Food and Agriculture Organization
of the United Nations

FAO SPECIFICATIONS AND EVALUATIONS

FOR AGRICULTURAL PESTICIDES

BENTAZONE

3-isopropyl-1H-2,1,3-benzothiadiazin-4(3H)
-one 2,2-dioxide

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Compliance with the specifications does not constitute an endorsement or warranty of the fitness of a particular pesticide for a particular purpose, including its suitability for the control of any given pest, or its suitability for use in a particular area. Owing to the complexity of the problems involved, the suitability of pesticides for a particular purpose and the content of the labelling instructions must be decided at the national or provincial level.

Furthermore, pesticides that are manufactured to comply with these specifications are not exempted from any safety regulation or other legal or administrative provision applicable to their manufacture, sale, transportation, storage, handling, preparation and/or use.

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[1] This disclaimer applies to all specifications published by FAO.

INTRODUCTION

FAO establishes and publishes specifications* for technical material and related formulations of agricultural pesticides, with the objective that these specifications may be used to provide an international point of reference against which products can be judged either for regulatory purposes or in commercial dealings.

From 1999 onward, the development of FAO specifications follows the **New Procedure**, described first in the 5th edition of the "Manual on the development and use of FAO specifications for plant protection products" and later in the 1st edition of "Manual for Development and Use of FAO and WHO Specifications for Pesticides" - currently available as 2nd edition (2022) - , which is available only on the internet through the FAO and WHO web sites.

This **New Procedure** follows a formal and transparent evaluation process. It describes the minimum data package, the procedure and evaluation applied by FAO and the Experts of the FAO/WHO Joint Meeting on Pesticide Specifications (JMPS). [Note: prior to 2002, the Experts were of the FAO Panel of Experts on Pesticide Specifications, Registration Requirements, Application Standards and Prior Informed Consent, which now forms part of the JMPM, rather than the JMPS.]

FAO Specifications now only apply to products for which the technical materials have been evaluated. Consequently from the year 1999 onwards the publication of FAO specifications under the **New Procedure** has changed. Every specification consists now of two parts namely the specifications and the evaluation report(s):

Part One: **The Specification** of the technical material and the related formulations of the pesticide in accordance with chapters 4 to 9 of the "Manual on development and use of FAO and WHO specifications for chemical pesticides".

Part Two: The Evaluation Report(s) of the pesticide, reflecting the evaluation of the data package carried out by FAO and the JMPS. The data are provided by the manufacturer(s) according to the requirements of chapter 3 of the "FAO/WHO Manual on Pesticide Specifications" and supported by other information sources. The Evaluation Report includes the name(s) of the manufacturer(s) whose technical material has been evaluated. Evaluation reports on specifications developed subsequently to the original set of specifications are added in a chronological order to this report.

FAO specifications developed under the **New Procedure** do not necessarily apply to nominally similar products of other manufacturer(s), nor to those where the active ingredient is produced by other routes of manufacture. FAO has the possibility to extend the scope of the specifications to similar products but only when the JMPS has been satisfied that the additional products are equivalent to that which formed the basis of the reference specification.

Specifications bear the date (month and year) of publication of the current version. Evaluations bear the date (year) of the Meeting at which the recommendations were made by the JMPS.

* NOTE: PUBLICATIONS ARE AVAILABLE ON THE INTERNET AT (Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at:
http://www.fao.org/pest-and-pesticide-management/guidelines-standards/faowho-joint-meeting-on-pesticide-specifications-jmps/pesticide-specifications/pesticide-specifications-list/en/

PART ONE

SPECIFICATIONS

BENTAZONE

BENTAZONE

INFORMATION

ISO common name

bentazone (ISO 1750, published, BSI, E-ISO, F-ISO, JMAF)

Synonyms

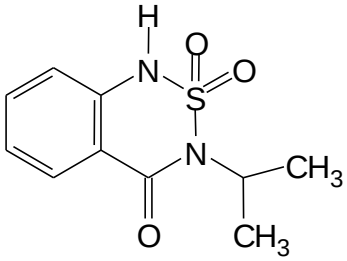
bentazon (ANSI, Canada, WSSA)

Chemical names

IUPAC 3-isopropyl-1*H*-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide

CA 3-(1-methylethyl)-1*H*-2,1,3,-benzothiadiazin-4(3*H)*-one 2,2-dioxide

Structural formula



Molecular formula	$C_{10}H_{12}N_2O_3S$
Relative molecular mass	240.3
CAS Registry number	25057-89-0
CIPAC number	366

Identity tests: Retention time matching in reverse phase HPLC; UV/Vis; IR; MS spectra; ^{1}H-NMR and ^{13}C-NMR. The HPLC retention time of bentazone in the sample solution should not deviate by more than 1% from that of bentazone in the calibration solution (CIPAC 1C, p. 1974).

BENTAZONE TECHNICAL MATERIAL

FAO Specification 366 / TC (October 2022*)

This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturers whose name are listed in the evaluation reports (366/1999, 366/2020.1, 366/2020.2 & 366/2021). It should be applicable to TC of these manufacturers but it is not an endorsement of those products, nor a guarantee that they comply with the specifications. The specification may not be appropriate for the products of other manufacturers. The evaluation reports (366/1999, 366/2020.1, 366/2020.2 & 366/2021) as PART TWO form an integral part of this publication.

1 Description

The material shall consist of bentazone together with related manufacturing impurities and shall be an ochre-yellow solid, free from visible extraneous matter and added modifying agents.

2 Active ingredient

2.1 Identity tests (366/TC/M/2, CIPAC Handbook 1C, p. 1974, 1985)

The active ingredient shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

2.2 Bentazone content (366/TC/M/3, CIPAC 1C, p. 1974, 1985)

The bentazone content shall be declared (not less than 960 g/kg) and when determined, the average measured content obtained shall not be lower than the declared minimum content.

3 Relevant impurities (Note 1)

Note 1 There are no relevant impurities that have to be controlled in the products of the manufacturers identified in the evaluation reports 336/2020.1, 336/2020.2 and 336/2021. However, residues of 1.2-dichloroethane (1,2-DCE) may occur as a result of certain production processes. If this impurity would occur at > 0.003 g/kg (of bentazone), this compound would be considered as a relevant impurity and and a clause would be required to limit its concentration.

*Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: http://www.fao.org/pest-and-pesticide-management/guidelines-standards/faowho-joint-meeting-on-pesticide-specifications-jmps/pesticide-specifications/pesticide-specifications-list/en/

BENTAZONE TECHNICAL CONCENTRATE

FAO Specification 288 / TK (October 2022*)

This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturer whose name is listed in the evaluation reports (366/1999 & 366/2020.1). It should be applicable to TK of this manufacturer but it is not an endorsement of those products, nor a guarantee that they comply with the specifications. The specification may not be appropriate for the products of other manufacturers. The evaluation reports (366/1999 & 366/2020.1) as PART TWO form an integral part of this publication.

1 Description

The material shall consist of bentazone together with related manufacturing impurities, complying with the requirements of FAO Specification 366/TC (October 2022) in the form of a bentazone salt dissolved in water, and shall be a clear or opalescent liquid, yellow to dark brown in colour. The solution shall be free from more than a trace of visible suspended matter or sediment.

2 Active ingredient

2.1 Salt

The name of the bentazone salt present shall be stated.

2.2 Identity tests (366/SL/(M)/2, CIPAC 1C, p. 1976, 1985)

The active ingredient shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

2.3 Bentazone content (366/SL/(M)/2, CIPAC 1C, p. 1976, 1985)

The bentazone content shall be declared (above 500 g/kg or g/l at 20 ± 2°C, Note 1) and, when determined, the mean measured content shall not differ from that declared by more than ±25 g/kg or g/l.

3 Relevant impurities (Note 2)

*Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: http://www.fao.org/pest-and-pesticide-management/guidelines-standards/faowho-joint-meeting-on-pesticide-specifications-jmps/pesticide-specifications/pesticide-specifications-list/en/

4 Physical properties

4.1 **pH range** (MT 75.3, CIPAC Handbook J, p. 131, 2000)

pH range: 6.5 to 9.5

Note 1 If the buyer requires both g/l at 20°C and g/kg, then in case of dispute the analytical results shall be calculated as g/kg.

Note 2 There are no relevant impurities that have to be controlled in the products of the manufacturer identified in the evaluation report 336/2020.1. However, residues of 1.2-dichloroethane (1,2-DCE) may occur as a result of certain production processes. If this impurity would occur at > 0.003 g/kg (of bentazone), this compound would be considered as a relevant impurity and and a clause would be required to limit its concentration.

BENTAZONE WETTABLE POWDER

FAO Specification 366 / WP (October 2022*)

This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturer whose name is listed in the evaluation reports (366/1999, 366/2020.1). It should be applicable to TC of this manufacturer but it is not an endorsement of those products, nor a guarantee that they comply with the specifications. The specification may not be appropriate for the products of other manufacturers. The evaluation reports (366/1999, 366/2020.1) as PART TWO form an integral part of this publication.

1 Description

The material shall consist of a homogeneous mixture of technical bentazone, complying with the requirements of FAO Specification 366/TC (October 2022), together with filler(s) and any other necessary formulants. It shall be in the form of a fine powder, free from visible extraneous matter and hard lumps.

2 Active Ingredient

2.1 **Identity tests** (366/TC/(M)/2, CIPAC Handbook 1C, p. 1974, 1985)

The active ingredient shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

2.2 **Bentazone content** (366/SL/(M)/3, CIPAC Handbook 1C, p. 1976, 1985) (Note 1)

The bentazone content shall be declared (g/kg) and, when determined, the mean measured content shall not differ from that declared by more than the following tolerances:

Declared content in g/kg	Tolerance
above 250 up to 500 g/kg	± 5% of declared content
above 500 g/kg	± 25 g/kg
Note: In each range the upper limit is included	

3 Relevant impurities (Note 2)

*Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: http://www.fao.org/pest-and-pesticide-management/guidelines-standards/faowho-joint-meeting-on-pesticide-specifications-jmps/pesticide-specifications/pesticide-specifications-list/en/

4 Physical properties

4.1 **pH range** (MT 75.3, CIPAC Handbook J, p. 131, 2000)

pH range: 2.0 to 4.0.

4.2 **Wet sieve test** (MT 185, CIPAC Handbook K, p. 149, 2003)

Maximum: 0.5 % retained on a 75 μm test sieve.

4.3 **Suspensibility** (MT 184.1, CIPAC P, p. 245, 2021) (Note 3)

A minimum of 75 % of the bentazone content found under 2.2 shall be in suspension after 30 minutes in CIPAC Standard Water D at 25 ± 5°C (Note 4).

4.4 **Persistent foam** (MT 47.3, CIPAC O, p. 177, 2017) (Note 5)

Maximum: 10 ml after 1 min.

4.5 **Wettability** (MT 53.3 CIPAC Handbook F, p. 165, 1995)

The product shall be completely wetted in 2 min without swirling.

5 Storage Stability

5.1 **Stability at elevated temperature** (MT 46.4, CIPAC Handbook P, p. 232, 2021)

After storage at 54 ± 2°C for 14 days, the determined average active ingredient content must not be lower than 95% relative to the determined average content found before storage (Note 6) and the formulation shall continue to comply with the clauses for:

- wet sieve test (4.2);
- suspensibility (4.3);
- wettability (4.5).

Note 1 There is no dedicated CIPAC method for bentazone wettable powders. For analysis, suspend the product containing approximately 0.1 M bentazone in 90 ml 1 N NaOH. Add 1 N NaOH until the pH 7.5 - 8.5 is reached. Isolate the solution by filtration. Suspend the undissolved residue in 50 ml fully de-ionized water. Filter and add the filtrate to the filtered solution of active ingredient. Dilute the combined solutions to 200 ml. Continue as for 366/SL/(M)/3, CIPAC 1C, p. 1976.

Note 2 There are no relevant impurities that have to be controlled in the products of the manufacturers identified in the evaluation report 336/2020.1. However, residues of 1.2-dichloroethane (1,2-DCE) may occur as a result of certain production processes. If this impurity would occur at > 0.003 g/kg (of bentazone), this compound would be considered as a relevant impurity and and a clause would be required to limit its concentration.

Note 3 This test will normally only be carried out after the heat stability test 5.1.

Note 3 Chemical assay is the only fully reliable method to measure the mass of active ingredient still in suspension. However, the simpler gravimetric method may be used on a routine basis provided that it has been shown to give results equal to those of chemical assay. In case of dispute, chemical assay shall be the "referee method".

For the chemical assay, adjust the pH of the 25 ml bottom sediment to 7.5 - 8.5 by adding 0.1 N NaOH solution. Add fully deionized water to obtain a volume of 50 ml. Remove insoluble matter by filtration or centrifugation and determine the amount of active ingredient on the clear solution according to the method 366/SL/(M)/3, CIPAC 1C, p. 1976.

Note 4 The formulation should be tested at the highest and lowest rates of use recommended by the supplier, provided this does not exceed the conditions given in method MT 184.1

Note 5 The concentration of sample to be used in the test should be specified at the highest rate of use recommended by the supplier.

Note 6 Samples of the product taken before and after the storage stability test may be analyzed concurrently after the test in order to reduce the analytical error.

BENTAZONE SALT SOLUBLE CONCENTRATE

FAO Specification 366 / SL (October 2022*)

This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturer whose name is listed in the evaluation reports (366/1999 & 366/2020.1). It should be applicable to relevant products of this manufacturer but it is not an endorsement of those products, nor a guarantee that they comply with the specifications. The specification may not be appropriate for the products of other manufacturers. The evaluation reports (366/1999 & 366/2020.1) as PART TWO form an integral part of this publication.

1 Description

The material shall consist of a salt of technical bentazone, complying with the requirements of FAO Specification 366/TK (October 2022), in the form of a bentazone salt dissolved in water, together with any other necessary formulants. It shall be in the form of a clear or opalescent aqueous liquid, to be applied as a true solution of the active ingredient in water. The material shall be of yellow to dark brown colour. The solution shall be free from more than a trace of visible suspended matter or sediment.

2 Active ingredient

2.1 Salt

The name of the bentazone salt present shall be stated.

2.2 Identity tests (366/SL/(M)/2, CIPAC Handbook 1C, p. 1976, 1985)

The active ingredient shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

2.3 Bentazone content (366/SL/(M)/3, Handbook 1C, p. 1976, 1985)

The bentazone content (g/kg or g/l at 20 ± 2ºC, Note 1) shall be declared and, when determined, the mean measured content shall not differ from that declared by more than the following tolerances:

Declared content in g/kg or g/l at 20 ± 2ºC	Tolerance
250 to 500 above 500 Note: In each range the upper limit is included	± 5% of declared content ± 25 g/kg or g/l

3 Impurities (Note 2)

3.1 Water insolubles (MT 10.3, CIPAC F, p. 28)

*Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: http://www.fao.org/pest-and-pesticide-management/guidelines-standards/faowho-joint-meeting-on-pesticide-specifications-jmps/pesticide-specifications/pesticide-specifications-list/en/

The product shall pass through a 150 μm test sieve leaving not more than 1 g/kg on the sieve.

4 Physical properties

4.1 **pH range** (MT 75.3, CIPAC Handbook J, p. 131, 2000)

pH range: 6.5 to 9.5

4.2 **Solution stability** (MT 41.1, CIPAC Handbook O, p. 174, 2017)

The formulation, following dilution (Note 3) with CIPAC standard water D and standing at 30 ± 2 °C for 24 h, shall give a clear or opalescent solution, free from more than a trace of sediment and visible solid particles. Any visible sediment or particles produced shall pass through a 75 µm test sieve.

4.3 **Persistent foam** (MT 47.3, CIPAC Handbook O, p. 177, 2017) (Note 4)

Maximum 25 ml after 1 min.

5 Storage stability

5.1 **Stability at 0°C** (MT 39.3, Handbook J, p. 126, 2000)

After storage at 0 ± 2°C for 7 days, the volume of solid and/or liquid which separates shall not be more than 0.3 ml.

5.2 **Stability at elevated temperature** (MT 46.4, CIPAC Handbook P, p. 232, 2021)

After storage at 54 ± 2°C for 14 days, the determined average active ingredient content must not be lower then 95% relative to the determined average content found before storage (Note 5) and the product shall continue to comply with the clauses for

- water insolubles (3.1),
- pH range (4.1)
- solution stability (4.2).

Note 1 If the buyer requires both g/l at 20°C and g/kg, then in case of dispute the analytical results shall be calculated as g/kg.

Note 2 There are no relevant impurities that have to be controlled in the products of the manufacturers identified in the evaluation report 336/2020.1. However, residues of 1.2-dichloroethane (1,2-DCE) may occur as a result of certain production processes. If this impurity would occur at > 0.003 g/kg (of bentazone), this compound would be considered as a relevant impurity and and a clause would be required to limit its concentration.

Note 3 The concentration used for the test should not be higher than the highest concentration recommended in the instructions for use.

Note 4 The concentration of sample to be used in the test should be specified at the highest rate of use recommended by the supplier.

Note 5 Samples of the product taken before and after the storage stability test may be analyzed concurrently after the test in order to reduce the analytical error.

PART TWO

EVALUATION REPORTS

BENTAZONE

BENTAZONE

FAO/WHO EVALUATION REPORT 366 / 2021

Recommendations

The Meeting recommended that:

(i) The bentazone TC proposed by Shandong Binnong Technology Co., Ltd. should be accepted as equivalent to the bentazone reference profile.

(ii) The FAO specification for bentazone TC should be extended to encompass the material produced by Shandong Binnong Technology Co., Ltd.

