United States Department of Agriculture

The Importation of Fresh Fruit of *Physalis peruviana* L. From Peru Into the Continental United States, Hawaii, and Puerto Rico

A Qualitative, Pathway-Initiated Pest Risk Assessment

United States Department of Agriculture

Animal and Plant Health Inspection Service

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Executive Summary

The Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) prepared this risk assessment to examine plant pest risks associated with importing commercially produced fresh fruit of Cape Gooseberry, *Physalis peruviana* L. (Solanaceae), for consumption from Peru into the continental United States, Hawaii, and Puerto Rico.

Based on the scientific literature, port-of-entry pest interception data, and information from the government of Peru, we developed a list of all potential pests with actionable regulatory status for the continental United States, Hawaii, and Puerto Rico that are known to occur in Peru, and to be associated with the commodity plant species (anywhere in the world). Of these, we found one organism, *Ceratitis capitata* (Wiedemann), that has a reasonable likelihood of being associated with the commodity following harvesting from the field and prior to any post-harvest processing, and thus is potentially able to follow the pathway.

We analyzed the pest risk potential of *Ceratitis capitata* and determined that it meets the threshold for unacceptable consequences of introduction and has a non-negligible likelihood of introduction. We therefore consider it to be a candidate for risk management.

Taxonomy	**Scientific name**	**Likelihood of Introduction overall rating**
Diptera: Tephritidae	*Ceratitis capitata* (Wiedemann)	Medium

Detailed examination and choice of appropriate phytosanitary measures to mitigate pest risk are part of the pest risk management phase within APHIS and are not addressed in this document.

Table of Contents

1. Introduction

1.1. Background

This document was prepared by the Plant Epidemiology and Risk Analysis Laboratory of the Center for Plant Health Science and Technology, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, to evaluate the pest risk associated with the importation of commercially produced fresh fruit of Cape gooseberry, *Physalis peruviana* L., for consumption, from Peru into the continental United States, Hawaii, and Puerto Rico.

This is a qualitative risk assessment, meaning that the likelihood and consequences of pest introduction are expressed as qualitative ratings rather than in numerical terms. Methodology and rating criteria used are detailed in the Guidelines for Plant Pest Risk Assessment of Imported Fruit and Vegetable Commodities (PPQ, 2012). This methodology is consistent with guidelines provided by the International Plant Protection Convention (IPPC) in the International Standard for Phytosanitary Measures (ISPM) No. 11, Pest Risk Analysis for Quarantine Pests (IPPC, 2016a). The use of biological and phytosanitary terms is consistent with ISPM No. 5, Glossary of Phytosanitary Terms (IPPC, 2016b).

As defined in ISPM No. 11, this document comprises Stage 1 (Initiation) and Stage 2 (Risk Assessment) of risk analysis. Stage 3 (Risk Management) will be covered in a separate document.

1.2. Initiating event

The importation of fruits and vegetables for consumption into the United States is regulated under Title 7 of the Code of Federal Regulations, Part 319.56 (7 CFR §319.56). Currently, under this regulation, the entry of fresh fruit of *P. peruviana* from Peru into the United States is not authorized.

1.3. Determination of the necessity of a weed risk assessment for the commodity

A weed risk assessment is unnecessary for *P. peruviana* because it is cultivated in the pest risk analysis (PRA) area and fruits are already enterable into the PRA area from other countries.

1.4. Description of the pathway

The IPPC (2016b) defines a pathway as "any means that allows the entry or spread of a pest." In the context of commodity pest risk assessments, the pathway is the commodity to be imported, together with all the processes the commodity undergoes that may have an impact on pest risk. In this risk assessment, the specific pathway of concern is the importation of fresh fruit of *P. peruviana* into the continental United States. The movement of this commodity provides a potential pathway for the introduction and/or spread of plant pests following harvesting from the field to the consumer.

