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Importance of 1-Methylcyclopropene in Storage Practice

History of 1-MCP

On postharvest life and quality of vegetables have impact many of physiological and biochemical parameters. Changes in quality are going during storage, because over storage in vegetable are still going life processes. There present degradation of storage substances and decrease of dry matter. They are producing CO_2 and their respiration is inhibited. It can be observed senescence of tissues through transpiration, respiration, and maturation. Some vegetables, like onion, are growing leaves (Gajewski, 2002). For producers, sellers and consumers quality of fresh product is very important. Consumers would like having access to vegetable and fruits through whole year. It led to storage of them. Maintenance good quality requires creating special conditions, not only by decrease of temperature. The story of modern storage technologies started on the beginning of XX century, when Kidd and West tested changes of atmosphere on apples and showed that these influence on inhibiting climacteric respiration and allow for prolong time of storage and determined what is effect of low O_2 and high CO_2 concentration in atmosphere using during storage (Reid and Staby, 2008).

In 60's of previous century two researchers Stanley and Ellen Burg observed that changes in composition of atmosphere led to inhibit of ethylene production and action.

Next step was discovered by Elmo Beyer working at DuPont in the middle of 70's low concentration of Ag^+ role as inhibitor action of ethylene. It prevented Cattleya orchid flowers before wilting induced by ethylene (Reid and Staby, 2008). Despite desirable effect, commercial treatment by Ag^+ was limited because it as a heavy metal could not be used to edible products.

In 1978 Veen and van de Geijn discovered different stable silver complex (silver thiosulfate – STS) which was also greatly portable in the vascular system and has an antiethylene influence. STS was started using commercially, especially in flower industry and to inhibit ethylene action for potted plants and different nursery plants. Now STS is used in commercial horticulture to protect cut flower before ethylene in US as an Environmental Protection Agency (EPA) and in The Nethederlandes flower market. At the same time an organic chemist, Edward Sisler (Photo 1), in the Biochemistry Department at North Carolina State University studied another possibility of ethylene. One of key moment for discover of 1-MCP was identifying the ethylene-binding site protein (Reid and Staby, 2008).

Together with his colleague – Sylvia Blankenship (Photo 1), in 1996, explored and patented one compound – gas, which was especially anti ethylene active even in low concentrations – 1-methylcyclopropene (1-MCP) (Sisler and Blankenship, 1996; Gajewski, 2002; EFSA Scientific Report, 2005; Reid and Staby, 2008; Kostansek, 2010; Yuan *et al.*, 2010).

At that time Sisler and Blankenship embarked working with Staby, which suggested to licence 1-methylcyclopropene for food and ornamentals. They started achieving registration of product in EPA. Thankful study, which confirmed safety of 1-MCP and similarity of structure to 1-aminocyclopropane-1-carboxylic acid – the ethylene precursor, his process was easier. For commercialisation of 1-MCP proved to be very important discovered by Jim Daly powdered formulation due to cyclodextrin-bound with 1-MCP. It has contributed to easier manner to store, transport, sell and use 1-MCP as diluted in water (EFSA Scientific Report, 2005; Reid and Staby, 2008; Kostansek, 2010). Since beginning of 2000 commercialisation of 1-MCP for postharvest treatment on fruit and vegetables to maintain their quality dealt AgroFresh, Inc. (Kostansek, 2010; Yuan *et al.*, 2010).


Photo 1. Inventors of 1-MCP: Edward Sisler and Sylvia Blankenship

Modern technical equipment

When the chamber is empty, before start of harvest, the growers should measure cubature in m^3 using laser rangefinder, which take only a few minutes and gave accurate result. 1-MCP application is doing directly after harvest of fruit/vegetable.

Efficiency of using 1-MCP depends on stage of maturity of fruits/vegetables and gas tightness of storage building/chamber during treatment by 1-MCP and short time between harvest and putting products to chamber. SmartFreshTM or SmartFresh 03VP, which contain 1-MCP in powder formulation, after diluted in small amount of water are ready to use.