Appraisal

The Meeting considered data and supporting information submitted in June 2021 by Shandong Binnong Technology Co., Ltd (Shandong Binnong) for the determination of the equivalence of bentazone TC (FAO Specification 366/TC). The data submitted were broadly in accordance with the requirements of the Manual on Development and Use of FAO and WHO specifications for Pesticides (2016 3rd revision of the 1st edition) and comply with the current FAO specification for bentazone TC. The reference specification for bentazone TC and the supporting data were provided by BASF SE, published in 1992 (under the old procedure), were revised in 1999 and again in 2020.

The Meeting was provided with a detailed description of the manufacturing process of the TC, specifications of the raw materials, the 5-batch analysis data for bentazone and all detectable impurities at or above 1g/kg and their manufacturing limits in the TC. The 5-batch analysis study was performed according to GLP guidelines.

Mass balances in the 5-batch analysis data were in the range from 983.0 g/kg to 986.4 g/kg. The minimum purity of bentazone in the TC is 970 g/kg and complies with the existing FAO specification minimum content of 960 g/kg. The percentage of the unknowns ranged from 14 to 17 g/kg (based on the submitted 5-batches) and were considered acceptable by the Meeting. The Meeting also noted that all impurities with chromatographic area equal or greater than 0.6 g/kg were reported.

Shandong Binnong's manufacturing process, impurity profile and five batch analysis data were compared with the data submitted by BASF in 1999. Shandong Binnong utilizes a four reaction steps process whereas BASF synthesizes bentazone in four reaction steps for the TK and one additional for the production of TC (5 reaction steps). The manufacturing process utilized by Shandong Binnong is similar to the one of BASF and leads to a product compliant with the bentazone TC reference FAO specification.

Based on the 5-batch analysis data submitted, the impurity profile of Shandong Binnong has fewer impurities than the reference profile of BASF, and their specified limits are lower.

The *in-vitro* mutagenicity assay for the TC produced by Shandong Binnong showed no indication of inducing reverse mutations in the tester strains, as did the reference bentazone TC. Thus, bentazone TC is considered as non-mutagenic to any of the five strains of *Salmonella typhimurium*.

The company also provided acute toxicity studies on the hazard profile of their bentazone TC. As these studies essentially belong to the data required for a Tier-2 equivalence, they were not further considered by the Meeting.

A limit of 3 mg/kg for impurity 1,2 dichloroethane (1,2-DCE) has been specified in the FAO reference specification for the TC. Shandong Binnong specifies 1,2 dichloroethane with a maximum limit of 3 mg/kg as well. 1,2-Dichloroethane is classified as carcinogen category 1B in accordance with the EPA, IARC Monograph and the requirements of Regulation (EC) No 1272/2008 (harmonised classification), considering that no concern is raised at the limit of 3 mg/kg.

The content of bentazone in the TC was determined by reverse phase HPLC on a C_{18} column with 0.1% formic acid aqueous solution and acetonitrile gradient elution system, and UV detection at 230 nm, resulting in a retention time of approximately 11 min. The in-house method was adequately validated. The Meeting requested the company to provide a bridging study to demonstrate that the analytical method used for the determination of the active ingredient in TC provides equivalent results with the CIPAC method published in CIPAC Handbook 1C [CIPAC method 366/TC/(M)/3]. The results were in good agreement for all three batches analysed.

The identity of bentazone and its organic impurities in the five batches of bentazone TC were confirmed by the comparison of HPLC-UV, ^{1}H-NMR, ^{13}C-NMR, FTIR and MS spectra of the sample and the reference standard. The identity of 1,2-DCE had been confirmed by GC-MS retention time and mass spectra.

The two organic impurities detected and specified in the 5 batches were determined by reversed phase HPLC with UV detection at 230 nm, a C_{18} chromatographic column and external standardization. 1,2-DCE was determined by GC-MS in the MRM mode and external standardization, operated in the splitless mode and a DB-5 MS chromatographic column. The reported LOQ for 1,2-DCE is 0.063 mg/L. The company was requested to provide the validated LOQ in mg/kg TC (as the lowest fortification level with acceptable recovery and RSD%), thus the validated LOQ is 2.34 mg/kg.

The methods used for the determination of the impurities were adequately validated and following the Meeting's request, the limit of quantitation (LOQ) as the lowest fortified concentration was provided for all the impurities. An inorganic impurity was determined by coulometric Karl Fischer titration according to USP 921 and CIPAC MT30.1 (CIPAC Handbook F).

Shandong Binnong also provided information on the content of an inorganic compound in the TC and provided the analysis of 5 new batches for this inorganic compound. The fully validated method used was ion chromatography with conductivity detector. The data

demonstrated that this inorganic compound is below the validated LOQ (LOQ = 0.77 g/kg), thus below 1g/kg.

The Meeting was further provided with a "Notice of Approval" of the TC in Australia (Australian Pesticides and Veterinary Medicines Authority) with a declared minimum purity of 970 g/kg which is in agreement with the declared minimum purity in the data submitted to FAO. It was considered acceptable by the Meeting.

Shandong Binnong provided a full data package on physical and chemical properties of pure bentazone using a purified reference standard with a content of >96 %. However, to avoid duplication with similar data evaluated for the reference profile, only the melting point of pure bentazone is referenced having a melting point of 138 ˚C whereas that of the reference profile was 139 ˚C (purity 99.8% w/w).

The company also provided acute toxicity studies on the hazard profile of their bentazone TC. As these studies may be requested by the Meeting on a case by case basis when an assessment on Tier-2 is deemed necessary, these studies and their outcome were not further considered by the Meeting.

The TC produced by Shandong Binnong meets the equivalence requirements of the Manual as follows:

- the material meet the requirements of the existing FAO specification; and
- assessments of the manufacturing process used, the impurity profile and results of mutagenicity (bacteria, *in vitro*) testing have been carried out with the result that the profiles complies with the corresponding data of the reference profile

and can therefore be considered as equivalent by Tier-1.

Shandong Binnong has did not request an equivalence for any formulation specification.

SUPPORTING INFORMATION
FOR
EVALUATION REPORT 366/2021

Table 1: Chemical composition and properties of bentazone technical material (TC)

Manufacturing process, maximum limits for impurities ≥ 1 g/kg, 5 batch analysis data	Confidential information supplied and held on file by FAO. Mass balances were 98.30 –-98.64 %.
Declared minimum bentazone content	970 g/kg
Relevant impurities ≥ 1 g/kg and maximum limits for them	None
Relevant impurities **<** 1 g/kg and maximum limits for them:	1,2-dichloroethane < 3 mg/kg
Stabilisers or other additives and maximum limits for them:	None

Parameter	Value and conditions	Purity %	Method reference	Study number
Melting temperature range of the TC	133.7 – 135.4 °C at normal atmospheric pressure (760 mmHg)	98.4± 0.5	OECD 102	202-2-11-17636
Solubility in organic solvents	>250g/l acetone at 20 °C	98.4± 0.5	CIPAC MT 181 OCSPP 830.7840	206-2-11-17642
	>250g/l methanol at 20 C	98.4± 0.5		

FORMULATIONS AND CO-FORMULATED ACTIVE INGREDIENTS

The current submission is only for TC.

METHODS OF ANALYSIS AND TESTING

The analytical method for the active ingredient (including identity tests) is based on an in-house validated RP-HPLC method using a C_{18} chromatographic column, external standardization and UV detection at 230 nm. Following the Meeting request, a bridging study was provided. The methods for determination of impurities are based on reversed phase HPLC-UV and GC-MS and had been adequately validated. Test methods for determination of physico-chemical properties of the technical active ingredient were OECD and CIPAC, where appropriate.

PHYSICAL PROPERTIES

The physical properties tested and the methods used comply with the requirements of the FAO/WHO Manual (2016 3rd revision of the 1st edition).

CONTAINERS AND PACKAGING

No special requirements for containers and packaging have been identified.

EXPRESSION OF THE ACTIVE INGREDIENT

The content of active ingredient in TC, is expressed as bentazone

ANNEX 1
HAZARD SUMMARY PROVIDED BY THE PROPOSER

Toxicological summaries

Notes.
(i) The proposer confirmed that the toxicological and ecotoxicological data included in the summary below were derived from bentazone having impurity profiles similar to those referred to in the table above.
(ii) The conclusions expressed in the summary below are those of the proposer, unless otherwise specified.

Table 2: Mutagenicity profile of bentazone technical material based on an *in vitro* test

Species	Test	Purity % Note[2]	Guideline, duration, doses and conditions	Result	Study number **Error! Bookmark not defined.**
Salmonella typhimurium TA1537, TA1535, TA98, TA100 and TA102	Bacterial reverse mutation test *in vitro*	98.4± 0.5	OECD 471, Two independent experiments, in the absence and presence of S9. Tester strains were exposed to TC at 8 concentrations in duplicate between 1.5 and 5000 µg/plate in the initial toxicity-mutation test. Tester strains were exposed to TC at 6 concentrations (three plates/concentration) between 156.25 and 5000µg/plate in the confirmatory mutation test.	Non-mutagenic	481-1-06-17645

[2] Note: Purity is the content of pure active ingredient in the technical material, expressed as a percentage.

ANNEX 2

REFERENCES

Study number	Author(s)	year	Study title. Study identification number. Report identification number. GLP [if GLP]. Company conducting the study.
0181	Ms. Nancy Bao	2017	Five-Batch Analysis of Bentazone Technical Grade Active Ingredient. Study 0181. Report 0181. Jiangsu Sinography Testing Co., Ltd. Unpublished. GLP
0184	Ms. Nancy Bao	2017	Five - Batch Analysis of Bentazone Technical Grade Active Ingredient: Solvent Residue. Study 0184. Report 0184. Jiangsu Sinography Testing Co., Ltd. Unpublished. GLP
J20181024	Shandong Binnong Technology Co., Ltd	2018	Justification of the Presence of Impurities in Bentazone Technical. Study J20181024. Report J20181024. Shandong Binnong Technology Co., Ltd. Unpublished. GLP
M20181024	Shandong Binnong Technology Co., Ltd	2018	Manufacturing process and Quality control of Bentazone technical. Study M20181024. Report M20181024. Shandong Binnong Technology Co., Ltd. Unpublished. GLP
202-2-11-17636	JAI Research Foundation	2018	Melting point or range of bentazone TC. Study 202-2-11-17636. Report 202-2-11-17636. JAI Research Foundation. Unpublished. GLP
205-2-11-17641	JAI Research Foundation	2018	Water solubility of bentazone TC. Study 205-2-11-17641. Report 205-2-11-17641. JAI Research Foundation. Unpublished. GLP
481-1-06-17645		2018	Bacterial reverse mutation of bentazone TC. Study 481-1-06-17645. Report 481-1-06-17645. Unpublished. GLP
0195	Ms. Summer Dong	2022	Analysis of Active Ingredient in Bentazone TC. Study: 0195. Shandong Binnong Technology Co., Ltd. Unpublished. GLP
0196	Ms. Helen Wang	2022	Validation of Analysis Method and Content Determination of ... in Bentazone TC. Study: 0196. Shandong Binnong Technology Co., Ltd. Unpublished. GLP

BENTAZONE

FAO/WHO EVALUATION REPORT 366 / 2020.2

Recommendations

The Meeting recommended that:

(i) The bentazone TC as proposed by Anhui Zhongshan Chemical Industry Co., Ltd should be accepted as equivalent to the bentazone reference profile.

(ii) The FAO specification for bentazone TC should be extended to encompass the material produced by Anhui Zhongshan Chemical Industry Co., Ltd.

Appraisal

The Meeting considered data and supporting information submitted in August 2018 by Anhui Zhongshan Chemical Industry Co., Ltd (Anhui Zhongshan) for the determination of the equivalence of bentazone TC (FAO specification 366/TC). The data submitted were broadly in accordance with the requirements of the Manual on Development and Use of FAO and WHO specifications for Pesticides (2016-third revision of the First Edition) and comply with the current FAO specification for TC bentazone. The reference specification for bentazone TC and the supporting data were provided by BASF, published in 1999 and revised in 2020.

Bentazone is a selective post-emergence herbicide belonging to the thiadiazine group. Bentazone is the ISO common name for 3-isopropyl-1*H*-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide (IUPAC). It is used for selective control of broadleaf weeds and sedges in arable crops like beans, rice, corn, peanuts and others.

Bentazone was first evaluated by JMPR in 1991 and had been reviewed in 1998 and 2012 as part of the periodic review programme of the Codex Committee on Pesticide Residues (CCPR).

The Meeting was provided upon request with a detailed description of the manufacturing process of the technical grade active ingredient, detailed specifications of the raw materials, the 5-batch analysis data for bentazone and all detectable impurities at or above 1g/kg and their manufacturing limits in the TC. The 5-batch analysis study performed according to GLP guidelines.

Mass balances in the 5-batch analysis data were in the range from 98.8 – 99.5 %. The declared minimum purity of bentazone in the TC is 970 g/kg and complies with the existing FAO specification minimum content of 960 g/kg. The percentage of the unknowns ranged from 0.40 to 1.09% (based on the submitted 5-batches), and were considered acceptable by the Meeting.

Anhui Zhongshan's manufacturing process, impurity profile and five batch analysis data were compared with the data submitted by BASF in 1999. Anhui Zhongshan utilizes a two reaction steps process whereas BASF synthesizes the compound in four reaction steps for the TK and one additional for the production of TC (5 reaction steps).

The manufacturing process utilized by Anhui Zhongshan is therefore different from that supporting the existing reference FAO specification for bentazone TC.

Based on the updated 5-batch analysis data submitted the impurity profile of Anhui Zhongshan has fewer impurities than the reference profile of BASF which, except one (a residual solvent), are common with the reference profile and their specified limits are considered equivalent. This residual solvent is a new impurity; however, it has been detected below the method LOQ (0.51 g/kg) and is not considered as a relevant impurity at its specified limit of 0.51 g/kg.

A limit of 3 mg/kg for the impurity 1,2 dichloromethane (1,2-DCE) was specified after the EU evaluation. Anhui Zhongshan specifies 1,2 dichloroethane with a maximum limit of 3 mg/kg. 1,2-dichloroethane is classified as a carcinogen category 1B in accordance with the EPA, IARC Monograph and the requirements of Regulation (EC) No 1272/2008 (harmonised classification); considers that no concern is raised at 3mg/kg limit.

The content of bentazone in TC was determined by using the CIPAC method 366/TC/M/- published in CIPAC Handbook 1C with minor modifications as regards the dilution system used in sample preparation. According to the CIPAC method bentazone is determined by a reverse phase HPLC method with external standardization. The method has been properly validated.

The identity of bentazone and its impurities in the five batches of bentazone TC were confirmed by ^{1}H-NMR, ^{13}C-NMR, MS spectra, FTIR and HPLC-UV retention time matching.

The two organic impurities specified in the 5-batch data were determined by reversed phase HPLC with UV detection at 234 nm, a C_{18} chromatographic column and external standardization. A remaining solvent used during manufacturing process and 1,2 dichloroethane were determined by GC-FID and internal standardization, operated in the split mode and a DB-5 chromatographic column. GC-FID method validated method LOQ for 1,2 dichloroethane is 0.049 g/kg and the proposer was requested to reconsider the method provided based on the specified limit.

The company provided an additional GC-MS method for 1,2 dichloroethane with a method LOQ of 2 mg/kg. The GC-MS method LOQ is more than 20% below the specification limit (3 mg/kg). GC-MS analysis performed with a HP-5 chromatographic column external standardization while quantification was achieved with ion 62 m/z using external standards.

The methods used for the determination of the impurities were adequately validated. The limit of quantitation (LOQ) was the lowest fortified concentration (%) at which method was validated with acceptable results (recovery and RSD). An inorganic impurity (water) was determined by Karl Fischer.

The Meeting was provided with a registration certificate of bentazon from the UK authorities (Health and Safety Executive-HSE) confirming that Anhui Zhongshan's bentazone TC has been registered in UK (COP number 201802465).

Anhui Zhongshan provided a full data package on physical and chemical properties of pure bentazone using a purified reference standard with a content of 98.6%. However, to avoid duplication with similar data evaluated for the reference, only the melting point of pure bentazone is referenced having a melting range of 136.5 -137.0 ºC whereas that of the reference was 139.4 (purity 99.8% w/w).

The Meeting therefore concluded that, based on the abovementioned considerations that the bentazone TC produced by Anhui Zhongshan can be considered equivalent to the reference profile by Tier-1 The *in-vitro* mutagenicity assay for the material produced by Anhui Zhongshan showed no indication of inducing reverse mutations in the tester strains, as did the reference bentazone.
The company also provided acute toxicity studies on the hazard profile of their bentazone TC. As these studies partially belong the the supporting data required for a Tier-2 equivalence, they were not further considered.

Anhui Zhongshan has proposed an equivalence for their TC only and did not request an equivalence for any formulation specification.

SUPPORTING INFORMATION
FOR
EVALUATION REPORT 366/2020.2

Table 1: Chemical composition and properties of bentazone technical material (TC)

Manufacturing process, maximum limits for impurities ≥ 1 g/kg, 5 batch analysis data	Confidential information supplied and held on file by FAO. Mass balances were 98.8 – 99.5 % and percentages of unknowns were 0.53– 1.2 %.			
Declared minimum bentazone content	970.0 g/kg			
Relevant impurities ≥ 1 g/kg and maximum limits for them	none			
Relevant impurities **<** 1 g/kg and maximum limits for them	none			
Stabilisers or other additives and maximum limits for them	none			
Parameter	Value and conditions	Purity %	Method reference	Study number
Melting temperature range of the TC and/or TK	80-82 °C	97.37	OECD 102 OPPTS 830.7200	Study 13225
Solubility in water and organic solvents	0,0106 mg/L in water at 20ºC g/l 6.598 g/l in hexane at 20 °C 21,367 g/l in methanol at 20°C > 500g/L in acetone, 0-xylene and ethyl acetate at 20 °C	97.37	OECD 105 OPPTS 830.7840	Study 13188 Study 13144

FORMULATIONS AND CO-FORMULATED ACTIVE INGREDIENTS

The current submission is for TC only.

