Survival of Foodborne Pathogens on Nuts: Tables and References

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Table 1. Storage survival studies of *E. coli* and foodborne pathogens on nuts

Pathogen	Nut	Nut type	Storage temp (°C)	Storage time	Reference
Escherichia coli	almond	flour (ground kernels)	−20	12 months	Cheng and Wang, 2018
		flour (ground kernels)	4	12 months	Cheng and Wang, 2018
		flour (ground kernels)	24	12 months	Cheng and Wang, 2018
	pecan	inshell	0	12 weeks	Beuchat, 1973
		kernel halves	−7	24 weeks	Beuchat, 1973
		kernel halves	0	24 weeks	Beuchat, 1973
		kernel halves	14	24 weeks	Beuchat, 1973
		kernel halves	21	24 weeks	Beuchat, 1973
		kernel halves	30	24 weeks	Beuchat, 1973
	walnut	inshell	ambient	9 months	Frelka et al., 2016
		kernel (extracted from inshells after storage)	ambient	9 months	Frelka et al., 2016
		kernel	ambient	8 months	Kokal, 1965
		kernel	9–14	8 months	Kokal, 1965
		kernel	−12	8 months	Kokal, 1965
Escherichia coli O157:H7	almond	kernel	−19	12 months	Kimber et al., 2012
		kernel	4	12 months	Kimber et al., 2012
		kernel	5	11 months	Hokunan et al., 2016
		kernel	15	11 months	Hokunan et al., 2016
		kernel	24	6 months	Kimber et al., 2012
		kernel	25	11 months	Hokunan et al., 2016
	hazelnut	inshell	24	12 months	Feng et al., 2018
	peanut	kernel	−24	12 months	Brar et al., 2015
		kernel	−20	3 months	Miksch et al., 2012
		kernel	4	3 months	Miksch et al., 2012
		kernel	4	12 months	Brar et al., 2015
		kernel	22	3 months	Miksch et al., 2012
		kernel	22	12 months	Brar et al., 2015

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Pathogen	Nut	Nut type	Storage temp (°C)	Storage time	Reference
Escherichia coli O157:H7 (continued)	pecan	kernel	−24	12 months	Brar et al., 2015
		kernel	4	12 months	Brar et al., 2015
		kernel	22	12 months	Brar et al., 2015
	pistachio	inshell	−19	12 months	Kimber et al., 2012
		inshell	4	12 months	Kimber et al., 2012
		inshell	24	8 months	Kimber et al., 2012
	walnut	inshell	10	7 months	Frelka, 2013
		inshell	10	12 months	Frelka et al., 2016
		inshell	23–25	14 weeks	Blessington et al., 2013b
		kernel	23	5 weeks /3 years[1]	Blessington et al., 2012
Enterohemorrhagic *E. coli* (EHEC)	almond	kernel	5	11 months	Hokunan et al., 2016
		kernel	15	11 months	Hokunan et al., 2016
		kernel	25	11 months	Hokunan et al., 2016
Listeria monocytogenes	almond	kernel	−19	12 months	Kimber et al., 2012
		kernel	4	12 months	Kimber et al., 2012
		kernel	24	7 months	Kimber et al., 2012
		meal (ground kernels)	4	48 weeks	Zhu et al., 2020
		meal (ground kernels)	22	48 weeks	Zhu et al., 2020
	peanut	kernel	−24	12 months	Brar et al., 2015
		kernel	4	12 months	Brar et al., 2015
		kernel	22	12 months	Brar et al., 2015
	pecan	kernel	−24	12 months	Brar et al., 2015
		kernel	4	12 months	Brar et al., 2015
		kernel	22	12 months	Brar et al., 2015
	pine nut	kernel	25	6 months	Salazar et al., 2019
	pistachio	inshell	−19	12 months	Kimber et al., 2012
		inshell	4	12 months	Kimber et al., 2012
		inshell	24	7 months	Kimber et al., 2012
		kernel, dry roasted	4	11 months (336 days)	Ly et al., 2020
		kernel, dry roasted	23	11 months (336 days)	Ly et al., 2020
	walnut	inshell	10	7 months	Frelka, 2013
		inshell	10	12 months	Frelka et al., 2016
		inshell	23–25	14 weeks	Blessington et al., 2013b
		kernel	23	5 weeks /15 weeks[1]	Blessington et al., 2012
Salmonella	almond	kernel	−20	6 months /18 months[2]	Uesugi et al., 2006
		kernel	−19	12 months	Kimber et al., 2012