An amount of SmartFresh 03VP using to treatment depends on cubature of chamber, where treatment will be done (Anonymous, 2010). When chamber is full treatment through 4-24 hours can be done. Time of treatment depends on species of vegetable/fruit and temperature, when temperature is lower than 13°C time of treatment should be longer than in higher temperature (Gajewski, 2002; Anonymous, 2010). After treatment by 1-MCP growers can chose any regime for storage. Applications are doing by groups, which had course given by AgroFresh and according to AgroFresh instruction (Anonymous,

Application of practice in horticultural crops

Producers can buy two preparations, which have 1-metylocyklopropen (1-MCP) as active substance: SmartFresh and EthylBloc (Gajewski, 2002; Anonymous, 2010; Kostansek, 2010). SmartFresh can be used to treat before storage for few horticultural crops: apple, pear, plume, kiwifruit, avocado, persimmon, banana, melon, tomato and EthylBloc for cut flowers (Pathak *et al.*, 2003; Kostansek, 2010). SmartFresh 03VP was registered in Poland in 2008 and there can be use before storage of apple (Anonymous, 2010; Kostansek, 2010). Researcher led study to check availability this product for some species of vegetable.

SmartFresh is totally safe for consumers and producers as well as for environment (Gajewski, 2002; EFSA Scientific Report, 2005; European Commission Health & Consumer Protection Directorate-General, 2005; Reid and Staby, 2008; Anonymous, 2010; Kostansek, 2010; Yuan *et al.*, 2010). It is confirmed by opinions, which are published by registration authorities in over 30 countries (Photo 2) (Anonymous, 2010; Internet 1; Kostansek, 2010).

Nowadays, new formulation of ethylene action inhibitor can be used, especially on ornamental plants. This recent preparation is salt – N,N-dipropyl(1-cyclopropenylmethyl)amine, which is applied in spray (Segliea *et al.*, 2010). Huge challenge is using of 1-MCP in preharvest time on agricultural crops for instance corn, cotton, rice and soybeans. Than it can have impact for yield (Kostansek, 2010).

