

ANTIOXIDANT USE IN APPLE AND PEAR STORAGE

PART 3 – STORAGE SCALD AND 1-METHLYCYCLOPROPENE (1-MCP)

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This article is the last part of the international survey which compiled the answers regarding the use of 1-MCP on apples and pears. See [Part 1](#) and [Part 2](#) for more information.

STORAGE SCALD AND 1-METHLYCYCLOPROPENE (1-MCP)

A *Canadian* researcher believes that pears treated with 1-MCP are hard to ripen, have reduced quality and sometimes scald control is not completely effective.

Researchers in *Chile* determined that 1-MCP treated fruit develop less scald as long as the recommendations with respect to fruit maturity are followed. It is used on 'Granny Smith', 'Red Delicious', 'Pink Lady' and in 'Fuji'. The exporters are exploring new alternatives but for the moment, 1-MCP is the only available tool. In many cases 1-MCP has replaced diphenylamine (DPA) because there are common processing lines for apples and other fruits such as plums; thus, using 1-MCP avoids cross-contamination in the line or with materials such as bins. Because pears treated with 1-MCP have ripening problems, researchers are evaluating the simultaneous application of 1-MCP and ethylene, and other conditioning strategies. They have obtained very good results with 1-MCP on 'Abate Fetel' pears due to the unique characteristics of this cultivar. It is harvested more mature than other cultivars and is firmer when consumed.

Researchers in *Germany* consider 1-MCP a good alternative to current chemicals and that it could easily replace them. 1-MCP is registered in Europe and there is no need to mention on the label that fruits have been treated with 1-MCP. In Germany the only postharvest product registered is 1-MCP; all other post-harvest treatments are not allowed even treatment of water with chlorine. There is resistance to use 1-MCP because of its cost. But even considering the cost, its use is increasing every year in southern Germany. However, there is a feeling (not quantified) that 1-MCP could produce an apple that is too firm, especially in the more acidic varieties like 'Elstar' when they are harvested early, treated with 1-MCP and sold early. This has been demonstrated in a small consumer tasting trial. But the impact this is having on the market is really difficult to tell. It is a situation that still remains to be learned: the industry has to learn more about 1-MCP and its application and will have to take care to deliver a good eating product. For pears there is interest in studying how to use 1-MCP without inhibition of ripening.

Researchers in *Israel* have determined that by reducing the concentration of DPA combined with 1-MCP is very effective to control scald in apples. The ripening of pears with 1-MCP is problematic, and although it is allowed, packers are reluctant to use it.

In *Italy* 1-MCP application is considered an alternative to DPA treatment for apples. Small packinghouses that don't have low O₂ rooms and equipment are particularly concerned about scald control and 1-MCP is the only alternative. Italian researchers found that 300 ppb 1-MCP is effective for scald control on pears depending on the stage of maturity. Ripening may be inhibited after storage in early harvested fruit, but on more mature fruit pears treated with 1-MCP

may ripen easier. Ethylene from adjacent apple rooms can reduce the effectiveness of 1-MCP to control scald on pears. Excellent results have been achieved in controlling scald on 'Abate Fetel' pears by treating early and middle harvested fruit with 300 ppb 1-MCP within 5 days of harvest and storing the fruits in conventional storage at 1 to 1.5°C (34 to 35 °F). This temperature allows the treated fruit to ripen after storage while controlling superficial scald. 'Abate Fetel' is the most important pear in Italy and is traditionally stored at -1° C (30 °F).

Researchers in *Portugal* reported that 1-MCP provides effective scald control in apples and pears. In agreement with other researchers they noted ripening problems in 'Rocha' pears; i.e., the pears do not ripen at the same rate so there is a percentage of fruit that remains green. However, studies using low 1-MCP concentrations demonstrated scald control similar to that obtained with DPA and without a high impact on the ripening process after storage. Portuguese researchers do not know if these low levels would be effective in commercial situations. This season some commercial applications of low concentrations of 1-MCP were done on pear and scald control was good. 'Rocha' pears stored in CA (2% O₂ and 0.5% CO₂) for more than 6 or 7 months can develop internal decay and cavities. DPA reduces this internal breakdown. Researchers are concerned about pears treated with 1-MCP and stored in CA without DPA. In addition there is the practical problem that 1-MCP treatment in pears can't be done commercially due to the large volume of fruit to be treated each day. Another aspect that must be considered is the risk of decay (*Penicillium* sp.). 'Rocha' pears are stored from August to May (10 months). Pears stored for 3 months ripen without decay problems, but after this period the fruit have a high incidence of decay. Thus, if the fruits are stored more than 4 months it becomes necessary to treat with fungicide. The industry would need to apply a fungicide by drenching or fogging, but are concerned that fogging may not work well due to treatment problems. Doubts remain on how to induce the ripening of pears after treatment. A recent trial reports on the benefit of treating with a low concentration of 1-MCP, it is uncertain whether this treatment will work in commercial situations.

