

Doubling the Shelf Life of Consumer Produce: Ethylene Remediation
Products for the Consumer Market:

Introducing the Healthy Harvest Freshness Extender

A unique partnership between Oakridge Products & Ethylene Control, Inc

www.gohealthyharvest.com

I. Introduction

Are you tired of throwing out wilted produce every week? Would you like to waste less food? American households throw out 25% of produce purchased - because it has gone bad, tossing out an average of \$600 of food per year per family, according to an eight year USDA funded study. The study reveals that restaurants, convenience stores and most families could help their bottom lines if they just learned to buy, store and use food more wisely.

Official surveys indicate that every year more than 350 billion pounds of edible food is available for human consumption in the United States. Of that total, nearly 100 billion pounds - including fresh vegetables, fruits, milk, and grain products - are lost to waste by retailers, restaurants, and consumers.

By contrast, the amount of food required to meet the needs of the hungry is only four billion pounds, according to advocacy groups.

Food waste is unfortunate not only in terms of the lost opportunity to feed hungry people, but also in terms of the negative effects on our environment and our wallets. The nation spends an estimated \$1 billion a year to dispose of excess food.

Of note, many households are now paying 10% - 30% over standard prices for organic products. Throwing away 25% of produce purchased at premium prices adds even more to the total amount of money households are spending on food they do not eat.

What can be done to help Americans consume the produce they purchase instead of wasting one quarter of it?

Is it possible to keep the produce purchased by households fresher, longer?

II. Mitigating Ethylene

The ripening of fruit and vegetables is caused by ethylene, a natural plant hormone. It initiates and accelerates the ripening of fruit and vegetables, and then causes them to deteriorate. By lowering the level of ethylene surrounding fruits and vegetables, their shelf life can be greatly increased, slowing the maturation of fruit, protecting vegetables, and greatly reducing spoilage (*See Table I - Ethylene sensitivity for more details regarding specific produce items.*)

When produce is shipped, trucked, and flown from farm to market, both the commercial and organic produce industries utilize devices to absorb the ethylene that fruits and vegetables emit as they ripen. The device essentially stops the

ripening process so that produce can be shipped to market looking freshly picked, and not wilted or fuzzy.

These ethylene absorbing or neutralizing devices (with an organic base of volcanic ash) have been utilized safely by both the organic and commercial produce industries for over 20 years.

A unique partnership between a commercial ethylene control products supplier and a niche consumer products company is bringing this solution to the retail consumer market - a simple, organic, non-toxic and recyclable device that doubles the life of the produce in your refrigerator bin. The Healthy Harvest Freshness Extender provides an inexpensive and readily available solution to consumers that keeps produce fresh, and that has been used safely and successfully by the commercial and organic produce industries for decades.

III. How Ethylene Absorption Works

Ethylene gas is a harmless, odorless, colorless gas that is produced from both natural and man-made sources. The ethylene molecule is very reactive and is readily oxidized into a state that will not do damage to produce.

There are several ways that may be used to remove ethylene from produce storage areas. One of the simplest and safest methods is to oxidize it with potassium permanganate. This reaction can remove ethylene to very low levels. Potassium permanganate (KMnO₄) is used in a number of familiar applications, such as in drinking water treatment systems.

The sources of potassium permanganate can vary, however, for the home market focus of the Healthy Harvest Freshness Extender, natural zeolite is used. Zeolite is a pure form of volcanic ash that has a very high surface area, providing an ideal substrate for the ethylene oxidation to occur.

Natural zeolite is often used as an odor absorber and a humidity stabilizer in refrigerators, closets, and automobiles. The very high surface area traps odor molecules and absorbs water when humidity is too high - releasing it back into the atmosphere when it gets too dry. Of course, the zeolite used in the Healthy Harvest Freshness Extender serves those purposes as well, but its primary function is to remove ethylene from the produce bin.

