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Fate of selected pathogens in spiked «SALAME NOSTRANO» produced without added nitrates following the application of NONIT™ technology

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Table 1.

Kinetic parameters ⁽¹⁾	<i>Lc. lactis lactis</i> 16		<i>Lc. lactis lactis</i> 340		<i>Lb. casei casei</i> 208		<i>E. faecium</i> UBEF-41	
Vm (Δ pH/min)	-2.06x10 ⁻⁰⁴		-2.35x10 ⁻⁰⁴		-1.51x10 ⁻⁰⁴		-1.39x10 ⁻⁰⁴	
Tm (min)	3754		7564		5003		4105	
pHm	6.00		5.47		5.70		6.09	
Regression coefficients								
	estimate	se	estimate	se	estimate	se	estimate	se
a	6.37	7.96x10 ⁻⁰⁴	6.35	7.67x10 ⁻⁰⁴	6.36	0.09x10 ⁻⁰²	6.34	4.01x10 ⁻⁰⁴
b	1.42x10 ⁻⁰⁴	9.85x10 ⁻⁰⁷	1.87x10 ⁻⁰⁵	8.96x10 ⁻⁰⁷	-8.84x10 ⁻⁰⁵	1.81x10 ⁻⁰⁶	1.17x10 ⁻⁰⁴	4.87x10 ⁻⁰⁷
c	-1.07x10 ⁻⁰⁷	3.58x10 ⁻¹⁰	-6.36x10 ⁻⁰⁹	3.07x10 ⁻¹⁰	4.49x10 ⁻⁰⁸	1.05x10 ⁻⁰⁹	-7.28x10 ⁻⁰⁸	1.74x10 ⁻¹⁰
d	1.33x10 ⁻¹¹	4.80x10 ⁻¹⁴	-3.32x10 ⁻¹²	3.89x10 ⁻¹⁴	-1.80x10 ⁻¹¹	2.25x10 ⁻¹³⁴	8.44x10 ⁻¹²	2.29x10 ⁻¹⁴
e	-5.06x10 ⁻¹⁶	2.12x10 ⁻¹⁸	2.38x10 ⁻¹⁶	1.63x10 ⁻¹⁸	1.50x10 ⁻¹⁵	1.60x10 ⁻¹⁷	-3.08x10 ⁻¹⁶	9.96x10 ⁻¹⁹
r ² ⁽²⁾	0.998		0.999		0.998		0.999	

Kinetic parameters ⁽¹⁾	NoNit TM formulation		NoNit TM formulation + <i>S. aureus</i> 27R		NoNit TM formulation + <i>E. coli</i> CSH26 K 12		NoNit TM formulation + <i>L. innocua</i> ATCC33090		NoNit TM formulation + <i>S. Derby</i> 27	
Vm (Δ pH/min)	-3.09x10 ⁻⁰⁴		-5.13x10 ⁻⁰⁴		-4.29x10 ⁻⁰⁴		-4.14x10 ⁻⁰⁴		-3.92x10 ⁻⁰⁴	
Tm (min)	2296		3262		2231		2554		2887	
pHm	5.69		5.5		5.71		5.63		5.53	
Regression coefficients										
	estimate	se	estimate	se	estimate	se	estimate	se	estimate	se
a	6.33	1.50x10 ⁻⁰³	6.17	9.48x10 ⁻⁰⁴	6.21	1.15x10 ⁻⁰³	6.10	7.04x10 ⁻⁰⁴	6.24	9.70x10 ⁻⁰⁴
b	-2.13x10 ⁻⁰⁴	1.89x10 ⁻⁰⁶	1.10x10 ⁻⁰⁴	2.65x10 ⁻⁰⁶	2.41x10 ⁻⁰⁴	2.53x10 ⁻⁰⁶	3.36x10 ⁻⁰⁴	1.33x10 ⁻⁰⁶	6.05x10 ⁻⁰⁵	2.49x10 ⁻⁰⁶
c	-4.56x10 ⁻⁰⁸	7.01x10 ⁻¹⁰	-5.38x10 ⁻⁰⁹	2.18x10 ⁻⁰⁹	-3.46x10 ⁻⁰⁷	1.63x10 ⁻⁰⁹	-3.41x10 ⁻⁰⁷	7.39x10 ⁻¹⁰	-1.65x10 ⁻⁰⁷	1.88x10 ⁻⁰⁹
d	8.32x10 ⁻¹²	9.61x10 ⁻¹⁴	-5.64x10 ⁻¹¹	6.60x10 ⁻¹³	7.24x10 ⁻¹¹	3.90x10 ⁻¹³	6.30x10 ⁻¹¹	1.51x10 ⁻¹³	2.19x10 ⁻¹¹	5.23x10 ⁻¹³
e	-3.70x10 ⁻¹⁶	4.35x10 ⁻¹⁸	8.73x10 ⁻¹⁵	6.60x10 ⁻¹⁷	-4.64x10 ⁻¹⁵	3.07x10 ⁻¹⁷	-3.62x10 ⁻¹⁵	1.03x10 ⁻¹⁷	-4.93x10 ⁻¹⁶	4.80x10 ⁻¹⁷
r ² ⁽²⁾	0,998		0,999		0,999		0,9995		0,999	

