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Environmental and human health risk assessment of the mites *Acarus siro* and *Suidasia pontifica* in the product POWERfood 3.0

Johan A. Stenberg, Daniel Flø, Lawrence R. Kirkendall, Kjetil K. Melby, Anders Nielsen, Selamawit Tekle, Beatrix Alsanius, Jorunn Børve, Paal Krokene, Christer Magnusson, Mogens Nicolaisen, Line Nybakken, May-Guri Sæthre, Iben M. Thomsen, Sandra A. I. Wright

Scientific Opinion of the Panel on Plant Health of the Norwegian Scientific Committee for Food and Environment

The Norwegian Scientific Committee for Food and Environment assessed potential environmental and human health risks associated with the mites *Acarus siro* and *Suidasia pontifica* used in the plant protection product POWERfood 3.0. *Acarus siro* occurs naturally in Norway and new introductions will most likely establish and spread. *Suidasia pontifica* has never been recorded in the wild in Norway and its tropical origin suggests that it will be unable to establish and spread in Norway. No records of negative effects of *A. siro* and *S. pontifica* on biodiversity were found. The likelihood of developing mite allergy from using the product is likely.

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Norwegian Scientific Committee for Food and Environment (VKM)
Postboks 222 Skøyen
0213 Oslo
Norway

Email: vkm@vkm.no
Website: vkm.no

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Preparation of the opinion

The Norwegian Scientific Committee for Food and Environment (Vitenskapskomiteen for mat og miljø, VKM) appointed a project group to draft the opinion. The project group consisted of four VKM members and two project managers from the VKM secretariat. Two referees commented on and reviewed the draft opinion. The Committee, by the Panel on Plant Health, assessed and approved the final opinion.

Authors of the opinion

The authors have contributed to the opinion in a way that fulfils the authorship principles of VKM (VKM, 2023). The principles reflect the collaborative nature of the work, and the authors have contributed as members of the project group and/or the VKM Panel on Plant health.

Members of the project group

Johan A. Stenberg – Chair of the project group and member of the Panel on Plant Health. Affiliation: 1) VKM; 2) Swedish University of Agricultural Sciences (SLU)

Daniel Flø – Project manager, VKM staff. Affiliation: VKM.

Lawrence R. Kirkendall – Member of the Panel on Biodiversity. Affiliation: 1) VKM; 2) University of Bergen (UiB)

Kjetil K. Melby – Member of the Panel on Genetically Modified Organisms - Medicinal Products Affiliation: 1) VKM; 2) University of Oslo (UiO); 3) Oslo University Hospital

Anders Nielsen – Member of the Panel on Biodiversity. Affiliation: 1) VKM; 2) Norwegian Institute of Bioeconomy Research (NIBIO)

Selamawit Tekle – Project leader, VKM staff. Affiliation: VKM

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VKM would like to thank the referees Torgeir Storaas, Haukeland University Hospital, and Mattias Jonsson, Swedish University of Agricultural Sciences, for reviewing and commenting on the manuscript. VKM emphasises that the referees are not responsible for the content of the final opinion. In accordance with VKM's routines for approval of risk assessments (VKM, 2024), VKM received the referee comments before evaluation and approval by the Panel on Plant Health, and before the opinion was finalised for publication.

Competence of VKM experts

Persons working for VKM, either as appointed members of the Committee or as external experts, do this by virtue of their scientific expertise, not as representatives for their employers or third-party interests. The Civil Services Act instructions regarding conflicts of interest apply to all work prepared by VKM.

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Summary

POWERfood 3.0 consists of the mite species *Acarus siro, Suidasia medanensis* (correct name *S. pontifica)* and *Carpoglyphus lactis*. *Carpoglyphus lactis* has previously been assessed by VKM. The Norwegian Food Safety Authority asked VKM to do an environmental and human health risk assessment of *Acarus siro* and *Suidasia pontifica.*

Occurrence and distribution in Norway: *Acarus siro* occurs naturally in Norway and can cause problems in food storage facilities. It is unclear how well it thrives in natural environments, but it has been reported from throughout the country.

Suidasia pontifica has a mainly tropical distribution and has never been recorded in the wild in Norway. There are no Norwegian records in the Global Biodiversity Information Facility (GBIF) or in Norway's Species Map Service (Artsdatabanken).

