Natural Mosquito Repellents

From Anne Marie Helmenstine, Ph.D.,
Your Guide to Chemistry.

Strategies That Work

When I was pregnant, I wanted to avoid using toxic chemical insect repellents, yet the mosquitoes seemed to find me tastier than ever. My solution at that time was to wear what I called my 'DEET sheet', which was an old cotton sheet that had been sprayed with S.C. Johnson's Off! Deep Woods formula. While this was highly effective, it wasn't practical for use around kids, so I did research into safer, natural mosquito repellents. I learned that many so-called natural mosquito repellents don't repel mosquitoes (e.g., ultrasonic electronic devices), but some are backed by reputable research and really work.

Mosquitoes have complex methods of detecting hosts and different types of mosquitoes react to different stimuli. Most mosquitoes are active at dawn and dusk, but there are also mosquitoes that seek hosts during the day. You can avoid being bitten by making sure you aren't attracting mosquitoes, using attractants to lure mosquitoes elsewhere, using a repellent, and avoiding actions that diminish the effectiveness of the repellent.

Mosquito Attractants

Use this list of items and activities that attract mosquitoes as a list of things to avoid or that can be used as bait to lure mosquitoes away from you.

- Dark Clothing

  Many mosquitoes use vision to locate hosts from a distance. Dark clothes and foliage are initial attractants.

- Carbon Dioxide

  You give off more carbon dioxide when you are hot or have been exercising. A burning candle or other fire is another source of carbon dioxide.

- Lactic Acid

  You release more lactic acid when you have been exercising or after eating certain foods (e.g., salty foods, high-potassium foods).

- Floral or Fruity Fragrances

  In addition to perfumes, hair products, and scented sunscreens, watch for the subtle floral fragrance from fabric softeners and dryer sheets.

- Skin Temperature

  The exact temperature depends on the type of mosquito. Many mosquitoes are attracted to the slightly cooler temperatures of the extremities.

- Moisture

  Mosquitoes are attracted by perspiration because of the chemicals it contains and also because it increases the humidity around your body. Even small amounts of water (e.g., moist plants or mud puddles) will draw mosquitoes. Standing water also allows mosquitoes to reproduce.

Natural Repellents

These natural products will effectively repel mosquitoes, but they require more frequent reapplication (at least every 2

hours) and higher concentrations than DEET. Because of the differences between types of mosquitoes, products that contain multiple repellents tend to be more effective than those containing a single ingredient. As you can see, natural repellents tend to be volatile plant oils.

- Citronella Oil
- Castor Oil
- Rosemary Oil
- Lemongrass Oil
- Cedar Oil
- Peppermint Oil
- Clove Oil
- Geranium Oil
- Possibly Oils from Verbena, Pennyroyal, Lavender, Pine, Cajeput, Cinnamon, Basil, Thyme, Allspice, Soybean, and Garlic

Another plant-derived substance, pyrethrum, is an insecticide. Pyrethrum comes from the flowers of the daisy *Chrysanthemum cinerariifolium*.

Things that Lower Repellent Effectiveness

- Many Sunscreens
- Dilution from Rain, Perspiration, or Swimming
- Absorption into the Skin
- Evaporation from Wind or High Temperatures

Keep in mind that 'natural' does not automatically imply 'safe'. Many people are sensitive to plant oils. Some natural insect repellents are actually toxic. Therefore, although natural repellents provide an alternative to synthetic chemicals, please remember to follow the manufacturer's instructions when using these products.

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Ethanol, or grain alcohol, is an essential laboratory solvent as well as a popular fuel alternative and gasoline additive. Here are instructions for how to distill your own ethanol.

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This is an index of famous chemists and other scientists who made important contributions to the field of chemistry, arranged alphabetically according to the scientist's last name.

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Here's a list of inorganic and organometallic chemical compounds, arranged alphabetically.

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This is a twist on the classic baking soda volcano, where you use the ingredients to make squirt-able fountains of foam.

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- Atom Basics Quiz - Test Your Chemistry Knowledge
- Atom Hangman Game

What's Hot

- Rock and Mineral Chemistry Quiz
- Molecules Hangman Game
- How To White Smoke Demo
- Flame Retardant People
- What Is Red Mercury?