The reaction between the ethylene and potassium permanganate oxidizes the ethylene away and, of course, reduces the potassium permanganate away, too. *(For a detailed explanation of the chemical reaction, see Figure 1.)* The amount of potassium permanganate available will last at least 3 months in most home refrigerators. After 3 months the packet inside the Healthy Harvest Freshness Extender should be replaced with a refill packet.

The makers of the Healthy Harvest Freshness Extender recommend that consumers recycle the spent zeolite by sprinkling it onto plants and flowers in the household. Zeolite is a natural soil and the MnO₂ provides trace minerals to the soil, making it a very good fertilizer.

Additional Information on Storing Fruits and Vegetables

The Healthy Harvest Freshness Extender can double the life of household produce. However, ideal storage conditions also impacts this process, and can significantly impact taste.

Research produce by the Post Harvest Technology Research and Information Center at UC-Davis stresses that to maintain the freshness and flavor of produce purchased at the market or grown in the garden, it is important to know how to store it at home. Many fruits and vegetables should be stored only at room temperature because refrigerator temperature damages them, or prevents them from ripening to full flavor. Other produce can be ripened on the counter and then stored in the refrigerator. A few fruits and fruit-type vegetables gain sugar or soften when stored at room temperature.

For more information, please refer to *Table 2. Handling Information for Fruits & Vegetables*

IV. Independent Research Supports Ethylene Control's Claims

Oakridge Products, a developer of unique consumer products, is in an exclusive partnership with Ethylene Control to bring the technology used by the corporate produce industry to the consumer retail market through the Healthy Harvest Freshness Extender.

In an independent study in 1997 at the University of California Davis, research reported that the removal of ethylene gas is "critical to prevent concentrations that exceed the threshold for ethylene injury." In this study, several products that claim to eliminate ethylene gas were tested.

Ethylene Control is the commercial ethylene manufacturing company partnering with Oakridge Products to bring ethylene mitigation products to consumers. In the study, only Ethylene Control's products were found to remove ethylene gas. Whether in the laboratory or in actual application, Ethylene Control's ethylene mitigation products are overachievers. They not only succeed in their primary function of counteracting ethylene gas, but also in killing air-borne bacteria, viruses, sour rot, blue mold and brown rot fungi.

Ethylene mitigation is an essential link in the commercial “cold chain” that keeps food fresh as it moves (sometimes half way across the world) from farm to market. As markets expand across the nation and the globe, preserving freshness is one of the biggest challenges. While refrigeration and humidity slow decay, they don't halt the production of harmful ethylene gas.

Ethylene mitigation products are used during post-harvest handling of fruit, vegetables and floral commodities during storage and shipment by truck or sea container. Commercial uses include:

Distribution Centers

Restaurants

Specialty Packers

Floral Reach-ins Packer/Shippers

Institutions

Retail Walk-ins

Re-packers

Ethylene filtration and absorption systems are safe. Ethylene is oxidized by nascent oxygen, converting absorption pellets of volcanic ash into manganese dioxide, which is an organic fertilizer. Independent quality consultants have proven that the ingredients utilized in the Healthy Harvest Freshness Extender also kills molds and rot. Unlike other products on the market, there are no disposal problems with this product. Materials and ink used to make this product are approved by the FDA and packet ingredients are OMRI listed.

COMPETITORS

- ExtraLife (DL Green Products - \$3.99 for one)
 - Has been notified of patent infringement

- Evert Fresh (Delicious Organics - \$4.99 for 10)
 - Plastic bag product
 - Not true ethylene neutralizer
 - More costly and messy to use
 - Must place produce in bag

- EZ Fresh (Stacks & Stacks - \$10.99 for 3)
 - No ethylene absorption material
 - Only absorbs moisture and control
 - Not true competitor

Although other products market themselves as providing the same benefit, the only other true ethylene neutralizer has been notified of patent infringement. Other competitors absorb moisture and odor, and are not true ethylene neutralizers.

