



· · ·

1. 가

(1).

가 (minimally processed)

가
가

가

30

fast-food

(23)

가,

가

1985

400

1989

가

35,000

가

, , , ,

2.

Hankin (12)
(pectinolytic bacteria) 10⁷ CFU/g
(4).

2.1

80 90%

Gram (rods) *Pseudomonas*
spp., *Enterobacter* spp., *Erwinia* spp.
(4,6-8,10,13-15), Pseudomonads
가 Marchetti (15)
Pseudomonas spp.가

Table 1

fast-food

가

Koek (16) Pseudomonadaceae
5 10

count agar

(mesophilic bacteria) 10³ 10⁹

King (9) pseudomonads
56.7%

CFU/g

가

Flavobacterium spp.(9,13,14),
Xanthomonas spp.(9,13,15), *Chromobacterium*
spp.(15), *Chryseomonas* spp.(15), *Rahnella*
aquatilis(15), *Serratia* spp.(13,17), *Alcaligenes*
spp. *Bacillus* spp.(9,13)

(4). 가

10³ 10⁶ CFU/g

가 (6,7)

(5- 10),

iceberg

(9).

가

pseudomonads *P. fluorescens*
(4,6,7,10,13,15)

MRS

(18). *P. fluorescens*

(11)

10⁹ CFU/g

pseudomonads (50 90%)

(4). 가

(7,15), *P. putida*, *P. chlororaphis*,
P. cepacia, *P. paucimobilis*, *P. viridiflava*
(4,6,10,13,15).

. Enterobacteriaceae

, desoxycholate

Enterobacter agglomerans *Erwinia*

10³ CFU/g (7)

herbicola(4,6,7,10,13-15) *R. aquatilis*(15)

가

CFC

pseudomonads

Enterobacteriaceae, *Enterobacter intermedium*(6)

E. cloacae(15)

1%

Leuconostoc spp. (7) *L.*

Brocklehurst (4)

가

mesenteroides (6), Brocklehurst

가

Enterobacter

(4) (homo)

*agglomerans*가 37

VRB

CFC

가

Table 1. Number of microorganisms found in minimally processed fresh vegetables sampled in industrial locations or in commercial display units

Product (time elapsed between processing and analysis) ^a	Mesophilic microflora	Lactic acid bacteria	Coliforms ^b	Fecal coliforms ^c	Yeasts & molds	Pectinolytic microflora ^d
Mixed vegetables from retail outlet: lettuce, cabbage, onion, pepper, cress, celery, sweet corn	$10^8 - 10^9$	$10^5 - 10^9$	$10^5 - 10^7$		$10^4 - 10^8$	$< 10^6 - 10^7$
Shredded cabbage	$10^4 - 10^7$	2.5×10^2			1.7×10^2	
Carrot sticks	$10^5 - 10^6$	10^3			1.8×10^4	
Cauliflower florets	$5 \times 10^5 - 5 \times 10^6$	< 10			3.5×10^2	
Spinach (1 day at 0 °C)	$10^5 - 5 \times 10^6$	< 10			1.2×10^2	
Shredded carrot (No storage)	10^4	10^4 $10^4 - 10^5$ 10^4			$< 10^2$ 10^3 $< 10^3 - 5 \times 10^4$	
Shredded vegetables: carrot, chicory, cabbage (1 day at 8 °C)	10^4	10^4 (carrot) 10^3 (chicory)	$10^4 - 10^5$	$< 10 - 10^3$	$10^4 - 10^5$	
Ready-to-eat salads: lettuce, mixed green salads with tomato and radish, coleslaw	$10^5 - 10^7$ for 90% of the samples		$< 10 - 10^7$ for 60% of the samples			
Mixed vegetables for caterers	$10^4 - 10^8$ mean 10^7	$10^3 - 10^8$ mean 2×10^6	$< 10^2 - 10^7$ mean 10^3		$10^2 - 10^6$ mean 2×10^4	
Precut salad vegetables	$10^7 - 10^9$		$10^5 - 10^7$			
Cut lettuce (No storage)	6×10^3				3×10^2	
Packs of shredded or cut vegetables: carrot, chicory salads, rocket	$10^7 - 10^9$	$10^4 - 10^7$	$10^4 - 10^7$		$10^3 - 10^7$	
Mixed vegetables from retail outlet: lettuce, cabbage, carrot, onion, pepper	10^5	10^3	10^4			
Prepared lettuce for caterers	4×10^5		8×10^3			
Shredded chicory (No storage)	10^7 10^5	$10^2 - 10^3$				$10^4 - 10^5$

^a Whenever specified by the authors.

