REASONED OPINION

Reasoned opinion on the review of the existing MRLs for carbofuran, carbosulfan, benfuracarb and furathiocarb and the setting of an import tolerance for carbofuran in cultivated mushrooms[1]

European Food Safety Authority[2]

European Food Safety Authority (EFSA), Parma, Italy

ABSTRACT

In accordance with Article 43 of Regulation (EC) No 396/2005, the European Commission requested EFSA to evaluate the information provided by the European Spice Association (ESA) with a view to setting an import tolerance on cultivated mushrooms and considering in parallel, a review of all existing EU MRLs for the N-methyl-carbamate insecticides; carbofuran, carbosulfan, benfuracarb and furathiocarb, including the CXLs that were taken over in the EU legislation. EFSA recommends the withdrawal of the carbofuran and/or carbosulfan CXLs transposed in the EU legislation for mandarin, orange, sunflower, rape seed and spices. EFSA recommends, to maintain the MRL for carbofuran in fresh cultivated mushrooms at the current LOQ of 0.01* mg/kg, since higher values will result in an acute consumer intake concern. No changes are proposed to the benfuracarb and furathiocarb MRLs (LOQs) listed in Annex V of Regulation (EC) No 396/2005. In contrast, for carbofuran and having regard to the low toxicological reference values proposed for this active substance, the setting of MRLs below the default LOQ value of 0.01*mg/kg would be requested, especially for the food commodities that contribute significantly to consumer diets.

KEY WORDS

carbofuran, carbosulfan, benfuracarb, furathiocarb, MRL review, N-methyl-carbamate

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[2] Correspondence: pesticides.mrl@efsa.europa.eu

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SUMMARY

The European Commission has been informed by the European Spice Association (ESA) that a significant number of lots of dried white mushrooms imported from China, contain residue levels of carbofuran above 0.1 mg/kg corresponding, when applying a dehydration factor of 10, to an exceedance of the default MRL value of 0.01* mg/kg established for fresh cultivated mushrooms. In accordance with Article 43 of Regulation (EC) No 396/2005, the European Commission requested EFSA to evaluate the information provided by ESA with view of setting an import tolerance on cultivated mushrooms and considering in parallel, a review of all existing EU MRLs for the N-methyl-carbamate insecticides carbofuran, carbosulfan, benfuracarb and furathiocarb, including the CXLs that were taken over in the EU legislation.

The toxicological profile of the active substances carbofuran, carbosulfan and benfuracarb was assessed in the framework of the peer review under Directive 91/414/EEC and the data were sufficient to derive the following toxicological end points:

	ADI	**ARfD**
- carbofuran	0.00015 mg/kg bw per day	0.00015 mg/kg bw
- carbosulfan	0.005 mg/kg bw per day	0.005 mg/kg bw
- benfuracarb	0.01 mg/kg bw per day	0.02 mg/kg bw

As the active substance furathiocarb has not been supported in the framework of the review under Directive 91/414/EEC, the ADI value of 0.003 mg/kg bw per day and the ARfD value of 0.006 mg/kg bw set at member state level were considered in this reasoned opinion.

The metabolism of carbofuran, carbosulfan and benfuracarb in primary crops was assessed during the peer review on a large number of crops, belonging to a total of five plant groups. Some information on the metabolism of furathiocarb was available from public literature. Following application, carbosulfan, benfuracarb and furathiocarb are rapidly converted to carbofuran and therefore, the metabolic profile of these active substances in plants is mainly driven by the metabolic pattern of the active substance carbofuran.

For carbofuran and from the available studies, the peer review concluded to establish the residue definition for risk assessment as the "s*um of carbofuran, 3-OH-carbofuran and their conjugates, expressed as carbofuran*". The inclusion of the 3-keto-carbosulfan metabolite and its conjugates for risk assessment was also recommended during the carbosulfan review. For monitoring, the residue definition was left open. It was agreed that at least, carbofuran and 3-OH-carbofuran have to be included in the residue definition, but it could not be concluded whether their conjugates should also be considered, pending the submission of information to confirm the efficiency of the analytical methods to consider the conjugates. For carbosulfan and benfuracarb, separate residue definitions for monitoring were proposed as carbosulfan and benfuracarb, respectively.

For animal commodities, considering that 3-OH-carbofuran free and conjugated was identified as the major toxicological relevant metabolite in animal matrices, the peer review suggested to define the residue for risk assessment as "*3-OH-carbofuran, free and conjugated expressed as carbofuran*". As for plants, the inclusion of the 3-keto metabolite was recommended in the carbosulfan conclusion. For monitoring, the residue definition was left open, pending the submission of information on the efficiency of the analytical methods to consider the conjugates. However, the peer review expressed a preference to define the residue for monitoring as proposed for risk assessment.

The current residue definitions for enforcement under Regulation (EC) No 396/2005 for the N-methyl-carbamate compounds for animal and plant commodities are the following:

- carbofuran: sum of carbofuran and 3-OH-carbofuran expressed as carbofuran,
- carbosulfan: carbosulfan
- benfuracarb benfuracarb
- furathiocarb: furathiocarb

For plant commodities, these residue definitions are overall similar to the proposals made for carbofuran, carbosulfan and benfuracarb in the course of the peer review, with the restriction that no final decision was taken concerning the possible inclusion of conjugates. For animal commodities the peer review suggested to limit the residue definition to 3-OH-carbofuran (preferably free and conjugated), while the current residue definition is defined as sum of carbofuran and 3-OH-carbofuran.

It is clear from the data provided in the framework of the peer review and from the information reported by the EU Reference Laboratories (EURL) and by the national control laboratories involved in the EU residue monitoring programs, that several validated analytical methods are available to analyse N-methyl-carbamate residues in plant and animal matrices at a LOQ of 0.01* mg/kg according to the current residue definitions. However for carbofuran, no information was provided, to confirm whether these methods are efficient to consider the conjugates. It is therefore no possible to conclude whether the residue levels reported in the supervised residue trials and in EU monitoring programs refer to the free residues only or whether they fully or partially include the conjugates.

EFSA recommends the withdrawal of the CXLs of 0.5 mg/kg (carbofuran) and 0.1 mg/kg (carbosulfan) in orange and mandarin taken over in the EU legislation, since the residues of carbofuran resulting from the use of the active substance carbosulfan on citrus, result in an acute intake concern for consumers. It is proposed to set MRLs for carbofuran and carbosulfan in orange and mandarin at the default LOQ level of 0.01* mg/kg.

EFSA recommends, the withdrawal of the CXLs set for carbofuran at 0.1* mg/kg on sunflower seed and at 0.05* mg/kg on rapeseed, as these uses are no longer supported by the GAPs initially proposed at Codex level. The default LOQ of 0.02* mg/kg is therefore proposed for sunflower seed and rape seed. No changes are proposed for cotton seed.

For carbosulfan, EFSA recommends the withdrawal of MRLs of 0.07* mg/kg and 0.1* mg/kg set on the "fruits and berries" and "roots and rhizomes" spice subgroups. These MRLs do not pose any consumer intake concerns, but the basis for these CXLs was not reported transparently and therefore, a conclusion whether these values are sufficiently supported by data is not possible.

For carbofuran, EFSA do not recommend the setting of an import tolerance of 0.04 mg/kg in fresh cultivated mushrooms requested by the European Spice Association (ESA). The proposed value is not sufficient to cover the range of residues observed in the ESA survey conducted on white Chinese mushrooms. Moreover, this level results in an acute intake concern for the consumers (IESTI 225 % ARfD, BE Child). Therefore, EFSA recommends to maintain the MRL for fresh cultivated mushrooms at the LOQ of 0.01* mg/kg.

For carbofuran, the LOQ levels reported as MRLs in the EU Regulation, are considered as being not sufficiently protective for European consumers, since resulting in large exceedance of the acute reference dose for a large number of food commodities. The setting of MRLs lower than the default LOQ value of 0.01* mg/kg is therefore recommended, especially for the food commodities that contribute significantly to consumer diets. For such commodities, lower LOQs as listed below are suggested to ensure that the ARfD is not exceeded:

- 0.005* mg/kg for strawberries, spinach & similar and pulses,
- 0.003* mg/kg for miscellaneous fruits,
- 0.002* mg/kg for stone fruits, grapes, tropical root/tuber, fruiting vegetables, brassica vegetables, lettuce & other salad plants and stem vegetables
- 0.001* mg/kg for apple, potato and milk; the highest contributors to consumer diets. For milk it is proposed to apply the LOQ of 0.001* mg/kg to the 3-OH-carbofuran metabolite only (free and conjugated), as carbofuran is not expected to be present in animal matrices.

This recommendation is however pending the availability of appropriate analytical methods.

For carbosulfan, no changes are suggested to the other MRL (LOQ) values established in Annex II and IIIB of Regulation (EC) No 396/2005, except for the citrus and spices groups were the setting of MRLs at the default LOQ levels of 0.01* and 0.05* mg/kg is recommended. The proposed levels result in no chronic or acute consumer intake concerns.

No changes are proposed to the MRLs (LOQs) listed for benfuracarb and furathiocarb in Annex V of Regulation (EC) No 396/2005, since these LOQs result in chronic and acute consumer exposures not exceeding the toxicological reference values.

Thus EFSA proposes to amend the existing MRLs as reported in the summary table.

SUMMARY TABLE

Code number[(a)]	**Commodity**	**Existing EU MRL** (mg/kg)	**Proposed EU MRL** (mg/kg)	**Justification for the proposal**
Carbofuran (sum carbofuran, 3-OH-carbofuran, expressed as carbofuran)				
110020	Oranges	0.5	0.01*	The use of carbosulfan on citrus results in carbofuran residues leading to a large acute intake concern for the consumers
110050	Mandarins	0.5	0.01*	
280020	Cultivated fungi	0.01*	0.01*	No change recommended
401050	Sunflower seed	0.10	0.02*	CXL no longer supported by US GAPs.
401060	Rape seed	0.05	0.02*	CXL no longer supported by Polish GAPs.
401090	Cotton seed	0.1	0.1	No change recommended
-	Other commodities	The setting of LOQs below the default value of 0.01* mg/kg recommended for a certain number of food commodities (see table 4-6)		
Carbosulfan				
110020	Oranges	0.1	0.01*	The use of carbosulfan on citrus results in carbofuran residues leading to a large acute intake concern for the consumers
110050	Mandarins	0.1	0.01*	
401090	Cotton seed	0.05*	0.05*	No change recommended
820000	Spices (fruits/berries)	0.7*	0.05*	Pending a common reassessment for both, carbofuran and carbosulfan
830000	Spices (roots/rhizomes)	0.1*	0.05*	

(a): According to Annex I of Regulation (EC) No 396/2005.
(*): Indicates that the MRL is set at the limit of analytical quantification.

TABLE OF CONTENTS

BACKGROUND

The European Commission received a request from the European spice Association (ESA) for the setting of an import tolerance for carbofuran in white mushrooms (champignons) from China based on monitoring data. ESA provided data showing that 70 % of dried white mushrooms from China exceed a level of 0.1 mg/kg. Taking into account a drying factor of 10, this would correspond to 70 % exceedances of the current EU maximum residue level of 0.01 mg/kg. The achievable maximum residue level proposed by ESA is 0.4 mg/kg for dried white mushrooms corresponding to 0.04 mg/kg for fresh white mushrooms.

In the EU, carbofuran is a non approved substance for which maximum levels have been set at the limit of quantification (LOQ) in Regulation (EC) No. 899/2012, apart from some Codex Limits (CXLs) that were taken over by the EU in Regulation (EC) No 520/2011 and were maintained in Regulation (EC) No 899/2012.

ESA submitted information that also in China, carbofuran is not authorised for use on white mushrooms, but stated that cross-contamination could take place from the substrate that is often composed of cereal straw. Rice and wheat are authorised to be treated with carbofuran in China.

The issue was brought to the attention of Member States in the Standing Committee of the Food Chain and Animal Health (SCOFCAH) of 16-17 September 2013. Concerns of the Member States were raised due to the low ADI and ARfD of carbofuran (both at 0.00015 mg/kg bw per day), not only as regards the specific import tolerance request, but also with regard to the existing maximum residue levels in Regulation (EC) No 396/2005. Since other active substances that are not authorised in the EU, but that may be used in third countries, i.e. carbosulfan, benfuracarb and furathiocarb, may also lead to residues of carbofuran, the existing maximum residue levels for these substances (including existing CXLs where available) should also be reviewed in this context.