Researchers in *Spain* believe that the only effective DPA alternative for scald control in apples is 1-MCP, although this treatment may have some problems, especially in 'Golden Delicious' apples.

Researchers in *South Africa* are investigating 1-MCP among the possible DPA alternatives. The banning of DPA could (at least over the short term) drastically reduce the volume of South African pome imported into the United Kingdom (UK) and the European Union (EU), since it is not practically feasible to treat all the fruit with 1-MCP due to insufficient number of gas-tight rooms, their availability and the cost of the product. Research has shown that 1-MCP cannot be used as a replacement for DPA on fruit harvested during the first part of the picking window since 1-MCP, can negatively influence the taste of the fruit. Currently in South Africa there is a roughly 10:1 cost ratio of 1-MCP to DPA. If all the apples were treated this would amount to an additional R30 million. 'Packham's Triumph' pears cannot be treated with 1-MCP as they do not ripen properly after treatment. Another researcher says that 1-MCP controls superficial scald development in 'Granny Smith' and 'Red Delicious' apples for 8 months and for 9 months in 'Packham's Triumph' pear.

In *United States*, 1-MCP is being widely used on apples especially in Washington State. Many researchers believe that 1-MCP could be an alternative to antioxidants and replace the use of DPA in apples. In some situations, DPA is also applied to improve scald control and help reduce internal browning. 1-MCP is not being widely used on pears and only a few packers have tested

it, but the industry is very interested in this technology. Because Bartlett ('Williams') pears are not very susceptible to storage scald, the primary objective for using on this cultivar is to reduce ripening and senescent scald, especially for pears that are to be exported. With regard to ripening inhibition of pears it seems that in some locations and/or with some cultivars pears will ripen after treatment with 1 ppm 1-MCP following long-term storage. In other locations or cultivars 50 ppb can cause irreversible ripening inhibition. In Hood River, Oregon researchers are evaluating strategies to promote the ripening of 'Beurre D'Anjou' after 1-MCP application and long term storage. One technique uses the simultaneous application of 1-MCP and ethylene (1:1), another is conditioning through high temperatures (a period at 10 °C [50 °F]) after storage to stimulate ripening.

Acceptance of 1-MCP Treated Fruit in the Markets

1-MCP is registered in most European countries and its use is legal. Researchers in *Brazil, Israel, Italy* and the *United States* said they have no information on any market refusing to buy treated fruit. Certain markets, especially in Europe, do not want any (or minimum) postharvest chemicals used so they don't accept 1-MCP treated fruit. For example 1-MCP is widely used on apples in *Italy* and *Germany* but certain wholesale buyers have made the decision to not buy fruit with any postharvest treatment, including 1-MCP. Some believe that a decision to reduce or eliminate all postharvest chemical residues would be one way by which local markets could encourage local producers by making imports more difficult.

A researcher from *Australia* considers that the reason some European markets would not buy 1-MCP treated pears would be the difficulty in ripening. A researcher from *Portugal* also said that the European markets (especially England) in some situations reject 1-MCP treated pears but not apples. Importing companies don't determine the ethylene production to see if they are treated with 1-MCP, but they determine the speed with which the pears ripen.

In *Canada*, reports indicate that most packers and retailers are happy with 1-MCP. In some cases buyers are requesting 1-MCP treated fruit. A major export market for Canada is England and so far DPA and/or 1-MCP use has been acceptable. Another researcher from Canada said that in Europe, there are supermarkets that control the use of chemicals and are now demanding chemical-free fruits and have forced suppliers to stop applications. 1-MCP is a synthetic chemical, so it is on the 'unacceptable' list of these market chains (mainly in Germany and Italy, but spreading).

Chile reports that some retail markets in specific regions of Germany and some other European countries do not want 1-MCP treated fruit.

In *England* 1-MCP is on the list of products approved by Tesco for use in postharvest and this chain is usually the most restrictive. In *South Africa* they have heard rumors of rejection of 1-MCP treated fruit in some markets in EU, but have not seen anything published. They believe that the reason for not allowing 1-MCP is because it is a chemical.

Researchers from *Italy* said that some retailers (i.e., Carrefour, Coop, Esselunga) do not allow postharvest treatment in some of their products (private label) and 1-MCP is included. Another researcher said that there is a general movement to drastically reduce chemical residues and postharvest treatment on all fruit, possibly including 1-MCP. A Danish supermarket, the 'Coop Norde' asked their providers not to use 1-MCP.

A researcher from the *Netherlands* said that there are no specific countries banning all postharvest chemicals but some retail organizations (i.e., ALDI) prefer not to buy treated fruit.

