Supplementary Materials: A Review on Mycotoxins and Microfungi in Spices in the Light of the Last Five Years

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Table S1. Studies positivity: Natural occurrence of mycotoxins produced by *Aspergillus* and *Penicillium* species in spices in the last 5 years (since 2015).

Mycotoxin[a]/ Spice	AFB_1 Positive[b] (%)	n[c]	AFB_2 Positive (%)	n	AFG_1 Positive (%)	n	AFG_2 Positive (%)	n	AFs Positive (%)	n	OTA Positive (%)	n	CIT Positive (%)	n	Reference
Allspice	- -	0	- -	0	- -	0	- -	0	● 100	1	× 0.0	1	- -	0	[9]
Anise	● 100	2	× 0.0	1	● 100	1	× 0.0	1	◉ 75.0	4	● 100	1	- -	0	[9,109,111,122]
Basil	× 0.0	2	- -	0	- -	0	- -	0	× 0.0	1	× 0.0	2	× 0.0	1	[9,110,123]
Bay leaf	× 0.0	3	× 0.0	2	○ 50.0	2	○ 50.0	2	○ 50.0	4	× 0.0	1	- -	0	[9,110,122,124]
Caraway	○ 40.0	5	○ 50.0	4	○ 25.0	4	○ 25.0	4	○ 50.0	6	◉ 66.7	3	× 0.0	1	[8,9,120,124–126]
Cardamom	× 0.0	2	× 0.0	1	× 0.0	1	× 0.0	1	◉ 60.0	5	◉ 66.7	3	- -	0	[9,109,119,122,126,127]
Carom	● 100	1	× 0.0	1	× 0.0	1	× 0.0	1	● 100	1	- -	0	- -	0	[125]
Chili	● 95.7	23	◉ 75.0	12	○ 50.0	12	○ 45.5	11	● 96.3	27	● 85.7	14	● 100	2	[8,9,106,108,110–118,120–122,128–138,147,148]
Cinnamon	○ 50.0	8	○ 20.0	5	○ 40.0	5	○ 20.0	5	◉ 57.1	7	○ 33.3	3	- -	0	[9,110–112,116,121,122,125,127,131]
Cloves	× 0.0	2	× 0.0	1	× 0.0	1	× 0.0	1	○ 40.0	5	× 0.0	3	- -	0	[9,35,122,127,131,147,148]
Coriander	◉ 57.1	7	○ 50.0	6	○ 33.3	6	○ 33.3	6	◉ 62.5	8	◉ 75.0	4	● 100	1	[8,9,109,111,112,120,124,125]
Cumin	◉ 57.1	7	○ 40.0	5	◉ 60.0	5	○ 40.0	5	◉ 66.7	6	◉ 66.7	3	● 100	1	[8,9,109–112,122,125]
Cumin, black	◉ 66.7	3	○ 50.0	2	● 100	2	○ 50.0	2	● 100	2	- -	0	- -	0	[109,110,125]
Curry	● 100	1	● 100	1	● 100	1	● 100	1	○ 33.3	3	● 100	1	- -	0	[112,147,148]
Dawadawa	● 100	1	- -	0	- -	0	- -	0	● 100	1	● 100	1	- -	0	[130]
Fennel	○ 40.0	10	○ 28.6	7	○ 42.9	7	○ 28.6	7	◉ 60.0	10	◉ 60.0	5	× 0.0	1	[8,9,109–112,124–127,131]
Fenugreek	○ 50.0	2	○ 50.0	2	● 100	2	○ 50.0	2	● 100	3	○ 50.0	2	● 100	1	[8,9,109]
Garlic	- -	0	- -	0	- -	0	- -	0	× 0.0	3	● 100	1	- -	0	[9,147,148]
Ginger	● 100	8	◉ 60.0	5	○ 40.0	5	○ 40.0	5	● 81.8	11	● 83.3	6	● 100	1	[8,9,109–111,117,120,122,130,139,140,147,148]
Licorice	○ 50.0	2	× 0.0	2	○ 50.0	2	× 0.0	2	○ 50.0	2	● 100	2	● 100	1	[109,120,141]
Mace	- -	0	- -	0	- -	0	- -	0	● 100	1	● 100	1	- -	0	[126]
Marjoram	● 100	1	× 0.0	1	× 0.0	1	× 0.0	1	○ 50.0	2	● 100	1	- -	0	[9,109]
Mint	× 0.0	3	× 0.0	2	× 0.0	2	× 0.0	2	× 0.0	3	× 0.0	1	- -	0	[9,110,124]
Mustard	○ 50.0	2	× 0.0	1	● 100	1	● 100	1	● 100	1	● 100	1	- -	0	[109,120,127]
Nutmeg	○ 33.3	6	○ 50.0	2	○ 50.0	2	× 0.0	2	● 85.7	7	● 100	3	× 0.0	1	[9,105,109,120,123,127,135,147,148,152,153]
Onion	× 0.0	1	- -	0	× 0.0	1	- -	0	× 0.0	2	× 0.0	2	- -	0	[9,133]