On 02 October 2013, in accordance with Article 43 of Regulation (EC) No 396/2005, the European Commission requested EFSA to evaluate the information provided by ESA with view of setting a temporary maximum level on cultivated mushrooms and considering in parallel, a review of all existing EU MRLs for carbofuran, carbosulfan, benfuracarb and furathiocarb. The request was included in the EFSA Register of Questions with the reference number EFSA-Q-2013-00844 and the following subject:

Carbofuran: Request for a scientific Opinion on the review of the existing MRLs of carbofuran and on the setting of a temporary MRL on mushrooms

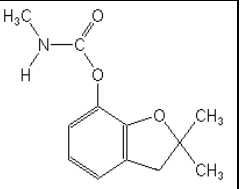
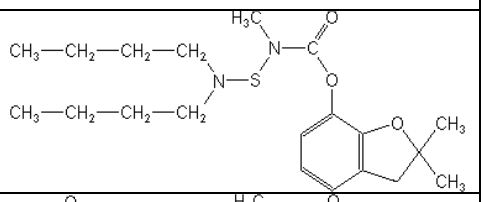
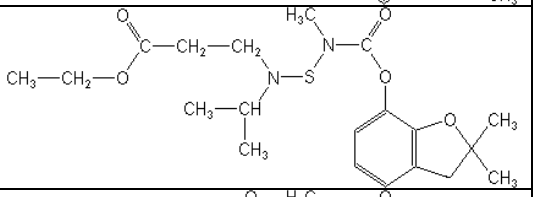
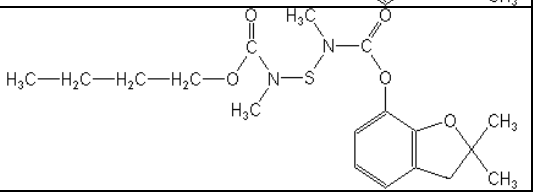
TERMS OF REFERENCE

In accordance with Article 43 of Regulation (EC) No 396/2005, the European Commission asks the European Food Safety Authority to provide by 31 January 2014 a scientific opinion considering the review of the existing maximum levels for carbofuran in all commodities of annex I to Regulation (EC) No 396/2005, including the CXLs that were taken over in the EU legislation by regulation (EC) No 521/2011. Possible residues resulting from the presence of other active substances should also be taken into account. Therefore, the existing MRLs (including CXLs where available) for the active substances carbosulfan, benfuracarb and furathiocarb should also be reviewed with view to their contribution to residues of carbofuran.

The deadline for providing the reasoned opinion was agreed to be 31 January 2014.

ACTIVE SUBSTANCES AND USE PATTERNS

Carbofuran, carbosulfan, benfuracarb and furathiocarb belong to the N-methyl carbamate insecticide group. N-methyl-carbamates act by inhibition of the acetylcholine esterase (AChE) that catalyses in the nervous system of mammals and insects, the hydrolysis of the neurotransmitter acetylcholine (Ach) to choline and acetic acid. N-methyl-carbamates are systemic compounds which have been registered within the EU for uses as insecticide, acaricide or nematicide. The ISO common names (IUPAC) and the chemical structures of the different compounds are reported in the table below.

Active substance	**ISO common name (IUPAC)** (MW: molecular weight)	**Chemical structure**
carbofuran	2,3-dihydro-2,2-dimethylbenzofuran-7-yl methylcarbamate MW: 221.3	
carbosulfan	2,3-dihydro-2,2-dimethylbenzofuran-7-yl(dibutylaminothio) methylcarbamate MW: 380.5	
benfuracarb	ethyl *N*-[2,3-dihydro-2,2-dimethyl benzofuran-7-yloxycarbonyl(methyl) aminothio]-*N*-isopropyl-β-alaninate MW: 410.5	
furathiocarb	butyl 2,3-dihydro-2,2-dimethylbenzofuran-7-yl *N,N′*-dimethyl-*N,N′*-thiodicarbamate MW: 382.5	

A dossier, in support to the inclusion of the active substance furathiocarb in Annex I to Directive 94/414/EEC was not provided and therefore, the active substance was not peer reviewed and a non-inclusion decision was taken by Commission regulation (EC) No 2076/2002[3]. All authorised uses were withdrawn within the EU Member States by 25 July 2003 (extended to 30 June 2007 for the use on leek in Belgium, as an essential use).

Carbofuran, carbosulfan and benfuracarb were evaluated in the framework of Directive 91/414/EEC with Belgium designated as Rapporteur Member State (RMS). The Draft Assessment Reports (DAR) were peer reviewed by EFSA (EFSA, 2006a, b, c), considering the following representative uses:

- carbofuran: Soil granule application at drilling, on maize, sugar beet and sunflower,
- carbosulfan: Soil granule application at drilling, on maize and sugar beet and foliar applications on citrus and cotton.
- benfuracarb: Soil granule application at pre-plantation, on brassica.

[3] Commission Regulation (EC) No 2076/2002 of 20 November 2002 extending the time period referred to in Article 8(2) of Council Directive 91/414/EEC and concerning the non-inclusion of certain active substances in Annex I to that Directive and the withdrawal of authorisations for plant protection products containing these substances. OJ L 31, 31.11.2002, p. 3-11.

Since a number of concerns related to the ground water contamination, the acute consumer exposure or the ecotoxicological effects were identified, it was concluded that the criteria for inclusion in Annex I to Directive 94/414/EEC were not met. Non-inclusion decisions were therefore published for carbofuran and carbosulfan by Commission decisions 2007/416/EEC[4] and 2007/415/EEC[5] (authorisations to be withdrawn by 13 December 2007) and by Commission decision 2007/615/EEC[6] for benfuracarb (withdrawal by 20 March 2008).

Following the non-inclusion decision and in accordance with the provisions in Chapter III of Commission Regulation (EC) No 33/2008[7], resubmission dossiers were introduced for carbofuran, carbosulfan and benfuracarb. The representative uses supported in the framework of this resubmission were limited to soil granule application on sugar beet at drilling for carbofuran and carbosulfan and to soil application on brassica at transplantation for benfuracarb. These active substances were peer reviewed again, considering the additional data provided in response to the areas of concern identified in the course of the initial review. Updated conclusions were issued by EFSA in 2009 (EFSA, 2009a, b, c). The additional data provided in support of the resubmission were concluded to be insufficient to address all areas of concern and therefore, the withdrawal decisions were maintained for all active substances. In accordance with Commission Implementing Regulation (EU) No 540/2011[8] these active substances are considered not approved under Regulation (EC) No 1107/2009, repealing Council Directive 91/414/EEC.

Following the non-approval, EU MRLs for carbofuran and carbosulfan were established in Annex II and IIIB of Regulation (EC) No 396/2005, last amended by Regulation (EU) No 899/2012[9], mostly at LOQ values, except for orange, mandarin (carbofuran and carbosulfan), sunflower, rape seed, cotton seed (carbofuran) and spices (carbosulfan), where CXLs were taken into account. In this Regulation, EU MRLs for benfuracarb and furathiocarb were set at default LOQ values in Annexe V of Regulation (EC) No 396/2005. For the four substances under consideration no MRL review under Article 12 of Regulation (EC) No 396/2005 is foreseen, since the non-approval decision was taken before the deadline triggering the review.

For carbofuran, Codex Alimentarius has established CXLs for several plant and animal commodities (see Appendix A), of which a CXL of 0.5 mg/kg on orange and mandarin (based on the use of carbosulfan) and 0.1 mg/kg on sunflower and cotton seeds, which were transposed in the EU legislation. CXLs have also been established for carbosulfan in various plant and animal commodities and the CXLs of 0.1 mg/kg for mandarin, orange and spices (roots or rhizome) and 0.7 mg/kg for spices (fruits or berries) were taken over in the EU legislation. No CXLs are available for benfuracarb and furathiocarb as these two compounds have never been reviewed by Codex.

[4] Commission Decision 2007/416/EC of 13 June 2007 concerning the non-inclusion of carbofuran in Annex I to Council Directive 91/414/EEC and the withdrawal of authorisations for plant protection products containing that substance, OJ L 156, 16.6.2007, p. 30-31.

[5] Commission Decision 2007/415/EC of 13 June 2007 concerning the non-inclusion of carbosulfan in Annex I to Council Directive 91/414/EEC and the withdrawal of authorisations for plant protection products containing that substance, OJ L 156, 16.6.2007, p. 28-29.

[6] Commission Decision 2007/615/EC of 20 September 2007 concerning the non-inclusion of benfuracarb in Annex I to Council Directive 91/414/EEC and the withdrawal of authorisations for plant protection products containing that substance, OJ L 246, 21.9.2007, p. 47-48.

[7] Commission Regulation (EC) No 33/2008 of 17 January 2008 laying down detailed rules for the application of Council Directive 91/414/EEC as regards a regular and an accelerated procedure for the assessment of active substances which were part of the programme of work referred to in Article 8(2) of that Directive but have not been included into its Annex I, OJ L 15, 10.1.2008, p. 5-12.

[8] Commission Implementing Regulation (EU) No 540/2011 of 23 May 2011 implementing Regulation (EC) No 1107/2009 of the European Parliament and of the Council as regards the list of approved active substances. OJ L 153, 11.06.2011, p. 1-186.

[9] Commission Regulation (EU) No 899/2012 of 21 September 2012 amending Annexes II and III to Regulation (EC) No 396/2005 of the European Parliament and of the Council as regards maximum residue levels for various active substances in or on certain products and amending that Regulation by establishing Annex V listing default values, OJ L 273, 6.10.2012, p. 1-75.

ASSESSMENT

EFSA bases its assessment on the Draft Assessment Reports (DAR) prepared under Council Directive 91/414/EEC for the active substances carbofuran, carbosulfan and benfuracarb (Belgium, 2008a, b, 2009), the Commission Review Reports on these active substances (EC, 2007a, b, c), the conclusions on the peer review of the pesticide risk assessment of the active substances carbofuran, carbosulfan and benfuracarb (EFSA, 2006a, b, c and 2009a, b, c) and the JMPR Evaluation reports (FAO, 1997, 1999, 2002, 2003, 2008, 2009, 2010 and 2012). Furathiocarb has not been supported under Directive 91/414/EEC and therefore, a DAR and an EFSA conclusion are not available. The assessment is performed in accordance with the legal provisions of the Uniform Principles for the Evaluation and the Authorisation of Plant Protection Products adopted by Commission Regulation (EU) No 546/2011[10] and the currently applicable guidance documents relevant for the consumer risk assessment of pesticide residues (EC, 1996, 1997a-g, 2000, 2010a,b, 2011; OECD, 2011).

1. Toxicological reference values applicable to N-methyl-carbamate active substances

The toxicological profile of the active substances carbofuran, carbosulfan and benfuracarb was assessed in the framework of the peer review under Directive 91/414/EEC and the data were sufficient to derive the toxicological reference values reported in Table 1-1 (EFSA, 2009a,b,c).

Little information is available for furathiocarb, as this active substance has not been peer reviewed. ADI values of 0.0035 mg/kg bw per day (BE) and 0.003 mg/kg bw per day (AUS) and an ARfD of 0.006 mg/kg bw (BE) are reported in the EU pesticides database (EC, 2014). The origin of these reference values is not stated, but a NOEL of 0.35 mg/kg bw per day based on a rat study, is reported in the Pesticide Manual[11]. The toxicological reference values considered in this Reasoned Opinion are listed in Table 1-1 below.

Table 1-1 Overview of the toxicological reference values applicable to N-methyl carbamates

	Source	Year	Value	Study relied upon	Safety factor
Carbofuran					
ADI	EFSA	2009	0.00015 mg/kg bw per day	Acute neurotoxicity (pups), rat	200
ARfD	EFSA	2009	0.00015 mg/kg bw	Acute neurotoxicity (pups), rat	200
Carbosulfan					
ADI	EFSA	2009	0.005 mg/kg bw per day	Acute neurotoxicity, rat	100
ARfD	EFSA	2009	0.005 mg/kg bw	Acute neurotoxicity, rat	100
Benfuracarb					
ADI	EFSA	2009	0.01 mg/kg bw per day	NOAEL dog, 2 generation rat	100
ARfD	EFSA	2009	0.02 mg/kg bw	28-day neurotoxicity, rat	100
Furathiocarb					
ADI	AUS	1991	0.003 mg/kg bw per day	Not reported	
ARfD	BE	1999	0.006 mg/kg bw	Not reported	

[10] Commission Regulation (EU) No 546/2011 of 10 June 2011 implementing Regulation (EC) No 1107/2009 of the European Parliament and of the Council as regards uniform principles for evaluation and authorisation of plant protection products. OJ L 155, 11.06.2011, p. 127-175.

[11] The e-Pesticide Manual (15th edn) ver. 5.1 Copyright © BCPC.

The toxicological reference values for carbofuran are based on a LOAEL of 0.03 mg/kg bw, derived from an acute neurotoxicity study on rat, considering a 20 % inhibition of the brain acetyl cholinesterase activity in pups (11 days). As the toxicological reference values were derived from a LOAEL, a safety factor of 200 was applied. In addition, it was concluded that the values proposed for carbofuran are also applicable to its main metabolites; 3-OH-carbofuran and 3-keto-carbofuran.

Considering the same acute neurotoxicity study on rat (pups), the JMPR in 2012 concluded on an ADI of 0.001 mg/kg bw per day and an ARfD of 0.001 mg/kg bw (FAO, 2012). Differences in the proposals result from the following points:

- The value of 0.03 mg/kg bw derived from the rat study was concluded to be a NOAEL,
- A reduce safety factor of 25 was considered to be appropriate, as supported by data from a toxicological study conducted on human volunteers in 1976, and since the acute toxic effects of carbofuran were seen to be C_{max} dependent. Given the apparent higher sensitivity of younger animals, the ARfD was concluded to be adequately protective of infants and children, as based on a NOAEL from a study in pups aged 11 days.