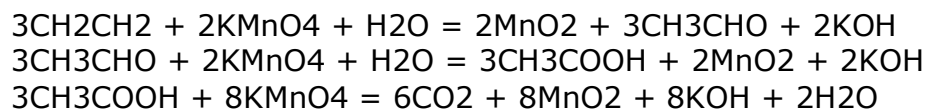
V. Conclusion

The Healthy Harvest Freshness Extender brings this technology to your home to reduce spoilage and extend the useful life of your produce. The products can simply be placed in the refrigerator produce drawer and the contents are protected from ethylene gas. On the countertop, produce should be placed in a container or plastic bag together with The Healthy Harvest Freshness Extender to absorb the ethylene gas released from fruits and vegetables. It's as simple as that. By changing the packet inside every three months, consumers have a year-round solution to doubling the life of the produce purchased from the store, reducing waste and saving money.

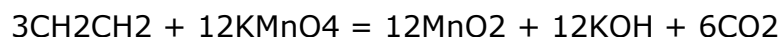
This product has repeatedly sold out on the QVC home shopping network, has been received with rave reviews at a recent food industry conferences. The Healthy Harvest Freshness Extender is now being brought to the broader retail market in the Intermountain West through both large chain (Associated Foods) and smaller, boutique grocery stores, and can also be purchased online at www.gohealthyharvest.com. Safe, non-toxic, organic and recyclable - this simple solution is a proven value.

Figure 1. Chemistry in Action

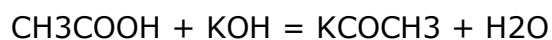
The chemical reaction is as follows:



Combining equations 1-3 generates:



Even if the reaction does not go all the way through to the carbon dioxide-producing step, many of the intermediate products formed either become irreversibly bound to the media or act as reactants themselves. Such is the case of the potassium hydroxide (KOH) formed in equation 1 and 2. The KOH will react with the acetic acid formed in equation 2 to produce the potassium acetate salt (KCOOCH₃) through a simple acid-base neutralization reaction. This is shown below.



Combining equations 1, 2, and 5 generates:



Table I. Ethylene Sensitivity - How Ethylene Gas Effects Your Produce

Fruits & Vegetables Types	Rate of Ethylene Production	Level of Ethylene Sensitivity	Principal reaction to Ethylene Gas
Apples	VH	H	Scald (*1)
Apricots	H	H	Decay
Asian Pears	H	H	Decay
Asparagus	VL	H	Toughness
Avocados	H	M	Decay
Bananas	M	H	Decay
Berries	L	H	Mold
Broccoli	VL	L	Yellowing
Brussel Sprouts	VL	H	Yellowing
Cantaloupe	H	H	Decay
Carrots	VL	M	Bitterness
Cherimoya	VH	L	Decay
Cherries	VL	H	Softening
Cucumbers	L	L	Yellowing
Eggplant	L	H	Brown Spots
Grapefruit	VL	M-H	Mold
Grapes	VL	M	Mold
Kiwifruit	L	L	Decay
Lemons, Limes	VL	H	Mold
Lettuce (*2)	VL	M	Russet spotting
Mangoes	M	H	Decay
Melons (*3)	M	H	Decay
Nectarines	H	H	Decay
Onions, Garlic	VL	H	Odor, sprouting
Oranges	VL	L	Mold (*4)
Papaya	H	M	Decay
Passion Fruit	VH	H	Decay
Peaches	H	H	Decay
Pears (*5)	H	H	Decay
Persimmons	L	H	Decay
Plums, Prunes	M	H	Decay
Potatoes (*6)	VL	H	Sprouting
Quinces	L	M	Decay
Tomatoes	M	H	Shrink, decay
Watermelons	L	H	Lose firmness