METHODS OF ANALYSIS AND TESTING

The analytical method for the active ingredient (including identity tests) is based on CIPAC 366/TC/M. The content of bentazone is determined by HPLC-DAD detector with an external standard quantitative method.
The methods for determination of impurities are based on HPLC-UV and GC-FID and had been validated for linearity of response, precision, specificity, accuracy, LOQ and LOD.
Test methods for determination of physico-chemical properties of the technical active ingredient were OECD and EPA.

PHYSICAL PROPERTIES

The physical properties, the methods for testing them comply with the requirements of the FAO/WHO Manual (3rd revision of the 1st edition, March 2016).

CONTAINERS AND PACKAGING

No special requirements for containers and packaging have been identified.

EXPRESSION OF THE ACTIVE INGREDIENT

The content of of the active ingredient is expressed as bentazone.

ANNEX 1
HAZARD SUMMARY PROVIDED BY THE PROPOSER

Toxicological summaries

Notes.
(i) The proposer confirmed that the toxicological and ecotoxicological data included in the summary below were derived from bentazone having impurity profiles similar to those referred to in the table above.
(ii) The conclusions expressed in the summary below are those of the proposer, unless otherwise specified.

Table 2: Mutagenicity profile of bentazone technical material based on an *in vitro* test

Species	Test	Purity % Note[3]	Guideline, duration, doses and conditions	Result	Study number
Salmonella typhimurium TA 1537, TA 1535, TA98, TA 100 and TA 102	In vitro, bacterial reverse mutation test	98.32	OECD 471 Doses: 156.25, 312.5, 625, 1250, 2500 and 5000 µg/plate with and without addition of S9	Non-mutagenic	481-1-06-10599

[3] Note: Purity is the content of pure active ingredient in the technical material, expressed as a percentage.

ANNEX 2
REFERENCES

Study number	Author (s)	year	Study title. Study identification number. Report identification number. GLP [if GLP]. Company conducting the study.
NC-2014-126		2015	Physical and Chemical Characterization of Bentazone TGAI, NC2014-126, GLP
401-1-01-11907		2015	Acute oral toxicity study of bentazone technical in rats. GLP
403-1-01-10602		2015	Acute dermal toxicity study of bentazone technical in rats. GLP
405-1-01-10603		2015	Acute inhalation toxicity study of bentazone technical in rats. GLP
406-1-01-10604		2015	Acute dermal irritation study of bentazone technical in rabbits. GLP
407-1-01-10605		2015	Acute eye irritation study of bentazone technical in rabbits. GLP
408-1-01-11908		2015	Skin sensitisation study of bentazone technical in guinea pigs. GLP
481-1-06-10599		2015	Bacterial reverse mutation test of bentazone technical using salmonella typhimurium. GLP
NC-2014-125		2015	Preliminary Analysis and 5-batch study of Bentazone TGAI Confidential Attachment. GLP
ABC-2018-036		2018	Five-Batch Analysis of Bentazone Technical -Validation of Analytical Methodology for the Assay of Active Ingredient and Impurity in Bentazone Technical and Subsequent 5-Batch Analysis of the Test Item. GLP

BENTAZONE

FAO/WHO EVALUATION REPORT 366 / 2020.1

Recommendations

The Meeting recommended that

i) The existing FAO specifications for bentazone TC and TK should be revised taking the recently submitted data into account.

ii) The new reference specifications for bentazone TC and TK, proposed BASF SE, and as amended, should be adopted by FAO.

iii) The FAO specifications for bentazone formulated products (SL and WP) should be editorially revised to refer to the latest CIPAC MT methods

Appraisal

The first FAO specifications for bentazone were published in 1992 under the old procedure and were revised in 1999 based on data submitted by at that time BASF AG (now BASF SE, BASF). Bentazone was one of the first compounds where specifications and a FAO/WHO evaluation report under the new procedure had been developed. In the meantime bentazone has been reviewed by national authorities (such as by EU in 2014) and differences between the 1999 TC and TK FAO specifications and those of the EU had become apparent. The Meeting also noted that the data package that had been submitted in support of bentazone BASF as reference source was outdated and expectedly no longer complied with the actual data requirements. The Meeting therefore requested BASF to submit an updated data package for this compound. Subsequently a new data package with confidential and non-confidential data for bentazone TK and SL was provided in November 2019 by BASF.

The data submitted were in accordance with the requirements of the Manual on Development and Use of FAO and WHO Specifications for Pesticides (2016, - 3rd revision of the 1st Edition) and supported the draft specifications.

Bentazone is not under patent.

Bentazone is a herbicide belonging to the benzothiadiazinones family. The main formulation type available are soluble concentrates (SL). It is generally not co-formulated with other pesticides. Bentazone formulations are registered and sold in many countries throughout the world.

Bentazone has been evaluated by FAO/WHO JMPR, WHO/IPCS, US EPA and the European Commission. In the EU, bentazone was re-approved in 2018 with minimum purity 960 g/kg and maximum content of 3 mg/kg for 1,2-dichloroethane as a relevant impurity (calculated on the technical material as manufactured).

Bentazone is manufactured as technical concentrate (TK), meeting the requirements of the FAO specification 366/TK (1999). The minimum purity of the active substance bentazone on a dry weight basis based was set at 960 g/kg which complies with the current FAO specification.

Bentazone TC is a white crystalline solid with a melting point of of 139 ˚C (onset temperature) and decomposes at 157 ˚C (onset temperature), whereas the technical concentrate is a red-brown clear liquid. The vapour pressure (4.9 x 10^{-4} Pa at 20 ˚C) indicates that bentazone is slightly volatile. It is moderately soluble in unbuffered water (the solubility in water is 0,57g/L at 20 ˚C and pH 7), however solubility is strongly pH-dependent and increases up to 17 g/L in pH 9 borate buffered water. Bentazone has a pK_a of 3.5 and has therefore acidic properties. It is readily soluble in medium polarity organic solvents like acetone, ethyl acetate, dichloromethane, toluene and methanol but only slightly soluble in apolar solvents like heptane (0.11± 0,1 g/L). The octanol/water partition coefficient - log P_{OW} of 1,49 (in deionized water) - indicates that the molecule is not lipophilic. Photolysis may contribute to degradation in aqueous solution with a half-life of approximately 5.5 days (tested at pH 5, 7 and 9). Bentazone is hydrolytically stable at 25°C and at pH 5, 7 and 9.

The Meeting was provided with commercially confidential information on the manufacturing process and five batch analysis data on impurities at or above 1 g/kg and their manufacturing limits in the TK (bentazone sodium salt). Mass balances ranged from 989 to 1007 g/kg in the 5-batch data. The maximum limits of the impurities were supported by the 5-batch data. The manufacturing process and the 5 batch analysis results for bentazone TK produced by BASF, submitted to JMPS are identical to those evaluated for the renewal of bentazone in EU. None of the impurities (except for 1,2-dichloroethane, see below) was considered to be relevant The identity of bentazone was confirmed by HPLC retention time matching, UV/Vis, IR, MS spectra, ^{1}H-NMR and ^{13}C-NMR.

Bentazone has been evaluated in 1999 by the WHO IPCS. The IPCS hazard classification of bentazone technical grade active ingredient is class II: moderately hazardous. Bentazone was originally evaluated by the JMPR in 1991 and re-evaluated for residues and toxicity several times up to 2004. 4. It was reviewed as part of the periodic re-evaluation programme of CCPR on toxicity in 2012. Bentazone was considered for the first time by FAO/WHO JMPR for toxicology in 1991 (WHO, 1992) and an acceptable daily intake (ADI) of 0-0.1 mg/kg bw was allocated. The ADI was unchanged after the JMPR toxicology review in 1998.

BASF submitted hazard summaries for acute and sub-acute to chronic toxicity, including carcinogenicity, reproductive developmental toxicity/teratogenicity, mutagenicity, ecotoxicology derived mainly from technical material. The submitted studies dated from 1969 to 1993. The purity of the test substance was not stated in some studies, but in others the stated purity ranged from 91.9% to 97.8%. Bentazone sodium salt was used in some studies; however its purity is not stated.

The analytical method for the determination of the active ingredient (including identity tests) is reversed phase HPLC with UV detection at 340 nm on the basis of peak area measurement. This method is a full CIPAC method published in CIPAC Handbook 1 C (page 1976). The official CIPAC method has been improved by applying a more efficient HPLC column. Bentazone TK was dissolved and separated with a mixture of methanol/ammonium acetate buffer as mobile phase.

The determination of the content of organic impurities was carried out by reversed phase HPLC on a Nucleosil 120 C_{18} column and separation of the compounds was achieved solvent gradient. The quantification was accomplished by external calibration with certified reference items after UV detection at 254 nm.

Trace amounts of the residual solvent 1,2-dichloroethane (relevant impurity) were determined by headspace GC-MS on a cyanopropylphenyl GC capillary column at SIM mode. The method has been validated in terms of specificity, linearity, accuracy, LOQ and LOD. The validated method LOQ has been set at 3 mg/kg.

The Meeting considered the consequences of the possible presence of residues of 1,2-dichloroethane in technical bentazone. 1,2-DCE is a non-threshold carcinogen. Therefore, the question regarding the acceptable limits, is not straightforward. Based on the classification and labelling of 1,2-DCE, the following limits can be derived:

Maximum acceptable limit:	1 g/kg
Limit for declaring the impurity relevant:	0.1 g/kg

However, different authorities have derived doses of 1,2-DCE which are deemed to be associated with a certain acceptable low risk (e.g. increased risk for cancer by $1/10^5$). These doses may differ substantially. For example, based on the oral slope factor derived by the US EPA (9.1 x 10 -2 per mg/kg-day) a maximum limit / limit for relevance for 1,2-DCE of 0.1 g/kg and 0.01 g/kg, respectively, can be derived, based on an increased risk for cancer of $1/10^5$. On the other hand, based on the drinking water limit for 1,2-DCE set by WHO, a case can be made to the set the limits for 1,2-DCE in bentazone at 1 g/kg (max) and 0.1 g/kg (limit for relevance). Last but not least, Health Canada, for example derived a dose 0,003 mg/kg bw/d associated with a risk of 10-5. Based on this, limits of 3 /0.3 g/kg can be derived.

Taking these considerations into account, the Meeting concluded that 1,2-DCE, should not be considered relevant at 3 mg/kg in the sense of the JMPS manual, as this concentration is below the different limits for relevance. However, as in other cases and in agreement with the provisions of the Manual, a footnote should be inserted into the specifications. The Manual states (Section 3.A7)

"In certain cases, impurities that could become relevant at higher concentrations were identified in technical materials, but careful control of manufacturing conditions keep these impurities at a level that renders them non-relevant. However, that impurity could occur in the material of other manufacturers at higher concentrations. In these cases, a footnote is added in the TC or TK specification and the proposer provides FAO and or WHO with a copy of a suitable analytical method for determination of that impurity to national programmes on request. "

SUPPORTING INFORMATION
FOR
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USES

Bentazone is a selective herbicide that is mainly used in arable crops like soybeans, cotton, rice and wheat to control annual dicotyledenous weeds. Bentazone acts by inhibiting photosynthesis at the Q_B site in the photosystem II in susceptible plants. It can be applied pre- or postemergent, and tolerant crops rapidly metabolize bentazone to form herbicidally inactive glucosyl conjugates.[4]

IDENTITY OF THE ACTIVE INGREDIENT

ISO common name

Bentazone (ISO 1750, published)

Chemical name(s)

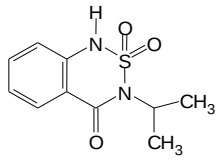
IUPAC 3-isopropyl-1*H*-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide

CA 3-(1-Methylethyl)-1*H*-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide

Synony*ms*

When this substance is used as a salt, its identity is stated as bentazone sodium. The name “bendioxide” is used in South Africa, and the name “bentazon” is used in Canada and the USA.

Structural formula
Bentazone:



Molecular formula

Bentazone: C10H12N2O3S

Bentazone sodium: $C_{10}H_{11}N_2NaO_3S$

Relative molecular mass

Bentazone: 240.3 g/mol

Bentazone sodium: 262.3 g/mol

CAS Registry number

Bentazone: 25057-89-0

Bentazone sodium: 50723-80-3

CIPAC number

Bentazone: 366

Bentazone sodium: none assigned

Identity tests

The test relies on the HPLC retention time matching, UV/Vis, IR, MS spectra, 1H-NMR and13C-NMR. The retention time of bentazone in the sample solution should not deviate by more than 1% from that of authentic bentazone in the calibration solution. [CIPAC 1C, p. 1974].

[4] Information based on the monograph "bentazone", Herbicide Handbook, Weed Science Society of America, 7th edt. 1994.

Table 1. Physico-chemical properties of pure bentazone

<table>
<tr><th>Parameter</th><th>Value(s) and conditions</th><th>Purity %</th><th>Method reference (and technique if the reference gives more than one)</th><th>Study number</th></tr>
<tr><td>Vapour pressure</td><td>4.9 x 10^{-4} Pa at 20 °C</td><td>99.6</td><td>EEC A4</td><td>PCF02041</td></tr>
<tr><td>Melting point</td><td>139 °C (onset temperature)</td><td>99.8</td><td>OECD 102; DSC</td><td>397906_1</td></tr>
<tr><td>Temperature of decomposition</td><td>157 °C (onset temperature)</td><td>99.8</td><td>OECD 102;DSC</td><td>397906_1</td></tr>
<tr><td>Solubility
in water</td><td><table>
<tr><th colspan="2">Solubility in Water at 20 °C by Flask Method</th><th>g/L</th></tr>
<tr><td rowspan="3">H_2O (demin) pH 7</td><td>Average</td><td>0.57</td></tr>
<tr><td>Standard Dev.</td><td>0.02</td></tr>
<tr><td>Actual pH at equilibrium</td><td>3.5 - 4</td></tr>
<tr><td rowspan="3">pH 7 Phosphate Buffer</td><td>Average</td><td>7.7</td></tr>
<tr><td>Standard Dev.</td><td>0.2</td></tr>
<tr><td>Actual pH at equilibrium</td><td>4</td></tr>
<tr><td rowspan="3">pH 4 Citrate Buffer</td><td>Average</td><td>3.0</td></tr>
<tr><td>Standard Dev.</td><td>0.2</td></tr>
<tr><td>Actual pH at equilibrium</td><td>3.5</td></tr>
<tr><td rowspan="3">pH 9 Borate Buffer</td><td>Average</td><td>17</td></tr>
<tr><td>Standard Dev.</td><td>0.3</td></tr>
<tr><td>Actual pH at equilibrium</td><td>4</td></tr>
</table></td><td>99.8</td><td>Flask method</td><td>397908_1ext</td></tr>
<tr><td>Octanol / water partition coefficient</td><td>Deionized water: log P_{OW}: 1.49
Buffer pH 4: log P_{OW}: 1.54
Buffer pH 7: log P_{OW}: -0.94
Buffer pH 9: log $P_{O}W$: -1.32</td><td>99.6</td><td>EEC A.8
OECD 107</td><td>PCP06005</td></tr>
<tr><td>Hydrolysis characteristics</td><td>Half-life3 = not applicable
Bentazone is hydrolytically stable at 25°C at pH
5, 7 and 9</td><td>>99.5</td><td>US EPA 161-1</td><td>1986/5018</td></tr>
<tr><td>Photolysis characteristics</td><td>DT_{50} bentazone < 5.5 d, tested at pH 5, 7 and 9</td><td>97.3 (^{14}C labeled bentazone)</td><td>OECD 316
US EPA
OPPTS 835 22-140</td><td>ID 335436</td></tr>
<tr><td>Dissociation characteristics</td><td>pK_a = 3.5</td><td>99.6</td><td>OECD 112
Titration method</td><td>PCP05901</td></tr>
</table>

Parameter	Value(s) and conditions	Purity %	Method reference (and technique if the reference gives more than one)	Study number
Solubility in organic solvents at 15 to 25 °C	Solubility in toluene: 24.5 g/L (± 1.6 g/L) Solubility in heptane: 0.11 g/L (± 0.1 g/L) Solvent / g/100 ml solution / g/100 ml solvent Acetone / 67.0 / 138.7 Methanol / 59.1 / 106.1 2-Propanol / 48.6 / 79.3 Ethyl acetate / 41.11 / 58.2 Acetonitrile / 33.8 / 44.9 Dichloromethane / 17.6 / 20.6 Toluene / 2.1 / 2.1 n-Heptane / 0.5×10^{-3} / 0.5×10^{-3} 1-Octanol / 16.8 / 19.5	99.8	Quantitative thin layer chromatography	PCP02841

Table 2. Chemical composition and properties of bentazone technical materials (TK)

Manufacturing process, maximum limits for impurities ≥ 1 g/kg, 5-batch analysis data	Confidential information supplied and held on file by FAO. Mass balances were 98.9-100.7 % and no unidentified impurities were reported
Declared minimum bentazone content	The minimum purity of 960 g/kg related to the theoretical dry active ingredient. Bentazone is handled as technical concentrate with 700 g/L bentazone sodium salt (corresponding to 640 g/L bentazone) in water.
Relevant impurities ≥ 1 g/kg and maximum limits for them	none
Relevant impurities < 1 g/kg and maximum limits for them	none
Stabilizers or other additives and maximum limits for them	none

Parameter	Value(s) and conditions	Purity %	Method reference	Study number
Melting temperature range of the TC and / or TK	Decomposes prior to melting	Bentazone Na: 83.18 % (calculated as bentazone)	OECD 102 DSC	397906_2
Solubility in organic solvents	Not applicable	Not applicable [4]	Not applicable	Not applicable

FORMULATIONS AND CO-FORMULATED ACTIVE INGREDIENTS

The main formulation types available are SL and WP. Bentazone is usually formulated as soluble concentrates (SL), however, a less common formulation is a wettable powder (WP)
Bentazone is generally not co-formulated other pesticides.
These formulations are registered and sold in many countries throughout the world.

