Potassium Bicarbonate

Crops

Identification

Chemical Names	Potassium bicarbonate	**CAS Numbers:**	298-14-6
Other Names:	Potassium acid carbonate; potassium hydrogen carbonate	**Other Codes:**	none

Characterization

Composition $KHCO_3$

Properties:
White granules, crystals or powder. Melting point 100°C; specific gravity 2.17. Appreciable solubility.

How Made:
Produced by carbonating potassium hydroxide to K_2CO_3 which is then carbonated to $KHCO_3$. Carbonation is accomplished by injecting carbon dioxide gas into an aqueous solution of potassium hydroxide. Potassium hydroxide is formed by the electrolysis of potassium chloride.

Specific Uses:
Disease control of powdery mildew (Sphaerotheca fuliginea) and early blight (Alternaria cucumerina) on cucurbits and tomatoes respectively. Also experimentally as disease control on grapes.

Action:
Bicarbonate ion has been identified as the probable cause of growth inhibition in some bacteria and fungi. The bicarbonate causes the collapse of hyphal walls and shrinkage of conidia (different parts of the fungus). In addition, pH elevation may also play a significant role.

Combinations:
Recommended to be used with a coating polymer to help provide uniform coverage of leaf surfaces. Oil and pinolene based coatings would be acceptable for organic growers and are much more effective than bicarbonate alone. Potassium bicarbonate is also sometimes mixed with sodium bicarbonate and inert ingredients in formulations.

Status

OFPA
The list of exemptions for synthetics on the National List in OFPA 6517(1)(B)(i) does not mention a material such as this, except to the extent that it could be considered a production aid.

Regulatory
The EPA has registered products for disease control just in the past few years. Registered for control of powdery mildew on grapes, cucumbers, strawberries, tobacco, and roses.

Status among Certifiers
none

Historic Use
none in organics because there were no registered products.

International
Not mentioned in IFOAM or CODEX.

OFPA 2119(m) Criteria

(1) The potential of such substances for detrimental chemical interactions with other materials used in organic farming systems.

The substance is stable and hazardous polymerization will not occur.

(2) The toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment.

Decomposition products are potassium carbonate, water, and carbon dioxide. These materials readily dissipate in the environment. In concentrations of greater that 1%, potassium bicarbonate can have phytotoxic effects on the plants in the form of beige necrotic spots on the leaves (Ziv, 1992). These can be alleviated by using a 1% or less concentration and by atomizing the spray so there are no big droplets.

(3) The probability of environmental contamination during manufacture, use, misuse or disposal of such substance.

There are some impurities created in the manufacture of potassium bicarbonate. The main ones are chlorine, sulfate and water, which are impurities primarily from the formation of potassium hydroxide from potassium chloride as the precursor material. The chlorine level is not exceeding 0.5% and the sulfate level is not exceeding 0.045%. Both of these impurities are common in nature and have biological processes which transform them into stable materials, although chlorine has well known concerns elaborated in the bleach TAP review from 1994.

(4) The effect of the substance on human health.

No carcinogenicity. No effects of overexposure were documented.
--Mild alkaline irritant to respiratory system. Coughing, sneezing, possible breathing difficulty in acute cases.
--Mild eye irritant, possible reddening due to alkaline effect or abrasion.
--No LD50 information found relating to normal routes of occupational exposure.

(5) The effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock.

Is known to inhibit the growth of bacteria and yeasts in agar media under certain conditions. There has been a little study of the bicarbonate ion (mostly from ammonium bicarbonate) on soil-borne pathogens. A suppression effect was found (Ziv, 1992). Its use may result in pH elevation, which will have a myriad of effects on the soil.

(6) The alternatives to using the substance in terms of practices or other available materials.
Potential alternative cultural, biological, natural, and existing organic controls also include:

1) Crop rotation.
2) Selection and cultivation of disease resistant varieties.
3) Nutrient management, particularly correcting Nitrogen:Calcium and Nitrogen:Potassium ratio balances.
4) Water management, including humidity control and air movement management for crops grown in greenhouses.
5) Planting density.
6) Trellising and pruning for improved air movement.
7) Sanitation: pruning and removal of diseased tissue.
8) Foliar application of non-synthetic materials:
    a) Compost tea extracts.
    b) Microbial fungicides and antagonists
9) Foliar application of synthetic materials recommended for inclusion on the National List
    a) Copper based materials.
    b) Sulfur.
    c) Suffocating oils.

