Mushrooms traded as food. Vol II sec. 1

Nordic Risk assessments and background on edible mushrooms, suitable for commercial marketing and background lists. For industry, trade and food inspection. Background information and guidance lists on mushrooms

Oyster Mushroom (Pleurotus ostreatus)

norden

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Content

Preface

Food safety has high priority in the Nordic countries in order to protect the Nordic consumers. Food safety is also of great importance for trade as foodstuffs that are imported to the Nordic countries both from EU and from third countries must be safe and of good quality.

Assessment of health risks connected with exposure to naturally occurring toxicants in foodstuffs has had a high priority in the co-operation within the Nordic Council of Ministers for many years.

The Nordic project group on inherent natural toxicants in food plants and mushrooms followed the scientific information on the toxicity of mushrooms from the end of the 1980s to 2006 and published a series of reports, and the area has increased in importance during recent years. The Nordic Council of Ministers has published reports on Hydrazones in the False Morel (*Gyromitra esculent*a) in 1995 and Phenylhydrazines in the Button Mushroom (*Agaricus bisporus)*, in 1991, 1998 and 2004.

Edible mushrooms have been collected and cultivated during many years. The exercise and experience of being in nature are beneficial for the general well-being and for health. In Finland, the tradition to collect mushrooms is longer than in the other Nordic countries but the interest to collect and consume different mushrooms species has spread to other Nordic countries. In order to reduce the risk that mushrooms cause adverse effects when consumed, Nordic consumers should be able to buy safe and well characterized mushrooms (and of good quality) when they are traded commercially.

There is an increased consumption of cultivated mushrooms in the Nordic countries, and an extensive interest to use wild, edible mushrooms in the Nordic kitchen. To facilitate this development, safety in trade of fresh and processed mushrooms is needed. In this report industry and retailers who use mushrooms commercially get tools to use in their in-house control. The tools comprise a questionnaire and background information, including four lists with mushrooms suitable for trade and non-suitable for trade. The questionnaire is in Vol. I, the background and the lists are in Volume II, section 1 and risk assessments of more than 100 individual mushroom species are found in Vol. II, section 2.

The four lists of mushrooms are based on risk assessesments which focuse on inherent toxicants, reports on intoxications by mushrooms and information from poison information centres as well as on of the potential risk to collect and trade toxic look-alike mushrooms.

It has been a prerequisite for the risk assessments to use updated unequivocal scientific names as well as preferred vernacular names. This has been fulfilled in co-orperation with mycological experts from the Nordic and British mycological societies.

All mushrooms placed on lists in this report have been risk assessed and evaluated to comply with the general requirement of the food law. Thus, the mushroom lists are guidance for trade, industry, including restaurants and other retailers, as well as the public food inspection.

The *Project Group* consisted of the following members:

Denmark	Bente Fabech (chairperson) and Lulu Krüger Danish Veterinary and Food Administration and Jørn Gry (consultant in food safety)
Finland	Niina Matilainen, Finnish Food Safety Authority Evira
Iceland	Grímur Olafsson, Public Health Authority of Hafnarfjörður and Kópavogur
Norway	Birgitte Lyrån and Laila Jensvoll, Norwegian Food Safety Autority
Sweden	Christer Andersson, National Food Agency.

Acknowledgement

The project group especially acknowledges the Danish food control project group: Lieane T. Jensen, Greta Leiholt and Marianne Friis Mikkelsen, all from food inspection units in the Danish Veterinary and Food Administration on practical experience collected from the use of the questionnaire and the check lists in the public control of edible mushrooms.

Jens H. Petersen and Jan Vesterholt are acknowledged for supplying the photos in the reports, including photos in the questionnaire. Furthermore, Henning Knudsen (The Golden Oyster Mushroom and Pink Oyster Mushroom), Benny Olsen (Deathcap), Ole Sparre Pedersen (Paddy Straw Mushroom) and Flemming Rune (*Armillaria Borealis*) are acknowledged.

The group also acknowledges the following organisations:

- Artdatabanken (Swedish Agricultural University)
- The Arctic Flavours Association (Arktiset Aromit ry)
- British Mycological Society
- Danish Mycological Society (Foreningen til Svampekundskabens Fremme)
- Finnish Mycological Society (Suomen Sieniseura ry)

- Icelandic Institue of Natural History, Gudridur Gyda Eyjofsdóttir
- The Norwegian Association of Fungi and Useful Plants (Norges sopp- og nyttevekstforbund)
- Swedish Mycological Society
- Sveriges Svampkonsulenters Riksförbund

The mycologists and mycological associations in the Nordic countries contributed to develop the lists, and supplying correct mushroom names in all Nordic languages.

For updating and correcting the English names acknowledgement to Neville Kilkenny, Field Mycologist, consultant, Elisabeth Holden, Field Mycologist, consultant, British Mycological Society and Richard Peebles, Wild Food Consultant to the Bristish Catering are thanked.

The mycologists involved have not only checked the names but have also elaborated new names if national names were missing.

Poison Information Centres in the Nordic countries have been consulted and are acknowledged.

Professor Karl Johan Johanson is acknowledged for supplying data and expertice in the area of radioactivity in mushrooms.

Hálfdan Ómar Hálfdanarson, Icelandic Ministry of Forrign Affairs, translation departement is thanked for having contributed to correct translation of Volume I into Icelandic.

The results of the project have been sent to the Permanent Committee under the Nordic Council of Ministers and comments have been incorporated in the text. The Nordic Council of Ministers provided funding and approved the project report.

Summary

Edible mushrooms have been collected and cultivated during many years, and in the Nordic countries there is especially a long tradition to collect mushrooms in Finland. However, the interest for eating mushrooms and several different species of mushrooms has increased in the other Nordic countries too.

Many people like to exercise and at the same time enjoy nature. Natural foods have become popular, so combining these interests and e.g., collecting mushrooms have beneficial effects for the general wellbeing and for health.

The goal for the project is to develop tools for the control in trade and industry, as well as for the public food inspection. The tools are a questionnaire and lists of risk assessed mushrooms and shall ensure that the Nordic consumers can buy edible mushrooms which are safe and well characterised, and prevent that commercially used mushrooms cause safety problems.

There is a large and still increasing consumption of cultivated and wild mushroom in the Nordic countries. The basis for achieving the goal of safety in trade with both fresh and processed mushrooms are elaborated guidance lists of mushrooms which have been risk assessed and can be used in compliance with the general requirements on food safety. In this project risk assessments have been made primarily with a focus on inherent toxicants.

The project has risk assessed the edible mushrooms sold in the Nordic countries and included them in guidance lists on edible mushrooms. These guidance lists are based on knowledge about which edible mushrooms (wild and cultivated) are sold in the Nordic countries, on registered intoxications and the general knowledge in mushroom guides which mushrooms are "edible".

Furthermore, the report contains information on relevant legislative areas, including labelling and correct naming, allergy, contaminantes (like heavy metals and radioactivity), food trade and need for education about mushroom.

The project group has co-operated with a Danish control project and some of the tools listed have been used in a Danish control project in 2010, where up to 300 inspections were made using these tools. The

experience from the Danish control was that the tools are a needed support to facilitate the control and the practical experience are taken into account in the Nordic project reports.

This project is focusing on mushrooms sold commercially and aims to give guidance to industry and trade involved in this area, and to the public food control. However, the questionnaire and guidance lists given here can also be used as guidance to consumers and to those who publish information in books, on the internet and elsewhere.

The report in front of you, vol. II, section 1 and 2 is the background for the Nordic questionnaire; "Mushrooms traded as food – Nordic questionnaire and guidance list of edible mushrooms, suitable for commercial marketing with background lists of relevant mushrooms", Volume I. Volume I has a questionnaire to be used for the development of proper in-house documentation in industry and trade, and food inspection to give guidance to the food inspection.[1]

The project recommends that the developed tools are used and that more focus on eductation and knowledge about mushrooms is given in industry, trade and the public food inspection. Knowledge is lacking in certain areas, and the project has identified area for future work to be done.

[1] The Nordic questionnaire, Volume I can be found on www.norden.org

1. Mushrooms as food

Mushrooms are commercially available foodstuffs but are also collected for private use. Some mushrooms are cultivated, while others are growing wild and collected in the nature. Both cultivated and wild mushrooms are commercially available.

There is a long tradition of eating mushrooms in some countries in Europe, while this is not the case in others. Natural foods have become popular and combining the possibility of exercising with collecting mushrooms is beneficial for the general well-being and for health.

The interest for more exotic food, including mushrooms, seems to be growing, and this can be a challenge for food industry and trade, which are the responsible parties for cultivation, trade and supplying food products for consumers. Control of the mushroom trade is also an emerging challenge for the public food inspection.

The present report aims to give advice on which mushrooms could safely be marketed and how to control it, but the information might also be usefull for privat collectors who want science-based advice on which mushroom can safely be traded and eaten.

1.1 Mushrooms in trade and industry

To ensure that mushrooms purchased on the market can be eaten without problem, Nordic consumers should be able only to buy mushrooms that are safe and well characterised according to the requirements in the food legislation.

Mushrooms can be used fresh or preserved, for example dried, deep-frozen or canned. They may be collected from nature or purchased on the market. The latter mushrooms are frequently cultivated, like Button Mushroom and Oyster Mushroom, whereas others, like Chanterelle and Cep are wild. As the global trade with foodstuffs is increasing it is expected that new mushroom species come into trade.

Mushrooms have to comply with the general requirements in the Food Law[2] when traded. Especially article 14, saying that "food shall not be placed on the market if it is unsafe" has to be followed. In deciding on whether any food may be injurious to health, regard shall be taken:

- not only to the probable immediate and/or short-term and/or long-term effects of that food on the health of a person consuming it, but also on subsequent generations
- to possible cumulative toxic effects
- to the sensitivity of a particular category of consumers (e.g. children)."

1.2 Nutrition

Mushrooms are considered a good source of delicious food, sometimes with nutritional attributes. Mushrooms are often used as a tasty garnish to a dish, sauce or stew, and not consumed in large quantities. Some mushrooms have traditionally been used for their alleged physiological effects mainly in form of food supplements and are not consumed mainly for their flavour or taste or nutritional properties. Quantitative data relating to the nutritive value of mushrooms is sparse, in particular regarding wild mushrooms. Although still poor, there is better knowledge on the nutritional quality of cultivated mushrooms.

The nutritional data available for cultivated mushrooms include information on the proximate composition (moisture, crude protein, crude fat, carbohydrate, crude fibre and ash), the spectrum of amino acids and fatty acids, vitamins, minerals and nucleic acids.

Thorough information on mushroom nutrients is available for the Button Mushroom (*Agaricus bisporus)* (OECD, 2007) and the Oyster Mushroom (*Pleurotus ostreatus*) (OECD, accepted for publication, July 2012) but these parameters have been studied also in other cultivated mushrooms e.g., as reviewed by Chang and Miles in 2004.

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[2] EU regulation Regulation (EC) Nno 178/2002 laying down the general principles and requirements of food law.

1.3 Mushrooms traded as foods – guidance based on risk assessments

The tools developed to guide the food control and are

- Volume I: Questionnaire and guidance lists of mushrooms
- Volume II, section 1: Background information with four guidance lists of mushrooms
- Volume II, section 2: Risk assessments of the individual mushrooms in the lists

The questionnaire, including the guidance lists are available in separate publications printed in Danish, English, Icelandic, Norwegian and Swedish, see www.norden.org

The background document, volume II is devided into two sections

- Section 1 gives more details on mushrooms, identification, edibility, poisoning, contaminants and legislation
- Section 2 covers the risk assessments of the more than 100 species of mushrooms from the four guidance lists.

Each risk assessment is referenced to demonstrate the scientific background and other information for the allocation of the specific mushrooms to one of the four lists. At the end, more than 80 of the more than 110 mushrooms, claimed to be edible were accepted on list 1 or 2, which present edible cultivated and wild mushrooms suitable for commercial marketing, directly or after consultion with a recognised mushroom expert. To increase the usefulness of the mushroom lists, each mushroom species is shown with a representative picture. The pictures of mushrooms in list 1 are shown in Volume II, section 1, whereas mushrooms in all four lists are shown in Volume II, section 2.

The present project has the goal to ensure consumer safety by improving the in-house food control on a scientific basis and thereby increase the safety of the traded mushrooms and mushroom products in the Nordic countries.

2. Legal requirements

Foodstuffs are covered by general requirements as well as specific requirements in the legislation.

Public food control and documentation are required from the trade and industry, also on mushrooms, showing the use is in compliance with the legislation. However, as details on the content of this documentation to demonstrate the safety of mushrooms is not described in the legislation, it might be difficult for each actor to know how to document it. With Denmark, Finland and Sweden being members of the European Union, and Iceland and Norway being associated through European Economic Agreements (EEA), the legislation mentioned in the report is the EU legislation. In general, the EU legislation is implemented in Norway and Iceland.

The following sections aim to give a short overview of the most relevant legislations influencing trade with mushrooms. Additional references to more details are given in Annex IV.

In Finland, Norway and Sweden authorities give general and also more specific advice to consumers regarding edible mushrooms. The advice is found at the homepage on internet of each authority, see addresses in Annex II.

Finland has national legislation on edible mushrooms suitable for marketing. All mushrooms collected or grown and mushroom products produced in Finland have to meet the requirements of the Decree on Marketing of Mushrooms (489/2006) given by the Ministry on Trade and Industry. Based on this decree the Finnish Food Safety Authority Evira has given an Order “List of Mushrooms Suitable for Marketing” (3/2007). There are about 24 different mushroom species on the list. In Finland it is allowed to collect for marketing purposes only those mushrooms mentioned on the list. As the legislation is national it is not applicable for imported mushrooms.

Besides EU and national legislation in some European countries, there are several FAO/WHO/Codex standards concerning mushrooms. These standards are used in international trade and are not further discussed in this document. They are included in the reference list e.g., as reference to Codex, EU or OECD Standards.

2.1 The general food law

The EU Food law (no. 178/2002), article 5 requests that "one or more of the general objectives of a high level of protection of human life and health and the protection of consumers' interests, including fair practices in food trade, taking account of, where appropriate, the protection of animal health and welfare, plant health and the environment". It is stated (EU Food Law, Article 7), that in order to achieve the general objective of a high level of protection of human health and life, food law shall be based on risk analysis, except where this is not appropriate to the circumstances or the nature of the measure. The risk assessment, which is the scientific part of the risk analysis, shall be based on the available scientific evidence and undertaken in an independent, objective and transparent manner. Risk management, which is the political part in the risk analysis, shall take into account the results of risk assessment, and in particular, the opinions of the European Food Safety Authority (EFSA), other factors legitimate to the matter under consideration and the precautionary principle where the conditions laid down in Article 7(1) are relevant, in order to achieve the general objectives of food law established in Article 5.

The precautionary principle is part of the Food Law, stating that "in specific circumstances where, following an assessment of available information, the possibility of harmful effects on health is identified but scientific uncertainty persists, provisional risk management measures necessary to ensure the high level of health protection chosen in the Community may be adopted, pending further scientific information for a more comprehensive risk assessment."

"Measures adopted shall be proportionate and no more restrictive of trade than is required to achieve the high level of health protection chosen in the Community, regard being had to technical and economic feasibility and other factors regarded as legitimate in the matter under consideration. The measures shall be reviewed within a reasonable period of time, depending on the nature of the risk to life or health identified and the type of scientific information needed to clarify the scientific uncertainty and to conduct a more comprehensive risk assessment."

2.2 EU Rapid Alert Systems

The EU Rapid Alert System for Food and Feed (RASFF) was put in place to provide food and feed control authorities with an effective tool to exchange information about measures taken responding to serious risks detected in relation to food or feed. This exchange of information is based on requirements in the general Food Law and helps Member States to act more rapidly and in a coordinated manner in response to a health threat caused by food or feed.

An inventory of the RASFF messages in the period 2001–2010 identified different problems in trade with edible mushrooms, such as unsuitable microbial contamination, unlawful chemical contamination (e.g. to high levels of cadmium or radioactive caesium) and contamination of edible mushrooms with non-edible or poisonous mushrooms, e.g. the edible *Amanita caesarea* has been found mixed with the poisonous *Amanita phalloides* and dried Cep have been sold in products with *Lactarius*, *Russula*, *Cortinarius*. RASFF has also sent out news notification of Yellow Knight (*Tricholoma equestre*) that has caused deaths in France within the last 10 years.

2.3 Public food control and in-house control

The EU regulation on public control (EU, 2004) obliges national authorities to control that marketed food complies with the legislation in the EU.

When wild, edible mushrooms are used commercially e.g. in restaurants, the staff in the kitchen shall be able to identify the mushrooms, and they need to know if specific mushrooms are edible without risk. However, the necessary skills might not always be available.

Public control in commercial businesses is one of the tasks for the public food inspection, and regarding mushrooms this is a specific challenge as a certain degree of knowledge on mushroom identification is needed. This knowledge has to include whether the mushrooms are edible or not and whether they have poisonous look-alikes. As none of the Nordic countries have requirements on food controllers, acting in trade and industry, to have specific expertise and education on identification (and edibility) of mushrooms (except regarding hygiene), this project focuses on identification and risk assessment of mushrooms sold commercially and aims to give guidance to the industry and trade involved, and the public control.

In order to achieve this goal guidance two lists (1 and 2) on mushrooms suitable to be traded as food have been elaborated. All mushrooms on lists 1–4 have been risk assessed and conclusions are made on whether they can be used in compliance with the general requirements on food safety, primarily with regard to safety of potential content of inherent toxicants.

2.4 Food Labelling

Community legislation on the labelling of foodstuffs includes general provisions on the labelling of foodstuffs to be delivered to the consumer. Mushrooms are not specifically mentioned in the community legislation on food standards, but it is assumed that mushrooms are included in the definition of fresh fruits and vegetables in Council Directive 2000/13/EC (EU, 2000).

Fresh fruits and vegetables, including mushrooms, are often sold in a way which means that these products are not regarded as pre-packaged and therefore not subject to labelling requirements. See also Annex IV.

2.5 Regulation on fruits and vegetables

In general, mushrooms are covered by standards on fruits and vegetables, even though they are neither fruits nor vegetables.