¹⁾ Vm is the maximum instantaneous acidification rate, Tm and pHm the time and the pH at which Vm occurred.

²⁾ Significant at p<0.001.

Table 2.

Time (hrs)	<i>S. aureus</i> 27R				<i>E. coli</i> CSH26 K12				<i>L. innocua</i> ATCC 33090				<i>S. Derby</i> 27			
	log cfu ml ⁻¹		log reduction		log cfu ml ⁻¹		log reduction		log cfu ml ⁻¹		log reduction		log cfu ml ⁻¹		log reduction	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
0 (control)	5,73	0,63	0.00	0.00	6,96	0,24	0.00	0.00	6,20	0,26	0.00	0.00	6,45	0,24	0.00	0.00
24	5,24	0,31	-0,50	0,17	7,17	0,1	0,21	0,17	6,38	0,21	0,18	0,19	6,68	0,37	0,23	0,16
72	5,20	0,24	-0,53	0,14	7,13	0,19	0,17	0,17	6,88	0,29	0,76	0,37	6,87	0,42	0,42	0,23
120	5,80	0,55	0,41	0,44	6,80	0,38	-0,36	0,14	6,91	0,09	0,71	0,13	7,06	0,17	0,71	0,12
168	5,23	0,19	-0,51	0,11	6,61	0,41	-0,56	0,18	5,60	0,46	-0,60	0,20	6,32	0,19	-0,13	0,43
240	3,94*	0,93	-1,45*	0,68	6,28*	0,21	-0,81*	0,23	4,80*	0,12	-1,30*	0,19	4,05*	0,21	-2,18*	0,33

*: indicates significant different means (p<0,005) when compared to control (time 0).

Table 3.

		Commercial		NoNit™	
		mean	sd	mean	sd
<i>S. aureus</i> 27R					
	day-0	4,19	0,17	4,26	0,15
	day-3	5,45 ^a	0,14	4,04 ^b	0,47
	day-7	5,89 ^a	0,10	3,69 ^b	0,50
	day-13	5,62 ^a	0,48	3,87	0,59
	day-21	6,00 ^a	0,12	3,85 ^b	0,15
	day-28	6,01 ^a	0,33	3,82 ^b	0,16
<i>E. coli</i> CSH26 K-12					
	day-0	4,03	0,22	4,18	0,24
	day-3	4,54	0,08	4,53	0,20
	day-7	5,05 ^a	0,03	4,39 ^b	0,21
	day-13	4,62 ^a	0,14	3,75 ^b	0,17
	day-21	3,92 ^a	0,39	2,94 ^b	0,16
	day-28	3,54 ^a	0,32	1,93 ^b	0,63
<i>L. innocua</i> ATCC 33090					
	day-0	4,09	0,20	4,31	0,05
	day-3	5,99 ^a	0,08	4,73 ^b	0,12
	day-7	5,88 ^a	0,12	4,97 ^b	0,01
	day-13	5,89 ^a	0,11	4,98 ^b	0,05
	day-21	5,89 ^a	0,12	5,02 ^b	0,24
	day-28	5,80 ^a	0,06	4,93 ^b	0,05
<i>S. Derby</i> 27					
	day-0	3,69	0,16	3,90	0,13
	day-3	5,42 ^a	0,13	4,43 ^b	0,17
	day-7	4,97	0,10	4,35	0,24
	day-13	4,37	0,47	3,63	0,28
	day-21	3,41 ^a	0,20	2,55 ^b	0,42
	day-28	3,67 ^a	0,44	1,79 ^b	0,86