For carbosulfan, the JMPR established in 2003 an ADI of 0.01 mg/kg bw per day on the basis of pathological changes in eye and inhibition of brain and erythrocyte cholinesterase activity in a 2-year study in rat and applying a safety factor of 100. This proposal was in compliance with the conclusion of the initial peer review conducted under Directive 91/414/EEC (EFSA, 2006b). However, on a basis of a new acute neurotoxicity study on rat provided in the framework of the 2009 resubmission, a NOAEL of 0.5 mg/kg bw for brain acetyl cholinesterase inhibition was proposed, resulting in an ADI value of 0.005 mg/kg bw per day when applying a safety factor of 100 (EFSA, 2009b). This study was not considered further by JMPR. The difference in the ARfD value of 0.02 mg/kg bw concluded by the 2003 JMPR, results from the use of a safety factor of 25.

Benfuracarb and furathiocarb have never been evaluated by JMPR and therefore, toxicological reference values are not available at Codex level.

2. Residue definitions for N-methyl-carbamate compounds

2.1. Residue definitions applicable to plant commodities

The metabolism of carbofuran, carbosulfan and benfuracarb in primary crops was evaluated by the RMS Belgium (Belgium, 2008a, b, 2009) and reviewed by EFSA in the framework of the peer review under Directive 91/414/EEC (EFSA, 2009a, b, c).

Numerous metabolism studies conducted on five crop groups were provided, using either carbofuran, carbosulfan or benfuracarb and soil or foliar applications. Some studies performed with carbosulfan were also submitted in support to carbofuran. An overview of the available metabolism studies is presented in Table 2-1. Some studies were considered informative only, as not supported by a sufficient identification of radioactive residues.

The metabolism studies show carbosulfan and benfuracarb to be rapidly converted to carbofuran by cleavage at the N-S bond. This observation is supported by the low DT_{50} in soil, estimated to be in the range of 0.5 to 11 days for carbosulfan and of 0.2 to 1.2 days for benfuracarb. Carbosulfan is almost not present in beet leaves 30 days after foliar application and not present in rice plants 11 days after soil application (<1 % TRR). Benfuracarb is not detected in cauliflower leaves and accounts for less than 1 % TRR in sugar beet leaves, 7 and 56 days after soil application. Little information is available for furathiocarb as this active substance has not been supported for annex I inclusion under Directive 91/414/EEC. Data from open literature, confirm that furathiocarb is quickly degraded to carbofuran

after application, with DT_{50} in soil estimated to be in the range of 3 to 15 days (Hendry KM, 1988, Rouchaud J, 1990, ToxNet[12]).

Table 2-1: Summary of available metabolism studies in plants

Crop group	Active substance	Year	Crop	Application type	Dose (g/ha)	Remarks
Fruits	carbosulfan	1996	Orange	foliar	500	
	benfuracarb	2003	Apple	Foliar	400	
Leafy crops	benfuracarb	2002	cabbage	Soil/at sowing	1032	informative
	benfuracarb	2008	cauliflower	Soil at trans-planting	20600a	
	carbosulfan	1982	alfalfa	Leaf/µ-syringe	500	
Root/tuber	carbofuran	1994	potato	Soil/post-emergence	7392	
	benfuracarb	2002	potato	Foliar (BBCH 69)	208	informative
	carbosulfan	1982	sugar beet	Soil or Foliar	1100	
	carbofuran	2005	sugar beet	Soil/at sowing	2400a	
	benfuracarb	2003	sugar beet	Soil/post sowing	1000	
Pulses/oilseeds	carbofuran	1977	soya bean	Soil/pre-planting	-	informative
	carbofuran	1994	soya bean	Soil/pre-planting	5520	
	carbosulfan	1983	soya bean	Soil/post-planting	2200	
	benfuracarb	1984	cotton	Leaf painting	-	
	benfuracarb	1985	bean/cotton	Leaf painting	-	
Cereals	carbofuran	1994	maize	Soil/pre-planting	3337	
	carbofuran	2005	maize	Soil/at sowing	3400a	
	carbofuran	2006	maize	Soil/at sowing	642	
	carbosulfan	1983	maize	Soil/at sowing	3360	
	carbosulfan	1980	rice	Soil/pre-planting	1100	
	benfuracarb	1985	maize	Leaf painting	-	

(a): lower dose rates were also investigated.

Following application, carbosulfan, benfuracarb and furathiocarb are rapidly converted to carbofuran and therefore, the metabolic profile of these active substances in plants is mainly the result of the metabolic pattern of the active substance carbofuran.

The metabolism of carbofuran in plants proceeds primarily via the hydroxylation of the furane ring to give the 3-OH-carbofuran[13] metabolite, with further oxidation to 3-keto-carbofuran[14]. 3-OH-carbofuran was identified as the major metabolite in plants, accounting mostly for more than 20% TRR, while 3-keto-carborufan was always less than 5 % TRR. In cabbage, following soil application prior to planting, carbofuran, 3-OH-carbofuran and 3-keto-carbofuran were also identified as their conjugated forms, accounting for 17 %, 6 % and 3 % of the TRR, respectively. The other metabolites identified in plants resulted from the hydrolysis of carbofuran to its phenolic derivatives[15],

[12] Toxicological data Network, US Department of Health and Human services, available at: http://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+6664.
[13] 3-OH-carbofuran: see Appendix B.
[14] 3-keto-carbofuran : see Appendix B.
[15] Phenolic derivatives 3-OH-carbofuran-phenol, 3-keto-carbofuran-phenol and 4-OH-carbofuran-phenol: see Appendix B.

leading to the 3-OH-carbofuran-phenol, 3-keto-carbofuran-phenol and 4-OH-carbofuran-phenol metabolites.

Based on these studies and for carbofuran, the peer review concluded to define the residue for risk assessment as the "*sum of carbofuran and 3-OH-carbofuran, both free and conjugated, expressed as carbofuran*" (EFSA; 2009a). However, for carbosulfan, considering that 3-keto-carbofuran is of similar toxicity to carbofuran, the residue definition was proposed as "*sum of carbofuran, 3-OH-carbofuran and 3-keto carbofuran, all free and conjugated, expressed as carbofuran*" (EFSA, 2009b).

For monitoring, the residue definitions for carbofuran were left open (EFSA, 2009a, b). It was agreed that at least, carbofuran and its metabolite 3-OH-carbofuran have to be included in the residue definition, but a final decision whether their conjugates should also be included was not taken since validation data demonstrating that the wider residue definition covering the conjugates can be enforced were lacking. Additional data were requested to confirm whether the proposed analytical methods are able or not to release and consider the conjugates. In addition for carbosulfan and benfuracarb, separate residue definitions for monitoring were proposed as carbosulfan and as benfuracarb

The current residue definitions for enforcement set in Regulation (EC) No 396/2005 for the N-methyl-carbamate compounds are the following:

- carbofuran: sum of carbofuran and 3-OH-carbofuran expressed as carbofuran,
- carbosulfan: carbosulfan
- benfuracarb: benfuracarb
- furathiocarb: furathiocarb

The current enforcement residue definitions are similar to the plant residue definitions proposed for carbofuran, carbosulfan and benfuracarb in the course of the peer review, with the restriction that no final decision was taken for carbofuran concerning the possible inclusion of conjugates. In the framework of this request no further information was made available to take a final decision on the enforcement residue definitions.

2.2. Residue definition applicable to animal commodities

The metabolism of the N-methyl-carbamate insecticides in livestock animals was evaluated in the framework of the peer review of the active substance carbofuran and carbosulfan (EFSA, 2009a, b). An overview of the available studies is presented in Table 2-2 below. The benfuracarb study was submitted in support of the carbofuran dossier.

Table 2-2 Summary of the available metabolism studies in animals

Active substance	Animal	Year	Dose rate	days	Metabolite characterisation
carbofuran	Goat	1994	25 mg/kg feed	7	milk, muscle, liver kidney
	Hen	1994	25 mg/kg feed	7	eggs, liver, kidney
	Hen	1970	2.7 mg/kg feed	1	informative (faeces)
benfuracarb	Goat	1983	13.5 mg/kg feed	10	informative (urine)
carbosulfan	Hen	1981	6.0 mg/kg feed	14	muscle, liver
	Goat	1982	10.9 mg/animal	7	milk, liver, kidney
	Goat	1996	25 mg/kg feed	7	milk, liver, kidney

In hen and goat, radioactive residues are mainly composed of the phenol metabolites; 3-keto carbofuran-phenol (up to 30 % TTR in milk), 3-OH-carbofuran-phenol (up to 39 % TRR in egg yolk, 21 % TRR in milk, 16 % TRR in liver and kidney). The parent compounds (carbofuran, carbosulfan and benfuracarb) are extensively metabolised and almost not detected. 3-OH-carbofuran was identified

as the major toxicological relevant metabolite, accounting up to 37 % TRR in muscle, 34 % TRR in milk, 22 % in kidney and 10 % in liver and eggs. It was concluded that most of the metabolites occurred as conjugates in animal matrices, since released after enzymatic digestion or acid hydrolysis, but no detailed information was given on the proportion of the radioactivity allocated to the conjugated compounds.

Based on the available data, it was concluded that the metabolism of the N-methyl-carbamates in animals proceeds first via the hydrolytic cleavage of the N-S bond into carbofuran with further hydroxylation to the major metabolite 3-OH-carbofuran, followed by additional hydrolysis and oxidation steps to 3-keto-carbofuran and the phenol derivatives (e.g. 3-OH-carbofuran-phenol, 3-keto-carbofuran-phenol).

For carbofuran and considering that 3-OH-carbofuran free and conjugated was identified as the major toxicological relevant metabolite in the different studies, the residue definition for risk assessment was proposed as "*3-OH-carbofuran, free and conjugated expressed as carbofuran*" (EFSA, 2009a). Although identified at low levels and proportions in animal matrices (up to 4 % TRR in liver and kidney), the inclusion of the 3-keto-carbofuran metabolite was recommended in the conclusion of the peer review of the active substance carbosulfan and therefore, the residue definition for carbofuran was proposed as "*sum of 3-OH-carbofuran and 3-keto carbofuran, both free and conjugated expressed as carbofuran*" (EFSA, 2009b).

For monitoring, the residue definitions for carbofuran and carbosulfan were left open, pending the submission of information on the efficiency of the analytical methods to release the conjugates. However, for both carbofuran and carbosulfan, the peer review expressed a preference to include the conjugates and to define the residue for monitoring as proposed above for risk assessment (EFSA, 2009a, b).

The residue definitions for enforcement in Regulation (EC) No 396/2005 for the N-methyl-carbamates are proposed as:

- carbofuran: sum of carbofuran and 3-OH-carbofuran expressed as carbofuran,
- carbosulfan: carbosulfan
- benfuracarb: benfuracarb
- furathiocarb: furathiocarb

For carbofuran, the current residues definition deviates from the peer review proposal where only 3-OH-carbofuran residues (free and conjugated) are considered. The inclusion of the parent carbofuran in the enforcement residue definition is questionable, as identified at very low levels and proportions in the metabolism studies, compared to its 3-OH metabolite. Its exclusion for monitoring purposes would make routine analysis simpler for the laboratories involved in the EU monitoring programs, especially for the matrices requesting a very low LOQ (milk, see section 4). A final decision on the inclusion of the conjugates is not possible, as no clear information on the contribution of the conjugates to the total residues is available and since no further information on the ability of the analytical methods to release the conjugates was presented. By default, the inclusion of the conjugates would be desirable.

3. Analytical methods for enforcement

3.1. Methods for enforcement of residues in food of plant origin

Numerous of analytical methods for the determination of carbofuran, carbosulfan and benfuracarb residues in plant commodities were submitted in support to the first review (EFSA, 2006a, b, c), using quantification by GC-NPD, GC-MS, HPLC/PCD-FLD or LC-MS and achieving LOQs of 0.01 mg/kg to 0.05 mg/kg per analyte. Finally, analytical methods based on LC/MS-MS quantification were proposed for post-registration control in the resubmission dossiers reviewed by EFSA (EFSA, 2009a, b, c).

The different methods proposed under the peer review are similar and involve first a solvent extraction. After filtration, the remaining filter cake is extracted again by refluxing in 0.25 M HCl in order to release the conjugates and the resulting extract is cleaned-up through SPE cartridge. Organic extracts are then combined, evaporated to dryness, diluted to reach the composition of the mobile phase and analysed by LC/MS-MS. Alternatively, both extracts are not pooled together and separate quantifications are done on each extracts. These methods were concluded to be sufficiently validated to analyse carbofuran, carbosulfan, and 3-OH-carbofuran in high water-, high-oil- and dry matrices, achieving an LOQ of 0.005 mg/k for each analyte. In addition, validation data were provided on high water content matrices (cabbage) at a LOQ of 0.05 mg/kg for benfuracarb, 0.0015 mg/kg for carbofuran and 0.003 mg/kg for 3-OH-carbofuran. Validation down to 0.001 mg/kg for each analyte was also confirmed in sugar beet. However, data gaps were identified to confirm the efficiency of the hydrolysis step to release the conjugates and the submission of ILV data was also requested (EFSA 2009a, b).