Mushrooms suitable for being commercial products should be safe to eat, and besides this

- Be of good quality (fresh) and not be physically spoiled
- Have an acceptable shelf life e.g. more than one day
- Comply with the contaminant's legislation (metals, radioactivity, pesticide residue, mycotoxins, PAH etc.)
- Have an acceptable microbiological quality

Besides the legal requirements, commercially sold mushrooms need to have an acceptable taste.

In the Commission Regulation (EU, 2011) for fresh fruits and vegetables marketing standards cover the fruits and vegetables sector, including cultivated but not wild mushrooms. In the regulation, the following minimum quality requirements are listed. In all classes, and bearing in mind the permitted tolerances (see below), the products must be:

- Intact
- Sound; products affected by rotting or deterioration such as to make them unfit for consumption are excluded
- Clean, practically free of any visible foreign matter
- Practically free from pests
- Practically free from damage caused by pests
- Free of abnormal external moisture
- Free of any foreign smell and/or taste

The condition of the products must be such as to enable them to withstand transport and handling and to arrive in satisfactory condition at the place of destination.

Products have to be marked with the full name of the country of origin. (For products originating in a Member State this shall be in the language of the country of origin or any other language understandable by the consumers of the country of destination. For other products, this shall be in any language understandable by the consumers of the country of destination).

2.6 Novel Food

Novel foods are foods and food ingredients that have *not been used* for human consumption to a significant degree within the Community before 15 May 1997. Regulation (EC) No 258/97 (EU, 1997): [3] lays down detailed rules for the authorisation of novel foods and novel food ingredients.

Foods commercialised in at least one Member State before the entry into force of the Regulation on Novel Foods are on the EU market under the "principle of mutual recognition". In order to ensure the highest level of protection of human health, novel foods must undergo a safety assessment before being placed on the EU market. Only those products considered to be safe for human consumption are authorised for marketing.

Companies that want to place a novel food on the EU market need to submit their pre-marketing application in accordance with Commission Recommendation 97/618/EC (EU, 1997 b) that concerns the scientific

[3] The regulation is not implemented in Norway (May 2012). Current legislation in Norway is "Forskrift 8. Juli 1983, nr. 1252 om general forskrift for produksjon om omsetning mv. Av næringsmidler", §16 b.

information and the safety assessment report required. This implies that "new" mushrooms require a safety assessment according to this legislation (EC, 1997).

According to the law, all products defined as Novel Foods and falling under Regulation (EC) No 258/97 must not (a) present a danger for the consumer, (b) mislead the consumer, and (c) differ from foods or food ingredients which they are intended to replace to such an extent that their normal consumption would be nutritionally disadvantageous for the consumer. Furthermore, such foods need to have a pre-market approval based on a risk assessment of the product supplied by the applicant. It should be noted that the intakes of the various mushroom species are not particularly well documented.

2.7 National legislation and/or guidance on bioactives

In the Nordic countries, Finland has legislation on mushrooms, and Sweden has specific legislation on the use of False Morel. In addition, Denmark, Norway and Sweden give guidance to industry and trade as well as to consumers, e.g. on edible mushrooms and intake of the Button Mushroom. In Denmark, the advice is a follow-up on Danish control campaign in 2010, including follow-up activities in trade and industry on education (DVFA, 2010).

Finland has national legislation on edible mushrooms suitable for marketing, and only mushrooms mentioned on the national list are allowed to be collected or grown in Finland for marketing purposes in Finland.

Bioactive constituents ("bioactives") in foods are defined as "inherent non-nutrient consistuents with anticipated health promoting/beneficial and/or toxic effects when ingested" (Gry et al., 2007). Components with possible health promoting effects are not subject to this report. However, if information on nutrition or health claims is presented, the regulation in this area shall be followed (EU, 2006).

Bioactive constituents with potential toxic effects ("inherent toxicants") in mushrooms are subject to the general requirements in the Food Law but not to specific, harmonised legislation in the EU. Some EU Member States, like Belgium, Czeck Republic, France, Hungary and Poland have national legislation or guidance regarding edible mushrooms.

In Chapter 4 information is given on some inherent toxicants in mushrooms in connection with poisonous and allergic reactions.

2.8 Contaminants, including radioactivity

EU Regulation on Contaminants (EU, 2006) have some requirements covering contaminants in mushrooms. Thus, for example there are maximum levels for *pesticides* used in mushroom cultivation and various types of contaminants (e.g. toxic metals and radioactivity), and also on contaminants coming from materials in contact with food.

Regarding toxic metals there are regulations on the maximum level of lead, cadmiumand tin in mushrooms. Cadmium and lead are taken up by the mushroom from the soil in which they are growing. Usually levels are higher in mushrooms coming from the wild than in those that have been cultivated.

The maximum levels in the legislation for lead in the following mushrooms Button Mushroom (*Agaricus bisporus*), Oyster mushroom (*Pleurotus ostreatus)*, Shiitake mushroom (*Lentinula edodes*) and are set at 0.30 mg/kg wet weight. The limit for cadmium, including a maximum limit of 1.0 mg per kg fresh weigh for mushrooms, except for the most frequently traded mushrooms Button Mushroom (*Agaricus bisporus*, Oester Mushroom (*Pleurotus ostreatus)* and Shiitake (*Lentinula edodes*) for which a limit of 0.20 mg per kg fresh weight for has been set (EU Commission, 2006).

Furthermore, the legislation specify a maximum limit for tin in canned mushrooms but in this case it is more likely that the tin comes from the packaging material than from the soil, see Annex IV (EU, 2004, 2006).

2.8.1 Radioactivity

Radioactivity is a special issue in relation to mushrooms and is therefor introduced in this chapter and described in more details in Annex IV.

Since 1986 there have been two nuclear accidents in the world with far-reaching implication for several countries regarding contamination of landscape and food products in the short- and long-term perspective. On 26 April 1986, reactor number four at the Chernobyl nuclear power plant exploded, due to a combination of construction flaws and a poorly developed general safety policy, allowing plant operators to make serious mistakes. The accident has clearly influenced the environment in three of the Nordic countries.

More lately, on 11 March 2011 the Fukushima nuclear power plant station in Japan was seriously damaged by an earth quake resulting in a tsunami that flooded and destroyed a part of the Japanese coast line. The Fukushima power plant located at this coast line lost power, and the capacity to cool down the reactor. Also in this accident, the safety policy was insufficient. After both accidents responsible authorities monitored considerable quantities of food and feed for radioactivity, including mushrooms.

The following text of the report compiles general information on the radioactive contamination of mushrooms in the Nordic countries as a consequence of the accident at the Chernobil nuclear power plant. The Chernobyl power plant (based on uranium dioxide fuel) is located 130 km north of Kiev, about 20 km from the south border of Belarus, and even closer in the East to the border of Russia. The explosion on 26 April 1986 released an enormous amount of energy and started a fire in the reactor that continued far into May. A very large quantity of radionuclide-containing aerosols was released into the atmosphere and got spread over an extensive area of land. The clouds of radioisotopes were transported by the wind in a northern direction from Ukraine over Scandinavia, and when the radioactive contamination was confirmed on 28 April in Sweden, systems to detect radioactive contamination were activated all over the world.

In total, over 40% of Europe and large areas of Asia, Northern Africa and North America got contaminated by radioisotopes. The Chernobyl accident is considered the worst nuclear power plant disaster experienced (Yablokov and Nesterenko 2009). The compiled data illustrate some of the problems that food authorities faced and had to consider when formulating advice to consumers and professional mushroom collectors.

After the accident in Chernobyl, the EU Member States directly took action, forming legislation both to take care of the consequences of the specific accident in Chernobyl, and to be prepared for any accident that may appear in the future.[4] As the arrangements of banning imports were limited in time, the European Council replaced it three weeks later with a regulation authorising a controlled resumption of imports of agricultural products originating in third countries following the accident in the Chernobyl nuclear power-station (Regulation (EEC) No 1707/86). Agricultural products except milk and milk products, and foodstuffs intended for the special feeding of infants during the first four to six months of life, could not contain more than 600 Bg/kg (the exceptions were not allowed to contain more than 370 Bq/kg).

[4] The first legislation (Council Regulation (EEC) No 1388/86) was in place already two and a half weeks after the accident and provisionally suspended the import of certain agricultural products originating in certain third countries.

The original legislations and specifications were subsequently integrated in the Council Regulation (EEC) No 737/90, adopted in 1990, which could be seen as a cornerstone for the legislation related to handling of foods and feeds after the Chernobyl accident (EEC, 1990). This regulation was extended on several occasions and certain changes were incorporated. In particular the list of agricultural products, including wild mushrooms, originating in third countries which must be subject to checks at the borders of the European Union was adopted. Council Regulation (EEC) No 737/90 at the end of the 1990's was discussed for extension, based on the observation that in wild mushrooms activity concentrations of radiocaesium in some mushroom species did not go down, but was unchanged or even slightly increased compared to shortly after the Chernobyl accident. It was recognised that import controls imposed on the Member States by Community legislation must take account of the degree of contamination of the country of origin. On the basis of the atlas of radioactive caesium deposition in Europe, and not least the result of national surveys performed in 1998 that identified repeated imports of fresh mushrooms with activity concentrations of radiocaesium above maximum limits, it was decided to extend Council Regulation (EEC) No 737/90 to 31 March 2010 and to adopt a series of Commission regulations requiring certain categories of products, in particular non-cultivated mushrooms, originating in third countries (Albania, Belarus, Bosnia and Herzegovina, Croatia, Liechtenstein, Former Yugoslav Republic of Macedonia, Moldova, Montenegro, Norway, Russia, Serbia, Switzerland, Turkey, and Ukraine) to be subject to stricter control. In 2008 all the amendments to the original Council Regulation (EEC) No 737/90 were codified into Council Regulation (EC) No 733/2008 (EC, 2008), and prolonged to 31 March 2020 (EC, 2009).

There are no common limit values on radioactivity in mushrooms and other foods established within the European Union, but many Member States use the same limit values as for common imported foods, i.e. 600 Bq/kg. Sweden has established other maximum limits (SLV, 1987). Cereal products, fruits and berries (except nuts), vegetables, diary products, foods for infant and fish must contain at most 300 Bq/kg fresh weight; other foods less than 1,500 Bq/kg fresh weight. The reason for this deviation is stated to be absence of acute health risks. It can be noted that Sweden has not controlled whether Swedish mushrooms on the market contain less than 1500 Bq radiocaesium per kg fresh weight. More details regarding the influence of the Chernocyl accident can be found in Annex IV.

2.9 Red-listing of threatened species

Certain threathened Nordic mushrooms are on national Red Lists (see Annes V) and categorised as critically endangered, endangered, vulnerable or near threatened.

These threatened species of mushrooms should not be sold commercially, unless they are cultivated or imported from a country where the species are red-listed.

In general, picking fruit bodies even of red-listed mushroom species do not influence their survival substantially, in particular regarding soil-living mushrooms, as their mycelium is long-lived. It is not the threat from picking fruit bodies of these mushroom species that is the major reason for them being red-listed but the fact that the particular environments they require are becoming rare. However, red-listed wood-living mushrooms should not be collected at all as their mycelium is more short-lived; they successively degrade their substrate and are more dependent on regularly being re-established from spores.

The comments column to Lists 1–4 in chapter 4 gives the status on Nordic Red Lists for these mushrooms (see also Annex IV).

A few mushroom species are placed under protection in some countries and must not be picked, whereas truffels in some countries (e.g. Sweden) are only allowed to be searched for and picked by the land-owner.

3. Edible mushrooms

Edible mushrooms mean fruit bodies of fungi, a group of organisms different from plants and animals.

3.1 Edible, what is edible?

Edible mushrooms[5] or fungi are either wild mushrooms or mushrooms that have been cultivated, and which are suitable for use as a food after appropriate processing. Not all edible mushrooms are suitable as mushrooms traded as food. The guidance lists in Chapter 6 are elaborated on the basis of lists on mushrooms for commercial trade and the compilations of edible mushrooms in the Nordic countries,[6] updated handbooks, written by recognised experts and consultations of Nordic mycological societies.

Mushrooms are sold fresh or as products such as dried, edible fungi (including freeze-dried fungi, fungus grits, fungus powder), pickled fungi, salted fungi, fermented fungi, fungi in vegetable oils, quick frozen fungi, sterilized fungi, fungus extract, fungus concentrate and dried fungus concentrate.

In general, mushrooms sold as edible should not harm the consumer, neither acutely, nor in the short or long-term. In this respect mushrooms follow the common ground in the EU legislation on food.

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[5] The European Food Law (regulation 178/2002) defines "food" (or "foodstuff") as "any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans". Thus, mushrooms are considered food.

[6] Finland has national legislation on edible mushrooms suitable for marketing.

3.2 Identification of mushrooms

The identification of mushrooms is a cornerstone for being able to give guidance on the safe use of food mushrooms. In particular, it is important to be able to distinguish whether a specific mushroom is an edible species or possibly a poisonous look-alike.

Advice on safe use of mushrooms

- Eat only mushrooms which you are 100% sure that you can recognize
- Eat only mushrooms, which are generally recognized as edible
- Do not eat mushrooms raw, as many mushrooms may cause discomfort e.g. stomach pain if eaten raw
- Do not eat spoiled mushrooms
- When eating a new species of mushroom for the first time, always start up with a small portion in order to minimize the risk for hypersensitivity reactions

Industry, trade and shops/restaurants dealing with mushrooms as foods to consumers are responsible for their products and must be able to correctly identify the marketed species. This is important for all types of mushroom preparations, including fresh, dried, preserved or deep-frozen mushrooms. Identification requires special knowledge and expertise, especially the identification of dried mushrooms.

As some mushrooms are acutely and deadly toxic, it is essential to recognise both edible species and the none-edible look-alikes, including the specific characters used to identify the edible and the toxic mushrooms.

3.2.1 Identification and information available

Information on identification of mushrooms is found in books, electronic media, mycological societies, universities etc. However, the validity of some of this information has to be evaluated before it is used in deciding whether a mushroom is edible without health risk for the consumer.

Many handbooks and other sources of information about mushrooms refer to "edible species". The background information required to conclude on which species are edible is dependent on the individual author, but in general, the data used for concluding "edible" is seldomly mentioned or discussed by the author(s).

The information on the internet seems to be of variable quality and the expertise of the author is in many cases unclear or even not mentioned. References to scientific literature are in most cases not found, but even in cases where references are given, e.g. on Wikipedia, these references need to be examined in order to evaluate the quality of the publication, if there is compliance between the references and the text or if key references are lacking.

Concerning the evaluation of whether a mushroom is "edible" or not, trade, industry, consumers and food inspection are advised to be critical and make sure, that the information they use is up–to-date and of an acceptable standard.

3.2.2 Identification of mushrooms, some options

The identification of mushrooms sold as foods in order to ensure compliance with the general and more specific requirements in the Food Law is the responsibility of the industry, trade and retailers (shops/restaurants). This section intends to give a brief introduction to some methods for identification of mushrooms.

For *cultivated mushrooms* it might be sufficient for business operators to have in place systems and standardised procedures to secure the authenticity of a marketed mushroom. The original mushroom culture used to establish a mushroom fruiting culture is usually derived from a well characterized strain of a known species. As long as documentation on the species follows the harvested mushrooms from growers to the super-market shelfs, it should be guaranteed for the identity of the mushroom.

Identification of *wild mushrooms* is normally done by macroscopic and/or microscopic investigation of the fruit body, studying the visible appearance of the fresh mushrooms. Several tools to aid the process are offered both in handbooks and on websites such as the Swedish "Svampguiden" (http://svampguiden.com/nyckel.asp) and the Danish "MycoKey" (www.mycokey.com). However, training and expertise are needed to conduct such identifications correctly. See Annex II for contacts that may be useful for identification of mushrooms.

In general, identification must be based on profound knowledge, and identification of processed mushrooms has to be based on special expertise.

Macroscopic /Microscopic identification

Identifying mushrooms requires a basic understanding of their macroscopic structure. Most, but not all edible mushroom belong to the group "Basidiomycetes" and have gills or tubes. Their spores, called basidiospores, are produced on the gills or tubes and fall in a fine rain of powder from under the cap as a result. At the microscopic level the basidiospores are released from the basidia and then fall between the gills in the dead air space. As a result, for most mushrooms, if the cap is cut off and placed gill-side-down overnight, a powdery impression reflecting the shape of the gills (or tubes, or spines, etc.) is formed (when the fruit body is sporulating). The colour of the print, a spore print, is used to help classifying and identifying mushrooms. The spore print – colours can be white (most common), creme brown, black, pink, etc.

The standard method for identification is still macroscopic examination. The macroscopic characters used by amateur and professional mycologists to identify mushrooms include presence of juices upon breaking, flavours, tastes, shades of colour etc. Sometimes these phenotypic characters are supplemented with microscopic examination. A common character studied in the microscope is the spore size and form.

Chemical methods, including PCR

Simple chemical reactions can be useful to differentiate between mushrooms and aid the identification of mushrooms. For example dropping a specific chemical on the flesh of a fruit body and examining the colour reaction might aid the identificantion.

Identification may also be done by chemical methods comparing at the molecular level the nucleotide sequences of particular parts of the mushroom genome. Such methods require very sophisticated, analytical machinery.

Modern molecular methods for identification of mushrooms have become popular. Because of the equipment required and the extensive expertise required to use it, these methods are not useful in most situations. However, the PCR (polymerase chain reaction)-based methods studying nucleic acid extracts of mushrooms are able to describe parts of the mushroom genome in great detail and this information is valuable when determining the genetic relationship between mushroom species. Thus, PCR-based methods to study DNA are now frequently used in taxonomy to complement traditional phenotypic/ecological characterization of mushrooms.

4. Mushrooms and adverse effects

Mushrooms sold as edible should not harm the consumer, neither acutely, nor in the short or long-term. Due to the very different health and nutritional status of consumers, it is understandable that some individuals might react unexpectedly even to mushrooms considered edible and safe. Our best known food mushrooms have all been reported to give rise to unexpected reactions in some individuals.

Mushrooms cover both edible species, like Cep, Chanterelle and Button Mushroom, and acutely and deadly poisonous species like the Deathcap, Destroying Angel and Deadly Webcap. Other species may give rise to for example nausea and gastrointestinal disturbances, or long-term effects like cancer, e.g. False Morel is suspected to be carcinogenic.