Do you have money to burn? Here's a neat trick for setting a bill on fire, without actually burning it. This demonstration illustrates the concept of combustion and also shows some properties of alcohol, water, and money.

03/13/06 - **Secret Formula or Equation?**
Here's a formula or equation submitted by a reader. He says he's been carrying it around in his wallet for twenty years and that at least one man's death was linked to the content. Does the equation still have significance today? You be the judge.

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Turn a clear liquid into a red liquid, then back to clear again. This demonstration is commonly called turning water into wine or blood, and can be used to demonstrate acid-base indicators.

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Make brightly colored pink and blue soap bubbles that won't stain clothing or surfaces.

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One way scientists have tried to lessen the severity of hurricanes is by seeding the clouds with silver iodide. This research program was Project Stormfury, which ran from 1962-1983. Learn whether cloud seeding worked and why the program was discontinued.

12/27/05 - **Famous Chemists Hangman Game**

How well do you know your history? This fun and educational hangman game draws on the names of scientists who made important contributions to the field of chemistry.

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Make liquid nitrogen ice cream as a cool cryogenics or phase change demonstration or for a quick and tasty treat.

12/19/05 - **Science Pictures**
This is an image gallery of science photographs and images. Most of the images relate to chemistry, though there are many which apply to science in general or are specific to biology, physics, or medicine.

12/19/05 - **Science Lab Safety Signs**
Science labs, particularly chemistry labs, have a lot of safety signs. This is a collection of public domain images you can use to learn what the different symbols mean or to construct signs for your own lab.

11/30/05 - **Christmas Tree Preservative Recipe**
Is there a secret special ingredient in those little packets of floral preservative? No! It's easy and economical to make your own Christmas tree or cut flower preservative, using ingredients found at home.

11/24/05 - **Element Mnemonic Device**
Here's a handy mnemonic device to help memorize the symbols and sequence of the first nine elements in the periodic table.

11/22/05 - **Blue Bottle Color Change Demonstration**
Learn how to perform the blue bottle chemistry demonstration, in which a blue liquid becomes clear, then returns to blue when swirled around. Instructions are also given for red -> clear -> red and green -> red -> green reactions.

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Are you wondering what cadmium and indium look like? Here's an alphabetical index of photographs of the elements.

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Work through an example chemistry problem on the rate of radioactive decay, a type of first order rate reaction.

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A chemistry scavenger hunt is an educational game where you find items that match a description. It's a great way to learn key concepts. Here's a list of chemistry scavenger hunt clues and items that match.

10/23/05 - **Mentos & Diet Soda Chemical Volcano**
Candies and diet soda together can make a chemical 'volcano' with an eruption several feet high. If the normal baking soda volcano is too tame for you, give this project a try.

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Use chemistry to make a bouncing polymer ball, then alter the procedure to see the effect the changes have on the charactertistics of the bouncing ball.

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ACS President Bill Carroll chats about his interest in chemistry, Chemistry Week 2005, and how chemistry impacts our daily lives in this exclusive interview with Stephanie Holbrook.

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Learn how to synthesize aspirin, acetylsalicylic acid, from salicyclic acid. Get information about the history of aspirin, the effects of salicylates, and see the structures of the reactants.

10/06/05 - **How to Write a Bibliography for a Science Fair Project**
Learn how to cite your sources for a science fair project. See examples for books, online references, and conversations.

10/04/05 - **Science Fair Project Help**
Science fair projects are a great way to learn about experimentation, the scientific method, and science concepts. However, it can be hard to find an idea or get answers to questions once you get started. Here is a collection of resources to give your project the winning edge.

09/27/05 - **Laboratory Safety Quiz**
Are you a safe scientist or a menace to yourself and others in the chemistry lab? Here's a ten question quiz you can take to test yourself. It's sarcastic and maybe even a little mean, but... some accidents just shouldn't happen.

09/14/05 - **History of Matches**
Fire may have been around since the dawn of civilization, but matches are a fairly recent invention. Learn about the somewhat gruesome history of the chemical or friction match and how antimony and phosphorus are used to start fire.

09/06/05 - **What Is Radioactivity?**
Learn about natural and induced radioactivity and alpha, beta, and gamma radiation.

08/31/05 - **What Is a Neutron Bomb?**
Learn what a neutron bomb is, how it works, and about a neutron bomb's strategic uses.

