

WUR Postharvest consultancy # 10: Tips to avoid bitter pit development in cold storage

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What is bitter pit?

Bitter pit is a physiological disorder that can be easily identified by soft round browning depressions on the peel as well as in the flesh of the fruit. A calcium deficiency during cell division is often associated with the development of this physiological disorder. Indeed, calcium is essential for cell wall structure and is a non-mobile element in the plant meaning that in times of lack of calcium, the growing part of the part will suffer from the deficiency. This phenomenon can be enhanced during a period of drought and warm weather as the leaves are using more water (bringing calcium with it) through transpiration than the fruits.

At the time of harvest, bitter pit is not always visible. During storage, the brown spots may appear. Luckily, bitter pit frequency and development can be reduced with an improved cold storage strategy. Low Calcium level is responsible for more disorders, but in this article will focus on the prevention of bitter pit on apples in postharvest. This also affects the post-harvest management and storability of the apples. The postharvest consultants of [Wageningen Food & Biobased Research](#) share their knowledge and experiences in this article.



The role of ethylene

Ethylene is known for its effect on ripening of the fruit. The fruit is becoming softer and sweeter. But ethylene is also responsible for enhancing the production of enzymes leading to cell wall break down. Meaning that if there is a deficiency in Calcium, the cell wall will break easily. This explains why bitter pit symptoms can increase during storage time.

Knowing that the presence of ethylene triggers the production of more ethylene by the fruit, we understand why the ethylene management of your cell will be important. Especially since apples are very good at producing ethylene, but also sensible to the presence of external ethylene.

To reduce the production of ethylene, it is essential to reduce the metabolic rate of the fruit. That means cooling down the fruit in order to bring the respiration rate down, and with it, the ethylene production. But remember that the production of ethylene is also triggered by ethylene outside of the fruit. One could think that blocking the ethylene production and sensitivity would be the answers, but in our experience, the use of 1-MCP have unreliable results on preventing bitter pit formation during storage.

What we do suggest are:

1. Pre-harvest interventions
2. Calcium application in post-harvest
3. Lowering the temperature
4. Lowering the oxygen level under CA regime
5. Use of samples and shelf-test
6. Do a stress test

This article will end with a short description of a new research.

1. Pre-harvest interventions

Fertilization: Bitter pit can be prevented using several techniques such as an adapted fertilisation plan with a low ratio of Calcium/potassium and of Calcium/magnesium. Meaning that a too high availability of K and Mg can increase the disorder occurrence. The amount of calcium in the soil is not always a good indicator for the availability of it as the challenge is to get the Calcium in the fruit. Furthermore the timing of the availability of the calcium and the presence of auxin are essential to the absorption of this element

Calcium sprays: To make sure calcium will be available to the fruit, sprays can be done in the orchard as soon as from the petal fall stage until short before harvest. But for better results, the sprays should be done when the cell division rate is high. Meaning when the fruit is forming rather than growing: from flowering until the fruit has reach 5 mm of diameter.

Pruning: Not only a low crop load in an “off year” can be prevalent of bitter pit due to bigger fruit size, but also an excess in tree vigour, which its vegetative growth occurs at the expense of the fruit growth, increase the chances of bitter pit. Summer pruning might be more adequate than a severe winter pruning. So make sure pruning is done properly.

Temperature management: If temperature are too hot, sprinklers can be used to reduce the temperature and reduce the transpiration rate trough the leaves helping the Calcium reaching the fruits.

2. Post-harvest Calcium application (dipping)

The application of calcium in the postharvest management during the dipping can also be a strategy to prevent bitter pit from developing if deficiency is suspected. It is often done during the grading and sorting of the apples.

Dipping fruit in a solution of 0.75-1% Calcium chloride (CaCl_2) or Calcium Nitrate ($\text{Ca}(\text{NO}_3)_2$) directly after harvest has been shown to reduce bitter pit occurrence.

3. Lowering the temperature

The most important factor in preserving the quality of your fruit is temperature. From cooling them down at the right pace to maintaining them at the right temperature. Make sure you measure the fruit temperature regularly and not only take the air temperature into account. Indeed, keep the apples in the shadow until brought to the packhouse and cooling them down as soon as possible. This is also useful to prevent sunburn.

The temperature of your fruit has the biggest effect on the respiration rate and the ethylene production. So, make sure you put your apples at the right temperature according to the variety you are storing. If you store under a CA regime, lowering the oxygen level will be of great interest to reduce the occurrence of bitter pit.

4. Lower oxygen level under CA regime

Once the apples are cooled down, their metabolism is also reduced. Then, the oxygen level can be reduced to further reduce the metabolism of the apple under a CA regime and with it the reduction of the development of bitter pit during the storage.

5. Use of samples and shelf-life test

By taking samples from the cold room and putting them at ambient temperature, you can test the shelf-life of your apples. As the apple recovers from the cold storage conditions, the respiration rate increases again, this way the development of bitter pit can be seen, if the disorder is present of course. This give only an indication.

6. Do a stress test

Although the stress test do not seem to be very accurate, it can give an indication of the presence of bitter pit. One way to do a stress test is to put a sample of apples under hot water (49°C) for 30 min after which they are left to dry. Regular observations of the development of bitter pit up to 21 days after the test is then done.

Cell wall preservation- research

As mentioned, enzymes are involved in the degradation of the cell wall. One of them is the phospholipase-D, or PLD, which acts on the degradation of the lipids during the ripening of the fruit. Knowing that cell walls are made of lipid molecules (fat), we understand rapidly that this is an important enzyme to be blocked, or slowed down in activity, to preserve our apples from bitter pit formation. This has been proven realistic by applying hexanal to several fruit type such as nectarine, raspberry, mango and of course, apples.

Studies showed that on Honeycrisp apples, the application of hexanal during pre-harvest, a natural compound in the plant, showed to reduce the occurrence of bitter pit during storage. The activity of the PLD enzyme increases during post-harvest. But when hexanal was applied, this activity did not increase as much, meaning that the cell walls were kept in better shape. Indeed, with the application of hexanal, less bitter pit was found on Honeycrisp. However, this product is not homologated yet for commercial use in orchards.

In the meantime, the postharvest management such as cooling down the apples, maintaining the right temperature and lowering the oxygen level in the cold storage rooms are our best allies..

More information

Our previous article in the series gave an introduction on [Ethylene in post-harvest quality management and Sunburn and postharvest management of apples](#).

If you want to improve your product quality, identification of post-harvest disorders, storage facilities and humidity related issues, contact one of our experts.

Wageningen Food & Biobased Research is a contract research organization which works together with companies, government authorities and other knowledge institutes. Postharvest consultancy is one of our areas of expertise.

Interested? Please contact us. Postharvest Consultancy Team:

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