Mycotoxin[a]/ Spice	AFB_1			AFB_2			AFG_1			AFG_2			AFs			OTA			CIT			Reference
	Positive[b]	(%)	n[c]	Positive	(%)	n	Positive	(%)	n	Positive	(%)	n	Positive	(%)	n	Positive	(%)	n	Positive	(%)	n	
Oregano	×	0.0	4	×	0.0	3	×	0.0	3	×	0.0	3	○	25.0	4	×	0.0	3	×	0.0	1	[9,123,124,131]
Paprika	●	100	3	●	100	1	●	100	2	●	100	1	●	100	4	●	100	4	-	-	0	[9,107,111,120,133]
Parsley	●	100	1	●	100	1	●	100	1	×	0.0	1	◌	50.0	2	×	0.0	1	-	-	0	[9,109]
Pepper, black	◉	64.3	14	◉	57.1	7	◌	42.9	7	◌	28.6	7	◉	73.3	15	◉	66.7	12	◉	66.7	3	[8,9,35,108–112,116–118,120–123,125–127,129–131,134]
Pepper, white	◌	33.3	3	◌	33.3	3	◌	33.3	3	◌	33.3	3	◌	50.0	4	○	25.0	4	-	-	0	[9,35,112,125,131]
Rosemary	◌	50.0	4	◌	50.0	4	○	25.0	4	◌	50.0	4	●	100	5	◌	50.0	2	-	-	0	[9,109,124,131]
Saffron	●	100	1	-	-	0	-	-	0	-	-	0	◌	50.0	2	×	0.0	1	-	-	0	[9,111]
Sage	◌	50.0	2	×	0.0	1	●	100	1	×	0.0	1	●	100	3	●	100	1	-	-	0	[9,109,110]
Star anise	×	0.0	1	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	[127]
Sumac	×	0.0	1	-	-	0	-	-	0	-	-	0	×	0.0	1	×	0.0	1	-	-	0	[9,110]
Thyme	◌	40.0	5	×	0.0	3	◌	33.3	3	×	0.0	3	◌	42.9	7	×	0.0	2	×	0.0	1	[9,109,110,123,124,147,148]
Turmeric	●	85.7	7	◉	66.7	6	◉	66.7	6	○	16.7	6	●	77.8	9	●	100	5	×	0.0	1	[8,9,109,110,112,116,121,122,125,126]

Notes: [a] AFB_1 = Aflatoxin B_1, AFB_2 = Aflatoxin B_2, AFG_1 = Aflatoxin G_1, AFG_2 = Aflatoxin G_2, AFs = Aflatoxins, OTA = Ochratoxin A, CIT = Citrinin; [b] Positive = the percentage of studies with at least one related spice sample positive on related mycotoxin; [c] n = number of studies concerning related spice and mycotoxin; × = none occurrence (0 %); ☆ = rare occurrence (up to 5 %); ○ = low occurrence (up to 25 %); ◌ = moderate occurrence (up to 50 %); ◉ = high occurrence (up to 75 %); ● = very high occurrence (more than 75 %).

Table S2. Studies positivity: Natural occurrence of *Fusarium* mycotoxins in spices in the last 5 years (since 2015).

Mycotoxin[a]/ Spice	FB_1 Positive[b] (%)		n[c]	FB_2 Positive (%)		n	DON Positive (%)		n	NIV Positive (%)		n	T-2 Positive (%)		n	HT-2 Positive (%)		n	ZEA Positive (%)		n	Reference
Basil	×	0.0	2	×	0.0	1	×	0.0	1	×	0.0	1	×	0.0	1	×	0.0	1	×	0.0	1	[123,143]
Bay leaf	×	0.0	3	×	0.0	1	-	-	0	-	-	0	×	0.0	2	×	0.0	2	-	-	0	[124,143]
Caraway	×	0.0	2	-	-	0	-	-	0	-	-	0	×	0.0	2	×	0.0	2	-	-	0	[124]
Chili	×	0.0	1	●	100	2	-	-	0	-	-	0	-	-	0	-	-	0	×	0.0	1	[118,133,137]
Coriander	×	0.0	3	×	0.0	1	-	-	0	-	-	0	◐	50.0	2	×	0.0	2	-	-	0	[124,143]
Dawadawa	●	100	1	●	100	1	×	0.0	1	×	0.0	1	●	100	1	●	100	1	●	100	1	[34]
Fennel	×	0.0	2	-	-	0	-	-	0	-	-	0	×	0.0	2	×	0.0	2	-	-	0	[124]
Garlic	●	100	1	×	0.0	1	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	[142]
Licorice	●	100	1	×	0.0	1	●	100	1	-	-	0	×	0.0	1	-	-	0	●	100	1	[141]
Mint	◐	33.3	3	×	0.0	1	-	-	0	-	-	0	◐	50.0	2	×	0.0	2	-	-	0	[124,143]
Nutmeg	●	100	1	-	-	0	×	0.0	1	×	0.0	1	×	0.0	1	×	0.0	1	×	0.0	1	[123]
Onion	●	100	1	●	100	1	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	[133]
Oregano	×	0.0	3	-	-	0	×	0.0	1	×	0.0	1	×	0.0	3	×	0.0	3	×	0.0	1	[123,124]
Paprika	◐	50.0	2	●	100	2	●	100	1	●	100	1	●	100	1	●	100	1	●	100	1	[107,133]
Pepper, black	◐	50.0	2	-	-	0	×	0.0	1	×	0.0	1	×	0.0	1	×	0.0	1	×	0.0	1	[118,123]
Rosemary	×	0.0	2	-	-	0	-	-	0	-	-	0	×	0.0	2	×	0.0	2	-	-	0	[124]
Thyme	○	25.0	4	×	0.0	1	●	100	1	×	0.0	1	×	0.0	3	×	0.0	3	●	100	1	[123,124,143]