These organic controls are not very effective and are not applicable in many cropping situations. The specific microbial fungicides are still in development and not yet approved for organic production. The diseases targeted by potassium carbonate are difficult to control organically. and the chemicals are now running into resistant strains of the disease organisms. Potassium carbonate may in many situations be more environmentally sound and safer for applicators and other farmworkers than the other synthetic alternatives.

(7) Its compatibility with a system of sustainable agriculture.
The NOSB has already recommended that this substance be allowed as an ingredient in food labeled as organic. See discussion below for compatability with sustainable agriculture.

Discussion

Condensed Reviewer Comments

None of the reviewers has a commercial or financial interest in potassium bicarbonate.

Reviewer 1
The diseases that this material can control are widespread and hard to manage with currently approved organic materials or even conventional chemicals. This material may be safer than already allowed materials such as sulfur to people and / or plants.

To evaluate this material, I believe it is important to look at the assumptions behind the organic law which allows natural materials and prohibits synthetic ones. One primary assumption is that natural materials are safer than synthetic ones AND their residue is safer for the consumer to ingest. Part of the assumption is that humans have coevolved with natural materials and our bodies have the ability to handle them without adverse effects. Another part of the assumption is the inability to handle synthetic or novel materials that can have an adverse effect on our bodies. . . .

It is far easier to define a material as being synthetic or natural than it is to determine its safety. Defining safety is expensive and ultimately based on the value system of the evaluators. . . . Banning safe alternatives to toxic chemicals used in conventional agriculture solely because they are synthetic is counter productive to the organic movement as a whole. The result will be less crops being produced in more limited regions and because of that, the overall impact on the environment and for the people will be negative in general. There will be less acreage under organic stewardship and more adverse effects from people growing crops . . . using conventional methods.

Potassium bicarbonate should be allowed for organic production under a category of synthetic - safe.

Reviewer 2
The compound, although synthetic, appears quite benign and should be compatible with organic production.

Potassium bicarbonate should be added to the National List of Allowed Synthetics. This material appears to be a least toxic, agronomically desirable material, with greater efficacy for controlling powdery mildew or late blight than does the currently available organic options. It is also available in different formulations which are grower and environmentally friendly.

Reviewer 3
The material is compatible with organic production when it is used for foliar disease control in non-fertilizer amounts. The only caution is that growers must not use it at fertilizer rates. However, if growers apply it foliarly in solution concentrations much above 0.5% potassium bicarbonate, they will cause phytotoxicity to their crop. Potassium bicarbonate should be allowed for foliar disease control when used at rates recommended for disease control. It should not be allowed at fertilizer rates.

Conclusion

The diseases which are controlled with potassium bicarbonate, powdery mildew and early blight, are very difficult to control with any acceptable organic practices or materials. In fact these diseases have influenced the ability to grow susceptible crops in certain environments at some seasons. While sodium bicarbonate, which is natural, does have some effect, it does not have enough of a control by itself to inspire product development on it.

The data available on this material points to it being safe and benign to the environment when used at recommended concentrations. It is, however, synthetic. It does not fit strictly within the itemized categories in OFPA pertaining to synthetics on the National List. Therefore the choice of whether it should be allowed in organic agriculture becomes a choice between the agronomic and precautionary approach vs. the regulatory one.

References

Corral, L.G.; Post, L.S. Montville, T.J. 1988. Antimicrobial activity of sodium bicarbonate. *J Food Sci Off Publ Inst Food Technol*., Chicago, IL: The Institute. May/June v. 53(3) p. 981-982.

Kirk-Othmer Encyclopedia of Chemical Technology, 3rd. edition, 1982. John Wiley & Sons.

Tisdale, S.L. , W.L. Nelson, and J.D. Beaton. *Soil Fertility and Fertilizers.* Eds.1985. Macmillan Pub. Co., NY.

Ziv, O. 1992. Effects of bicarbonates and film-forming polymers on cucurbit foliar diseases. *Plant Disease.*

Zitter, T.A. & Drennan, J.L. 1994. Comparison of Hydraulic and Electrostatic Sprayers for Fungicidal Control of Early and Late Blight in Tomato, 1993. *Fungicide and Nematocide Tests* Vol. 49:174.

Zitter, T.A. & Drennan, J.L. 1995. Early Blight Control in Susceptible and Resistant Tomato. *Fungicide and Nematocide Tests* Vol. 50:182.

Ziv, O. & Zitter, T.A. 1992. Effects of Bicarbonates and Film-Forming Polymers on Cucurbit Foliar Diseases. *Plant Disease* 76:513-517.