FOOD SAFETY INFORMATION PAPERS
*Corn Refiners Association, Inc.*

# PESTICIDES

**QUESTION:**

*Pesticides are commonly used in the field and during storage to protect growing and harvested corn from pest damage. What procedures are followed to minimize the risk that food ingredients from the corn wet-milling industry will contain residual pesticides that might pose a significant health risk in food products?*

## Summary


- Modern pesticide management practices have enabled farmers to feed a growing world population, grow crops in otherwise unproductive locales and climates, extend growing seasons, maintain crop quality and prolong post-harvest storage.
- Pesticide use on field and post-harvest stored corn is regulated by the U.S. Environmental Protection Agency (EPA). Pesticide use requirements are enforced by EPA and state pesticide regulatory authorities. EPA establishes tolerances for pesticide residues in food. The U.S. Food & Drug Administration (FDA) monitors and enforces tolerances for pesticides in food.
- Field corn entering corn wet-milling plants may have been exposed to a variety of crop protection materials. The corn wet-milling process consists of a series of exhaustive washing, refining (ion exchange and carbon), filtration and evaporation unit processes. These processes are designed to be effective in reducing residual pesticides to non-detectible levels in finished products. As reported in USDA's 1998 Pesticide Data Program *Annual Summary*, no pesticide residues were detected in any of 298 high fructose corn syrup samples collected across the country.
- Corn Refiners Association, Inc. (CRA) member companies monitor corn wet-milling-based food ingredients for residual pesticides so that their products conform to regulatory requirements.


## 1. Pesticide Regulation

Agricultural crops are under attack each year from 80,000 plant diseases, 30,000 weed varieties, 1,000 nematode species and more than 10,000 types of insects. Unchecked, these combatants can destroy crops in a matter of hours or days. It is estimated worldwide that 45% of crop production is lost to these pests annually.

Chemical pest control has enabled farmers to dramatically increase crop yields, produce crops profitably in inhospitable locations, extend growing seasons, maintain crop quality and prolong post-harvest storage.

The term "pesticide" applies to a broad class of crop protection chemicals, encompassing:

- insecticides, used to control flying or crawling insects;
- rodenticides, used to control rodents;
- herbicides, used to control weeds and undesirable plants;
- fungicides, used to control fungi and plant diseases;
- nematicides, used to control nematodes (e.g., cutworms);
- antimicrobials, used to control microorganisms (e.g., bacteria, viruses, mold and fungi);
- plant growth regulators, used to accelerate or retard plant growth;
- insect growth regulators, used to affect insect growth rates; and
- biopesticides, naturally occurring compounds with pesticide properties.

Pesticides that are proven to have no unreasonable adverse effects for specific applications are granted a license or 'registration' by the U.S. Environmental Protection Agency (EPA), permitting their distribution, sale and use. EPA is required by law to re-register pesticides that were originally registered before November 1, 1984 to ensure they meet current standards. EPA's registration program places a high priority on registering pesticides that pose lower risks to human health or the environment than currently registered pesticides.

Before a pesticide can be registered for use on a food crop, EPA must set a 'tolerance' value. Tolerance is the maximum pesticide residue that may remain on the crop or in foods processed from the crop. Where a tolerance is in effect for a pesticide on a raw commodity, the carryover of a residue of the pesticide from the raw commodity to a processed food is permissible provided that the residue in the processed food does not exceed the raw product tolerance and has been removed to the extent possible in good manufacturing practice. In addition to setting tolerances for new pesticides, EPA is required to reassess pre-1996 pesticide tolerances to ensure they meet stringent new standards under the Food Quality Protection Act of 1996.

The U.S. Food and Drug Administration (FDA) monitors pesticide residues, and enforces pesticide tolerances, in all foods except meat, poultry and eggs. If illegal pesticide residue levels are discovered, FDA may enjoin or seize shipments, or pursue criminal penalties. FDA and state authorities work together to promote cooperative sampling and information exchange.

## 2. Field Use Pesticides

Major corn herbicides and insecticides approved for field use in leading corn-producing states and states with corn refining plants are listed in Table 1. Pesticides listed reflect those in most frequent use in Alabama, California, Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, New York, North Carolina, Ohio, Pennsylvania, South

**Table 1: Herbicides and insecticides approved for field use.**

| Herbicide | Tolerance (ppm) |
|---|---|
| 2,4-D | 2 for post-harvest |
| Alachlor | 0.2 for corn grain |
| Ametryn | 0.25 for corn grain |
| Atrazine | 0.25 for corn grain |
| Bentazon | 0.05 for corn grain |
| Bromoxynil | 0.1 for corn grain |
| Butylate | 0.1 for corn grain |
| Dicamba | 0.5 for corn grain |
| EPTC | 0.1 for grain crops |
| Glyphosate | 0.1 for grain crops |
| Metolachlor | 0.1 for corn grain |

