

NAVY BEST PRACTICE RECOMMENDATION FOR PRESERVING FRESH FRUITS AND VEGETABLES AT SEA

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To: U.S. Navy Food Service Personnel

Subj.: BEST PRACTICE RECOMMENDATION FOR
PRESERVATION OF FRESH FRUITS AND
VEGETABLES

BACKGROUND

The Navy has always been faced with the challenge of trying to extend the shelf life of fresh fruit and vegetables (FFV) aboard ships, in an effort to provide a high quality of life, and to meet the nutritional needs of our sailors. Spoilage of FFV is a universal problem in all food service operations, caused by release of ethylene gas, which is a natural by-product of the ripening process of fruits and vegetables. Ethylene gas is a "growth regulator" that leads to rapid deterioration and reduced shelf life of FFV, as the gas accumulates in the refrigerated shipboard storage spaces.¹ Navy Supply System (NAVSUP) policy supports and encourages the use of ethylene filters on all US Navy ships. NAVSUP P-486 Chap 5, ¶5701, in describing best practices for the management air circulation in the storage environment of FFV, states that "The use of Ethylene Absorber Blankets and/or Ethylene filters are strongly encouraged to also reduce ethylene gas levels and prolong the storage life of perishable foods."

Surprisingly, no additional guidance appears to be available to assist Navy Supply personnel in responding to this recommendation. Navy Supply Corps School curriculum does not currently address the issue of FFV spoilage caused by high concentrations of ethylene gas in reefers and dry storage spaces, nor do Navy "A" and "C" school instructional materials address this concern in any significant way. Consequently, year after year, the Navy as a whole records substantial amounts of losses of FFV through spoilage, principally caused by high concentrations of ethylene gas.

¹ The U.S. Department of Agriculture Tropical Products Transport Handbook (No. 668) provides guidance on both those products which are ethylene producers and those which are ethylene sensitive. In general, fruits are ethylene producers, and vegetables are ethylene sensitive. Given the space constraints on most, if not all, Navy vessels, the open storage of these products in close proximity to one another cannot be avoided. The USGA confirms in this reference that one of the recognized methods of abatement of ethylene gas is the use of filtering devices containing potassium permanganate.

In studies conducted by food experts, it has been found that higher than normal levels of ethylene are found at sea, either from chemical reactions related to salt water, or because of the stack gas emissions of ships. For this reason, FFV in the maritime environment is particularly at risk to rapid spoilage. There appears to be unanimous agreement among U.S. Navy food service personnel that rapid spoilage of FFV is common on Navy ships, with estimated loss rates of between 15 and 30 percent. This dynamic appears to have come to be an accepted norm in the shipboard environment.

Tests conducted by the USDA and the produce industry have shown that installing ethylene gas absorption devices (filters or small sachets), in food storage spaces, can significantly increase the shelf life of FFV. When placed in refrigerated shipping containers, cold storage rooms, or smaller shipboard refrigerators in the galleys, these devices reduce produce spoilage and aging by absorbing the ethylene gas.

In a recent related study conducted on behalf of Defense Logistics Agency (DLA) and NAVSUP at the Army Research and Development Center, Natick, MA, the Systems Equipment and Engineering team, (DoD Combat Feeding Directorate) found that FFV spoilage costs² could be significantly reduced by implementing changes in the packaging of FFV being shipped to Navy commands, simply by reducing the respiration rate of the produce during shipment.³ However, once aboard ship, and removed from the protective packaging, FFV will quickly begin to deteriorate, unless ethylene removal measures are implemented.

The recent Natick research is only the latest scientific confirmation of the value of using proven ethylene removal methods to extend the life of FFV. An earlier Natick study, conducted on behalf of both the Navy and the Army, conclusively showed that produce deterioration at sea could be dramatically reduced by the use of permanganate filters, and in fact, these filters were the most effective means of reducing ethylene gas – superior to other methods - including catalytic oxidizers and even periodic ventilation of the produce storage spaces.⁴

² The Modified Atmosphere Packaging (MAPS) for Fresh Fruit and Vegetables research team concluded that Navy's losses to spoilage across the Fleet in 2005 were \$3.2 million, or about 12.2% of the total FFV procured. Anecdotal evidence from a wide variety of Fleet sources suggests that FFV loss rates could be much higher, as much as 30% of total procurement. The annual DOD budget for Service Members' daily rations is estimated to be in the range of approximately \$2 billion. Of this, as much as \$200 million is attributable to FFV purchases. Using these estimates, annual FFV losses across DOD due to spoilage could be as much as \$20 million to \$60 million. The Navy's portion of these losses could be significant.

³ The MAPS initiative is part of the Technology Insertion Program for Savings (TIPS), which includes participation by NAVSUP, DLA, DOD, and DON. A complete copy of the MAPS report is available from the Natick Center.