Floral & Nursery Commodities			
Carnations -Cut	VL	H	Sleepiness (*7)
Roses -Cut	VL	H	Prem. opening
Flower Bulbs	VL	H	Shrink (*8)
Nursery Stock	VL	H	Slower start
<p><i>VL = Very low, L = Low, M = Moderate, H = High, VH = Very High</i></p> <p>*1. Lose crunch *2. Leafy greens *3. Crenshaw, Honeydew, Persian *4. Rind breakdown *5. Anjou, Bartlett, Bosc *6. Processing, Seed *7. Leaf curl *8. Retards flower formation</p> <p>* Source: <i>Fresh Produce Manual</i> for 1997 from the Produce Marketing Association and the 1991 <i>Sea Land Shipping Guide for Perishables</i>. This is only a partial list. For more information on specific commodities and about the impact of ethylene under various storage and shipping conditions call us toll free in the U.S. (800) 200-1909 or (559) 896-1909.</p>			

Table 2. Handling Information for Fruits & Vegetables

Most fruit (including avocados and tomatoes) should be stored at room temperature until ripe. Exceptions to this are berries, grapes, fresh figs, melons, pineapple, coconut and tangerines. Apples can be refrigerated or stored in a cool dark place.

To speed ripening, place fruit in a loosely closed paper bag. Leave at room temperature, out of direct sunlight. The paper bag holds in ethylene, a gas

produced naturally by the fruit, which helps speed up the ripening process. Don't use a plastic container as it traps moisture and air which causes spoilage.

Once ripe, fruit can also be refrigerated, and with the Healthy Harvest Freshness, will remain fresh for days extra.

Vegetables

CROP	RELATIVE PERISHABILITY ¹	DESIRABLE HARVEST QUALITY	OPTIMUM STORAGE CONDITIONS		CHILLING SENSITIVE? ²	COMMENTS
			Temp (°F)	Humidity (%)		
Beans, Lima	M	Seeds developed and plump with tender green seed coats.	40-45	95	Yes	Sprinkle lightly.
Beans, pole & snap	H	Seeds immature; crisp pods free from blemishes	38-42	95+	Yes	Sprinkle lightly.
Beets	M	Roots firm, deep red, 1.5 to 3" diam.	32	98-100	No	Sprinkle lightly; remove tops.
Broccoli	VH	Green heads, flower buds developed but tight.	32	95+	No	Sprinkle lightly.
Brussels Sprouts	H	Firm sprouts, 1" diameter	32	95+	No	Sprinkle lightly.
Cabbage	M	Crisp, firm, compact heads.	32	95+	No	Sprinkle lightly.
Cantaloupes	M	Stem scar at maturity; skin yellowish tan; sweet, firm flesh with deep color.	38-41	95+	Yes	
Carrots	M	Tender, crisp, sweet roots, deep orange.	32	95+	No	Sprinkle lightly; remove tops; ethylene exposure may cause bitterness.
Cauliflower	VH	Heads with compact, white curds.	32	95+	No	Sprinkle lightly.

CROP	RELATIVE PERISHABILITY ¹	DESIRABLE HARVEST QUALITY	OPTIMUM STORAGE CONDITIONS		CHILLING SENSITIVE? ²	COMMENTS
			Temp (°F)	Humidity (%)		
Celery	VH	Stalks with crisp and tender petioles; no seed stalks.	32	95+	No	Sprinkle lightly.
Chard & Collards	H	Leaves fresh, green, young, and tender.	32	95+	No	Sprinkle lightly.
Corn, Sweet	VH	Kernels plump, sweet, milky, tender	32	95+	No	Sprinkle or top ice.
Cucumbers	H	Pickling: (1-4" long), crisp, green. Slicing: (6" long), crisp, green.	50-55	95+	Yes	
Eggplants	H	Shiny, deep purple skin; seeds immature.	50-55	95+	Yes	Sprinkle lightly
Endive & Escarole	VH	Leaves fresh, crisp, and tender, free from discoloration.	32	95+	No	Sprinkle lightly.
Honeydew Melons	M	Surface waxy, white to creamy white in color; blossom-end springy under moderate pressure; characteristic aroma.	45-50	95+	Yes	
Lettuce	VH	Heads compact and firm, fresh, crisp.	32	95+	No	Sprinkle lightly; ethylene exposure may cause russet spotting.

