Category	Reference	Product Characteristics				Experimental Details		
		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Composite Food	Golden MC, Wanless BJ, David JRD, Kottapalli B, Lineback DS, Talley RJ, Glass KA (2017) Effect of Cultured Celery Juice, Temperature, and Product Composition on the Inhibition of Proteolytic *Clostridium botulinum* Toxin Production. J Food Prot 80 (8):1259-1265.	Cauliflower potatoes	Potatoes, cauliflower, cream, dried chives, unsalted butter, garlic, salt, and black pepper	5.49 to 5.55	0.991 to 0.992	*Clostridium botulinum* (Proteolytic strains, toxin type A and type B)	Cultured celery juice powder [CCJP]: added to 0.4% to marinade and sauce to give a nitrite concentration of 80 mg/kg	The addition of CCJP delayed toxin production by 1 week in the cauliflower potatoes stored at 15°C or 20°C
Composite Food	Golden MC, Wanless BJ, David JRD, Kottapalli B, Lineback DS, Talley RJ, Glass KA (2017) Effect of Cultured Celery Juice, Temperature, and Product Composition on the Inhibition of Proteolytic *Clostridium botulinum* Toxin Production. J Food Prot 80 (8):1259-1265.	Marinated grilled pork with Dijon mustard sauce	Marinated (water, Dijon mustard, olive oil, salt, and pepper) grilled pork chops with added Dijon sauce (water, maple syrup, Dijon mustard, corn starch, pork base, salt, pepper)	5.9 to 5.95 for the composite product; 4.43 to 4.61 for the sauce and 5.93 to 5.96 for the protein component	0.983 to 0.984 for the composite product; 0.981 for the sauce, 0.989 for the protein component	*Clostridium botulinum* (Proteolytic strains, toxin type A and type B)	Cultured celery juice powder [CCJP]: added to 0.4% to marinade and sauce to give a nitrite concentration of 80 mg/kg Temperature control	• Neither the control nor the samples with CCJP showed toxicity during 8 weeks storage at 10°C. • At a warmer temperature (15°C), toxicity occurred in some control samples by 5 weeks, but no toxicity was seen in the CCJP samples throughout 8 weeks of storage. • At the highest temperature tested (20°C), both control samples and samples with CCJP showed toxicity by 1 week of storage.
Composite Food	Hwang CA, Huang LH (2014) the effect of potassium sorbate and pH on the growth of *Listeria monocytogenes* in ham salad. J Food Process Pres 38 (4):1511-1516.	Ham salad	Cooked ham Mayonnaise	5.4 to 5.8	0.97 to 0.98	*Listeria monocytogenes*	Potassium sorbate pH (lowered from ingredients)	• The population increases of *L. monocytogenes* in salads stored at 4°C for 4 weeks were correlated to salad pH and sorbate concentration. • In salads with pH levels of 5.4–5.8 containing 0.0, 0.1, 0.15 and 0.2% sorbate, the populations of *L. monocytogenes* increased 2.7–6.4, 2.4–5.2, 1.0–3.7 and 0.2–2.0 log cfu/g, respectively.
Composite Food	Lewis R, Bolocan AS, Draper LA, Ross RP, Hill C (2019) The Effect of a Commercially Available Bacteriophage and Bacteriocin on *Listeria monocytogenes* in Coleslaw. Viruses-Basel 11 (11):12.	Coleslaw	NR (purchased from a market)	Not measured, but reported to be usually 3.9 to 4.5	NR	*Listeria monocytogenes* Scott A	Bacteriophage (P100) at 2.6 x 10^6 PFU/g Nisin (Nisaplin®)at 25 µg/mL	• Coleslaw was inoculated with *L. monocytogenes*, antimicrobials were added, and the coleslaw was stored for up to 10 days at 4°C. • Phage P100 on its own had a significant effect on *L. monocytogenes* numbers in coleslaw over a 10-day period at 4°C. • Nisaplin alone had no significant effect on *L. monocytogenes* numbers. • P100 and Nisaplin in combination were more effective than Nisaplin alone, but not P100 alone.

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		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Composite Foods	Alali, W.Q., Mann, D.A. and Beuchat, L.R., 2012. Viability of *Salmonella* and *Listeria monocytogenes* in Delicatessen Salads and Hummus as Affected by Sodium Content and Storage Temperature. Journal of Food Protection 75: 1043-1056.	New York style potato salad, original macaroni salad, shredded coleslaw, and hummus	See paper (Table 1) for detailed ingredient lists	Potato salad: 5.07 Macaroni salad: 4.47 Coleslaw: 3.94 Hummus: 4.59	Potato salad: 0.984 to 0.995 Macaroni salad: 0.985 to 0.995 Coleslaw: 0.985 to 0.994 Hummus: 0.975 to 0.992	Mixture of *Salmonella enterica* serotypes Anatum, Enteritidis, Heidelberg, Typhimurium, and Newport; mixture of *L. monocytogenes* strains F8025, F8369, F8385, H0222, and G1091	Sodium concentration (varied by addition of sodium chloride): Potato salad: 133 to 364 mg/100 g Macaroni salad: 190 to 336 mg/100 g Coleslaw: 146 to 272 mg/100 g Hummus: 264 to 728 mg/100 g	• The acidic pH of mayonnaise-based salads and hummus is a major factor preventing growth and influencing rates of inactivation of *Salmonella* and *L. monocytogenes* refrigerated storage. • The presence of added sodium protected *Salmonella* from inactivation in macaroni salad stored at 4°C and hummus stored at 4 or 10°C. • Similarly, higher levels of *L. monocytogenes* were found in potato salad and hummus with added sodium (vs. no added sodium) when stored at 4°C. • However, the authors concluded altering the sodium levels in deli salads or hummus did not markedly alter *Salmonella* or *L. monocytogenes* when products were stored for up to 27 days at 4 or 10°C.
Composite Foods	Al-Rousan, W.M., Olaimat, A.N., Osaili, T.M., Al-Nabulsi, A.A., Ajo, R.Y. and Holley, R.A., 2018. Use of acetic and citric acids to inhibit *Escherichia coli* O157:H7, *Salmonella Typhimurium* and *Staphylococcus aureus* in tabbouleh salad. Food Microbiology 73: 61-66.	Tabbouleh salad	Fresh parsley Tomatoes Onions Salt Bulgur wheat Olive oil	Without any acetic or citric acid: 4.97 After adding acid: 3.15 to 4.11	NR	*Salmonella* Typhimurium (ATCC 14028 and 127) *Staphylococcus aureus* (ATCC 25923) *E. coli* O157:H7 strains 003581 and 02-0304	Acetic acid (0.3 to 0.4%) Citric acid (1% to 1.4%)	*Salmonella*: • Acetic acid reduced *S.* Typhimurium numbers by 1.1 to 1.4 log CFU/g when added to tabbouleh salad stored 6 days at 10°C and 0.9 to 1 log CFU/g when stored 6 days at 4°C. • Numbers of *S.* Typhimurium in tabbouleh were reduced by 2.3 and 3.4 log CFU/g at 10°C or by 1.5 and 4.1 log CFU/g at 4°C in the samples treated with 1 and 1.4% citric acid, respectively. • The combined effects of acetic and citric acid against *S.* Typhimurium in tabbouleh was synergistic at all temperatures used. *Staphylococcus*: • 1.4% citric acid or its combination with 0.3% acetic acid were inhibitory against *S. aureus* in tabbouleh; the levels of this pathogen were reduced by 3.2 log CFU/g after 7 days at 4°C. *E. coli* O157:H7 • At 10 or 4°C, a combination of 1% citric acid plus 0.4% acetic acid reduced *E. coli* O157:H7 levels in tabbouleh by 1.9 and 1.4 log CFU/g, respectively.

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Composite Foods	Ayari, S., Dussault, D., Hamdi, M., and Lacroix, M. 2016. Growth and toxigenic potential of *Bacillus cereus* during storage temperature abuse in cooked irradiated chicken rice in combination with nisin and carvacrol. LWT-Food Sci. Tech. 72:19.	Chicken and rice	Long-grain white rice and chicken	NR	NR	*Bacillus cereus*	• Carvacrol (156 to 625 ppm) • Nisin (312 to 1250 IU/g) • Irradiation (gamma, 1 to 1.8 kGy at a dose rate of 15.6 kGy/h)	Combinations of low irradiation doses with moderate concentrations of antimicrobial agents significantly decreased *B. cereus* levels and prevented toxin formation until Day 12 of storage at 10°C.
Composite Foods	Cufaoglu, G., Onaran, B., Ayaz, N.D., Goncuoglu, M. and Ormanci, F.S., 2017. Biocontrol of *Escherichia coli* O157:H7 in ready-to-eat salad using a lytic bacteriophage. Medycyna Weterynaryjna-Veterinary Medicine-Science and Practice 73: 422-424.	Mayonnaise-based RTE Italian salad	Mayonnaise, beans, carrots, potatoes, pickled cucumber, and salami	NR	NR	*E. coli* O157:*H7* strains (ATCC 43895 and NCTC 12900)	Bacteriophage M8AEC16 Temperature control	• When stored at 4°C, application of bacteriophage could reduce *E. coli* O157:H7 levels by ≤1.38 log by 3 to 5 hours. • Higher reductions (up to 2.7 log) were observed when stored at a higher temperature (10 or 22°C) for 5 hours.
Composite Foods	Mitchell, M. 2006. The evaluation of novel antimicrobial ingredients in maintaining the safety and shelf-life of refrigerated foods. Food Safety Magazine 12:58.	Chicken salad (CS), vegetable soup (VS), and tapioca pudding (TP)	NR	4.78 (CS) 6.48 (VS) 6.40 (TP)	0.968 (CS) 0.981 (VS) 0.969 (TP)	*Listeria monocytogenes*	• Lemon juice + vinegar (MOstatin LV) at 2% • Vinegar (MOstatin V) at 1.1% • Cultured dextrose (RME 551) at 1.6% • Lactic acid plus acetic acid (Purac Fresh S) at 0.6% • Potassium sorbate plus sodium benzoate at 0.1%	This challenge study measured inoculated *L. monocytogenes* levels during 35 days of storage at ~7°C in three different chilled foods. Chicken salad: As expected, no growth was observed in any of the formulations. None of the treatments reduced *Listeria* to a "non-hazard" level. Vegetable soup: "One antimicrobial ingredient (MOstatin V) was shown effective in preventing growth of *Listeria* in the vegetable soup sample. However, it did not reduce the pathogen below the initial 2-log *Listeria* inoculation." Tapioca pudding: "Only one novel antimicrobial ingredient (MOstatin V) was successful against Listeria growth during the 35 days"