Potential for establishment and spread: *Acarus siro* occurs naturally in Norway and new introduced individuals will most likely be able to establish and spread, at least in food storage facilities. To what extent it can establish and spread in the wild is unclear.

Suidasia pontifica has never been recorded in the wild in Norway and its tropical origin suggests that it is unlikely that it will establish and spread in Norway due to climate limitations.

Potential effects on biodiversity: No records of negative effects on biodiversity from *A. siro* or *S. pontifica* were found.

Risk to human health: Several studies reported allergies to mites, including the species in the product POWERfood 3.0. The likelihood of developing mite allergy due to handling of the product is, therefore, likely. However, the likelihood of allergic reactions following consumption of plants treated with the product appears to be low.

Taxonomic challenges that may affect risk assessment: *Acarus siro* can be mistaken for *A. farris* and *A. immobilis* that differ only slightly in development and ecology. From the limited knowledge available about their biology, these three species are expected to have similar effects on biodiversity and human health.

No problems with species identification have been reported for *Suidasia pontifica*. The main taxonomic issue with this species is that most of the recent and older literature use an invalid name; *S. medanensis*.

Key words: Allergy, *Acarus siro*, *Acarus siro* complex, Flour mites, Norwegian Food Safety Authority, Norwegian Scientific Committee for Food and Environment, *Suidasia medanensis*, *Suidasia pontifica*

Sammendrag på norsk

POWERfood 3.0 inneholder middartene *Acarus siro*, *Suidasia medanensis* (korrekt navn *S. pontifica*) og *Carpoglyphus lactis*. *Carpoglyphus lactis* har tidligere blitt vurdert av VKM. Mattilsynet har bedt VKM å gjøre en miljø- og helserisikovurdering av *Acarus siro* og *Suidasia pontifica*.

Forekomst og utbredelse i Norge: *Acarus siro* forekommer naturlig i Norge og kan forårsake problemer i matlagre. Det er usikkert i hvilken grad den trives i naturlige miljøer, men den har vært rapportert fra hele landet.

Suidasia pontifica har en hovedsakelig tropisk utbredelse og har aldri blitt registrert i naturen i Norge. Det er ingen norske registreringer i GBIF (*Global Biodiversity Information Facility*) eller i Artsdatabanken.

Potensial for etablering og spredning*: Acarus siro* forekommer naturlig i Norge, og nye introduserte individer vil mest sannsynlig kunne etablere og spre seg, i det minste i matlagre. Det er uklart i hvilken grad den kan etablere og spre seg i naturen.

Suidasia pontifica har aldri blitt registrert i naturen i Norge, og dens tropiske opprinnelse tilsier at det er lite sannsynlig at den vil kunne etablere og spre seg i Norge.

Potensielle effekter på biodiversitet: Det finnes ingen dokumentasjon på at *A. siro* eller *S. pontifica* kan ha negative effekter på biodiversitet.

Risiko for menneskers helse: En rekke studier rapporterte om har rapportert allergi mot midd, inkludert mot artene i produktet POWERfood 3.0. Sannsynligheten for å utvikle middallergi etter håndtering av produktet er derfor høy. Imidlertid er det lav sannsynlighet for allergiske reaksjoner etter konsum av planter som er behandlet med produktet.

Taksonomiske utfordringer som kan påvirke risikovurderingen*: Acarus siro* kan forveksles med *A. farris* og *A. immobilis* som er svært like i utvikling og økologi. Ut fra den begrensede tilgjengelige kunnskapen om deres biologi, forventes det at disse tre artene har ganske like effekt på biodiversitet og menneskers helse.

Det er ingen kjente problemer med artsidentifikasjon for *Suidasia pontifica*. Det taksonomiske problemet med denne arten er at mye av den nylige og eldre litteraturen bruker et ugyldig navn; *S. medanensis*.

Nøkkelord: Allergi, *Acarus siro*, *Acarus siro*-kompleks, Melmidd, Mattilsynet*, Suidasia medanensis*, *Suidasia pontifica,* Vitenskapskomiteen for mat og miljø

Background and terms of reference as provided by the Norwegian Food Safety Authority

The Norwegian Food Safety Authority hereby ask for a risk assessment of *Acarus siro* and *Suidasia medanensis* in the product POWERfood 3.0. The product shall be used as a food source for different mites.