Whether food items are safe to eat or not is mainly based on empirical knowledge gathered during centuries and transmitted to the following generations in a cultural context.

The most important causes for adverse reactions to mushrooms are mentioned below.

4.1 Microbial contamination

Microbial contamination is not covered by this project, but it is one of the relevant issues related to safety that needs to be considered if adverse effects are seen after consumption of mushrooms. Like other food items, mushrooms can be contaminated with microorganisms. In cultivated mushrooms the contamination can come from the soil or from the irrigation water. The risk of wild mushrooms becoming contaminated to some extent depends on the site where the mushroom is growing. But surely the soil is a potential contaminator. Another possibility would be that the mushroom might have been attacked by infecting microfungi and these may produce some toxic compounds.

4.2 Inherent toxicants

Bioactive substances ("Bioactives") in mushrooms are inherent none-nutritive constituents, with potential health protective and/or potential toxic effects when indested (Gry *et al.,* 2007).

Only "bioactives"with potential toxic effects ("inherent toxicants") are dealt with in this chapter.

Some natural toxicants may be produced due to microorganisms if mushrooms are inadquately storaged, e.g. biogenic amines and mycotoxins, which are considered as contaminants in the mushrooms.

The fact that a mushroom tastes good is no guarantee that it is safe to eat. Humans, who have survived the consumption of e.g. Deathcap, say that this mushroom has an acceptable taste. Many mushroom species produce inherent toxicants, which can lead to adverse effects, sometimes fatal, after consumption of the mushrooms. It is not known how many of the mushroom species growing in the Nordic countries that can be classified as poisonous but overviews and information on the most known poisonous species in the Nordic countries are often given in text books.

There are several types of inherent toxicants in mushrooms and they may affect the human body in different ways:

- Affect the nervous system, e.g. Fly Agaric, Panthercap and Liberty Cap
- Affect the gastrointerstinal tract, e.g. Yellow Stainer, Clouded Funnel and Dark Honey Fonus
- Damage internal organs, e.g. Destroying Angel, Deathcap and Deadly Webcap
- Alter sensitivity to alcohol ("Antabus-effect"), e.g. Common Inkcap
- Suspected to be genotoxic and carcinogenic, e.g. White Domecap, Ugly Milkcap and False Morel

Several inherent toxicants in the mushrooms may have more than one of the effects described above, e.g. False Morel and Deathcap.

Further information on health effects of specific mushrooms are given in Volume II, section 2 presenting the risk assessments of the various mushroom species in the four lists.

4.3 Other constituents with adverse effects

Many edible mushrooms may give rise to adverse effects when eaten raw or insufficiently cooked. The effects are not due to e.g. allergens or known inherent toxicants. The symptoms are generally transient and not serious but unpleasant with nausea, vomiting, stomach ache and diarrhoea. Such rather unspecific effects may easily be mixed up with similar symptoms caused by microbial contamination and vice versa.

Most of such compounds in mushrooms giving rise to adverse effects are unknown, but certain lectins (haemaglutinins), low molecular weight carbonhydrates and polyols ("sugar alcohols") and more or less indigestible polysaccharides e.g. chitin (mushroom cell wall component) may all give rise to some of the of the aforementioned adverse effects. Among edible mushrooms these effects are most frequently seen after consumption of raw or insufficiently cooked species of the "Honey Fungus" complex and certain boletes (*Leccinum* species).

4.4 Biogenic amines

Several biogenic amines are potential causes of acute food poisoning. Until recently, only histamine in fishery products has been the subject for risk managament measures including maximum limits in the legislation. The knowledge of the importance of other amines and other types of food than fish as their source has been limited.

Biogenic amines[7] (histamine, tyramine, phenylethylamine, dopamine, tryptamine, serotonine, putrescine, cadaverine, spermidine, spermine and agmatine) are bioactive constituents produced at carefully regulated levels by our body and occurring as normal constituents of many foods such as cheese, fermented meat, vegetables, fruits, wine, bear, fish and fish products, as well as of some types of mushroom (preparations). Although biogenic amines are produced endogenously at low levels by several organisms used as food, most biogenic amines in foods have been produced by micro-organisms decarboxylating free amino acids. Thus, larger amounts of biogenic amines have been reported to be

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[7] They are characterized by their chemical structure – being organic aliphatic, alicyclic and heterocyclic derivatives of ammonia. The number of alkyl- or aryl-groups bound to nitrogen atoms determines whether it is a primary, secondary or tertiary amine. The number of reactive amine groups decides whether it is a mono-, di- or poly-amines.

formed in aged, fermented or spoiled products (Askar and Treptow, 1986). A working group under the Nordic Council of Ministers in 2002 summarized our knowledge up to that time regarding biogenic amines in foods in the Nordic countries (TemaNord, 2002). Included in this work was a report by Andersson et al. (2000) reviewing the available information on the occurrence of these constituents in various mushrooms. These two publications form the basis of the following review on their occurrence in mushrooms, with a few new data having been added.

Low levels of biogenic amines are usually of no concern for consumers. At lower doses absorbed biogenic amines are rapidly inactivated either via methylation or via sequential breakdown by oxidases in the small intestine and liver. However, exposure to larger amounts of biogenic amines or to conditions that reduce the capability to metabolise amines (e.g. various medicinal drugs, alcohol or other biogenic amines) may result in acute toxic symptoms. The Nordic report mentioned above reports a case of intoxication after consumption of spiced mushrooms that contained 19 mg/kg histamine, 31 mg/kg tyramine, 32 mg/kg putrescine and 26 mg/kg cadaverine.

Some biogenic amines are vasoactive and act on the vascular system (tyramine, tryptamine, phenylethylamine and isoamylamine increase blood pressure and histamine and serotonin reduce blood pressure), whereas some are psychoactive (norepinephrine, serotonin and dopamine) via action on neural transmitters in the central nervous system. Some biogenic amines such as putrescine, cadaverine, spermine and spermidine do not have an effect on its own but may potentiate the effects of histamine by inhibiting the detoxifying enzymes diamine oxidase and hydroxylmethyl transferase. Tyramine and phenylethylamine have been reported to cause hypertensive crisis (high blood pressure, headache, fever, perspiration and vomiting) during treatment with drugs inhibiting monoamine oxidase. The most common biogenic amines in intoxications are histamine and tyramine. Unfortunately, it has not been possible to establish a safe dose below which no intoxications will appear – too many factors are involved. Symptoms of histamine intoxication can be difficult to distinguish from allergic symptoms and may include nausea, vomiting, facial flushing, headache, epigastric pain, burning sensation in mouth and throat, swelling of the lips and urticaria, which appear within 30 minutes of ingestion and disappear within 24 hours.

Already in 1958 Stein von Kamienski reported that some mushroom species contain biogenic amines, and shortly thereafter List (1958) identified histamine, tyramine and spermidine in *Coprinus comatus*. During the fifty years that have followed only a few reports have dealt with identification and quantification of biogenic amines in mushrooms. Available information has been compiled in Table 1 and show that in most cases concentrations are low in fresh mushrooms.

Table 1. **Amount of biogenic amines found in various mushroom species (mg/kg resh weight)**

Artb	Putrescine	Spermidine	Spermine	Histamine	Tyramine	Seroto-nine	Trypt-amine	Phenethyl-amine	Cadave-rine	Agmatine	Reference
Agaricus bisporus	0.1–0.2[c]	34–40 [c]	0.8–1.2 [c]								Bardócz et al., 1993
Agaricus bisporus	nd	59		nd	nd	nd			nd		Ziegler et al., 1994
Agaricus bisporus	1.6	178	2.6						nd		Yamamoto et al., 1982
Agaricus bisporus	nd			nd	nd				nd		Kalac and Krizek, 1997
Agaricus bisporusa	nd			nd	nd				nd		Kalac and Krizek, 1997
Agaricus bisporusb	nd	47		nd	nd	nd			nd		Ziegler et al., 1994
Armillaria mellea						2.21[e]	2.74[e]				Muszyńska et al., 2011
Boletus badius (1994)	80.4			nd	nd				4.0		Yen, 1992
Boletus badius (1995)	65.5			nd	nd				9.4		Kalac and Krizek, 1997
Boletus badius (1994)[a]	137			nd	nd				7.9		Kalac and Krizek, 1997
Boletus badius (1995)[a]	46.8			nd	nd				nd		Kalac and Krizek, 1997
Boletus chrysentereon	49.6			nd	nd				nd		Kalac and Krizek, 1997
Boletus chrysentereon[a]	58.8			nd	nd				85		Kalac and Krizek, 1997
Boletus variegatus	43.2			nd	nd				nd		Kalac and Krizek, 1997
Boletus variegatusa	69.2			nd	nd				7.7		Kalac and Krizek, 1997
Cantharellus cibarius					nd						Lee et al., 1975
Collybia velutipes	6.1	95.4	nd						3.1		Yamamoto et al., 1982
Lactarius deterrimus							2.73[e]				Muszyńska et al., 2007
Lentinus edodes	2.6	129	nd							nd	Okamoto et al., 1997
Lentinus edodes	1.6	82	nd						1.8		Yamamoto et al., 1982
Pholiota nameko	24.4	85.6	3.3						8.1		Yamamoto et al., 1982
Pleurotus ostreatus	7.4	195	< 1						1.6		Yamamoto et al., 1982
Tricholoma equestre						0.18[e]	2.01[e]				Muszyńska et al., 2009
Volvariella volvacead	4.8±0.3[d]			1.8±0.05[d]	65.5 ± 2.0[d]		7.4±0.3[d]	65.9±2.7[d]	2.3±0.13[d]		Yen, 1992
Volvariella volvacea[a,d]	3.3±0.1[d]			0.68±0.02[d]	4.1 ± 0.2[d]		1.6±0.02[d]	17.2±0.8[d]	1.2±0.03[d]		Yen, 1992
Volvariella volvacea[b,d]	0.5±0.01[d]			ndd	3.3 ± 0.13[d]		nd[d]	3.3±0.3[d]	nd[d]		Yen, 1992
Xerocomus badius						0.52[e]	0.47[e]				Muszyńska et al., 2009

[a] boiled; [b] canned; [c] range for three samples; [d] average for three samples; erecalculated from dry weight assuming 90% moisture.

Paddy Straw Mushroom, *Volvariella volvacea* (Bull.Ex.Fr.), is one of the best studied mushrooms regarding biogenic amines. It is cultivated in subtropical regions and can in the Nordic countries be purchased fresh, frozen or preserved. The cooked mushroom has a pleasant smell and taste, and is much appreciated as a complement to a dish. However, one disadvantage with the mushroom is that it is difficult to store after harvest. If it is not directly frozen it will deteriorate and loose taste. Fresh *V. volvacea* contains quite large amounts of tyramine (65.5 mg/kg) and 2-phenylethylamine (65.9 mg/kg), but only low quantities of histamine, tryptamine, putrescine and cadaverine. Fortunately, the levels of biogenic amines are considerably reduced by processing – boiling the mushroom for five minutes reduced the total level of biogenic amines in the mushroom from 147.7 mg/kg to 28.2 mg/kg (Yen, 1992). As many biogenic amines are stable at high temperatures but are water soluble, they will be extracted to the cooking fluid during processing (Askar and Treptow, 1986; Yen, 1986; Ziegler et al., 1994). The quality of the harvested *V. volvacea* is significantly reduced during storage. Yen (1992) followed the level of biogenic amines during storage for five days at 25°C and noted a significant reduction in quality and in nearly a 100-fold increase in the level of putrescine, and several hundred times increase in the levels of histamine and cadaverine. When stored at 4°C the increase in biogenic amines was considerably less marked.

Kalač and Křižek (1997) studied the level of four biogenic amines in wild *Boletus* species and in the cultivated Button Mushroom (*Agaricus bisporus*). None of the studied mushrooms contained histamine and tyramine. The wild mushrooms but not the mushrooms cultivated indoors contained considerable amounts of putrescine,[8] but levels of cadaverine were lower. Storage of the mushrooms for two days at 6 and 20°C had no marked influence on the level of putrescine and cadaverine. When the mushrooms started to deteriorate, the level of these biogenic amines started to increase.

Fresh samples of Button mushroom (*Agaricus bisporus*) contain low levels of the toxic biogenic amines, if any. However, it contains some spermidine (Kalač and Křižek, 1997) but if boiled close to 50% is extracted to the cooking water during processing.

[8] This could be due to the temperature during fruit body formation or to the microflora associated with the mushrooms and presumably different in wild and cultivated mushrooms.

Low levels of biogenic amines are usually of no concern for consumers. At lower doses absorbed biogenic amines are rapidly inactivated either via methylation or via sequential breakdown by oxidases in the small intestine and liver. However, exposure to larger amounts of biogenic amines or to conditions that reduce the capability to metabolise amines (e.g. various medicinal drugs, alcohol or other biogenic amines) may result in acute toxic symptoms. The Nordic report mentioned above reports a case of intoxication after consumption of spiced mushrooms that contained 19 mg/kg histamine, 31 mg/kg tyramine, 32 mg/kg putrescine and 26 mg/kg cadaverine.

Some biogenic amines are vasoactive and act on the vascular system (tyramine, tryptamine, phenylethylamine and isoamylamine increase blood pressure and histamine and serotonin reduce blood pressure), whereas other are psychoactive (norepinephrine, serotonin and dopamine) via action on neural transmitters in the central nervous system. Some biogenic amines such as putrescine, cadaverine, spermine and spermidine do not have an effect on its own but may potentiate the effects of histamine by inhibiting the detoxifying enzymes diamine oxidase and hydroxylmethyl transferase. Tyramine and phenylethylamine have been reported to cause hypertensive crisis (high blood pressure, headache, fever, perspiration and vomiting) during treatment with drugs inhibiting monoamine oxidase. The most common biogenic amines in intoxications are histamine and tyramine. Unfortunately, it has not been possible to establish a safe dose below which no intoxications will appear – too many factors are involved. Symptoms of histamine intoxication can be difficult to distinguish from allergic symptoms and may include nausea, vomiting, facial flushing, headache, epigastric pain, burning sensation in mouth and throat, swelling of the lips and urticaria, which appear within 30 minutes of ingestion and disappear within 24 hours.

In conclusion, available information indicates that fresh mushrooms that have been cooked (not using a fermentation step) only contain low amounts of biogenic amines and do not constitute a concern for the average consumer. Prolonged storage of mushrooms may results in their deterioration, and during this processes an increase in the level of biogenic amines may occur. The risk of being intoxicated by biogenic amines in mushrooms is thus linked either to the case when a consumer ingests a meal prepared from spoiled mushrooms, or mushrooms that have been fermented before consumption. Thus, potential risks due to biogenic amines in mushrooms are best handled by only using fresh or properly handled mushrooms as food.

4.5 Allergens

It should be recognised that allergy is a characteristic of a person and not of a compound or food. It is a pathological deviation of the immune response to a particular substance which affects only some individuals where a combined effect of variations in the environment and genetic predisposition has resulted in allergic sensitization. In allergic individuals, sometimes minute amounts of a food that is well tolerated by the vast majority of the population can cause serious symptoms and death. It is not the allergen per se, but the allergic person's abnormal reaction to the allergen that causes the adverse health effect (EFSA, 2010).

The scientific challenge to identify fungi/mushrooms that give rise to allergy and their allergens have been discussed by several investigators (e.g. Lehrer et al., 1983; Burge, 1985; Bush et al., 1987, Koivikko and Savolainen, 1988; Burge, 1989; Horner et al., 1992, 1995). Three types of allergy can be distinguished – (1) respiratory allergy, either due to occupational exposure to dust of mushrooms, mycelia or compost during cultivation of mushrooms, or daily life exposure to basidiospores; (2) contact allergy due to dermal exposure; and (3) food allergy after ingestion of mushrooms.

Hypersensitivity from inhalation or skin contact is in general not cover by this report. Though mushroom workers's disease is not a reaction on intake of mushrooms as food, this specific issue was found to have some relevance for the topic considered, and is described in more detail in Annex V. Although contact allergy is mainly a problem related to harvesting and handling of cultivated mushrooms, it is shortly mentioned below after the discussion of food allergy due to the skin contacts being evident when preparing the mushrooms for consumption.

4.5.1 Food allergy

Reports of food allergy to edible mushrooms are rare, although many people have reported symptoms after eating mushrooms. In nearly all of these cases there is no scientific basis for claiming there is an allergic reaction. For example, many mushroom guides refer to the Brown Rollrim (*Paxillus involutus*) as an allergenic mushroom, but there is very litte scientific support for this hypothesis (see risk assessment of *Paxillus involutus*). There are a large number of foods to which an individual may develop adverse reactions but to which the general public is insensitive. In nearly all of these cases the cause of the reaction is unknown. Mushrooms contain a very large number of different compounds and any of them, alone or in combination with other constituents, can be responsible for the adverse effect. Since mushrooms spoil quickly and humans may have difficulties to digest particular mushroom constituents, such as specific fibers or sugars, these reactions probably occur on a pseudo-allergic (nonallergic hypersensitivity; non-immune-mediated intolerance) or toxic basis (Benjamin, 1995). They may also occur due to the presence of various bioactive constituents (e.g. lectins biogenic amines and bacterial toxicins).

Food allergy has only been confirmed to be induced by a handful of species. As the number of patients developing allergic reactions to each species is low, cases of allergenicity have generally been observed in the most frequently consumed mushroom species. Thus, the mushrooms reported to give rise to allergenicity are Shiitake (*Lentinus edodes*), Button Mushroom (*Agaricus bisporus*), Matsutake (*Tricholoma matsutake*) and Cep (*Boletus edulis*). A case with the most severe clinical manifestation is reported in a publication by Koivikko and Savolainen (1988). These investigators mention a personal communication from Tony Foucard in Sweden where ingestion of the Golden Coral Fungus (*Ramaria flava*) led to anaphylaxis and death. Further details on food allergy due to the mentioned species are given in the respective risk assessments in Volume II, section 2 of this report.

