

White Pepper Profile

Active Ingredient Eligible for Minimum Risk Pesticide Use

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Label Display Name: White pepper

U.S. EPA PC Code: Not found

Active Components: Piperine, piperidine, and various piperamides; α - and β - pinenes; D- and L-limonene; D-hydrocarveol

CA DPR Chem Code: 5012

Other Names: Piper nigrum seeds; Montok pepper, Muntok pepper, Muntok pepper

CAS Registry #: None (White Pepper)
 92-62-2 (Piperine)

Other Codes: SMILES: O=C(\C=C\C=C\c1ccc2O-COc2c1)N1CCCCC1

Summary: White pepper is the seed of the most consumed spice in the world, black pepper, and is not considered a health risk. Its pesticidal use is primarily as a vertebrate animal repellent with a non-toxic mode of action. Because pepper extracts also have insect repellent and insecticidal activity, white pepper is sometimes used for that purpose.

Pesticidal Uses: Vertebrate pest repellent; insect repellent; insecticide.

Formulations and Combinations: Putrescent whole egg solids, garlic, cloves, dried blood.

Basic Manufacturers: Agri Spices Indonesia, Haldin Pacific, Neka Boga Perisa (Indonesia); Vilacona; Fuchs GmbH; Cochin, Jyothi, Kerala Agro Industries.

Safety Overview: While a sensitive part of the population is allergic, white pepper is not considered a health risk. Because it is readily biodegradable and is not a carcinogen, mutagen, or reproductive toxicant, white pepper is assumed to have no environmental risk. There is some evidence that constituents of black pepper are carcinogenic or tumorigenic, but whether these constituents remain in white pepper—and if so, how much—is unknown.

This document profiles an active ingredient currently eligible for exemption from pesticide registration when used in a Minimum Risk Pesticide in accordance with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) section 25b. The profile was developed by the New York State Integrated Pest Management Program at Cornell University, for the New York State Department of Environmental Conservation. The authors are solely responsible for its content. [The Overview Document](#) contains more information on the scope of the profiles, the purpose of each section, and the methods used to prepare them. Mention of specific uses are for informational purposes only, and are not to be construed as recommendations. Brand name products are referred to for identification purposes only, and are not endorsements.

Background

White pepper is derived by removing the pericarp or fruit wall from black pepper (*Piper nigrum*) (Ravindran 2003), leaving it less aromatic and more delicate in taste than black pepper (Khan and Abourashed 2010). Pepper—both white and black—is the most commonly consumed spice in the world (Ravindran 2003). *Piper nigrum* is a tropical perennial that has been used as a spice for at least 3,000 years. Leading producers are Vietnam, India and Indonesia; combined, they account for two-thirds of the world's production. Other major producers include Brazil, Malaysia, Sri Lanka and China (IPC 2013). Most production in India is carried out in the southern state of Kerala, where pepper is produced as an intercrop by many small landholders. Indonesian production is centered on the island of Sarawak, dominated by larger scale monocrop plantations. Vietnamese production has expanded greatly in the past ten years, surpassing the two historically largest producers, India and Indonesia (IPC 2013).

In contrast to other production areas, Indonesia processes more white pepper than black pepper (Risfaheri and Nurdjannah 2000). White pepper production begins with ripe, black peppercorns in permeable sacks set to soak in water. Next they are dried in the sun until the moisture content is approximately 13-14%, at which point the seed's outer layer is removed by friction (Risfaheri and Nurdjannah 2000; Khan and Abourashed 2010). White pepper is approximately four times more expensive than black pepper (IPC 2013).

Black pepper and black pepper oil are not active ingredients eligible for exemption from pesticide registration and are outside the scope of this profile. Piperine is believed to be the most biologically active component of pepper (Vijayan and Thampuran 2000), but other pepper constituents appear to have pesticidal properties that may be synergistic with or derived from piperine. Because of its relative abundance in white pepper and the literature on its efficacy, piperine is sometimes used as a proxy where data on white pepper was not found. The isobutyl amides of piperine appear to have potent insecticidal properties (Su and Horvat 1981; Scott et al. 2004). Other constituents with pesticidal properties include eugenol, farnesol, limonene, and linalool. Eugenol is an active ingredient that is eligible for exemption from registration, but piperine and all the other extracts from pepper are not.