Carbofuran, carbosulfan, benfuracarb and furathiocarb were included in the 2010 and/or 2011 monitoring programs related to EU official controls of MRLs according Chapter V of Regulation (EC) No 396/2005 (EFSA, 2013; data 2011 not yet published). Up to 50000 to 80000 plant samples were analysed for each individual active substance. The LOQs achieved by the different national control laboratories were mostly reported as 0.01 mg/kg for carbofuran (sum)[16], carbosulfan, benfuracarb and furathiocarb. LOQs down to 0.002 mg/kg were also reported for carbofuran (sum) in some plant matrices. These LOQ values were confirmed by the information provided by EU Reference Laboratory (EURL) on single residue methods (personal communication of EURL representative). According to the data reported by the EURL, validated analytical methods are available to monitor carbofuran (sum) at LOQs of 0.01 mg/kg in plant matrices. Moreover, LOQ of 0.003 mg/kg and 0.002 mg/kg seem achievable for carbofuran and its metabolite 3-OH-carbofuran respectively, in high water-content and acidic commodities.

It is clear from the available information, that several analytical methods were validated to monitor carbofuran (sum), carbosulfan, benfuracarb and furathiocarb at a LOQ level of 0.01 mg/kg in the different plant matrix types.

Such an LOQ is appropriate to ensure that carbosulfan, benfuracarb and furathiocarb residues are not present in plant commodities at levels resulting in acute or chronic intake concerns for consumers (see section 4). In contrast, for carbofuran (sum) and having regard to its low toxicological reference values, LOQs lower than 0.01 mg/kg would be necessary, to attest that carbofuran residues are not present in plant commodities at levels of toxicological concerns for the consumers, especially for the plant commodities that contribute significantly to the consumer diets (see section 4.3).

3.2. Methods for enforcement of residues in food of animal origin

In the course of the peer review, the setting of MRLs in products of animal origin was considered unnecessary for carbosulfan and benfuracarb and therefore, analytical methods to enforce residues in commodities of animal origin were evaluated for carbofuran only (EFSA, 2009a, b, c).

The analytical method assessed in the course of the peer review was claimed to analyse carbofuran and its metabolite 3-OH-carbofuran and 3-keto-carbofuran. Residues are extracted by liquid-liquid partition for milk and by acid hydrolysis for the other matrices. After clean up on SPE cartridges, extracts are quantified by HPLC/PCD-FLD. For each individual compound, the LOQ was validated at a level of 0.05 mg/kg in meat and eggs and 0.025 mg/kg in milk. As the inclusion of conjugates in the residue definition was proposed during the peer review, a data gap was set for the validation of the efficiency of the hydrolysis step to release the conjugates.

[16] In the Reasoned Opinion and to avoid any misunderstanding, the wording carbofuran refers the compound carbofuran only, and the wording carbofuran (sum) to the "sum of carbofuran and its metabolite 3-OH-carbofuran expressed as carbofuran", as proposed in the current residue definition for monitoring.

Animal matrices were included in the 2010 and 2011 EU monitoring programs and analysed for carbofuran (sum), carbosulfan, benfuracarb and furathiocarb, according to the residue definitions currently stated under Regulation (EC) No 396/2005. Almost 1000 samples of animal origin were analysed for (125 samples only for benfuracarb). The LOQs achieved by the different national control laboratories were reported as 0.01 mg/kg for carbofuran (sum), carbosulfan, benfuracarb and furathiocarb. The availability of validated analytical methods to analyse the N-methyl-carbamate residues in animal matrices at a LOQ of 0.01 mg/kg was confirmed by the EURL (personal communication by EURL). As for plants, considering the low ARfD value set for carbofuran and the significant contribution of milk to the infant/child diets, a lower LOQ would be necessary for milk (see section 4.3).

In conclusion for plant and animal matrices, it must be highlighted that no information was submitted to confirm whether the different available analytical methods are efficient or not to consider the conjugates as suggested for carbofuran in the conclusion of the peer review. It is therefore not possible to conclude whether conjugated residues were taken into account, fully or partially, in the residue levels reported in the supervised residue trials or in the EU residue monitoring programs. This might results in an underestimation of the residue levels reported for carbofuran (sum), as conjugates were seen to represent a significant part of the TRRs in the metabolism studies (up to 17 % TRR in cabbage) and were also reported to be present in animal matrices.

4. MRL review for carbofuran, carbosulfan, benfuracarb and furathiocarb

4.1. Review of the carbofuran and carbosulfan CXLs transposed in the EU legislation.

Numerous supervised residue trials were assessed from 1997 to 2012 by the JMPR meetings to propose CXL values for carbofuran and/or carbosulfan on mandarin, orange, oilseeds (sunflower, rapeseed, cotton) and spices. All these CXLs were taken over in the EU legislation by regulation (EC) No 520/2011. It should be noted that the assessments reported in the JMPR evaluations were not fully conducted according to the current recommendations and practices, as nowadays reported in the OECD guidelines or FAO recommendations (FAO, 2009b). In particular, the following deficiencies or approximations have to be noted:

- Analytical methods were validated at LOQs in the range 0.03 to 0.05 mg/kg per analyte, but residues were quantified down to the LOD of 0.01 mg/kg. For sake of transparency, in this Reasoned Opinion, residues quantified below the LOQ were reported within brackets.
- When supported by low recoveries, residue values were sometimes corrected for recoveries.
- In some assessments, residues below the LOD/LOQ were assumed to be "zero" for the calculation of the total residues.
- Having regard to the low ARfD concluded for carbofuran at EU level, the reported LOQs are not appropriate to conclude that no residues are present at levels of toxicological concern for the consumers.
- When including a hydrolysis step, the analytical method was claimed to consider conjugates, but no data were reported to confirm this assertion,
- Trials conducted according to very dissimilar GAPs were pooled together to derive a CXL proposal.

Considering the points above, it should be highlighted that the assessments conducted in the framework of this Reasoned Opinion are affected by some uncertainties that could result in some underestimations of the consumer exposure to carbofuran residues.

a. Orange and mandarin

For orange and mandarin, the CXLs of 0.5 mg/kg (carbofuran (sum)) and 0.1 mg/kg (carbosulfan) based on the use of the active substance carbosulfan, were transposed in the EU legislation by Regulation (EU) No 520/2011 of 25 May 2011. These CXLs were initially proposed by the 1997 JMPR and reviewed for residues and/or toxicology at regular intervals, in 2002, 2003, 2004, 2008 and 2009.

- JMPR assessment

CXLs were derived from a total of 30 residue trials conducted from 1993 to 1995 in Latin America (Mexico, Brazil) and Spain, using two of three foliar applications of carbosulfan. Although performed according to dissimilar GAPs (see Table 4-1), data were pooled all together to derive a CXL.

Table 4-1 Summary of the carbosulfan residue trials on citrus assessed by the 1997 JMPR meeting

State	Year	No of trials	Citrus	No of applications and dose rate (g/ha or g/tree)	PHI (day)	Residues[(a)] (mg/kg)		
						Carbo-sulfan	Carbofuran (sum)[(b)]	
							Range	STMR
Mexico	1995	7	orange	2/3x 250 g/ha	7	<0.05	0.08-0.42	0.18
Brazil	1993	6	orange	2x 1.0 to 1.7 g/tree	7	<0.03	(0.02)-0.09	0.06
Spain	1994	4	orange	2x 3.1 to 3.6 g/tree	112	<0.03	(0.02)-0.50	0.09
	1993 & 1994	13	orange & mandarin	2x 938 g/ha	92 to 147	(0.01)	(0.04)-0.13	0.10

[(a)]: values quantified below the LOQ are reported within brackets.
[(b)]: Sum carbofuran + 3-OH-carbofuran expressed as carbofuran.

Duplicate samples were collected in most of the trials and analysed for carbosulfan, carbofuran and their metabolites 3-OH-carbofuran, 3-keto-carbofuran, carbofuran-phenol, 3-OH-carbofuran-phenol, 3-keto-carbofuran-phenol and dibutylamine (DBA). Samples from the 13 trials conducted in Spain in 1993 and 1994 were however not analysed for DBA and phenol metabolites. The analytical methods were validated at LOQs of 0.03 mg/kg or 0.05 mg/kg per analyte, but residues were quantified down to the LOD of 0.01 mg/kg.

For carbosulfan, residues were observed in the range of <0.01 mg/kg (LOD) to <0.05 mg/kg (LOQ). Based on these data and considering the HR value of (0.04) mg/kg equivalent to 0.08 mg/kg when corrected from the low recovery observed in the experiment, a CLX of 0.1 mg/kg was proposed for carbosulfan in orange and mandarin. The STMR was set at the LOD of 0.01 mg/kg (FAO, 1997).

Based on the 30 residue trials and considering the distribution of the residues observed in a total of 53 samples (duplicates counted separately) in the range of (0.02) mg/kg to 0.50 mg/kg, a CXL of 0.5 mg/kg and a STMR of 0.1 mg/kg was proposed for carbofuran (sum) (FAO, 1997).

This STMR was reconsidered further by the 2004 and 2009 JMPR meetings. Based on the initial data sets and the 6 Spanish trials where fruits were analysed for peel and pulp separately, a STMR and HR value of 0.01 mg/kg was proposed for citrus pulp. Levels of (0.02) mg/kg and (0.03) mg/kg measured in pulp in one trial at PHIs of 30, 45 days were disregarded as not relevant for the PHI of 110 days requested by the Spanish GAP. One additional value of (0.02) mg/kg in pulp was overlooked indeed, as residues of (0.02) mg/kg in whole fruit were measured in the control samples (*vs.* 0.13 mg/kg in the treated plot).

Based on the STMR of 0.01 mg/kg in pulp and considering an ADI and ARfD value of 0.001 mg/kg bw per day, the 2009 JMPR meeting concluded that the long term and short term intakes of residues of carbofuran are unlikely to present a public health concern, since the IEDI was estimated to be in the range of 20 to 70 % of the ADI and the maximum IESTI 60 % of the ARfD for children (FAO, 2009).

- EFSA assessment

Contrary to the JMPR conclusion and based on the ARfD value of 0.00015 mg/kg bw per day derived in the course of the peer review (EFSA, 2009), EFSA is of the opinion that it cannot be concluded that the use of carbosulfan on citrus crops will not result in an acute exposure exceedance the ARfD. Using the EFSA PRIMo model and the STMR of 0.01 mg/kg proposed for citrus pulp, the IESTI is estimated to be 371 % and 884 % of the ARfD for mandarin and orange respectively (UK infant and UK toddler).

Moreover, the 1997 JMPR evaluation was conducted according practices and procedures no longer compliant with the guidance documents currently in use and resulting in several approximations :

- analytical methods were validated at a LOQ of 0.03 or 0.05 mg/kg while quantifications were performed down to 0.01 mg/kg. Residue levels reported below the LOQ are affected by some uncertainties and therefore, not fully reliable,
- values below the LOD (<0.01 mg/kg) were assumed to be "zero" for the calculation of the total residues (sum carbofuran + 3-OH-carbofuran).
- no information was provided to confirm whether the analytical methods used to generate the residue data were able to consider the conjugates.
- an additional contribution to the consumer intake is expected from the 3-keto-carbofuran metabolite, detected at level of (0.01) to (0.04) mg/kg in one third of 42 samples analysed for. Based on the available data, a 10 % additional contribution is expected from 3-keto-carbofuran.

Considering the points above and since an acute intake concern for the consumers cannot be excluded, EFSA recommends the withdrawal of the current MRLs of 0.5 mg/kg (carbofuran) and 0.1 mg/kg (carbosulfan) on oranges and mandarins. EFSA proposes to set the MRL for oranges and mandarins at the default LOQ of 0.01* mg/kg.

In order to refine the consumer risk assessment, EFSA proposes to consider the residue trials conducted in Spain in 1993 and 1994, following two foliar applications at 938 g/ha, where citrus fruits were analysed separately for residues in pulp and peel. The processing factors (transfer whole fruit → pulp) calculated by EFSA at the different PHIs are reported in table 4-2 below.

Table 4-2: PF for carbofuran (sum) derived from the trials conducted in Spain

PHI (day)	**No trials**	**Mean residues** (sum, mg/kg)[(b)]		**Median PF**
		Whole fruit	**Pulp**	
0[(a)]	4	0.53	(0.04)	0.06
30 to 60	6	0.21	(0.03)	0.10
92 to 140	6	(0.07)	<0.02	<0.27

(a): fruits collected shortly after the second application.
(b): levels quantified below the LOQ of 0.1 mg/kg are reported within brackets, <0.02 mg/kg = below the LOD

Total residues in pulp were all below the LOQ and mostly related to the presence of the metabolite 3-OH-carbofuran (<0.01 to 0.05 mg/kg). Carbofuran was not detected at the LOD of 0.01 mg/kg, except in one situation at 0 day PHI at (0.02) mg/kg. For the estimation of the transfer of the residues in pulp, EFSA proposes to consider the PF of 0.1 calculated at PHI 30-60 days and to disregard the value estimated at PHI 92-140 days, as derived from residue levels below the LOQ and below the LOD. This proposal is supported by the metabolism study conducted on orange with the active substance carbosulfan (BE, 2009). Based total radioactivity measured 0, 7, 15 and 30 days after treatment, in the range of 0.775 to 0.853 mg/kg in whole fruits and of 0.001 to 0.002 mg/kg in pulp, the transfer of the residues in pulp is estimated to be less than 0.3 %. This transfer is calculated to be less than 2 % when based on the carbofuran and 3-OH-carbofuran residue levels only.

Having regard to limited transfer observed in the metabolism study on orange, EFSA is of the opinion that the use of a PF of 0.1, as derived from the residue trials conducted in Spain at day 30-60, is sufficiently conservative to be used to refine the consumer intake calculations.