4.5.2 Allergic contact dermatitis

There are considerably fewer reports on allergic reactions upon direct skin contact with mushrooms. The first report on edible mushrooms producing contact dermatitis described two cases in which patch tests had revealed sensitivity to Cep (*Boletus edulis*) in both patients, and, in addition, sensitivity to Saffron Milkcap (*Lactarius deliciosus*) and "Golden Coral Fungus" (*Ramaria flava*; syn. *Clavaria flava*) in one of the patients (Hellerström, 1941). All three mushrooms are popular among mushroom pickers. Later contact dermatitis was reported in mushroom workers after contact with *Agaricus bisporus* (Korstanje and Van de Staak, 1990), and *Lentinus edodes* (Tarvainen et al., 1991; Ueda et al., 1992). Bruhn and Soderberg (1991) reported on a case, where few days after contact with five *Suillus* species developed reddening, swelling, and itching developed at the site of contact with pileus cuticle mucilage. Two other species failed to induce allergic symptoms. Rosina et al. (1995) described another case where symptoms appeared at harvest time of cultivated *Pleurotus* species and included red scaly vesicular lesions on the hands, sometimes spreading to the upper and lower limbs, face and trunk.

4.6 Poisonings and Poison Information Centres

The Poison Control Hotlines in the Nordic countries have special knowledge about poisonings and concern for being poisoned, including those that are due mushrooms. Some of the intoxications dealt with by these services are severe and may lead to death or require organ transplantation, others are considerably less severe.

The cases of actual mushroom intoxications experienced by the Poison Information Centers have been used when describing the most common types of mushroom poisonings regarding latency period and types of symptoms. Several intoxications are due to children consuming raw mushrooms.

A brochure giving information on possible potential fatal mistakes between the edible Paddy Straw Mushroom and the two deadly poisoinous mushrooms Deathcap and Destroying Angel for foreign collectors when collecting mushrooms in the Nordic countries is one of the outcomes of the present project. According to information from the Nordic Poison Hotlines, such mistakes have especially been a problem when people from Southeast Asian countries have collected mushrooms in the Nordic countries. The brochure "Information on potential deadly mistakes" (between Paddy Straw Mushroom cultivated in Southeast Asia and deadly poisonous mushrooms growing wild in the Nordic countries)" can be found at the internet address www.norden.org.

The *Danish* Poison Information Centre covers Denmark, Faroe Islands, Greenland and Danish ships and co-operates with other Poison Information Centres, especially those in the other Nordic contries. The centre answers questions on possible poisonings 24 hours a day. Annually, they get 100-200 inquiries on possible mushroom poisonings. Up to five of these intoxications are serious and demand hospitalisation. More cases are less serious, mainly with gastro-intestinal symptoms and can be treated at home. Most of the calls received concern children who have tried to taste a mushroom, and the cases are generally harmless. E.g. in 2009 80% of 160 inquiries on possible poisoning with mushrooms were dealing with children below 6 years, who had tasted or eaten a part of a mushroom, and none of these became seriously ill. Most of the serious cases are due to intake of Deathcap and a few due to intake of Destroying Angel or Deadly Webcap. During the last two decades more than a dozen of these serious intoxications have been fatal and several liver transplantations have been necessary. In the reacent years several of the most serious intoxications in Denmark have involved people from Southeast Asisa, who have mistaken Deathcap for Paddy Straw Mushroom. In co-operation between the Danish Mycological Society and the centre has been worked out a network of Danish mycological experts all over Denmark, who assist with the identification of mushrooms using transmission of digital photos by mobile phone or E-mail and assisting with direct identification.

The Danish Poison Information Centre has an active surveillance programme and makes contact with distributors or regulatory authorities when situations call for it. Moreover, some of their primary responsibilities are to undertake research and development within the field of poisoning (clinical toxicology), to provide education, to assist in cases of poisoning emergencies and to provide guidance and advice to authorities.

The same is the case in the other Nordic countries, and as examples more detailed information is given below from Norway and Finland.

In *Finland* the Poison Information Centre answers questions concerning the prevention and treatment of acute poisonings 24 hours a day. The Centre is reached by telephone and serves the whole of Finland. It provides guidance to the public and to health care professionals. The Centre also acts as a source of information for authorities and the media whenever necessary. The Poison Information Centre does not treat patients or analyse for toxins.

The number of telephone requests varies from year to year. In 2005 there were 806 calls concerning mushroom poisonings and in 2006 the Finnish Poison Information Centre received 417 calls. Latest figures can be seen in the table 2 below.

Tabel 2 Finland, contact to the Finnish Poison Information Centre.

Year	2009	2009	2010	2010
	number	%	number	%
Unknown mushrooms	494	60	356	54
Mushrooms affecting the central nervous system	138	17	139	21
Mushrooms irritating the digestive tract	92	11	79	12
Mushrooms containing cytotoxins	105	13	78	12
Mushrooms causing antabus reaction	0	0	2	0
Total	829	100	654	100

As indicated in the Table, the Finnish Poison Information Centre has divided poisonous or harmful mushrooms into:

- Mushrooms affecting the central nervous system
  (e.g. *Amanita muscaria, Psilocybe semilanceata, Amanita regalis, Inocybe rimosa, Inocybe geophylla var. geophylla, Clitocybe rivulosa, Amanita pantherina*)

- Mushrooms irritating the digestive tract
  (e.g. *Lactarius ssp., Leccium ssp., Paxillus involutus*)
- Mushrooms containing cytotoxins
  (e.g. *Gyromitra esculenta, Amanita virosa, Cortinarius rubellus, Galerina marginata, Amanita phalloides, Cortinarius limonius, Gyromitra infula*)
- Mushrooms causing antabus reaction

In *Norway*, the Poison Information Center recieves calls from the public and health care professionals 24 hours a day all year round.

Questions concerning intoxications from mushrooms are made though-out the year, but the peak season is from July through October. To assist the staff on call the Center has employed the service of a company, which has expert knowledge in identifying mushrooms by telephone. They aid in the identification of mushrooms involved in possible poisonings.

The number of inquiries is increasing and the poison center receives 800–900 requests about mushrooms every year. The majority of the calls concern children, aprox. 60%. Children often taste smaller amounts of mushrooms and seldom require hospitalisation. Just over 30% of the requests concerned the consumption of mushrooms in adults. Adults often eat a large amount of mushrooms, and they sometimes mistake edible species with toxic look-a-like mushrooms. Because of the amount eaten, exposures in adults are more likely to result in serious poisoning compared to children. Recently there have been serious cases where people from foreign countries mistakenly collect deadly poisonous Norwegian mushroom species as they look similar to edible mushrooms in their country of origin.

The *Swedish* Poison Information Centre is located at the Karolinska University Hospital in Stockholm. The main responsibility of the centre is to inform about risks, symptoms and treatment in cases of acute poisoning. The service is on a twenty-four hour basis. Inquiries are received from hospitals and physicians as well as from the general public. The number of calls involving mushrooms was 1–4% of all calls.

Statistics regarding calls related to potential mushroom intoxication is available for the last thirty years. The number of calls a particular year is very much related to whether it was a good or a poor mushroom year. The lowest number of calls was registered in 1981, about 875 calls, and the highest in 1993, about 2 300 calls. The annual average number of calls due to mushroom intoxications is about 1 300. The Swedish Poison Information Centre has a register over fatal cases of mushroom intoxication. Seventeen people have died since 1951, all due to Deathcap (*Amanita phalloides*) and/or Destroying Angel (*Amanita virosa*) intoxications. All but two of the fatal cases were adult people. Some of the latest were immigrants. Due to this trend, the Swedish Poison Information Centre has together with Svampkonsulenternas Riksförbund produced a small brochure "The most dangerous poisonous mushrooms in Sweden" which is available in over twenty languages.

Addresses to the internet sites of the Nordic Poison Information Centres are given in Annex II.

5. Risk assessment of mushrooms, overview

Over centuries people have selected what they eat and accumulated experiences from the consumption of raw or processed foods. In this way, common knowledge of which mushrooms can safely be eaten has developed. With time some of this empirical knowledge has obtained scientific support, whereas other empirical observations have been difficult to support. For example, the Nordic risk assessments of the Button Mushroom (*Agricus bisporus*) and False Morel (*Gyromitra esculenta*) have contributed to the development of a science-based cumulative knowledge on these (and other *Agaricus* species) particular species regarding food safety. This work identified the concern for long-term effects especially after high consumption of insufficiently processed mushrooms.

As there are still only partial knowledge on whether it is safe to consume many species of mushrooms, the question which criteria should be used to establish whether a particular mushroom species is safe to consume had to be tackled in the present project.

Would it be sufficient that an author of a handbook on mushroom – especially mushrooms for commercial trade- claims that a mushroom species is edible? Is it enough that humans for centuries have been eating a mushroom without being able to link adverse effects to the consumption?

These are typical questions continuously considered by industry, trade, local markets, restaurants and the food inspection authorities in the European countries. It is a prerequisite for being able to answer these questionsto be able to identify the mushrooms and distinguish the edible ones from the poisonous ones, both when they are fresh and when they are processed, e.g., dried.

The risk assessments worked out within this project and the lists identifying suitable/non-suitable mushrooms for trade as food are meant to be guiding tools for the industry, trade, market, and food inspection.

The risk assessments in Volume II, section 2 of this report are the assessments for the various mushroom species considered for trade as food mushrooms, based on published, scientific literature and other information. These assessments, which have been used for the allocation of the more than 100 mushroom species to the four lists should also be the basis for risk managers when deciding on which mushrooms should be considered suitable for commercial use as food.

The scientific risk assessment of foods consists of 4 major steps:

Hazard identification
Hazard characterization
Exposure assessment
Risk characterization

Hazard identification identifies the potential hazards related to a particular mushroom species. This could be reported particular toxic effects or the occurrence of a specific toxic compound in the mushroom.

Hazard characterization describes how the hazard is influenced by various conditions, frequently the concentration of a compound. In this respect it is common to describe in experimental animals a relationship between the dose of the hazardous compound and the effects observed.

Exposure assessment determines the actual exposure for various consumers, both regarding a single meal, and averaged over a much longer time. The exposure is dependent both on the level of the hazard in the consumed mushroom/food, and the amount consumed.

Risk characterization is the qualitative and/or quantitative estimation, including attendant uncertainties, of the probability of occurrence and severity of known or potential adverse health effects in a given population based on hazard identification, hazard characterisation and exposure assessment. By bringing the information on actual exposure together with the characterized hazard it is possible to characterize the risk. In some cases it might be concluded that exposure levels are so low that no relevant risk can be established. Regarding mushrooms, in many cases there will not be enough information to perform a complete risk assessment. In such cases it is important to present uncertainties and assumptions in the risk assessment. As science is not static but constantly evolving, older risk assessments should be re-evaluated over time.

The individual steps of the risk assessment are further explained in Volume II, section 2, Chapter 1 of this report.

6. Guidance lists on mushrooms traded as food

The guidance lists developed in this report on mushrooms suitable to be traded as food and supporting list are mainly based on

- Existing guidance and legislation from the Nordic countries on edible mushrooms[9]
- Textbooks on mushrooms, published by recognized mycological experts during the last ten years (older manuals and manuals written by not-recognized mycologists were in general not used)
- Scientific information retrieved from search in the databases Sci Finder and PubMed (see the risk assessments in Volume II, section 2 of this report)
- Information on intoxications from the Nordic and other Poison Information Centers
- Consultation of the Nordic mycological societies

Four lists on mushrooms were produced

- *List 1* Edible mushrooms suitable for commercial marketing (cultivated and/or wild)
- *List 2* Wild edible mushrooms, where the identity has to be documented by recognised experts, to be suitable for commercial marketing
- *List 3* Wild mushrooms, which may easily be mistaken for poisonous look-alikes and therefore are not regarded as suitable for commercial marketing
- *List 4* Wild mushrooms earlier regarded as edible, but which are suspected to cause acute or long-time adverse effects after ingestion and therefore not regarded as suitable for commercial marketing

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[9] Some mushrooms are used as food supplements because of their potential health promoting properties. Some examples are *Agaricus rufenscens*, Ophio*cordyceps sinensis* and *Ganoderma lucidum*. These mushrooms are risk assessed in some countries, e.g. in Belgium, but they are not coverd by the lists below, as long as they are not used as normal foods in the Nordic countries.

Pictures of the mushrooms on the 4 lists are in Volume II, section 2, see www.norden.org.

Vernacular names of the mushrooms in the Nordic languages and English and scientific names are indexed in Annex I. The nomenclature used is explained in Volume II, section 2.

If no preferred vernacular names were available from the primary source, the names are shown in brackets together with synonyms. Trade names are additionally provided with hyphens.

Comments column in the lists

The comments in the lists are from various sources, including scientific literature, experience of handling the mushroom and mycological societies.

The comment column cover among others

- Special pretreatment
- Conclusions from the risk assessments
- Contaminants e.g., accumulation of cadmium
- Status regarding red-listing

For red-listning it is decided, that if a mushroom species is red-listed in a Nordic country, the mushroom should not be traded, unless it is known to be imported from countries where it is not a threatened species, or is a cultivated mushroom.

The background for the four lists has been described in Volume II, section 1 and 2.

List 1

List 1 Edible mushrooms suitable for commercial marketing (cultivated and/or wild)

No.	*Scientific name*	English name	Comments
1–01	*Agaricus arvensis*	Horse Mushroom	As Horse Mushroom efficiently bioaccumulates cadmium, the content of this toxic and carcinogenic metal should be regularly controlled Due to the potentially high levels of phenylhydrazine derivatives and cadmium, Horse Mushroom should not be eaten in larger amounts (see *A. bisporus* (Button Mushroom) risk assessment). The wild Horse Mushroom is in list 2.
1–02	*Agaricus bisporus* *(A. hortensis, A. brunnescens*)	Cultivated Mushroom (Button Mushroom)	As it is concluded from animal and *in vitro* studies that the phenylhydrazine derivatives occuring in Button Mushroom (*A. bisporus*) as well as the mushroom itself may be genotoxic and carcinogenic, a carcinogenic risk for humans cannot be excluded. It is therefore recommended not to eat Button Mushroom in larger amounts. A significantly higher intake than 2 kg/year (average consumption in Denmark, Iceland, Norway and Sweden) is regarded as "larger amounts". Proper processing of the fresh mushroom reduces the amounts of potentially carcinogenic constituents. The fried, microwave-heated, boiled (especially if boiling water is discarded), and canned mushrooms contain significantly less of the potentially carcinogenic phenylhydrazines. Also ordinary freezing and subsequent thawing (but not freeze-drying) will reduce the content of phenylhydrazine in the mushroom. It is therefore recommended to process/cook Button Mushroom before consumption.
1–03	*Albatrellus ovinus*	Forest Lamb	The mushroom is redlisted as regionally extinct in Denmark. Should only be marketed in the Nordic countries, if it is from countries where it is cultivated or not red-listed.
1–04	*Amanita caesarea*	Caesar's Mushroom (Caesar's Amanita)	
1–05	*Auricularia auricula-judae*. (*A. auricula*)	Jelly Ear (Jew's Ear, Judas's Ear Fungus)	
1–06	*Auricularia polytricha* and other *Auricularia* species	(Ear species)	
1–07	*Boletus edulis*	Penny Bun, Cep	
1–08	*Boletus pinophilus* *(B. pinicola*)	Pine Bolete ("Pine Cep")	
1–09	*Boletus reticulatus* *(B. aestivalis)*	Summer Bolete ("Summer Cep")	
1–10	*Cantharellus cibarius*	Chanterelle ("Girolle")	
1–11	*Cantharellus pallens*	No English name	
1–12	*Craterellus cornucopioides* *(Cantharellus cornucopioides*)	Horn of Plenty (Black Chanterelle, Black Trumpet)	

No.	*Scientific name*	English name	Comments
1–13	*Craterellus lutescens* (*Cantharellus lutescens*)	Golden Chanterelle (“Chanterelle Jaune”, “Autumn Chanterelle”)	May form weak mutagenic compounds if injured.
1–14	*Craterellus tubaeformis* (*Cantharellus tubaeformis*)	Trumpet Chantarelle (“Chanterelle gris”, “Win-ter Chanterelle”)	May form weak mutagenic compounds if injured.
1–15	*Flammulina velutipes*	Velvet Shank (“Enoki-take”, “Golden Needle Mushroom”)	The wild Velvet Shank is in list 2.
1–16	*Grifola frondosa*	Hen of the Woods	Red-listed in Denmark, Norway and Sweden as near threatened. Should only be marketed in the Nordic countries, if it is from countries, where it is cultivated or not red-listed
1–17	*Hericium coralloides*	Coral Tooth	Red-listed in Denmark, Norway and Sweden as near threatened. Should only be marketed in the Nordic countries, if it is from countries, where it is cultivated or not red-listed
1–18	*Hericium erinaceus*	Bearded Tooth (“Lion's Mane, Mush-room”,” Pom Pom”)	Redlisted in Denmark, Sweden and Norway as critically endangered. Should only be marketed in the Nordic countries, if it is from countries where it is cultivated or not red-listed
1–19	*Hydnum repandum*	Wood Hedgehog (“Pied de Mouton”, “Hedgehog”)	
1–20	*Hydnum rufescens*	Terracotta Hedgehog	
1–21	*Hypsizygus spp.*	Elm Leech (Brown Beech Mushroom, White Beech Mushroom,“Brown Shime-ji”,,“White Shimeji”)	
1–22	*Lentinula edodes* *(Lentinus edodes)*	(Shii-take)	
1–23	*Lepista nuda* (*Tricholoma nudum*)	Wood Blewit	The wild Wood Blewit is in list 2
1–24	*Macrolepiota procera*	Parasol	
1–25	*Morchella conica*. (*M. elata*)	Black Morel “Morel” (“Pointed Morel”, “Ribbed Morel”)	Black Morel *(M. conica* and the closely related Morel (*M. esculenta)*: Should never be eaten raw Should be cooked for at least 10 minutes Intake of higher amount (more than 100 g per meal) of cooked, fresh – or corresponding amounts of dried morels – may occasionally, beyond gastro-intestinal disturbances, give rise to neurological effects like ataxia, dizziness and visual disturbances and should accordingly be avoided
1–26	*Morchella esculenta*	Morel	Morel (*M. esculenta*) and the closely related Black Morel (*M. conica)*: Should never be eaten raw Should be cooked for at least 10 minutes Intake of higher amounts (more than 100 g per meal) of cooked, fresh – or correspond-ing amounts of dried morel – may occasion-ally, beyond gastro-intestinal disturbances, give rise to neurological effects like ataxia, dizziness and visual disturbances and should accordingly be avoided
1–27	*Pholiota nameko*	(“Pholiote”, “Nameko”)	
1–28	*Pleurotus citrinopileatus*	(The Golden Oyster Mushroom)	