⁴ The Natick study's conclusion is simple and direct - "It is clear from these studies that ethylene absorber filters containing zeolite coated with potassium permanganate should be used in all fruit and

NAVY SHIPBOARD STUDIES

In September 2000, NAVSUP conducted a study of Extend-a-Life™ ethylene gas absorption filters aboard USS Theodore Roosevelt (CVN-71). The purpose of the study was to conduct a controlled test measuring the effectiveness of the filters in extending the shelf life of FFV. Two refrigerators were used during the test; one had no filters and the other had filters installed in front of the air intakes of the refrigeration system. Ten pounds each of lettuce, tomatoes, celery, cucumbers, and oranges were placed in each refrigerator. The test was conducted over a 30-day period, with the Leading Mess Management Specialist, CSSC Duane Wright, regularly monitoring the test product for deterioration and spoilage. The results of the test showed a 9% improvement in shelf life for oranges, 10% for cucumbers, 88% for lettuce and celery, and 245% for tomatoes. Additional findings of the test were that the filters were preferable to ethylene blankets, which, in addition to being bulky and inconvenient to use, had to be returned for disposal, while the expended ethylene filters are non-toxic, and contain only trace elements of potassium.⁵ Recent tests on various ship classes throughout the Fleet confirm the results of the earlier studies.

For the past several years, a number of Navy commands have been utilizing Extend-A-Life™ ethylene absorption filters, which are available through the Navy Supply System, to mitigate the effects of the gas and to significantly extend the useful life of FFV.⁶ The filters are compact (18"L x 5 ¾"W x 11/16" thick) and simple to install; by hanging one or more filters in the overhead of the space, depending upon size, roughly one filter required for every 500 cubic feet of storage space. In refrigerated spaces, the filters should be mounted in close proximity to the refrigeration system air intakes, which greatly improves their effectiveness. Filters last approximately one month before they should be replaced. All of the component parts of the spent filters are non-toxic and bio-degradable, and may be easily disposed of at sea.⁷

vegetable storage areas in order to ensure maximum shelf life at an affordable cost. Many ships and commands in the Navy are successfully using the filters." Use of Ethylene Absorbers in Extending Shelf Life. Food Engineering Directorate, U.S. Army Natick Research Development and Engineering Center, Natick, MA, October, 1988.

⁵ Highly unpopular because of their bulkiness, ethylene blankets are no longer available in the Navy Supply System, due to a determination that the stocking and use of these materials is too much trouble. See footnote 7 for recommended disposal procedures for Extend-A-Life™ filters.

⁶ Extend-A-Life™ filters have been used successfully aboard the following classes of US Navy and MSC ships: AS, CVN, CG, DDG, FFG, LHA, LHD, LSD, MCM, SSB, SSN, T-AFS, T-AKE, as well as ashore at NAS Ft. Worth, TX. Extend-A-Life™ filters are in use in a number of large commercial produce warehouse operations, including Giant Foods Corporation.

⁷ The Material Safety Data Sheet for Extend-A-Life™ Filters indicates that they initially contain an active ingredient of 6-8% Potassium Permanganate (KMnO4) covering zeolite stones. After combining with ethylene gas (C2H3), the active ingredient is expended while creating CO2 and water, leaving

In addition to the Extend-A-Life™ filters, a second ethylene-abatement device is available through the Navy Supply System – a smaller version of the supply storeroom filter called “Produce Saver™” packets. These sachets contain the same chemical compound as the filters, but are designed for use in the storage boxes of fruit stored outside of the reefers (principally bananas) as well as in the many small refrigerators aboard ship that are used to store food in small quantities – Wardroom, CPO Mess, etc. Placed on the shelves or in the reefer’s fruit and vegetable drawer, Produce Saver™ packets achieve the same results – a significant lengthening of the usable life of FFV. These small packets utilize waterproof but air-permeable packaging, which allows the sachets to be placed directly in with the produce. As with the larger filters, after about a one-month period, the sachets become inert and should be discarded.

RECOMMENDATION

A significant opportunity now exists for the Navy to capitalize on technology currently available, to significantly reduce waste and to raise the quality of food service in the Fleet through the use of ethylene removal measures. The potential combination of the Modified Atmosphere Packaging (MAP) initiative, along with an aggressive program of utilizing ethylene removal tools available through the Navy Supply System, can greatly enhance the quality and usable volume of FFV in the Fleet, boosting morale, improving the nutrition of our sailors, and saving substantial budget dollars.⁸ Additional information on the contents of this Best Practice Recommendation can be obtained from AgraCo Technologies (www.AgraCo.com), or by contacting David M. Webster, CEO, AgraCo Technologies International, LLC, at 800-337-4469/610-239-7001.

AgraCo personnel are currently conducting no-cost assist visits throughout the Fleet, providing on-site instruction to culinary service personnel in the science of FFV storage and preservation. If your command would like to take advantage of this service, contact AgraCo personnel at the numbers listed above.

behind only trace elements of Potassium. The remainder of the filter housing is composed of light filter paper and metal mesh.

⁸ The last word in this recommendation is economy. All of the studies conclude that FFV spoilage can be substantially reduced by the use of ethylene filters, such that the cost of the filters will be paid for many times over by the direct savings resulting in reduction of spoiled produce. Over time, this reduction of waste will cause a substantial reduction in the demand for FFV across the Fleet, reducing all of the indirect costs associated with loading of stores, working parties, etc. Recoupment of this time can only raise the combat efficiency and quality of life of US Navy Sailors.