Based on the EFSA PRIMo model and considering a transfer of 0.1 in pulp, acute consumer concerns are not expected from the presence of carbofuran residues in the whole fruit at the proposed LOQ level of 0.01* mg/kg, since the highest IESTI is calculated to be 88 % and 37 % of the ARfD for oranges and mandarins respectively (UK infant and UK toddler).

b. Cotton

The EU MRLs for cotton seeds were maintained by Regulation (EU) No 899/2012 at the level of 0.1 mg/kg for carbofuran and 0.05*mg/kg for carbosulfan, as corresponding to CXLs considered acceptable with regard to the consumer safety.

- JMPR assessment

CXLs for carbofuran and carbosulfan on cotton seed were considered by the JMPR meetings in 2002 and 2003. Proposals were based on trials conducted according to different GAPs, defined as soil application, foliar applications or seed dressing, and using different application rates and PHIs as summarised in the table 4-3 below. Analytical methods were validated at a LOQ of 0.05 mg/kg, but residues were quantified down to the LOD of 0.01 mg/kg.

Table 4-3: Residue trials on cotton assessed by the 2002 and 2003 JMPR meetings

Active Sub-stance	**State**	**No of trials**	**applications**		**PHI** (day)	**Residues**[(a)] (range, mg/kg)		
			Type	Number x dose (g/ha)		carbosulfan	carbofuran	3-OH-carb.
Carbo-furan	Brazil	4	Soil	1x 3000	44/46	-	<0.01	<0.01
	Colombia	4	Foliar	1x 700	25/26	-	(0.01)-(0.03)	<0.01
Carbo-sulfan	EU (SP, GR)	12	Foliar	2x 330/389	27/64	<0.05	<0.05	<0.05
	Australia	4	Foliar	1x 720/1000	55/187	(0.03)/<0.05	-	-
	Brazil	3	foliar	1x 120	55/87	<0.01/<0.05	<0.01	<0.01
		2	seed	7 g/kg seed	154/194	<0.05	-	-

[(a)]: values quantified below the LOQ are reported within brackets, <0.05 = <LOQ, <0.01 = <LOD

Considering that carbosulfan, carbofuran and 3-OH-carbofruan were not detected above the LOQ of 0.05 mg/kg in any of the trials conducted according to the different GAPs, a CXL of 0.05 mg/kg was proposed for carbosulfan and of 0.1 mg/kg for carbofuran (sum). For dietary risk assessment, the STMR and HR were proposed as 0.05 mg/kg for carbosulfan. An STMR of 0.02 mg/kg and an HR of 0.04 mg/kg was recommended for carbofuran (FAO, 2002, 2003). These proposals were adopted by the 2004 and 2005 CAC meetings.

One processing study performed with the active substance carbofuran was provided. Residue levels (sum carbofuran, 3-OH-carbofuran) in cotton seed, delinted seed, cotton meal and crude oil were 0.25, 0.06, (0.03) and (0.05) mg/kg respectively, leading to processing factor values of 0.2, 0.1 and 0.2.

- EFSA assessment

Consumption figures are not available for cotton seed oil for the diets included in the PRIMo model. For carbofuran, estimation performed considering the highest consumption figure reported for peanut oil (2.9 g/kg bw[17], NL child), a PF of 0.2 for crude oil and the CXL of 0.1 mg/kg, result in an acute intake of 39 % of the ARfD.

For carbosulfan, the acute intake is estimated to be less than 6 % of the ARfD when calculations are performed using the CXL of 0.05 mg/kg and the peanut consumption figure. Although performed according to very dissimilar GAPs, and since the uses of carbofuran and carbosulfan are not expected to result in an acute consumer concern, EFSA suggests maintaining the current CXLs in the EU legislation.

[17] 2.9 g peanut oil/kg bw, based on a 5.85 g/kg bw daily consumption of peanut seeds and a mean oil content of 50%.

c. Sunflower

The EU MRL for carbofuran in sunflower seeds was maintained at the level of 0.1 mg/kg by Regulation (EU) No 899/2012, as corresponding to a CXL considered acceptable with regard to the consumer safety.

- JMPR assessment

The CXL proposal on sunflower is based on the use of the active substance carbofuran. The assessment reported in the1997 JMPR Evaluation (FAO, 1997) is over-summarised and therefore, the basis for the CXL proposal is not fully understandable.

The evaluation was supported by the US-GAP defined for carbofuran as one in furrow application at planting (1100 g/ha), followed by four foliar applications at 560 g/ha with a 28 day PHI. Six US trials were submitted in support to these GAP with residue levels in the range of (0.03) mg/kg to 0.42 mg/kg (sum carbofuran + 3-OH-carbofuran), but they were disregarded, as conducted with a PHI of 42 to 61 days. Finally, a CXL proposal of 0.1* mg/kg (sum of LOQs) was derived from six trials conducted in Canada, with one or two foliar applications at 280 or 560 g/ha and PHIs of 91 to 111 days, where carbofuran residues were in the range of (0.01) to (0.03) mg/kg and 3-OH-carbofuran in the range of <0.01 to (0.01) mg/kg. These trials were claimed to comply with the maximum US GAP. This proposal was adopted by the 1999 CAC meeting.

- EFSA assessment

It is difficult from the over-summarised evaluation report, to understand why the six Canadian trials conducted with 2 foliar applications were concluded to be representative of the US GAP defined with a total of one soil and 4 foliar applications. Moreover, the PHIs of 91 to 111 days considered in the Canadian trials are indeed, not compliant with the 28 day PHI supported by the US GAP. Nevertheless, as the decision was taken by the US EPA to revoke all uses and tolerances for carbofuran from 31 December 2009 in the USA (USA, 2009), and according to the Codex procedures, the US GAP proposed on sunflower in 1997 cannot be considered anymore, to support the setting of a CXL at Codex level.

Since the CXL of 0.1* mg/kg on sunflower is nowadays no longer supported by the US GAP, EFSA recommends the withdrawal of the current MRL value of 0.1* mg/kg and proposes to set the MRL for sunflower at the default LOQ of 0.02* mg/kg.

In addition to the US GAPs, it is noted that in the 1997 JMPR evaluation, GAPs for sunflower were also reported for Bulgaria and Hungary, Member States where carbofuran uses are no longer authorised. No information is available to confirm whether the US GAPs are nowadays supported by countries outside the EU.

d. Rape seed

The CXL of 0.05* mg/kg for carbofuran on rape seed, adopted by the Codex Alimentarius Commission in 2004, was transposed in the EU legislation by Regulation (EU) No 899/2012. Although taken up as a LOQ by Codex, the CXL was not reported as a limit of quantification in the EU regulation (listed as 0.05 mg/kg instead of 0.05* mg/kg).

- JMPR assessment

The CXL proposal for rape seed is based on the GAPs supported by Poland at Codex level, based on the use of carbofuran as seed dressing at a dose rate of 5.25 g/kg seed (FAO, 2002).

Six residue trials conducted in Poland during the 2000 growing season according to the proposed GAPs were submitted. All residue levels for carbofuran and 3-OH-carbofuran were below the LOD of 0.01 mg/kg in all samples collected 321 to 337 days after sowing. Based on these trials, a CXL of 0.05* mg/kg and a STMR of 0.05 mg/kg were proposed for rape seed, corresponding the LOQ values achieved for each individual compounds (0.1 mg/kg for the sum carbofuran and 3-OH-carbofuran).

Rape seeds from the trials were subject to processing, but no reliable processing factors were derived, as no detectable residues were observed in the RAC and in any of the processed samples.

- EFSA assessment

Since the use of carbofuran within the European Union is no longer authorised (Commission decisions 2007/416/EEC), and according to the Codex procedures, the GAP on rape seed proposed by Poland in 2002 cannot be considered anymore, to support the setting of a CXL at Codex level. Therefore, EFSA recommends the withdrawal of the current MRL value of 0.05 mg/kg and proposes to set the MRL for rape seeds at the default LOQ of 0.02* mg/kg.

GAPs for rape seed have been reported by Poland only in the 2002 JMPR evaluation. No information is available to confirm whether GAPs for carbofuran on rape seed are still supported by countries outside the EU.

e. Spices

On spices and for carbosulfan, CXLs of 0.07 mg/kg for the subgroup "*fruits and berries*" and 0.1 mg/kg for "*roots or rhizomes*" were adopted by the Codex Alimentarius Commission in 2011. By Regulation (EU) No 899/2012, all MRLs in the spice group were decreased from 0.1* mg/kg to 0.05* mg/kg, except for the subgroups "*spices fruits and berries*" and "*roots and rhizomes*", where the MRLs were set at the values of 0.07* and 0.1* mg/kg respectively, corresponding to the CXL levels.

- JMPR assessment

The CXL proposals for spices are based on the result of a targeted monitoring program conducted in Thailand from 2005 to 2008 on a total of 407 spice samples, including root or rhizome spices (ginger, turmeric root, kra-chai root and galangal rhizome) and fruit or berry spices (pepper, black and white). Samples were analysed for a total of 38 pesticides in two accredited laboratories, using either multi-residue methods or the QuEChER method (Anastassiades et al., 2003). Considering that the submitted data were in compliance with the basic principles for the evaluation of monitoring data to estimate maximum residue levels in spices, as reported in the FAO Manual (FAO, 2009), MRL proposals were derived for several active substances.

For carbosulfan, taking into account that sufficient number of random samples were analysed for and since no detectable residues were found in any of the samples, CXLs, STMRs and HRs were proposed at the highest reported LOQ; 0.07 mg/kg for the fruits or berries spice subgroup and 0.1 mg/kg for roots and rhizomes spice subgroup. These values were adopted by the 2011 CAC meeting.

- EFSA assessment

The CXLs of 0.07 and 0.1 mg/kg for "fruits and berries" and "roots and rhizomes" spices, were derived from residue survey data, according to the procedures agreed at Codex level. Having regard to the low consumption figures incorporated in the EFSA PRIMo model, these values are of no concern for the consumers, since leading to maximum acute intake of less than 1 % of the ARfD (DE child). However, and since it is clear from the metabolism studies that, following the use of carbosulfan, the main residues of concern in plants are its metabolites carbofuran and 3-OH-carbofuran, it seems not fully consistent to adopt MRLs for carbosulfan without in parallel, proposals for carbofuran (sum carbofuran + 3-OH-carbofuran).

Moreover, it should be noted that the CXL of 0.1 mg/kg on root and rhizome spices adopted for carbosulfan is not reported in the Codex CXL data base available online[18]. In contrast, a CXL of 0.1 mg/kg on root and rhizome spices is displayed for carbofuran as adopted by the 2011 CAC, although carbofuran is mentioned neither in the JMPR evaluation (FAO, 2010) nor in the report of the 2011 CAC meeting (CAC, 2011). In addition, these CXLs are not reported as LOQs, while it is clearly stated it the 2010 JMPR evaluation that CXL proposals are based on LOQ of pesticides.

[18] http://www.codexalimentarius.net/pestres/data/pesticides/index.html

Since it is not consistent to adopt MRLs for carbosulfan without in parallel, proposals for carbofuran and, as it is not possible from the available information to understand why a CXL of 0.1 mg/kg supposedly adopted by the 2011 CAC meeting for carbosulfan, is displayed for carbofuran on the Codex website, EFSA would recommend the withdrawal of the MRLs of 0.07* and 0.1* mg/kg, pending the reassessment of the available data in order to derived proposals for both active substances. For all commodities included in the spice group, it is therefore proposed to set the MRLs at the default LOQ of 0.05* mg/kg.

4.2. Import tolerance proposal for cultivated mushrooms

Carbofuran residues were detected on dried cultivated mushrooms imported from China. N-methyl carbamate insecticides are not registered on mushrooms in China and the presence of residues is supposed to be the result of cross-contaminations from the growing substrate composed of cereal straw. According to the information provided by European Spice association, carbofuran is registered on rice and wheat in China and a transfer to mushrooms of the residues present in straw and resulting from the legal use of carbofuran on cereals, is expected.

Carbofuran residues were not observed on cultivated mushrooms in the 2010 and 2011 EU monitoring survey, where a total of 495 samples were analysed for, at LOQ levels ranging from 0.002 mg/kg to 0.05 mg/kg (sum carbofuran, 3-OH-carbofuran).

In contrast, carbofuran was almost always detected in a survey conducted by the European Spice Association (ESA) in 2012 and 2013 and focussed on cultivated dried mushrooms imported from China. Residues above the LOQ of 0.01 mg/kg were measured in 62 samples out of a total of 73. Carbofuran residues above 0.1 mg/kg were observed in 77 % of the samples, up to a maximum of 2.4 mg/kg. The mean residue level was calculated to be 0.39 mg/kg and the 95th and 97.5th percentiles, 1.3 and 1.8 mg/kg respectively. Based on this data, the ESA proposed to set an import tolerance of 0.4 mg/kg on dried cultivated mushrooms (equivalent to 0.04 mg/kg for fresh mushrooms, based on a dehydration factor of 10).