No.	*Scientific name*	English name	Comments
1–29	*Pleurotus djamor*	(Pink Oyster Mushroom)	
1–30	*Pleurotus eryngii*	(French Horn Mushroom, King Trumpet Mushroom, "King Oyster")	

List 2

Wild edible mushrooms, where the identity has to be documented by recognised experts, to be suitable for commercial marketing

No.	Scientific name	English name	Comments
2–01	*Agaricus arvensis*	Horse Mushroom	As Horse Mushroom efficiently bioaccumulates cadmium, the content of this toxic and carcinogenic metal should be regularly controlled. Due to the potentially high levels of phenylhydrazine derivatives and cadmium, Horse Mushroom should not be eaten in larger amounts (see *A. bisporus* (Button Mushroom) risk assessment). The cultivated Horse Mushroom is in list 1.
2–02	*Agaricus augustus*	The Prince	As The Prince efficiently bioaccumulates cadmium, the content of this toxic and carcinogenic metal should be regularly controlled. Due to the potentially high levels of phenylhydrazine derivatives and cadmium, The Prince should not be eaten in larger amounts (see *A. bisporus* (Button Mushroom) risk assessment).
2–03	*Agaricus bitorquis*	Pavement Mushroom	Due to the potentially high levels of phenylhydrazine derivatives, Pavement Mushroom should not be eaten in larger amounts (see *A. bisporus* (Button Mushroom) risk assessment).
2–04	*Agaricus campestris*	Field Mushroom	Due to the potentially high levels of phenylhydrazine derivatives, Field Mushroom should not be eaten in larger amounts (see *A. bisporus* (Button Mushroom) risk assessment).
2–05	*Agaricus* species, other not yellowing e.g. *A. langei* (*A. haemorrhoidarius*) and *A. sylvaticus*	Agaricus species, other not yellowing e.g. Scaly Wood Mushroom and Blushing Wood Mushroom	Due to the potentially high levels of phenylhydrazine derivatives, other not yellowing *Agaricus* species (e.g. Scaly Wood Mushroom and Blushing Wood Mushroom) should not be eaten in larger amounts (see *A. bisporus* (Button Mushroom) risk assessment).
2–06	*Agaricus* species, other yellowing e.g. *A. sylvicola* (*A. abruptibulbus*) and *A. urinascens* (*A. excellens, A. macrosporus*)	Agaricus species, other yellowing e.g. Wood Mushroom and Macro Mushroom	As yellowing, edible *Agaricus* species e.g. Wood Mushroom and Macro Mushroom efficiently bioaccumulate cadmium, the content of this toxic and carcinogenic metal should be regularly controlled Due to their potential high levels of phenylhydrazine derivatives, yellowing, edible *Agaricus* species should not be eaten in larger amounts (see *A. bisporus* (Button Mushroom) risk assessment).

No.	Scientific name	English name	Comments
2–07	*Calocybe gambosa* (*Lyophyllum gambosum*) (*Tricholoma gambosum, T. georgii*)	St. George's Mushroom	
2–08	*Coprinus comatus*	Shaggy Inkcap, Lawyer's Wig, (Shaggy Mane)	
2–09	*Cortinarius caperatus* (*Rozites caperatus*)	The Gypsy	
2–10	*Flammulina velutipes*	Velvet Shank (Golden Needle Mush-room)	The cultivated Velvet Shank is in list 1.
2–11	*Gomphidius glutinosus*	Slimy Spike	
2–12	*Gomphus clavatus*	Pig's Ear	Red-listed in Denmark and in Sweden as vulnerable and in Norway as near threat-ened. Should only be marketed in the Nordic countries, if it is from countries, where it is not red-listed.
2–13	*Hygrocybe pratensis* (*Camarophyllus pratensis*)	Meadow Waxcap (Buffcap)	
2–14	*Hygrocybe punicea*	Crimson Waxcap	Red-listed as near threatened in Sweden and Denmark. Should only be marketed in the Nordic countries, if it is from countries, where it is not red-listed.
2–15	*Hygrophorus camarophyllus*	Arched Woodwax	Red-listed in Denmark as critically endan-gered. Should only be marketed in the Nordic countries, if it is from countries, where it is not red-listed.
2–16	*Hygrophorus hypothejus*	Herald of Winter	
2–17	*Lactarius deliciosus*	Saffron Milkcap	
2–18	*Lactarius deterrimus*	False Saffron Milkcap	
2–19	*Lactarius rufus*	Rufous Milkcap (Red Hot Milkcap)	Need to be pre-treated (salted/heat treated) to destroy the acrid substances in the mushroom. Cooking water should be discarded.
2–20	*Lactarius torminosus*	Woolly Milkcap	Need to be pre-treated (salted/heat treated) to destroy the acrid substances in the mushroom. Cooking water should be discarded.
2–21	*Lactarius trivialis*. (*L.s utilis*)	No English name	Need to be pre-treated (salted/heat treated) to destroy theacrid substances in the mushroom. Cooking water should be discarded. Red-listed as near threatened in Denmark. Should only be marketed in the Nordic countries, if it is from countries, where it is not red-listed.
2–22	*Lactarius volemus*	Fishy Milkcap (Weeping Milkcap)	Red-listed in Denmark Should only be marketed in the Nordic countries, if it is from countries, where it is not red-listed
2–23	Leccinum aurantiacum (L. albostipitatum, L. quercinum)	Orange Aspen Bolete (Orange Oak Bolete)	Thorough heat treatment is necessary as insufficiently cooked mushrooms can give intoxications.
2–24	*Leccinum* species, other e.g. *L. Scabrum*	Leccinum species, other species, e.g. Brown Birch Bolete	Thorough heat treatment is necessary as insufficiently cooked mushrooms can give intoxications.
2–25	*Leccinum versipelle*	Orange Birch Bolete	Thorough heat treatment is necessary as insufficiently cooked mushrooms can give intoxications.

No.	Scientific name	English name	Comments
2–26	*Leccinum vulpinum*	Foxy Bolete	Thorough heat treatment is necessary as insufficiently cooked mushrooms can give intoxications.
2–27	*Lepista nuda* (*Tricholoma nudum*)	Wood Blewit	The cultivated Wood Blewit is in list 1.
2–28	*Lepista saeva* (*L.personata, Tricholoma personatum*)	Field Blewit	
2–29	*Russula claroflava* (*R. flava*)	Yellow Swamp Brittlegill	
2–30	*Russula decolorans*	Copper Brittlegill	
2–31	*Russula integra*	Nutty Brittlegill	
2–32	*Russula paludosa*	("Tall Brittlegill")	
2–33	*Russula vesca*	The Flirt (Bare-toothed Russula)	
2–34	*Russula vinosa* (*R. obscura*)	Darkening Brittlegill	
2–35	*Russula xerampelina*	Crab Brittlegill (Shrimp Mushroom)	There are more species, closely related to Crab Brittlegill. Like this mushroom, they smell of cooked shellfish and are edible, but they are not common in the Nordic countries.
2–36	*Suillus granulatus*	Weeping Bolete (Granulated Bolete)	
2–37	*Suillus grevillei*	Larch Bolete (Greville's Bolete)	
2–38	*Suillus variegatus*	Velvet Bolete (Variegated Bolete, "Swedish Jack")	
2–39	*Tricholoma portentosum*	Charbonnier ("The Coalman")	
2–40	*Xerocomus badius* (*Boletus badius*)	Bay Bolete	

List 3

Wild mushrooms, which may easily be mistaken for poisonous look-alikes and therefore are not regarded as suitable for commercial marketing

No.	Scientific name	English name	Comments
3–01	*Amanita fulva*	Tawny Grisette (Orange-Brown Ringless Amanita)	Immature Tawny Grisette (especially when it looks like "small hen's eggs") may be mistaken for the deadly poisonous Deathcap (*A. phalloides*) or Destroying Angel (*A. virosa*) which also may look like "small hen's eggs", when they are very young).
3–02	*Amanita rubescens*	Blusher	The Blusher resembles Panthercap (*A. pantherina*), which is very poisonous.
3–03 3–04 3–05 3–06	*Armillaria borealis* *Armillaria cepistipes* (*Armillariella cepistipes*) *Armillaria lutea* (*Armillaria gallica*) *Armillaria mellea* (*Armillariella mellea*)	No English name No English name Bulbous Honey Fungus Honey Fungus	The "Honey Fungus species" should never be eaten raw, should be thoroughly cooked, and should only be eaten in small amounts, when eaten for the first time, However, "Honey Fungus species"are very difficult to distinguish from the toxic Dark Honey Fungus (*A. ostoyae*), and should therefore not be used for marketing. For the time being (June 2012) *Armillaria* species are leagally marketed in Finland, but the status is subject to change.
3–07	*Boletus luridiformis*	Scarletina Bolete (Dotted-Stemmed Bolete)	Resembles Devils Bolete (*B. satanas*) and *B. legaliae* which are both poisonous.
3–08	*Boletus luridus.*	Lurid Bolete	Resembles Devils Bolete (*B. satanas*) and *B. legaliae* which are both poisonous.
3–09	*Chlorophyllum olivieri* (*Lepiota olivieri, Macrolepiota olivieri*)	No English name	Resembles *Chlorophyllum brunneum* which is suspected to be poisonous.
3–10	*Chlorophyllum rachodes* (*Macrolepiota rachodes, Lepiota*)	Shaggy Parasol	Resembles *Chlorophyllum brunneum* which is suspected to be poisonous.
3–11	*Clitopilus prunulus*	The Miller	Resembles some small Funnel species (*Clitocybe* species) like Fools Funnel (*Clitocybe rivulosa*) which are very poisonous.
3–12	*Cortinarius spp*. e.g. *Cortinarius armillatus*	Webcap species e.g. Red Banded Webcap	Many webcaps (*Cortinarius* species) are difficult to identify, and some of them are deadly poisonous, e.g., Deadly Webcap (*Cortinarius rubellus*).
3–13	*Hypholoma capnoides*	Conifer Tuft	Conifer Tuft (*Hypholoma capnoides*) resembles Sulphur Tuft (*Hypholoma fasciculare*) which is poisonous.
3–14	*Kuehneromyces mutabilis* (*Pholiota mutabilis*)	Sheathed Woodtuft ("Two-tone Pholiote")	Sheathed Woodtuft (*Kuehneromyces mutabilis*) resembles Funeral Bell (*Galerina marginata*) which is deadly poisonous.
3–15	*Russula aeruginea* and other glaucous green *Russula* species, e.g. *Russula cyanoxantha* *Russula grisea* *Russula ionochlora* *Russula parazurea* *Russula virescens*.	Green Brittlegill and other Brittlegill species e.g. Charcoal Burner No English name Oilslick Brittlegill Powdery Brittlegill Greencracked Brittlegill	Green Brittlegill (*Russula aeruginea*) and other glaucous green Brittlegill species resemble Deathcap (*Amanita phalloides*) which is deadly poisonous.

List 4

Wild mushrooms earlier regarded as edible, but which are suspected to cause acute or long-time adverse effects after ingestion and therefore not regarded as suitable for commercial marketing

No.	Scientific Name	English name	Comments
4–01	*Armillaria ostoyae* (*Armillarialla ostroyae.*)	Dark Honey Fungus	May give rise to intoxications, even if thoroughly cooked and should therefore not be used in commercial trade. The toxicant is not known. For the time being (June 2012) "Honey Fungus species" (*Armillaria* species) are legally marketed in Finland, but the status is subject to change.
4–02	*Clitocybe connata* (*Lyophyllum connatum*)	White Domecap	
4–03	*Clitocybe nebularis* (*Lepista nebularis)*	Clouded Funnel	Gives rise to intoxincation in some peo-ple, even after thorough cooking. The toxicant is not known.
4–04	*Coprinopsis atramentaria* (*Coprinus atramentarius*)	Common Inkcap	Contains coprin, a toxin with "antabus"-like effects and with suspected reproduc-tive toxic effects.
4–05	*Gyromitra esculenta*	False Morel (Turban, Brain Mush-room)	Should not be consumed as it even after months of drying or after repeated boiling and discarding of the water, still contains significant amounts of suspected genotox-ic and carcinogenic hydrazinderivatives.[10]
4–06	*Laccaria amethystina*	Amethyst Deceiver	Accumulates arsenic, and contains organic arsenic compounds, especially dimethylar-sinic acid, which cannot be excluded to be genotoxic and carcinogenic.
4–07	*Lactarius necator* (*L. plumbeus, L. turpis*)	Ugly Milkcap	Contains the heat stable necatorin which is suspected to be genotoxic.
4–08	*Paxillus involutus*	Brown Rollrim (Common Rollrim, Poison Pax)	Contains potent, but unknown toxicant(s), which are not efficiently destroyed after cooking, and which after repeated meals may give severe adverse reactions, in some cases deadly.
4–09	*Pholiota squarrosa*	Shaggy Scalycap	May occationally give rise to intoxications. The toxicant is unknown.
4–10	*Pleurocybella porrigens*	Angel's Wings	Contains pleurocybellaziridine which has given rise to several fatal intoxications.
4–11	*Tricholoma equestre* (*T. flavovirens, T. auratum*)	Yellow Knight (Man on Horseback, "Canary Mushroom")	Severe, also some fatal intoxicantions have been reported after consumption of repeated meals with substantial amounts of this mushroom.Yellow Knight should not be marketed before occurrence and identity of the toxicant(s) has been elucidated and not before the mecanism of the toxicity has been explaned. Due to the intoxications, some European countries have forbidden trade with Yellow Knight.

[10] May under specified conditions be marketed in Finland and Sweden, see risk assessment of False Morel (Gyromitra esculenta), Volume II, section 2.

7. Education

Basic knowledge on identification of mushrooms is highly important for using mushrooms in a safe way in trade, restaurants etc.

The EU regulation on food hygiene (EU, 2004b) identifies requirements regarding hazard analysis and critical control points stating that "Food business operators shall put in place, implement and maintain a permanent procedure or procedures based on the HACCP principles." The Regulation addresses training by stating that "food business operators are to ensure (1) that food handlers are supervised and instructed and/or trained in food hygiene matters commensurate with their work activity; and (2) that those responsible for the development and maintenance of the procedure referred to in Article 5(1) of this Regulation or for the operation of relevant guides have received adequate training in the application of the HACCP principles." These requirements are more evident in the area of food mushrooms than in many other food areas as mistakes can be fatal.

Mushrooms traded commercially as food may be cultivated or growing wild and collected by private collectors and brought to markets and restaurants. Many of these seem to have an interest in using natural foods from the local market. It is a challenge for the responsible persons in the restaurant kitchen when these foods are mushrooms, as incorrect identification may result in severe consequences.

Besides an academic education in mycology in universities, there are limited possibilities in the Nordic countries to get a formal education in identification, edibility/toxicity of mushrooms.

Some countries in the European Union, like *Poland*, have formal, legal requirements for specific training on mushroom identification. This is specified in the Polish legislation on edible mushrooms.

Finland has long tradition and good experience of voluntary based education and training on edible mushrooms suitable for marketing. Local mushroom societies and educational institutes on the natural resource sector arrange courses on identifying marketable mushroom species.

Some of the *Nordic mushroom associations*, like the Norwegian Association of Fungi and Useful Plants and the Danish Society on Mushrooms, have courses that give an exam, and includes a "diplomacy test". The exams cover knowledge on mushroom identification. For example, in

Norway the test covers requirements to identify accurately approximately 130 species. The Norwegian association also has a more limited exam for persons who collect and sell mushrooms commercially. Sweden has similar options, including courses for food inspectors and university courses.

As, identification of mushrooms is not an easy task and the risk to get poisonous mushrooms on the table is there, one of the recommendations from the Nordic project group is that obligatory training for business operators that produce foods with mushrooms or who use or import mushrooms should be considered in the Nordic countries.

The Nordic project group stresses that eduction on correctly identify mushrooms is highly important for a commercial safe use of mushrooms in trade and industry. It is proposed to establish courses at two different requirement levels depending of the estimated need at the food producer or importer. Restaurants, supermarkets and canteens might use a very limited number of mushroom species and e.g., only cultivated mushrooms, while other restaurants might have a need for more in-depth knowledge, e.g., if they buy a huge variety of wild mushrooms from private collectors.

Level 1 courses should be suitable for chefs, who buy and use mushrooms to restaurants from private collectors and to people collecting mushrooms for commercial sale. Importers of mushrooms, including dried mushrooms would also be a target group for this level of education. This could be an obligatory course and be a part of the documentation in the in-house control in trade and industry.

Level 2 courses should go more in depth into the issues and be finalised with a test, giving a certificate for participants certifying a level of knowledge as “recognized mushroom expert”. This level is suitable for restaurants/importers who will receive the mushrooms included in lists 1–2 private collectors, and the public food inspection, mushroom collectors for further processing and also public food inspectors. Having the knowledge given by a level 2 course would smoothen the use of the questionnaire elaborated by this project. In addition to these two courses it would also be necessary to have a re-approval of the “recognized mushrooms expert” after e.g. 5–10 years.

The level 1 courses should contain a general introduction to mushrooms identification and hygiene and other legal requirements, and information on the mushrooms given in list 1 and possible look-alikes. It should also give information on the shelf-life of mushrooms and description of the most important poisonous mushroom species. It is important that participants leave the course able to identify mushrooms species and are able to handle questions of the type in the Nordic questionnaire.

The level 2 courses should give more in depth knowledge, including on the mushrooms on lists 1–4. At the end of the course the participants should get the possibility to take an exam. Passing the exam would qualify the participant the status as "recognised mushrooms expert". Furthermore, recognised experts should be required to keep their knowledge base on mushrooms updated and could, therefore, be required to be member of a national mushroom association in order to be regularly offered possibilities to keep the knowledge updated.

It is recognised that the organisation of the courses suggested above could take place nationally or on a Nordic platform. This project group has recognized that there might be winnings to discuss the content of such courses jointly between the Nordic countries.