The following description of this pathway focuses on the conditions that may affect plant pest risk, including morphological and physiological characteristics of the commodity, as well as processes that the commodity will undergo from production in Peru through importation and distribution in the continental United States. These conditions provided the basis for creating the pest list and assessing the likelihood of introduction of the pests selected for further analysis.

Hence, the risk ratings in this risk assessment are contingent upon the application of all components of the pathway as described below

1.4.1. Description of the commodity

The commodity to be imported for consumption is fresh fruit of *P. peruviana* from Peru. The fruit is between 1.25 and 2.5 cm in diameter, and from 4 to 10 g in mass.

1.4.2. Production and harvest procedures in the exporting area

Cultivation of *P. peruviana* occurs in the mountain range of Peru (Ancash, Arequipa, Ayacucho, Cajamarca, Cusco, Huánuco, Huancavelica, Junín, Moquegua, and Tacna) and also on the coast. *Physalis peruviana* can be harvested throughout the year, however the harvest season in the mountains ranges from April to June, while the coast harvest season runs from October to November. The harvest begins when the fruit is yellow-orange in color, and the calyx shows a yellowish-green color. Harvesting is done every 15 days, then weekly. Fruit is harvested manually using scissors.

1.4.3. Post-harvest procedures in the exporting area

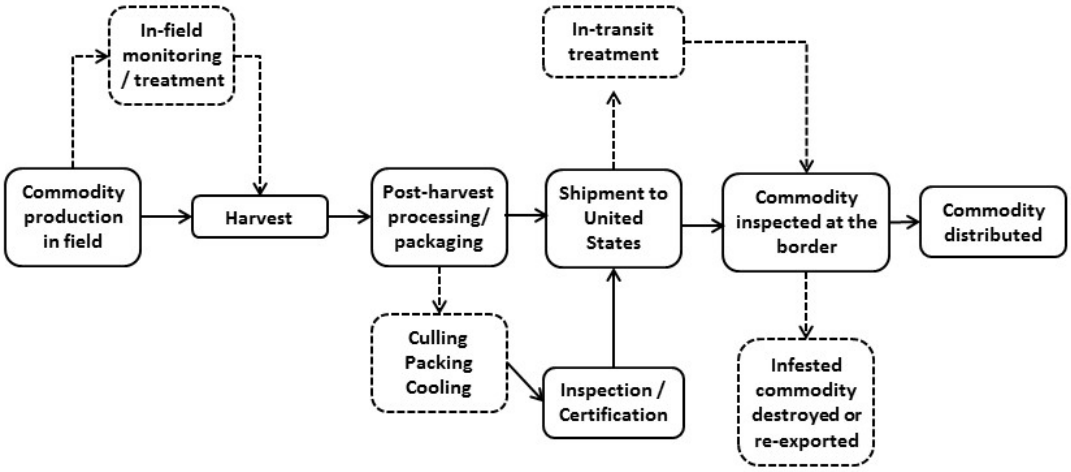
In the collection centers or packing plants, fruit are processed on clear and smooth surfaces, which allow for determination of quality. The fruit is examined externally, and then the calyx is carefully opened to check for the integrity of the fruit. Fruit without the calyx is disinfected in a 100 ppm sodium hypochlorite solution for two to six minutes, and then left to dry. Fruit with the calyx is dehydrated at environmental conditions, or using 28° C hot air, and forced ventilation.

1.4.4. Shipping and storage conditions

Packing is either in boxes of polyethylene terephthalate, or baskets covered with vinipel.

1.4.5. Summary of the pathway

Fig. 1 summarizes the pathway of concern: the importation of fresh *P. peruviana* fruit from Peru into the continental United States. Dashed lines in the diagram means that requirement of the particular step needs to be determined.



2. Pest List and Pest Categorization

The pest list is a compilation of all plant pests with actionable regulatory status for the continental United States that are present in Peru (on any host) and associated with *P. peruviana* (anywhere in the world). Species on the pest list with a reasonable likelihood of being present on *P. peruviana* fruit at the time of harvest could follow the pathway into the continental United States, and are therefore analyzed in more detail to determine their pest risk potential. Pests are considered to be of regulatory significance if they are actionable at U.S. ports-of-entry. Actionable pests include quarantine pests, regulated non-quarantine pests, pests under official control or considered for official control, and pests that require evaluation for regulatory action.