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Composite Foods	Molinos AC, Abriouel H, Lopez RL, Ben Omar N, Valdivia E, Galvez A (2009) Enhanced bactericidal activity of enterocin AS-48 in combination with essential oils, natural bioactive compounds and chemical preservatives against *Listeria monocytogenes* in ready-to-eat salad. Food Chem Toxicol 47 (9):2216-2223.	RTE salads containing mayonnaise (Russian salad, crabmeat salad, tuna salad, coleslaw, and alioli salad	See paper for details; Russian salad contained mayonnaise, potatoes, carrots, peas, egg, and lives	4.07 to 4.44; Russian salad was pH 4.44	NR	*Listeria monocytogenes*	AS-48 (enterocin) Essential oils (thyme, verbena, thyme red, oregano, ajowan, tea tree, clove, sage, and rosemary) Bioactive compounds (carvacrol, eugenol, thymol, terpineol, tyrosol, hydroxytyrosol, caffeic acid, ferulic acid, vanillic acid, and more; see paper for details Citric acid, lactic acid, sucrose palmitate, sucrose stearate, p-hydroxybenzoic methylester acid (PHBME), and Nisaplin	Various types of salad were inoculated with *L. monocytogenes*, antimicrobials were added, and the salads stored at 10°C for 7 days. AS-48 alone had small but variable degrees of inhibition against *L. monocytogenes* in the various salads. AS-48 acted synergistically with citric, lactic acid, and PHBME against *L. monocytogenes* in the Russian salad. A mixed population of two *L. monocytogenes* strains was markedly reduced for one week in salad treated with AS-48 in combination with lactic acid, PHBME or Nisaplin.
Composite Foods	Munoz, N., Sonar, C. R., Bhunia, K., Tang, J., Barbosa-Canovas, G. V., and Sablani, S. S. 2019. Use of protective culture to control the growth of *Listeria monocytogenes* and *Salmonella typhimurium* in ready-to-eat cook-chill products. Food Contr. 102:81.	Cream of potato soup (cook-chill)	Campbell's condensed soup, reconstituted with whole milk	6.28	0.993	*Listeria monocytogenes* *Salmonella* spp.	*Lactobacillus rhamnosus* GG (LGG) (Culturelle®), a commercial probiotic supplement Temperature control	Without the LGG protective culture, *L. monocytogenes* growth was observed after 9 and 15 days during storage at 15°C and 10°C, respectively, up to 5.0 and 3.6 log CFU/g by day 21. When LGG was present, no *L. monocytogenes* growth was observed at 15°C. At 10°C, LGG did not completely prevent *L. monocytogenes* growth at 9 days, but a decrease was noted after 15 days. Co-inoculation of LGG with *Salmonella* prevented growth at 15°C during 21 days of storage.

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Composite Foods	Necidova L, Mrnousova B, Harustiakova D, Bursova S, Janstova B, Goliane J (2019) The effect of selected preservatives on the growth of *Listeria monocytogenes* in ready-to-eat foods. LWT-Food Sci Tech 116:7.	A variety of RTE foods: • Egg aspic • Ham aspic • Cheeks in aspic • Chicken aspic with broccoli • Cheese spread • Hardboiled eggs in mayonnaise • Mayonnaise salad • Pasta salad • Potato mayonnaise salad	NR	4.51 to 5.77 without preservatives	0.932 to 0.996 without preservatives	*Listeria monocytogenes*	Sodium benzoate (0.225 g/kg) plus potassium sorbate (0.675 g/kg) A commercially available preservative (Defence JB, which is obtained by natural fermentation of lactic acid bacteria and yeast starter cultures) at 2 g/kg	• Various food products were inoculated with *L. monocytogenes* and preservatives and stored at 5 to 6°C for 8 to 23 days. • In most of the test foods without preservatives (except pasta salad and hardboiled eggs in mayonnaise), *L. monocytogenes* did not grow and gradually decreased in numbers during storage at 5 or 6°C. • Neither the benzoate/sorbate mixture nor the Defence JB showed significant antimicrobial activity against *L. monocytogenes* in the tested RTE foods.
Composite Foods	Olaimat, A.N., Al-Holy, M.A., Abu Ghoush, M.H., Abu Hilal, H.M., Al-Nabulsi, A.A., Osaili, T.M. and Rasco, B.A., 2019. Population dynamics of *Salmonella* spp. and *Shigella* spp. in ready-to-eat Mediterranean vegetable salads. Journal of Food Safety. (4):1.	Tomato-cucumber (TC) salad, with and without tahini (10% wt/wt) or lemon juice plus salt	Tomatoes Cucumbers	TC salad: 4.24 TC salad with lemon juice plus salt: 3.73 TC salad plus tahini: 4.98	NR	*Shigella sonnei* ATC 25931, *Shigella flexneri* [2b] ATCC 12022 *Salmonella enterica* (S. Heidelberg 271, S. Typhimurium 02:8423, S. Copenhagen PT 99, S. Enteritidis CRIFS 1016, and S. Kentucky 64701)	1% lemon juice plus 0.5% salt Temperature control	• Inoculated salads were stored at 4, 10, or 24°C for 5 days. • At 4°C, both pathogens survived well in all salads, with a 0.2 to 1.6 log CFU/g reduction after 5 days. • At 10°C, *Salmonella* in the salads remained constant, whereas *Shigella* numbers significantly increased by 1.0–1.7 log CFU/g after 5 days. • At 24°C, *Salmonella* numbers significantly increased in salad without additives by 1.4 log CFU/g after 5 days but were below the detection level in the other types of salad after 5 days. • However, *Shigella* numbers significantly increased by 1.0 log CFU/g in the tomato cucumber salad with tahini, but they significantly declined by 1.9–2.9 log CFU/g in TC salads after 5 days

