

3. AGRICULTURAL USES AND OCCURRENCE IN FOOD

FROM FIELD TO TABLE

Imagine a vineyard on a spring morning. The temperatures are mild, the air is humid and, after several days of rain, the vine leaves remain wet for many hours.

For a farmer, these conditions may mark the beginning of a problem.

Humidity and favourable temperatures create ideal conditions for the development of certain plant diseases, including grapevine downy mildew, caused by a microorganism known as *Plasmopara viticola*.

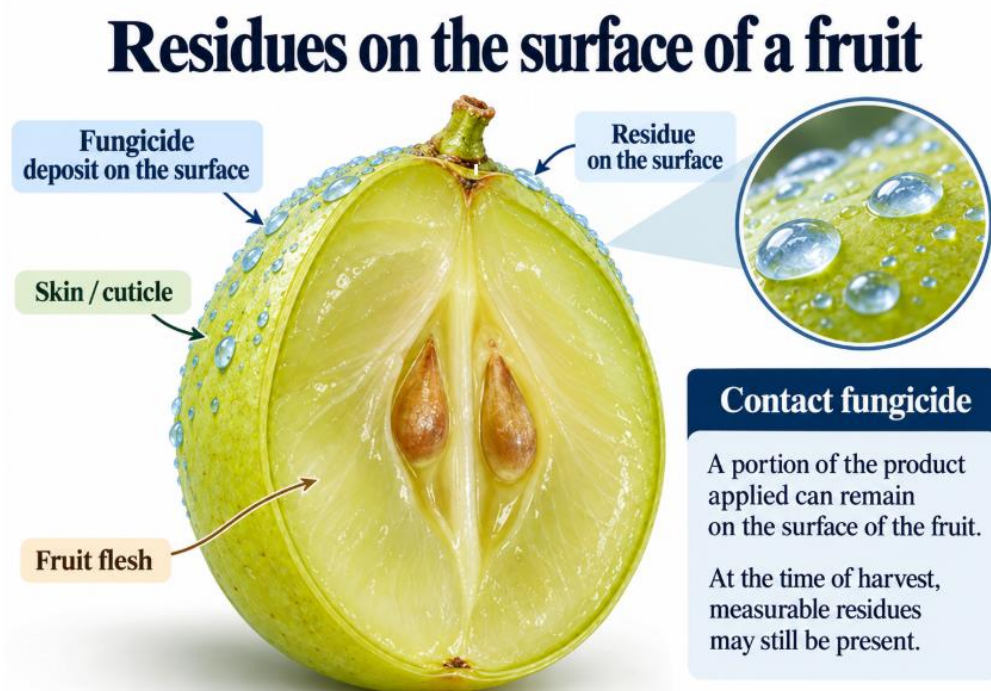
If the infection spreads, it can damage leaves and grape bunches and compromise a substantial part of the harvest.

To counter this risk, numerous fungicides were developed during the twentieth century, including the dithiocarbamates. For decades, substances such as mancozeb and metiram were used to protect a range of crops.

But what happens to these substances after they have been applied to plants?

And, more importantly, how can they end up in our food?

PROTECTION THAT REMAINS ON THE SURFACE



Many dithiocarbamates act primarily through contact.

This means that, when applied to vegetation, they form a protective deposit on the surface of leaves and fruit, hindering spore germination and the development of infections.

They therefore behave differently from systemic fungicides, which can be absorbed and transported within the plant.

Their effectiveness depends largely on the active substance remaining on the surfaces that need protection.

But this has a consequence.

Some of the substance applied may remain on the plant even after treatment.

Over time, this deposit may diminish as a result of rain, light, temperature, plant growth and chemical degradation processes.

However, these processes do not necessarily cause residues to disappear immediately or completely.

At harvest, traces of the original product or substances arising from its transformation may therefore still be present.

This is how a treatment carried out in the field can leave a measurable trace in food that reaches the consumer.

WHICH CROPS HAVE BEEN AFFECTED?

Dithiocarbamates have been used on a very wide range of agricultural crops.

Historically, these have included grapevines, apple and pear trees, potatoes, tomatoes and various vegetable crops.

Their widespread use reflected their ability to control numerous diseases, particularly through preventive action.

However, the need for protection varies considerably from one crop to another.

Grapevines may need protection against downy mildew, whereas apple orchards can be affected by other diseases, such as apple scab. Potatoes and tomatoes may also be attacked by pathogens capable of rapidly damaging their foliage.

Dithiocarbamates were used in precisely this wide variety of situations.

It is important, however, to distinguish historical uses from those currently permitted. Many substances in this family are no longer approved in the European Union, while other countries may apply different rules.