Background

Acarus siro, *Suidasia medanensis* and *Carpoglyphus lactis* constitute the product POWERfood 3.0. The product will be used as a food source for different beneficial mites on indoor plants, outdoors, and in greenhouses.

Carpoglyphus lactis has been evaluated by VKM earlier. The organisms *Acarus siro* and *Suidasia medanensis* have not been evaluated earlier.

Description of the assessment

With the view on *Acarus siro* and *Suidasia medanensis*, we order an assessment of the following:

- The human health risk by using the plant protection product POWERfood 3.0.
- The human health risk by consumption of food products where the *Acarus siro* and *Suidasia medanensis* are used.
- The occurrence of *Acarus siro* and *Suidasia medanensis* in Norway, and whether they are naturally occurring.
- The organisms' potential to establish and spread in the environment under Norwegian climatic conditions, specified by the use of POWERfood 3.0 in greenhouses and outdoors.
- Potential risks of effects on indigenous species under Norwegian climatic conditions should also be assessed.
- Uncertainty about taxonomy which can make the risk assessment difficult.

1 Introduction

1.1 Purpose and scope

This opinion presents a risk assessment of the mites *Acarus siro* L. (flour mite) and *Suidasia pontifica* Oudemans (widely reported as *S. medanensis* Oudemans) (scaly grain mite) used as feed for biological control agents. The product POWERfood 3.0 contains these two mites in addition to Carpoglyphus lactis L. (dried fruit mite). The latter species was evaluated by VKM in an earlier report assessing the risk posed by the product Swirski-Mite (VKM, 2006) and will hence not be assessed in this report. The current opinion was prepared as a response to a request from the Norwegian Food Safety Authority. The assessment area for this opinion is Norway.

1.2 Product and constituent organisms

The product POWERfood 3.0 is to be used as feed for predatory mites and bugs used in plant protection. It is shipped to buyers in 5L paper bags containing a mix of prey mites and undefined complementary food, with wheat bran as carrier material. We assume that the unspecified complementary food may contain yeasts or other microbial-based elements, as the dietary preference of *S. pontifica* includes yeasts (Pirayeshfar et al., 2021).

Acarus siro has a colourless body with rose to darker red or reddish-brown legs. Female body length averages 0.44 mm and the males are a little larger (CABI, 2019a). *Acarus siro* dominates in most postharvest habitats, from farm stores to household larders and all points in the commercial chain in between (Griffiths, 1964a & b). It can be a serious pest of stored cereals, cereal products, and other foodstuffs. It has also been recorded on dried meat, tea, spices, dried fruit, and pulses (CABI, 2019a). On the positive side, *A. siro* mites are key to the ripening process of Mimolette cheese in France, imbibing it with a characteristic nutty, fruity flavour and aroma (Melnyk et al., 2010).

The body length of *Suidasia pontifica* averages 0.63 mm in females and 0.47 mm in males (Balmes-Pacia & Corpuz-Raros, 1998). The species has a mainly tropical distribution, thriving in areas with high temperature and humidity throughout the year (Mangoba & Alvindia, 2019). As far as we know it has never been recorded in the wild in Norway and there are no records of it in Norway's Species Map Service (Artsdatabanken). It is also not mentioned in Mehl's review of mites found in indoor environments and in stored products in Norway (Mehl, 1998). The species is mostly associated with stored agricultural products such as flour, cereal grains, oilseeds, animal feed, cheese and nuts, and is commonly found in house dust (Ho, 1996; Mercado et al., 2001; Colloff 2009; Ernieenor et al., 2018; Fan et al., 2020). It is also reported to infest nests of honeybees and solitary bees (Xylocopa) in the tropics (Koeniger et al., 1993; IDtools et al., 2016).

2 Data and literature search

Literature searches were performed in ISI Web of Science and Scopus using the search terms "*Acarus siro*" and "*Suidasia pontifica*". In addition, literature searches were carried out using earlier scientific names of the mites "*Aleurobius farina*" and "*Suidasia medanensis*". The literature searches were performed on January 28, 2025. After removing duplicates, the searches resulted in a total of 448 records for "Acarus siro" or "Aleurobius farina". A total of 51 records were registered for "*Suidasia medanensis*" or "*Suidasia pontifica*". Screening and quality assessment of publications were performed in Rayyan (Rayyan | Home) independently by each member of the project group. Publications on research conducted under environmental conditions not relevant to Norway and publications that did not address the questions in the terms of references were excluded. For human health assessments, searches were performed in PubMed using the scientific names of the mites together with the terms "clinical presentation" and "human". Snowballing, i.e. checking articles that were referred to in papers found in the main literature searches, was also performed.