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Composite Foods	Ro, E.Y., Kim, G.S., Kwon, D.Y., Park, Y.M., Cho, S.W., Lee, S.Y., Yeo, I.H. and Yoon, K.S., 2018. Effects of natural antimicrobials with modified atmosphere packaging on the growth kinetics of *Listeria monocytogenes* in ravioli at various temperatures. Journal of Food Safety 38: e12392.	Ready-to-cook spinach or artichoke ravioli	Durum semolina flour, water, egg, and "spinach or artichoke base materials" purchased from a ravioli manufacture r	NR	NR	*Listeria monocytogenes*	Cultured sugar/vinegar blend (0.1, 0.3, 0.5, 1% CSV) Nisin (0.1, 0.2, and 0.3%) MAP (0.3% CO_2 and 99.7% N_2) Temperature control (4, 10, 17, and 24°C for 60 days)	• Ravioli with spinach filling materials yielded a higher risk than that with artichoke. • *L. monocytogenes* was able to survive in ravioli with artichoke, but did not grow. • The addition of 1% CSV blend or 0.3% nisin in spinach ravioli with the combination of MAP effectively controlled the growth of *L. monocytogenes* at the temperature below 10°C. • The organoleptic quality of spinach ravioli was not also affected by the application of 1% CSV blend.
Composite Foods	Shahbazi Y, Karami N, Shavisi N (2018) Effect of *Ziziphora clinopodioides* essential oil on shelf life and fate of *Listeria monocytogenes* and *Staphylococcus aureus* in refrigerated chicken meatballs. J Food Saf 38 (1):10.	Refrigerated raw chicken meatballs	Chicken breast, onion, salt, saffron	NR	NR	*Staphylococcus aureus* ATCC 6538 *Listeria monocytogenes* ATCC 19118	*Ziziphora clinopodioides* essential oil (0.1, 0.2, and 0.3%), which contains carvacrol and thymol as major components	• Raw chicken meatballs were formulated with the essential oil, inoculated with pathogens, and then stored at 4°C for 12 days. • Inclusion of the essential oils at any of the tested levels decreased *L. monocytogenes* levels during 12 days of storage by at least 2 log and completely eliminated *S. aureus* by 10 days of storage.
Composite Foods	Shahbazi Y, Shavisi N, Mohebi E (2016) Potential Application of *Ziziphora Clinopodioides* Essential Oil and Nisin as Natural Preservatives Against *Bacillus cereus* and *Escherichia coli* O157: H7 in Commercial Barley Soup. J Food Saf 36 (4):435-441.	Commercial barley soup	Barley, onion, salt, vegetable oil, parsley, yeast extract, carrot, MSG, citric acid, spices	NR	NR	*Bacillus cereus* (ATCC 11774) *E. coli* O157:H7 (ATCC 10536)	Nisin (250 to 500 IU/mL *Ziziphora clinopodioides* essential oil (0.1 and 0.2%), which contains carvacrol and thymol as major components	• Soup was made with the antimicrobials, inoculated, and then stored at 4°C for up to 9 days. • Pathogen levels were significantly affected by the addition of the essential oil. • Nisin was more effective against *B. cereus* than E. coli O157:H7 in barley soup during storage. • The lowest population of the pathogens was found in the samples treated with the essential oil at 0.2% in combination with nisin at 500 IU/mL. • Neither the nisin nor the essential oil caused sensory changes to the food.
Composite Foods	Stratakos AC, Linton M, Tessema GT, Skjerdal T, Patterson MF, Koidis A (2016) Effect of high pressure processing in combination with *Weissella viridescens* as a protective culture against *Listeria monocytogenes* in ready-to-eat salads of different pH. Food Contr 61:6-12.	Ready-to-eat salad	Cooked potato, cooked chicken, sour cream, and other ingredients (see paper for full list)	4.32 or 5.59	0.966 to 0.967	*Listeria monocytogenes*	*Weissella viridescens* protective culture High pressure processing (400 MPa for 1 min)	• HPP alone reduced *L. monocytogenes* levels by 4 and 1.5 log CFU/g in low and higher pH RTE salads, respectively. • In the lower pH RTE salad, the protective culture gradually reduced *L. monocytogenes* counts during storage, whereas in the higher pH RTE salad, in some cases it delayed growth significantly or exerted a bacteriostatic effect. • Increased storage temperature (12 vs. 4°C) led to an increase in the inactivation/inhibition of *L. monocytogenes* in the presence of *W. viridescens*. • The combination of HPP and the protective culture resulted in a "synergistic effect against *L. monocytogenes* that was even more pronounced during storage at an abusive temperature."

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Composite Foods	Takahashi H, Takahashi T, Miya S, Yokoyama H, Kuda T, Kimura B (2015) Growth inhibition effects of ferulic acid and glycine/sodium acetate on *Listeria monocytogenes* in coleslaw and egg salad. Food Contr 57:105-109	Coleslaw Egg salad	Coleslaw: cabbage, mayonnaise, and salt Egg salad: egg salad and mayonnaise	Coleslaw without additives: 4.55 Egg salad without additives: 6.75	NR	*Listeria monocytogenes*	Ferulic acid Ferulic acid plus glycine/sodium acetate	Salads were inoculated with *L. monocytogenes*, antimicrobials were added, and then were incubated at 10˚C for 5 days. Without added antimicrobials, *L. monocytogenes* did not grow in coleslaw. However, *L. monocytogenes* levels increased 3.6 log CFU/g in the untreated egg salad. In coleslaw, the addition of 1500 ppm ferulic acid resulted in a 1.5 log CFU/g reduction in *L. monocytogenes* in 5 days. Ferulic acid alone at concentrations of 3000 ppm did not inhibit *L. monocytogenes* growth in egg salad; however, when combined with glycine/sodium acetate, *L. monocytogenes* levels did not increase.
Composite Foods	TREVISANI M, CESARE AD, VITALI S, MANCUSI R, BOVO F, MANFREDA G (2019) Growth Potential of *Listeria monocytogenes* in Chef-Crafted Ready-to-Eat Fresh Cheese-Filled Pasta Meal Stored in Modified Atmosphere Packaging. J Food Prot 82 (9):1546-1552.	RTE fresh cheese-filled pasta meal	Ravioli stuffed with spinach and ricotta cheese, cherry tomatoes, rocket, Grana cheese, and sunflower oil	6 to 6.2	0.993 to 0.994	*Listeria monocytogenes*	Temperature control (6 vs. 14˚C) Lactic acid bacteria levels (endogenous) MAP (50% CO_2, 50% N_2)	• Product was inoculated with *L. monocytogenes* and stored under MAP for up to 14 days at either 6 or 14˚C. • Growth of LAB was faster at 14˚C than at 6˚C. • *Listeria monocytogenes* growth was never observed in the products stored at 14˚C. • In products stored at 6˚C, *L. monocytogenes* grew only in the samples with LAB <5.7 log CFU/g. • LAB interaction might thus inhibit the growth of *L. monocytogenes* in temperature-abused products.
Composite Foods	Witkowska AM, Hickey DK, Wilkinson MG (2014) Effect of variation in food components and composition on the antimicrobial activity of oregano and clove essential oils in broth and in a reformulated reduced salt vegetable soup product. Journal of Food Research 3 (6):92-106.	Reduced salt vegetable soup	Potatoes, carrots, turnips, celery, diced onions, vegetable stock, and water	5.0 or 6.2	NR	*Listeria innocua*	Oregano essential oil Clove essential oil Citric acid (to alter pH) NaCl	• A combination of oregano EO and acidification with citric acid appeared to control growth of *L. innocua* in vegetable soup during storage at 4 or 10˚C. • Antimicrobial activity of EOs was enhanced in presence of NaCl (≥ 0.5 g/100 ml), or in media with low pH values (≤ 5.0), especially when adjusted with organic acids.
Dairy	Davies EA, Bevis HE, DelvesBroughton J (1997) The use of the bacteriocin, nisin, as a preservative in ricotta-type cheeses to control the food-borne pathogen *Listeria monocytogenes*. Letters in Applied Microbiology 24 (5):343-346.	Ricotta-type cheeses	Raw cow's milk, calcium chloride, acetic acid	NR	NR	*Listeria monocytogenes*	Nisin Potassium sorbate	• The efficacy of nisin (added to milk) to control the food-borne pathogen *Listeria monocytogenes* in ricotta-type cheeses over long storage (70 d) at 6 to 8˚C was determined. • Nisin at a level of 2 to 5 mg/L could effectively inhibit the growth of *L. monocytogenes* for a period of 8 weeks or more (dependent on cheese type). Cheese made without the addition of nisin contained unsafe levels of the organism within 1–2 weeks of incubation. • The authors speculate that sorbate plus nisin may have enhanced activity against *L. monocytogenes*.

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Dairy	Gadotti C, Forghani F, Diez-Gonzalez F (2020) Evaluation of single and combined antimicrobial treatments to inhibit *Salmonella* in queso fresco. Food Microbiol 85:6.	Queso fresco	Milk, non-fat dried milk, calcium chloride, chymosin, salt	NR	NR	*Salmonella spp.* (multiple strains in a cocktail)	Nisin (N) at 5 g/kg Caprylic acid (CA) at 0.4 to 1.6 g/kg Trans-cinnamaldehyde (CN) 0.3 to 1.2 g/kg	• Curds were inoculated and mixed with antimicrobials and stored at 8°C for 20 days. • Application of CN at 0.6 g/kg inhibited Salmonella growth during storage, resulting in at least 3 Log CFU/g difference with the untreated controls. • Addition of N (0.5 g/kg) and CA (0.4 g/kg) with CN (0.3 and 0.6 g/kg) further enhanced the antimicrobial activity resulting in complete suppression of growth. • The combination of N and CA at 0.5 and 0.4 or 0.5 and 0.7 g/kg cheese, respectively, did not result in any significant inhibition of Salmonella over the course of 20 days storage at 8 °C. Using 0.5 and 1.6 g/kg N and CA, respectively, resulted in reductions of 1–2 Log CFU/g compared to the untreated control. • In a sensory analysis, participants preferred the untreated samples, but accepted CN at 0.3 g/kg.
Dairy	Komora N, Maciel C, Pinto CA, Ferreira V, Brandao TRS, Saraiva JMA, Castro SM, Teixeira P (2020) Non-thermal approach to *Listeria monocytogenes* inactivation in milk: The combined effect of high pressure, pediocin PA-1 and bacteriophage P100. Food Microbiol 86:9.	Milk	Milk	NR	NR	*Listeria monocytogenes*	High-pressure processing (200 and 300 MPA for 5 min) Pediocin PA-1 Bacteriophage P100	• For inoculum levels of 10^4 CFU/mL, HHP combined with phage P100 eliminated *L. monocytogenes* immediately after pressurization. • When *L. monocytogenes* was inoculated at levels of 10^7CFU/mL, a synergistic effect between phage P100, pediocin PA-1 and HHP (300 MPa) on the inactivation of *L. monocytogenes* was observed during storage of milk at 4 °C. • For non-pressure treated samples inoculated with phage or pediocin or both, *L. monocytogenes* counts decreased immediately after biocontrol application, but regrowth was observed in a few samples during storage. • Phage particles were stable during refrigerated storage for seven days while pediocin PA-1 remained stable only during three days.
Dairy	Lawton MR, Jencarelli KG, Kozak SM, Alcaine SD (2020) Short communication: Evaluation of commercial meat cultures to inhibit *Listeria monocytogenes* in a fresh cheese laboratory model. Journal of Dairy Science 103 (2):1269-1275.	Queso fresco	Milk, calcium chloride, rennet	6.68 to 6.71	NR	*Listeria monocytogenes*	Commercial bacterial cultures used in meat (*Lactobacillus curvatus, Lactobacillus sakei, Pediococcus acidilactici*, and *Leuconostoc carnosum*)	Commercial cultures used in processed meat products (and shown to be effective against *L. monocytogenes*) were incorporated into queso fresco during manufacturing. The cheese was then surface inoculated with *L. monocytogenes* and stored at 6 and 21 °C for up to 21 days. "Our results suggest that the selected LAB are unable to inhibit the growth of *L. monocytogenes* in a fresh cheese matrix. Although *L. monocytogenes* counts were reduced compared with the control on certain days, the difference was only about 0.5 log cfu/g. This reduction was not significant from a biological standpoint and would not be effective as a control strategy."