The detection of a residue in food should therefore not automatically be interpreted as evidence of a treatment legally authorised in European agriculture.

WHAT HAPPENS BETWEEN TREATMENT AND HARVEST?

Let us return to our vineyard.

Imagine that a fungicide treatment has been applied and that the grape bunches continue to grow over the following weeks.

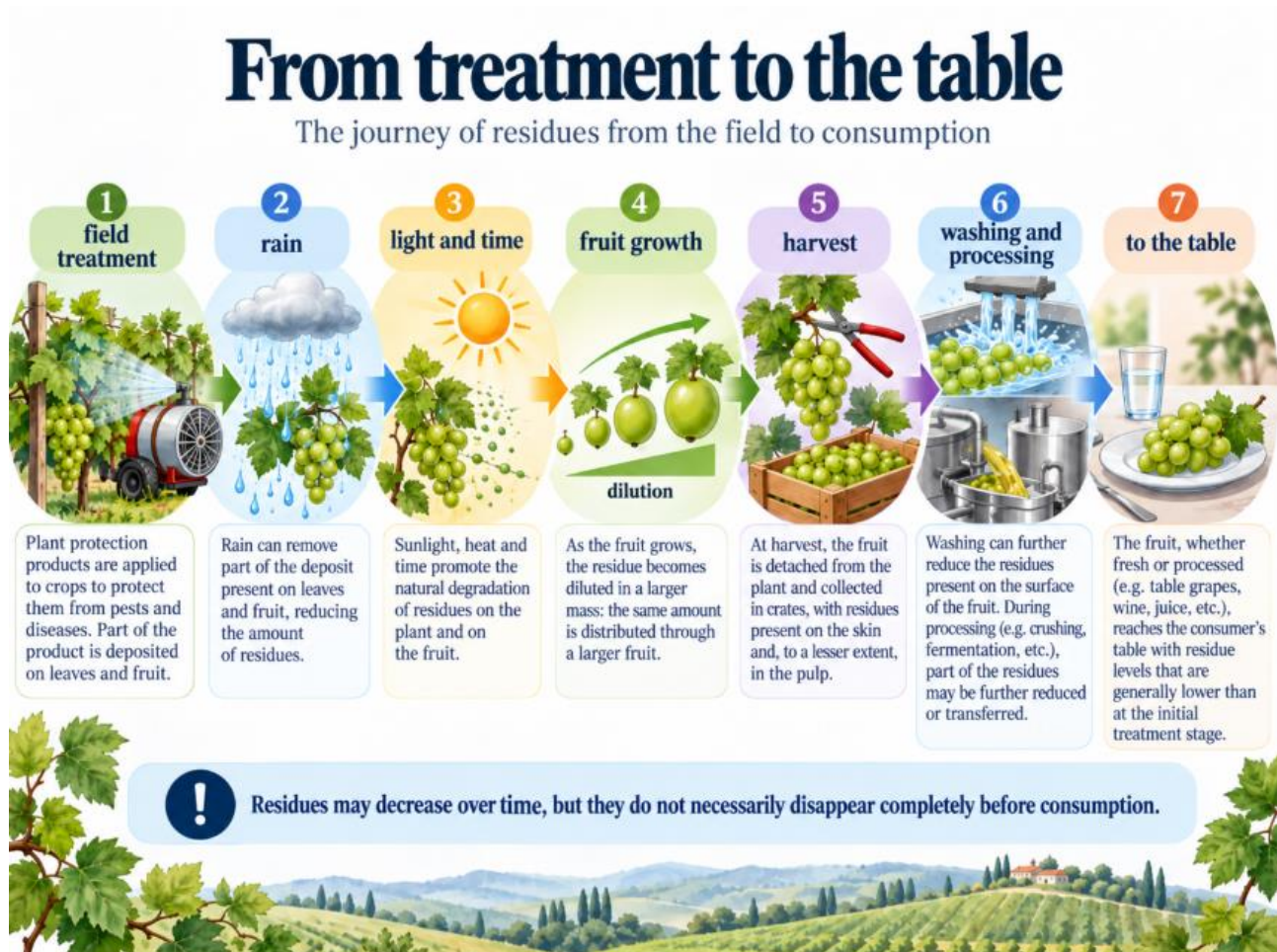
During this period, the original deposit changes.

Some of it may be washed away by rainfall. Another portion may undergo chemical transformations. In addition, as the grapes grow larger, the residue may become distributed over a progressively greater mass of plant material.

This phenomenon is known as growth dilution.

The principle is easy to understand: if the quantity of a substance remains relatively constant while the fruit gains weight, its concentration decreases.

But this is not always what happens.



