

Supplementary Data

Table S1. Combinations of stored-product arthropods tested for their behavioral response to an assortment of complex microbial headspaces, including documented occurrences of attraction (+), repellency (−), or no statistical difference from included controls (○) in the primary literature.

Arthropod & Microbial Taxon	% Behavioral Response			N
	−	○	+	
<i>Acanthoscelides obtectus</i>				
<i>Trichoderma harzianum</i> (multiple strains)	25	0	75	4
<i>Carpophilus hemipterus</i>				
<i>Candida krusei</i> (inoculated food)	0	0	100	1
<i>Saccharomyces cerevisiae</i> (pure culture & inoculated food)	0	0	100	3
<i>Carpophilus humeralis</i>				
<i>Fusarium verticillioides</i> (NRRL25457)	0	0	100	1
<i>Cryptolestes ferrugineus</i>				
<i>Aspergillus repens</i> (inoculated grain)	0	0	100	1
<i>Cephalosporium acremonium</i> (inoculated grain)	0	0	100	1
<i>Fusarium</i> sp. (inoculated grain)	0	0	100	1
<i>Penicillium corymbiferum</i> (inoculated grain)	0	0	100	1
<i>Scopulariopsis brevicaulis</i> (inoculated grain)	0	0	100	1
Spoiled grain from field	0	0	100	1
<i>Streptomyces</i> sp. (inoculated grain)	0	100	0	1
<i>Cynaesus angustus</i>				
<i>Cladosporium</i> sp. (inoculated maize flour)	0	0	100	1
<i>Lariophagus distinguendus</i>				
<i>Aspergillus sydowii</i> (inoculated grain)	100	0	0	2
<i>Aspergillus versicolor</i> (inoculated grain)	100	0	0	3
<i>Liposcelis bostrychophila</i>				
Biodeteriorated paper incubated for 8 days	100	0	0	1
<i>Eurotium amstelodami</i> (on malt-agar)	100	0	0	1
<i>Ulocladium botrytis</i> (two strains on paper or agar)	66	33	0	6
<i>Oryzaephilus mercator</i>				
Brewer's yeast	0	0	100	2
<i>Oryzaephilus surinamensis</i>				
Brewer's yeast	50	0	50	2
<i>Plodia interpunctella</i>				
<i>Alternaria alternata</i>	0	0	100	1
<i>Aspergillus flavus</i>	0	0	100	1
<i>Fusarium graminearum</i>	0	0	100	1

<i>Penicilium auranziogriseum</i>	0	0	100	1
<i>Sitophilus zeamais</i>				
<i>Fusarium verticillioides</i> (various forms)	80	0	20	5
<i>Tenebrio molitor</i>				
<i>Beauveria bassiana</i>	100	0	0	1
<i>Fusarium avenaceum</i>	100	0	0	1
<i>Fusarium culmorum</i>	0	0	100	1
<i>Fusarium poae</i>	0	0	100	1
<i>Fusarium proliferatum</i> (pure & inoculated grains)	0	0	100	2
<i>Fusarium</i> sp.	100	0	0	1
<i>Tribolium castaneum</i>				
<i>Alternaria solani</i> (triglycerides extract)	0	0	100	1
<i>Aspergillus glaucus</i> (extracts) with spores	0	0	100	2
<i>Aspergillus niger</i>	0	100	0	1
<i>Aspergillus ochraceus</i>	50	50	0	2
<i>Aspergillus tamarii</i>	0	50	50	2
<i>Aspergillus tubingensis</i>	50	50	0	2
<i>Aspergillus wentii</i>	0	100	0	1
<i>Byssoschamlys spectabilis</i>	0	100	0	1
Delinted cotton	50	50	0	2
<i>Epicoccum nigrum</i>	1	0	0	
Fungal isolate (A, B, C, D, E isolate)	20	60	20	5
Fungal isolate (A, B, C, D, E isolate) + wheat seed	0	100	0	5
Fungal-infected wheat kernels (direct & extracts)	0	0	100	3
<i>Fusarium chlamydosporum</i>	0	100	0	1
<i>Fusarium proliferatum</i>	0	100	0	1
<i>Fusarium</i> sp.	0	100	0	1
<i>Helminthosporium sativum</i> (triglycerides extract)	0	0	100	1
<i>Hypocrea</i> sp. (inoculated grain)	0	100	0	1
Linted cotton	0	33	66	3
<i>Nigrospora sphaerica</i> (triglycerides extract)	0	0	100	1
<i>Penicillium citrinum</i>	100	0	0	1
<i>Rhizopus oryzae</i>	0	100	0	2
<i>Trichoderma harzianum</i>	0	100	0	1
Unknown fungi; obtained from cotton	0	0	100	1
<i>Tribolium confusum</i>				
Fungal-produced acids	0	0	100	1
<i>Penicillium chrysogenum</i>	50	0	50	2
<i>Penicillium citrinum</i>	50	0	50	2
<i>Penicillium crustosum</i>	50	50	0	2