Category	Reference	Product Characteristics				Experimental Details		
		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Dairy	Lourenco A, Kamnetz MB, Gadotti C, Diez-Gonzalez F (2017) Antimicrobial treatments to control *Listeria monocytogenes* in queso fresco. Food Microbiol 64:47-55.	Queso fresco	Milk Non-fat dried milk Calcium chloride Chymosin Salt	Not reported, but referenced to be 5.3 to 6.5	NR	*Listeria monocytogenes*	Caprylic acid (CA) Nisin (N) Sodium lactate plus sodium diacetate (SL/SD) Lactococcus lactis sbp. lactis DPC 3147 Monolaurin Lactic acid (LA)	• Batches of queso fresco curds were inoculated with *L. monocytogenes* and stored at 4°C for three weeks. • During storage the count of *L. monocytogenes* reached 7 to 8 Log CFU/g in control samples. • Most individual antimicrobial treatments resulted in less than 1 Log CFU/g reductions in final counts, with the exception of N (0.5 g/kg) and CA (2.9 g/kg) that caused more than 3 and 5 Log CFU/g differences with controls, respectively. • Mixtures of ingredients were more effective in inhibiting *L. monocytogenes* growth, and treatments with N and CA consistently delivered 6 log CFU/g less counts than controls. • Supplementation of 12 g/kg LA to treatments with SL/SD (3%/0.22%) caused differences of more than 4 log CFU/g in final *Listeria* populations.
Dairy	Nithya V, Prakash M, Halami PM (2018) Utilization of Industrial Waste for the Production of Bio-Preservative from Bacillus licheniformis Me1 and Its Application in Milk and Milk-Based Food Products. Probiotics Antimicrob Proteins 10 (2):228-235.	Milk and milk-based food products including cheese and paneer	NR	NR	NR	*Listeria monocytogenes* Scott A *Micrococcus luteus* ATCC 9341 *Staphylococcus aureus* FRI 722	Partially purified antibacterial peptide (ppABP) produced by *Bacillus licheniformis* Me1	• The addition of ppABP in milk samples stored at 4 ± 2 °C and 28 ± 2 °C resulted in the growth inhibition of pathogens *Listeria monocytogenes* Scott A, *Micrococcus luteus* ATCC 9341, and *Staphylococcus aureus* FRI 722. • Antilisterial effect was also observed in cheese and paneer samples treated with ppABP.
Diary	Gadotti C, Nelson L, Diez-Gonzalez F (2014) Inhibitory effect of combinations of caprylic acid and nisin on *Listeria monocytogenes* in queso fresco. Food Microbiol 39:1-6.	Queso fresco	Milk, non-fat dried milk, calcium chloride, chymosin, and salt	NR	NR	*Listeria monocytogenes* strain mixtures	Nisin (N) at 0.4 and 0.49 g/kg Caprylic acid (CA) at 0.36 and 0.72 g/kg Trans-cinnamaldehyde (CN) 0.3 to 1.2 g/kg	• Curds were inoculated and mixed with antimicrobials and stored at 4°C for 20 days. • All N and CA combinations (≥0.4 g/kg each) were effective against *L. monocytogenes* and reduced the final counts by at least 3 log CFU/g after 20 days of storage compared to controls. • The levels of most strain mixtures were reduced immediately after treatment and their numbers remained below 10^3 CFU/g during storage. • CN (1.2 g/kg) was bacteriostatic against *L. monocytogenes*, but it did not reduce initial counts. The addition of CN to the combination of N and CA did not enhance their antimicrobial effect.

Category	Reference	Product Characteristics				Experimental Details		
		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Eggs	Kim KW, Daeschel M, Zhao Y (2008) Edible coatings for enhancing microbial safety and extending shelf life of hard-boiled eggs. J Food Sci 73 (5):M227-M235.	Hard-boiled eggs (shell-on)	Eggs	7.6 before storage	NR	*Listeria monocytogenes* *Salmonella* Enteritidis	Chitosan/lysozyme (CL) Whey protein isolate (WPI) Bake Sheen (BS)	• Hard-boiled eggs were inoculated on the surface and then coated with chitosan/lysozyme, WPI, or BS before storing at 10˚C for up to 4 weeks. • None of the coatings were effective at inhibiting *L. monocytogenes* growth by more than 1 log CFU/g in or on the surface of eggs. • At the end of 4-wk storage, the numbers of *S.* Enteritidis in or on CL-coated eggs were about 4-log CFU/g less than that of the controls. • WPI also reduced *S.* Enteritidis levels in and on eggs after 4 weeks storage at 10˚C. • CL was also effective at preventing most of the pH increase observed in unpeeled eggs during storage for 10 weeks at 10˚C.
Eggs	Claire, B., Smith, J.P., El-Khoury, W., Cayouette, B., Ngadi, M., Blanchfield, B. and Austin, J.W., 2004. Challenge studies with *Listeria monocytogenes* and proteolytic Clostridium botulinum in hard-boiled eggs packaged under modified atmospheres. Food Microbiology 21: 131-141.	Hard-boiled eggs (shells removed), as egg white, egg yolks, or mashed eggs	Eggs	8.2 (egg whites before storage) 6.6 (egg yolk before storage) 7.2 (mashed eggs before storage)		*Listeria monocytogenes* *Clostridium botulinum* (proteoloytic)	Modified atmosphere packaging (80% CO_2) Temperature control (4, 8, and 12˚C for *L. monocytogenes*; 12 and 25˚C for C. botulinum)	• Growth of *L. monocytogenes* occurred in all inoculated egg samples stored at 4°C, 8°C, and 12°C with counts increasing from ~10^2 to >10^6 cfu/g after 3–20 days, depending on the packaging atmosphere and storage temperature. Growth was slower at lower temperatures. • MAP (80% CO2) had little effect in controlling the growth of *L. monocytogenes* in egg white, egg yolk and mashed eggs particularly at mild (8°C) and moderate abuse (12°C) conditions of storage. Some effect was observed at 4˚C. • In challenge studies with proteolytic strains of C. botulinum, botulinum neurotoxin was not detected in any samples after 21 days at 12°C. • However, neurotoxin was detected in all inoculated eggs that had been initially stored at 12°C, then transferred to 25°C for a further 7 days, regardless of the packaging atmosphere.
Fish and Seafood	Aymerich T, Rodriguez M, Garriga M, Bover-Cid S (2019) Assessment of the bioprotective potential of lactic acid bacteria against *Listeria monocytogenes* on vacuum-packed cold-smoked salmon stored at 8 degrees C. Food Microbiol 83:64-70.	Cold-smoked salmon (vacuum packaged)	NR	6.03 to 6.10	0.96	*Listeria monocytogenes*	Protective lactic acid bacterial cultures	• Three different types of smoked salmon (with different fat, moisture, phenol, and acetic acid content) were inoculated with *L. monocytogenes* and then LAB cultures and stored for 21 days at 8˚C. • *L. sakei* CTC 494 prevented *L. monocytogenes* growth in all products, while the other two LAB cultures were less effective.