EFSA does not recommend the setting of an MRL of 0.04 mg/kg on fresh cultivated mushrooms since:

- The proposed value results in an acute intake concern for consumers. Using the EFSA PRIMo model and a variability factor of 1, the IESTI is estimated to be 225 % of the ARfD (BE, child). No further refinement is possible.
- About one third of the samples analysed for in the ESA survey denotes residue levels above 0.04 mg/kg (0.4 mg/kg on dried mushroom) and therefore, the proposed value is not appropriate to cover the range of residues observed in Chinese mushrooms.
- Since for some active substances (e.g. diflubenzuron) the metabolism in mushroom was seen to be significantly different to that observed in primary crops (EFSA, 2009), it cannot be excluded that additional compounds of toxicological concern are present in significant levels in mushrooms (e.g. 3-keto-carbofuran).

In conclusion, EFSA recommends to maintain the current LOQ value of 0.01* mg/kg for carbofuran in fresh cultivated mushrooms (equivalent to 0.1 mg/kg in dried cultivated mushrooms).

4.3. Reviews of all existing MRLs for carbofuran, carbosulfan, benfuracarb and furathiocarb

a. Benfuracarb and furathiocarb

By Regulation (EU) No 899/2012, all MRLs for benfuracarb and furathiocarb were set at default LOQ values in Annex V of Regulation (EC) No 396/2005. Depending on the commodity groups, LOQs were proposed at 0.02*, 0.05* or 0.1* mg/kg for benfuracarb and at 0.01*, 0.02* or 0.05* mg/kg for furathiocarb (see table 4-4).

Considering these LOQ values in the EFSA PRIMo model, no chronic or acute consumer intake concerns were identified. For both active substances, the highest acute intakes were calculated to be 15% and 26 % of the ARfD (potato, UK Infant) and the highest TMDI 14 % and 23 % of the ADI (NL

Child, main contributor milk). It is therefore concluded that the benfuracarb and furathiocarb LOQs listed in annex V of Regulation (EC) No 396/2005 were all set at levels resulting in chronic and acute consumer exposures not exceeding the toxicological reference values. No changes are therefore proposed to the current benfuracarb and furathiocarb MRL values.

b. Carbosulfan

The EU MRLs for carbosulfan were established in Annex II and IIIB of Regulation (EC) No 396/2005 by Regulation (EU) No 899/2012. Most of the MRLs were set at the LOQ values of 0.01*, 0.02* or 0.05* mg/kg. However, CXLs of 0.1 mg/kg on orange, mandarin and spices "roots and rhizomes", 0.07 mg/kg on spices "fruits and berries" and of 0.05 mg/kg on cotton were taken over in the EU legislation.

Assuming that MRLs for carbosulfan on orange and mandarin are set at the LOQ of 0.01* mg/kg and at 0.05* mg/kg for the spice group, and considering the MRLs (LOQs) reported in Table 4-4, no chronic or acute consumer intake concerns were identified, considering the estimations based on the EFSA PRIMo model. As previously for benfuracarb and furathiocarb, the highest IESTI is related to the consumption of potato (31 % ARfD) and the highest TMDI to the NL Child (18 % ADI, main contributor milk).

In conclusion, since the use of carbosulfan on orange and mandarin according to the GAPs supported in the JMPR evaluations, results in carbofuran residues leading to a large exceedance of the acute reference dose proposed for carbofuran (see section 4.1), EFSA recommends the withdrawal of the current MRLs of 0.1 mg/kg on oranges and mandarins. It is proposed to decrease these MRLs to the LOQ of 0.01* mg/kg, as for the other citrus fruits. In the same way, EFSA recommends to withdraw the CXLs of 0.7 mg/kg and 0.1 mg/kg transposed in the EU legislation for the spice sub-groups "fruits and berries" and "roots and rhizomes" and to harmonise the MRLs for the entire spice group to the defaults LOQ of 0.05* mg/kg, pending the reassessment of the data and the setting of residue levels for both, carbofuran and carbosulfan. No changes are proposed to the other MRLs listed for carbosulfan in Annex II and IIIB of Regulation (EC) No 396/2005.

c. carbofuran

The EU MRLs for carbofuran (sum carbofuran + 3-OH-carbofuran) were established in Annex II and IIIB of Regulation (EC) No 396/2005 by Regulation (EU) No 899/2012. Most of the MRLs were set at the LOQs of 0.01*or 0.02* mg/kg and at 0.05* mg/kg for the commodities supposed difficult to analyse such as tea, hops, spices. CXLs of 0.5 mg/kg on orange and mandarin, 0.1 mg/kg on sunflower and cotton seeds and 0.05* mg/kg on rape seeds were transposed in the EU legislation.

An acute and chronic consumer risk assessment was conducted using the EFSA PRIMo model, the MRLs set at the LOQ values in the EU regulation and, for orange, mandarin and sunflower, the LOQs of 0.01* and 0.02* mg/kg proposed following the review of the CXLs (see section 4.1, 4.2 and 4.3). The results of this assessment are reported in Table 4.5.

The LOQ values reported as MRLs for carbofuran (sum) in the EU regulation, cannot be concluded as safe for the consumers, since they result in large exceedance of the acute reference dose for a large number of food commodities, up to an IESTI of 828 % ARfD for products of animal origin (milk) and 1025 % ARfD for products of plant origin (potato). Considering the calculation process built-in the EFSA PRIMo model, a LOQ of 0.01*mg/kg will result in an exceedance of the ARfD of 0.00015 mg/kg bw per day for all food commodities that contribute significantly to the consumer diets and as soon as, the daily consumptions are above:

- 15 g/kg bw/day for the small unit size commodities (below 25 g) for which a variability factor of 1 applies.
- 2 to 5 g/kg bw/day for the large unit size commodities (above 25 g) for which a variability factors of 3, 5 or 7 apply.

Table 4-4: MRL (LOQs) proposals for carbosulfan, benfuracarb and furathiocarb and chronic and acute consumer risk assessments

Code	Groups and individual products	Carbosulfan		Benfuracarb		Furathiocarb	
		MRL	IESTI[a]	MRL	IESTI[a]	MRL	IESTI[a]
100000	1. FRUIT FRESH OR FROZEN, NUTS						
110000	(i) Citrus fruit	0.01*[b]	27	0.02*	13	0.01*	22
120000	(ii) Tree nuts	0.02*	2	0.05*	1	0.02*	1
130000	(iii) Pome fruit	0.01*	20	0.02*	10	0.01*	16
140000	(iv) Stone fruit	0.01*	12	0.02*	6	0.01*	10
150000	(v) Berries & small fruit	0.01*	13	0.02*	7	0.01*	11
160000	(vi) Miscellaneous fruit	0.01*	20	0.02*	10	0.01*	17
200000	2. VEGETABLES FRESH OR FROZEN						
210000	(i) Root and tuber vegetables	0.01*	31	0.02*	15	0.01*	26
220000	(ii) Bulb vegetables	0.02*	16	0.05*	10	0.02*	13
230000	(iii) Fruiting vegetables	0.01*	30	0.02*	15	0.01*	25
240000	(iv) Brassica vegetables	0.01*	14	0.02*	7	0.01*	11
260000	(vi) Legume vegetables (fresh)	0.01*	2	0.02*	1	0.01*	2
270000	(vii) Stem vegetables (fresh)	0.01*	12	0.02*	6	0.01*	10
280000	(viii) Fungi	0.01*	3	0.02*	1	0.01*	2
290000	(ix) Sea weeds	0.01*	0	0.02*	0	0.01*	0
300000	3. PULSES, DRY	0.01*	4	0.02*	2	0.01*	3
400000	4. OILSEEDS/OILFRUITS (except cotton)	0.02*	2	0.05*	1	0.01*	2
401090	Cotton seed	0.05*	0	0.05*	0	0.01*	0
500000	5. CEREALS	0.02*	7	0.02*	1	0.01*	2
600000	6. TEA, COFFEE, INFUSIONS, COCOA	0.05*	2	0.1*	1	0.05*	2
700000	7. HOPS (dried)	0.05*	0	0.1*	0	0.05*	0
800000	8. SPICES	0.05*	1	0.1*	0.4	0.05*	0.6
900000	9. SUGAR PLANTS	0.01*	13	0.02*	6	0.01*	11
1000000	10. PRODUCTS OF ANIMAL ORIGIN						
1010000	(i) Tissue	0.05*	13	0.02*	1	0.01*	2
1020000	(ii) Milk	0.01*	25	0.02*	12	0.01*	21
1030000	(iii) Bird eggs	0.05*	1	0.02*	1	0.01*	2
1040000	(iv) Honey	-	-	0.02*	0.1	0.01*	0.2
Chronic consumer risk assessment	Highest TMDI	18 % ADI		14 % ADI		23 % ADI	
	MS diet	NL child		NL child		NL child	
	Highest contributor	Milk (6 % ADI)		Milk (6 % ADI)		Milk (10 % ADI)	

(a): IESTI: Highest acute intake calculated for the group commodity considered (expressed as % ARfD).
(b): Carbosulfan MRLs for orange and mandarin at the LOQ of 0.01* mg/kg as proposed under section 3.1.2a.
(*): MRL set at the Limit of Quantification (LOQ).

For such commodities, lower LOQs as listed in Table 4-5 for carbofuran (sum), would be requested to ensure that the ARfD is not exceeded, down to:

- 0.005* mg/kg for strawberries, spinach & similar and pulses,
- 0.003* mg/kg for miscellaneous fruits,
- 0.002* mg/kg for stone fruits, grapes, tropical root/tuber, fruiting vegetables, brassica vegetables, lettuce & other salad plants and stem vegetables
- 0.001* mg/kg for the highest contributors to the consumer diets such as apple, potato and milk (respectively 21, 22 and 124 g/kg bw, UK infant).

For milk, the information provided by the metabolism studies on goat conducted with the active substances carbofuran and carbosulfan indicates that carbofuran is not present in milk and the residues of toxicological concern mostly limited to the 3-OH-carbofuran metabolite (free and conjugated). As carbofuran is not expected to be present in milk since extensively metabolised, it is proposed to apply the LOQ value of 0.001* mg/kg to the metabolite 3-OH-carbofuran only (equivalent to 0.002* mg/kg for the sum carbofuran + 3-OH-carbofuran if carbofuran level is by default, assumed to be <0.001 mg/kg). The use of an analytical method validated to consider the possible conjugates would be desirable.

Additional refinement of the acute intake estimations, using processing factors (PF) or information on residues in the edible parts is limited. As most of the residues studies were conducted using analytical methods achieving an LOQ of 0.05 mg/kg per analyte (0.1 mg/kg for the sum carbofuran, 3-OH-carbofuran), a "no-residues" situation was often concluded for a large number of crops and the submission of processing studies was therefore not required. Moreover when provided, no reliable processing factors could be derived, since residues in the RAC and processed fractions were often close or below the LOQs.

However for citrus, a PF of 0.1 was proposed for the transfer from the whole fruit to the pulp (see section 4.1). Even if not supported by data, it is proposed to extrapolate this PF of 0.1 to the miscellaneous fruits group and cucurbit group (inedible peel). Assuming such an extrapolation, the setting of a MRL at the LOQ of 0.01* mg/kg would indeed, result in an acute consumer intake lower than the ARfD.

In conclusion, for a certain number of crops, the setting of default MRLs at LOQ values below 0.01* mg/kg, down to 0.001* mg/kg for apple and potato, would be necessary to ensure that carbofuran residues are not present in food commodities at levels resulting in an acute intake concern for consumers. Even if reached by some laboratories on a limited number of matrix types (see section 3), it is not sure that such low levels can be routinely achieved for the different commodity groups listed in Table 4-5.

The chronic consumer intake calculations result in an exceedance of the ADI of 0.00015 mg/kg bw per day, with chronic intakes calculated to be 494 % ADI using the current MRL (LOQ) values and 202 % ADI when LOQ of 0.005* to 0.001* mg/kg are considered in the assessment for a certain number of food commodities (see table 4-5). These exceedances should however be considered as theoretical since the PRIMo model assumptions for the long-term exposure are very conservative, assuming that residues are present in all food items at LOQ levels. In reality, it is unlikely that all crops included in the model have been treated with the active substance and therefore, that all food consumed contain residues at the LOQ levels. For this reason, an effective exceedance of the long-term toxicological reference value can be excluded with an acceptable probability and these exceedances considered theoretical.