Notes: [a] FB_1 = fumonisin B_1, FB_2 = Fumonisin B_2, DON = Deoxynivalenol, NIV = Nivalenol, T-2 = T-2 toxin, HT-2 = HT-2 toxin, ZEA = Zearalenone; [b] Positive = the percentage of studies with at least one related spice sample positive on related mycotoxin; [c] n = number of studies concerning related spice and mycotoxin; × = none occurrence (0 %); ☆ = rare occurrence (up to 5 %); ○ = low occurrence (up to 25 %); ◐ = moderate occurrence (up to 50 %); ◍ = high occurrence (up to 75 %); ● = very high occurrence (more than 75 %).

Table S3. Studies positivity: Natural occurrence of *Alternaria* mycotoxins in spices in the last 5 years (since 2015).

Mycotoxin[a]/ Spice	ALT Positive[b] (%)		n[c]	AOH Positive (%)		n	TEA Positive (%)		n	Reference
Allspice	×	0.0	1	●	100	1	×	0.0	1	[10]
Anise	×	0.0	1	×	0.0	1	×	0.0	1	[10]
Basil	×	0.0	1	×	0.0	1	×	0.0	1	[10]
Bay leaf	×	0.0	1	×	0.0	1	●	100	1	[10]
Caraway	×	0.0	1	×	0.0	1	●	100	1	[10]
Cardamom	×	0.0	1	×	0.0	1	●	100	1	[10]
Chili	●	100	1	●	100	1	●	100	1	[10]
Cinnamon	●	100	1	●	100	1	●	100	1	[10]
Cloves	●	100	1	×	0.0	1	●	100	1	[10]
Coriander	×	0.0	1	×	0.0	1	●	100	1	[10]
Cumin	×	0.0	1	×	0.0	1	●	100	1	[10]
Fennel	×	0.0	1	×	0.0	1	●	100	1	[10]
Fenugreek	×	0.0	1	×	0.0	1	●	100	1	[10]
Garlic	×	0.0	1	●	100	1	●	100	1	[10]
Ginger	●	100	1	●	100	1	●	100	1	[10]
Licorice	-	-	0	●	100	1	-	-	0	[141]
Marjoram	×	0.0	1	×	0.0	1	●	100	1	[10]
Mint	×	0.0	1	●	100	1	●	100	1	[10]
Nutmeg	×	0.0	1	●	100	1	●	100	1	[10]
Onion	×	0.0	1	●	100	1	●	100	1	[10]
Oregano	×	0.0	1	●	100	1	●	100	1	[10]
Paprika	●	100	2	●	100	2	●	100	2	[10,107]
Parsley	×	0.0	1	×	0.0	1	×	0.0	1	[10]
Pepper, black	×	0.0	1	●	100	1	●	100	1	[10]
Pepper, white	×	0.0	1	●	100	1	●	100	1	[10]
Rosemary	×	0.0	1	×	0.0	1	●	100	1	[10]
Sage	×	0.0	1	●	100	1	●	100	1	[10]
Sumac	×	0.0	1	●	100	1	●	100	1	[10]
Thyme	×	0.0	1	×	0.0	1	●	100	1	[10]
Turmeric	●	100	1	×	0.0	1	●	100	1	[10]

Notes: [a] ALT = Altenuene, AOH = Alternariol, TEA = Tenuazonic acid; [b] Positive = the percentage of studies with at least one related spice sample positive on related mycotoxin; [c] n = a total number of studies concerning related spice and mycotoxin; × = none occurrence (0 %); ☆ = rare occurrence (up to 5 %); ○ = low occurrence (up to 25 %); ◔ = moderate occurrence (up to 50 %); ◕ = high occurrence (up to 75 %); ● = very high occurrence (more than 75 %).