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Fish and Seafood	Wu J, Jahncke ML, Eifert JD, O'Keefe SF, Welbaum GE (2016) Pomegranate peel (Punica granatum L) extract and Chinese gall (Galla chinensis) extract inhibit Vibrio parahaemolyticus and *Listeria monocytogenes* on cooked shrimp and raw tuna. Food Contr 59:695-699.	Cooked shrimp	Tail-on, peeled, deveined shrimp	NR	NR	*Vibrio parahaemolyticus* *Listeria monocytogenes*	Pomegranate peel extract (PPE) Chinese gall extract (CGE)	Cooked shrimp were soaked in PPE or CGE, inoculated with either *L. monocytogenes* or V. parahaemolyticus, and stored at 10 or 12°C for 10 days. Both Chinese gall and pomegranate peel extracts significantly inhibited the growth of V. parahaemolyticus in shrimp. Only Chinese gall extract significantly inhibited growth of *L. monocytogenes*. Neither extract completely inhibited the growth of V. parahaemolyticus or *L. monocytogenes*.
Fish and Seafood	Yamaki S, Shirahama S, Kobayashi T, Kawai Y, Yamazaki K (2015) Combined Effect of Nisin and Commercial Pectin-hydrolysate Treatment on Survival and growth of *Listeria monocytogenes* in Soy-seasoned Salmon Roe Products. Food Science and Technology Research 21 (5):751-755.	Soy-seasoned salmon roe products	Salmon roe, saline, liquid seasoning	6.1 (alone or with nisin) 5.6 to 5.7 (with Neupectin L)	NR	*Listeria monocytogenes*	Nisin (0.5 mg/g) Commercial pectin hydrosylate (Neupectin L) at 0.5%	• Treatment with 0.5 mg/g nisin completely inhibited the growth of *L. monocytogenes* in raw salmon roe. • However, treatment with nisin alone did not inhibit *L. monocytogenes* in soy-seasoned salmon roes. • Further work showed that combined treatment with 0.5 mg/g nisin and 0.5% Neupectin L completely inhibited the growth of *L. monocytogenes* during 7 days of storage at 12°C.
Meat and Poultry	Brasileiro IS, Barbosa M, Igarashi MC, Biscola V, Maffei DF, Landgraf M, Franco B (2016) Use of growth inhibitors for control of *Listeria monocytogenes* in heat-processed ready-to-eat meat products simulating post-processing contamination. LWT-Food Sci Tech 74:7-13.	Bologna and frankfurters	See paper for recipe	6 to 6.5 for all products throughout the experiments	0.930 and 0.960 for bolognas and between 0.950 and 0.970 for frankfurters	*Listeria monocytogenes*	Bologna: Nisin-based NovaGARD(R) LM100, NR100, and their individual components (nisin, rosemary extract, and in LM100, sodium diacetate) Frankfurters: sodium lactate and liquid smoke (AM5)	This study tested the ability of various antimicrobials in the product formulation to limit the growth of *L. monocytogenes* in bologna or frankfurters stored at 8°C for 30 days. On the 10th day at 8°C, counts of *L. monocytogenes* in experimentally contaminated bolognas containing NovaGARD®LM100 and in frankfurters containing sodium lactate and treated with liquid smoke were 3 log lower than in controls, and in the products manufactured with the individual components of NovaGARD®LM100 and NovaGARD®NR100.
Meat and Poultry	Churklam W, Chaturongakul S, Ngamwongsatit B, Aunpad R (2020) The mechanisms of action of carvacrol and its synergism with nisin against *Listeria monocytogenes* on sliced bologna sausage. Food Contr 108:7.	Sliced bologna sausage	NR	NR	NR	*Listeria monocytogenes* 10403S	Carvacrol Nisin	• The synergic effect of carvacrol and nisin on the survival of *L. monocytogenes* was examined during 4°C storage of sliced bologna sausages. • For up to 7 days, the presence of carvacrol combined with nisin resulted in significant growth rate reductions compared to those of controls.

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		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Meat and Poultry	Dussault D, Vu KD, Lacroix M (2016) Development of a model describing the inhibitory effect of selected preservatives on the growth of *Listeria monocytogenes* in a meat model system. Food Microbiol 53:115-121.	Ham	Lean pork, sodium erythorbate, sodium tripolyphosphate, and water	5.53 to 6.67	NR	*Listeria monocytogenes*	Sodium nitrite Sodium chloride Sodium acetate Sodium lactate Calcium propionate Nisin/hop alpha acids (HAA) blend	• A variety of ham formulations (containing various levels of different antimicrobials and at various pH levels) were tested for their ability to support *L. monocytogenes* during storage for 90 days at 4°C. • This data was used to create a predictive model of the rate of *L. monocytogenes* growth in RTE meat products. • Increasing concentration of sodium chloride, sodium nitrite, sodium acetate, potassium lactate and calcium propionate in meat reduced bacterial growth rate • Increasing pH in meat increased the growth rate of *L. monocytogenes*. • Only the blend of nisin and hop alpha acids did not show any significant effect in the concentrations used in this study.
Meat and Poultry	Figueiredo ACL, Almeida RCC (2017) Antibacterial efficacy of nisin, bacteriophage P100 and sodium lactate against *Listeria monocytogenes* in ready-to-eat sliced pork ham. Brazilian Journal of Microbiology 48 (4):724-729.	RTE sliced pork ham	NR	NR	NR	*Listeria monocytogenes*	• Nisin • Bacteriophage (P100) • Sodium lactate • Nisin plus P100 • Nisin plus sodium lactate	The ability of several antimicrobials (alone or in combination) against *L. monocytogenes* on the surface of sliced ham during storage at 6-8°C for up to 72 hours was assessed. Bacteriophage P100 alone or with nisin, was much more effective than nisin or sodium lactate in reducing *L. monocytogenes* levels at 72 hours.
Meat and Poultry	Glass KA, McDonnell LM, Rassel RC, Zierke KL (2007) Controlling *Listeria monocytogenes* on sliced ham and turkey products using benzoate, propionate, and sorbate. J Food Prot 70 (10):2306-2312.	Sliced, cooked, uncured turkey breast and smoked cured ham	See paper for formulations	Turkey: 6.42 Ham: 6.39	Turkey: 0.972 Ham: 0.967	*Listeria monocytogenes*	Sodium lactate: 1.6 to 3.2% Sodium diacetate: 0.1 to 0.2% Benzoate: 0.05 to 0.1% Propionate: 0.05 to 0.3% Sorbate: 0.05 to 0.3%	• 0.1% benzoate, 0.2% propionate, 0.3% sorbate, or a combination of 1.6% lactate with 0.1% diacetate prevented the growth of *L. monocytogenes* on ham stored at 4°C for 12 weeks. • When no nitrite was included in the formulation, 0.2% propionate used alone, a combination of 0.1% propionate with 0.1% sorbate, or a combination of 3.2% lactate with 0.2% diacetate was required to prevent listerial growth on the product stored at 4°C for 12 weeks. • When stored at 7°C, select treatments delayed listerial growth for 4 weeks but supported significant growth at 8 weeks. • All treatments supported more than a 1-log increase in listerial populations when stored at 10°C for 4 weeks.

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Meat and Poultry	Golden MC, McDonnell LM, Sheehan V, Sindelar JJ, Glass KA (2014) Inhibition of *Listeria monocytogenes* in deli-style turkey breast formulated with cultured celery powder and/or cultured sugar-vinegar blend during storage at 4 degrees C. J Food Prot 77 (10):1787-1793.	Deli-style turkey breast	See paper for formulation	6.39 to 6.49	0.962 to 0.976	*Listeria monocytogenes*	NaNO2: 0 to 120 mg/kg from either purified NaNO2 or cultured celery powder 3.8% lactate-diacetate blend (LD) 1% cultured sugar/vinegar blend (DF)	• Deli-style turkey breast was formulated with various antimicrobials (with and without nitrite), surface inoculated with *L. monocytogenes*, and stored at 4°C for up to 12 weeks. • Results revealed an average 2.4-log increase in *L. monocytogenes* at 3 weeks in the control without antimicrobials, a 1.3-log increase at 4 weeks for both 80 mg/kg NO2 treatments, and a 1.5-log increase at 6 weeks for the 120 mg/kg NO2 treatments • In uncured turkey with 3.8% LD or 1% DF, growth was delayed until 6 weeks, whereas supplementation with LD or DF and 80 mg/kg nitrite from either source delayed listerial growth through 12 weeks. • No significant difference in growth inhibition was found between nitrite sources when equivalent concentrations were added.
Meat and Poultry	Gouveia, A. R., Alves, M., de Almeida, J., Monteiro-Silva, F., Gonzalez-Aguilar, G., Silva, J. A., and Saraiva, C. 2017. THE ANTIMICROBIAL EFFECT OF ESSENTIAL OILS AGAINST LISTERIA MONOCYTOGENES IN SOUS VIDE COOK-CHILL BEEF DURING STORAGE. J. Food Process. Pres. 41:9.	Sous-vide cook-chill beef	Beef	NR	NR	*Listeria monocytogenes*	Rosemary essential oil Thyme essential oil Temperature control	" A reduction of the counts of *L. monocytogenes* was observed in all samples at 2°C. At 8°C counts of *L. monocytogenes* were almost similar in control samples and those with thyme EO with an increase of the microbial counts since day 7. Inversely, counts of *L. monocytogenes* in beef samples with rosemary EO stored at 2 and 8°C decreased about 2 log10 CFU. These results support the possibility of using rosemary EO as natural preservative due to its antimicrobial effect against *L. monocytogenes*."

Meat and Poultry	Hassan AHA, Cutter CN (2020) Development and evaluation of pullulan-based composite antimicrobial films (CAF) incorporated with nisin, thymol and lauric arginate to reduce foodborne pathogens associated with muscle foods. Int J Food Microbiol 320:108519.	Raw beef
		
		Raw chicken breast
		
		Ready-to-eat turkey breast
			NR	NR	NR	Shiga toxin-producing *E. coli* (cocktail)
						
						Salmonella spp. (cocktail)
						
						Listeria monocytogenes (cocktail)
						
						Staphylococcus aureus (cocktail)
							Pullulan-based composite antimicrobial films (CAF) incorporated with the following:
							
							Nisin (N)
							
							Thymol (T)
							
							Lauric arginate (LAE) at 1 to 2.5%
								• Nisin and thymol did not generate suitable results in preliminary experiments, so the paper focused on films made with LAE.
								• Meat products were surface inoculated and transferred to CAFs containing LAE, vacuum packaged, and stored for up to 28 days at 4°C.
								• By day 28, CAFs containing 0.5, 1, and 2.5% LAE reduced:
								  ○ STEC by 1.13, 1.33 and 2.88 log10 CFU/cm2 respectively, on raw beef;
								  ○ *Salmonella* by 2.03, 2.12 and 3.01 log10 CFU/cm2 respectively, on raw chicken breast;
								  ○ *L. monocytogenes* by 1.12, 1.81 and 3.56 log10 CFU/cm2 respectively, on RTE turkey breast; and
								  ○ *S. aureus* by 0.68, 2.02 and 3.43 log10 CFU/cm2, respectively, on RTE turkey breast.