^b Counted by plating on appropriate selective media incubated at temperature between 30 and 37 °C.

^c Counted by plating on Desoxycholate media incubated at 44 °C.

^d Counted by plating on Hankin media (12), or by testing for pectinolysis a representative number of colonies from mesophilic microflora count plates (10).

P. fluorescens, Enterobacteriaceae (Gram) *L. mesenteroides* (Gram)가 가
Candida spp., *Cryptococcus* spp., *Rhodotorula* spp., *Trichosporon* spp., *Pichia* spp., *Torulasporea* spp.
 (9,13,15,19). 가 *Sclerotinia*, *Mucor*, *Aspergillus*, *Cladosporium*, *Phoma*, *Rhizopus* 가 가 (6,9,14,15).

가

가 (20-24).
 가 ml g 10^3 10^5 가 ,
 10^3 10^4 가 ,
Candida maltosa,
C. sake, *C. tropicalis*, *C. magnoliae*,
Hansenula spp., *Hanseniaspora* spp.,
Saccharomyces cerevisiae, *Schwamomyces*
occidentalis, *Trichosporon* spp., *Zygo-*
saccharomyces rouxii
Lactobacillus spp. *Leuconostoc*
mesenteroides (21-23).

2.2

(Pectinolytic Microorganisms)

(pectinolysis)

10 20%가 (13).

pseudomonads (20 60%)가

(6,10). Brocklehurst (4) 가 10^8 10^9 CFU/g

Hankin

10^6 10^7 CFU/g

Pseudomonas fluorescens (biovars), *P. paucimobilis*, *P. viridiflava*, *P. luteola*, *Xanthomonas maltophilia*, *P. viridiflava*, *P. luteola*, *Xanthomonas maltophilia*, *Flavobacterium* spp., *Cytophaga* spp., *Vibrio fluvialis* (6,7,10,25).
 (*Mucor* sp. *Sclerotinia sclerotiorum*) (*Trichosporon* spp.) (6,19).

2.3

Table 2

Listeria monocytogenes 3
 19% ,
 1 CFU/g 100 CFU/g (26).
Yersinia enterocolitica 76%
 , Brocklehurst 가
 (4) 가
 serovar 가
 (27,28)
Aeromonas hydrophila
 . *E. coli*
 enterotoxicity

cytotoxicity

(29).

3.

3.1

3.1.1

(Saprophytic Microorganisms)

Table 2. Occurrence of potential foodborne pathogens in minimally processed fresh (MPF) vegetables and similar products

Microorganisms	Product	Positive samples (%)	Observations	Country
<i>Listeria monocytogenes</i>	Chicory salads ^a	48		France
	Chicory salads ^a	88 ^d	< 1 CFU/g	France
	Shredded cabbage ^a	N.S.		France
	Processed vegetables and salads	13		England
	Mixed vegetables ^a	7		England
	Mixed vegetables	5		Germany
	Mixed vegetables ^a	19 ^d		England
	Mixed vegetables	3 to 11	< 100 CFU/g	Europe
	Range of MPF vegetables	0		France
<i>Yersinia enterocolitica</i>	Range of MPF vegetables ^a	76	Strains not pathogenic to man	France
	Range of MPF vegetables ^a	22.2 to 55.6	Strains not pathogenic to man	France
	Range of MPF vegetables ^a	75	No indication of pathogenicity	France
	Mixed vegetables ^a	N.S.	Strains not pathogenic to man except one strain ambiguous ^c	England
<i>Aeromonas hydrophila</i>	Range of MPF vegetables ^a	N.S.	10 ⁴ - 10 ⁶ CFU/g	Italy
	Prepared salads	21.6		England
<i>Staphylococcus aureus</i>	Mixed vegetables ^a	0	Limit of detection 20 CFU/g	England
	Range of MPF vegetables ^a	0	Limit of detection 100 CFU/g	Swiss
	Mixed vegetables ^b	3 to 14		USA
<i>Escherichia coli</i>	Mixed vegetables ^a	25	< 500 CFU/g	England
	Range of MPF vegetables ^a	0	Limit of detection 10 CFU/g	Swiss
	Mixed vegetables ^b	2 to 6		USA
<i>Salmonella</i> spp.	Range of MPF vegetables ^a	0	Limit of detection 1 CFU/25 g	France

N.S. not specified.