**Table 1: Herbicides and insecticides approved for field use – continued.**

| Herbicide | Tolerance (ppm) |
|---|---|
| Paraquat | 0.05 for corn grain |
| Pendimethalin | 0.1 for corn grain |
| Propachlor | 0.1 for corn grain |
| Simazine | 0.25 for corn grain |
| Trifluralin | 0.05 for corn grain |
| Vernolate | 0.1 for corn grain |
| **Insecticide** | **Tolerance (ppm)** |
| Carbofuran | 0.2 for grain |
| Chlorpyrifos | 0.1 for corn; 3.0 for oil; 1.0 for soapstock |
| Fonofos | 0.1 for corn grain |
| Terbufos | 0.05 for corn grain |

Dakota, Tennessee, Texas and Wisconsin. Use and application vary from state-to-state, depending on indigenous pest types, crop varieties, growing conditions and agronomics.

Accompanying each pesticide is the tolerance limit set by EPA. Tolerance data were extracted from the *National Pesticide Information Retrieval System* (NPIRS), a database jointly administered by Purdue University and EPA. Data are revised periodically due to ongoing registration, re-registration and tolerance assessments; values should be checked against the NPIRS database for currency. All pesticide tolerances are issued as regulations by EPA and codified in the *Code of Federal Regulations*, Title 40, Parts 180 to 186.

Further information on each pesticide is available from EPA fact sheets and Material Safety Data Sheets (MSDS).

## 3. Storage Pesticides

The pesticides listed in Table 2 have been approved for post-harvest treatment of stored corn. They include a variety of insecticides and insect growth regulators. Pesticide class, target and EPA tolerances are provided for each pesticide.

Data resources found at the end of this report should be consulted for up-to-date information.

**Table 2: Pesticides approved for treatment of stored corn.**

| Pesticide | Class | Target | Tolerances |
|---|---|---|---|
| Actellic | Insecticide | Armyworms, banana borers, Japanese & seed corn beetles, carrot flies, caterpillars, chinch bugs, corn rootworms, onion flies, rust mites, scale, sod webworms, wireworms | 8 ppm for corn; 40 ppm for milled corn fractions (except flour); 88 ppm for corn oil |
| Chlorpyrifos | Insecticide | Ants, boll weevils, bollworms, chinch bugs, cockroaches, corn rootworms, cutworms, leafhoppers, mealy bugs, mosquitoes, peach tree borers, silverfish, spiders, thrips, ticks, webworms, white flies | 0.1 ppm for field corn; 3 ppm for corn oil; 1 ppm for corn soapstock |
| Methoprene | Insect growth regulator | | No tolerance for field corn; 10 ppm for cereal corn, corn meal, grits & hominy |
| Piperonyl butoxide | Insecticide | | 20 ppm for post-harvest corn; 10 ppm for milled corn fractions |
| Pyrethrin | Insecticide | Aphids, Mexican bean beetles, Colorado potato beetles, cabbage worms, flea beetles, flies, leafhoppers, loopers, lice, mealy bugs, mosquitoes, sod webworms, thrips | 3 ppm for post-harvest corn; 1 ppm for milled cereal grain fractions; 1 ppm for processed foods |

## 4. Pesticide Residues on Corn-Derived Food Ingredients

The U.S. Department of Agriculture (USDA) began the Pesticide Data Program (PDP) in 1991 to provide information on actual pesticide dietary exposure, food consumption and pesticide usage. PDP is now a critical component of the 1996 Food Quality Protection Act, which directs the Secretary of Agriculture to provide improved pesticide residue data collection, including guidelines for the use of comparable analytical and standardized reporting methods and increased sampling for foods most highly consumed by infants and children.

In 1998, PDP analyzed 298 high fructose corn syrup samples (HFCS-55) for the 109 pesticides listed in Table 3. Samples were collected at 17 plants representing over 95% of HFCS-55 production. Participating refineries were sampled once, twice or three times per month based on plant production capacity. One-quart size samples were drawn from plant storage containers and sent to the New York State Laboratory for analysis.

The corn wet-milling and refining process can consist of a series of exhaustive washing, refining (ion exchange and carbon), filtration and evaporation unit processes. These processes can be effective in reducing residual pesticides to non-detectible levels in finished products, as confirmed in USDA's 1998 Pesticide Data Program *Annual Summary*:

> "residues which may have been present in the raw agricultural commodity were either eliminated or reduced to non-detectable levels by the [corn wet-milling] process employed in manufacturing [high fructose] corn syrup."

*No* pesticide residues were detected in *any* of the 298 samples analyzed.

## 5. Pesticide Management by the Corn Wet-Milling Industry

As noted above, member companies of the Corn Refiners Association participated in the USDA Pesticide Data Program, providing HFCS-55 samples from production plants in different geographical locations. In addition, CRA member companies monitor pesticide residues in commercial products so that they do not exceed approved tolerance levels.