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		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Meat and Poultry	Heintz E, Vega L, Jahr G (2018) Inhibition of Listeria Monocytogenes and Spoilage Bacteria on Cured Ready-to-Eat Meats by Sodium-Free and Clean-Label Antimicrobial Ingredients. Meat and Muscle Biology 2 (2):137-138.	Cured, deli-style ham	Not reported, except 156 mg/kg sodium nitrite and 547 mg/kg sodium erythorbate	6.2 to 6.3	NR	*Listeria monocytogenes*	Potassium acetate/diacetate blend (Provian K) Natural fermented and neutralized dry vinegar blend (Provian NDV)	• Control ham supported > 1 log increase of *L. monocytogenes* at 4 and 2 weeks storage at 4°C and 7°C, respectively. • In contrast, hams supplemented with 0.5 or 0.75% Provian K or 0.65% NDV *inhibited L. monocytogenes* growth for 12 and 8 week s at 4 and 7°C, respectively.
Meat and Poultry	Lindstrom, M., Mokkila, M., Skytta, E., Hyytia-Trees, E., Lahteenmaki, L., Hielm, S., Ahvenainen, R., and Korkeala, H. 2001. Inhibition of growth of nonproteolytic Clostridium botulinum type B in sous vide cooked meat products is achieved by using thermal processing but not nisin. J. Food Prot. 64:838.	Sous vide processed ground beef and pork cubes	NR	Ground beef: 6.0 Pork cubes: 6.2	NR	*Clostridium botulinum (nonproteolytic type B)*	• Nisin (250 to 500 IU/g) • Temperature control	"Nisin did not inhibit the growth of nonproteolytic *C. botulinum* in either product; growth was detected in both products at 4 and 8°C, and ground beef became toxic with all nisin levels within 21 to 28 days at 8°C."
Meat and Poultry	McDONNELL LM, GLASS KA, SINDELAR JJ (2013) Identifying Ingredients That Delay Outgrowth of *Listeria monocytogenes* in Natural, Organic, and Clean-Label Ready-to-Eat Meat and Poultry Products. J Food Prot 76 (8):1366-1376.	Alternatively cured ham Uncured roast beef Deli-style turkey breast Traditionally cured ham with 2.8% lactate diacetate (control)	See paper for details on formulations	See paper for details; all were between 5.64 and 6.44	See paper for details; all were between 0.974 and 0.985	*Listeria monocytogenes*	1.5 % vinegar-lemon-cherry powder blend (VLC) 2.5 % buffered vinegar (BV) 3.0 % cultured sugar-vinegar blend (CSV) Temperature control	• A variety of meat and poultry products were produced including different antimicrobials in the formulation, inoculated with *L. monocytogenes*, and stored at 4 or 7°C for up to 12 weeks. • Compared with the control, the addition of either vinegar-lemon-cherry powder blend or buffered vinegar delayed *L. monocytogenes* growth for an additional 2 weeks, while the addition of cultured sugar-vinegar blend delayed growth for an additional 4 weeks for both ham and turkey. • Growth (>1-log increase) in the sodium lactate-diacetate control ham was delayed until week 6. • The greatest *L. monocytogenes* delay was observed in roast beef containing any of the three antimicrobial ingredients, with no growth detected through 12 weeks at 4°C for all the treatments. • As expected, *L. monocytogenes* grew substantially faster in products stored at 7°C than at 4°C.

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		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Meat and Poultry	Mojsova, S., Angelovski, L., Jankuloski, D., Simonovska, J., and Velickova, E. 2019. Antimicrobial effect of oregano-chitosan double coatings on *Listeria monocytogenes* in meat products. In IOP Conference Series: Earth and Environmental Science: IOP Publishing.	Smoked pork neck, ham, and smoked beef tenderloin	Pork, beef	NR	NR	*Listeria monocytogenes*	• Chitosan (1%) coating • Oregano extract (10%) coating	At 7 days of storage at 4°C, 1-2 log reductions in *L. monocytogenes* numbers were noted for the meat products when coated with both antimicrobials vs. uncoated products. Even larger reductions in *L. monocytogenes* numbers were noted for coated products after 14 days of storage (3-4 logs) compared to uncoated products. The coatings resulted in slightly lower sensory characteristic scores but were still "very well graded".
Meat and Poultry	Olaimat AN, Holley RA (2016) Inhibition of *Listeria monocytogenes* on cooked cured chicken breasts by acidified coating containing allyl isothiocyanate or deodorized Oriental mustard extract. Food Microbiol 57:90-95.	Cooked cured chicken breasts	Chicken breast, water, salt, dextrose, sodium phosphate, spice extractives, carrageenan, sodium erythorbate, sodium nitrite, and caramel	Uncoated chicken: 5.45 at day 17 Coated chicken: 4.2 to 5.2	NR	*Listeria monocytogenes*	Allyl isothiocyanate (25 to 50 μL/g) or deodorized Oriental mustard extract (100 to 250 mg/g) in a carrageenan/2% chitosan coating prepared with 1.5% malic or acetic acid	• Acidified carrageenan/chitosan coatings containing 25 to 50ml/g AITC or 100 to 250 mg/g mustard reduced the viability of *L. monocytogenes* and aerobic bacteria on cooked, cured roast chicken slices by 4.1 to >7.0 log CFU/g compared to uncoated chicken stored at 4C for 70 d. • Coatings containing malic acid were significantly more antimicrobial than those with acetic acid.
Meat and Poultry	Porto-Fett ACS, Campano SG, Rieker M, Stahler LJ, McGeary L, Shane LE, Shoyer BA, Osoria M, Luchansky JB (2018) Behavior of *Listeria monocytogenes* on Mortadella Formulated Using a Natural, Clean-Label Antimicrobial Agent during Extended Storage at 4 or 12 degrees C. J Food Prot 81 (5):769-775.	Mortadella (a RTE pork deli meat)	Pork Salt Water Celery powder Cherry powder	6.36 to 6.57	0.96 to 0.97	*Listeria monocytogenes*	Liquid buffered vinegar (LBV) at 1 or 1.5% Dry buffered vinegar (DBV) at 0.4 to 1% Potassium lactate and sodium diacetate (2.5%) Temperature control	• Mortadella was formulated with different antimicrobials, inoculated with *Listeria monocytogenes*, and then stored at 4°C for 120 day or 12°C for 28 days. • In the absence of antimicrobials, *L. monocytogenes* levels increased by ca. 2.6 and 6.0 log CFU per slice after up to 120 or 28 days at 4 or 12°C, respectively. • With inclusion of 1.0 or 1.5% LBV, 1.0% DBV, or 2.5% KLac as ingredients, pathogen levels decreased by ca. 0.3 to 0.7 log CFU per slice after 120 days at 4°C, whereas with inclusion of 0.4 or 0.6% DBV, *L. monocytogenes* levels increased by ca. 1.2 and 0.8 log CFU per slice, respectively. • After 28 days at 12°C, inclusion of 2.5% KLac, 1.0 or 1.5% LBV, or 0.4 or 0.6% DBV resulted in a ca. 1.4- to 5.7-log increase in *L. monocytogenes* levels. • When 1.0% DBV was included in the formulation, pathogen levels remained unchanged after 28 days at 12°C