METHODS OF ANALYSIS AND TESTING

The analytical method for the determination of the active ingredient (including identity tests) is reversed phase HPLC with UV detection at 340 nm and external standardization. This method is a full CIPAC method published in CIPAC Handbook 1 C (page 1976). The official CIPAC method has been improved by applying a more efficient HPLC column. Bentazone TK was dissolved and separated with a mixture of methanol/ammonium acetate buffer as mobile phase.
Bentazone in soluble concentrates is determined by method 366/TC/(M)/3 following sample dilution (366/SL/(M)/3, CIPAC 1C, p. 1976).

Bentazone in wettable powders is determined by a modification of method 366/SL/(M)/3,. The formulation is suspended in 1 M NaOH and the pH adjusted to 7.5 - 8.5 with additional NaOH solution. The solution is filtered, the undissolved residue is rinsed with de-ionized water, filtered again and the filtrates are combined. After making to volume, the determination is continued as for 366/SL/(M)/3, CIPAC 1C, p. 1976

Organic impurities were determined by reversed phase HPLC on a Nucleosil 120 C_{18} column. Quantization was accomplished by external calibration with certified reference items after UV detection at 254 nm. The method was adequately validated i.a. for recoveries and repeatability.

Trace amounts of the residual solvent 1,2-dichloroethane (relevant impurity) were determined by headspace gas chromatography on a cyanopropylphenyl GC capillary column.

Test methods for determination of physico-chemical properties of the technical active ingredient and the formulations were OECD, CIPAC, ASTM and EC, as indicated in the specifications.

CONTAINERS AND PACKAGING

No requirements specific to bentazone call for specifications. Soluble concentrate (SL) formulations are marketed in mold blown high-density polyethylene containers (HDPE; 0.15-10 L). They are sealed by foil seals or by polyamide laminated PE foam gaskets, protected by screw caps made of polyethylene.

EXPRESSION OF THE ACTIVE INGREDIENT

Bentazone is expressed as bentazone (acid).

The concentration in formulations is expressed as g bentazone per kg (or alternatively for liquid formulations, g/l at 20ºC) of formulation. Where applicable, the name of the bentazone salt present is stated.

ANNEX 1
HAZARD SUMMARY PROVIDED BY THE PROPOSER

Notes.
(i) The proposer confirmed that the toxicological data included in the summary below were derived from bentazone having impurity profiles similar to those referred to in the table above.
(ii) The conclusions expressed in the summary below are those of the proposer, unless otherwise specified

Table 3: Toxicology profile of bentazone or bentazone sodium salt technical material, based on acute toxicity, irritation and sensitization.

Species	Test	Purity % Note[5]	Guideline, duration, doses and conditions	Result	Study number [2]
Rat (Sprague Dawley, ♂ + ♀)	oral	bentazone sodium salt, purity not specified	Prior to guideline and GLP implementation; single gavage application in 0.8% CMC (aqueous carboxymethyl cellulose), 5 animals/sex/dose; observation for 14 days; Doses: 800; 1000; 1250; 1600 and 2000 mg/kg bw	LD50 = 1480 mg/kg bw, equivalent to 1360 mg/kg bw free acid	BASF 1973; DocID 1973/023
Rat (Sprague Dawley, ♂ + ♀)	oral	bentazone, purity not specified	Prior to guideline and GLP implementation; single gavage application in 0.8% CMC (aqueous carboxymethyl cellulose), 5 animals/sex/dose; observation for 14 days; Doses: 500; 640; 800; 1000; 1250; 1600 and 2000 mg/kg bw	LD50 = 1220 mg/kg bw (♂ + ♀)	BASF 1973; DocID 1973/022
Rat (Wistar, ♂ + ♀)	oral	bentazone, 93.9%	OECD 401 single gavage application in 0.5% CMC (aqueous carboxymethyl cellulose), 5 animals/sex/dose; observation for 14 days; Doses: 825; 1210; 1780 and 2610 mg/kg bw	LD50 = 1780 mg/kg bw (♂) LD50 = 1470 mg/kg bw (♀) LD50 = 1640 mg/kg bw (♂+♀)	BASF 1983; DocID 1983/114

Species	Test	Purity % Note[5]	Guideline, duration, doses and conditions	Result	Study number [2]
Rat (Wistar, ♂ + ♀)	oral	bentazone, purity not specified	OECD 401 single gavage application in 0.5% CMC (aqueous carboxymethyl cellulose), 5 animals/sex/dose; observation for 14 days; Doses: 562; 825; 1210; 1780 and 2610 mg/kg bw	LD50 = 1780 mg/kg bw (♂) LD50 = 1790 mg/kg bw (♀) LD50 = 1710 mg/kg bw (♂+♀)	BASF 1983; DocID 1983/113

Species	Test	Purity % Note[5]	Guideline, duration, doses and conditions	Result	Study number [2]
Rat (Sprague Dawley, ♂ + ♀)	oral	bentazone, 94.6%	Prior to guideline and GLP implementation; single gavage application in 0.5% CMC (aqueous carboxymethyl cellulose), 10 animals/sex/dose; observation for 14 days; Doses: 1500; 1800; 2160; 2592; 3110 and 3732 mg/kg bw	LD50 = 2340 mg/kg bw (♂) LD50 = 2470 mg/kg bw (♀)	DocID 1978/053
Rat (Sprague Dawley, ♂ + ♀)	oral	bentazone, purity not specified	Prior to guideline and GLP implementation; single gavage application in 2 - 16% aqueous tragacanth suspension, 5 animals/sex/dose; observation for 14 days; Doses: 200; 400; 800; 1000; 1250 and 1600 mg/kg bw	LD50 ~ 850 mg/kg bw	BASF 1969; DocID 1969/0013
Rat (Sprague Dawley, ♂ + ♀)	oral	bentazone, purity not specified	Prior to guideline and GLP implementation; single gavage application in 8% CMC (aqueous carboxymethyl cellulose), 5 animals/sex/dose; observation for 14 days; Doses: 400; 500; 640; 800; 1000; 1250; 1600 and 2000 mg/kg bw	LD50 = 1050 mg/kg bw	BASF 1972; DocID 1972/051

Guinea pig (Strain not specified, ♂ + ♀)	oral	bentazone, purity not specified	Prior to guideline and GLP implementation; single gavage application in 4 - 16% CMC (aqueous carboxymethyl cellulose), 5 animals/sex/dose; observation for 14 days; Doses: 400; 800; 1200; 1600 or 3200 mg/kg bw	LD50 ~ 1100 mg/kg bw	BASF 1974; DocID 1991/10147

Species	Test	Purity % Note[5]	Guideline, duration, doses and conditions	Result	Study number [2]
Guinea pig (Strain not specified, ♂ + ♀)	oral	bentazone sodium salt, purity not specified	Prior to guideline and GLP implementation; single gavage application in 6.4 - 16% CMC (aqueous carboxymethyl cellulose), 5 animals/sex/dose; observation for 14 days; Doses: 640; 800; 1000; 1250 and 1600 mg/kg bw	LD50 = 1100 mg/kg bw, equivalent to 1000 mg/kg bw free acid	BASF 1974; DocID 1974/035
Rabbit (Strain not specified, ♂ + ♀)	oral	bentazone, purity not specified	Prior to guideline and GLP implementation; single gavage application in 2.5; 5 or 20% aqueous tragacanth suspensions, 1 animals/sex/dose; observation for 7 days; Doses: 100; 250; 500; 1000 and 2000 mg/kg bw	LD50 ~ 750 mg/kg bw	BASF 1969; DocID 1969/005[#]

Species	Test	Purity % Note[5]	Guideline, duration, doses and conditions	Result	Study number [2]
Rabbit (NWZ, ♂ + ♀)	oral	bentazone, purity not specified	Only abstract available in English 7 animals/sex/dose	LD50 = 1139 mg/kg bw	Published literature Neuschl and Kacmar, 1993; DocID 1993/11411##
Cat (Strain not specified, ♂ + ♀)	oral	bentazone, purity not specified	Prior to guideline and GLP implementation; single gavage application in 5 - 20% aqueous tragacanth solutions; 2-6 animals/sex/dose; observation for 14 days; Doses: 250; 500; 1000 and 2000 mg/kg bw	LD50 ~ 500 mg/kg bw	BASF 1970; DocID 1970/017

Species	Test	Purity % Note[5]	Guideline, duration, doses and conditions	Result	Study number [2]
Dog (Beagle, ♂ + ♀)	oral	bentazone, purity not specified	Prior to guideline and GLP implementation; single gavage application in 1 - 20% aqueous tragacanth solutions; 2 animals/sex/dose; observation for 14 days; Doses: 50; 100; 250; 500; 1000 and 2000 mg/kg bw	LD50 > 500 mg/kg bw	BASF 1970; DocID 1970/017
Rat (Sprague Dawley, ♂ + ♀)	intraperitoneal	bentazone, 94.6%	Prior to guideline and GLP implementation; single subcutaneous injection in 0.5% CMC (aqueous carboxymethyl cellulose), 10 animals/sex/dose; observation for 14 days; Doses: 329, 378, 435, 500 and 572 mg/kg bw	LD50 = 403 mg/kg bw (♂) LD50 = 407 mg/kg bw (♀)	Keio University 1978; DocID 1978/053
Rat (Wistar, ♂ + ♀)	intraperitoneal	bentazone, purity not specified	Prior to guideline and GLP implementation; single subcutaneous injection in 0.5% CMC (aqueous carboxymethyl cellulose), 5 animals/sex/dose; observation for 14 days; Doses: 261; 316; 383 and 562 mg/kg bw	LD50 >316, < 383 mg/kg bw	BASF, 1983; DocID 1983/161

Species	Test	Purity % Note[5]	Guideline, duration, doses and conditions	Result	Study number [2]
Rat (Sprague Dawley, ♂ + ♀)	intraperitoneal	bentazone, purity not specified	Prior to guideline and GLP implementation; single subcutaneous injection in CMC (aqueous carboxymethyl cellulose), 5 animals/sex/dose; observation for 14 days; Doses: 200; 250; 320; 400; 500; 640; 800 and 1000 mg/kg bw	LD50 = 344 mg/kg bw	BASF, 1972; DocID 1972/10130

Species	Test	Purity % Note[5]	Guideline, duration, doses and conditions	Result	Study number [2]
Mouse (ICR, ♂ + ♀)	intraperitoneal	bentazone, 94.6%	Prior to guideline and GLP implementation; single subcutaneous injection in 0.5% CMC (aqueous carboxymethyl cellulose), 10 animals/sex/dose; observation for 14 days; Doses: 400; 460; 529; 608 and 699 mg/kg bw	LD50 = 494 mg/kg bw (♂) LD50 = 505 mg/kg bw (♀)	Keio University 1978; DocID 1978/054
Mouse (NMRI, ♂ + ♀)	intraperitoneal	bentazone, purity not specified	Prior to guideline and GLP implementation; single subcutaneous injection in 2-8% aqueous tragacanth solution, 5 animals/sex/dose; observation for 14 days; Doses: 200; 250; 320; 400; 500; 640 and 800 mg/kg bw	LD50 ~ 400 mg/kg bw	BASF, 1969 DocID 1969/018

Rat (Sprague Dawley, ♂ + ♀)	dermal	bentazone, 94.6%	In compliance with Directive 92/69/EEC, part B single dermal application in 1% CMC (aqueous carboxymethyl cellulose), 10 males and 10 females; exposure: 24 h (semi-occlusive) observation for 14 days; Doses: 5000 mg/kg bw (limit test)	LD50 > 5000 mg/kg bw	Keio University 1978; DocID 1978/055

Species	Test	Purity % Note[5]	Guideline, duration, doses and conditions	Result	Study number 2
Rat (Sprague Dawley, ♂ + ♀)	dermal	bentazone, purity not specified	Prior to guideline and GLP implementation; single dermal application as 50% aqueous paste; 10 males and 10 females; exposure: 24 h observation for 14 days; Doses: 2500 mg/kg bw (limit test)	LD50 > 2500 mg/kg bw	BASF 1969; DocID 1969/002
Rat (Sprague Dawley, ♂ + ♀)	subcutaneous	bentazone, 94.6%	Prior to guideline and GLP implementation; single subcutaneous injection in 0.5% CMC (aqueous carboxymethyl cellulose), 10 animals/sex/dose; observation for 14 days; Doses: 694; 833; 1000; 1200; 1440 and 1728 mg/kg bw	LD50 = 970 mg/kg bw (♂) LD50 = 975 mg/kg bw (♀)	Keio University 1978; DocID 1978/053

Species	Test	Purity % Note[5]	Guideline, duration, doses and conditions	Result	Study number [2]
Mouse (ICR, ♂ + ♀)	subcutaneous	bentazone, 94.6%	Prior to guideline and GLP implementation; single subcutaneous injection in 0.5% CMC (aqueous carboxymethyl cellulose), 10 animals/sex/dose; observation for 14 days; Doses: 522; 600; 690; 794 and 913 mg/kg bw	LD50 = 655 mg/kg bw (♂) LD50 = 580 mg/kg bw (♀)	Keio University 1978; DocID 1978/054
Rat (Sprague Dawley, ♂ + ♀)	inhalation	bentazone, purity not specified	Prior to guideline and GLP implementation; 12 animals exposure: 8 h as dust aerosol observation for 14 days; Doses: ~1.2 mg/L (limit test) MMAD / GSD = not specified	LC50 >1.2 mg/L	BASF 1969; DocID 1969/003
Rat (Wistar, ♂ + ♀)	inhalation	bentazone, 97.8%	OECD TG 403 10 males and 10 females; exposure: 4 h (head/nose) as dust aerosol observation for 14 days; Doses: 5.1 mg/L (limit test) MMAD = 6.4 µm, GSD = 2.5 µm	LC50 > 5.1 mg/L (♂) LC50 > 5.1 mg/L (♀)	BASF, 1986; DocID 1986/220

Species	Test	Purity % Note[5]	Guideline, duration, doses and conditions	Result	Study number [2]
Rabbit (White Vienna, ♂ + ♀)	skin irritation	bentazone, purity not specified	In compliance with Directive 92/69/EEC, part B 3 males and 3 females; exposure: 24 h (occlusive) observation for 14 days; Doses: 0.5 g test item as 50% aqueous solution	Slightly irritating (classification and labelling not required)	BASF, 1983; DocID 1983/081
Rabbit (White Vienna, ♂ + ♀)	eye irritation	bentazone, purity not specified	In compliance with Directive 92/69/EEC, part B 3 males and 3 females; exposure: not washed out after 24 h observation for 14 days; Doses: 0.1 mL test item	Irritating to eyes	BASF, 1983; DocID 1983/083
Guinea pig (Pirbright White, ♀)	skin sensitisation	bentazone, 94.0%	OECD TG 406 (M&K) 20/10 females in treatment/control group vehicle: aqua dest. intradermal induction: 5% dermal induction: 0.3 g challenge (x3): 50%	Maximisation test: skin sensitizer	BASF, 1986; DocID 1986/195

Species	Test	Purity % Note5	Guideline, duration, doses and conditions	Result	Study number 2
Guinea pig (Pirbright White, ♀)	skin sensitisation	bentazone sodium salt formulation, ~60% (600 g/L)	OECD TG 406 (OET) 8 females per group vehicle: aqua dest. induction (x20): 2%, 10%, 50% and 100% challenge (x2): 2%, 10%, 50% and 100%	Open Epicutaneous Test: Sensitizing at 50% aqueous dilution; Not sensitizing at 2% and 10% aqueous dilution	BASF, 1986; DocID 1986/221

Study considered unacceptable for evaluation due to methodical reasons

Published literature with no assessment of acceptance

Table 4. Toxicology profile of bentazone or bentazone sodium salt technical material based on repeated administration (subacute to chronic)

Species	Test	Purity % Note[6]	Guideline, duration, doses and conditions	Result	Study number 2
Rat (F344, ♂ + ♀)	31/33-d oral feeding study	bentazone, 93.9%	Prior to guideline and GLP implementation, but in compliance with Directive 92/69/EEC, part B; 8 animals/sex/dose – 1-month daily exposure Dose levels: 0, 600; 1800, 5000 (4000) and 10000 ppm, equivalent to 0, 64/71, 196/217, 554/607, 1068/1132 mg/kg bw/d for ♂/♀	NOAEL ~ 200 mg/kg bw/d LOAEL = 554 mg/kg bw/d	Nippon Institute for Biological Science, 1981; DocID 1981/10240
Mouse (B6C3F1, ♂ + ♀)	30-d oral feeding study	bentazone, purity not specified	Prior to guideline and GLP implementation, but in compliance with Directive 92/69/EEC, part B; 6 animals/sex/dose – 1-month daily exposure Dose levels: 0, 400; 2000; 5000 and 10,000 ppm, equivalent to 0, 91/100, 407/487, 905/1004, 1469/1663 mg/kg bw/d for ♂/♀	Study not appropriate for NOAEL setting, as crucial parameter (blood coagulation) was not measured; LOAEL = 407 mg/kg bw/d	Nippon Institute for Biological Science, 1980; DocID 1981/10239

[6] Note: Purity is the content of pure active ingredient in the technical material, expressed as a percentage.