On the EU level, eduction on commercially used edible mushrooms could be proposed for the program "Better Training in Safer Food". This program has courses on several food safety issues, and a mushroom course would be relevant as the risks when consuming mushrooms are much higher than many other risks related to food consumption.

8. Advice and recommendations

This chapter includes general advice and recommendations for future work in the area of mushrooms traded as food. The recommendations given and need for future activities identified should be taken into consideration by trade, industry and food control authorities in the Nordic countries.

8.1 Advice on safe use of mushrooms

Trade and industry, including catering units and restaurants should only trade or serve mushrooms, which are well-known as edible and correctly identified.

The following advice of safe use of mushrooms are given to consumers but are also relevant for trade and industry

- Eat only mushrooms, which you are 100% sure that you recognize
- Eat only mushrooms, which are generally recognized as edible
- Do not eat mushrooms raw, as many mushrooms may cause discomfort e.g., stomach pain if eaten raw
- Do not eat spoiled mushrooms
- When eating a new species of mushrooms for the first time, always start up with a small portion in order to minimize the risk for intolerance or other hypersensitivity reactions

8.2 Recommendations

- *Training and education*: This project group recommends that obligatory training for business operators that produce foods with mushrooms, or who import mushrooms, should be considered in the Nordic countries. In general, guidance and training is needed in this area in order to prevent fatal and other types of severe intoxications (see also chapter 7). This is not a specific need for the Nordic countries but a general requirement. It would be advantageous to have a joint discussion of the organisation of such courses in the Nordic countries, both regarding content and organization

- Propose *eduction on commercially used edible mushrooms on the EU level* for the program “Better Training in safer Food”. This program has courses in several food safety issues, and would be relevant as the risks when consuming mushrooms are much higher than many other risks related to food consumption
- *Food inspectors* should have a general knowledge on which mushrooms are edible and which are not. This knowledge can be obtained by training, education and/or guidance
- *Hypersensitivity* (both allergic and non-allergic) symptoms caused by various mechanisms are seen in relation to intake of mushrooms. However, the litterature review in the project points to the need for more research be conducted into the mushroom components causing symptoms like stomach pain
- The communication between actors influenced by mushroom intoxications (Poison Information Centres, Hospitals, Food Authorities, Mushroom societies, etc.) should be improved within and between the Nordic countries. Thus, it is important that knowledge on intoxications are wiedely distributed
- Professionals using mushrooms in food production should have *formal education* as mushrooms can be fatal to consume
- The *Nordic lists in the report should be updated* in accordance with new knowledge on safe use of mushrooms and for new mushrooms assessed as mushrooms in the present lists 1–2
- In EU, guidance on edible mushrooms should be discussed and, preferably harmonised

Focus areas for the food inspection and safety authorities

Focus areas for the food safety authorities should be:

- Importers e.g. of dried mushrooms and restaurants buying wild mushrooms from private collectors
- Knowledge in food production units, like restaurants and canteens and control of critical points like identification of mushrooms used, the quality, microbiology and cooking procedures
- Data on radioactivity should be compiled, analysed and concluded on as experience for the future

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10. Optional summaries

10.1 Sammendrag

Spiselige sopp har blitt sanket og dyrket gjennom mange år, og det er spesielt en lang tradisjon for å sanke sopp i Finland. Imidlertid har interessen for å spise sopp, og flere ulike arter av sopp, økt i de andre nordiske landene også.

Mange mennesker liker å trene og samtidig nyte naturen. Naturlige matvarer har blitt populære, så å kombinere disse interessene og f.eks. sanke sopp er positivt for den generelle velvære og for helsen.

Målet for prosjektet er å utvikle verktøy for kontroll i næringsmiddelforetak som importerer og omsetter sopp, samt til offentlige næringsmiddelinspektører. Verktøyet skal sikre at de nordiske forbrukerne kan kjøpe spiselig sopp som er trygge og godt karakterisert, og forhindre at sopp som brukes kommersielt er helsefarlig.

Det er et stort og økende forbruk av dyrket og sanket skogsopp i de nordiske landene. Grunnlaget for å nå målet om sikkerhet ved omsetning av sopp, både fersk og bearbeidet sopp, er utarbeidelse av veiledningslister over sopp som er risikovurdert, og som kan brukes i samsvar med de generelle kravene til mattrygghet. I dette prosjektet er risikovurderingene laget primært med fokus på soppens naturlige toksiner som kan forårsake uheldige helseeffekter.

Sopp som selges i Norden er risikovurdert i rapporten og inkludert i veiledningslister over spiselig sopp egnet for omsetning. Veiledningslistene er basert på kunnskap om spiselig sopp (skogsopp og kultivert sopp) som omsettes i Norden, registrerte forgiftningstilfeller og knytter dette til trygg omsetning av matsopp til forbrukerne.

Videre har rapporten mer utfyllende informasjon om aktuelt regelverk, herunder merking og korrekt navngiving og forurensende stoffer, som tungmetaller og radioaktivitet, og behovet for utdanning.

Prosjektgruppen har samarbeidet med danske næringsmiddelinspektører og det ble gjennomført et dansk kontrollprosjekt i 2010. I prosjektet ble opptil 300 inspeksjoner gjort ved hjelp av verktøyet som var utarbeidet. Erfaringene fra den danske kontrollen er ivaretatt i den nordiske rapporten.

Dette prosjektet fokuserer på sopp som omsettes kommersielt og tar sikte på å gi veiledning til næringsmiddelaktører (grossister, dagligvarehandelen og restauranter), samt til offentlige kontrollører. Imidlertid kan verktøyet; spørreskjema og veiledningslistene, også benyttes som veiledning til forbrukere og til informasjon i bøker, på internett og andre steder.

Rapporten, Volum II, del 1 og 2, er bakgrunnen for det nordiske spørreskjemaet (Volum I); "Omsetning av matsopp – Nordisk spørreskjema, med veiledningslister på spiselig sopp egnet og ikke egnet for omsetning". Bakgrunnsrapporten inneholder flere detaljer om sopp, de fire veiledningslistene og risikovurderinger på de enkelte soppartene. Volum I har et spørreskjema som kan benyttes for utvikling av behørig dokumentasjon for internkontroll hos relevante næringsmiddelaktører, eller for næringsmiddelinspeksjon.[11]

Det anbefales å bruke verktøyet og å fokusere på utdannelse og kunnskap hos næringsmiddelaktører som importerer og omsetter matsopp, samt hos næringsmiddelinspektører. Det er lite kunnskap og prosjektet har identifisert områder for framtidig arbeid.

10.2 Tiivistelmä

Syötäviä sieniä on kerätty ja kasvatettu vuosien ajan. Pohjoismaissa erityisesti Suomessa sienien keräämisellä on pitkät perinteet. Muissakin Pohjoismaissa erilaisten sienten käyttämisestä on enenevästi kiinnostuttu. Luonnossa liikkuminen ja luonnosta kerättävät ruoat kiinnostavat.

Tämä projekti keskittyy kaupallisesti myytäviin syötäviksi tarkoitettuihin sieniin. Tavoitteena on kehittää työvälineitä kaupan ja teollisuuden omavalvontaan sekä elintarvikkeiden viranomaisvalvontaan. Projektissa on kehitetty sienten omavalvonnan ja valvonnan tueksi kyselylomake. Lisäksi on tuotettu sienistä luettelot, joissa on tieteellisten ja englanninkielisten nimien lisäksi kuvat ja sienten nimet pohjoismaisilla kielillä. Näitä työvälineitä käyttämällä pyritään varmistumaan siitä, että pohjoismaiset kuluttajat voivat ostaa turvallisia sieniä joiden ominaisuudet tunnetaan hyvin.

Tuoreiden ja jalostettujen sienten turvallisen kaupallisen käytön edistämiseksi ja valmistamiseksi sienistä on tehty riskianalyysi. Tämän projektin riskianalyyseissa on keskitytty lähinnä luontaisiin myrkkyihin.

[11] Det nordiske spørreskjemaet er tilgjengelig på www.norden.org

Luetteloiden sienet on valittu sen perusteella, mitä syötäviä sieniä (luonnonvaraiset ja kasvatetut sienet) Pohjoismaissa on myynnissä. Lisäksi lähteinä on käytetty tietoja rekisteröidyistä myrkytystapauksista sekä sienioppaiden tietoja.

Tanskassa toteutettiin vuonna 2010 sienten valvontaprojekti, jossa tehtiin noin 300 tarkastusta. Tanskan valvontakokemukset osoittivat, että työkaluja tarvitaan tukemaan valvontaa. Tanskan projektissa käytettyjä valvontamenettelyjä ja työkaluja on tässä projektissa edelleen kehitetty.

Raportin osa I käsittää kyselylomakkeen, jota voidaan käyttää apuna omavalvonnassa ja sen dokumentoinnissa niin teollisuuden kuin kaupan alalla. Myös elintarvikevalvontaviranomaiset voivat hyödyntää kyselylomaketta tarkastustyössään.

Raportin osa II käsittää kaksi kokonaisuutta, josta ensimmäisessä käsitellään sieniä koskevaa lainsäädäntöä (mm. pakkausmerkinnät, sienten nimeäminen), tietoa sienten tunnistamisesta ja syötävyydestä sekä elintarviketurvallisuudesta (mikrobiologia, vieraat aineet ym.). Lisäksi on käsitelty mm. sienten myyntiin ja sienivalitukseen liittyviä kysymyksiä. Toisessa kokonaisuudessa on esitetty sienikohtaiset riskinarvioinnit.

Projekti suosittelee, että niin elintarvikealan toimijat kuin elintarvikevalvontaviranomaiset hyödyntävät kehitettyjä työkaluja ja taustaaineistoa. Lisäksi katsotaan, että sieniosaamiseen ja sen lisäämiseen tulisi panostaa nykyistä huomattavasti enemmän. Projektissa on havaittu merkittäviä puutteita ja tunnistettu asiat, jotka vaativat jatkotoimenpiteitä.

Annex I Listed mushrooms and their Nordic names

The lists below give the scientific names as well as the Danish, Finnish, Icelandic, Norwegian and Swedish names together with synonyms. Swedish names are also used in Finland, but as the Finnish-Swedish names are the same as the names used in Sweden, they are not in the list under Finland.

List 1 Edible mushrooms suitable for commercial use (cultivated and/or wild)

Scientific name	English name	Danish name	Finnish names	Icelandic name	Norwegian name	Swedish name
Agaricus arvensis	Horse Mushroom	Ager-Champignon	Peltoherkkusieni	Mókempa	Åkersjampinjong	Snöbollschampinjon
Agaricus bisporus (A. hortensis, A. brunnescens)	Cultivated Mushroom (Button Mushroom)	Have-Champignon (Hvid Have-Champignon Brun Have-Champignon, "Champignon" "Portobello")	Viljelyherkkusieni	Matkempa (matkempingur)	Dyrket sjampinjong ("Aromasopp" og "Portobello")	Trädgårdschampinjon (Odlade former av Träd-gårdchampinjon, "Porto-bello", Vit träd-gårdchampinjon, Brun trädgårdchampignon, Odlat champignon)
Albatrellus ovinus	Forest Lamb	Hvidlig Fåreporesvamp	Lampaankääpä	No Icelandic name	Fåresopp	Fårticka
Amanita caesarea	Caesar's Mushroom (Caesar's Amanita)	Kejser-Fluesvamp	Keisarikärpässieni	Kejsaraserkur	Keiserfluesopp	(Kejsarflugsvamp)
Auricularia auricula-judae (A. auricula)	Jelly Ear (Jew's Ear, Judas's Ear Fungus)	Almindelig Judasøre	Auricularia - puunkorvat	Eyrasveppir (Júdaseyra)	Judasøre	Judasöra
Auricularia polytricha and other Auricularia species	(Ear species)	Kinesisk Judasøre og andre Judasøre-arter	Auricularia - Puunkorvat	Eyrasveppir (Júdaseyra) og aðrir	Geléøre-arter	Skogsöra och andra arter inom geléöronsläktet
Boletus edulis	Penny Bun, Cep	Spiselig Rørhat (Karl Johan, Karl Johan-Rørhat)	Herkkutatti	Kóngssveppur (Ætiboldungur)	Steinsopp	Stensopp, Karljohan ("Karljohansvamp")
Boletus pinophilus (B. pinicola)	Pine Bolete ("Pine Cep")	Rødbrun Rørhat ("Karl Johan")	Männynherkkutatti	Greniboldungur	Rødbrun steinsopp	Rödbrun stensopp
Boletus reticulatus Schaeff. (B. aestivalis)	Summer Bolete ("Summer Cep")	Sommer-Rørhat ("Karl Johan")	Tammenherkkutatti	No Icelandic name	Bleklodden steinsopp	Finluden stensopp
Cantharellus cibarius	Chanterelle ("Girolle")	Almindelig Kantarel ("Kantarel")	Keltavahvero	Kantarella	Kantarell	Kantarell
Cantharellus pallens	No English name	Bleg Kantarel ("Kantarel")	Kalvasvahvero	No Icelandic name	Blek kantarell	Blek kantarell
Craterellus cornucopioides (Cantharellus cornucopioides)	Horn of Plenty (Black Chanterelle, Black Trumpet)	Trompetsvamp	Mustatorvisieni	Svartlúður	Svart trompetsopp	Svart trumpetsvamp
Craterellus lutescens. (Cantharellus lutescens	Golden Chanterelle ("Chanterelle Jaune", "Autumn Chanterelle")	Gylden Kantarel	Kosteikkovahvero	Gulllúður	Gul trompetsopp	Rödgul trumpetsvamp

Scientific name	English name	Danish name	Finnish names	Icelandic name	Norwegian name	Swedish name
Craterellus tubaeformis (Cantharellus tubaeformis)	Trumpet Chantarelle (“Chanterelle gris”,“Winter Chanterelle”)	Tragt-Kantarel	Suppilovahvero	Gralúður	Traktkantarell	Trattkantarell
Flammulina velutipes	Velvet Shank (Enoki-take, Golden Needle Mushroom)	Almindelig Fløjlsfod (“Enoki”)	Talvijuurekas	Loðfótur (Veturfönungur)	Vintersopp (“Enoki”, “Enokitake”)	Vinterskivling (Vinternagelskivling)
Grifola frondosa	Hen of the Woods	Tueporesvamp	Koppelokääpä	Blöðkubora	Korallkjuke	Korallticka
Hericium coralloides	Coral Tooth	Koralpigsvamp	Siiliorakas	Broddkórall	Korallpiggsopp	Koralltaggsvamp
Hericium erinaceus	Bearded Tooth (Lion's Mane, Mushroom, Pom Pom)	Pindsvinepigsvamp (“Pom-Pom”)	No Finnish name	Ígulbroddkórall	Piggsvinsopp	Igelkotttaggsvamp (“Pom-Pom”)
Hydnum repandum	Wood Hedgehog (“Pied de Mouton”, “Hedgehog”)	Almindelig Pigsvamp (“Pigsvamp”)	Vaaleaorakas	Gulbroddi	Blek piggsopp	Blek taggsvamp
Hydnum rufescens	Terracotta Hedgehog	Rødgul Pigsvamp (“Pigsvamp”)	Rusko-orakas	Rauðbroddi	Rødgul piggsopp	Rödgul taggsvamp
Hypsizygus	Elm Leech (Brown Beech Mushroom, White Beech Mushroom, “Brown Shimeji”, “White Shimeji”)	Bøgehat	Runkovalmuska	No Icelandic name	Almeknippesopp	No Swedish name
Lentinula edodes (Lentinus edodes)	(Shii-take)	Shiitake	Siitake	Shii-take sveppur, Tókasveppur	Shiitake	Shiitake (Ekmussling, Ekskivling)
Lepista nuda (Tricholoma nudum)	Wood Blewit	Violet Hekseringshat (“Blåfod”)	Sinivalmuska	Fjólujússa	Blå ridderhat	Blåmusseron
Macrolepiota procera	Parasol	Stor Parasolhat	Ukonsieni	Sólhlífarskermill	Stor parasollsopp	Stolt fjällskivling
Morchella conica M. elat.)	Black Morel (“Morel”, “Pointed Morel”, “Ribbed Morel”)	Kegle-Morkel (“Morkel”)	Kartiohuhtasieni	Keilumyrkill	Spissmorkel	Toppmurkla
Morchella esculenta	Morel	Spiselig Morkel (“Morkel”)	Pallohuhtasieni	Matmyrkill	Rundmorkel	Rund toppmurklar
Pholiota nameko	(“Pholiote”, “Nameko”)	Nameko-Skælhat	No Finnish name	Namekoskrýfa	(Nameko)	Namekotofsskivling
Pleurotus citrinopileatus	(The Golden Oyster Mushroom)	Gul Østershat	Sitruunavinokas	Gulvængur	Sitronøsterssopp	Citronmussling

Scientific name	English name	Danish name	Finnish names	Icelandic name	Norwegian name	Swedish name
Pleurotus djamor	(Pink Oyster Mushroom)	Rød Østershat	No Finnish name	Roðavængur	Flamingoøsterssopp	(Rosa ostronmussling)
Pleurotus eryngii	King Oyster (French Horn Mushroom, King Trumpet Mushroom)	Kejser-Østershat	Kuningasosterivinokas (Kuningasvinokas)	Ístruvængur	Kongeøsterssopp	("Kungsmussling")
Pleurotus ostreatus.	Oyster Mushroom	Almindelig Østershat	Osterivinokas	Ostruvængur	Blågrå østerssopp	Ostronmussling (Ostronskivling)
Sparassis crispa	Wood Cauliflower	Blomkålssvamp	Kurttusieni	Blómkálssveppur	Blomkålsopp	Blomkålssvamp
Suillus luteus	Slippery Jack	Brungul Rørhat	Voitatti	Furusúlungur, Furusveppur	Smørsopp	Smörsopp
Tricholoma matsutake (T. nauseosum)	Spicy Knight (Matsu-take)	Duft-Ridderhat ("Matsutake")	Tuoksuvalmuska	No Icelandic name	Kransmusserong	Goliatmusseron ("Matsutake")
Tuber aestivum	Summer Truffle	Sommer-Trøffel	("Kesätryffeli")	Sumartryffill	Sommertrøffel	Sommartryffel (Bourgognetryffel)
Tuber indicum (Tuber sinense)	("Chinese Truffle")	KinesiskTrøffel	("Kiinalainen musta tryffeli")	No Icelandic name	No Norwegian name	(Kinesisk tryffel)
Tuber magnatum	("White Truffle", "Alba Truffle")	Piemonteser-Trøffel ("Hvid Trøffel", "Alba-Trøffel")	("Valkotryffeli")	("Tryffill")	Kongetrøffel	Albatryffel ("Piemontetryffel")
Tuber melanosporum	("Black Truffle", "Black Winter Truffle")	Perigord-Trøffel ("Sort Trøffel")	("Mustatryffeli")	("Tryffill")	Perigordtrøffel	Perigordtryffel
Volvariella volvacea (Volvaria volvacea)	(Paddy Straw Mushroom, Straw Mushroom)	Spiselig Posesvamp	Viljelytuppisieni	Matsokka	Grå sliresopp	Halmslidskivling

List 2 Wild edible mushrooms, where the identity has to be documented by recognised experts to be suitable for commercial marketing.