3 Assessments

3.1 Occurrence and distribution in Norway

Acarus siro occurs on farms and in homes throughout Norway and can also be found in the wild, e.g. in birds' nests (Mehl, 1998). However, it is unclear whether the species thrives outside post-harvest habitats such as stored cereals, cereal products, or other foodstuffs (CABI, 2019a). The uncertainty is due to potential misidentification of sampled individuals of the related species *A. farris* and *A. immobilis*, which are thought to occur more commonly in the wild than *A. siro* (Griffiths, 1964a, b; see also Boström et al., 1997).

Acarus siro is said to have a temperate origin but has currently a global distribution (CABI, 2019 a). In the Global Biodiversity Information Facility (GBIF) database there are no records of the species from Norway. However, according to the Natural History Museum in Oslo, the species is reported from throughout the country (NHM, 2009). Large numbers of *A. siro* were found associated with material from archaeological excavations of an archbishop's residence in Trondheim, Norway, dated to ca. 1500 A.D., and in several surveys where homes, barns, and storage facilities were sampled across the country (Mehl, 1998). *Acarus siro* also appears to be common and widespread in Sweden (Boström et al., 1997) and Finland (Terho et al., 1982) and has been reported from house dust samples in Denmark (Mehl 1998, and references therein).

Suidasia pontifica has a mainly tropical distribution (CABI, 2019b) and has never been recorded in the wild in Norway. There are no Norwegian records in GBIF, Norway's Species Map Service, or Mehl (1998).

3.2 Potential for establishment and spread

Acarus siro is already established in Norway, and introduced individuals are expected to be able to establish as well. The species is not very mobile but can probably be spread by farm workers, farm equipment, and larger animals such as birds.

Suidasia pontifica has a mainly tropical distribution and has never been recorded in the wild in Norway. Based on available knowledge about its original distribution, we find it very unlikely that it will be able to establish and spread in the wild due to climatic conditions in Norway.

3.3 Potential effects on biodiversity

Acarus siro can be a serious pest on stored cereals, cereal products and other foodstuffs, but we are not aware of any reports documenting negative effects of the species on biodiversity. It is unclear if and where the species might thrive in nature. If indeed *A. siro* occurs mainly in food storage facilities and only occasionally in natural habitats, effects on biodiversity would be negligible.

Suidasia pontifica has mainly been reported from human environments, having been collected from a wide variety of dry foodstuffs as well as being a common inhabitant of house dust (Ho, 1996; Mercado et al., 2001, Colloff 2009, Ernieenor et al., 2018; Fan et al., 2020). It has also been reported from bee nests (honeybees and large carpenter bees), where it most likely acts as a commensal, feeding on dead insects (Koeniger at al., 1983). This feeding habit makes it a

potential pest in museum collections (CABI, 2019b), but we are not aware of any reports documenting negative effects of this species on biodiversity.

3.4 Human health

The literature reviewed regarding transmission of infectious diseases by *A. siro* and *S. pontifica* revealed no reports. Thus, the risk of contracting infectious diseases from these mites seems negligible.

The prompt and important immune responses to mite exposure in humans are of type I, meaning the induction of immediate allergic reactions involving specific IgE-antibodies (immunoglobulin E antibodies) (Šošić et al., 2023). These antibodies bridge mite structures to various human effector cells that release substances that may confer prompt allergic manifestations. The released substances are directed against various antigens from mites including digestive enzymes and faecal material (Müsken et al., 2003).

There are numerous reports on clinical allergies to mites, including the species present in POWERfood 3.0 (Table 1 & 2). The studies have been performed mainly on patients that have been referred to allergy clinics due to rhinitis, rhinosinusitis, or other symptoms from the respiratory tract. Reports were based on clinical studies, including application of skin prick tests and various immunological tests (specific immunoglobulin E tests etc), and clinical examinations (spirometry etc).