Table 4

	Commercial		NoNit™	
	mean	sd	mean	sd
<i>Total mesophilic microbiota</i>				
day-0	6,69 ^a	0,02	6,34 ^b	0,06
day-3	7,87	0,07	8,00	0,13
day-7	8,50 ^a	0,11	8,23 ^b	0,08
day-13	8,50 ^a	0,10	8,24 ^b	0,07
day-21	8,40 ^a	0,10	8,10 ^b	0,07
day-28	8,48 ^a	0,06	8,06 ^b	0,12
<i>Lactococcus ssp.</i>				
day-0	6,34	0,15	6,16	0,07
day-3	6,72 ^a	0,06	6,29 ^b	0,04
day-7	6,94 ^a	0,16	6,35 ^b	0,04
day-13	7,06 ^a	0,03	6,37 ^b	0,06
day-21	7,05 ^a	0,05	6,49 ^b	0,35
day-28	6,76 ^a	0,03	6,37 ^b	0,12
<i>Lactobacillus spp.</i>				
day-0	6,66 ^a	0,06	6,20 ^b	0,05
day-3	8,38 ^a	0,13	8,05 ^b	0,10
day-7	8,21	0,10	8,12	0,06
day-13	8,31	0,04	8,25	0,08
day-21	8,25	0,12	8,08	0,06
day-28	8,40 ^a	0,16	8,05 ^b	0,15
<i>Enterococcus spp.</i>				
day-0	4,14 ^a	0,23	6,11 ^b	0,04
day-3	6,76	0,26	6,98	0,06
day-7	6,64	0,39	6,82	0,20
day-13	6,24	0,03	6,58	0,19
day-21	6,49	0,31	6,75	0,15
day-28	6,47	0,29	6,66	0,08
<i>Staphylococcus spp.</i>				
day-0	4,03	0,22	3,06	0,23
day-3	4,54	0,08	3,83	0,34
day-7	5,05 ^a	0,03	3,24 ^b	0,10
day-13	4,62 ^a	0,14	3,13 ^b	0,49
day-21	3,92 ^a	0,39	1,59 ^b	1,20
day-28	3,25 ^a	0,26	0,22 ^b	0,67

Table 5

<u>Initial batch</u>	<u>day of stuffing</u>	<u>Mean</u>	<u>sd</u>	<u>n</u>
proteins g 100 g ⁻¹ total solids		40.44	0.35	3
fat g 100 g ⁻¹ total solids		50.32	2.56	3
ashes g 100 g ⁻¹ total solids		8.88	0.19	3
moisture g 100 g ⁻¹		58.67	1.77	3
<u>Salami with commercial starter and pathogens</u>	<u>end of ripening</u>	<u>Mean</u>	<u>sd</u>	<u>n</u>
proteins g 100 g ⁻¹ total solids		43.38	4.11	3
fat g 100 g ⁻¹ total solids		45.84	6.02	3
ashes g 100 g ⁻¹ total solids		9.51	0.58	3
moisture g 100 g ⁻¹		28.28	1.40	3
<u>Salami with NoNit™ starter and pathogens</u>	<u>end of ripening</u>	<u>Mean</u>	<u>sd</u>	<u>n</u>
proteins g 100 g ⁻¹ total solids		43.91	4.72	3
fat g 100 g ⁻¹ total solids		45.50	4.13	3
ashes g 100 g ⁻¹ total solids		9.26	1.33	3
moisture g 100 g ⁻¹		29.30	0.72	3

Table 6.

	Commercial		NoNit™	
	mean	sd	mean	sd
color intensity	4,38	0,92	4,53	1,81
color uniformity	3,38 ^a	1,30	5,00 ^b	1,65
fat/lean connection	3,63	1,19	4,47	1,64
fat/lean distribution	3,43 ^a	0,79	4,87 ^b	1,69
odour (global)	3,88	0,83	4,53	1,36
mould odor	3,00	1,51	2,47	1,46
elasticity	3,88	1,81	3,27	1,62
hardness	2,50 ^a	1,60	3,87 ^b	1,41
cohesiveness	4,63	1,92	4,93	1,34