Indonesian ground white pepper has approximately the same piperine content as black pepper, approximately 3.0-3.5% (Risfaheri and Nurdjannah 2000). Distribution of piperine in a *P. nigrum* plant appears to depend on its maturity (Semler and Gross 1998). Black pepper is higher in volatile oils (Khan and Abourashed 2010), but total volatile oils depend more on the variety and maturity at harvest than the post-harvest processing (Buckle et al. 1985). The blackening of pepper from the immature green stage is attributed to various polyphenolic compounds that become enzymatically oxidized (Naranayan 2000). These compounds are presumably reduced or absent from white pepper. As a result, white pepper presumably has fewer polyphenols than black pepper. White pepper oil has higher levels of monoterpenes than black pepper oil or green pepper oil extracted from *P. nigrum* (Orav et al. 2004).

White pepper is harvested at peak maturity when oleoresin content falls and starch content increases. The proportions of the different terpenoids also change (Buckle et al. 1985). Storage under oxidative conditions can make a difference. In general, the essential oils of all forms of *P. nigrum* will decrease, presumably by volatilization and evaporation. Within the oils, terpene and sesquiterpene content decreases over time, and the amount of oxygenated terpenoids increases. (Orav et al. 2004).

Black pepper, black pepper oil, and piperine are not eligible for use as active ingredients in minimum-risk pesticides, but black pepper oil and piperine are registered with EPA as biopesticides (US EPA 2004a,

2004b; Reilly et al. 2005a). Even though these active ingredients are not eligible for use in minimum risk pesticides, white pepper shares many of their chemical and functional properties. Implications for relative toxicity and efficacy were not found in the literature. However, piperine is an active component of white pepper and is presented as a proxy when values were unavailable for white pepper.

Chemical and Physical Properties

The physical and chemical properties of white pepper appear in Table 1. Values are for white pepper unless otherwise specified.

Table 1
Physical and Chemical Properties of White Pepper and Piperine

Property	Characteristic/Value	Source
Molecular Formula:	Piperine: C ₁₇ H ₁₉ NO ₃	(Merck 2015)
Molecular Weight:	Piperine: 285.34	(Merck 2015)
Percent Composition:	Monoterpene hydrocarbons 55-59%, Sesquiterpene hydrocarbons 31-32%; Oxygenated compounds 8-11%; other constituents 2-4%.	(Buckle et al. 1985)
Physical state at 25°C/1 Atm.	Solid	(Ravindran 2003)
Color	Buff	(Ravindran 2003)
Odor	Distinct pepper odor	(Ravindran 2003)
Density/Specific Gravity	Not found	
Melting point	N/A (decomposes before melting)	
Boiling point	N/A (decomposes before boiling)	
Solubility	Piperine: Almost insoluble in water; soluble in alcohol, chloroform, ether, benzene, and acetic acid	(Merck 2015)
Vapor pressure	N/A	
pH	Not found	
Octonol/Water (K _{ow}) coefficient	Piperine: 2.30	(EPI 2012)
Viscosity	Not found	
Miscibility	Not found	
Flammability	Not found	
Storage stability	Not found	
Corrosion characteristics	Not found	
Air half life	Piperine: 0.708 hrs	(EPI 2012)
Soil half life	Piperine: 1,800 hrs	(EPI 2012)
Water half life	Piperine: 900 hrs	(EPI 2012)
Persistence	Piperine: 1,420 hrs	(EPI 2012)

Human Health Information

Relatively little information about the human health effects of white pepper was available. The US EPA waived toxicity data requirements for the related substances black pepper oil and piperine (Reilly et al. 2005a, 2005b).

Acute Toxicity

No data was found on the acute toxicity of white pepper. There is more data on black pepper oil and its active constituent, piperine, and these values are reported in Table 2.

Table 2
Acute Toxicity of Piperine

Study	Results	Source
Acute oral toxicity	Mice: 330 mg/kg	(Srinivasan 2007; HSDB 2015)
Acute dermal toxicity	Not found	
Acute inhalation	Not found	
Acute eye irritation	Not found	
Acute dermal irritation	Not found	
Skin sensitization	Not found	

Sub-chronic Toxicity

No data was found on the sub-chronic toxicity of white pepper.

Chronic Toxicity

White pepper is not identified as a carcinogen by the International Agency for Research on Cancer (IARC 2014). It is not on the California Proposition 65 list of known carcinogens (Cal-EPA 1997) and does not appear on the Toxics Release Inventory (TRI) Basis of OSHA Carcinogens (US EPA 2015). Compared with a control, the ethanolic extract of black pepper at a dose of 28 mg over a three month period was linked to an increase in malignant tumors in mice (Concon et al. 1979). Safrole and tannic acid are both constituents of black pepper and these weak carcinogens were implicated in further studies in mice (Wrba et al. 1992). Our literature search did not reveal how much of these constituents remain in the white pepper after processing, and whether white pepper is carcinogenic. There is evidence that black pepper derivatives, as well as piperine, inhibit malignant tumors (Srinivasan 2007) and prevent carcinogenesis in mice (Selvendiran et al. 2004).