Table 4-5: Current MRL (LOQ) values for carbofuran (sum) and LOQ levels requested

Code	Groups & individual products Commodity with IESTI >ARfD		MRL (LOQ) (mg/kg)	IESTI (%ARfD)	Refined assessment LOQ required for IESTI<ARfD[a]		
					MRL	IESTI	Comment
100000	1. FRUIT FRESH OR FROZEN NUTS						
110000	(i) Citrus fruit	Grapefruit	0.01*	595	0.01*	60	Assuming a PF whole fruit/pulp of 0.1
		Orange	0.01*[b]	884	0.01*	88	
		Lemon	0.01*	230	0.01*	23	
		Lime	0.01*	134	0.01*	13	
		Mandarin	0.01*[b]	371	0.01*	37	
120000	(ii) Tree nuts		0.02*	56	0.02*	56	
130000	(iii) Pome fruit	Apple	0.01*	653	0.001*	65	Refinement not possible, LOQ lowered to 0.001 or 0.002 mg/kg
		Pear	0.01*	607	0.001*	60	
140000	(iv) Stone fruit	Apricot	0.01*	206	0.002*	41	
		Peach	0.01*	396	0.002*	79	
		Plum	0.01*	219	0.002*	44	
150000	(v) Berries & small fruit						
151010	(a) table/Wine grapes	Table grape	0.01*	437	0.002*	87	
152000	(b) Strawberries		0.01*	104	0.005*	52	
153000	(c) Cane fruit		0.01*	71	0.01*	71	
154000	(d) Other small fruit & berries		0.01*	62	0.01*	62	
160000	(vi) Miscellaneous fruit						
161000	(a) Edible peel	Fig	0.01*	106	0.003*	32	
		Persimmon	0.01*	266	0.003*	80	
162000	(b) Inedible peel, small	Kiwi	0.01*	268	0.01*	27	0.01* if PF of 0.1 applies, unless 0.001 or 0.002 mg/kg
163000	(c) Inedible peel, large	Avocado	0.01*	225	0.01*	23	
		Banana	0.01*	557	0.01*	56	
		Mango	0.01*	524	0.01*	52	
		Pineapple	0.01*	675	0.01*	68	
200000	2. VEGETABLES FRESH OR FROZEN						
210000	(i) Root and tuber vegetables						
211000	(a) Potatoes		0.01*	1025	0.001*	103	Slight exceedance
212000	(b) Tropical root/tuber	Sweet potato	0.01*	136	0.002*	27	refinement not possible, LOQ lowered to 0.001 or 0.002 mg/kg
		Yam	0.01*	290	0.002*	58	
213000	(c) Other except sugar beet	Beetroot	0.01*	292	0.002*	58	
		Carrot	0.01*	423	0.002*	85	
		Celeriac	0.01*	369	0.002*	74	
		Parsnip	0.01*	241	0.002*	48	
		Radish	0.01*	146	0.002*	29	
		Salsify	0.01*	262	0.002*	52	
		Turnip	0.01*	239	0.002*	48	
220000	(ii) Bulb vegetables	Onion	0.02*	531	0.002*	106	Slight exceedance
230000	(iii) Fruiting vegetables						
231000	(a) Solanacea	Tomato	0.01*	388	0.002*	78	
		Pepper	0.01*	420	0.002*	84	
		Aubergine	0.01*	167	0.002*	33	
232000	(b) Cucurbits-edible peel	Cucumber	0.01*	390	0.002*	78	
		Gherkin	0.01*	109	0.002*	22	
		Courgette	0.01*	310	0.002*	62	
233000	(c) Cucurbits-inedible peel	Melon	0.01*	1010	0.01*	101	0.01* if PF of 0.1 applies, unless 0.001
		Pumpkin	0.01*	228	0.01*	23	
		Watermelon	0.01*	815	0.01*	82	
234000	(d) Sweet corn		0.01*	489	0.002*	98	

Table 4-5 (continu)

Code	Groups & individual products Commodity with IESTI >ARfD		MRL (mg/kg)	IESTI	Refined assessment or LOQ required for IESTI<ARfD[a]		
					MRL	IESTI	Comment
240000	(iv) Brassica vegetables						
241000	(a) Flowering brassica	Broccoli	0.01*	388	0.002*	78	Refinement not possible, LOQ lowered to 0.002 mg/kg
		Cauliflower	0.01*	441	0.002*	88	
242000	(b) Head brassica	Head cabbage	0.01*	351	0.002*	70	
243000	(c) Leafy brassica	Chinese cabbage	0.01*	248	0.002*	50	
		Kale	0.01*	451	0.002*	90	
244000	(d) Kohlrabi		0.01*	334	0.002*	67	
250000	(v) Leaf vegetables & fresh herbs						
251000	(a) Lettuce/other salad plants	Lettuce	0.01*	179	0.002*	36	
		Scarole	0.01*	583	0.002*	116	Slight exceedance
252000	(b) Spinach & similar (leaves)	Spinach	0.01*	151	0.005*	75	
		Purslane	0.01*	101	0.005*	50	
		Beet leaves	0.01*	117	0.005*	59	
253000	(c) Vine leaves		0.01*	14	0.01*	14	
254000	(d) Water cress		0.01*	3	0.01*	3	
255000	(e) Witloof		0.01*	309	0.002*	62	
256000	(f) Herbs		0.02*	76	0.02*	76	
260000	(vi) Legume vegetables (fresh)		0.01*	76	0.01*	76	
270000	(vii) Stem vegetables (fresh)	Celery	0.01*	306	0.002*	61	
		Fennel	0.01*	136	0.002*	27	
		Artichoke	0.01*	134	0.002*	26	
		Leek	0.01*	393	0.002*	79	
		Rhubarb	0.01*	248	0.002*	50	
280000	(viii) Fungi		0.01*	84	0.01*	84	
300000	3. PULSES, DRY	Beans	0.01*	122	0.005*	61	
400000	4. OILSEEDS/OILFRUITS (except cotton)		0.02*	78	0.02*	78	
		Cotton seed	0.1*	39[b]	0.1*	39[b]	
500000	5. CEREALS	Rice	0.02*	168	0.01*	84	
		Wheat	0.02*	193	0.01*	97	
600000	6. TEA, COFFEE, INFUSIONS, COCOA		0.05*	68	0.05*	68	
700000	7. HOPS (dried)		0.05*	1	0.05*	1	
800000	8. SPICES		0.05*	24	0.05*	24	
900000	9. SUGAR PLANTS	Sugar beet	0.01*	426	0.01*	-	no transfer to sugar
1000000	10. PRODUCTS OF ANIMAL ORIGIN						
1010000	(i) Tissue		0.01*	85	0.01*	85	
1020000	(ii) Milk	Cattle	0.01*	828	0.001#	83	or 0.002* for carbofuran (sum)
		Goat	0.01*	161	0.001#	16	
1030000	(iii) Bird eggs		0.01*	83	0.01*	83	
1040000	(iv) Honey		0.01*	9	0.01*	9	
Chronic consumer Risk assessment	Highest TMDI		494 % ADI		202 % ADI		
	MS diet		NL Child		WHO Cluster B		
	Highest contributor		Milk (195 %)		Cereals (79 %)		

(a): LOQ required to achieve an IESTI<ARfD for all commodities included in the group or subgroup.
(b): IESTI calculation based on the consumption of peanut oil and a transfer factor in crude oil of 0.2 (see
(*): MRL set at the Limit of Quantification (LOQ)
(#): LOQ of 0.001* mg/kg proposed for 3-OH-carbofuran, since carbofuran not expected to be present in milk.

In conclusion, EFSA recommends the withdrawal of the CXLs of 0.5 mg/kg (carbofuran) and 0.1 mg/kg (carbosulfan) in orange and mandarin, transposed in the EU legislation by Regulation (EU) 520/2011, since an acute intake concern cannot be excluded for the residues resulting from the use of the active substance carbosulfan on citrus fruits. It is proposed to set the MRL for carbofuran in orange and mandarins at the default LOQ of 0.01* mg/kg. The withdrawal of the CXLs of 0.1* mg/kg on sunflower seed and of 0.05* mg/kg on rape seed are recommended, as the uses of carbofuran on sunflower and rape seed are no longer supported by national GAPs at Codex level. The default LOQ of 0.02* mg/kg is proposed as for the other oilseeds.

For carbofuran, the LOQ levels reported as MRLs in the EU Regulation, cannot be concluded safe for consumers, since they result in an exceedance of the acute reference dose for a large number of food commodities. The setting of MRLs (LOQs) below the default level of 0.01* mg/kg is recommended, especially for the food commodities that contribute for a significant amount in consumer diets. Recommended LOQs are summarised in table 4-6 overleaf. These recommendations are however pending the availability of appropriate analytical methods.

In addition, it should be highlighted that the assessment conducted in section 4 of this Reasoned Opinion is affected by some uncertainties that could results in some underestimations of the consumer exposure to carbofuran residues:

- No information is available to confirm whether the analytical methods validated to analysed carbofuran are efficient to consider the conjugates.
- The additional contribution to the consumer exposure of the 3-keto-carbofuran metabolite was not taken into account in the assessment. Information from the residue trials conducted on citrus, shows this metabolite to contribute to a 10 % additional consumer exposure.
- Residues were often quantified below the LOQ levels and are therefore subject to large uncertainties.

Table 4-6: Summary of the recommended MRLs (LOQs) for carbofuran

Code	Groups & individual products	Existing MRL (mg/kg)	LOQs recommended for the different commodity groups to have all IESTI<ARfD	
100000	1. FRUIT FRESH, FROZEN & NUTS			
110000	(i) Citrus fruit	0.01*	0.01*	Assuming a PF of 0.1
120000	(ii) Tree nuts	0.02*	0.02*	
130000	(iii) Pome fruit	0.01*	0.001*	
140000	(iv) Stone fruit	0.01*	0.002*	
150000	(v) Berries & small fruit			
151010	(a) table/Wine grapes	0.01*	0.002*	
152000	(b) Strawberries	0.01*	0.005*	
153000	(c) Cane fruit	0.01*	0.01*	
154000	(d) Other small fruit & berries	0.01*	0.01*	
160000	(vi) Miscellaneous fruit			
161000	(a) Edible peel	0.01*	0.003*	
162000	(b) Inedible peel, small	0.01*	0.01*	Assuming a PF of 0.1
163000	(c) Inedible peel, large	0.01*	0.01*	Assuming a PF of 0.1
200000	2. VEGETABLES FRESH, FROZEN			
210000	(i) Root and tuber vegetables			
211000	(a) Potatoes	0.01*	0.001*	Slight IESTI exceedance
212000	(b) Tropical root/tuber	0.01*	0.002*	
213000	(c) Other except sugar beet	0.01*	0.002*	
220000	(ii) Bulb vegetables	0.02*	0.002*	
230000	(iii) Fruiting vegetables			
231000	(a) Solanacea	0.01*	0.002*	
232000	(b) Cucurbits-edible peel	0.01*	0.002*	
233000	(c) Cucurbits-inedible peel	0.01*	0.01*	Assuming a PF of 0.1
234000	(d) Sweet corn	0.01*	0.002*	
240000	(iv) Brassica vegetables	0.01*	0.002*	
250000	(v) Leaf vegetables & fresh herbs			
251000	(a) Lettuce/other salad plants	0.01*	0.002*	Slight IESTI exceedance for scarole
252000	(b) Spinach & similar (leaves)	0.01*	0.005*	
253000	(c) Vine leaves	0.01*	0.01*	
254000	(d) Water cress	0.01*	0.01*	
255000	(e) Witloof	0.01*	0.002*	
256000	(f) Herbs	0.02*	0.02*	
260000	(vi) Legume vegetables (fresh)	0.01*	0.01*	
270000	(vii)Stem vegetables (fresh)	0.01*	0.002*	
280000	(viii) Fungi	0.01*	0.01*	
300000	3. PULSES, DRY	0.01*	0.005*	
400000	4. OILSEEDS AND OILFRUITS	0.02*	0.02*	Except cotton seed 0.1 mg/kg
500000	5. CEREALS	0.02*	0.01*	
600000	6. TEA, COFFEE, INFUSION, COCOA	0.05*	0.05*	
700000	7. HOPS (dried)	0.05*	0.05*	
800000	8. SPICES	0.05*	0.05*	
900000	9. SUGAR PLANTS	0.01*	0.01*	
1000000	10. ANIMAL PRODUCTS ORIGIN	0.01*	0.01*	Except Milk
1020000	(ii)Milk	0.01*	0.001*	0.001* for 3-OH-carbofuran only

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The European Commission has been informed by the European Spice Association (ESA) that a significant number of lots of dried white mushrooms imported from China, contain residue levels of carbofuran above 0.1 mg/kg corresponding, when applying a dehydration factor of 10, to an exceedance of the default MRL value of 0.01* mg/kg established for fresh cultivated mushrooms. In accordance with Article 43 of Regulation (EC) No 396/2005, the European Commission requested EFSA to evaluate the information provided by ESA with view of setting an import tolerance on cultivated mushrooms and considering in parallel, a review of all existing EU MRLs for the N-methyl-carbamate insecticides carbofuran, carbosulfan, benfuracarb and furathiocarb, including the CXLs that were taken over in the EU legislation.

The toxicological profile of the active substances carbofuran, carbosulfan and benfuracarb was assessed in the framework of the peer review under Directive 91/414/EEC and the data were sufficient to derive the following toxicological end points:

	ADI	ARfD
- carbofuran	0.00015 mg/kg bw per day	0.00015 mg/kg bw
- carbosulfan	0.005 mg/kg bw per day	0.005 mg/kg bw
- benfuracarb	0.01 mg/kg bw per day	0.02 mg/kg bw

As the active substance furathiocarb has not been supported in the framework of the review under Directive 91/414/EEC, the ADI value of 0.003 mg/kg bw per day and the ARfD value of 0.006 mg/kg bw set at member state level were considered in this reasoned opinion.

The metabolism of carbofuran, carbosulfan and benfuracarb in primary crops was assessed during the peer review on a large number of crops, belonging to a total of five plant groups. Some information on the metabolism of furathiocarb was available from public literature. Following application, carbosulfan, benfuracarb and furathiocarb are rapidly converted to carbofuran and therefore, the metabolic profile of these active substances in plants is mainly driven by the metabolic pattern of the active substance carbofuran.

