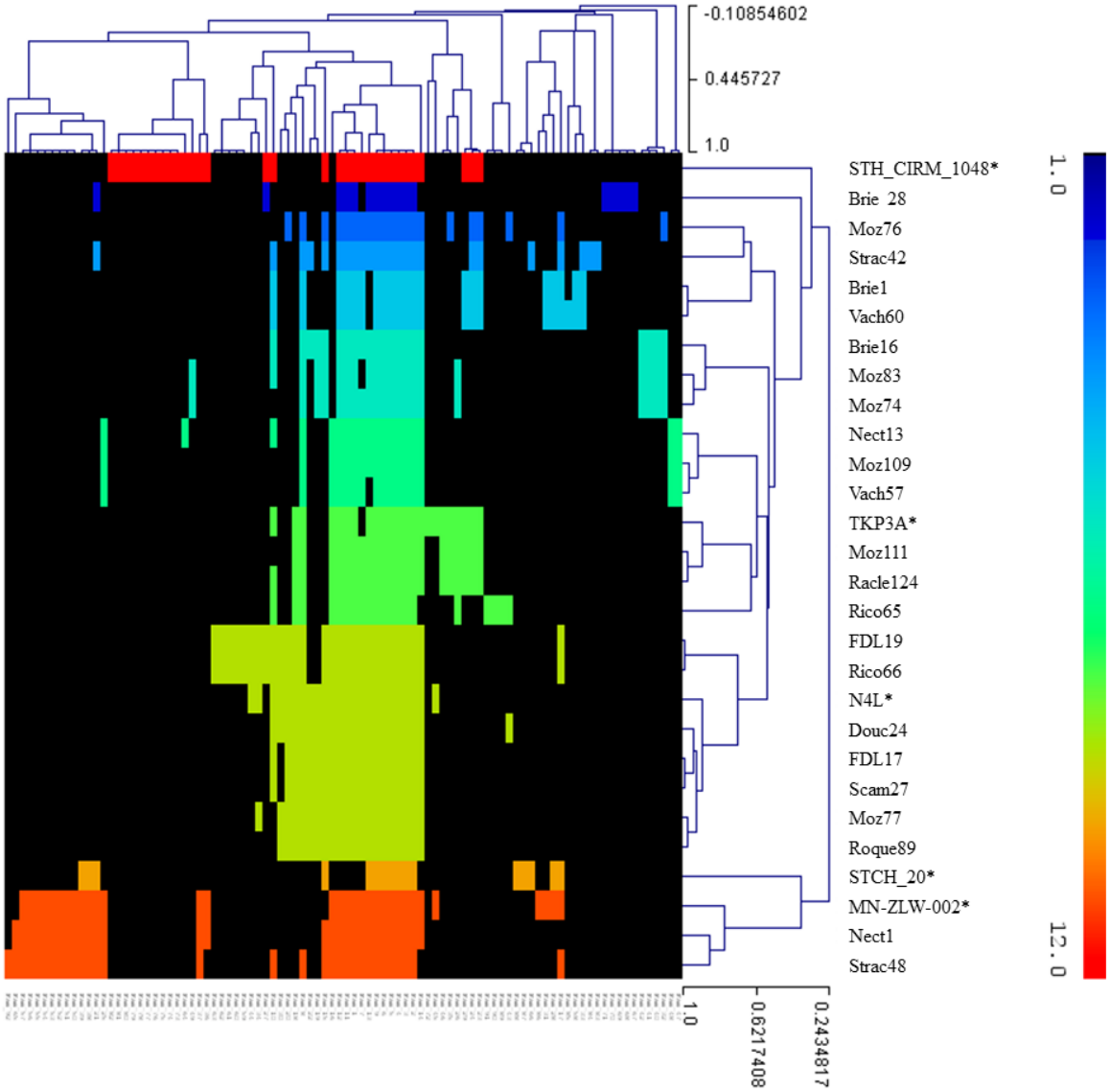

Figure S2. Heatmap displaying the presence (colour) or absence (black) of individual protein families within the EPS biosynthesis operon of 23 streptococcal strains sequenced in this study and 5 streptococcal strains used as reference (*).