Scientific name	English name	Danish name	Finnish name	Icelandic name	Norwegian name	Swedish name
Agaricus arvensis	Horse Mushroom	Ager-Champignon	Peltoherkkusieni	Mókempa (Mókempingur)	Åkersjampinjong	Snöbollschampinjon
Agaricus augustus (A. perrarus)	The Prince	Prægtig Champignon	Upeaherkkusieni	No Icelandic name	Kongesjampinjong	Kungschampinjon
Agaricus bitorquis	Pavement Mushroom	Vej-Champignon	Puistoherkkusien	No Icelandic name	Bysjompinjong	Vägchampinjon
Agaricus campestris	Field Mushroom	Mark-Champignon	Nurmiherkkusieni	Túnkempa (Túnkempingur, Túnætisveppur)	Beitesjampinjong	Ängschampinjon
Agaricus species, other not yellowing e.g. A. langei (A. haemor-rhoidarius and A. sylvati-cus)	Agaricus species, other not yellowing e.g. Scaly Wood Mush-room and Blushy Wood Mushroom	Champignoner, andre ikke-gulnende F.eks.. Stor Blod-Champignon og Lille Blod-Champignon	Agaricus lajin herkkusienet, muut ei kellertävät esim, Veriherkkusieni tapion-herkusieni	Kempur, aðrar sem ekki gulna við hnjask.	Sjampinjonger andre ikke gulnende, fx Stor blod-sjampinjong og blodsjam-pinjong	Agaricus arter, andra icke gulnande, som till exemple Blodchampinjon (Stor blodchampignon) och Skogschampinjon)
Agaricus species, other yellowing e.g. A. sylvicola (A.abruptibulbus, A.urinascens (A. excellens, A. macroporus)	Agaricus species, other yellowing e.g. Wood Mushroom and Macro Mushroom	Champignoner, andre gul-nende F.eks. Gulhvid Champignon og Landsby-Champignon	Agaricus herkkusienet, muut ei kellertävät esimkuusiherkkusieni	Kempur, aðrar sem gulna við hnjask	Sjampinjonger andre gulnende, for eksempel snøballsjampinjong og kjempesjampinjong	Agaricus arter, andra gulnande, som till exemple Knölchampinjon
Calocybe gambosa (Lyophyllum gambosum (Tricholoma gambosum , T. georgii)	St. George's Mushroom	Vårmusseron	Kevätkaunolakki	Vorkolla	Vårmusserong	Vårmusseron
Coprinus comatus	Shaggy Inkcap,Lawyer's Wig, (Shaggy Mane)	Stor Parykhat (Paryk-Blækhat)	Suomumustesieni	Ullblekill	Matblekksopp	Fjällig bläcksvamp
Cortinarius caperatus (Rozites caperatus)	The Gypsy	Klidhat	Kehnäsieni	Hrukkuhös-sveppur	Rimsopp	Rimskivling (Rynkad tofsskivling)
Flammulina velutipes	Velvet Shank (Golden Needle Mush-room)	Almindelig Fløjlsfod	Talvijuurekas	Loðfótur (Veturfönungur)	Vintersopp	Vinterskivling (Vinternagelskivling)
Gomphidius glutinosus	Slimy Spike	Grå Slimslør	Limanuljaska	Slímgumpur (Slímstautull)	Sleipsopp	Citronslemskivling (Citrongul slemskivling)
Gomphus clavatus	Pig's Ear	Køllekantarel	Pölkkysieni	Fjólusteðji	Fiolgubbe	Violgubbe
Hygrocybe pratensis ((Camarophyllus pratensis)	Meadow Waxcap (Buffcap)	Eng-Vokshat	Niittyvahakas	Vallhnúfa	Engvokssopp	Ängsvaxskivling (Ängvaxing)

Scientific name	English name	Danish name	Finnish name	Icelandic name	Norwegian name	Swedish name
Hygrophorus camarophyllus	Arched Woodwax	Sodbrun Sneglehat	Mustavakakas	Sótsniglingur	Sotvokssopp	Sotvaxskivling (Sotväxing)
Hygrophorus hypothejus	Herald of Winter	Frost-Sneglehat	Hallavahakas	No Icelandic name	Frostvokssopp	Frostvaxskivling (Frostvaxing)
Hygrocybe punicea	Crimson Waxcap	Skarlagen-Vokshat	Punikkivahakas	Skarlattoppa	Skarlagenvokssopp	Scharlakansvaxskivling
Lactarius deliciosus	Saffron Milkcap	Velsmagende Mælkehat	Männynleppärousku	Ljúflekta	Furumatriske	Läcker riska (Läckerriska, Tallblodriska)
Lactarius deterrimus	False Saffron Milkcap	Gran-Mælkehat	Kuusenleppärousku	Matlekta	Granmatriske	Blodriska (Granblodriska)
Lactarius rufus	Rufous Milkcap (Red Hot Milkcap)	Rødbrun Mælkehat,	Kangasrousku	No Icelandic name	Rødbrun pepperriske	Pepparriska
Lactarius torminosus	Woolly Milkcap	Skægget Mælkehat	Karvarousku	Loðlekta, (Loðglætingur)	Skjeggriske	Skäggriska
Lactarius trivialis (L. utilis)	No English name	Nordisk Mælkehat (Slimet Mælkehat)	Haaparousku, Kalvashaapa-rousku	No Icelandic name	Hulriske (Blek hulriske)	Skogsriska
Lactarius volemus	Fishy Milcap (Weeping Milkcap)	Spiselig Mælkehat	Kultarousku	No Icelandic name	Mandelriske	Mandelriska
Leccinum aurantiacum (L. albostipitatum, L. quercinum)	(Orange Aspen Bolete, Orange Oak Bolete)	Orange Aspe-Rørhat, Rustrød Ege-Rørhat	Haavanpunikkitatti	Asparlubbi	Ospeskrubb	Aspsopp
Leccinum versipelle	Orange Birch Bolete	Rød Birke-Rørhat	Koivunpunikkitatti	Reyðilubbi (Rauðhetta)	Rødskrubb	Tegelsopp (Teglröd björksopp)
Leccinum vulpinum	Foxy Bolete	Fyrre-Rørhat	Männynpunikkitatti	No Icelandic name	Furuskrubb	Tallsopp (Rävsopp)
Leccinum species, other e.g. L. scabrum	Leccinum, other species, e,g, Brown Birch Bolete	Skælrørhatte, andre Brun Birke-Rørhat	Muut Leccinum lajin tatit.	Lubbar, aðrir e.g., No Icelandic name	Skrubb arter, andre for eksempel brunskrubb	Soppar av släktet Lecci-num, the example has no Swedish name
Lepista nuda (Tricholoma nudum)	Wood Blewit	Violet Hekseringshat ("Blåfod")	Sinivalmuska	Fjólujússa	Blå ridderhatt	Blåmusseron
Lepista saeva (L. personata, Tricholoma personatum)	Field Blewit	Bleg Hekseringshat	Syysvalmuska	No Icelandic name	Lillastilket ridderhatt	Höstmusseron
Russula claroflava (R. flava)	Yellow Swamp Brittlegill	Birke-Skørhat	Keltahapero	Glóhnefla	Mild gulkremle	Gulkremla (Mild gulkremla)

Scientific name	English name	Danish name	Finnish name	Icelandic name	Norwegian name	Swedish name
Russula decolorans	Copper Brittlegill	Afblegende Skørhat	Kangashapero	No Icelandic name	Gulrød kremle	Tegelkremla
Russula integra	Nutty Brittlegill	Mandel-Skørhat	Mantelihapero	No Icelandic name	Mandelkremle	Mandelkremla
Russula paludosa	("Tall Brittlegill")	Prægtig Skørhat	Isohapero	Mýrahnefla	Storkremle	Storkremla
Russula vesca.	The Flirt (Bare-toothed Russula)	Spiselig Skørhat	Palterohapero	Garðhnefla	Nøttekremle	Kantkremla
Russula vinosa (R. obscura)	Darkening Brittlegill	Vinrød Skørhat	Viinihapero	No Icelandic name	Vinrød kremle	Vinkremla
Russula xerampelina	Crab Brittlegill (Shrimp Mushroom)	Hummer-Skørhat	Sillihapero	Móhneflur	Rød sildekremle	Sillkremla
Suillus granulatus	Weeping Bolete (Granula-ted Bolete)	Kornet Rørhat	Jyvästatti	Kornasúlungur	Ringløs smørsopp	Grynsopp
Suillus grevillei	Larch Bolete (Greville's Bolete)	Lærke-Rørhat	Lehtikuusentatti	Lerkisúlungur, (Lerkisveppur)	Lerkesopp	Lärksopp
Suillus variegatus	Velvet Bolete (Variegated Bolete) "Swedish Jack"	Broget Rørhat	Kangastatti	Sandsúlungur	Sandsopp	Sandsopp
Tricholoma portentosum	The Coalman ("Charbonnier")	Grå Ridderhat	Viiruvalmuska	No Icelandic name	Gråmusserong	Streckmusseron
Xerocomus badius (Boletus badius)	Bay Bolete	Brunstokket Rørhat	Ruskotatti	No Icelandic name	Svartbrun rørsopp	Brunsopp

List 3 Wild mushrooms, which may easily be mistaken for poisonous look-alikes and therefore are not regarded as suitable for commercial marketing.

Scientific name	English name	Danish name	Finnish name	Icelandic name	Norwegian name	Swedish name
Amanita fulva	Tawny Grisette (Orange-Brown Ringless Amanita)	Brun Kam-Fluesvamp	Ruostekärpässieni	Rauðserkur	Brun kamfluesopp	Brun kamskivling (Gul-brun kamskivling)
Amanita rubescens	Blusher	Rødmende Fluesvamp	Ruskokärpässieni	No Icelandic name	Rødnende fluesopp	Rodnande flugsvamp
Armillaria borealis	No English name	Nordlig Honningsvamp ("Honningsvamp")	Pohjanmesisieni	Hunangssveppur	Skoghonningsopp	Vanlig honungsskivling
Armillaria cepistipes (Armilla-riella cepistipes)	No English name	Knoldfodet Honningsvamp ("Honningsvamp")	No Finnish name	Hunangssveppur	Hagehonningsopp	Finfjällig honungsskivling
Armillaria lutea (A. gallica)	Bulbous Honey Fungus	Køllestokket Honningsvamp ("Honningsvamp")	Nuijamesisieni	Hunangssveppur	Klubbehonningsopp	Klubbhonungs-skivling
Armillaria mellea (Armillariella mellea)	Honey Fungus	Ægte Honningsvamp ("Honningsvamp")	Keltamesisieni	Hunangssveppur	Ekte honningsopp	Sydlig honungsskivling
Boletus luridiformis	Scarletina Bolete (Dotted-Stemmed Bolete)	Punktstokket Indigo-Rørhat	Veritatti	No Icelandic name	Blodrørsopp	Blodsopp
Boletus luridus	Lurid Bolete	Netstokket Indigo-Rørhat	Tauriontatti	No Icelandic name	Ildrørsopp	Eldsopp
Chlorophyllum olivieri (Lepiota olivieri, Macrolepiota olivieri)	No English name	Almindelig Rabarberhat ("Rabarber-Parasolhat")	No Finnish name	Garðskermill	Maurtueparasollsopp	No Swedish name
Chlorophyllum rachodes (Macrolepiota rachodes, Lepiota rhacodes)	Shaggy Parasol	Ægte Rabarberhat ("Rabarber-Parasolhat")	Akansieni	No Icelandic name	Rødnende parasollsopp	Rodnande fjällskivling
Clitopilus prunulus	The Miller	Gråhvid Melhat	Jauhosieni	Voðhöttur (Vatthöttur)	Melsopp	Mjölskivling
Cortinarius spp. e.g., C. armillatus.	Webcap species e.g. Red Banded Webcap	Visse slørhatte, f.eks. Cinno-berbæltet Slørhat	Cortinarius lajin seitikit, esim. Punavyöseitikki	Einstaka kögrar t.d. No Icelandic name	Slørsopper f. eks. Rødbelteslørsopp	Vissa spindlingar (Spin-delskivlingar)t.ex. röd-bandad spindling
Hypholoma capnoides	Conifer Tuft	Gran-Svovlhat	Kuusilahokka	Viðarnollur (Kirkjugarðsnollur)	Svovelsopp	Rökslöjskivling
Kuehneromyces mutabilis (Pholiota mutabilis)	Sheathed Woodtuft ("Two-tone Pholiote")	Foranderlig Skælhat	Koivunkantosieni	Hverfiskrýfa, (Hverfisveppur)	Stubbeskjellsopp	Föränderlig tofsskivling
Russula aeruginea and other glaucous green Russula species, e.g. see the following examples *(R. cyanoxantha, R. grisea, R. ionochlora, R. parazurea, R. virescens*)	Green Brittlegill and other glaucous green Brittlegill species, e.g., see the following.	Græsgrøn Skørhat og andre grå-grønne skørhat-te, fx. Se de følgende	Koivuhapero ja muut har-maanvihreät Russula lajin haperot	Grænhnefla og aðrar græn-leitar hneflur	Grønnkremle og andre grå-grønne kremler, f.eks se nedenfor	Grönkremla och andra blågröna kremle-arter, se följende:

Scientific name	English name	Danish name	Finnish name	Icelandic name	Norwegian name	Swedish name
Russula cyanoxantha	Charcoal Burner	Broget Skørhat	Kyyhkyhapero	No Icelandic name	Broket kremle	Brokkremla
Russula grisea	No English name	Grålig Skørhat	Teräskirjohapero	No Icelandic name	Gråfiolett kremle	Duvkremla
Russula ionochlora	Oilslick Brittlegill	Violetgrøn Skørhat	Jirishapero	No Icelandic name	Iriskremle	Iriskremla
Russula parazurea	Powdery Brittlegill	Blågrøn Skørhat	Patinahapero	No Icelandic name	Blågrønn kremle	Blågrön kremla
Russula virescens	Greencracked Brittlegill	Spanskgrøn Skørhat	No Finnish name	Bláhnefla	Rutekremle	Rutkremla

List 4 Wild mushrooms earlier regarded as edible, but which are suspected to cause acute or long-time adverse effects after ingestion and therefore not regarded as suitable for commercial marketing.

Scientific Name	English name	Danish name	Finnish name	Icelandic name	Norwegian name	Swedish name
Armillaria ostoyae (Armillariella ostoyae)	Dark Honey Fungus	Mørk Honningsvamp	Mäntymesisieni	Hunangssveppur	Mørk honningsopp	Mörkfjällig honungsskivling
Clitocybe nebularis (Lepista nebularis)	Clouded Funnel	Tåge-Tragthat	Härmämalikka	Trektla	Puddertraktsopp	Pudrad trattskivling
Clitocybe connatat (Lyophyl-lum connatum)	White Domecap	Knippe-Gråblad	Nurmitupaskynsikäs	Gráspyrða (Gráknipplingur)	Hvit knippesopp	Vit tuvskivling
Coprinopsis atramentaria (Coprinus atramentarius)	Common Inkcap	Almindelig Blækhat	Harmaamustesieni	Slöttblekill	Grå blekksopp	Grå bläcksvamp
Gyromitra esculenta	False Morel (Turban, Brain Mushroom)	Spiselig Stenmorkel	Korvasieni	Krymplusveppur, (Krymplumyrkill)	Sandmorkel	Stenmurkla
Laccaria amethystina	Amethyst Deceiver	Violet Ametysthat	Lehtolohisieni	Fjólulakka	Ametystsopp	Ametistskivling
Lactarius necator (L.s plumbeus, L. turpis)	Ugly Milkcap	Olivenbrun Mælkehat, Manddraber-Mælkehat	Mustarousku	Grænlekta	Svartriske	Svartriska
Paxillus involutus	Brown Rollrim (Common Roll-rim, Poison Pax)	Almindelig Netbladhat	Pulkkosieni	Garðlumma (Lummusveppur)	Pluggsopp	Pluggskivling
Pholiota squarrosa.	Shaggy Scalycap	Krumskællet skælhat	Pörhösuomuhelokka	Ígulskrýfa	Raspkjellsopp	Fjällig tofsskivling
Pleurocybella porrigens	Angel's Wings	Kridthat	No Finnish name	No Icelandic name	Krittøstersopp	Öronmussling
Tricholoma equestre (T. flavovirens, T. auratum)	Yellow Knight (Man on Horseback, "Canary Mushroom")	Ægte Ridderhat	Kangaskeltavalmuska	Riddaraskjalda	Riddermusserong	Riddarmusseron

Annex II Addresses

The Annex list addresses of importance.