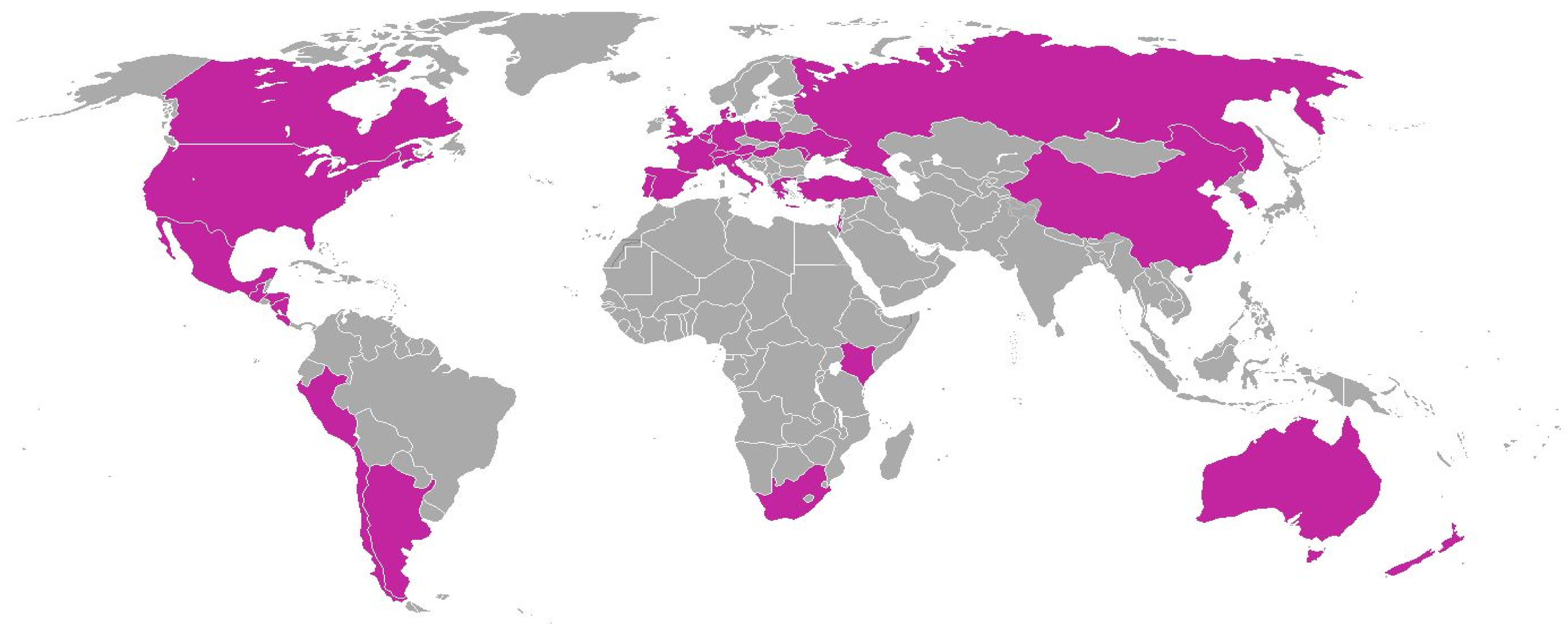

Photo 2. The map with country where 1-MCP can be used (they are marked by purple colour)

Effect on morphology and physiology of practice on different horticultural crops

Using 1–MCP is very important for prolong storage time, especially for fruit and vegetable, which produce a lot of ethylene (melon, tomato), are sensitive for ethylene (very – broccoli, medium – tomato) and have limited shelf life (Gajewski, 2002). 1-MCP inhibit ethylene action due to stronger bind with ethylene receptor sites than ethylene. In cells 1-MCP bind with ethylene receptors irreversibly; it led to lack of response for exogenous ethylene. In this manner 1-MCP can prevent fruits and vegetables against changes induced by ethylene (Gajewski, 2002; Jameel Jhalegar *et al.*, 2011; Kostansek, 2010).

In case of cut flowers is striking correlation between increased production of ethylene and decreased of length of vase life (Asil et al., 2013). 1-MCP can prolong the life of cut flowers (Sisler and Blankenship, 1996). When cut flower are untreated with 1-MCP, ethylene production is increase very fast and produce the most amount on 5^{th} day of storage. Longer, 6 hours treatment with 1-MCP is more effective in ethylene production inhibition than shorter treatment, through 3 hours. Independent on concentrations of 1-MCP using to treatment, vase life of cut carnations was longer in contrast to untreated flowers, the best treatment (0.6 g m^{-3} through 6 hours) can prolong this time even about 11 days (Asil *et al.*, 2013).

1-MCP effect on inhibition ripening in both stages of maturity fruits (breaker and pink fruits) about 4 to 6 days and delay loss of firmness for breaker fruits about 6 days and for pink fruits about 3 days (Mir *et al.*, 2004). Lower respiration rate in kiwifruits after treatment with 1-MCP is presumably related to inhibited ethylene production and retarding of senescence (Jameel Jhalegar *et al.*, 2011).

Usage 1-MCP delayed kiwifruits ripening – almost a week later compared to control fruits. In 1-MCP treated fruits enzymes as polygalactouronase (PG) and lipoxygenase (LOX) were less active compared to untreated fruits, which respired more and evolved more ethylene (Jameel Jhalegar *et al.*, 2011).

Shelf life of plums is extremely limited by their perishability and big tendency to softening during storage time. Even after 4 days of storage firmness of plums decrease about 63% and after next 4 days loss of firmness is 20 %. At that time firmness loss of plums treated with 1-MCP was only 30 and 56% respectively. Treated fruits show also lower ethylene production – on 2^{nd} day it was 3.1 times (Kan *et al.*, 2011).

PG and β-gal activities are higher when ethylene production increases. Presumably, fruit firmness maintenance after 4 days since treatment can indicate that 1-MCP suppress of two keys wall degradation enzymes (Krongyut *et al.*, 2011). Commercialisation of postharvest using of 1-MCP gave a new tool to maintenance of fresh product quality in horticulture. It can overcome the ethylene effects in fruits and vegetables (Kostansek, 2010; Yuan *et al.*, 2010).

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Web source (Internet 1)
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