2.1. Pest list

In Table 1, we list the actionable pests associated with *P. peruviana* that occur in Peru. We developed this pest list based on the scientific literature, port-of-entry pest interception data, and information provided by the government of Peru. Based upon these sources, the only actionable organisms were insects or mites; no actionable plant pathogens were discovered. Pests in shaded rows are pests identified for further evaluation, as we consider them reasonably likely to be associated with the harvested commodity; we summarize these pests in a separate table (Table 2). Additionally, while we found evidence of the organisms listed in the Appendix being associated with *P. peruviana* and being present in Peru, these organisms have non-actionable regulatory status for the PRA area, so we did not include them in Table 1.

Table 1. Actionable pests associated with *Physalis peruviana* (in any country) and present in Peru (on any host).

Pest Name	Evidence of presence in Peru	Association with *P. peruviana*	Plant part(s) association	On harvested plant part?	Remarks
INSECTA					
COLEOPTERA					
Chrysomelidae					
Diabrotica speciosa (Germar)	CABI, 2017	Bado et al., 2005	Flower (Bado et al., 2005)	No	
DIPTERA					
Agromyzidae					
Liriomyza huidobrensis (Blanchard)	Weintraub et al., 2017	Bado et al., 2005	Leaf (Wei et al., 2000)	No	
Liriomyza quadrata Malloch	Spencer, 1973	Spencer, 1990	Leaf (Spencer, 1990)	No	
Tephritidae					
Ceratitis capitata (Wiedemann)	Davies et al., 1999	Liquido et al., 1991	Fruit (Liquido et al., 1991)	Yes	This fly is established in Hawaii (CABI, 2017)
LEPIDOPTERA					
Gelechiidae					
Tuta absoluta (Meyrick)	Tropea Garzia et al., 2012	Angulo, 2003	Bud, Leaf (Angulo, 2003)	No	
Noctuidae					
Copitarsia decolora (Guenée)	Angulo and Olivares, 2010	Martínez et al., 2010	Leaf, Flower, Fruit (Martínez et al., 2010)	No	See section 2.2.
Sphingidae					
Manduca sexta (L.)	CABI, 2017	Bado et al., 2005	Leaf (CABI, 2017)	No	See section 2.2.
ORTHOPTERA					
Acrididae					
Dichroplus maculipennis (Blanchard)	Angulo, 2007	Bado et al., 2005	Foliage, Stem (Angulo, 2003)	No	

2.2. Notes on pests identified in the pest list

Copitarsia decolora only affects new tissues such as foliar shoots, floral buds, and young fruits growing inside the husk (first stages) (Martínez et al., 2010). Young fruit are highly unlikely to be harvested, and affected fruits will be easily detectable and culled during standard harvest and post-harvest processing.

Manduca sexta is not present in Hawaii, it is present in the continental US (Poole and Gentili, 1996), and Puerto Rico (CABI, 2017).

2.3. Pests selected for further analysis

We identified one pest for further analysis (Table 2). This organism is an actionable pest for the United States, and Puerto Rico, and has a reasonable likelihood of being associated with the commodity plant part(s) at the time of harvest and remaining with the commodity, in viable form, throughout the harvesting process.

Table 2. Pests selected for further analysis.