<i>Penicillium cyclopium</i>	50	0	50	2
<i>Penicillium expansum</i>	50	0	50	2
<i>Penicillium griseofulvum</i>	50	50	0	2
<i>Penicillium martensii</i>	50	50	0	2
<i>Penicillium oxalicum</i> (Isolate 787, 2300)	50	25	25	4
<i>Penicillium palitans</i>	50	0	50	2
<i>Penicillium puberulum</i>	50	0	50	2
<i>Penicillium pulvillorum</i>	50	0	50	2
<i>Penicillium rubrum</i>	50	50	0	2
<i>Penicillium stoloniferum</i>	50	0	50	2
<i>Penicillium urticae</i> (patulum)	50	50	0	2
<i>Penicillium viridicatum</i> (Isolate 5572, 5583, 60, 963)	38	25	38	8
<i>Typhaea stercorea</i>				
<i>Aspergillus flavus</i>	0	0	100	1
<i>Tyrophagus putrescentiae</i>				
<i>Alternaria</i> sp. (plated)	0	0	100	1
<i>Aspergillus chevalieri</i> (plated)	0	0	100	1
<i>Aspergillus flavus</i> (plated)	100	0	0	1
<i>Aspergillus fumigatus</i> (plated)	100	0	0	1
<i>Aspergillus niger</i> (plated)	100	0	0	1
<i>Aspergillus oryzae</i> (plated)	100	0	0	1
<i>Microsporum gypseum</i> (plated)	0	0	100	1
<i>Trichophyton mentagrophytes</i> (plated)	0	0	100	1
Overall response across taxa	34	24	41	140

Table S2. Combinations of stored-product arthropods tested for their behavioral response to an assortment of individual microbial compounds, including documented occurrences of attraction (+), repellency (-), or no statistical difference from included controls (○) in the primary literature.

Arthropod Taxa & Compound Identity	% Behavioral Response			N
	–	○	+	
<i>Ahasverus advena</i>				
(R,S)-3-octanol	33	33	33	3
1-octen-3-one	33	33	33	3
2-phenylethanol	50	0	50	2
3-methyl-1-butanol	0	50	50	2
3-octanone	33	33	33	3
ethanol	0	50	50	2
<i>Callosobruchus maculatus</i>	0	0	0	
Binary mixture I [10-5 w/w nonanal, 10-6 w/w (E)-2-octenal]	0	0	100	1
Binary mixture II [10-6 w/w nonanal, 10-6 w/w (E)-2-octenal]	0	0	100	1
Binary mixture III [1-pentanol, 1-octen-3-ol]	0	100	0	1
Quaternary mixture [1-pentanol, nonanal, (E)-2-octenal, 3-carene]	100	0	0	1
Ternary mixture I [1-pentanol, nonanal, (E)-2-octenal]	0	0	100	1
Ternary mixture II [3-carene, nonanal, (E)-2-octenal]	100	0	0	1
<i>Carpophilus hemipterus</i>				
Ethyl acetate, acetaldehyde, 2-pentanol, 3-methyl-1-butanol	0	100	0	1
Synthetic 18-component blend mimicking <i>S. cerevisiae</i> -inoculated banana	0	100	0	2
<i>Cathartus quadricollis</i>	0	0	0	
(R,S)-3-octanol	50	0	50	2
1-octen-3-one	50	0	50	2
2-phenylethanol	50	0	50	2
3-methyl-1-butanol	0	50	50	2
3-octanone	50	0	50	2
<i>Cryptolestes ferrugineus</i>				
(R)-(-)-1-octen-3-ol (multiple isomers, with or without pheromone)	25	50	25	12
(R,S)-3-octanol	33	33	33	3