The actual reduction in residues depends on the substance, the crop, environmental conditions and the time elapsed since treatment.

For this reason, the authorised use of plant protection products specifies a minimum period between the last treatment and harvest, known as the pre-harvest interval (PHI).

This interval is established on the basis of authorised conditions of use and residue studies, helping to ensure that food complies with the applicable maximum residue levels.

It does not, however, mean that every residue must have disappeared completely by the end of that interval.

A food product can comply fully with the law and still contain measurable residues of plant protection products.

This distinction is essential: regulatory compliance does not necessarily mean the absence of detectable substances.

THE JOURNEY DOES NOT END AT HARVEST

Once harvested, agricultural products may be washed, sorted, stored, transported and processed.

Each of these operations can affect residue concentrations.

Washing, for example, can reduce some of the deposits on the surface, but its effectiveness varies according to the substance and the food. It therefore does not guarantee complete removal.

Peeling can also reduce exposure to residues concentrated in the outer layers of certain fruits and vegetables.

Industrial processing may have different effects.

During cooking or other heat treatments, some substances may break down. However, degradation does not always mean complete elimination: transformation products may form with their own chemical and toxicological properties.

In other processes, such as drying, the loss of water may even increase the concentration of certain residues when expressed per kilogram of product.

There is therefore no universal rule that processed food necessarily contains fewer residues than the raw material.

To understand what happens, each combination of substance, food and production process must be studied.

IMPORTED FOODS: ANOTHER VARIABLE

Today, a substantial proportion of the food we consume comes from international markets.

Fruit, vegetables, cereals and other agricultural products may be grown in countries with different pesticide authorisation systems.

A substance that is no longer approved in the European Union may still be used legally in a non-EU country.

This does not mean that imported food can be marketed freely without complying with European rules.

Imported products must also comply with the maximum residue levels applicable in the European Union.

Under certain circumstances, specific import tolerances may also be established and assessed according to the criteria laid down in the legislation.

Residue monitoring must therefore take account of an agricultural market that extends far beyond Europe's borders.

This is also why testing for dithiocarbamates remains important, despite the non-renewal of approval for many active substances in this family.

WHEN A RESIDUE DOES NOT COME FROM A FUNGICIDE

We now come to one of the most surprising aspects of this story.

Imagine analysing a sample of broccoli grown without the use of dithiocarbamates.

The laboratory uses the traditional method based on measuring carbon disulphide, CS₂.

Yet the result may indicate a measurable quantity of this substance.

How is that possible?

The explanation lies in the natural chemistry of plants.

Some plants, particularly those belonging to the Brassicaceae and Alliaceae families, contain sulphur-rich organic compounds.

During sample preparation and chemical treatment, some of these compounds can contribute to the formation of CS₂.

The laboratory therefore measures a substance that does not necessarily originate from pesticide use.

This is not merely a theoretical possibility.

In its 2023 review, the European Food Safety Authority (EFSA) also examined data on the natural occurrence of compounds capable of producing CS₂ in different plant-based matrices.

The purpose was precisely to better understand the meaning of analytical results and take this into account when assessing maximum residue levels.

This shows that the presence of a chemical marker does not always make it possible to determine its origin with certainty.

Nor does it mean that every positive result should be attributed to natural causes. Rather, correct interpretation requires consideration of the type of food, the analytical method used and the other information available.

FROM RESIDUE TO RISK: TWO DIFFERENT QUESTIONS

We have followed the journey of dithiocarbamates from field to table.



But an important question remains: does finding a residue necessarily mean that the food is dangerous?

The answer is no.

The presence of a substance and the risk associated with consuming it are two different concepts.

Risk depends on the toxicity of the substance, the amount ingested, how frequently the food is consumed and the characteristics of exposure.

However, compliance with a legal limit does not in itself demonstrate the absolute absence of any risk.

Maximum residue levels are established within a framework that takes account of agricultural uses and scientific assessments of consumer safety.

They do not necessarily represent the concentration at which a substance begins to produce toxic effects.

It is therefore important to avoid two opposite but equally simplistic conclusions: treating any detectable residue as dangerous, or assuming that legal compliance alone makes any further assessment unnecessary.

Scientific understanding calls for greater care.

For dithiocarbamates, this is particularly important because substances within the family can have different toxicological properties, and some of their degradation products may require specific assessment.

This is exactly what we shall examine in the next chapter.

SCIENTIFIC REFERENCES FOR CHAPTER 3

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4. European Commission (2020). Commission Implementing Regulation (EU) 2020/2087 concerning the non-renewal of approval of the active substance mancozeb. [Read the Regulation on EUR-Lex \(Italian version\).](#)