Table 1. Reactions to *Acarus siro* by patients examined for possible allergic illnesses. N = number of cases, SPT = Skin Prick Test, Resp. outpat. = Outpatients with respiratory illnesses, Prev study = Prevalence study.

No. cases	Study group	Laboratory signs	Clinical setting	% positive	Comments/ Most common agent (%)	Country of origin	Reference
200	Resp. outpat.	SPT	Rhinitis, Rhinosinusitis, gen. allergy	24.2%	*L. destructor 69.9%*	Portugal	Marques et al., 2022
229	Resp. outpat.	SPT	As above	46.2%	*Dermatophagoides farinae 90.8%*	Venezuela	Sanches - Borges et al., 2014
136	Prev. study	SPT, Total IgE, Phadiatop test	Gen study of respiratory illness	13.2%	*L. destructor* 18.4%	Poland	Spiewak et al., 2001
133	Prev. study	SPT	As above	45%	*L. destructor, D. farinae,* and *A. siro*	Denmark	Korsgaard et al., 1985.
1 (case report)		SPT, Specific IgE, Bronchial provocation tests	Case of asthmatic disease	-	Also reactive to *L. destructor* and *Tyrophagus putrescentiae*	Norway	Kirkeleit et al., 2015

A Scandinavian study showed that mite allergy was prevalent in an asthmatic patient cohort (Korsgaard et al., 1985). Clinical reports on the interaction of *A. siro* in humans show that reactivity to *A. siro* is prevalent in Scandinavia (Kirkeleit et al., 2015, Korsgaard et al., 1985). Another study from Poland found clinical signs of mite allergy among students in an

agricultural college and concluded that allergic students should be discouraged from work in agriculture (Spiewak et al., 2001).

There are a few reports on clinical allergies to *S. pontifica* (Mariana, 2000; Miranda et al., 2019; Olsen, 1998). These reports are based on laboratory studies (skin prick tests) and case reports. These reports are mainly from tropical or subtropical areas, where exposure is more extensive than in a Scandinavian setting.

Table 2. Reports on reactions to *Suidasia pontifica* in individuals examined for possible allergic illnesses. SPT = Skin prick test.

No. cases	Study group	Laboratory signs	Clinical signs	Comments/ % positive	Other comments	Country	References
1 (case report)		SPT	Anaphylaxis	Strong reaction to *S. pontifica*	Also reactive to *Blattisocius keegani*	Panama	Miranda et al., 2019
Review		Various signs	Anaphylaxis	Reaction to *S. pontifica*	*D. farinae*, *Tyrophagus entomophagus*	USA	Olsen, 1998
85	Potentially allergic individuals	SPT		74.1%	Extract of *S. pontifica* which was present in 80% of the households	Malaysia	Mariana, 2000

In conclusion, it is likely to develop mite allergy when handling POWERfood 3.0 (operator risk). However, the likelihood of allergic reactions following consumption of food from plants treated with the product (consumer risk) appears to be low.

3.5 Taxonomy

3.5.1 Taxonomy of Acarus siro

- Phylum: Arthropoda
- Subphylus: Chelicerata
- Class: Arachnida
- Superorder: Acariformes
- Order: Sarcoptiformes
- Family: Acaridae
- Genus*: Acarus* Linnaeus
- Species: *Acarus siro* Linnaeus

Older scientific names (CABI 2019a):

- *Acarus siro* var. *farinae* Linnaeus
- *Aleurobius farinae* Koch
- *Tyroglyphus farinae* Latreille
- *Tyroglyphus siro* Lat.

Acarus siro is well established as the name for the flour mite. The synonyms cited above have not been used for at least half a century, other than being cited as older names.
In the first half of the 20th century, *A. siro* was considered to be a highly variable species consisting of three different forms with slightly different ecological niches, even though all three can be found together (Griffiths, 1962; 1964a & b; Boczek & Cross, 1983). In the cited works, Griffiths concluded that both morphological differences and attempts at hybridization supported there being three species: *A. siro* L., *A. farris* Oudemans and *A. immobilis* Griffiths. While *A. siro* was easy to separate by morphology from the other two, *A. farris* and *A. immobilis* are nearly identical (Webster et al., 2004). In laboratory crosses between *A. siro* and *A. farris,* males of both species mate freely with females, and eggs are occasionally produced by interspecific crosses. A few eggs from hybrid matings do develop into adults, and a few of these can be fertile (Griffiths, 1962, 1964; Chimielewski, 1975; Boczek & Cross, 1983). Subsequent molecular analyses clearly supported the findings of Griffith, that the siro clade consists of three similar species (Webster et al., 2004). Familiarity with mite taxonomy (morphological or molecular) would be necessary for correct species identifications (Griffiths, 1970, Webster, 2004). In a study of mites found in Swedish barn dust, Boström et al. (1997) cautiously used "*Acarus siro*-complex" when identifying flour mites.

