

## Survival of Foodborne Pathogens on Nuts: Tables and References

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Table 1. Storage survival studies of foodborne pathogens on nuts

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

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

Pathogen	Nut	Nut type	Storage temp (°C)	Storage time	Reference
<i>Escherichia coli</i>	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
<i>Escherichia coli</i> 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

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Pathogen	Nut	Nut type	Storage temp (°C)	Storage time	Reference	
<i>Escherichia coli</i> O157:H7 (continued)	pecan	kernel	22	12 months	Brar et al., 2015	
		kernel	-24	12 months	Brar et al., 2015	
		kernel	4	12 months	Brar et al., 2015	
	pistachio	kernel	22	12 months	Brar et al., 2015	
		inshell	-19	12 months	Kimber et al., 2012	
		inshell	4	12 months	Kimber et al., 2012	
	walnut	inshell	24	8 months	Kimber et al., 2012	
		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 <sup>1</sup>	Blessington et al., 2012	
Enterohemorrhagic <i>E. coli</i> (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	
<i>Listeria monocytogenes</i>	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 <sup>1</sup>	Blessington et al., 2012		
<i>Salmonella</i>	almond	kernel	-20	6 months /18 months <sup>2</sup>	Uesugi et al., 2006	

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Pathogen	Nut	Nut type	Storage temp (°C)	Storage time	Reference	
<i>Salmonella</i> (continued)		kernel	-19	12 months	Kimber et al., 2012	
		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
		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
		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	
		kernel	-24	12 months	Brar et al., 2015	
		kernel halves	-18	32 weeks	Beuchat and Heaton, 1975	

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Pathogen	Nut	Nut type	Storage temp (°C)	Storage time	Reference	
<i>Salmonella</i> (continued)		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
		walnut	inshell	4	20 weeks /3 years <sup>1</sup>	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	

<sup>1</sup> Multiple studies over a range of storage times.

<sup>2</sup> 171 days (6 months) or 550 days (18 months).

**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
<i>Clostridium botulinum</i>	peanut	peanut spread	30	16 weeks	Clavero et al., 2000
<i>Escherichia coli</i> 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
<i>Listeria innocua</i>	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
<i>Listeria monocytogenes</i>	peanut	chocolate-peanut spread	20	24 weeks	Kenney and Beuchat, 2004
		peanut butter	20	24 weeks	Kenney and Beuchat, 2004
<i>Salmonella</i>	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
	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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<b>Pathogen</b>	<b>Nut</b>	<b>Nut or seed product</b>	<b>Storage temp (°C)</b>	<b>Storage time</b>	<b>Reference</b>
		tahini	37	28 days	Al-Nabulsi et al, 2014
<i>Staphylococcus aureus</i>	sesame	helva (halva)	4	9 months	Sengun et al., 2005
		helva (halva)	20	9 months	Sengun et al., 2005

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