08/24/05 - **Crystal Growing Quiz**
Are you an ace at growing your own crystals? Test your knowledge about seed crystals, the factors that affect crystal growth, and crystal types with this fun multiple choice quiz.

08/16/05 - **Absinthe Chemistry**
The liqueur absinthe has been enjoying a resurgence in popularity, as countries continue to lift the ban on making

and drinking the green wormwood and anise-flavored spirit. Learn about the history of the liqueur, why it was banned, a bit about its chemistry, how to make absinthe, and how to drink it.

08/04/05 - **How to Perform a Recrystallization**
Recrystallization is a laboratory technique used to purify a sample based on the different solubilites of its components. Learn how to perform a recrystallization and get tips on how to avoid common problems and improve your product yield.

07/26/05 - **Why Does Ice Float?**
Learn about density and hydrogen bonding to understand why ice floats on water.

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Moonshine is a liquor made from fermented corn. Learn about distillation, condensation, and how this alcoholic beverage is made.

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Learn how blood tests and home pregnancy urine tests work, how early they can be used, and some reasons for false positive and negative test results.

06/28/05 - **Molecule Hangman Game**
This hangman game draws on names of molecules from the Molecular Structures Library. Possible chemicals include amino acids, nucleic acids, chemical warfare agents, pesticides, molecules found in food, and other names from the libary list.

06/14/05 - **Science Hangman Game**
Here's a hangman game, just for fun, using scientific terms, types of sciences, and names of scientists from all disciplines. It's a very broad category. Can you guess the word in time?

06/08/05 - **How to Make Liquid Magnets - Synthesize Ferrofluid**
Make your own ferrofluid, or liquid magnet, which can be used with a magnet to change the liquid's density and to form spikes and other amazing shapes.

06/02/05 - **Caffeine Chemistry**
Learn about the chemical and biological properties of caffeine, the methylxanthine stimulant found in coffee and other foods.

05/17/05 - **Groups of Elements - Periodic Table**
Elements can be categorized according to their similar properties. Here's a periodic table that organizes the elements according to groups. Click an element symbol and learn about the group to which it belongs.

05/11/05 - **What Is Activated Charcoal and How Does it Work?**
Activated charcoal isn't the same as your average barbeque briquette! It's a special type of carbon. Learn what activated charcoal is and why it is used in filters and medicines.

05/04/05 - **Atom Hangman Game**
All of the words in this hangman game relate to atoms or parts of atoms. It's a fun and easy way to test your grasp of some elementary chemistry terms and concepts.

04/26/05 - **Basics of Acids and Bases Quiz**
How well do you understand the basic concepts of acids, bases, and pH? Here's a ten question multiple choice and true/false quiz you can take to test yourself.

04/12/05 - **Carbon 14 Dating**
Here's a worked example of the calculation for carbon 14 dating of organic material. The same principle can be applied to other isotopic ratios used to estimate age.

03/29/05 - **Grow Table Salt or Sodium Chloride Crystals**
It's easy to grow your own table salt or sodium chloride crystals. All it takes is salt and boiling water. One method even yields crystals within a few hours. Another method can yield perfect cubic crystals.

03/22/05 - **Can a Candle Burn in Zero Gravity?**
Can a candle burn in the absence of gravity? Here's the answer to this frequently asked question about fire.

03/16/05 - **What Elements Are Named After People?**
Here's an alphabetical list of element eponyms, or chemical elements named after people.

03/08/05 - **If civilization ended today, could I still make beer?**
Not all frequently-asked chemistry questions involve equations and complex chemical reactions. When you get right down to it, chemistry plays a big role in everyday existence. For instance, consider the brewing of beer, stout, ale, and lager. If modern society ended, do you think you would have what it takes to make your own beer?

03/01/05 - **Chemistry Glossary Update**
The chemistry glossary has been updated with definitions for addition polymer, addition reaction, alcohol, aldehyde, alkaline, alkaline earth metal, alkyl group, allotrope, alloy, and alpha particle.

02/22/05 - **Scientific Method Quiz**
Do you really understand what the scientific method is and how to apply it? Here's a ten question multiple choice quiz you can take to test your knowledge.

02/08/05 - **What is the State of Matter of Fire or Flame?**
Is a flame a liquid, solid, or gas? Learn the answer to this question and get information about the chemistry of fire.