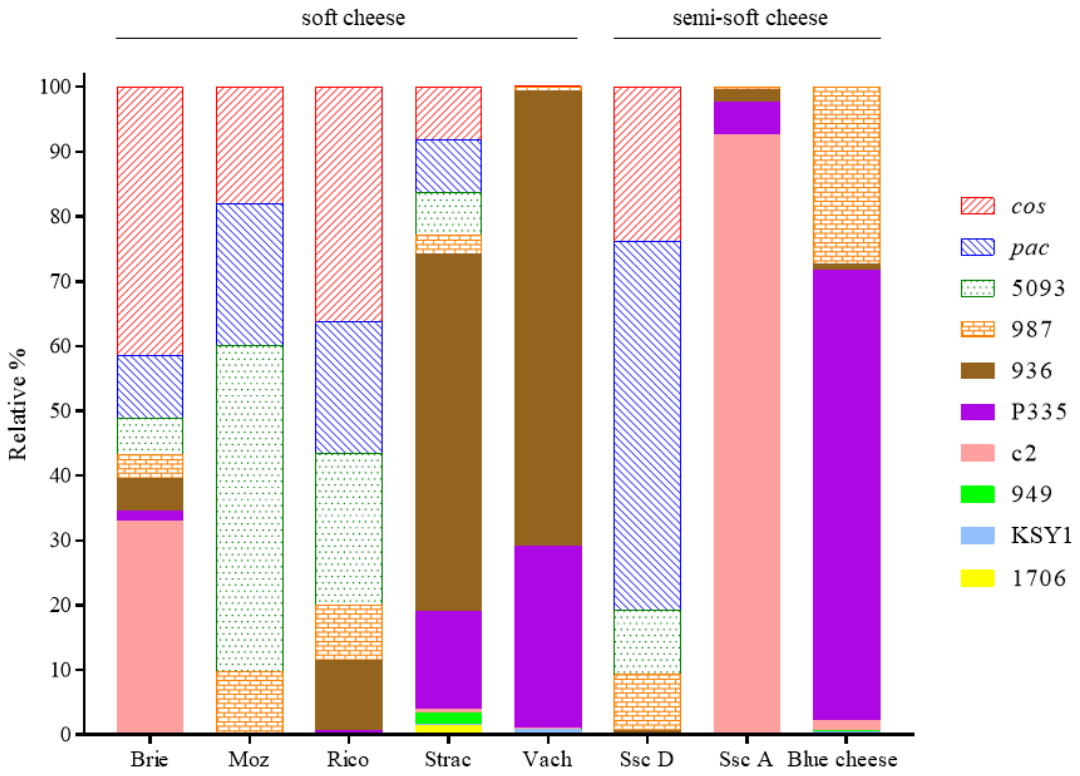

Figure S3. Relative % of reads mapping to streptococcal (coloured pattern: cos, pac, 5093, 987) and lactococcal (solid colour: 936, P335, c2, 949, KSY1, 1706) phage (cos, pac, 5093, 987) distribution in eight cheese samples – brie, mozzarella B (moz), ricotta (rico), straciatella (strac), vacherin (vach), semi-soft cheese D (ssc D), semi-soft cheese A (ssc A) and blue cheese, based on virome analysis. There were no reads mapped against members of the streptococcal P738 phage group lactococcal phage groups: P087, P034, 1358 and Q54.

Table S4. List of streptococcal phages (30) and their respective propagating host strains tested in this study.

Streptococcal phage	Group	Host strain	Reference
SW1	*cos*	UCCSt23	Lavelle et al. 2018 [3]
SW2	*cos*	UCCSt86	
SW3	*cos*	UCCSt83	
SW4	5093	UCCSt89	
SW5	*cos*	UCCSt86	
SW6	*cos*	UCCSt95	
SW7	*cos*	UCCSt84	
SW8	*cos*	UCCSt89	
SW9	*cos*	UCCSt23	
SW10	*cos*	UCCSt23	
SW11	*cos*	UCCSt92	
SW12	*cos*	UCCSt96	
SW13	*pac*	UCCSt50	
SW14	*pac*	UCCSt96	
SW15	*pac*	UCCSt96	
SW16	987	UCCSt97	
SW18	*pac*	UCCSt93	
SW21	*cos*	UCCSt82	
SW24	5093	UCCSt89	
SW25	987	UCCSt97	
SW30	*cos*	UCCSt95	
SW40	*cos*	UCCSt12	
SW1151	*pac*	UCCSt10	
SWK4	*cos*	UCCSt63	
STP1	*cos*	STP1	Lavelle et al. 2018 [4]
SW41	*cos*	UCCSt101	Unpublished
9	*cos*	UCCSt12	
12	*cos*	UCCSt12	
14	*cos*	UCCSt12	
20	*cos*	UCCSt12	