^a Product sealed in polymeric film pouches or in plastic trays.

^b Product from hospital.

^c Virulence markers were calcium dependent at 37 and fermentation of salicin. In other cases, pathogenicity of strains of *Y. enterocolitica* was established on the basis of their serovar.

^d Contamination during processing suspected or mentioned by the authors (104,105).

CFU/g *Leuconostoc* spp. ,
(1 33%)가 (35).

. *P. fluorescens*, *E. herbicola*, *E.* 가

agglomerans

(epiphytic microflora) (17,30-33). (13,30,36,37). *P. fluorescens*

Mundt (34) 2.5 × 10⁴ *Xanthomonas* spp., *Cytophaga* spp.

<i>flavobacterium</i> spp.			(61).
	(38-40).	<i>Salmonella</i> spp.	
	fluo- rescent pseudomonads	(62), <i>Salmonella poona</i>	
(41-47),	1 cm ² 10 ⁴ CFU	1%가	(63).
<i>Pseudo- monas</i> (30)		가	
		<i>Salmonella</i> 가	
	10 ⁹ CFU/g	(64).	
<i>Pseudo- monas</i> 가		<i>Salmonella</i> spp	
(48).		7.5% (65), 8 63% (66)	, 가 <i>Shigella</i> spp.,
(49),	Pseudomonads	<i>Salmonella</i> spp., <i>S. aureus</i> (10 ³ CFUg ⁻¹)	(67). Notermans (68)
		13.6% (69)	
<i>Erwinia</i> spp. Brocklehurst (4)		(70), (71),	C
<i>E. carotovora</i>		<i>botulinum</i> 가 , <i>B. cereus</i>	(72).
	, 가		
	<i>P. cichorii</i>		
	(50). 가		
		20%,	66%가
	가	<i>Aeromonas</i> spp.	
	가	1% (73).	가
<i>Erwinia</i> (51)		42%가 <i>Aeromonas</i> spp.	, 가
(48)		가	
(52,53).		(74).	
		가	26
3.1.2		80%가 <i>L. monocytogenes</i>	
(Food-borne Pathogens)		(75,76).	
	(54-57).	<i>Y. enterocolitica</i>	
<i>Listeria monocytogenes</i> (, <i>Yersinia</i>	(77,78).
9%, 58) (7.8%, 59)		가	
가		가	
(25.8 30.3%, 60)		(79,80).	
10 ² 10 ⁴ CFU/g	<i>Aeromonas</i> spp.가	<i>Vibrio cholerae</i>	

(81,82). 가 가

1982 Listeria 가 . L.

(83). *monocytogenes* ,

(84). (85) (92)

가 ,

(Table 3). Bryan(79)

Van

. 가 Renterghem (93)

Salmonella L.

monocytogenes ,

100% (85), 44.6% (86) L. Bryan(79)

*mono-cytogenes*가 7 200

CFU/g (87). *Salmonella*가 . *E. coli*

Salmonella

E. coli 21 (94).

(66,80,88).

clostridia

E. coli 가 (49). (55,95,96) *B. cereus* (97)

. *A. hydrophila*

10% *L. monocytogenes*가 3 5 CFU/g (multilocus-enzyme-electrohoresis, bio and serotyping)

Salmonella

(98,99). 가

(89). 가 (61). *L. monocytogenes*

67%가 *L. monocytogenes* , (90,100- 102).

25 *L. monocytogenes* 가

12% (90). 가 가

Campylobacter spp.

(91), 3.2 가

(80).