For carbofuran and from the available studies, the peer review concluded to establish the residue definition for risk assessment as the "s*um of carbofuran, 3-OH-carbofuran and their conjugates, expressed as carbofuran*". The inclusion of the 3-keto-carbosulfan metabolite and its conjugates for risk assessment was also recommended during the carbosulfan review. For monitoring, the residue definition was left open. It was agreed that at least, carbofuran and 3-OH-carbofuran have to be included in the residue definition, but it could not be concluded whether their conjugates should also be considered, pending the submission of information to confirm the efficiency of the analytical methods to consider the conjugates. For carbosulfan and benfuracarb, separate residue definitions for monitoring were proposed as carbosulfan and benfuracarb, respectively.

For animal commodities, considering that 3-OH-carbofuran free and conjugated was identified as the major toxicological relevant metabolite in animal matrices, the peer review suggested to define the residue for risk assessment as "*3-OH-carbofuran, free and conjugated expressed as carbofuran*". As for plants, the inclusion of the 3-keto metabolite was recommended in the carbosulfan conclusion. For monitoring, the residue definition was left open, pending the submission of information on the efficiency of the analytical methods to consider the conjugates. However, the peer review expressed a preference to define the residue for monitoring as proposed above for risk assessment.

The current residue definitions for enforcement under Regulation (EC) No 396/2005 for the N-methyl-carbamate compounds for animal and plant commodities are the following:

- carbofuran: sum of carbofuran and 3-OH-carbofuran expressed as carbofuran,

- carbosulfan: carbosulfan
- benfuracarb benfuracarb
- furathiocarb: furathiocarb

For plant commodities, these residue definitions are overall similar to the proposals made for carbofuran, carbosulfan and benfuracarb in the course of the peer review, with the restriction that no final decision was taken concerning the possible inclusion of conjugates. For animal commodities the peer review suggested to limit the residue definition to 3-OH-carbofuran (preferably free and conjugated), while the current residue definition is defined as sum of carbofuran and 3-OH-carbofuran (free).

It is clear from the data provided in the framework of the peer review and from the information reported by the EU Reference Laboratories (EURL) and by the national control laboratories involved in the EU residue monitoring programs, that several validated analytical methods are available to analyse N-methyl-carbamate residues in plant and animal matrices at a LOQ of 0.01* mg/kg according to the current residue definitions. However for carbofuran, no information was provided, to confirm whether these methods are efficient to consider the conjugates. It is therefore no possible to conclude whether the residue levels reported in the supervised residue trials and in EU monitoring programs refer to the free residues only or whether they fully or partially include the conjugates.

RECOMMENDATIONS

EFSA recommends the withdrawal of the CXLs of 0.5 mg/kg (carbofuran) and 0.1 mg/kg (carbosulfan) in orange and mandarin, taken over in the EU legislation, since the residues resulting from the use of the active substance carbosulfan on citrus result in an acute intake concern for consumers. It is proposed to set MRLs for carbofuran and carbosulfan in orange and mandarin at the default LOQ level of 0.01* mg/kg.

EFSA recommends, the withdrawal of the CXLs set for carbofuran at 0.1* mg/kg on sunflower seed and at 0.05 mg/kg on rapeseed, as these uses are no longer supported by GAPs initially proposed at Codex level. The default LOQ of 0.02* mg/kg is therefore proposed for sunflower seed and rape seed. No changes are proposed for cotton seed.

For carbosulfan, EFSA recommends the withdrawal of MRLs of 0.07* mg/kg and 0.1* mg/kg set on the "fruits and berries" and "roots and rhizomes" spice subgroups. These MRLs do not pose any consumer intake concerns, but the basis for these CXLs was not reported transparently and therefore, a conclusion whether these values are sufficiently supported by data is not possible.

For carbofuran, EFSA do not recommend the setting of an import tolerance of 0.04 mg/kg in fresh cultivated mushrooms requested by the European Spice Association (ESA). The proposed value is not sufficient to cover the range of residues observed in the ESA survey conducted on white Chinese mushrooms. Moreover this level results in an acute intake concern for the consumers (IESTI 225 % ARfD, BE Child). Therefore, EFSA recommends to maintain the MRL for fresh cultivated mushrooms at the LOQ of 0.01* mg/kg.

For carbofuran, the LOQ levels reported as MRLs in the EU Regulation, are considered as being not sufficiently protective for European consumers, since resulting in large exceedance of the acute reference dose for a large number of food commodities. The setting of MRLs lower than the default LOQ value of 0.01* mg/kg is therefore recommended, especially for the food commodities that contribute significantly to the consumer diets. For such commodities, lower LOQs as listed below are suggested to ensure that the ARfD is not exceeded:

- 0.005* mg/kg for strawberries, spinach & similar and pulses,
- 0.003* mg/kg for miscellaneous fruits,
- 0.002* mg/kg for stone fruits, grapes, tropical root/tuber, fruiting vegetables, brassica vegetables, lettuce & other salad plants and stem vegetables

- 0.001* mg/kg for apple, potato and milk; the highest contributors to the consumer diets. For milk it is proposed to apply the LOQ of 0.001* mg/kg to the 3-OH-carbofuran metabolite only (free and conjugated), as carbofuran is not expected to be present in animal matrices.

This recommendation is however pending the availability of appropriate analytical methods.

For carbosulfan, no changes are suggested to the MRL (LOQ) values established in Annex II and IIIB of Regulation (EC) No 396/2005, except for the citrus and spices groups were the setting of MRLs at the default LOQ levels of 0.01* and 0.05* mg/kg is recommended. The proposed levels result in no chronic or acute consumer intake concerns.

No changes are proposed to the MRLs (LOQs) listed for benfuracarb and furathiocarb in Annex V of Regulation (EC) No 396/2005, since these LOQs result in chronic and acute consumer exposures not exceeding the toxicological reference values.

Thus EFSA proposes to amend the existing MRLs as reported in the summary table.

Summary table

Code number[(a)]	Commodity	Existing EU MRL (mg/kg)	Proposed EU MRL (mg/kg)	Justification for the proposal
Carbofuran (sum carbofuran, 3-OH-carbofuran, expressed as carbofuran)				
110020	Oranges	0.5	0.01*	The use of carbosulfan on citrus results in carbofuran residues leading to a large acute intake concern for the consumers
110050	Mandarins	0.5	0.01*	
280020	Cultivated fungi	0.01*	0.01*	No change recommended
401050	Sunflower seed	0.10	0.02*	CXL no longer supported by US GAPs.
401060	Rape seed	0.05	0.02*	CXL no longer supported by Polish GAPs.
401090	Cotton seed	0.1	0.1	No change recommended
-	Other commodities	The setting of LOQs below the default value of 0.01* mg/kg recommended for a certain number of food commodities (see table 4-6)		
Carbosulfan				
110020	Oranges	0.1	0.01*	The use of carbosulfan on citrus results in carbofuran residues leading to a large acute intake concern for the consumers
110050	Mandarins	0.1	0.01*	
401090	Cotton seed	0.05*	0.05*	No change recommended
820000	Spices (fruits/berries)	0.7*	0.05*	Pending a common reassessment for both, carbofuran and carbosulfan
830000	Spices (roots/rhizomes)	0.1*	0.05*	

[(a)]: According to Annex I of Regulation (EC) No 396/2005.
[(*)]: Indicates that the MRL is set at the limit of analytical quantification.

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APPENDICES

Appendix A. Codex residue limits (CXLs) for Carbosulfan and Carbofuran

(Available at: http://www.codexalimentarius.net/pestres/data/pesticides/index.html)

Commodities	Carbosulfan		Carbofuran		
	mg/kg	CAC[(a)]	mg/kg	CAC[(a)]	observations
Oranges, Sweet, Sour	0.1	2010	0.5	2010	use of carbosulfan
Mandarin	0.1	2010	0.5	2010	use of carbosulfan
Citrus pulp, Dry	0.1	2005	2	2001	use of carbosulfan
Banana			0.1*	1999	
Cotton seed	0.05	2005	0.1	2004	
Rape seed			0.05*	2004	
Sunflower seed			0.1*	1999	
Maize	0.05*	2005	0.05*	2005	use of carbosulfan
Sorghum			0.1*	1999	
Sorghum straw and fodder, Dry			0.5	2001	
Rice straw and fodder, Dry	0.05*	2005	1	2004	
Rice, Husked			0.1	2004	
Coffee beans			1	1999	
Spices, Fruits and Berries	0.07	2011			
Spices, Roots and Rhizomes			0.1	2011	
Sugar beet	0.3	2005	0.2	2005	use of carbosulfan
Sugar cane			0.1*	1999	
Meat (from mammals)	0.05*	2005	0.05*	1999	
Cattle, pig, sheep, goat, horse fat			0.05*	1999	
Edible offal (mammalian)	0.05*	2005	0.05*	1999	
Poultry meat	0.05*	2005			
Poultry, Edible offal of	0.05*	2005			
Eggs	0.05*	2005			

[(a)]: Year of adoption of the CLX by the Codex Alimentarius Commission (CAC)

*: CLX set at the limit of quantification

Carbofuran

ADI/PTDI: 0-0.001 mg/kg body weight 1996

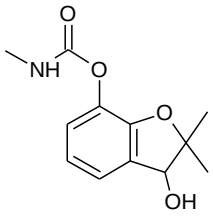
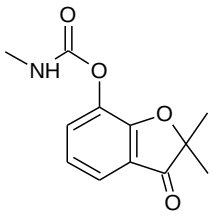
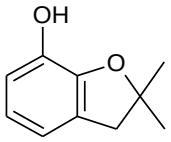
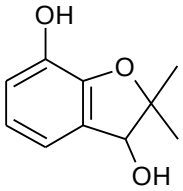
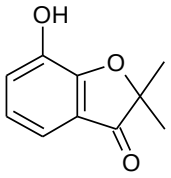
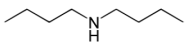
Residue definition: Residue for compliance with MRLs and for estimation of dietary intake for plant and animal commodities: carbofuran and 3-OH-carbofuran expressed as carbofuran. Residue not fat-soluble

Carbosulfan

ADI/PTDI: 0-0.01 mg/kg body weight 1986

Residue definition: Residue for compliance with MRLs and for estimation of dietary intake for plant and animal commodities: carbosulfan

Appendix B. List of metabolites and related structural formula

Code/Trivial name	Chemical name	Structural formula
3-OH-carbofuran 3-hydroxy-carbofuran	3-hydroxy-2,2-dimethyl-2,3-dihydro-1-benzofuran-7-yl methylcarbamate	
3-keto-carbofuran	2,2-dimethyl-3-oxo-2,3-dihydro-1-benzofuran-7-yl methylcarbamate	
carbofuran-phenol carbofuran-7-phenol	2,2-dimethyl-2,3-dihydro-1-benzofuran-7-ol	
3-OH-carbofuran-phenol 3-OH carbofuran-7-phenol	2,2-dimethyl-2,3-dihydro-1-benzofuran-3,7-diol	
3-keto-carbofuran-phenol 3-keto-carbofuran-7-phenol	7-hydroxy-2,2-dimethyl-1-benzofuran-3(2*H*)-one	
DBA	dibutylamine	

ABBREVIATIONS

ACh	AcethylCholin
AChE	AcethylCholin Esterase
ADI	acceptable daily intake
ARfD	acute reference dose
a.s.	active substance
BBCH	growth stages of mono- and dicotyledonous plants
BE	Belgium
bw	body weight
CAC	Codex Alimentarius Commission
CCPR	Codex Committee on Pesticide Residues
CF	conversion factor for enforcement residue to risk assessment residue definition
CIPAC	Collaborative International Pesticide Analytical Council
CXL	Codex Maximum Residue Limit (Codex MRL)
d	day
DAR	Draft Assessment Report
DAT	days after treatment
DT_{50}	period required for 50 % dissipation (define method of estimation)
EC	European Community
EEC	European Economic Community
EFSA	European Food Safety Authority
eq	residue expressed as a.s. equivalent
ESA	European Spice association
EU	European Union
EURL	EU Reference Laboratory (former CRL)
FAO	Food and Agriculture Organisation of the United Nations
FLD	fluorescence detector
GAP	good agricultural practice
GR	Greece
GS	growth stage
ha	hectare
hL	hectolitre
HR	highest residue
i.e.	that is (id est, *Latin*)
IESTI	International Estimated Short Term Intake
ILV	independent laboratory validation
ISO	International Organisation for Standardisation
IUPAC	International Union of Pure and Applied Chemistry
JMPR	Joint FAO/WHO Meeting on Pesticide Residues
kg	kilogram
L	litre

LC	liquid chromatography (= HPLC)
LOAEL	lowest observed adverse effect level
LOD	limit of detection
LOQ	limit of quantification
MRL	maximum residue level
MS/MS	tandem mass spectrometry
MS	mass spectrometry
MS	Member States
NOAEL	no observed adverse effect level
NOEL	no observed effect level
MW	molecular weight
NL	Netherland
NPD	nitrogen/phosphorous detector
OECD	Organisation for Economic Co-operation and Development
PCD	post column derivation
PF	processing factor
PHI	pre-harvest interval
PRIMo	(EFSA) Pesticide Residues Intake Model
RAC	raw agricultural commodity
RD	residue definition
RMS	Rapporteur Member State
SCoFCAH	Standing Committee of the Food Chain and Animal Health
SEU	Southern European Union
SP	Spain
SPE	Solid Phase Extraction
STMR	supervised trials median residue
TMDI	theoretical maximum daily intake
TRR	total radioactive residue
USA	United States of America
WHO	World Health Organization