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		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Meat and Poultry	Porto-Fett ACS, Campano SG, Shoyer BA, Wadsworth S, Luchansky JB (2014) Viability of *Listeria monocytogenes* on uncured turkey breast commercially prepared with and without buffered vinegar during extended storage at 4 and 10 degrees c. J Food Prot 77 (6):987-992.	Uncured, deli-style turkey breast	Turkey meat, water, salt, evaporated cane sugar, food starch, carrageenan, and natural flavors	6.18 to 6.36	0.98	*Listeria monocytogenes*	Buffered vinegar (in formulation) Stabilized solution of sodium chlorite in vinegar (VSC) as a surface treatment	Uncured turkey breast was for formulated buffered vinegar, then surface inoculated with *Listeria monocytogenes*, then surface treated with VSC prior to vacuum sealing at storage at 4 or 10˚C for 90 days. Although VSC alone was not able to suppress outgrowth of *L. monocytogenes* during an extended shelf-life, combining it with buffered vinegar in the formulation resulted in a significant control of the pathogen.
Meat and Poultry	Tosati JV, de Oliveira EF, Oliveira JV, Nitin N, Monteiro AR (2018) Light-activated antimicrobial activity of turmeric residue edible coatings against cross-contamination of *Listeria innocua* on sausages. Food Contr 84:177-185.	Commercial cooked chicken sausages	NR	NR	NR	*Listeria innocua*	Edible hydrogel coatings containing turmeric residue (TGH) or curcumin (CGH) UV-A light activation of the turmeric/curcumin within the hydrogel	UV-light treatment of TGH or CGH-coated sausages reduced *L. innocua* levels by 3-5 log; CGH resulted in a faster inactivation of the pathogen. The light-mediated antimicrobial activity was not affected by refrigeration temperatures.
Meats and Poultry	Aasen IM, Markussen S, Moretro T, Katla T, Axelsson L, Naterstad K (2003) Interactions of the bacteriocins sakacin P and nisin with food constituents. Int J Food Microbiol 87 (1-2):35-43.	Raw chicken Chicken cold-cuts Smoked salmon	NR	Raw chicken: 6.0 Chicken cold-cuts: 6.2 Smoked salmon: 6.3	Raw chicken: 0.986 Chicken cold-cuts: 0.969 Smoked salmon: 0.954	*Listeria monocytogenes*	Sakacin P Nisin	• In foods that had not been heat-treated, proteolytic activity caused a rapid degradation of the bacteriocins, with < 1% of the total activity left after 1 week in cold-smoked salmon or raw chicken. • In heat-treated foods, the bacteriocin activity was stable for more than 4 weeks. • Growth of *Listeria monocytogenes* was completely inhibited for at least 3 weeks at 10˚C in both chicken cold cuts and cold-smoked salmon by addition of sakacin P (3.5 Ag/g), despite the proteolytic degradation in the salmon.
Pasta	Del Nobile MA, Di Benedetto NA, Suriano N, Conte A, Lamacchia C, Corbo MR, Sinigaglia M (2009) Use of natural compounds to improve the microbial stability of Amaranth-based homemade fresh pasta. Food Microbiol 26 (2):151-156.	Fresh pasta (amaranth-based)	Amaranth flour, water	NR	NR	*Staphylococcus spp.* (endogenous, not inoculated)	Thymol Lemon extract Chitosan (in a 1% lactic acid solution) Grapefruit seed extract (GFSE)	• Antimicrobials were mixed into the pasta dough, and pasta was stored at 4˚C for up to 25 days. • Chitosan at 2000 mg/kg was most effective and appeared to completely prevent *Staphylococcal* growth. • Lemon extract had no effect. • GFSE and thymol showed intermediate efficacy against *Staphylococcal* growth.

Category	Reference	Product Characteristics				Experimental Details		
		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Pasta	Del Torre, M., Stecchini, M. L., Braconnier, A., and Peck, M. W. 2004. Prevalence of Clostridium species and behaviour of Clostridium botulinum in gnocchi, a REPFED of Italian origin. Int. J. Food Microbiol. 96:115. (Del Torre et al., 2004)	Refrigerated gnocchi (plain and with mushrooms)	Potato flakes, skimmed milk powder, flour, starch, flavorings	4.9 to 5.1	0.96 to 0.98	*Clostridium botulinum* (protetolytic and non-proteolytic)	Sorbic acid (0.09%) Temperature control	"For all gnocchi stored at 8°C (as recommended by the manufacturer) or 12°C (mild temperature abuse), growth and toxin production were not detected in 75 days. …When inoculated packs were stored at 20°C (severe temperature abuse), toxin production in 75 days was prevented by the inclusion of 0.09% (w/w) sorbic acid"
Produce	Alvarez MV, Ponce AG, Mazzucotelli CA, Moreira MR (2015a) The impact of biopreservatives and storage temperature in the quality and safety of minimally processed mixed vegetables for soup. J Sci Food Agr 95 (5):962-971.	Fresh-cut mixed vegetables for soup	Celery, leek, and butternut squash	NR	NR	*E. coli* O157:H7	Tea tree oil (15 µL/mL) Propolis extract (15 µL/mL) Gallic acid 2 mg/mL Temperature control (5 or 15˚C)	• Samples of the mixed cut vegetables were sprayed with an antimicrobial, inoculated with pathogen, and then stored at 5° or 15˚C for up to 10 days. • The antimicrobials reduced total E. coli levels (both endogenous and inoculated E. coli O157:H7) by ~1 log at 7 days relative to controls during storage at 5˚C • The antimicrobials were not effective at 15˚C.
Produce	Alvarez MV, Ponce AG, Moreira MR (2015b) Combined Effect of Bioactive Compounds and Storage Temperature on Sensory Quality and Safety of Minimally Processed Celery, Leek and Butternut Squash. J Food Saf 35 (4):560-574.	Fresh-cut vegetables (celery, leek, and butternut squash)	Celery, leek, and butternut squash	NR	NR	*E. coli* O157:H7	Tea tree oil (30 µL/mL) Propolis extract (64 µL/mL) Gallic acid 2 mg/mL Temperature control (5 or 15˚C)	• Samples of the individual cut vegetables were sprayed with an antimicrobial, inoculated with pathogen, and then stored at 5° or 15˚C for up to 10 days. • Propolis extract and tea tree essential oil reduced total *E. coli* levels (both endogenous and inoculated *E. coli* O157:H7) relative to controls during storage at 5˚C • The antimicrobials were not effective at 15˚C.
Produce	Cho Y, Kim H, Beuchat LR, Ryu JH (2020) Synergistic activities of gaseous oregano and thyme thymol essential oils against *Listeria monocytogenes* on surfaces of a laboratory medium and radish sprouts. Food Microbiol 86:6.	Radish sprouts	Radish sprouts	NR	NR	*Listeria monocytogenes*	Gaseous essential oils (oregano, thyme, and cinnamon bark)	• A combination of oregano and thyme, each at 0.313 µL/mL, caused a significant reduction in the number of *L. monocytogenes* on radish sprouts compared with reductions caused by treatment with oregano or thyme thymol EO gas alone at the same concentration. • Essential oil treatments were performed for 24 hours at 30˚C (so not refrigerated).

Category	Reference	Product Characteristics				Experimental Details		
		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Produce	NOTERMANS S, DUFRENNE J, KEYBETS MJH (1985) Use of Preservatives to Delay Toxin Formation by Clostridium botulinum (Type B, Strain Okra) in Vacuum-Packed, Cooked Potatoes. J Food Prot 48 (10):851-855.	Vacuum packaged, cooked potatoes	Peeled potatoes cut into pieces	5.9 to 6.0 before dipping 5.4 to 5.8 after dipping in ascorbic and citric acid solution	NR	*Clostridium botulinum* (Type B, Strain Okra)	2% ascorbic and 1% citric acid solution 5% potassium sorbate and 2% ascorbic acid solution 2% ascorbic acid solution 2% ascorbic acid and 0.1% $Na_2S_2O_5$ solution Temperature control	• Dipping potatoes in a solution of ascorbic and citric acid before (inoculation and) vacuum-packing and cooking (95°C for 50 min) inhibited growth and toxin production by proteolytic *C. botulinum* type B at an incubation temperature of 15°C for 70 d and at 20°C for at least 14 days. • Potassium sorbate plus ascorbate prevented outgrowth and toxin formation at 15°C, but resulted in off-flavors during storage. • Other treatments showed some efficacy relative to control at 15°C but not 20°C.
Produce	Scollard J, Francis GA, O'Beirne D (2013) Some conventional and latent anti-listerial effects of essential oils, herbs, carrot and cabbage in fresh-cut vegetable systems. Postharvest Biology and Technology 77:87-93. (Scollard et al., 2013)	Fresh-cut vegetables	Lettuce, carrots, cabbage, and dry coleslaw mix	NR	NR	*Listeria innocua*	Essential oils (EO) Shredded fresh herbs (thyme, oregano, and rosemary) Shredded carrots	• This study tested the efficacy of natural antimicrobials inoculated *Listeria innocua* on fresh cut vegetables during modified atmosphere storage for 10 days at 4 or 8°C. • EO were sprayed on vegetables; fresh herbs and carrots were cut and mixed with the vegetables. • Anti-listerial effects were in the order: thyme EO > oregano EO > rosemary herb > rosemary EO. • Direct application of all the EOs damaged product appearance. • Shredded fresh rosemary herb appeared to have a major anti-listerial effect, but shredded fresh thyme and oregano showed no anti-listerial effects. • However, fresh rosemary herb was only effective in fresh-cut products when it was stomached with the product prior to microbial analysis. • Greater anti-listerial effects were recorded on carrot discs and shredded cabbage than on shredded lettuce. Adding shredded carrot to packages enhanced the apparent anti-listerial effects, and combination data suggested a synergistic effect between carrot and rosemary.