가 가 가 가 . 1986 shigellosis
가 가 가 (109) , 가
(9,10).
Salmonella spp. 가 .
가 . 4.
가 ,
 10^3
 10^4 CFU/g 가 10^5 10^6 CFU/g
(8), 10^4
 10^5 10^6 CFU/g 가 가 (103). ,
(9,25,110- 114),
1
0.5 log cycle 가 (necrosis)(10),
가 가 가 (115,116),
(23). 가 (6,117)
가 가
 10^3 /ml ,
(10). 10^5 ,
 10^6 CFU/g ,
가 .
4.1
가 가
(,
),
가 (13, 10).
1.8% *L. monocytogenes* King (9) 2 26
19% 가
가 (104). , 가
가 *L. monocytogenes* 가 가
. Laine Michard(105) 가
가
L. monocytogenes serotype 1/2a
. *L. mono- cytogenes*
가 . Barriga (25)
(106- 108), 가

가 , 가 5 35%가 P.
 가 coleslaw) 가 (fluorescens
 (7) P. fluo-
 , 7 14 rescens pseudomonads 60%
 (118). 4 1
 , 2 0 4 가 , 10⁷
 CFU/g
 가 10-16 pseudomonads 가 10⁸ CFU/g
 (20,24) P. fluorescens

가 10 10 pseudomonads
 가 가 (6).
 5 40% 가 , Brocklehurst (4)
 (10).

가 Erwinia carotovora
 (6). 가 가
 (10⁹ CFU/g) (4). fluorescent pseudomonads
 가 가 peptidolipid biosurfactant
 가 . Bolin (113) viscosin (119).
 가 가 가 (120),
 가 가

(10³ 10⁵ CFU/ml)
 7.8 가
 (20). 가 10⁸ CFU/g
 4.2 (6,7,117). 50 1
 0 14
 Leuconostoc mesen- teroides
 가
 (6). , ,
 100 , 가
 , 10 10 25%

L. mesenteroides (heterofermentative metabolism) (6). *L. mesenteroides* (25%) 10 가 (121). *L. mesenteroides* 가 (122). *Leuconostoc* spp. (123). 100 mg/g (5) 1 (15). (15), (25), *Lactobacillus* spp. *Leuconostoc mesenteroides* diacetyl (124). (4) 가 diacetyl 가 (24), 가 4.3 가 (125,126), (127) (silage) (128) (25). 가 1% (36,129), (8). 4 가 10 가 (22,124). 7.8 1

(20). Babic (19)

Candida

C. sake, *Candida lambica*

가

10 12

가

(,)

(

(*A. bisporus*)

가

(110,111).

(116)

,

,

(psychrotrophic)

(25).

가

1%

(8).

4

가

10

(22,124).

1

7.8

(19). fluorescent pseudomonads, 가 4.4

, *P. marginalis* (pectinolytic fluorescent pseudomonad) *E. carotovora* 2 (doubling time) 0.2 1) 15 20 5.7 15.4 가 CO₂ O₂ (3). (132,133). (MA) 가 (MA) (134). (MAP) 5 : 10⁵ 10⁷ CFU/g) (9). (112,135). (5), (117), (119,130) 가 10 (13), (2.8 14 CO₂ 19% 7 0 20 2 iceberg (9). 10% CO₂/3% O₂ iceberg (14). (25). 가 10 6 (131). 20% CO₂ air 10 (5) 7.8 (20). 가 CO₂ 가 Mazollier (114) butterhead 97% N₂ 10% CO₂ 90% N₂ 8 가 10.5% CO₂ 2.25% O₂ , 가 (136). , 2.5% 5% O₂ 2.5%, 5%, 7.5% CO₂가 10 (A. *bisporus*) fluorescent pseudo- monads 가

(110). fluorescent pseudomonads
 1 2 log cycles
 10 가
 . CO₂
 . 20%
P. fluorescens
 (140).
 pectinolytic enzyme

2) CO₂ pseudomonads
 , 가 ,
 (137,138,139,115). 가 0.2%
 O₂ 10% CO₂ *P.*
fluorescens *E. carotovora*
 (252), pseudomonads
 2%

P. marginalis 4% 10% O₂ 4.4.2
 MA in vitro butter-
 (118). head
 Barriga (15) 10% CO₂/3% O₂ 0% O₂/10% CO₂
 가 in vitro *P. marginalis* (114).
 2, 6, 10
 15% 20% CO₂ 20% CO₂

(74). (5). 가 CO₂
 CO₂
 (6,49, 135,136). CO₂ O₂ (137). 40% CO₂ 1% O₂
 10
 ,
L. mesenteroides in vitro (6,121).
 , 가 가 vitro

(139). Carlin Nguyen-the (5)
 2 6 CO₂ 가
 (121).