Species	Test	Purity % Note[6]	Guideline, duration, doses and conditions	Result	Study number 2
Rabbit (NZW, ♂ + ♀)	21-d dermal study	bentazone, purity not specified	Prior to guideline and GLP implementation; 6 animals/sex/dose vehicle: 1% aqueous tylose exposure: 8 h / day for 21 days, semi- occlusive for 10% of body surface Dose levels: 0; 250; 500 and 1000 mg/kg bw/d	NOAEL = 1000 mg/kg bw/d LOAEL = >1000 mg/kg bw/d	LPT, 1971; DocID 1971/005
Rabbit (NZW, ♂ + ♀)	21-d dermal study	bentazone, 97.64%	OECD TG 410; 5 animals/sex/dose vehicle: 1% aqueous tylose exposure: 6 h / day for 21 days, semi- occlusive for 10% of body surface Dose levels: 0; 250; 500 and 1000 mg/kg bw/d	NOAEL = 1000 mg/kg bw/d LOAEL = >1000 mg/kg bw/d	BASF, 1992; DocID 1993/10760
Rat (Sprague Dawley, ♂ + ♀)	90-d oral feeding study followed by a 6-week recovery period	bentazone, purity not specified	Prior to guideline and GLP implementation 20 animals/sex/dose – main group: 13 weeks daily exposure 10 animals/sex/dose – recovery group: 4-week basal diet after 13-week exposure Dose levels: Main group: 0; 70; 200 (~ 10 mg/kg bw/d); 800 and 1600 ppm; Recovery group: 0; 70 and 1600 ppm	NOAEL = 10 mg/kg bw/d LOAEL = 800 ppm	BASF, 1970; DocID 1970/008

Species	Test	Purity % Note[6]	Guideline, duration, doses and conditions	Result	Study number 2
Rat (Wistar, ♂+♀)	90-d oral feeding study followed by a 4-week recovery period	bentazone, 97.8%	OECD TG 408 10 animals/sex/dose – main group: 13 weeks daily exposure 10 animals/sex/dose – recovery group: 4-week basal diet after 13-week exposure Dose levels: Main group: 0, 400; 1200 and 3600 ppm, equivalent to 0, 25.3/28.9, 77.8/86.1 and 243.3/258.3 mg/kg bw/d for ♂/♀; Recovery group: 0 and 3600 ppm	NOAEL = 77.8 mg/kg bw/d LOAEL = 243.3 mg/kg bw/d	RCC, 1987; DocID 1987/0173

Species	Test	Purity % Note[6]	Guideline, duration, doses and conditions	Result	Study number 2
Rat (Wistar, ♂ + ♀)	90-d oral feeding study	bentazone, 100%	OECD TG 408 10 animals/sex/dose– 13 weeks daily exposure Dose levels: 0, and 3600 ppm, equivalent to 0, 238/252 mg/kg bw/d for ♂/♀, equivalent to 4275 ppm bentazone-Na salt	NOAEL <238 mg/kg bw/d LOAEL = 238 mg/kg bw/d	BASF, 2011, 2012; DocID 2011/1173365, 2012/1009658
Rat (Wistar, ♂ + ♀)	90-d oral feeding study	bentazone sodium salt, 91.9%	OECD TG 408 10 animals/sex/dose– 13 weeks daily exposure Dose levels: 0, 475, 1425, 4275 ppm, equivalent to 0, 31/42, 91/98 and 290/304 mg/kg bw/d for ♂/♀, equimolar to doses tested in RCC, 1987 study	NOAEL = 91 mg/kg bw/d LOAEL = 290 mg/kg bw/d	BASF, 2011, 2012; DocID 2011/1173365, 2012/1009658
Dog (Beagle, ♂ + ♀)	90-d oral feeding study	bentazone, purity not specified	Prior to guideline and GLP implementation, but in compliance with Directive 87/302/EEC, part B. 3 animals/sex/dose – 13 weeks daily exposure Dose levels: 0; 100; 300; 1000 and 3000 ppm, equivalent to 0; 4.0; 12.0; 39.6 and 113.8 mg/kg bw/d for ♂+♀	NOAEL = 12 mg/kg bw/d LOAEL = 39.6 mg/kg bw/d	LPT, 1970; DocID 1970/009

Species	Test	Purity % Note[6]	Guideline, duration, doses and conditions	Result	Study number 2
Dog (Beagle, ♂ + ♀)	1-y oral feeding study	bentazone, 97.8%	OECD TG 452 6 animals/sex/dose - 1-y daily exposure Dose levels: 0; 100; 400 and 1600 ppm, equivalent to 0, 3.0/3.3, 13.1/13.2 and 49.7/54.8 mg/kg bw/d for ♂/♀	NOAEL = 13.1 mg/kg bw/d LOAEL = 49.7 mg/kg bw/d	RCC, 1989; DocID 1989/0049
Rat (Sprague Dawley, ♂ + ♀)	2-y oral feeding chronic study	bentazone, purity not specified	Prior to guideline and GLP implementation 50 animals/sex/dose - 2-y daily exposure Dose levels: 0; 100; 350 and 1600 ppm, equivalent to 0, 5, 17 and 76 mg/kg bw/d for ♂+♀	NOAEL = 17 mg/kg bw/d LOAEL = 76 mg/kg bw/d	Cannon Laboratories Inc., 1974 DocID 1974/004
Rat (Wistar, ♂ + ♀)	2-y oral feeding chronic and carcinogenicity study	bentazone, 93.9%	OECD TG 453 50 animals/sex/dose – 2-y daily exposure 10 animals/sex/dose – 1-y daily exposure 10 animals/sex/dose – 6 months daily exposure Dose levels: 0; 200; 800 and 4000 ppm, equivalent to 0, 9/11, 35/45 and 180/244 mg/kg bw/d for ♂+♀	NOAEL = 9 mg/kg bw/d LOAEL = 47 mg/kg bw/d	Nippon Institute for Biological Science, 1985; DocID 1985/433

Species	Test	Purity % Note[6]	Guideline, duration, doses and conditions	Result	Study number 2
Mouse (Swiss Webster, ♂ + ♀)	18-months oral feeding chronic and carcinogenicity study	bentazone, purity not specified	Prior to guideline and GLP implementation 50 animals/sex/dose – 18 months daily exposure 5 animals/sex/dose – 1-year daily exposure Dose levels: 0; 100; 350 and 1600 ppm, equivalent to 0; 15; 52 and 237 mg/kg bw/d for ♂+♀	NOAEL = 52 mg/kg bw/d LOAEL = 237 mg/kg bw/d	Cannon Laboratories Inc., 1974 DocID 1974/041
Mouse (CFLP, ♂ + ♀)	82-95 weeks oral feeding, carcinogenicity study	bentazone, purity not specified	Prior to guideline and GLP implementation 40 animals/sex/dose – 82 weeks daily exposure for 1600 ppm group / 95 weeks daily exposure for all other dose groups Dose levels: 0; 100; 350 and 1600 ppm, equivalent to 0; 8.4/9.5; 29.7/34.3 and 138.4/152.9 mg/kg bw/d for ♂/♀	NOAEL = 146 mg/kg bw/d LOAEL = >146 mg/kg bw/d	Huntingdon Research Centre, 1998 DocID 1978/034

Species	Test	Purity % Note[6]	Guideline, duration, doses and conditions	Result	Study number 2
Mouse (B6C3F1, ♂ + ♀)	2-y oral feeding chronic and carcinogenicity study	bentazone, 93.9%	OECD TG 453 50 animals/sex/dose – 2-y daily exposure 10 animals/sex/dose – 1-y daily exposure 10 animals/sex/dose – 6 months daily exposure Dose levels: 0; 100; 400 and 2000 ppm, equivalent to 0, 12/12, 47/48 and 242/275 mg/kg bw/d for ♂/♀	NOAEL = 12 mg/kg bw/d LOAEL = 47 mg/kg bw/d	Nippon Institute for Biological Science, 1985; DocID 1985/432
Rat (Sprague Dawley, ♂ + ♀)	3-generational oral feeding study	bentazone, purity not specified	Prior to guideline and GLP implementation 20 animals/sex/dose pre-mating: 8-18 weeks mating: 1:1 Dose levels: 0; 20; 60 and 180 ppm, equivalent to 0, 2.0, 6.0 and 18.3 mg/kg bw/d for ♂+♀	NOAEL parental / offspring / reproductive 18 mg/kg bw/d LOAEL parental / offspring / reproductive = >18 mg/kg bw/d	LPT, 1973; DocID 1973/010
Rat (Wistar, ♂ + ♀)	2-generational oral feeding study	bentazone, 97.8%	OECD TG 416 25 animals/sex/dose pre-mating F0 / F1: 70 / 123 days mating: 1:1 Dose levels: 0; 200; 800 and 3200 ppm, equivalent to 0, 22, 80 and 163.4 mg/kg bw/d for ♂+♀	NOAEL parental / offspring ≈ 22 mg/kg bw/d LOAEL parental / offspring ≈ 80 mg/kg bw/d NOAEL reproductive= 163.4 mg/kg bw/d LOAEL reproductive = >163.4 mg/kg bw/d	RCC, 1989; DocID 1989/0068
Rat (Sprague Dawley, ♀)	teratogenicity and developmental toxicity oral gavage study	bentazone, 97.8%	OECD TG 414 25 pregnant females/sex/dose	NOAEL maternal = 250 mg/kg bw/d LOAEL maternal = >250 mg/kg bw/d NOAEL	RCC, 1986; DocID 1986/421

Species	Test	Purity % Note[6]	Guideline, duration, doses and conditions	Result	Study number 2
			exposure: GD 6 – 15 caesarean section: GD 21 Dose levels: 0, 40; 100 and 250 mg/kg bw/d	developmental = 100 mg/kg bw/d LOAEL developmental = 250 mg/kg bw/d	
Rat (Sprague Dawley, ♀)	teratogenicity and developmental toxicity oral dietary study	bentazone, 93.9%	in compliance with Directive 87/302/EEC 23 females/sex/dose exposure: GD 0 – 21 caesarean section: GD 21 Dose levels: 0; 2000; 4000 or 8000 ppm, equivalent to 0, 162, 324 and 631 mg/kg bw/d	NOAEL maternal = 162 mg/kg bw/d LOAEL maternal = 324 mg/kg bw/d NOAEL developmental = 324 mg/kg bw/d LOAEL developmental = 631 mg/kg bw/d	Nippon Institute for Biological Science, 1982; DocID 1984/066

Species	Test	Purity % Note[6]	Guideline, duration, doses and conditions	Result	Study number 2
Rat (Sprague Dawley, ♀)	teratogenicity and developmental toxicity oral gavage study	bentazone, 92.5%	Prior to guideline and GLP implementation 26-29 females/sex/dose exposure: GD 6 – 15 caesarean section: GD 21 Dose levels: 0; 22.2; 66.7 and 200 mg/kg bw/d	NOAEL maternal / developmental = 200 mg/kg bw/d LOAEL maternal / developmental = >200 mg/kg bw/d	BASF, 1978; DocID 1978/039
Rat (Sprague Dawley, ♀)	teratogenicity and developmental toxicity oral gavage study	bentazone, purity not specified	Prior to guideline and GLP implementation 20-32 pregnant females/sex/dose exposure: GD 6 – 15 caesarean section: GD 21 Dose levels: 0, 22.2; 66.7 and 200 mg/kg bw/d	NOAEL maternal = 200 mg/kg bw/d LOAEL maternal = >200 mg/kg bw/d NOAEL developmental = 66.7 mg/kg bw/d LOAEL developmental = 200 mg/kg bw/d	BASF, 1971; DocID 1971/0041
Rat (Strain not specified, ♀)	teratogenicity and developmental toxicity oral gavage study	bentazone formulation (Basagran), purity not specified	Not a guideline GLP study 3 pregnant females/sex/dose single exposure on GD6/GD8/GD11/GD14 or GD16 caesarean section: GD 20 Dose levels: 0; 12.0; 43.2 or 96 mg of bentazon/kg bw	NOAEL/LOAEL maternal = no data provided NOAEL developmental = 150 mg/kg bw/d LOAEL developmental = 375 mg/kg bw/d	Published literature El-Mahdi and Lofti, 1988# DocID 1988/10538

Species	Test	Purity % Note[6]	Guideline, duration, doses and conditions	Result	Study number 2
Rabbit (Himalayan, ♀)	teratogenicity and developmental toxicity oral gavage study	bentazone, 92.5%	Prior to guideline and GLP implementation 15 inseminated females/sex/dose exposure: GD 6 – 18 caesarean section: GD 28 Dose levels: 0, 50; 100 and 150 mg/kg bw/d	NOAEL maternal / developmental = 150 mg/kg bw/d LOAEL maternal / developmental = >150 mg/kg bw/d	BASF, 1984; (date of original report 1978) DocID 1984/048
Rabbit (Chinchilla, ♀)	teratogenicity and developmental toxicity oral gavage study	bentazone, 97.8%	OECD TG 414 16 pregnant females/sex/dose exposure: GD 6 – 18 caesarean section: GD 28 Dose levels: 0, 75; 150 and 375 mg/kg bw/d	NOAEL maternal / developmental = 150 mg/kg bw/d LOAEL maternal / developmental = 375 mg/kg bw/d	RCC, 1987; DocID 1987/058
Rat (Wistar, ♂ + ♀)	90-d oral feeding neurotoxicity study	bentazone, 96.9%	OECD TG 424 10 animals/sex/dose– 13 weeks daily exposure Dose levels: 0, 300, 1000, 3500 ppm, equivalent to 0, 21.9/27.0, 73.6/86.4 and 258.1/306.3 mg/kg bw/d for ♂/♀	NOAEL systemic / neurotoxicity = 258.1 mg/kg bw/d LOAEL systemic / neurotoxicity = >258.1 mg/kg bw/d	BASF, 2004; DocID 2004/1013171, 2004/1025741

Published literature was excluded from risk assessment due to poor quality

Table 5. Mutagenicity profile of the bentazone or bentazone sodium salt technical material based on in vitro and in vivo tests

Species	Test	Purity % Note[7]	Guideline, duration, doses and conditions	Result	Study number2
S. typh TA 98, TA 100 and TA 1537	in vitro Ames test	bentazone, 92.5%	Prior to guideline and GLP implementation Doses tested: ± S9: 3.1 - 2000 µg/plate	± S9 (rat): negative	University of Mainz, 1977; DocID 1977/028
S. typh TA 1535, TA 1537, TA 1538, TA 98, TA 100 and *E. coli* WP2 hcr	in vitro Ames test	bentazone, 94%	According to Ames et al., 1973 and mainly in compliance with Directive 92/69/EEC, part B Doses tested: ± S9: 0 - 1000 µg/plate	± S9 (rat): negative	Japanese Institute of Environmental Toxicology, 1976 DocID 1976/009
S. typh TA 1535, TA 100, TA 1537, TA 1538, TA 98	in vitro Ames test	bentazone, 97.7%	According to Ames et al., 1973/1975 and in compliance with Directive 92/69/EEC, part B Doses tested: ± S9: 20 - 5000 µg/plate	± S9 (rat): negative	BASF, 1983; DocID 1983/222
S. typh TA 1535, TA 1537, TA 1538, TA 98, TA 100 and *E. coli* WP2 hcr	in vitro Ames test	bentazone, 94%	According to Ames et al., 1973 and mainly in compliance with Directive 92/69/EEC, part B Doses tested: ± S9: 0 - 10000 µg/plate	± S9: negative	Japanese Institute of Environmental Toxicology, 1984 DocID 1984/10285

[7] Note: Purity is the content of pure active ingredient in the technical material, expressed as a percentage.