Table 3
Chronic Toxicity of Piperine

Study	Results	Source
Chronic toxicity	Ames Test: Negative	(Karekar et al. 1996)
Carcinogenicity	Non-carcinogenic	(Wrba et al. 1992; Srinivasan 2007)
Combined chronic toxicity & carcinogenicity	Mice: Negative	(Karekar et al. 1996)

Human Health Incidents

Between April 1, 1996 and March 30, 2016, the National Pesticide Information Center (NPIC) received six reports of human health incidents involving white pepper as an active ingredient (NPIC 2016). All reported symptoms were dermal, ocular or respiratory irritation occurring upon exposure while applying the repellent, and involved vertebrate animal repellents with multiple active ingredients.

Environmental Effects Information

Effects on Non-target Organisms

No data was found regarding white pepper's effects on non-target organisms or its environmental fate. Black pepper has an LC₅₀ of 0.2% for beneficial ladybird beetles (*Hippodamia convergens*) (Scott et al. 2004). Between April 1, 1996 and March 30, 2016, NPIC received seven reports of animal incidents involving white pepper as an active ingredients (NPIC 2016). The US EPA waived data requirements for freshwater fish, freshwater invertebrate non-target insect, and avian dietary toxicity for the related substances black pepper oil and piperine (Reilly et al. 2005a, 2005b).

Environmental Fate, Ecological Exposure, and Environmental Expression

White pepper is a biodegradable natural plant product, and no data was found on its effects on non-target organisms or its environmental fate. The US EPA waived data requirements for environmental fate and groundwater data for the related substances black pepper oil and piperine (Reilly et al. 2005a, 2005b).

Environmental Incidents

Between April 1, 1996 and March 30, 2016, NPIC received 19 reports involving white pepper as an active ingredients; the reports were not human health or animal related (NPIC 2016). None were in New York State. Where detailed reports were available, all incidents involved formulated products with multiple active ingredients. No other environmental impact studies were found.

Efficacy

Vertebrate Repellent Activity

White pepper is seldom applied by itself. Twenty deer repellents were tested for efficacy against black-tailed deer (*Odocoileus hemionis*) foraging on western red cedar (*Thuja plicata*). Trees treated with Not-To-Night-Deer, a product containing 12% white (Montok) pepper and 88% dehydrated whole egg solids, had less damage than the control for 13 weeks, but this product was not amongst the most effective tested (Wagner and Nolte 2001).

Insecticidal Activity

White pepper is occasionally used as an insecticide, but no efficacy studies were found for that form of pepper by itself. One study implied that white pepper was either a synergist or toxicant to various root-feeding white grubs including Japanese beetles (*Popillia japonica*), oriental beetle (*Anomala orientalis*), northern masked chafer (*Cyclocephala borealis*), and European chafer (*Rhizotragus majalis*) (Ranger et al. 2009). In that study, Armorex (Soil Technologies), a 25(b) exempt formulation consisting of 0.5% white

pepper, 84.5% sesame oil, 2% clove, 2% garlic, and 1% rosemary oil, had the lowest LC₅₀ determination: 0.42 ml/L for the Japanese beetle, 0.39 ml/L for the oriental beetle and 0.49 ml/L for the northern masked chafer. Of the eight products formulated for all four species of grubs, Veggie Pharm (Pharm Solutions), a product consisting of 2.5% pure garlic oil, 12.5% coconut soap, 3% soybean oil and 0.1% peppermint oil, had the highest LC₅₀. This led the authors to conclude that synergy—possibly with white pepper—was an important factor in efficacy.

There is a considerable body of literature on the efficacy of black pepper and various extracts as insecticides. White pepper is extracted from black pepper and retains many of the insecticidal constituents found in whole black pepper. Black pepper, black pepper oil, and other substances extracted from them are not eligible to be used as a minimum risk pesticide active ingredient.

Fungicidal Activity

Although white pepper is used as an anti-microbial, a fungicide, and mostly as a food preservative, no efficacy studies were found for these categories.

Standards and Regulations

EPA Requirements

As a commonly consumed food, white pepper is exempt from the requirement of a tolerance [40 CFR 180.950(a)].

FDA Requirements

White pepper is Generally Recognized As Safe (GRAS) [21 CFR 182.10] as a spice and seasoning.

Other Regulatory Requirements

White pepper is non-synthetic and is allowed by the USDA's National Organic Program (NOP).

Literature Cited

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