02/01/05 - **Effect of Acids and Bases on the Browning of Apples**
Perform an experiment to observe the effects of acids, bases, and water on the rate of browning of cut apples or other produce.

01/24/05 - **Why Do Cut Apples Turn Brown?**

Learn why apples, pears, bananas, potatoes, and other fruits and vegetables turn brown when they are cut or bruised.

01/10/05 - **How to Grow Epsom Salt Crystals**
Epsom salt (magnesium sulfate) crystals are safe to handle, easy to grow, and form quickly. Here's what you need to know to make your own crystals.

01/03/05 - **Rock & Mineral Chemistry Quiz**
Do you know about the chemistry of rocks and minerals? Here's a ten question quiz you can take to test your knowledge.

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Chemistry

How To Distill Ethanol or Grain Alcohol

From Anne Marie Helmenstine, Ph.D.,
Your Guide to Chemistry.

Ethanol is also called ethyl alcohol or grain alcohol. It's made from a fermented mixture of corn, yeast, sugar, and water. The resulting alcohol is 100 to 200 proof (200 proof is pure alcohol).

In addition to use in the lab, ethanol is a popular fuel alternative and gasoline additive. Because it is flammable, ethanol can be prohibitively expensive to ship, so it may make sense to distill your own. Anyone can have a still, but be advised you may need to get a permit in order to make ethanol.

Difficulty: Easy

Time Required: 3 - 10 days, sometimes longer

Here's How:

1. If you are starting with whole corn, you first need to convert the cornstarch into sugar by 'sprouting' the corn. Place the corn in a container, cover it with warm water, and drape a cloth over the container to prevent contamination and conserve heat. Ideally, the container will have a slowly draining hole at the bottom. Add warm water from time to time as the liquid level falls. Maintain the setup ~3 days or until the corn has sprouts about 2 inches long.
2. Allow the sprouted corn to dry. Then grind it into meal. Alternatively, start with cornmeal. Other grains can be prepared in much the same way (e.g. rye mash).
3. Mash or mush is made by adding boiling water to the corn meal. The mash is kept warm to start the fermentation process. Yeast is added, if available (half pound yeast per 50 gallons of mash, for example), and sugar (variable recipe). With yeast, fermentation takes about 3 days. Without yeast, fermentation could require more than 10 days. The mash is ready to 'run' once it stops bubbling. The mash has been converted into carbonic acid and alcohol. It is called 'wash' or 'beer' or 'sour mash'.
4. The wash is placed into a cooker, which has a lid that is pasted shut, so that it has a seal which can be blown off should internal pressure become too great. At the top of the cooker, there is a copper pipe, or 'arm' that projects to one side and tapers down from a 4-5 inch diameter to the same diameter as the 'worm' (1 to 1-1/4 inch). The 'worm' could be made by taking a 20 ft length of copper tubing, filling it with sand and stopping the ends, and then coiling it around a fence post.
5. The sand prevents the tubing from kinking while being coiled. Once the worm is formed, the sand is flushed out of the tube. The worm is placed in a barrel and sealed to the end of the arm. The barrel is kept full of cold, running water, to condense the alcohol. Water runs in the top of the barrel and out an opening at the bottom. A fire is maintained under the cooker to vaporize the alcohol in the wash.
6. The ethanol vaporizes at 173°F, which is the target temperature for the mixture. The spirit will rise to the top of the cooker, enter the arm, and will be cooled to the condensation point in the worm. The resulting liquid is collected at the end of the worm, traditionally into glass jars. This fluid will be translucent, and about the color of dark beer.
7. The very first liquid contains volatile oil contaminants in addition to alcohol. After that, liquid is collected. The containers of liquid collected from over the wash are called 'singlings'. Liquid collected toward the end of this run is called 'low wine'. Low wine can be collected and returned to the still to be cooked again. The initial collections are higher proof than those collected as the distillation progresses.
8. The singlings tend to have impurities and require double-distillation, so once the low wine has been run to the point where a tablespoon or so thrown on a flame won't burn (too low proof), the heat is removed from the still and the cooker is cleaned out. The liquid remaining in the still, the 'backings' or 'slop', can be recovered and poured over new grain (and sugar, water, and possibly malt) in a mash barrel for future distillations. Discard mash after no more than eight uses.
9. The singlings are poured into the cooker and the still is returned to operation. The initial collections can approach pure alcohol (200 proof), with the end collections, using the flash test on the flame, at about 10 proof.
10. The desired proof depends on the application. The highest proof usually obtained from a still is 190 proof. For using alcohol as a fuel alternative, for example, addition purification with a sieve may be required to obtain 200 proof ethanol.