Species	Test	Purity % Note[7]	Guideline, duration, doses and conditions	Result	Study number 2
S. typh TA 1535, TA 100, TA 1537, TA 1538, TA 98 and *E. coli* WP2	in vitro Ames test	bentazone, 92.6%	According to Ames et al., 1973/1975 and in compliance with Directive 92/69/EEC, part B Doses tested: ± S9: 20 - 5000 µg/plate	± S9 (mice): negative	BASF, 1985; DocID 1985/108
S. typh TA 1538, TA 98, TA 1537, TA 1535 and TA 100	in vitro Ames test	bentazone sodium salt (pure), purity not specified	According to Ames et al., 1973/1975 and in compliance with Directive 92/69/EEC, part B Doses tested: ± S9: 500 - 10000 µg/plate	± S9 (rat): negative	BASF, 1985 DocID 1985/081
S. typh TA 1538, TA 98, TA 1537, TA 1535 and TA 100	in vitro Ames test	bentazone sodium salt formulation, 55% (550 g/L)	According to Ames et al., 1973/1975 and in compliance with Directive 92/69/EEC, part B Doses tested: ± S9: 0 - 3000 µg/plate	± S9 (rat): negative	BASF, 1985 DocID 1985/081
S. typh TA 98, TA 100, TA 1535, TA 1537 and *E. coli* WP2uvrA	in vitro Ames test	bentazone sodium salt, 91.9%	OECD TG 471 Doses tested: ± S9: 33 - 5500 µg/plate	± S9 (rat): negative	BASF, 2011 DocID 2011/1106427

Species	Test	Purity % Note[7]	Guideline, duration, doses and conditions	Result	Study number 2
Bacillus subtilis H 17 and M 45	in vitro Rec assay	bentazone, 94%	According to Rec assay: Kada T. (1973) Doses tested: - S9: 20 - 2000 µg/plate	- S9: negative	Japanese Institute of Environmental Toxicology, 1976 DocID 1976/009
Bacillus subtilis H 17 and M 45	in vitro Rec assay	bentazone, 94%	According to Rec assay: Kada T. (1973) Doses tested: - S9: 0 - 10000 µg/plate	- S9: negative	Japanese Institute of Environmental Toxicology, 1984 DocID 1984/10285
CHO	in vitro HPRT	bentazone, 93.9%	In compliance with OECD TG 476 Exposure: 4 h (± S9) Doses tested: ± S9: 0.1; 0.464; 1.0; 4.64 and 10 mg/mL	- S9: negative + S9 (rat): negative + S9 (mice): weakly positive	BASF, 1985; DocID 1985/396
CHO	in vitro HPRT	bentazone, 93.9%	In compliance with OECD TG 476 Exposure: 4 h (± S9) Doses tested: ± S9: 1.25 - 15 mg/mL	± S9 (rat / mice): negative	Litton Bionetics, 1985 DocID 1985/403

Species	Test	Purity % Note[7]	Guideline, duration, doses and conditions	Result	Study number 2
CHO	in vitro HPRT	bentazone, 97.64%	OECD TG 476 Exposure: 4 h (± S9) Doses tested: ± S9: 0.1; 0.3; 0.6; 1.2; 2.5 and 5.0 mg/mL	± S9 (mice): negative	RCC, 1991; DocID 1991/11108
CHO	in vitro HPRT	bentazone sodium salt, 91.9%	OECD TG 476 Exposure: 4 h (± S9) Doses tested: ± S9: 187.5 to 3000 µg/mL	± S9 (rat): negative	BASF, 2011; DocID 2011/1106426
CHO	in vitro CA	bentazone, purity not specified	Mainly in compliance with OECD TG 473 Exposure: 2 h (+ S9); 17.5 h (- S9) Doses tested: - S9: 0.5; 1.0; 2.0 and 3.0 mg/mL + S9: 2.0; 3.0; 4.0 and 5.0 mg/mL	± S9 (rat): negative	Hazleton, 1986 DocID 1987/0169
V79	in vitro CA	bentazone sodium salt, 91.9%	OECD TG 473 Exposure: 4 h (± S9); Doses tested: ± S9: 187.5 - 3000 µg/mL	± S9 (rat): positive	BASF, 2011; DocID 2011/1106426

Species	Test	Purity % Note[7]	Guideline, duration, doses and conditions	Result	Study number 2
Primary mice hepatocytes	in vitro UDS	bentazone, purity not specified	Mainly in compliance with Directive 87/302/EEC, part B Exposure: 18 h Doses tested: 2.5 - 1004 µg/mL	- S9: negative	Litton Bionetics, Inc., 1985 DocID 1985/067
Mouse (ICR, ♂)	ex vivo Host mediated assay	bentazone, 94%	Not a guideline study, prior GLP implementation 6 males/dose exposure: oral (gavage) twice (0 h and 24 h) inoculation: immediately after 2nd application, with *S. thyph*. G46 (his+) into peritoneal cavity bacteria re-isolation: 3 h after 2nd application – cultured for 48 h Doses tested: 50 and 200 mg/kg bw	Negative	Japanese Institute of Environmental Toxicology, 1976; DocID 1976/009
Mouse (NMRI, ♂ + ♀)	in vivo Dominant lethal test	bentazone, purity not specified	Prior to guideline and GLP implementation, partly in compliance with Directive 87/302/EEC, part B 20 males treated i.p. once mating with untreated females: 20 h after application, 1:3 for 7 consecutive, weekly matings termination: GD 18 Doses tested: 0, 195 mg/kg bw	Negative	BASF, 1973; DocID 1973/025
Rat (Sprague Dawley, ♂ + ♀)	in vivo Dominant lethal test	bentazone, purity not	Prior to guideline and GLP implementation 20 animals/sex/dose	Negative	LPT1971; DocID 1971/018

Species	Test	Purity % Note[7]	Guideline, duration, doses and conditions	Result	Study number 2
		specified	exposure: ♂: dietary for the whole study duration (incl. mating periods) mating with untreated females: after 90-days, 1:1 termination: GD 18 Doses tested: of 0; 2 0; 60 and 180 ppm		
Mouse (NMRI, ♂ + ♀)	in vivo MNT	bentazone, 95.65%	In compliance with Directive 92/69/EEC, part B 5 animals/sex/dose exposure: once by gavage bone morrow sampling 16, 24 and 48 h post-treatment Doses tested: 0; 200; 400 and 800 mg/kg bw	Negative	BASF, 1985; DocID 1985/036

Species	Test	Purity % Note[7]	Guideline, duration, doses and conditions	Result	Study number 2
Mouse (NMRI, ♂ + ♀)	in vivo MNT	bentazone sodium salt, 91.9%	OECD TG 474 5 animals/sex/dose exposure: once by gavage bone morrow sampling: 24 and 48 h post-treatment Doses tested: ♂: 340, 680 and 1360 mg/kg bw, equimolar to 312.5, 625, and 1250 mg/kg bw bentazone; ♀: 217.5, 435 and 870 mg/kg bw, equimolar to 200, 400 and 800 mg/kg bw bentazone	Negative	BASF, 2011; DocID 2011/1184970, 2011/1277971
Rat (Wistar, ♂)	in vivo CA	bentazone, purity not specified	Not a guideline GLP study, but according to methods published in literature group size not specified exposure: twice by gavage, 24 h apart bone morrow sampling: 24 h after 2nd treatment Doses tested: 0 (untreated), 0 (vehicle CMC), 27.5; 55; 110; 220 and 700 mg/kg bw	Negative	Published literature Postica F et al., 1982; DocID 1982/10236

Species	Test	Purity % Note[7]	Guideline, duration, doses and conditions	Result	Study number 2
Mouse (B6C3F1, ♂)	in vivo UDS	bentazone, purity not specified	According to methods published in literature 2 males/dose exposure: once by i.p. hepatocyte isolation: 6 h post- treatment Doses tested:0 (untreated), 0 (vehicle DMSO) ~45, ~90, ~180 and ~360 mg/kg bw	Negative	Litton Bionetics, Inc., 1985; DocID 1985/159
Rat (Wistar, ♂)	in vivo UDS	bentazone sodium salt, 91.9%	OECD TG 486 4/6 males/dose – treatment 3/4 males/dose - evaluation exposure: once by gavage hepatocyte isolation: 3 h and 14 h post-treatment Doses tested: 275, 550 and 1100 mg/kg bw, equimolar to 250, 500 and 1000 mg/kg bw bentazone	Negative	BASF, 2011; DocID 2011/1192857, 2011/1277972
Drosophila melanogaster	in vivo Wing spot test	bentazone, >95%	Not a guideline GLP study eggs from two crosses/dose exposure: chronic (until pupation) starting with 3-d old larvae Doses tested: 6 concentrations from 0.05 to 5 mM	Negative (standard test) Positive (high-bioactivation cross)	Published literature Kaya et al. 2004 DocID 2011/1257369

Table 6. Ecotoxicology profile of bentazone or bentazone sodium salt technical material

Species	Test	Purity % Note[8]	Guideline, duration, doses and conditions	Result	Study number 2
Colinus virginianus	Oral, Acute	Bentazone, 94%s	EPA PB 83-153908; Doses 0, 250, 500, 1000, and 2000 mg a.s./kg b.w.; 5 males and 5 females per dose group; observation period of 14 days;	LC50 > 500 mg/kg feed LD50 ≈ 1140 mg a.s./kg b.w.	BASF, 1986; 1986/9002
Colinus virginianus	Dietary, subchronic	Bentazone, 94%	EPA PB 83-153908; Doses 0, 1250, 2500 and 5000 mg a.s./kg diet; 10 chicks per dose group; 5 days feeding period + 3 days post exposure observation	LC50 > 5000 mg a.s./kg diet, equivalent to > 1924 mg a.s./kg b.w./day	BASF, 1986; 1986/9003
Anas platyrhynchos	Dietary, subchronic	Bentazone, 94%	EPA PB 83-153908; Doses 0, 1250, 2500 and 5000 mg a.s./kg diet; 10 chicks per dose group; 5 days feeding period + 3 days post exposure observation	LC50 > 5000 mg a.s./kg diet, equivalent to > 760 mg a.s./kg b.w./day	BASF, 1986; 1986/9000

[8] Note: Purity is the content of pure active ingredient in the technical material, expressed as a percentage.

Species	Test	Purity % Note[8]	Guideline, duration, doses and conditions	Result	Study number 2
Taeniopygia guttata	Oral, Acute	Bentazone, Purity 100 ± 1%	OPPTS 850.2100; Doses 50, 90, 160, 280 and 500 mg a.s./kg b.w. in gelatin capsules (gavage); 5 males and 5 females per dose group; observation period of 14 days	LD50 = 280 mg a.s./kg b.w.	BASF, 2012; 2012/1188601, Amendment 2014/1294285
Anas platyrhynchos	Dietary Reproductive toxicity	Bentazone, purity 98 % w/w	OECD 206; Doses 100, 400, 600 and 800 mg/kg feed; 16 pairs per dose group; observation period of 20 weeks	NOEC ≥ 800 mg a.s./kg diet NOEL = 129 mg a.s./kg b.w./day	BASF, 1997; 1997/5306
Colinus virginianus	Dietary Reproductive toxicity	Bentazone, purity 98 %	OECD 206; Doses 100, 400, 600 and 800 mg/kg feed; 16 pairs per dose group; observation period of 20 weeks	NOEC ≥ 800 mg/kg food NOEL = 75.44 mg a.s./kg b.w./d	BASF, 1997; 1997/5007

Species	Test	Purity % Note[8]	Guideline, duration, doses and conditions	Result	Study number[2]
Oncorhynchus mykiss	acute	Bentazone; purity 97.8 %	OECD 203; 96 h static; 50 and 100 mg/L, water control; 3 replicates for highest item concentration, one replicate for the second test concentration and control; 10 fish per replicate,	LC50 > 100 mg a.s./L nom	BASF, 1987; 1987/0428
Pimephales promelas	acute	bentazone sodium salt, 91.9%	OPPTS 850.1075, OECD 203; 96 h static; 120 mg/L, water control; 3 replicates per treatment and 2 per control; 10 fish per replicate,	LC50 > 120 mg a.s./L nom	BASF, 2011; 2011/1173854
Lepomis macrochirus	acute	Bentazone; purity 94 %	OECD 203; 96 h static; 50 and 100 mg/L, water control; 3 replicates for highest item concentration, one replicate for the second test concentration and control; 10 fish per replicate,	LC50 > 100 mg a.s./L nom	BASF, 1986 1986/9005
Cyprinus carpio	acute	bentazone sodium salt, purity: 91.9%	OECD 203; 96 h static; 180, 320, 560 and 1000 mg/L, water control; 1 replicate per treatment and control;10 fish per replicate,	LC50 > 1000 mg a.s./L nom	BASF, 1983; 1983/10048
Cyprinodon variegatus	acute	Bentazone technical, purity 53%	ASTM E 729-88; EPA FIFRA-E 540/9-82-024 (1982); 96 h, flow-through; 120 mg/L and salt-water control;1 replicate per treatment and control; 10 fish per replicate,	LC50 >120 mg a.s./L mm	BASF, 1991; 1991/5191

Species	Test	Purity % Note[8]	Guideline, duration, doses and conditions	Result	Study number[2]
Pimephales promelas	Early life stage study	bentazone sodium salt, 91.9%	US EPA-FIFRA 72-4, EPA-OPPTS 850.1400, and OECD 210 (1992);35 d, flow-through;10 mg/L and control; 4 replicates per concentration; 25 fertilised eggs per replicate	NOEC ≥ 10 mg a.s./L nom	BASF, 2011; 2011/1256797

Species	Test	Purity % Note[8]	Guideline, duration, doses and conditions	Result	Study number[2]
Daphnia magna	acute	Bentazone, purity: 98.4%	OECD 202; OPPTS 850.1010; 48 h, static; 12.5, 25, 50, 100 mg a.s./L, and control; 4 replicates per treatment; 5 daphnids/replicate	LC50 > 100 mg a.s./L nom	BASF, 2003; 2003/1004524
Daphnia magna	chronic	bentazone sodium salt, 91.9%	OECD 211; OPPTS 850.1300; 21 days, semi-static; 0, 6.25, 15.2, 25, 50, and 100 mg a.s./L; 10 replicates per treatment; 1 daphnid/replicate	NOEC = 100 mg a.s./ L nom	2012/1136727
Mysidopsis bahia	acute	Bentazone technical, purity 53%	EPA-E 540/9-82-024, ASTM E 729-88; 96 h, flow-through; 120 mg/L and salt-water control; 3 replicates per treatment and control; 10 shrimps per replicate,	LC50 > 132.5 mg a.s./L mm Corrected for analytical measured test concentration (at some sample times far above 120% of nominal)	BASF, 1991; 1991/5192

Species	Test	Purity % Note[8]	Guideline, duration, doses and conditions	Result	Study number 2
Crassostrea virginica	acute	Bentazone technical, purity 53%	EPA-E 540/9-82-024, ASTM E 729-88; 96 h, flow-through; 15.6, 25.9, 43.2, 72.0, and 120 mg/L and salt-water control; 1 replicate with 20 oysters per treatment and control;	EC50 > 109 mg a.s./L mm	BASF, 1991; 1991/5017
Pseudokirchneriella subcapitata	Chronic	Bentazone, purity 98.4%	OECD 201 (1984), EPA OPPTS 850.5400; 72 h, static; 6.25, 12.5, 25, 50, and 100 mg/L and a control; 3 replicates for test substance and 5 in the control; Initial cell density: $1x10^4$/mL	**ErC50 = 33.3 mg a.s./L nom** EyC50 = 16.8 mg a.s./L nom	BASF, 2003; 2003/1012046
Lemna gibba	Chronic	Bentazone, Purity: 100%	OECD 221; 7 d, static; 0.41, 1.23, 3.70, 11.1, 33.3, and 100 mg/L and control; 3 replicates per treatment and 6 control; 3 plants with 11 fronds/replicate	ErC50 = 25.3 mg a.s./L mm (fronds) EyC50 = 9.1 mg a.s./L mm (fronds) ErC50 = 12.0 mg a.s./L mm (weight) EyC50 = 7.1 mg a.s./L mm (weight)	BASF, 2001; 2011/1102365

Species	Test	Purity % Note[8]	Guideline, duration, doses and conditions	Result	Study number[2]
Lemna gibba	Chronic	bentazone sodium salt, 91.9%	OECD 221; 7 d, static; 0.41, 1.23, 3.70, 11.1, 33.3, and 100 mg/L and control; 3 replicates per treatment and 6 control; 3 plants with 11 fronds/replicate	ErC50 = 23.0 mg a.s./L mm (fronds) EyC50 = 9.8 mg a.s./L mm (fronds) ErC50 = 18.6 mg a.s./L mm (weight) EyC50 = 8.6 mg a.s./L mm (weight)	BASF, 2001; 2011/1102366
Apis mellifera (adults)	acute oral	Bentazone, purity: 99.9%	OECD 213; 48 h; 25, 50, 100, 150 and 200 µg µg a.s./bee in sugar syrup (50% w/w);5 cages/treatment; 10 bees/cage; a toxic reference was included	LD50 > 200.0 µg a.s./bee	BASF, 1994; 1994/10508, Amendments: 1994/10518 and 1997/10941
Apis mellifera (adults)	acute contact	Bentazone, purity: 99.9%	OECD 214; 48 h; 25, 50, 100, 150 and 200 µg a.s./bee (nominal) in acetone; 5 cages/treatment; 10 bees/cage; a toxic reference was included;	LD50 > 200.0 µg a.s./bee	BASF, 1994; 1994/10508, Amendments: 1994/10518 and 1997/10941
Eisenia fetida	Acute toxicity	Bentazone, purity 98.4%	OECD 207; 14 d; 0, 197.5, 296.3, 444.4, 666.7 and 1000 mg/kg dry soil mixed into artificial soil (10% organic matter); 4 replicates for each group; 10 worms/replicate	LC50 > 1000 mg a.s./kg dry soil	BASF, 2003; 2003/1001066

Species	Test	Purity % Note[8]	Guideline, duration, doses and conditions	Result	Study number[2]
Eisenia fetida	Acute toxicity	bentazone sodium salt, 91.9%	OECD 207; 14 d; 0, 198, 296, 444, 667, and 1000 mg/kg dry soil mixed into artificial soil (5% organic matter); 4 replicates for each group; 10 worms/replicate	LC50 > 1000 mg a.s./kg dry soil	BASF, 2011; 2011/1000321
Soil micro-organisms	Nitrogen transformation	bentazone 100%	OECD 216; 56 d, aerobic; 0, 1.92 and 5.76 mg a.s./kg d.w.; silty sand (DIN4220) / sandy loam (USDA)	< 25% effect at day 56 at 5.76 mg a.s./kg d.w. soil	BASF, 2010; 2010/1144223
Soil micro-organisms	Nitrogen transformation	bentazone sodium salt, 91.9%	OECD 216; 42 d, aerobic; 0, 2.09 and 6.27 mg a.s./kg d.w.; silty sand (DIN4220) / sandy loam (USDA)	< 25% effect at day 42 at 2.09 mg a.s./kg d.w. soil	BASF, 2011; 2011/1057030
Soil micro-organisms	Carbon transformation	bentazone 100%	OECD 217; 28 d, aerobic; 0, 1.92 and 19.2 mg a.s./kg d.w.; loamy sand (DIN4220) / sandy loam (USDA)	< 25% effect at day 28 at 19.2 mg a.s./kg d.w. soil	BASF, 2010; 2010/1144219

Bentazione was evaluated by JMPR in 2012 and EFSA in 2015. The outcome of these evaluations allowed the following conclusions:

- Bentazone has moderate acute toxicity when administered orally to rats, guinea-pigs and rabbits and low toxicity when administered dermally or by inhalation to rats. In rats, the LD_{50} was greater than or equal to 850 mg/kg bw. The dermal LD_{50} in rats was greater than 5000 mg/kg bw. The inhalation LC_{50} was greater than 5.1 mg/l of air (4-hour exposure; nose only).
- The compound may cause serious eye irritation and skin sensitisation and is a dermal sensitizer
- Bentazone is unlikely to be genotoxic and neurotoxic
- Bentazone is not carcinogenic
- Bentazone is not teratogenic
- Bentazone is not neurotoxic
- No adverse health effects or poisoning in manufacturing plant personnel or in operators and workers exposed to bentazone have been reported
- Bentazone is almost completely absorbed after oral administration, poorly metabolised and rapidly excreted mainly via urine; showing no potential for accumulation.
- FAO (1991) reported that bentazone is not considered to be hazardous to aquatic organisms under normal conditions of use and is only slightly toxic to wildfowl, as represented by bobwhite quail and mallard ducks. Results of ecotoxicity tests are summarized in Table 6.