Table S5. Percentage distribution of eukaryote, prokaryote and viruses, classified according to its genera/family and species, obtained from representative 100,000 reads.

Sample	Domain	Genera/Family	Species	%	Number of filtered reads*
Brie	Eukaryote	*Phytophthora*	Unknown	1.0	18,561
	Prokaryote	*Brevibacterium*	Unknown	67.2	
		Brevibacterium	*aurantiacum*	3.3	
		Corynebacterium	Unknown	2.8	
		Brachybacterium	Unknown	2.7	
		Glutamicibacter	Unknown	2.5	
		Arthrobacter	Unknown	1.5	
		Streptomyces	Unknown	1.4	
		Ornithinimicrobium	Unknown	1.3	
		Kocuria	Unknown	1.3	
		Nocardiopsis	Unknown	1.1	
		Microbacterium	Unknown	1.1	
		Cryobacterium	Unknown	1.0	
		Gulosibacter	Unknown	1.0	
		Dermabacter	Unknown	0.9	
		Dermacoccus	Unknown	0.9	
		Mycolicibacterium	Unknown	0.9	
		Staphylococcus	Unknown	0.8	
		Sinomonas	Unknown	0.7	
		Rhodococcus	Unknown	0.7	
		Gordonia	Unknown	0.7	
		Nocardia	Unknown	0.6	
		Salinicoccus	Unknown	0.6	
	Virus	*Siphoviridae*	Unknown	3.9	
Mozarella B	Prokaryote	*Streptococcus*	Unknown	2.0	94,051
		Streptococcus	*thermophilus*	1.9	
	Virus	*Siphoviridae*	Unknown	16.0	
		Siphoviridae	Streptococcal	80.1	
Semi-soft cheese D	Eukaryote	*Fusarium*	Unknown	0.9	42,288
	Prokaryote	*Pseudoalteromonas*	Unknown	8.8	
		Pseudoalteromonas	*translucida*	15.5	
		Pseudoalteromonas	*arctica*	5.8	
		Pseudoalteromonas	*distincta*	4.3	
		Pseudoalteromonas	*nigrifaciens*	4.0	
		Pseudoalteromonas	*agarivorans*	0.7	
		Pseudoalteromonas	*prydzensis*	0.6	
		Vibrio	Unknown	3.9	
		Vibrio	*casei*	5.2	
		Vibrio	*toranzoniae*	2.2	
		Streptococcus	*thermophilus*	5.0	
		Brevibacterium	Unknown	2.1	
		Brevibacterium	*aurantiacum*	3.9	