CROP	RELATIVE PERISHABILITY ¹	DESIRABLE HARVEST QUALITY	OPTIMUM STORAGE CONDITIONS		CHILLING SENSITIVE? ²	COMMENTS
			Temp (°F)	Humidity (%)		
Mustard & Turnip Greens	H	Leaves tender and crisp; plants without flower stalks.	32	95+	No	Sprinkle lightly.
Onions, Dry	L	Firm bulbs, tight necks, dry leaf scales.	32	65-70	No	
Onions, Green	VH	Crisp, green stalks with long white shanks.	32	95+	No	Sprinkle lightly.
Parsley	VH	Tender, crisp, green leaves.	32	95+	No	Sprinkle lightly.
Peas, English	VH	Seeds developed, but tender and sweet; pods still green.	32	95+	No	Sprinkle lightly.
Peas, Snow/Chinese	VH	Crisp, tender, green pods; seeds immature.	32	95+	No	Sprinkle lightly.
Peppers, Green	H	Crisp, firm, with shiny appearance.	50	95+	Yes	
Potatoes, Irish	M	Well-shaped tubers free from sunburn and other defects.	55-70	90	Yes	If washed, dry thoroughly.
Potatoes, Sweet	L	Firm, smooth-skinned roots free from growth cracks and other injuries	55	90	Yes	All open surfaces should be well healed.
Pumpkins	L	Hard rinds, good color; heavy.	50-60	60	Yes	

CROP	RELATIVE PERISHABILITY ¹	DESIRABLE HARVEST QUALITY	OPTIMUM STORAGE CONDITIONS		CHILLING SENSITIVE? ²	COMMENTS
			Temp (°F)	Humidity (%)		
Radishes	M	Firm, crisp roots; red should be bright red, sizes up to 1.25" in diameter.	32	95+	No	Remove tops; sprinkle lightly.
Rutabagas	L	Firm roots with smooth surface.	32	95+	No	Sprinkle lightly.
Spinach	VH	Tender leaves, dark green, fresh, crisp	32	95+	No	Sprinkle lightly.
Squash, Yellow and Zucchini	H	Firm, shiny fruits, 4 to 6" long.	50	95+	Yes	
Squash, Acorn	L	Fruits with hard, dark green skin with small, yellowish-orange areas.	50-60	60	Yes	Trim close, allow to heal.
Squash, Butternut	L	Fruits with hard, cream-colored skin.	50-60	60	Yes	Trim close, allow to heal.
Strawberries	VH	Berries firm, plump and red.	32	95+	No	
Tomatoes, Green	H	Solid fruit with light green color, mature seeds, and locular jelly.	70	95+	Yes	
Tomatoes, Ripe	VH	Solid fruits with uniform pink or red.	50-70	95+	Yes	Avoid storage below 50°F.
Turnips	M	Firm, heavy roots with good color.	32	95+	No	Remove tops; sprinkle lightly.

CROP	RELATIVE PERISHABILITY ¹	DESIRABLE HARVEST QUALITY	OPTIMUM STORAGE CONDITIONS		CHILLING SENSITIVE? ²	COMMENTS
			Temp (°F)	Humidity (%)		
Watermelons, Whole	L	Mature with good flesh color; flesh sweet and crisp.	>55	80-90	Yes	Trim stems close to fruit and allow to heal.
Watermelons, Sliced	H	Mature with good flesh color; flesh sweet and crisp.	32	95+	---	Overwrap slices for protection.

¹Relative perishability under good storage conditions: L = Low, M = Moderate, H = High, VH = Very High.

¹Chilling sensitive crops should not be stored below their optimum temperature.

Vegetable Handling Information Provided by the UC Davis Small Farm Center

www.gohealthyharvest.com