

ESA WHITE PAPER

on ETO/ ECH RESIDUES IN CULINARY HERBS AND SPICES

Background

Members of the European Spice Association (ESA) have, as part of their due diligence program, undertaken periodic testing for ethylene oxide (ETO) and 2-chloroethanol (ECH) residues in herbs and spices.

Members of the European Spice Association reported a small number of findings with traces/ very low amounts slightly above the current maximum residue levels.

The current EU legislation regulating residues of ethylene oxide (sum of ethylene oxide and 2-chloroethanol expressed as ethylene oxide) is Reg. (EU) 2015/868, which sets the "permitted" level (Maximum Residue Level MRL) for the sum of ETO and ECH in herbs and spices.

The use of ETO for the sterilisation of foodstuffs within the EU as well as the import of foodstuffs containing residues of ETO and ECH above the MRLs into the EU is not permitted.

Applications of biocidal products containing ethylene oxide are allowed for disinfection in the EU, but without food contact.

Ethylene Oxide (ETO) treatment

The treatment of herbs and spices with ETO is still permitted in many producing countries outside the EU and is allowed to be used within the United States of America. The toxicological experts within the USA allow up to 920 mg/kg ECH residues and 7 mg/kg residues of ETO.

This data showed the typical ECH residues present in spices when the multiple washing ETO system was used. In this treatment the product is exposed to a 20% ETO and 80% CO₂ mixture for 6 hours at a temperature of 52 – 62 °C and this equates to an ETO concentration of around 300 mg/l.

Following treatment 21 low vacuum cycles are conducted to remove the ETO residue and this is followed by 4 fresh air washes. At the end of the process ETO levels seem to be in the range of zero to 25 mg/kg, then when retested after 72 hours of storage the ETO residue levels are around 1 mg/kg.

There is no international process standard for ETO treatment and we know that in other regions higher concentrations of gas are used, without the multistage air washing after

treatment. Therefore, we can anticipate that outside the USA, higher levels of ETO are likely to be in the product when the product comes out of the chamber.

During the ASTA application for the continued use of ETO 29 different herbs and spices were checked for ECH residues, before, immediately after treatment, 24 hours later and then 72 hours after treatment. Interestingly there were several positive control samples (organic material), that had not been treated.

Ethylene

Large quantities of this gas are industrially produced every year, 141 million tonnes in 2011, mainly used for detergent, thickener, solvent, plastic, antifreeze production.

Ethylene is a hormone and is produced by plants as part of the natural ripening process and extra ethylene is produced if the plant becomes damaged as this helps the healing process.

Ethylene is used on a commercial basis to induce the ripening of fruit that have been shipped from origin unripe. In this type of operation ethylene is produced from ethanol. Research indicates that burning ethanol in vehicle engines generate ethylene gas. (13.5 metric tonnes in USA in 2014).

Ethylene is produced naturally in the sea from photochemical reactions of dissolved organic carbon, it is also produced from fires and when volcanoes erupt. In fact, as humans we emit ethylene from our skin and as we breath out.^c

In a peer review, published on 11. January 2012, EFSA makes reference to ETO formation from Ethylene, mentioning a study that estimated the atmospheric half-life in air of ethylene oxide is approximately 38 days.

Ethylene Oxide production

A study from the USA, as far back as 1982, has shown that vegetables such as peas convert ethylene to ethylene oxide. The report goes on to say that over a dozen plants have been shown to have the same effect.^d

A World Health Organisation study in 1995 reported that in addition to plants converting Ethylene to Ethylene Oxide, ETO is also generated on water logged soil, manure and sewage.^a

This clearly seems to indicate that ethylene oxide is being generated naturally in the growing environment. A Spanish study circa 1980's shows that ECH can be generated 'naturally' under laboratory conditions at temperatures from 20 – 45 deg C, during the ripening of the plant.^b

Another possible source of ethylene, which can subsequently be further converted to ETO, are approved plant protection products such as ethephon.

Ethephon is a plant growth regulator which is used with foliar sprays to regulate growth. By Regulation (EU) No 2017/1777 of 20 October 2017, the authorised maximum residue levels were set at 0.05 mg/kg for herbs and 0.1 mg/kg for spices.

In its peer review of 7 June 2006, EFSA described that the degradation products of ethephon are ethylene gas and the non-volatile 2-hydroxyethylphosphonic acid. The major routes of dissipation appear to be chemical hydrolysis and microbial degradation. A 2005 study cited by EFSA shows that ethylene is the main degradation product of ethephon under aerobic conditions.

Cross contamination

Several ESA members, including members of the ESA ETO working group, have evaluated the risk of ECH residues due to cross contamination within a manufacturing or storage environment. Considering the information from the USA re-registration data it appears there is a good hypothesis that there is a potential risk of cross contamination of ethylene oxide if none treated materials are stored or shipped together with ETO treated material.

For example, the use of shipping containers, or wooden pallets that were previously treated with Ethylene Oxide. Within the EU Ethylene Oxide is still permitted for the sterilisation of medical devices and this knowledge, together with what has been said previously, potentially adds a risk factor when public non dedicated warehousing is used.

Conclusion

There is a strong argument that suggests that there is an identified pathway for the natural generation of low levels of ECH residues from within the growing environment.

In addition, it appears that managing the risk of cross contamination, especially from overseas suppliers that operate this type of treatment process, during storage and shipping, is something that should be added to a supplier risk assessment.

As is often the case more research is required as, whilst materials that have such low levels of ECH residue do not appear to be an immediate food safety concern, they are outside the current EU legislation.

However given the information contained in this white paper it would be reasonable to assume that when low levels of ECH residues are found within a product, it is probably due to natural generation, cross contamination or environmental contamination and not due to the fact that the product for the European market was intentionally treated with Ethylene

Oxide. Intentional use of ETO for products intended to be placed on the EU market, is in the opinion of ESA illegal and must be regarded as food fraud.

From the ASTA submission to the EPA in 2020, the majority of results for ECH residue levels, in a product after ETO treatment, were between 25 and 335 mg/kg. Members might like to take these numbers into consideration in the eventuality they find low levels of ECH residue, which are above the legal limit. In any case they are advised to undertake their own risk assessment to understand the root cause for the levels they are detecting.

Materials that have such low levels of ECH residue do not appear to be an immediate food safety concern to several respected authorities around the world. ^e

References

^a WHO document – Concise International Chemical Assessment Document 54

^b Study of the Formation of Chlorohydrins in Paprika as a Secondary Metabolism of Ethylene Synthesis (Félix Romojaro Almela, Consejo Superior de Investigaciones Científicas, Murcia, 20/7/1999)

^c <http://www.drjoonyun.com/uncategorized/ethylene-important-molecule-youve-never-heard/>

^d Ethylene and Plant Protection, by J.A.Roberts PhD and G.A.Tucker PhD, University of Nottingham, published by Butterworths.

^e In addition to the details mentioned above about the processing using ETO within the USA it is also worth noting that the New Zealand Ministry of Health estimated a “lifetime cancer risk” from 0.8 to 12 cases in a million, for the whole substances (ETO, ECH and EBH) and in the worst conditions (overestimating the exposure expected for the average consumer), considering “cancer potency factors” (CPFs) of 0.55 (mg/kg/d)-1 (oral) and 0.29 (mg/kg/d)-1 (inhalation) and a ETO/ECH/EBH content below 50 ppm.

EUROPEAN SPICE ASSOCIATION
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