ANNEX 2

REFERENCES

Study number	Author(s)	Year	Study title. Study identification number. Report identification number. GLP [if GLP]. Company conducting the study.
356722_1		2012	Analytical characterization of five batches Bentazone technical concentrate TK 356722_1, 2011/1074519 GLP, unpublished
Not applicable		2011	Analytical method APL0632/01 - Determination of impurities in technical Bentazone (TK) 2011/1074531 unpublished
397904_2ext		2011	Validation of analytical method APL0632/01: Determination of impurities in technical Bentazone (TK) 397904_2ext 2011/1074532 GLP, unpublished
Not applicable		2011	Analytical method APL0633/01 - Quantitative determination of 1,2-dichloroethane in technical Bentazone and formulations containing Bentazone 2011/1074537 unpublished
397904_3ext		2011	Validation of analytical method APL0633/01: Quantitative determination of 1,2-dichloroethane in technical Bentazone and formulations containing Bentazone 397904_3ext 2011/1074538 GLP, unpublished
Not applicable		2011	Determination of chloride, sulfate, and phosphate in Bentazone TK by ion chromatography 2011/1074533 BASF SE - GKC Competence Center Analytics, Ludwigshafen, Germany unpublished
11L0 0305		2011	Development and validation of an analysis method for the determination of chloride, sulfate, and phosphate in Bentazone TK 11L00305 2011/1074534 GLP BASF SE - unpublished
Not applicable		2011	Analytical method AM/01237/01e - Determination of sodium in Bentazone TK by ICP-OES 2011/1074535 BASF SE, Ludwigshafen/Rhein, Germany unpublished

11L00306		2011	Development and validation of an analytical method for the determination of sodium in Bentazone TK 11L00306 2011/1074536 Yes BASF SE Ludwigshafen, Germany unpublished
MX/11/004/1		2011	Analytical method APL0631/01 - Determination of active ingredient Bentazone in Bentazone TC, Bentazone TK and formulations containing Bentazone MX/11/004/1, 2011/1074529 unpublished
397904_1ext		2011	Validation of analytical method APL0631/01: Determination of active ingredient Bentazone in Bentazone TC, Bentazone TK and formulations containing Bentazone 397904_1ext 2011/1074530 GLP, unpublished
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1993/10760		1993	Study of the dermal toxicity of Reg.No. 51 929 in white rabbits - Application to the intact skin over 3 weeks 1993/10760 unpublished
1989/0049		1989	52-week oral toxicity (feeding) study with Bentazon technical (ZST No.: 86/48) in the dog 1989/0049 yes, unpublished
1974/004		1974	Two year chronic oral toxicity study of BAS 351-H in rats 1974/004 no, unpublished
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1985/433		1984	Studies on the 24-month chronic toxicity of Bentazon in rats 1985/433 unpublished
1974/041		1974	18 month chronic oral toxicity study of BAS 351-H in mice 1974/041 unpublished
1970/008		1970	90-day feeding trial on rats with 3-isopropyl-2,1,3-benzothiadiazinone- (4)2,2-dioxide 1970/008 unpublished
1973/010		1973	Chronic oral toxicity of Bentazon in a reproduction study covering three generations of Sprague Dawley rats 1973/010 unpublished
1986/421		1987	Embryotoxicity (including teratogenicity) study with Bentazon technical in the rat 1986/421 GLP, unpublished
1989/0068		1989	Two-generation reproduction study with Bentazon technical (ZST-No.86/48) in the rat 1989/0068 unpublished

1984/066		1983	Teratogenicity study of Bentazon, Reg.No. 51 929 (ZNT No. 81/273) in rats by dietary administration 1984/066 GLP, unpublished
1985/432		1984	Studies on the 24-month chronic toxicity of Bentazon Reg.No. 51 929 (ZNT No. 81/273) in mice, 1985/432 GLP unpublished
1978/039		1978	Investigation to determine the prenatal toxicity of 3-isopropyl-2,1,3- benzothiadiazin-4-one-2,2-dioxide on rats 1978/039 unpublished
1978/034		1978	Tumorigenicity of Bentazone acid to mice in long term dietary administration, 1978/034 unpublished
1988/10538		1988	Teratological effects of pesticide (Basagran) on embryo of albino rat 1988/10538 Published
1976/009		1976	Mutagenicity testing on Bentazon in microbial systems 1976/009 unpublished
1987/058		1987	Embryotoxicity (including teratogenicity) study with Bentazon technical in the rabbit 1987/058 GLP, unpublished
1971/0041		1971	Bericht ueber die Pruefung von 3-Isopropyl-2,1,3-benzo-thiadiazinon- (4)-2,2-dioxid (= Bentazon) auf etwaige teratogene Wirkung an der Ratte bei peroraler Applikation 1971/0041 unpublished
1983/222		1983	Report on the study of Reg.No 51 929 (Bentazone) (ZNT test substance No.: 83/ 3) in the AMES test (standard plate test with Salmonella typhimurium) 1983/222 unpublished
1984/048		1978	Study to determine the prenatal toxicity of 3-(1-methylethyl)-1H-2,1,3- benzothiadiazin-4(3H)-on-2,2-dioxide in rabbits 1984/048 unpublished

1985/081		1985	Report on the study of Bentazone Na (pure active ingredient) ZNT No.: 84/298 and Bentazon Na (technical grade) ZNT No.: 84/299 in the AMES test (standard plate test with Salmonella typhimurium) 1985/081 unpublished
1985/108		1985	Report on the study of Bentazone (ZNT test substance No.: 84/140) in the AMES Salmonella/microsome plate assay and reverse mutation assay - E. coli WP2 uvrA (standard plate test) - E.coli WP2 uvrA (Standard plate test) 1985/108 unpublished
1985/396		1985	Report on a point mutation test carried out on CHO cells (HGPRT locus) with the test substance Bentazon (substance No. 84/140) 1985/396 unpublished
2011/1106427		2011	Reg.No. 88691 (Bentazone-sodium, BAS 351 H-Na) - Salmonella typhimurium / Escherichia coli - Reverse mutation assay 2011/1106427 unpublished
1971/018		1971	To assess the effect of oral administration of Bentazon on the fertility of male Sprague-Dawley rats (with particular reference to dominant lethal factors) reference to dominat lethal factors) 1971/018 unpublished
1977/028		1977	AMES test for Bentazone 1977/028 unpublished
1984/10285		1984	Bentazon: Microbial mutagenicity study - Addendum 1984/10285 unpublished
1987/0169		1987	Clastogenic evaluation of Bentazon (ZNT No. 86/48) in an in vitro cytogenetic assay measuring chromosome aberration frequencies in Chinese hamster ovary (CHO) cells 1987/0169 GLP, unpublished
1973/025		1973	Report on the testing of 3-isopropyl-1H-2,1,3-benzothiadiazin-4(3H)- one-2,2 dioxide for mutagenicity after intraperitoneal administration to the male mouse 1973/025 unpublished

1985/067		1985	Evaluation of Bentazon in the in vitro mouse primary hepatocyte unscheduled DNA synthesis assay 1985/067 unpublished
2004/1025741		2004	Amendment No. 1: BAS 351 H (Bentazone) subchronic neurotoxicity study in Wistar rats - Administration in the diet for 3 months 2004/1025741 GLP, unpublished
1985/036		1985	Cytogenetic investigations in NMRI mice after a single oral administration of Bentazone - Micronucleus test 1985/036 unpublished
2011/1106426		2011	Reg.No. 88691 (Bentazone-sodium, BAS 351 H-Na) - In vitro chromosome aberration assay in V79 cells 2011/1106426 GLP, unpublished
1985/403		1985	Mutagenicity evaluation of Bentazon techn. 84/140 in the CHO HGPRT forward mutation assay 1985/403 GLP, unpublished
2004/1013171		2004	BAS 351 H (Bentazone) subchronic neurotoxicity study in Wistar rats - Administration in the diet for 3 months 2004/1013171 GLP, unpublished
2011/1277971		2011	Amendment No. 1 - Reg.No. 88691 (Bentazone-sodium, BAS 351 H- Na) - Micronucleus test in bone marrow cells of the mouse 2011/1277971 GLP, unpublished
2011/1184970		2011	Reg.No. 88691 (Bentazone-sodium, BAS 351 H-Na) - Micronucleus test in bone marrow cells of the mouse 2011/1184970 GLP, unpublished
2011/1257369		2003	Evaluation of the genotoxicity of four herbicides in the wing spot test of Drosophila melanogaster using two different strains 2011/1257369 Published

2011/1277972		2011	Amendment No. 1- Reg.No. 88691 (Bentazone-sodium, BAS 351 H- Na) - In vivo unscheduled DNA synthesis (UDS) assay in rat hepatocytes 2011/1277972 GLP, unpublished
1986/9003		1986	Avian dietary LC50 test of Reg.Nr. 51 929 Bentazon (= test substance No. 83/5) to the bobwhite quail (Colinus virginianus) 1986/9003 GLP, unpublished
1986/9002		1986	Avian single-dose oral LD50 of Reg.Nr. 51929 - Bentazon (= test compund No. 83/5) to the bobwhite quail (Colinus virginianus) 1986/9002 GLP, unpublished
1986/9000		1986	Avian dietary LC50 test of Reg.Nr. 51 929 - Bentazon (= test substance No. 83/5) in the mallard duck (Anas platyrhynchos L.) 1986/9000 GLP, unpublished
1991/11108		1991	Gene mutation assay in Chinese hamster ovary CHO cells in vitro with Bentazon technical 1991/11108 GLP unpublished
2011/1173854		2011	Reg.No. 88691 (Bentazone-sodium, BAS 351 H-Na) - Acute toxicity study in the fathead minnow (Pimephales promelas) 2011/1173854 BASF SE, Ludwigshafen/Rhein, Germany Fed.Rep. yes unpublished
2014/1294285		2014	Amendment No. 1 to the report: BAS 351 H (Bentazone) - Acute toxicity in the Zebra finch (Taeniopygia guttata) after single oral administration (LD50) 2014/1294285 GLP, unpublished
1997/5306		1997	Bentazon: A definitive reproduction study with the mallard (Anas platyrhynchos) 1997/5306 GLP, unpublished
1997/5007		1997	Bentazon: A definitive reproduction study with the Northern bobwhite (Colinus virginianus) 1997/5007 GLP, unpublished
1987/0428		1987	Report on the study of the acute toxicity - Reg.No. 51 929 - Rainbow trout (Salmo gairdneri RICH.) 1987/0428 GLP, unpublished

2011/1192857		2011	Reg.No. 88691 (Bentazone-sodium, BAS 351 H-Na) - In vivo unscheduled DNA synthesis (UDS) assay in rat hepatocytes 2011/1192857 GLP, unpublished
2012/1188601		2013	BAS 351 H (Bentazone) - Acute toxicity in the Zebra finch (Taeniopygia guttata) after single oral administration (LD50) 2012/1188601 GLP, unpublished
1983/10048		1983	Report on the study of the acute toxicity - Bentazon-Na - Carp (Cyprinus carpio L.) 1983/10048 GLP, unpublished
1991/5191		1991	Bentazon: A 96-hour flow-through acute toxicity test with the sheepshead minnow (Cyprinodon variegatus) 1991/5191 GLP, unpublished
1986/9005		1986	Report on the study of the acute toxicity - Reg.No. 51 929 (Bentazon) - Bluegill (Lepomis macrochirus RAF.) 1986/9005 GLP, unpublished
1982/10236		1982	Potential mutagenic evaluation of the Bentazone 1982/10236 Published
1985/159		1985	Evaluation of Bentazon 84/140 in the in vivo mouse hepatocyte unscheduled DNA synthesis assay 1985/159 GLP, unpublished
1991/5192		1991	Bentazon: A 96-hour flow-through acute toxicity test with the saltwater mysid (Mysidopsis bahia) 1991/5192 GLP, unpublished
1991/5017		1991	Response to reviewers comments 14C-Quinclorac confined accumulation study in fall and spring rotation crops (EFGWB study 21 -MRID 41063566) 1991/5017 unpublished
2012/1136727		2012	Chronic toxicity of Bentazone-Na (Reg.No. 88691) to Daphnia magna STRAUS in a 21 day semi-static test 2012/1136727 GLP, unpublished
2003/1012046		2003	BAS 351 H (Bentazone) - Determination of the inhibitory effect on the cell multiplication of unicellular green algae 2003/1012046 GLP, unpublished

1994/10508		1994	Effect of Reg.No. 51929 (common name: Bentazon) on the honeybee (Apis mellifera L.) in laboratory trials 1994/10508 GLP, unpublished
2011/1256797		2011	Reg.No. 88691 (Bentazone-sodium, BAS 351 H-Na) - Early-life-stage toxicity test on the fathead minnow (Pimephales promelas) in a flow through system 2011/1256797 GLP, unpublished
1997/10941		1997	Addendum No. 2 to study code P93-E135: Effect of Reg.No. 51 929 (common name: Bentazon) on the honeybee (Apis mellifera L.) in laboratory trials 1997/10941 unpublished
1994/10518		1994	Addendum No. 1 to BASF report No. 3909: Effect of Reg.No. 51 929 (common name: Bentazon) on the honeybee (Apis mellifera) in laboratory trials 1994/10518 GLP, unpublished
2003/1001066		2003	Effect of BAS 351 H (Reg.No. 51926) on the mortality of the earthworms Eisenia fetida 2003/1001066 GLP, unpublished
2011/1102366		2011	Effect of Bentazone-Na (Reg.No. 88691) on the growth of Lemna gibba 2011/1102366 GLP, unpublished
2003/1004524		2003	BAS 351 H (Bentazone) - Determination of the acute effect on the swimming ability of the water flea Daphnia magna STRAUS 2003/1004524 GLP, unpublished
2011/1102365		2011	Effect of Bentazone (Reg.No. 51929) on the growth of Lemna gibba 2011/1102365 GLP, unpublished

BENTAZONE

EVALUATION REPORT 366/1999

Explanation

Bentazone was scheduled as an existing FAO specification to be reviewed in 1999 under the procedure introduced in 1998 (FAO Panel, 1998).

FAO had existing specifications for bentazone technical (FAO Specification 366/TC/S/F (1992)), technical concentrates (TK), wettable powders (WP) and bentazone salt aqueous solutions (SL).

Bentazone was considered for the first time by FAO/WHO JMPR for toxicology in 1991 (WHO, 1992) and an acceptable daily intake (ADI) of 0-0.1 mg/kg bw was allocated. The ADI was unchanged after the JMPR toxicology review in 1998.

Bentazone was also evaluated for the first time by JMPR for residues and environmental fate in 1991 (FAO. 1991). The JMPR concluded that bentazone and its metabolite 2-amino-*N*-isopropylbenzamide (the only degradation product detected in soil) are readily leached in light sandy soils. The JMPR has not reviewed the ecotoxicology of bentazone.

The Proposer for bentazone specifications was BASF AG. Data were provided in 1999.

Uses

Bentazone formulations are used as post-emergence herbicides for the control of broad-leaved weeds and *Cyperaceae* in a range of crops, including dicotyledonous (broad-leaved) and non-edible agricultural crops, and in other situations such as lawns and pastures. Bentazone has a contact action on the leaves and to a lesser extent an action via the soil. The active ingredient is principally absorbed by the green parts of plants and acts as a photosynthesis inhibitor (FAO, 1991).

Identity

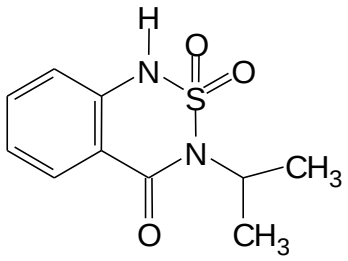
ISO common name
bentazone (BSI, E-ISO, F-ISO, JMAF)

Synonyms
bentazon (ANSI, Canada, WSSA)

Chemical names
IUPAC
3-isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide

CA
3-(1-methylethyl)-1*H*-2,1,3,-benzothiadiazin-4(3*H)*-one 2,2-dioxide

Structural formula



Molecular formula
$C_{10}H_{12}N_2O_3S$

Relative molecular mass
240.3

CAS Registry number
25057-89-0

CIPAC number
366

EEC number
613-012-00-1

Identity tests
The test relies on the HPLC method for bentazone analysis. The retention time of bentazone in the sample solution should not deviate by more than 1% from that of authentic bentazone in the calibration solution. [CIPAC 1C, p. 1974]. IR, TLC and gas chromatography (after methylation) form additional identity tests.