Pest type	Taxonomy	Scientific name
Arthropod	Diptera: Tephritidae	*Ceratitis capitata* (Wiedemann)

3. Assessing Pest Risk Potential

3.1. Introduction

For each pest selected for further analysis, we estimate its overall pest risk potential. Risk is described by the likelihood of an adverse event, the magnitude of the consequences, and uncertainty. In this risk assessment, we first determine for each pest if there is an endangered area within the PRA area. The endangered area is defined as the portion of the import area where ecological factors favor the establishment of the pest and where the presence of the pest will result in economically important losses. Once an endangered area has been determined, the overall risk of each pest is then determined with two separate components: 1) the likelihood of its introduction into the endangered area on the imported commodity, *i.e*., the likelihood of an adverse event, and 2) the consequences of its introduction, *i.e*., the magnitude of the consequences. In general, we assess both of these components for each pest. If we determine that the risk of either component is negligible, assessing the other is not necessary, because the overall pest risk potential will be negligible regardless of the result of the second component. For example, if we determine that pest introduction is highly unlikely, we do not assess the consequences of it being introduced.

The likelihood and consequences of introduction are assessed using different approaches. For the consequences of introduction, we determine if the pest meets the threshold (Yes/No) of being likely to cause unacceptable losses. We base that determination on the physical damage the pest is likely to cause and/or the proportion of exports likely to be disrupted, rather than on an absolute value or amount of monetary loss.

The likelihood of introduction is based on the likelihoods of entry and establishment. We qualitatively assess risk using the ratings Negligible, Low, Medium, and High. The risk factors comprising the model for likelihood of introduction are interdependent and, therefore, the model is multiplicative rather than additive. Thus, if any one risk element is rated as Negligible, then the overall likelihood will be Negligible. For the overall likelihood of introduction risk rating, we define the different categories as follows:

High: Pest introduction is highly likely to occur.

Medium: Pest introduction is possible, but for that to happen, the exact combination of required events needs to occur.

Low: Pest introduction is unlikely to occur because one or more of the required events are unlikely to happen, or the full combination of required events is unlikely to align properly in time and space.

Negligible: Pest introduction is highly unlikely to occur given the exact combination of events required for successful introduction.

3.2. Assessment results

3.2.1. *Ceratitis capitata* (Wiedemann)

We determined the overall likelihood of introduction of *C. capitata* to be Medium. We present the results of this assessment in the table below. We determined that establishment of *C. capitata* in the United States, and Puerto Rico is likely to cause unacceptable impacts. We present the results of this assessment in the table below.

Determination of the portion of the United States and Puerto Rico endangered by *Ceratitis capitata.*

Climatic suitability	*Ceratitis capitata* is widely distributed in the Mediterranean region, South and Central America, west Asia, Australia, and Hawaii (CABI, 2017). A comparison of global Plant Hardiness Zones (USDA, 2012) indicates that potential establishment in the continental United States could occur in Plant Hardiness Zones 8-12.
Potential hosts at risk in PRA area	*Ceratitis capitata* is extremely polyphagous, using over 400 different wild and cultivated species across a wide variety of plant families. Some of those that are at risk in the PRA area include Anacardiaceae (*Mangifera indica*), Annonaceae (*Annona cherimola*), Cactaceae (*Opuntia* spp.), Caricaceae (*Carica papaya*), Ebenaceae (*Diospyros* spp.), Moraceae (*Ficus carica*), Myrtaceae (*Psidium guajava*), Oleaceae (*Olea europaea*), Rhamnaceae (*Zizphus* spp.), Rosaceae (*Cydonia oblonga*, *Malus* spp., *Prunus* spp. *Pyrus* spp., *Rubus* spp.), Rutaceae (*Citrus* spp.), Solanaceae (*Capsicum annuum*, *C. frutescens*, *Solanum lycopersicum, Solanum* spp.) and Vitaceae (*Vitis vinifera*) (USDA, 2016).
Economically important hosts at risk	Some of the economically important hosts are: *Annona cherimola*, *Capsicum* spp., *Carica papaya*, *Citrus* spp., *Cydonia oblonga*, *Diospyros* spp., *Ficus carica*, *Opuntia* spp., *Malus* spp., *Olea europaea*, *Psidium guajava*, *Prunus* spp. *Pyrus* spp., *Rubus* spp., *Solanum* spp., *Vitis vinifera*, *Zizphus* spp.
Pest potential on economically important hosts at risk	Commercial and dooryard production of any of the host plants would potentially be at risk.
Defined Endangered Area	The wide host range and current geographic distribution of *C. capitata* encompass USDA Plant Hardiness Zones 8-12.