1-octen-3-one	33	33	33	3
2-ethyl-1-hexanol	0	0	100	1
2-phenylethanol	25	25	50	4
3-methyl-1-butanol	0	33	67	3
3-octanone	25	50	25	4
4-ethylacetophenone	0	0	100	1
hexanoic acid	0	0	100	1
nonanal	0	0	100	1
trans-3-octen-2-one	0	0	100	1
valeraldehyde	0	0	100	1
<i>Holepyris sylvanidis</i>	0	0	0	
(E)-2-nonenal	0	100	0	1
1-pentadecene	0	100	0	1
2-component mixture ((E)-2-nonenal, 1-pentadecene)	100	0	0	1
octanoic acid	0	0	100	1
<i>Lariophagus distinguendus</i>	0	0	0	
1-octen-3-ol	50	0	50	2
<i>Oryzaephilus mercator</i>				
(R,S)-3-octanol	33	33	33	3
1-octen-3-one	0	50	50	2
2-phenylethanol	0	50	50	2
3-methyl-1-butanol	0	50	50	2
3-octanone	33	33	33	3
ethanol	0	50	50	2
propionic acid	100	0	0	1
<i>Oryzaephilus surinamensis</i>				
(R,S)-3-octanol	33	33	33	3
1-octen-3-one	0	50	50	2
2-phenylethanol	33	33	33	3
3-methyl-1-butanol	0	50	50	2
3-octanone	33	33	33	3
ethanol	0	50	50	2
<i>Plodia interpunctella</i>				
1-hexanol	0	50	50	2
3-methyl-1-butanol	33	33	33	3
nonanal	0	50	50	2
Phenylacetaldehyde	0	0	100	1
<i>Sitophilus granarius</i>				
(E)-2-hexenal (with or without wheat)	33	33	33	3
(E)-2-hexenal + (E,E)-2,4-nonadienal + wheat	50	0	50	2
(E,E)-2,4-decadienal (with or without wheat)	50	0	50	4

(E,E)-2,4-heptadienal	33	33	33	3
(E,E)-2,4-nonadienal (with or without wheat)	50	0	50	4
1-butanol	0	50	50	2
1-hexanol (with or without wheat)	50	0	50	4
1-octanol	0	50	50	2
1-octen-3-ol	0	50	50	2
1-pentanol	33	33	33	3
2,3-butanedione	50	0	50	2
2,3-butanedione + wheat	100	0	0	1
2-heptanone (with or without wheat)	50	0	50	4
2-hexanone (with or without wheat)	50	0	50	4
2- or 3-methyl-1-butanol	0	100	0	2
2-pentanone	50	0	50	2
2-pentanone + wheat	100	0	0	1
butanal (with or without wheat)	50	0	50	4
butanal + (E)-2-hexenal + wheat	50	0	50	2
butanal + (E,E)-2,4-nonadienal + wheat	50	0	50	2
butanal + (E)-2-hexenal + (E,E)-2,4-nonadienal + wheat	50	0	50	2
fufural + wheat	50	0	50	2
heptanal (with or without wheat)	50	0	50	4
hexanal (with or without wheat)	50	0	50	4
Multilayer PCL coating + (E)-2-hexenal packaging	100	0	0	1
pentanal	0	50	50	2
<i>Sitophilus zeamais</i>				
(E)-2-hexenal	100	0	0	1
(E)-2-nonenal	100	0	0	1
(E, Z)-2.6-nonadienal	100	0	0	1
1-butanol	50	50	0	2
1-hexanol	100	0	0	1
1-octen-3-ol	100	0	0	1
1-pentanal	100	0	0	1
1-pentanol	100	0	0	1
2-decanone	50	50	0	2
3-decanone	50	50	0	2
3-methyl-1-butanol	50	50	0	2
3-octanol	100	0	0	1
3-octanone	100	0	0	1
Fumonisin B extract	33	67	0	3
Maize exposed to 1-octen-3-ol	100	0	0	1
Maize exposed to 3-octanol	100	0	0	1
propionic acid	100	0	0	1

<i>Tenebrio molitor</i>				
deoxynivalenol	75	0	25	4
<i>Tribolium castaneum</i>				
1-butanol-3-methyl	0	0	100	1
1-octen-3-ol	100	0	0	1
2,3-butanediol	0	0	100	1
2,3-butanediol + 2-pentanone-4-hydroxy-4-methyl + 1-butanol-3-methyl	0	0	100	2
2-nonanone	0	0	100	1
2-pentanone-4-hydroxy-4-methyl	0	100	0	1
3-methylanisol	0	100	0	1
3-octanone	0	100	0	1
5-methyl-3-heptanone	100	0	0	1
acetic acid	0	0	100	1
acetic acid + 1-butanol-3-methyl	0	0	100	1
butyl acetate	0	100	0	1
hexanal	0	100	0	1
trans-2-hexenal	50	0	50	4
<i>Tribolium confusum</i>				
elaidic acid	0	100	0	1
myristic acid	0	100	0	1
oleic acid	0	100	0	1
stearic acid	0	100	0	1
<i>Trogoderma granarium</i>				
oleic acid	50	0	50	2
<i>Trogoderma inclusum</i>				
oleic acid	50	0	50	2
<i>Trogoderma variabile</i>				
oleic acid	100	0	0	2
<i>Tyrophagus putrescentiae</i>				
benzaldehyde	0	100	0	1
cedrol	0	100	0	1
cis-octa-1,5-dien-3-ol	0	100	0	1
dihydrocarveol	0	100	0	1
trans-octa-1,5-dien-3-ol	0	100	0	1
α -terpilene	0	100	0	1
β -caryophyllene	0	100	0	1
Net behavioral response	35	28	37	243