3.5.2 Taxonomy of Suidasia pontifica

- Phylum: Arthropoda
- Subphylus: Chelicerata
- Class: Arachnida
- Superorder: Acariformes
- Order: Sarcoptiformes
- Family: Susidasiidae
- Genus: *Suidiasia* Oudemans
- Species: *Suidasia pontifica* Oudemans

Older scientific names:

- *Suidasia insectorum* Fox
- *Suidasia medanensis* Oudemans

Suidasia pontifica Oudemans, 1905 is the correct name for this species. Until recently, nearly all research on the species was under the junior synonym *S. medanensis* Oudemans, 1924 (see Fain and Philips, 1978 for synonymy). Though incorrect, *S. medanensis* seems to still be the commonly used name for the species (e.g. Mercado et al., 2001; Midthassel et al., 2014, Ernieenor et al., 2018, Podder et al., 2021; Bakr et al., 2022).

The challenges for *Suidasia pontifica* lie in researching the literature rather than in taxonomy. Both the correct name *S. pontifica* and the older name *S. medanensis* are used in the National Centre for Biotechnology Information (NCBI) database for genetic sequences and there are more genetic data for the former than the latter (Schoch et al., 2020). In GBIF, there are four times as many occurrences for *S. medanensis* as for *S. pontifica* (GBIF, 2023).

4 Uncertainties

Most research on *A. siro* and *S. pontifica* (and other dust mites) has been done from an agricultural or medical perspective. We have not found any reports discussing potential negative effects of *A. siro* or *S. pontifica* on biodiversity. This does not mean that there are no potential negative effects. The minute size of the two species renders them hard to detect. It is also difficult to distinguish at least *Acarus* from other closely related species. There are also uncertainties related to the limited information on the distribution of the species, both in Norway and globally, and which natural habitats the species prefer.

5 Conclusions (with answers to the terms of reference)

5.1 Occurrence and distribution in Norway

Acarus siro occurs naturally in Norway and can cause problems in food storage facilities. It is uncertain as to what extent it thrives in natural environments, but it has been reported from throughout the country.

Suidasia pontifica has a mainly tropical distribution and has never been recorded in the wild in Norway. There are no Norwegian records in GBIF or Norway's Species Map Service.

5.2 Potential for establishment and spread

Acarus siro is already established in Norway and it can be spread by adhering to farm equipment, plants, people or other animals, such as birds.

Suidasia pontifica can be found in house dust and food products but has a mainly tropical distribution, suggesting it will not be able to establish and spread in the wild under Norwegian climatic conditions.

5.3 Potential effect on biodiversity

We are not aware of any reports documenting negative effects of *A. siro* or *S. pontifica* on biodiversity.

5.4 Risk to human health

The likelihood of developing mite allergy following product handling (operator risk) seems to be high. However, the likelihood of allergic reactions following consumption of food from plants treated with the product appears to be low.

5.5 Uncertainty about taxonomy

Two similar species of *Acarus*, *A. farris* and *A. immobilis*, can easily be confused with *A. siro*. Taxonomic expertise is required for reliable species identification.

6 Data gaps

It is not clear if *A. siro,* a species that is widespread and abundant on farms and in houses, occurs in natural environments in Norway. There are no records of *S. pontifica* in the wild from Norway, nor from any other Nordic country. Nor is it known how common it is in stored foods, on farms and in house dust. The minute size of *A. siro* and *S. pontifica* makes them difficult to observe in the wild and their presence might therefore go undetected. There is also limited information on climate preferences and tolerances of these species. We are not aware of any studies assessing the potential effect of these species on biodiversity.

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