Tips:

1. If you live in the United States, a permit may be required in order to legally distill ethanol.
2. Stills traditionally were operated close to a water source, like a stream or river, because the cool water was used to condense the alcohol in the tubing (called the 'worm')

3. Stills needed to have removable tops, so that they wouldn't explode when pressure built up from heating the mash.

What You Need:

- 25 lb corn meal or 25 lb shelled whole corn
- 100 lb sugar (sucrose)
- 100 gallons water
- 6 oz yeast

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Chemistry

Photosynthesis Basics - Study Guide

From Anne Marie Helmenstine, Ph.D.,
Your Guide to Chemistry.

How Plants Make Food - Key Concepts

- In plants, photosynthesis is used to convert light energy from sunlight into chemical energy (glucose). Carbon dioxide, water, and light are used to make glucose, oxygen, and water.
- Photosynthesis is not a single chemical reaction, but rather a set of chemical reactions. The overall reaction is: $6CO_2 + 12H_2O + \text{light} \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$
- The reactions of photosynthesis can be categorized as light-dependent reactions and dark reactions.
- Chlorophyll is a key molecule for photosynthesis, though other cartenoid pigments also participate. There are four (4) types of chlorophyll: a, b, c, and d. Although we normally think of plants as having chlorophyll and performing photosynthesis, many microorganisms use this molecule, including some prokaryotic cells. In plants, chlorophyll is found in a special structure, which is called a chloroplast.
- The reactions for photosynthesis take place in different areas of the chloroplast. The chloroplast has three membranes (inner, outer, thylakoid) and is divided into three compartments (stroma, thylakoid space, inter-membrane space). Dark reactions occur in the stroma. Light reactions occur the thylakoid membranes.
- There is more than one form of photosynthesis. In addition, other organisms convert energy into food using non-photosynthetic reactions (e.g. lithotroph and methanogen bacteria)

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Chemistry

How To Do a Vinegar & Baking Soda Foam Fight

From Anne Marie Helmenstine, Ph.D.,
Your Guide to Chemistry.

This is a twist on the classic baking soda volcano, where you use the ingredients to make squirt-able fountains of foam.

Difficulty: Easy

Time Required: Mere Minutes

Here's How:

1. First, you need bottles for everyone. The classic 2-liter bottle is nice because it's compressible and holds a large volume. Gatorade bottles are also good because they have wide mouths, so it's easier to recharge the bottle.
2. Fill each bottle most of the way full of warm water and add a squirt of dishwashing detergent.
3. Gather the rest of the materials you will need: lots of vinegar and baking soda and food coloring if you want colored bubbles. Be advised: adding food coloring could result in staining of clothing and other surfaces.
4. Add some baking soda to the bottle (couple of tablespoons or so). Put your hand over the bottle opening and shake it up to get the detergent water all sudsy. Drip a bit of food coloring onto the suds.
5. Note: if you add the food coloring before shaking the detergent water, then the dye will go into the water and the bubbles will be clear. If you add the coloring just prior to adding the vinegar then the bubbles will be deeply colored (which also increases the staining potential).
6. Pour in some vinegar. This starts the reaction. Feel free to give the bottle a little squeeze to help things along. Do NOT seal the bottle with a cap or lid. That basically makes a baking soda bomb, which is dangerous.
7. You can recharge the reaction with more baking soda and then more vinegar. If at any time you feel like shaking up the bottle only do this with your hand over the opening and never cap or seal the bottle.
8. The foam fight part most people figure out on their own. Have fun!

Tips:

1. Avoid getting the mixture into your eyes or mouth. If eye contact occurs, rinse the solution out. Don't drink the contents of the foam fight bottle.
2. Avoid contact with unreacted vinegar or undiluted dishwashing detergent. Both can irritate skin and mucous membranes.

What You Need:

- empty compressible plastic bottle - no lids
- water
- diswashing detergent
- baking soda
- vinegar
- food coloring (optional)

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