## 6. Pesticide Data Resources

- U.S. Environmental Protection Agency
- U.S. Department of Agriculture, National Agricultural Statistics Service
- U.S. Department of Agriculture, Pesticide Data Program (PDP)
- National Pesticide Information Retrieval System (NPIRS), jointly administered by Purdue University and the Environmental Protection Agency
- Resources for the Future, a non-governmental research organization
- Corn Refiners Association, Inc. member companies

**Table 3: Pesticides analyzed in HFCS-55 by the 1998 Pesticide Data Program.**

| Pesticide | *LOD (ppm) | Pesticide | *LOD (ppm) |
|---|---|---|---|
| 1-Napthol | 0.002 | Fenvalerate | 0.001-0.090 |
| 3-Hydroxycarbofuran | 0.001-0.009 | Fonofos | 0.001 |
| Acephate | 0.025 | Heptachlor | 0.001 |
| Acetochlor | 0.001-0.003 | Heptachlor epoxide | 0.001 |
| Alachlor | 0.002 | Hexachlorobenzene-HCB | 0.001 |
| Aldicarb | 0.007 | Imazalil | 0.004 |
| Aldicarb Sulfone | 0.009 | Iprodione | 0.005 |
| Aldicarb sulfoxide | 0.009 | Lambda cyhalothrin | 0.001 |
| Ametryn | 0.015 | Lindane | 0.010 |
| Atrazine | 0.002 | Linuron | 0.002 |
| Azinphos methyl | 0.040-0.133 | Malathion | 0.001 |
| BHC alpha | 0.001 | Metalaxyl | 0.001-0.20 |
| BHC beta | 0.001 | Methamidophos | 0.015 |
| Bifenthrin | 0.001-0.050 | Methidathion | 0.002 |
| Captan | 0.040-0.133 | Methomyl | 0.007 |
| Carbaryl | 0.006 | Methoxychlor | 0.002 |
| Carbofuran | 0.001-0.009 | Methoxychlor olefin | 0.001 |
| Carbophenothion | 0.048 | Metolachlor | 0.002 |
| Chlordane cis | 0.001 | Metribuzin | 0.003 |
| Chlordane trans | 0.001 | Mevinphos E | 0.002 |
| Chlorfenvinphos alpha | 0.001 | Myclobutanil | 0.005 |
| Chlorfenvinphos beta | 0.001 | Omethoate | 0.030 |
| Chlorpropham | 0.002 | Oxamyl | 0.009 |
| Chlorpyrifos | 0.001 | Oxychlordane | 0.003 |
| Chlorpyrifos methyl | 0.001 | Oxyfluorfen | 0.003 |
| Coumaphos | 0.003 | Parathion | 0.002 |
| Coumaphos oxygen analog | 0.013 | Parathion methyl | 0.008 |
| Cyanazine | 0.015 | Pendimethalin | 0.001 |
| Cyfluthrin | 0.008 | Pentachlorobenzene-PCB | 0.001 |
| DCPA | 0.002 | Permethrin cis | 0.001-0.003 |
| DDD | 0.001-0.005 | Permethrin trans | 0.001-0.003 |
| DDE | 0.001-0.002 | Phorate | 0.002 |
| DDT | 0.001 | Phorate sulfone | 0.002 |
| Demeton-S Sulfone | 0.002 | Phosalone | 0.004 |
| Diazinon | 0.002 | Phosmet | 0.002-0.007 |
| Dichlorvos-DDVP | 0.001 | Phosphamidon | 0.003 |
| Dicloran | 0.004 | Piperonyl butoxide | 0.001 |
| Dicofol | 0.001 | Pirimiphos methyl | 0.001 |
| Dieldrin | 0.002 | Profenofos | 0.008 |
| Dimethoate | 0.001-0.003 | Prometryn | 0.002 |
| Disulfoton | 0.010 | Propachlor | 0.004-0.013 |
| Disulfoton sulfone | 0.002 | Propargite | 0.008 |
| Diuron | 0.010 | Propiconazole | 0.008 |
| Endosulfan I | 0.001 | Quintozene-PCNB | 0.001-0.003 |
| Endosulfan II | 0.002 | Simazine | 0.004 |
| Endosulfan sulfate | 0.005 | Sulprofos | 0.002 |
| Esfenvalerate | 0.001 | Tecnazine | 0.002 |
| Ethalfluralin | 0.008 | Terbufos | 0.002 |
| Ethion | 0.001 | Terbufos sulfone | 0.002 |
| Ethoprop | 0.003 | Tetrachlorvinphos | 0.002 |
| Fenamiphos | 0.005 | Thiabendazole | 0.010 |
| Fenamiphos sulfoxide | 0.008 | Triadimenol | 0.015 |
| Fenamiphos sulfone | 0.008 | Trifluralin | 0.001 |
| Fenitrothion | 0.003 | Vinclozolin | 0.001 |
| Fenthion | 0.001 | *LOD = Limits of Detection | |