O₂ CO₂ 5.

(132).

가 ,

가 (Table 3).

가 1991 , 가 ,

4.4.3 (145), 1973 1987

가

3% O₂ 3% O₂/10% CO₂ CA 가 2% (146). 1988 1990 *L. monocytogenes* (147,148),

(130). iceberg

(9). 10 20 50%

CO₂ 2 10% O₂ 가 , 가 *L. monocytogenes* listeriosis

(19).

O₂ CO₂ (142).

(MAP) 가 Table 3 (83,109,

가 가 137,149,150).

5.1

가 가 ,

(54) , 가 , (143,144)

가

가) (12 3 log cycle (24 3 4 (109, 151). 3 . *L.* pH가 . *L.*

Table 3 Examples of foodborne infections linked to the consumption of raw vegetables and fruits

Microorganisms	Product suspected	Country
<i>Clostridium botulinum</i>	Shredded cabbage in coleslaw	USA
<i>Listeria monocytogenes</i>	Shredded cabbage in coleslaw ^a	Canada
	Raw vegetables in salads	USA
	Alfafa tablets	Canada
	Salted mushrooms	Sweden
<i>Vibrio cholerae</i>	Cabbage ^a	Peru
<i>Salmonella</i>	Cantaloupe in fruit salads	USA
	Watermelon	USA
	Unpasteurized apple juice ^a	USA
	Bean sprouts	England
<i>Shigella sonnei</i>	Shredded lettuce ^b	USA
<i>Escherichia coli</i> enterotoxic	Salads of raw vegetables	Mexico
<i>Bacillus cereus</i>	Bean sprouts	USA
Virus hepatitis A	Lettuce	USA

^a Outbreaks linked to the contamination of vegetables in the field by organic fertilizers or polluted irrigating water (83,84).

^b Outbreak linked to a contamination during processing of vegetables (109).

<i>monocytogenes</i>	(25 , 8	22 25	4 6
1 log 7†)	(25 , 1 2 log 7†)	(139), B type	.
	(152,153),		
	. 23 24	25 7	
	<i>E. coli</i> , <i>Salmonella</i>	(157), 7†	
<i>typhimurium</i> , <i>Staphylococcus aureus</i>		(<i>A. bisporus</i>)	4
(154). <i>S. aureus</i>		(158).	C
10 ⁵ CFU/g		<i>botulinum</i> (type A, B, E)	2
	2 10 ² 10 ³	1 8	
CFU/g	(155).	(A.	,
<i>bisporus</i>)		37	(inhibitors)7†
<i>S.aureus</i> 7†	2	(159). <i>C. botulinum</i> (A B type	
(156).	A type C)	MAP	23
<i>botulinum</i> (100 spores/g)		26	,

Table 4. Growth of *Listeria monocytogenes* in minimally processed vegetables at refrigeration temperatures

Product	Packaging conditions	Temperature (°C)	Increase in counts (log) during storage (days)	
Shredded lettuce	Pouches sealed in air	5	0.3 log in 7 days 1.1 log in 14 days	
		12	2 log in 7 days 3 log in 14 days	
	Pouches sealed in air ^a and pouches sealed under 97% N ₂	5	0 log in 8 days 1 log in 14 days	
		10	2 log in 3 days 2.5-3.5 log in 10 days	
		Shredded cabbage	5	1.5 log in 13 days
			5	3 log in 9 days 4 log in 25 days
Shredded chicory	Pouches ^c made with high barrier or semipermeable film, sealed in air	4	0 log in 10 days	
		8	0 log in 8 days	
	Pouches made with semipermeable film sealed under 100% N ₂	4	0 log in 6 days 1 log in 10 days	
		8	2 log in 8 days	
	Pouches made with high barrier film sealed under 100% N ₂	4	0.5 log in 8 days 1.2 log in 10 days	
		8	1.8 log in 3 days 2.6 log in 8 days	
		Salads of mixed vegetables	4	0.3 log in 4 days

^a No differences between modified atmospheres and air.

^b high barrier film used for modified atmosphere packaging.

^c No differences between the two films tested.