Assessment of the likelihood of introduction of *Ceratitis capitata* into the United States and Puerto Rico via the importation of *Physalis peruviana* from Peru.

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	Low	C	*Ceratitis capitata* has infested *P. peruviana* in Hawaii. Liquido et al. (1991) reported that one of five collections (collected from 1949 to 1985) of *P. peruviana* fruits was infested and produced 10.99 *C. capitata* adults/kg of infested fruit. Nakagawa et al. (1968) reported the emergence of two adult *C. capitata* adults from a collection of 200 *P. peruviana* fruit. Other reports list *P. peruviana* as a host of "unknown importance" (Thomas et al., 2001), "rarely infested" (Holbrook, 1967), or "other" (CABI, 2017).
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	Low	MC	In general, fruit attacked by *C. capitata* usually shows signs of oviposition punctures (EPPO, 2007). In Peru, the selection process for the berries occurs on clear, smooth surfaces which allow for the detection of defects. Also, the calyx of each fruit is opened, and the berry is checked for integrity (SENASA, 2016). However, internal feeding insects can still escape detection.
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	High	MC	The eggs and larvae of the fruit flies are borne internally and would survive transport and storage conditions should infested fruit remain undetected.
Risk Element A: Overall risk rating for likelihood of entry	Low	N/A	
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	High	C	*Ceratitis capitata* has an expansive host range consisting of at least 167 commercial hosts (CABI, 2017). Suitable hosts such as apple, peach, and pear are present in the endangered area.

Risk Element B2: Likelihood of arriving in the endangered area	Medium	C	Although *P. peruviana* is not a preferred host for *C. capitata*, more than 25 percent of the U.S. population lives within the endangered area and thus there is the potential for infested fruit to be shipped to the endangered area.
Risk Element B: Combined likelihood of establishment	High	N/A	
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	Medium	N/A	

Assessment of the consequences of introduction of *Ceratitis capitata* into the United States and Puerto Rico.

Criteria	Meets criteria (Y/N)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Direct Impacts			
Risk Element C1: Damage potential in the endangered area	Yes	C	Larvae of *C. capitata* feed internally in infested fruit.
Risk Element C2: Spread potential	Yes	C	Studies have demonstrated low dispersal rates of *C. capitata*. Dispersal distances of sterile adults, of 500 m (Hafez et al., 1973) and 700 m (Wakid and Shoukry, 1976) were reported in Egypt. Using wild and irradiated, and non-irradiated laboratory-reared flies, in Hawaii, Wong *et al*. (1982) recovered adult flies 240 m from a release point. Plant and Cunningham (1991), using irradiated flies, reported that most of the dispersal occurred within the first three days after release, and that the average distance flown over the maximum life span of the cohort was <300 m, and virtually the entire population remained within the 1 km^2 test area.
Risk Element C: Pest introduction is likely to cause unacceptable direct impacts	Yes	N/A	
Trade Impacts			
Risk Element D1: Export markets at risk	N/A	N/A	
Risk Element D2: Likelihood of trading partners imposing additional phytosanitary requirements	N/A	N/A	
Risk Element D: Pest is likely to cause significant trade impacts	N/A	N/A	
Conclusion			
Is the pest likely to cause unacceptable consequences in the PRA area?	Yes	N/A	

[a]C=Certain, MC=Moderately Certain, MU=Moderately Uncertain, U=Uncertain

4. Summary and Conclusions of Risk Assessment

Of the organisms associated with fresh *P. peruviana* fruit worldwide and present in Peru, we identified one organism that is an actionable pest for United States and Puerto Rico, and has a reasonable likelihood of being associated with the commodity following harvesting from the field and prior to any post-harvest processing. We further evaluated this organism for its likelihood of introduction (i.e., entry plus establishment) and its potential consequences of introduction. We determined it to be a candidate for risk management, because it is likely to cause unacceptable consequences of introduction, and it received a likelihood of introduction risk rating above Negligible (Table 3). These results represent a baseline estimate of the risks associated with the import commodity pathway as described in section 1.4.