Category	Reference	Product Characteristics				Experimental Details		
		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Sauces, Dips, and Purees	Hwang D, White E, Purohit A, Mohan A, Mishra A (2019) Survival of Escherichia coli O157:H7 and *Listeria monocytogenes* in an acidified low-fat mayonnaise based hibachi sauce. LWT-Food Sci Tech 108:297-300.	Low-fat, mayonnaise-based hibachi sauce	Water, soybean oil, modified starch, egg yolk apple cider vinegar, high fructose corn syrup, sugar, salt, spices, potassium sorbate, tocopherol, beta-carotene, natural flavors, and seasonings	Without lactic acid or vinegar: 4.34 to 4.35 With vinegar: 4.3 to 4.32 With lactic acid: 3.51 to 3.94	NR	*Listeria monocytogenes* *E. coli* O157:H7	Lactic acid (0.25 or 0.5 g/100 g sauce) Vinegar (0.5 g/100 g sauce) Temperature control	• Sauce was acidified with either lactic acid or vinegar, inoculated with *L. monocytogenes* or *E. coli* O157:H7, and stored at 4 or 23°C • Both pathogens survived longer at 4°C than at 23°C. • Addition of at 0.25 g lactic acid/100 g sauce decreased *E. coli* O157:H7 and *L. monocytogenes* populations in the low-fat mayonnaise based sauce from ≥6 to <2.2 log CFU/g, the limit of detection, after 3 d when stored at 23 °C. • Lactic acid at either concentration was more effective than vinegar for either pathogen.
Sauces, Dips, and Purees	Al-Nabulsi, A. A., T. M. Osaili, A. N. Olaimat, W. E. Almasri, M. Ayyash, M. A. Al-Holy, Z. W. Jaradat, R. S. Obaid, and R. A. Holley. 2020. Inactivation of Salmonella spp. in tahini using plant essential oil extracts. Food Microbiol. 86:9.	Tahini and rehydrated tahini as a tahini-based product model (10% w/v)	Tahini; tahini and water	6.23 (tahini); 6.31 (rehydrated tahini)	0.25 (tahini); 0.96 (rehydrated tahini)	*Salmonella serotypes (S. Typhimurium T123, S. Aberdeen T069, S. Cubana T109 and S. Paratyphi A T193)*	2% cinnamon oil 2% thyme oil	• In tahini, the addition of 2.0% cinnamon oil (CO) reduced the numbers of Salmonella spp. by 2.87, 2.64 or 2.35 $\log_{10}$ CFU/ml at 37, 25 or 10 °C, respectively, by 28 d. • The antimicrobial activity of CO was more pronounced in hydrated tahini where no viable cells were detected after 3 d storage at 25 and 37 °C, or after 7 d at 10 °C. However, at 25 and 37 °C, the antimicrobial activity of CO was more evident since no viable cells were detected after 14 d when 0.5% was used. • The numbers of *Salmonella* spp. were reduced by 3.29, 3.03 or 2.17 $\log_{10}$ CFU/ml at 37, 25 or 10 °C, respectively, after 28 d when 2.0% TO was added to tahini. • Salmonella spp. were not detected in the hydrated tahini treated with 2.0% TO after 28 d at 37 °C or 25 °C, while at 10 °C, the numbers of Salmonella spp. were not significantly reduced after 28 d in hydrated tahini compared to the initial numbers at zero time.
Sauces, Dips, and Purees	Nyhan L, Begley M, Mutel A, Qu Y, Johnson N, Callanan M (2018) Predicting the combinatorial effects of water activity, pH and organic acids on *Listeria* growth in media and complex food matrices. Food Microbiol 74:75-85.	Bernaise sauce Zucchini puree	See paper for complete ingredient list	4.7 (Bernaise sauce) 5.6 (Zucchini puree)	0.983 (Bernaise sauce) 0.995 (Zucchini puree)	*Listeria innocua*	Acetic acid Propionic acid	This report assessed the ability of predictive models for assessing the growth rate of *Listeria* spp. in several refrigerated food products formulated with acetic acid or propionic acid; in some cases, actual bacterial growth rate was underestimated by the models.

Category	Reference	Product Characteristics				Experimental Details		
		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Sauces, Dips, and Purees	Olaimat AN, Al-Nabulsi AA, Osaili TM, Al-Holy M, Ayyash MM, Mehyar GF, Jaradat ZW, Abu Ghoush M (2017) Survival and inhibition of *Staphylococcus aureus* in commercial and hydrated tahini using acetic and citric acids. Food Contr 77:179-186.	Tahini paste and rehydrated tahini paste (10% w/v)	Tahini paste Water	Initial pH of tahini: 6.76 Initial pH of diluted tahini: 6.80	Tahini paste: 0.33 Rehydrated tahini paste: 0.95	*Staphylococcus aureus*	Acetic acid Citric acid	• The antimicrobial activity of citric acid and acetic acid against *S. aureus* was more pronounced in the hydrated form of tahini compared to the commercial form. • Acetic acid posed a noticeable inhibitory effect against *S. aureus* in commercial tahini, especially when used at concentrations higher than 0.3% at all the tested temperatures (10, 21, and 37°C). • Citric acid was more inhibitory than acetic acid at 10 °C. • Complete elimination of *S. aureus* from hydrated tahini was attained before the end of the 28 d storage period when using acetic acid at all the tested levels except at 10 °C.
Sauces, Dips, and Purees	Olaimat, A.N., Al-Holy, M.A., Abu Ghoush, M., Al-Nabulsi, A.A. and Holley, R.A., 2018. Control of *Salmonella enterica* and *Listeria monocytogenes* in hummus using allyl isothiocyanate. International Journal of Food Microbiology 278: 73-80.	Hummus	Dried chickpeas Tahini Water	6.4 to 6.62 before inoculation	NR	*Salmonella enterica (*S. Heidelberg 271, S. Typhimurium 02:8423, S. Copenhagen PT 99, S. Enteritidis CRIFS 1016, and S. Kentucky 64701 in a cocktail*)* *Listeria monocytogenes (*2–138, 2–243, GLM-1, GLM-3, and GLM-5 in a cocktail)	Allyl isothiocyanate (AITC) at 0.1 to 1%	• *S. enterica* numbers were reduced by >6 log CFU/g in hummus containing ≥0.5% AITC when stored for 3 days at both 4 and 10°C. • 0.1–0.25% AITC reduced *S. enterica* by 2.5–5.1 log CFU/g at 4°C or by 4.7–6.0 log CFU/g at 10 °C by 10 days. • Similarly, *L. monocytogenes* numbers decreased by>6 log CFU/g in hummus with ≥0.5% or ≥1.0% AITC when stored for 3 days at 4 or 10°C, respectively. • 0.25% AITC significantly reduced *L. monocytogenes* in hummus by 2.7 and 4.3 log CFU/g at 4 and 10°C, respectively. • Moreover, 0.1% AITC reduced *L. monocytogenes* by 1.8 log CFU/g in hummus at 10 °C and inhibited the growth at 4°C for up to 10 days. • Sensory analysis showed that AITC levels of 0.25% and lower were well accepted.
Sauces, Dips, and Purees	Tsiraki, M.I., Yehia, H.M., Elobeid, T., Osaili, T., Sakkas, H. and Savvaidis, I.N., 2018. Viability of *Escherichia coli* O157:H7 and *Listeria monocytogenes* in a delicatessen appetizer (yogurt-based) salad as affected by citrus extract (Citrox [(c)]) and storage temperature. Food Microbiology 69: 11-17.	Tzatziki (an appetizer yogurt-based deli salad)	Strained yogurt Cucumber Garlic Salt Olive oil Dill	~3.0 to 4.0 (but not tested)	NR	*E. coli O157:H7* *Listeria monocytogenes* *Listeria innocua*	Citrus extract (Citrox®, 14WPlus, ProGarda)	• Citrus extract at 1 ml/kg or 2 ml/kg in tzatziki resulted in significant reductions in *E. coli* O157:H7 relative to controls at refrigerated temperatures during 77 days of storage. • Citrus extract at 2 mL/kg in tzatziki reduced *L. monocytogenes* levels by 1.5 to 3 logs after storage at 70, 35, and 15 days at 4, 10, and 21°C.

Category	Reference	Product Characteristics				Experimental Details		
		Chilled Food	Ingredients	pH	Water Activity	Pathogens Tested	Antimicrobial and Other Hurdles Tested	Results
Sauces, Dips, and Purees	Villarreal-Lara R, Rodriguez-Sanchez DG, De la Garza RID, Garcia-Cruz MI, Castillo A, Pacheco A, Hernandez-Brenes C (2019) Purified avocado seed acetogenins: Antimicrobial spectrum and complete inhibition of *Listeria monocytogenes* in a refrigerated food matrix. CyTA-J Food 17 (1):228-239.	Commercial baby food puree containing beef, vegetables, and rice	See paper for details	NR	NR	*Listeria monocytogenes*	Avocado seed acetogenins (Avosafe®)	During refrigerated storage (4°C, 72 days), Avosafe® inhibited *L. monocytogenes* completely, decreasing the initial 3-log inoculum to undetectable levels within 3 h, and maintaining the effect to completion.
Sauces, Dips, and Purees	Girardin H, Albagnac C, Dargaignaratz C, Nguyen-The C, Carlin FT (2002) Antimicrobial activity of foodborne *Paenibacillus* and *Bacillus* spp. against *Clostridium botulinum*. J Food Prot 65 (5):806-813.	Broccoli puree	Broccoli	NR	NR	*Clostridium botulinum* strain Nanaimo	*Paenibacillus polymyxa*	• In co-cultures with the positive strain of *P. polymyxa* in nutrient broth and vegetable purees, a *C. botulinum* type E strain was inhibited whenever *P. polymyxa* reached stationary phase and produced its antimicrobial activity before *C. botulinum* began its exponential growth • phase. • The antimicrobial activity of *P. polymyxa against C. botulinum* was attributed to the production of antimicrobial peptides resistant to high temperature and acidity. • Other gram-positive and -negative bacteria (*Escherichia coli*, *Streptococcus mutans*, *Leuconostoc mesenteroides*, and *Bacillus subtilis*) were also sensitive to these antimicrobial peptides.

NR: not reported

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