22	<i>Salmonella typhimurium</i> 가		
(160).		(<i>Flammulina velutipes</i>)	<i>A. bisporus</i>
		15	가 4
	<i>Shigella sonnei</i>	6	(158,161).
15			
(109), <i>Staphylococcus aureus</i>	25		<i>C. botulinum</i> (162)
(<i>A. bisporus</i>)	(156),		.
<i>Salmonella typhimurium</i>	4		
22			. <i>Shigella sonnei</i> 5
(160).	<i>C. botulinum</i>		3

7 1 log 가 (109). 5 가 2% (2.2 7.0%) 7 24 (170). (151). 21 in vitro , *L. monocytogenes*가 5 가 1% nutrient broth 15 가 (163). proteolytic *C. botulinum* 가 1 Enterovirus (20 pH7) , (171). 2% (164,165). (psychrotrophic foodborn) , 가 . *A. bisporus* (158,169), (157), (69) , . *L. monocytogenes* 가 가 *C. botulinum* (Table 4). (*Flammulina velutipes*) Stein- bruegge (152) *L. monocytogenes*가 (161), *Alternaria* spp. *C. botulinum* , Ringle (166) 2 9 8 (168). *L. monocytogenes* . 가 pH가 4.6 4.8 *Aeromonas hydrophila* *Aeromonas* spp. 가 가 . 4 5 5.2.2 (61,167). 10^3 10^4 10^6 CFU/g 가 *A. hydrophila*가 10 (15). 가 가 5.2 (, 30% $N_2/70\% CO_2$,) 24 *Shigella sonnei* 1 5.2.1 *Clostridium botulinum* 3 4 log cycles 가 , 가 *C. botulinum* (151). 0 6 *S. sonnei* 가 MAP . *L. monocytogenes* 97% $N_2/3\% O_2$ 가 (130) 70% $CO_2/30\% N_2$ (153) 가 . 8 4 *L.*

*monocytogenes*가 , (Table .

4). 3가 *L. monocytogenes* .
L. monocytogenes *P. fluorescens*
 가 , *Lactobacillus plantarum*
 . in vitro (181).
L. mono- cytogenes 가

pH 4.5 yeast ,
 extract 가 tryptone soybean (182,183). 가
L. monocytogenes 가 *Leuconostoc* spp. ,
 가 (172), CO₂
 (173).
 (6,114,121,131). *Leuconostoc* spp.
 가 *L. monocytogenes*
 bacteriocins
 (CA) (184).
L. monocytogenes A. Fluorescent pseudomonads
hydrophila 4 15 3 10% CO₂/ 1 *L. monocytogenes*
 0 18% O₂ pseudomonads가
 (167,174). *L. monocytogenes*
 CO₂ (50% 100%)가 가 (185).
L. monocytogenes , *L. monocytogenes*가
 (175- 179). 가 pseudo-
A. hydrophila monads 가
 100% CO₂ 가 (186,187).
 (180). 가 fluorescent
 (132). MAP
 (C.
botulinum) 가 .
 5.4
 5.3 (Epiphytic
 Microorganisms) 가 , , .

pH 가 acetylene (197).

5.4.1 pH A.
Listeria monocytogenes *hydrophila* (15).
L. monocytogenes (163). pH (Lund(57)가),
 pH *L. monocytogenes* pH7가 *L. monocytogenes* (188), pH 3.68 (198,199).
Salmonella typhimurium (160) proteolytic C. 5.4.3
botulinum pH 4.32 가

pH 가 (174)
 pH 6.0 pH 4.6 (6), 24 가 *L. monocyto-*
 4 pH 5.09 pH *genes* (4 20
 3.70 (151) 1 2 log cycles, 15 1 3 4 log
 cycles) (Table 4).

5.4.2 (189). (200).
 (190-192), 가 *L. mono-*
cytogenes (bacteriostatic) 가 ,
 (193). *monocytogenes* L.
 가 (166)
 oleuropein *Bacillus cereus* . Chambroy(201)
 lactobacilli ()
 (194,195). (196)) 가
 coumarins poly-

6.

10⁷ 10⁸ CFU/g
가 .

MAP

(phytopathogenic micro-organism)

가

가

가
가

가

가

가

가

가 . GMP

HACCP

가 ,

가 .

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