In the *United States*, producers in Washington State have not been aware of problems associated with European markets related to 1-MCP on apples in part since Europe is not a major market. A large part of the Washington apple production is currently treated with 1-MCP. 1-MCP is not registered for use in the organic market. In the United States, the reaction of pears with respect to 1-MCP depends on the cultivar. In 'Bartlett' ('Williams') canners have had problems with ripening some lots of freshly treated pears. Fresh market 'Bartletts' hold up well with good shelf-life and are less sensitive to scuffing. 'Bartletts' treated with 1-MCP provide a different product to the consumer—not better or worse, just different. Due to the challenge of ripening 'Beurre D'Anjou', after storage they have used banana ripening rooms to condition the fruit to ripen. These rooms used forced air to warm the fruit to about 15.5 °C (60 °F) and then treat with ethylene for 24 hours followed with forced air cooling. In the view of a commercial packer 1-MCP extends the packaging season and probably has an application on pears stored in bins and packed late in the season (i.e., 6 months after harvest). It also changes the ripening response to ethylene, with differences noted between growers.

An AgroFresh representative says that no country has banned the entry of fruit treated with 1-MCP. What exists is a resistance of some supermarkets or cooperatives especially in the Scandinavian countries who prefer to buy fruit without 1-MCP. This pressure has decreased significantly due to continuous education by AgroFresh to demonstrate the safety and advantages of using this technology, although there is still some resistance. As part of this strategy they have tried to register the chemical in these countries; registration in Denmark has significantly decreased the resistance in that country.

Acceptance of 1-MCP Treated Fruit by Consumers

Acceptance of 1-MCP treated fruit by consumers depends on the country and whether the fruit is apples or pears.

In *Australia* some retailers are aware of 1-MCP and purchase 1-MCP treated fruit as they know that it is better quality fruit. The packer puts a special label on the box and the wholesaler pays a premium for the treated fruit. This happens only in the case of one packer, but is an important packer in Australia.

A *Brazilian* researcher thinks that 1-MCP in pears is a problem for growers, packers and even more for those who sell and consume pears as they often have problems to ripen. Therefore 1-MCP application is only recommended for fruits that are firm when consumed.

In *Canada*, consumers have not expressed concern about 1-MCP. They consider it is a wonderful discovery and see it as an advantage to get rid of synthetic antioxidants. However, another researcher believes that consumers are unaware that 1-MCP treatment was carried out. In his opinion consumers who appreciate taste will be disappointed with 1-MCP treated fruit.

In *Italy* consumers prefer fruit that is both juicy and has a good sugar/acid balance. In Europe, 1-MCP is considered a safe treatment even from the point of view of packinghouse workers. They are not aware of concerns or complaints from consumers, but it is probably that, unlike other European countries, Italy is using it only in recent years and only in apples.

In *Portugal*, they observe that Europeans prefer to consume pears that are soft, unlike apples that are preferred crisp. They have clients in England that ripen pears there and provide them to the supermarkets as 'ready to eat'.

In *Spain* they do not have specific information on consumer attitudes, but they have reported on 1-MCP technology in industry magazines and no one has objected. They believe that this is due to the gas formulation and because low concentrations are used. If liquid formulation treatments are developed that use adjuvants or emulsifiers this attitude may be different, especially if it generates unwanted taste which is easy to detect in pears.

In the *United States* consumers primarily value firmness so they have no problem eating treated fruit, but *French* consumers who value aromas might demur. In the United States there is a minority of the population who only buys organic fruit but the majority of the population agrees with the traditional production methods and is happy to have firmer fruit. 1-MCP is widely used in the United States and many markets now require treated fruit, except among organic consumers.

In Summary

Researchers report that 1-MCP has been very effective as a tool to control storage scald in apples and pears. Because apples are preferred with a crisp, firm texture it has provided a fruit to consumers that meet their expectations for firmness. Some researchers report a lack of satisfaction with the aroma of treated apples. It is legal to apply and market treated fruit in EU markets. However, some retailers in certain EU countries are demanding that the fruit they buy does not have any postharvest chemical treatment, which includes 1-MCP.

The application of 1-MCP to pears presents a difficult problem because consumers prefer most varieties of pears to be soft, buttery and juicy. Each pear variety has its own definition of quality, with some being consumed more firm than others. Application of 1-MCP to pears provides control of storage scald as well as the reduction in senescent scald, but makes the pear more difficult to ripen, especially soon after application. Researchers are attempting to improve ripening in a number of ways including reducing the concentration of 1-MCP, combining application of 1-MCP with the application of ethylene, delaying ripening until after long-term storage and using banana ripening rooms to speed ripening. It will be up to local researchers to determine how best to use 1-MCP if the more traditional antioxidants are no longer available to producers.