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Pathogen	Nut	Nut type	Storage temp (°C)	Storage time	Reference
Salmonella (continued)		kernel	4	6 months /18 months	Uesugi et al., 2006
		kernel	4	48 weeks	Abd et al., 2012
		kernel	4	12 months	Kimber et al., 2012
		kernel	5	11 months	Hokunan et al., 2016
		kernel	15	11 months	Hokunan et al., 2016
		kernel	21	4 weeks	Komitopoulou and Peñaloza, 2009
		kernel	23	6 months /18 months	Uesugi et al., 2006
		kernel	23	48 weeks	Abd et al., 2012
		kernel	23	14 weeks	Blessington et al., 2013a
		kernel	23	68 weeks/103 weeks	Limcharoenchat et al., 2019
		kernel	24	12 months	Kimber et al., 2012
		kernel	25	11 months	Hokunan et al., 2016
		kernel	35	6 months	Uesugi et al., 2006
		meal (ground kernels)	4	12 months	Zhu et al., 2021
		meal (ground kernels)	22	12 months	Zhu et al., 2021
		flour (ground kernels)	21	17 weeks (120 days)	Sharma et al., 2021
	Brazil nut	kernel	8	59 weeks (413 days)	Onarinde, 2021
		kernel	23	59 weeks (413 days)	Onarinde, 2021
		kernel	37	59 weeks (413 days)	Onarinde, 2021
	chestnut	flour (ground kernels)	21	17 weeks (120 days)	Sharma et al., 2021
	hazelnut	flour (ground kernels)	21	17 weeks (120 days)	Sharma et al., 2021
	peanut	inshell	28	60 weeks (420 days)	Nascimento et al., 2018
		kernel	−24	12 months	Brar et al., 2015
		kernel	−20	3 months	Miksch et al., 2012
		kernel	4	3 months	Miksch et al., 2012
		kernel	4	12 months	Brar et al., 2015
		kernel	22	12 months	Brar et al., 2015
		kernel	23	3 months	Miksch et al., 2012
		kernel	28	60 weeks (420 days)	Nascimento et al., 2018
		kernel	28	6 months (180 days)	Pereira et al., 2020
	pecan	inshell	−20	78 weeks (~18 months)	Beuchat and Mann, 2010
		inshell	−18	32 weeks	Beuchat and Heaton, 1975
		inshell	−7	32 weeks	Beuchat and Heaton, 1975
		inshell	4	78 weeks (~18 months)	Beuchat and Mann, 2010
		inshell	5	32 weeks	Beuchat and Heaton, 1975
		inshell	21	32 weeks	Beuchat and Heaton, 1975
		inshell	21	78 weeks (~18 months)	Beuchat and Mann, 2010
		inshell	37	78 weeks (~18 months)	Beuchat and Mann, 2010
		kernel halves or pieces	−20	52 weeks	Beuchat and Mann, 2010