Physical and chemical properties of pure active ingredient

Vapour pressure	5.4×10^{-6} Pa at 20°C (99.9% purity, bentazone) Method: evaporation rate determination (Gückel *et al*, 1995)
Melting point	139.4-141.0°C (99.8% purity, bentazone) Method: CIPAC MT2, CIPAC F, p. . 5
Temperature of decomposition	210°C, with gas evolution (99.8% purity, bentazone) Method: CIPAC MT2, CIPAC F, p. 5
Solubility in water	490 mg/l water (pH 3, 20°C) (99.9% purity, bentazone) Method: CIPAC MT157, CIPAC F, p. 384
	>1000 g/l water (pH ≥ 7, at 20°C) (bentazone sodium salt)
Octanol/water partition coefficient	log P_{OW} = 0.77 (pH 5 buffer) log P_{OW} = -0.46 (pH 7 buffer) log P_{OW} = -0.55 (pH 9 buffer) Method: EEC A 8.1.4, flask shaking method
Hydrolysis	Solutions of [^{14}C]bentazone were stable to hydrolysis in the dark at pH 5, 7 and 9 at 25°C for 30 days Bentazone was not degraded after 120 days in either distilled water or WHO Standard Hard Water in the dark at pH levels of 5, 7 or 9 (FAO, 1991)
Photolysis	The half-lives and the major photo-decomposition products were a function of solution pH The half-life decreased from 122 to 93 to 14 hours as the pH increased from 5 to 7 to 9 in a photolysis study of aqueous solutions exposed to simulated sunlight at 25°C
Dissociation constant	pK_a = 3.28 at 24°C (99.5% purity) Method: OECD 112, titration method

Chemical composition and properties of the technical material (TC and TK)

The Meeting was provided with commercially confidential information on the manufacturing process and batch analysis data on impurities present at or above 1 g/kg in free bentazone and bentazone sodium salt.

Data were provided on the identified impurities present at or above 1 g/kg in 5 batches of bentazone TK 600 g/l (sodium salt). Mass balances for the 5 batches were in the range 98.4% to 99.6%. Total impurities accounted for 1.1-1.3%, expressed on a whole TK basis.

Data were also provided on the identified impurities in 5 batches of bentazone TC. The 5 TC batches were derived from the 5 TK batches previously mentioned. Mass balances for the 5 TC batches were in the range 98.7% to 99.3%. Total impurities accounted for 0.67% to 0.93%. The production of the TC material acted as a purification step for those impurities which tended to remain in solution rather than to precipitate with the bentazone, e.g. levels of compounds containing a sulphamic acid group were much lower in the TC material. For this reason, the TC and TK impurity profiles are quite different for a few impurities but similar for the majority.

The 1991 JMPR reported that the content of impurities ranged between 0.1 and 0.7 % w/w and consisted mainly of benzothiadiazines or benzamides related to the parent compound (FAO, 1991).

The list of impurities and their maximum limits were identical to the impurity profile delivered to the German authorities for review under the European Union procedure.

Declared minimum bentazone content in the TC
960 g/kg (maximum 10 g/kg water content).

Declared minimum of bentazone (present as sodium salt) in the TK
600 g/l.

Relevant impurities and maximum limits for them
none of the impurities was considered relevant.

Hazard summary

The 1991 JMPR reported that bentazone has a relatively low acute toxicity in rats, guinea pigs and rabbits (WHO, 1992). WHO has classified bentazone as slightly hazardous. Acute oral toxicity results are summarized in Table ; other acute exposure tests are summarized in

Table *2*.

Table 1. Acute oral toxicity of bentazone[5] and bentazone sodium salt[5] (WHO, 1992)

Compound	Species	Sex	LD_{50} mg/kg bw	Source[6]
Bentazone	rat	m f	1220 (1056-1409)	BASF
Bentazone	rat	m f	1780, 1470	BASF
Bentazone	rat	m f	2340, 2470	BASF
Bentazone	rabbit	m f	750[7]	BASF
Bentazone	cat	m f	ca. 500[7]	BASF
Bentazone	dog	m f	>100[7]	BASF
Bentazone	guinea pig	m f	ca. 1100[7]	BASF
Bentazone sodium salt	rat	m f	1480, 1336	BASF
Bentazone sodium salt	guinea pig	m f	1100, 1000 (as acid)	BASF

JMPR reported that most ^{14}C was still on the skin 10 and 72 hours after treatment in a rat dermal absorption study with [^{14}C]bentazone sodium. The amount absorbed was no more than 1.2-2.9% of applied dose (WHO, 1992).

[5] Purity of test materials not reported.
[6] Source of data submitted to WHO.
[7] Approximate median lethal dose (ALD_{50})

Table 2. Acute dermal and inhalation toxicity, skin and eye irritation and skin sensitization testing of bentazone (WHO, 1992)

Test substance	Purity	Species	Sex	Test	Test result	Source[8]
Bentazone	not stated	rat	m f	dermal toxicity	> 2500 mg/kg bw	BASF
Bentazone	not stated	rat		acute inhalation, bentazone volatiles at 1.2 mg/l at 20°C	no mortality for 8 hours exposure	BASF
Bentazone	97.8%	rat	m f	dust inhalation, at 5.1 mg/l	body weight gain slightly retarded, signs of toxicity, noisy respiration, no deaths	BASF
Bentazone 50% formulation	not stated	rabbit	m f	application for 24 hours to intact and abraided skin at 0.5 g/dose	irritation index 1, slight erythema, clearing by day 8 post dosing	BASF
Bentazone	not stated	rabbit	m f	eye irritation, 0.1 ml (ca. 33 mg bentazone)	irritation index 35 (moderately irritating)	BASF
Bentazone	not stated	guinea pig		open epicutaneous test	bentazone has sensitizing potential	BASF

[8] Source of data submitted to FAO.

Table 3. Short-term and chronic toxicity of bentazone (WHO, 1992)

Compound	Purity	Species	Duration or test	Route	Sex	NOAEL	Source [9]
Bentazone	97.8%	rat	13 weeks	oral	m f	400 ppm (25.3, 28.9 mg/kg bw/day)	BASF
Bentazone	technical	rat	90 days	oral	m f	800 ppm (40 mg/kg bw/day)	?
Bentazone	97.8%	rabbit	21 days (6 hours/day)	dermal	m f	500 mg/kg bw/day	BASF
Bentazone	not stated	dog	13 weeks	oral	m f	300 ppm (12 mg/kg bw/day)	BASF
Bentazone	97.8%	dog	52 weeks	oral	m f	400 ppm (13.07 mg/kg bw/day)	BASF
Bentazone	93.9%	mouse	24 months	oral	m f	100 ppm (12 mg/kg bw/day)	BASF
Bentazone	93.9%	rat	2 years	oral	m f	200 ppm (9, 11 mg/kg bw/day)	BASF
Bentazone	not stated	rat	multi-generation	oral	m f	180 ppm (14 mg/kg bw/day)	BASF
Bentazone	technical	rat	two-generation	oral	m f	200 ppm (15 mg/kg bw/day)	?
Bentazone	97.8%	rat	embryo/fetotoxicity	oral	f	100 mg/kg bw/day - no evidence of teratogenic activity even at the highest dose	BASF
Bentazone	93.9%	rat	embryo/fetotoxicity	oral	f	2000 ppm - no evidence of teratogenic activity even at the highest dose	BASF
Bentazone	92.5%	rat	embryo/fetotoxicity	oral	f	>200 mg/kg bw/day - no evidence of teratogenic activity at the highest dose	BASF
Bentazone	97.8%	rabbit	embryo/fetotoxicity	oral	f	150 mg/kg bw/day - no evidence of teratogenic activity at the highest dose	BASF
Bentazone	92.5%	rabbit	embryo/fetotoxicity	oral	f	50 mg/kg bw/day - no evidence of teratogenic activity at the highest dose	BASF

The 1991 JMPR concluded that there was no evidence of genotoxicity for bentazone (WHO, 1992).

[9] Source of data submitted to FAO.

FAO (1991) reported that bentazone is not considered to be hazardous to aquatic organisms under normal conditions of use and is only slightly toxic to wildfowl, as represented by bobwhite quail and mallard ducks. Results of ecotoxicity tests are summarized in Table 4.

Table 4. Bentazone toxicity to aquatic organisms and birds (FAO, 1991)

Test substance	Purity	Species	Test	Test result	Source[10]
Bentazone	not stated	trout	LC50 (96 h)	> 100 mg/l	BASF
Bentazone formulation (480 g/l)	not stated	trout	LC50 (96 h)	> 100 mg/l	BASF
Bentazone	not stated	bluegill	LC50 (96 h)	> 100 mg/l	BASF
Bentazone formulation (480 g/l)	not stated	bluegill	LC50 (96 h)	> 100 mg/l	BASF
Bentazone	not stated	*Daphnia*	EC50 (48 h)	125 mg/l	BASF
Bentazone formulation (480 g/l)	not stated	*Daphnia*	EC50 (48 h)	>500 mg/l	BASF
Bentazone	not stated	algae	EC50 (96h)	47 mg/l	BASF
Bentazone formulation (480 g/l)	not stated	algae	EC50 (96h)	30 mg/l	BASF
Bentazone	not stated	Bobwhite quail	LD50	1140 mg/kg	BASF
Bentazone	not stated	Bobwhite quail	LC50	>5000 mg/l	BASF
Bentazone	not stated	mallard duck	LC50	>5000 mg/l	BASF

The effects of Basagran (BAS 351 32 H) and bentazone (salt or acid) on non-target organisms were studied in birds, laboratory mammals, aquatic organisms, bees and other arthropods, earthworms and soil micro-organisms.

Single-dose and short-term feeding studies showed a low toxicity of bentazone to birds :
- single-dose LD50 (bobwhite quail) = 1140 mg/kg body weight;
- dietary LC50 (bobwhite quail and mallard duck > 5000 mg/kg feed.

A hazard assessment based on short-term exposure of birds to dietary residues of bentazone revealed no practical hazard.

Single-dose and feeding studies in mammals showed that bentazone was equally non-toxic:
- single dose LD50 (rats) = 1470 mg/kg body weight;
- 4 weeks feeding NOEL (rats) = 1800 mg/kg feed.

The hazard assessment based on exposure of free-living mammals to residues of bentazone did not indicate adverse effects.

Acute and chronic exposure of fish, daphnids, green algae and duckweed to bentazone or Basagran confirmed the low environmental toxicity of these compounds :
- LC50 (96 hours) in fish > 100 mg/l;
- EC 50 (48 hours) in daphnids = 125 mg/l;
- EC50 (72 hours) in green algae = 60-70 mg/l;
- EC50 (14 days) in duckweed = 5.3 mg/l;
- NOEC (28 days) in trout = 48 mg/l;
- NOEC (21 days) in daphnids = 125 mg/l.

[10] Source of data submitted to FAO.

A hazard assessment based on predicted environmental concentrations of bentazone and Basagran in surface waters including the negligible bioaccumulation potential of bentazone revealed no practical hazard to aquatic organisms.

Exposure of honeybees and beneficial arthropods to field rates of bentazone or Basagran relevant to the practical use led to the following classifications:

- non-toxic to honeybees;
- harmless to the ground beetles *Aleochara*, *Bembidion* and *Poecilus*;
- harmless to the aphid predator *Chrysopa*;

The toxicity of bentazone and Basagran to earthworms is equally low:

- LC50 (14 days) > 1000 mg/kg soil.

The hazard assessment demonstrated that earthworm populations will not be affected adversely by exposure to concentrations of bentazone resulting from practical application of Basagran.

Laboratory trials with biologically active soils showed that the exposure of soil micro-organisms to field rates of bentazone or Basagran will result in negligible effects.

Bentazone or Basagran will not impair the function of sewage treatment plants.

Formulations

Main formulation types available in the market

Bentazone is usually formulated as soluble concentrates (SL) and the most commonly used trade name is Basagran; a less common formulation is a wettable powder (WP). Bentazone or its sodium salt may be formulated in mixtures with other herbicides.

Main countries where bentazone is registered and sold

Bentazone is registered and sold in about 80 countries.

Methods of analysis and testing

Chemical analysis methods for active ingredient

Bentazone in technical materials is separated by HPLC on a reversed-phase column (C_{18}, methanol/acetate buffer) and quantitatively determined by UV detection with external standardization (366/TC/(M)/3, CIPAC 1C, p. 1974).

Bentazone in soluble concentrates is determined by method 366/TC/(M)/3 following sample dilution (366/SL/(M)/3, CIPAC 1C, p. 1976).

Bentazone in wettable powders is determined by a modification of method 366/SL/(M)/3, which is described in Note 1 of the specification. The formulation is suspended in 1 M NaOH and the pH adjusted to 7.5 - 8.5 with additional NaOH solution. The solution is filtered, the undissolved residue is rinsed with de-ionized water, filtered again and the filtrates are combined. After making to volume, the determination is continued as for 366/SL/(M)/3, CIPAC 1C, p. 1976.

Analytical methods for relevant impurities

Water insolubles are the only relevant impurities identified and, in both cases, the method used is MT 10.3 CIPAC F, p 28.

Analytical methods used for other impurities

Organic impurities in bentazone TC and bentazone-sodium TK (batch analyses) were determined by an HPLC method with UV detection. The method was proven acceptable in terms of recoveries and repeatability.

Physical testing methods

Bentazone TK	pH range, MT 75.1 CIPAC F, p 205.
Bentazone WP	pH range, MT 75.2 CIPAC F, p 206.
	Wet sieve test, MT 59.3 CIPAC F, p 179.
	Suspensibility, MT15.1 CIPAC F, p 45.
	Persistent foam, MT 47 CIPAC F, p 152.
	Wetting of the product, MT 53.3.3.1 CIPAC F, p 165.
	Stability at elevated temperature, MT 46.1.1 CIPAC F, p 149.
Bentazone SL	pH range. MT 75.1 CIPAC F, p 205.
	Stability on dilution, MT 41 CIPAC F, p 131.
	Persistent foam. MT 47.2 CIPAC F, p 152.
	Stability at 0°C. MT 39.3 CIPAC, 4043/m, Menschel, G).
	Stability at elevated temperature. MT 46.1.3 CIPAC F, p 150.

Physical properties

The Proposer has declared that bentazone produced and commercialized by BASF complies with the proposed FAO specifications (1999).

Containers and packaging

No requirements specific to bentazone call for specifications.

Expression of active ingredient

The concentration in formulations is expressed as g bentazone per kg (or alternatively for liquid formulations, g/l at 20ºC) of formulation. Where applicable, the name of the bentazone salt present is stated.

Appraisal

The previous FAO specifications for bentazone were published in 1992. The Proposer for revised bentazone specifications was BASF AG.

Bentazone itself has sparing solubility in water but, at pH above 7, the bentazone sodium salt is highly water-soluble (>1000 g/l). Bentazone is stable to hydrolysis at pH 5, 7 and 9 but it is subject to photolytic breakdown in sunlight, particularly at high pH.

The Meeting was provided with information on the manufacturing process and the nature of the impurities exceeding 0.1% and their maximum limits (0.1-1.5%) in TC and TK materials. The list of impurities and their maximum limits were identical to the bentazone impurity profile presented to the German authorities for review under the European Union procedure. Analyses for impurities in 5 batches of TK and the 5 corresponding batches of TC bentazone were provided. Material balances were high.

The production of the TC material acted as a purification step for those impurities which tended to remain in solution rather than to precipitate with the bentazone, e.g. levels of compounds containing a sulphamic acid group were much lower in the TC material. For this

reason, the TC impurity profile is quite different for a few impurities from the TK impurity profile, but is similar for the majority. The Meeting noted the differences and recommended that the appropriate profile be used if equivalence of TC or TK materials is to be determined.

None of the impurities was considered to be relevant, except for water insolubles in TK and SL products.

Bentazone has a relatively low acute toxicity in rats, guinea pigs and rabbits. WHO has allocated an ADI of 0-0.1 mg/kg bw for bentazone based on a full package of toxicology data including short-term and chronic testing on rats, rabbits, dogs and mice. The purity of the test substance was not stated in some studies, but in others the stated purity ranged from 92.5% to 97.8%.

WHO has classified bentazone as slightly hazardous.

FAO reported that bentazone is considered not to be hazardous to aquatic organisms under normal conditions of use and is only slightly toxic to wildfowl. Data submitted indicated that it is non-toxic to honeybees and that it is harmless to beneficial arthropods and soil microorganisms.

The Proposer declared that bentazone produced and commercialized by BASF complies with the FAO specifications (1999).

The primary test of identity is HPLC retention time matching (CIPAC 1C, p. 1974). IR, TLC and GLC (after methylation) were proposed as additional identity tests.

A confidential document of the bentazone reference profile is held by FAO. It contains summary information on: bentazone synthesis; bentazone impurity profile; bentazone TK and TC batch analyses profiles; bentazone toxicological profile; bentazone ecotoxicological profile.

Recommendations

IR, TLC and gas chromatography (after methylation) were proposed for additional identity tests. The Meeting recommended that details of the tests should be provided to FAO by the Proposer.

The Meeting recommended that extension of the CIPAC analytical method to WP should be validated, using the AOAC, CIPAC or equivalent approaches.

The Meeting recommended adoption of the specifications for TC, TK and SL. The Meeting recommended adoption of the specification for WP upon satisfactory validation of the extension of analytical method for bentazone.

References

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