		Brachybacterium	Unknown	2.1	
		Glutamicibacter	Unknown	2.0	
		Glutamicibacter	*arilaitensis*	2.0	
		Psychrobacter	Unknown	3.4	
		Psychrobacter	*immobilis*	0.9	
	Virus	*Autographiviridae*	Unknown	5.3	
		Siphoviridae	Unknown	8.6	
		Siphoviridae	Streptococcal	12.6	
Semi-soft cheese A	Prokaryote	*Lactococcus*	Unknown	5.2	70,469
		Lactococcus	*lactis*	27.0	
		Halomonas	Unknown	7.4	
		Halomonas	*titanicae*	0.9	
		Brevibacterium	Unknown	0.6	
		Brevibacterium	*aurantiacum*	5.3	
		Psychrobacter	Unknown	4.9	
		Bacillus	Unknown	0.8	
		Bacillus	*altitudinis*	1.4	
		Staphylococcus	Unknown	1.0	
		Brachybacterium	Unknown	0.6	
		Halovibrio	Unknown	0.6	
	Virus	*Siphoviridae*	Unknown	23.3	
		Siphoviridae	Lactococcal	20.9	
Ricotta	Prokaryote	*Enterococcus*	Unknown	6.0	75,882
		Enterococcus	*malodoratus*	1.8	
		Enterococcus	*avium*	1.5	
		Enterococcus	*xiangfangensis*	0.8	
		Enterococcus	*hermanniensis*	0.7	
		Streptococcus	Unknown	3.1	
		Streptococcus	*thermophilus*	3.0	
		Lactococcus	Unknown	1.0	
		Lactococcus	*lactis*	0.9	
		Vibrio	Unknown	0.8	
	Virus	*Siphoviridae*	Unknown	26.9	
		Siphoviridae	Streptococcal	50.2	
		Siphoviridae	Lactococcal	3.3	
Blue cheese	Prokaryote	*Lactococcus*	Unknown	6.8	61,535
		Lactococcus	*lactis*	55.8	
		Lactococcus	*petauri*	2.2	
		Staphylococcus	Unknown	5.7	
		Brevibacterium	Unknown	0.8	
	Virus	*Autographiviridae*	Unknown	2.4	
		Herelleviridae	Unknown	2.4	
		Podoviridae	Unknown	0.9	
		Siphoviridae	Unknown	5.0	
		Siphoviridae	Streptococcal	0.7	
		Siphoviridae	Leuconostoc	3.5	

		Siphoviridae	Lactococcal	13.8	
Straciatella	Prokaryote	*Pseudomonas*	Unknown	7.4	79,919
		Pseudomonas	*proteolytica*	21.1	
		Pseudomonas	*helleri*	17.1	
		Pseudomonas	*qingdaonensis*	16.7	
		Pseudomonas	*lundensis*	5.6	
		Pseudomonas	*carnis*	5.2	
		Pseudomonas	*lactis*	2.5	
		Pseudomonas	*gessardii*	1.4	
		Pseudomonas	*rhodesiae*	0.6	
		Pseudomonas	*brenneri*	0.6	
		Buttiauxella	Unknown	1.9	
		Buttiauxella	*gaviniae*	5.8	
		Buttiauxella	*noackiae*	1.1	
		Buttiauxella	*brennerae*	0.8	
		Serratia	*liquefaciens*	4.5	
		Carnobacterium	*maltaromaticum*	2.6	
		Leuconostoc	*mesenteroides*	1.6	
		Streptococcus	*thermophilus*	1.2	
		Kluyvera	*intermedia*	0.9	
		Shewanella	*baltica*	0.7	
		Hafnia	*paralvei*	0.6	
Vacherin	Prokaryote	*Lactococcus*	Unknown	1.6	69,906
		Lactococcus	*lactis*	73.0	
		Brevibacterium	Unknown	0.7	
		Brevibacterium	*aurantiacum*	8.1	
		Glutamicibacter	Unknown	3.8	
		Glutamicibacter	*arilaitensis*	0.9	
		Psychrobacter	Unknown	3.7	
		Psychrobacter	*immobilis*	1.2	
		Lactobacillus	*paracasei*	1.6	
		Halomonas	Unknown	0.8	
		Brachybacterium	Unknown	0.8	
	Virus	*Siphoviridae*	Unknown	2.2	
		Siphoviridae	Lactococcal	1.5	

* Number of filtered reads obtained from 100,000 representative reads.

Reference

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2. **Kouwen RHM, Van Sinderen D, McDonnell B, Ver Loren Van Themaat P, Emiel, Mahony J**. *Streptococcus thermophilus* starter cultures, Netherlands, Patent 20190367866, 2019.

3. **Lavelle K, Martinez I, Neve H, Lugli GA, Franz CMAP, Ventura M, et al.** Biodiversity of *Streptococcus thermophilus* Phages in Global Dairy Fermentations. Viruses. 2018;10(10):577, doi:10.3390/v10100577.

4. **Lavelle K, Murphy J, Fitzgerald B, Lugli GA, Zomer A, Neve H, et al.** A Decade of *Streptococcus thermophilus* Phage Evolution in an Irish Dairy Plant. Appl Environ Microbiol 2018;84(10):e02855-17, doi:10.1128/aem.02855-17.