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Pathogen	Nut	Nut type	Storage temp (°C)	Storage time	Reference
Salmonella (continued)		kernel	−24	12 months	Brar et al., 2015
		kernel halves	−18	32 weeks	Beuchat and Heaton, 1975
		kernel halves or pieces	4	52 weeks	Beuchat and Mann, 2010
		kernel	4	12 months	Brar et al., 2015
		kernel halves	5	32 weeks	Beuchat and Heaton, 1975
		kernel halves	21	32 weeks	Beuchat and Heaton, 1975
		kernel halves or pieces	21	52 weeks	Beuchat and Mann, 2010
		kernel	22	12 months	Brar et al., 2015
		kernel halves or pieces	37	52 weeks	Beuchat and Mann, 2010
	pistachio	inshell	−19	12 months	Kimber et al., 2012
		inshell	4	12 months	Kimber et al., 2012
		inshell	24	12 months	Kimber et al., 2012
		inshell	25	12 months	Haendiges et al., 2021
	walnut	inshell	4	20 weeks /3 years[1]	Blessington et al., 2013b
		inshell	10	7 months	Frelka, 2013
		inshell	10	12 months	Frelka et al., 2016
		inshell	23–25	2 weeks /3 years	Blessington et al., 2013b
		kernel	−20	3 weeks /3 years	Blessington et al., 2012
		kernel	4	3 weeks /3 years	Blessington et al., 2012
		kernel	23	3 weeks /3 years	Blessington et al., 2012
		kernel	23	14 weeks	Blessington et al., 2013a

[1] Multiple studies over a range of storage times.

[2] 171 days (6 months) or 550 days (18 months).

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Table 2. Storage survival studies of foodborne pathogens on nut pastes and seed paste products

Pathogen	Nut	Nut or seed product	Storage temp (°C)	Storage time	Reference
Clostridium botulinum	peanut	peanut spread	30	16 weeks	Clavero et al., 2000
Escherichia coli O157:H7	peanut	peanut butter	4	30 days	He et al., 2011
		peanut butter	25	30 days	He et al., 2011
	sesame	tahini (sesame paste)	10	28 days	Al-Nabulsi et al., 2013
		tahini	21	28 days	Al-Nabulsi et al., 2013
		tahini	37	28 days	Al-Nabulsi et al., 2013
Listeria innocua	sesame	tahini	10		Al-Nabulsi et al., 2013
		tahini	21	28 days	Al-Nabulsi et al., 2013
		tahini	37	28 days	Al-Nabulsi et al., 2013
Listeria monocytogenes	peanut	chocolate-peanut spread	20	24 weeks	Kenney and Beuchat, 2004
		peanut butter	20	24 weeks	Kenney and Beuchat, 2004
Salmonella	peanut	peanut butter	4	14 days	Park et al., 2008
		peanut butter	4	30 days	He et al., 2011
		peanut butter	4	14 days	Ban and Kang, 2014
		peanut butter and spread	5	24 weeks	Burnett et al., 2000
		peanut butter	20	4 weeks	Grasso et al., 2010
		peanut paste	20	12 months	Kataoko et al., 2014
		peanut butter and spread	21	24 weeks	Burnett et al., 2000
		peanut butter	22	14 days	Park et al., 2008
		peanut butter	25	2 weeks	Keller et al., 2012
		peanut butter	25	14 days	Ban and Kang, 2014
		peanut butter	25	30 days	He et al., 2011
		peanut butter	25	4 weeks	He et al., 2013
	sesame	halva (sesame confection)	6	8 months	Kotzekidou, 1998
		halva	18–20	8 months	Kotzekidou, 1998
		tahini	4	16 weeks	Torlak et al., 2013
		tahini	4	7 days	Xu et al., 2021
		tahini	10	28 days	Al-Nabulsi et al., 2014
		tahini	10	12 months	Osaili et al., 2021
		tahini	21	28 days	Al-Nabulsi et al., 2014
		tahini	22	16 weeks	Torlak et al., 2013
		tahini	25	12 months	Osaili et al., 2021
		tahini	25	7 days	Xu et al., 2021

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Pathogen	Nut	Nut or seed product	Storage temp (°C)	Storage time	Reference
		tahini	37	28 days	Al-Nabulsi et al, 2014
Staphylococcus aureus	sesame	helva (halva)	4	9 months	Sengun et al., 2005
		helva (halva)	20	9 months	Sengun et al., 2005

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