Detailed examination and choice of appropriate phytosanitary measures to mitigate pest risk are part of the pest risk management phase within APHIS and are not addressed in this document.

Table 3. Summary for pest selected for further evaluation and determined to be a candidate for risk management. This pest meet the threshold for unacceptable consequences of introduction.

Pest	**Likelihood of Introduction overall rating**	**Uncertainty statement (optional)[a]**
Ceratitis capitata	Medium	

[a]The uncertainty statement, if included, identifies the most important source(s) of uncertainty.

5. Acknowledgements

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7. Appendix. Pests with non-actionable regulatory status.

We found some evidence of the below listed organisms being associated with the commodity and being present in the export area. Because these organisms have non-actionable regulatory status for the PRA area, however, we did not list them in Table 1 of this risk assessment, and we did not evaluate the strength of the evidence for their association with the commodity or their presence in the export area. Because we did not evaluate the strength of the evidence, we consider the following pests to have only "potential" association with the commodity and presence in the export area.

Pest Name	Evidence
ACARI	
Tarsonemidae	
Polyphagotarsonemus latus Banks	Peru, US (continent, Puerto Rico) (CABI, 2017), Hawaii (Knowledge Master, 2017)
Tetranychidae	
Tetranychus desertorum Banks	Peru, US (continent, Hawaii, Puerto Rico) (Bolland et al. 1998)
Tetranychus evansi Baker & Pritchard	Peru, US (continent, Hawaii, Puerto Rico) (Migeon and Dorkeld, 2006-2017)
Tetranychus urticae Koch	Peru, US (continent, Hawaii, Puerto Rico) (Migeon and Dorkeld, 2006-2017)
INSECTA	
HEMIPTERA	
Aleyrodidae	
Trialeurodes vaporariorum (Westwood)	Peru, US (continent, Puerto Rico) (CABI, 2017), Hawaii (Knowledge Master, 2017)
Aphididae	
Aphis gossypii Glover	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)
Macrosiphum euphorbiae (Thomas)	Peru, US (continent, Puerto Rico) (CABI, 2017), Hawaii (Knowledge Master, 2017)
Myzus persicae Sulzer	Peru, US (continent, Puerto Rico) (CABI, 2017), Hawaii (Knowledge Master, 2017)
Diaspididae	
Aspidiotus destructor Signoret	Peru, US (continent, Hawaii, Puerto Rico) (García Morales et al., 2016)
Ortheziidae	
Insignorthezia insignis (Browne)	Peru, US (continent, Hawaii, Puerto Rico) (García Morales et al., 2016)
LEPIDOPTERA	
Gelechiidae	
Phthorimaea operculella (Zeller)	Peru, US (continent, Puerto Rico) (CABI, 2017), Hawaii (Knowledge Master, 2017)
THYSANOPTERA	
Thripidae	
Frankliniella occidentalis (Pergande)	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)

Pest Name	Evidence
Thrips tabaci Lindeman	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)
PLANT PATHOGENS	
BACTERIA	
Ralstonia solanecearum	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)
FUNGI	
Cercospora nicotianae (Ellis & Everh.)	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)
Chalara elegans (L.)	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)
Phytophthora infestans (Mont) de Bary	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)
VIRUS	
Potato spindle tuber viroid	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)
Potato virus Y	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)
Tomato mosaic virus	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)
Tomato spotted wilt virus	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)
NEMATODA	
Hoplolaimidae	
Rotylenchulus reniformis (Linford and Oliveira)	Peru, US (continent, Hawaii, Puerto Rico) (CABI, 2017)