Food Authorities

Danish Veterinary and Food Administration (Fødevarestyrelsen):
www.fvst.dk

Finnish Food Safety Authority Evira:
http://www.evira.fi

Icelandic Matis:
http://www.matis.is

Norwegian Food Safety Authority (Mattilsynet):
http://www.mattilsynet.no (informastion for trade and industry)
http://www.matportalen.no (information for public)

Swedish National Food Agency (Livsmedelsverket):
http://www.slv.se

National Poison Information Centres in the Nordic Countries

Acute cases: In Denmark, Finland and Sweden: Acute cases call 112, for *Norway: Acute cases call 113***.** In all countries**,** ask for poison information center in less severe cases contact the National Poison Information centre. See addresses and phone numbers below:

Denmark	Giftlinjen http://www.bispebjerghospital.dk/giftlinjen/forside/ Phone +45 82 12 12 12
Finland	Myrkytystietokeskus http://www.hus.fi/default.asp?path=1,28,824,2049,2265,2260 Giftinformationscentralen http://www.hus.fi/default.asp?path=58;373;19337;9738;7645 Poison Information Centre http://www.hus.fi/default.asp?path=59;403;19336;9739;9541 Phone + 358 9 47 19 77
Iceland	Eitrunarmiðstöð http://www.landspitali.is/eitrunarmidstod Phone + 354 543 2222
Norway	Giftinformasjonen www.giftinfo.no Phone +47 22591300 *Note, that for accute cases call 113*
Sweden	Giftinformationscentralen http://www.giftinformation.se/ Phone +46;(0)8 331231)

Nordic, national societies on mushrooms

Denmark	Danish Mycological Society www.svampe.dk
Finland	*Mycological Society of Finland* Suomen Sieniseura Ry, Unioninkatu 44, SF 00170, Helsinki 17, Finland http://www.funga.fi/
Norway	The Norwegian Association of Fungi and Useful Plants (Norges sopp- og nyttevekstforbund) http://www.soppognyttevekster.no/
Sweden	Sveriges Mykologisk Förening, Institutionen för växt- och miljövetenskaper Göteborgs universitet, Box 461, 405 30 Göteborg, Sverige http://www.svampar.se/

Annex III Recommended books

Many mushroom handbooks and other sources of information discuss mushroom edibility. The information given varies greatly, depending on the author, regarding whether a particular mushroom species is edible or not. In order to identify mushrooms correctly and conclude on the edibility of mushrooms, it is essential to use only recent handbooks of good quality. Older mushroom handbooks and manuals of authors not recognized as mycologists should generally not be used.

Even in some official documents it might be difficult to trace where information on edibility of mushrooms come from. This is for example the case for the FAO corporate document "Wild edible fungi, a global overview of their use and importance to people" (Non-Wood Forest Products from Temperate Broad-Leaved Trees, FAO, 2002).

Information from the Internet is very tricky to handle – the quality is variable, and the author's mycological expertise is frequently difficult to assess, if the author is given at all. A common drawback is that it often is unclear on which data a conclusion has been drawn, and when references are given, their quality has not been adequately assessed.

Below is a short non-exhaustive list of handbooks, which could be usefull for the identification of mushrooms in the Nordic countries. The list was elaborated in March 2012. New updated handbooks should be taken into account.

Denmark

Danmarks Bedste Spisesvampe, Thomas Læssøe, Morten Bech Køster, Gads Forslag, 2001.

Danmarks Svampe, Jan Vesterholt, Gyldendal, 2. udgave, 2009.

De Bedste Spisesvampe, Michal Krikorev, Aschehoug Dansk Forlag A/S, 2007.

Politikens Svampebog, Henning Knudsen og Jens H. Petersen, Politikens Forlag, 2007.

Svampe, bestemmelse og indsamling, Till R. Lohmeyer og Ute Künkele, Parragon Books Ldt., Bath, England, 2006.

Funga Nordica, Agaricoid, boletoid and cyphelloid genera, Editors Henning Knudsen og Jan Vesterholt, Nordsvamp, København, 2008 .

Finland

Marja Härkönen, Irma Järvinen, Seppo Huhtinen & Tapani Hänninen 2003: Suomen kauppasienet. Edita. Helsinki.

Mauri Korhonen 2001: Uusi sienikirja. Kustannusosakeyhtiö Otava.

Mauri Korhonen 2008: Löydä ruokasieni. Otava.

Mauri Korhonen 2009: Sienet Suomen luonnossa. Otava.

Mauri Korhonen 2012: Sienestäjän taskukirja. Otava.

Pertti Salo, Tuomo Niemelä & Ulla Salo 2006: Suomen sieniopas. WS Bookwell Oy. Porvoo.

Pertti Salo, Tuomo Niemelä, Ulla Nummela-Salo & Esteri Ohenoja (toim.) 2005: Suomen helttasienten ja tattien ekologia, levinneisyys ja uhanalaisuus. Suomen ympäristökeskus, Helsinki. Suomen ympäristö 796. http://www.ymparisto.fi/default.asp?contentid=159350&lan=fi

http://www.helsinki.fi/pinkka/harrastus/sienet/index.htm

http://pinkka.helsinki.fi/virtuaalikasvio/index.php?bundle=456&pcat=6

Red-listing http://www.ymparisto.fi/default.asp?contentid=15166&lan=fi http://www.ymparisto.fi/download.asp?contentid=123016&lan=fi http://www.ymparisto.fi/download.asp?contentid=123017&lan=fi

Iceland

Islenskir sveppir og sveppafrædi, Helgi Hallgrimsson, Skudda, 2010

Matt Sveppirí náttúru Íslands. Ása Magrét Ásgrimsdóttir. Mál og Menning. 2010.

Norway

Inger Lagset Egeland & Steinar Myhr. 2011: Norske sopper. 4 utgave, Gyldendal Norsk Forlag

Inger Lagset Egeland & Steinar Myhr. 2009: Sikre sopper. Gyldendal Norsk Forlag

Else Wiborg. 2007: Sopp i naturen. 1 utgave, Kolibri Forlag.

Per Marstad. 2001: Våre beste matsopper. 1 utgave, Landbruksforlaget.

Leif Ryvarden og 2010: Norske matsopper. 2 utgave, Cappelen Damm Forlag.

Gro Gulden. 2004: Soppbok for begynnere. 2 utgave, Gyldendal Norsk Forlag.

The Norwegian Association of Fungi and Useful Plants (Norges sopp- og nyttevekstforbund), 21. mars 2012: NORMLISTE for norske soppers matverdi- http://www.soppognyttevekster.no/default.aspx?id=1602

The mycological herbarium (soppherbariet): http://nhm2.uio.no/botanisk/sopp/

Sweden

Svengunnar Ryman och Ingmar Holmåsen. (1992) Svampar, en fälthandbok. Interpublishing, Stockholm. xnd Edition. 718 sidor.

Pelle Holmberg & Hans Marklund (2009) Nya Svampboken. 5:e editionen. Prisma. 253 sidor.

Henning Knudsen & Jens H Petersen. (2003) Bonniers svampbok. Albert Bonniers Förlag. 311 sidor.

Klas Jaederfeldt (2003) Tickboken. Sverige Mykologiska Förening, Stockholm. 325 sidor.

Bo Nylén (2005) Svampar i skog och mark. Prisma. 343 sidor.

Bo Nylén (2007) Våra matsvampar. Natur och Kultur. 191 sidor.

Lohmeyer, R. & Künkele, U. (2008) Svampar – plockning och artbestämning. Parragon Books Ltd. 256 sidor.

Annex IV Labelling and contaminants

In this Annex more details are given on the legislation on labelling and on contaminants, in particular on radiocaesium after the Chernobyl accident. These specific issues have earlier raised specific problems in trade with mushrooms.

Labelling

Mushrooms are special concerning labelling. Some species do not have names in national languages and it is quite common that mushrooms are sold as mixtures of fresh or mixtures of dried mushrooms, the latter frequently being imported. It is important to identify the content, not only for safety reasons but also for labelling purposes.

In Finland according to the national legislation it is not allowed to mix different mushroom species in one lot. Mushrooms sold fresh have to be in a condition that allows identification of the species.

Examples on inadequate or misleading labelling identified in the Danish control campaign in 2010 included

- A mixture of dried mushrooms was called "Forrest mushrooms" although the content was dried cultivated Button Mushroom
- "Dried Mixed Ceps" were in reality dried cultivated Button Mushroom
- Ordinary Button Mushrooms sold as "Portobello"

The legislation requires labelling and the way it is done must not mislead the purchaser (Article 2, point 1).[12] Labelling of mushroom products should include the following information (non-exhaustive list):

- Name under which the product is sold
- List of ingredients

[12] European Parliament and Council Directive 2000/13/EC, Corrigenda of 20 March 2000.

- The quantity of certain ingredients or categories of ingredients as provided for in Article 7
- In the case of pre-packaged foodstuffs, the net quantity.
- The date of minimum durability or, in the case of foodstuffs which, from the microbiological point of view, are highly perishable, the "use by" date
    - Any special storage conditions or conditions of use.
    - The name or business name and address of the manufacturer or packager, or of a seller established within the Community.
    - Particulars of the place of origin or provenance where failure to give such particulars might mislead the consumer to a material degree as to the true origin or provenance of the foodstuff
    - instructions for use when it would be impossible to make appropriate use of the foodstuff in the absence of such instructions

Exceptions:

- Ingredients need not be listed in the case of fresh fruit and vegetables, which have not been peeled, cut or similarly treated (Article 6, point 2)
- Indication of the durability date shall not be required for fresh fruit and vegetables, which have not been peeled, cut or similarly treated (Article 9, point 5)

Where foodstuffs are offered for sale to the ultimate consumer or to mass caterers without pre-packaging, or where foodstuffs are packaged on the sales premises at the consumer's request or pre-packaged for direct sale, the Member States shall adopt detailed rules concerning the manner in which the particulars specified in Article 3 and Article 4(2) are to be shown. They may decide not to require the provision of all or some of these particulars, provided that the purchaser still receives sufficient information (Article 14).

"Final, packaged food" is defined as 'pre-packaged foodstuff' and mean any single item for presentation as such to the ultimate consumer and to mass caterers, consisting of a foodstuff and the packaging into which it was put before being offered for sale, whether such packaging encloses the foodstuff completely or only partially, but in any case in such a way that the contents cannot be altered without opening or changing the packaging.

Contaminants

Mushrooms can be contaminated from many sources, most notably the environment, but also from processing, from degradation and spoilage and from food contact materials like packaging materials.

The most common contaminantes of concern in mushrooms are:

- Toxic metals
- Process contaminants and contaminants from food contact materials
- Pesticides (including nicotine)
- Radioactive isotopes

Toxic metals

The maximum levels of contaminants in foods are set by the Regulation (EC) No 1881/2006 on maximum levels for certain contaminants in foodstuffs.

Regarding wild and cultivated mushrooms the Regulation regulate the level of lead and cadmium, and to the level of tin in canned mushrooms. The European Commission has set limits for cadmium in a series of food items, including a maximum limit of 1.0 mg per kg fresh weigh for mushrooms, except for the most frequently traded mushrooms Button Mushroom (*Agaricus bisporus*, Oester Mushroom (*Pleurotus ostreatus)* and Shiitake (*Lentinula edodes*) for which a limit of 0.20 mg per kg fresh weight for has been set (EU Commission, 2006).

Canned foods other than beverages can not contain more than 200 mg/kg fresh weight of tin.

Some mushrooms bioaccumulate metals and minerals from the soil and can contain very high amounts. This is the case for example for cadmium and some countries, like e.g. Denmark, therefore advice not to eat these bioaccumulating mushrooms.

A minor control project in Denmark published in 2009 showed that 6 samples out of 38 exceeded the maximum levels for lead and cadmium, and 3 had a level of mercury above the action level set particularly for the control activity (Danish Veterinary and Food Administration, 2009). The species investigated in this control activity were: *Agricus bisporus, Pleurotus ostrreatus, Lentinula edodes, Boletus edulis, Cantharellus cibarius* and a few other species. Three Norwegian control activities can be mentioned. The first of these were made in 2002 on 137 samples from all over Norway of wild mushrooms analysed for cadmium and lead (Mattilsynet, 2002). The mushrooms sampled included the ten most common species of mushrooms. There was a large variation in the average level of cadmium and lead between the groups of mushrooms. The highest average content of cadmium was found in The Gypsy (*Cortinarius caperatus*) with an average content of 0.777 mg/kg fresh weight. Four of the Gypsy samples contained at least 1 mg cadmium/kg fresh weight. The highest content of lead was found in Yellow Swamp Brittlegill (*Russula claroflava)* with an average contained 0.115 mg/kg fresh weight. In a latter study 12 samples of wild mushrooms collected from areas in Norway with potential environmental contamination were examined for the lvel of mercury, cadmium, lead, cupper, manganese, chromium and arsen. In this study the levels of the analysed metals did not raise safety concern (Mattilsynet, 2006). More recently, 18 samples of fresh mushrooms purchased in 2011 and 14 samples of canned mushrooms were analysed for heaby metals. Although the data of this control activity has not yet been published, four of the fresh and dried mushroom samples contained cadmium levels close to the maximum level for cultivated mushrooms, two of the fresh samples also containe lead over the maximum limit and four samples of canned mushrooms contained lead close to the maximum level in the legislation on contaminants.

Process contaminants and food contact materials

Process contaminants like PAH can come from drying of mushrooms or from contamination from the enviroment. PAH have been assessed by EFSA, but there are no maximum limits in the legislation.

Food contact materials like packaging materials are potential contaminants in all foodstuffs. In EU there are general requirements for safety, also in the regulation on food contact materials.

Pesticides (including nicotine)

The maximum residue levels (MRL) for pesticide residues in mushrooms are set by the regulation (EC) No 396/2005 (EU, 2005) on maximum residue levels of pesticides in or on food and feed of plant and animal origin. There are set levels for cultivated mushrooms (common mushroom, oyster mushroom and shi-take), as well as wild mushrooms (chanterelle, truffel, morel and cep and others mushrooms).

There is a limited monitoring of mushrooms for pesticide residues in the Nordic countries. However, in Norway about one hundered samples of cultivated mushrooms have been analysed the last three years. None of the samples contained residue levels that exceeded allowed levels. Nicotine was not studied in this control activity.

Before 2008, no-one had expected to find considerable amounts of *nicotine* in mushrooms until a regional office for food control in Germany (Sigmaringen (Chemishen und Veterinäruntersuchungsamt, CVUA) in Baden Württemberg), reported that all of 26 analysed samples of dried Ceps contained considerable quantities of nicotine, between 0.22 and 5.87 mg/kg (CVUA Sigmaringen, 2008). Most of these samples were reported to come from China. When they analysed a fresh sample of Ceps from Germany, no nicotine was found, and this was claimed to be the case also after drying. CVUA also found no nicotine in fifteen samples of dried mushrooms of other species (e.g. Chanterelle, jelly ear, shiitake and oyster mushroom). This finding not only activated the retailers (customers) selling the products, but also the producers of mushroom products, the local and federal Competent Authorities in Germany, and the international spice industry.

Nicotine has for a long time been known to constitute a hazard, not least from the exposure of smokers and snuffers to the compound. However, also non-smoking consumers have a low but less known exposure to nicotine via food (Andersson et al., 2003). Food plants belonging to the nightshade family, to which the tobacco plant belongs, i.e. tomato, potato, eggplant, and pepper, are known to contain low quantities of the compound. These low levels have been shown not to raise safety concerns. Nicotine has earlier been used as insecticide in the European agricultural systems, including in organic farming. Pesticides with nicotine as the active ingredient are no longer allowed on EU farming and cultivation. Based on the historic context, nicotine is included in the pesticide legislation and at the time, in 2008, the MRL was sat at a default level of 0.01 mg/kg fresh weight for cultivated and wild mushrooms.[13] In order not to prohibit all products from being withdrawn from the market, the European Commission requested the European Food Safety Authority to risk assess the occurrence of nicotine residues in dried mushrooms. As a consequence of this risk assessment it has now been decided that the highest levels of nicotine in mushrooms allowed is (a) 0.04 mg/kg in fresh mushrooms; (b) 1.2 mg/kg in dried wild mushrooms other than ceps; and (c) 2.3 mg/kg in dried ceps (WTO, 2009).

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[13] For processed products, the MRLs set for fresh products have to be recalculated using specific processing factors. For dried mushrooms, a drying factor of 9 should be applied (accommodates for the loss of water in the drying process).

The obvious question to ask is: where does the nicotine come from? Three different scenarios appeared possible to explain the occurrence of nicotine in dried Ceps. These were: (1) application of nicotine-containing insecticides, (2) contamination of the samples with nicotine, and (3) endogenous formation of nicotine in the mushrooms. Since most samples of dried mushrooms having a high content of nicotine, came from Yunnan, a Province of China also being the centre of Chinese tobacco production, scenarios (1) and (2) were initially favoured. When it was noted that nearly all samples of dried Ceps contain nicotine, and it is fairly unlikely that Ceps processors around the world are using the same insecticidal pesticide, scenario (3) became more interesting. The cause for the high levels of nicotine in dried mushrooms has not yet been determined.

Radioactive isotopes

The accident at the nuclear power plan in Chernobyl in 1986 resulted in large areas of Europe being contaminated with radioactive caesium. However, the contamination is not uniformly distributed. In the Nordic countries, Sweden, Norway and Finland had the most severe contamination in areas where rain was falling shortly after the accident. As a consequence fishes from lakes, forrest animals, reindeer, wild berries and mushrooms contain considerable amounts of cesium-137. Today, after 25 years, the content of these contaminants are much lower in most foods originating from the wild, but mushrooms remain a problem as some species accumulate radiocaesium and the level in the mushroom can increase even many years after a fallout. In areas were contamination was high authorities still recommend mushroom collectors to be careful. If people eat wild mushrooms often, they should focus on mushrooms which do not accumulate caesium. Fortunately, cooking and discarding of the cooking water reduce the content of radiocaesium considerably (up till 80%).

Exposure of radioactivity via foods is not a problem for the general consumer in the Nordic countries, but exposure can be high for consumers that heavily rely on consuming products from nature such as reindeer meat, mushrooms and berries.

Within EU there is a consolidation of existing Regulations governing the admissibility for consumption of foodstuffs (Council Regulation (Euratom) No 3954/87; Commission Regulation (Euratom) 944/89) and of feedstuffs (Regulation (Euratom) nr 770/90) which have been subjected to radioactive contamination. In the EU maximum limits of total cesium (and some other isotopes) in food, including mushrooms is 400 Bq/kg i baby foods, 1000 Bq/kg in dairy products, and liquid foodstuffs, and 1,250 Bq/kg i other foodstuffs excepts minor foodstuffs. The latter are specified in the legislation (e.g. truffels) and may contain ten times higher activity levels. The maximum permitted levels laid down in the EU Regulations may be revised or supplemented in the light of expert opinion. This possibility has been used by Sweden who has other maximum limits than most EU countries after the Chernobyl accident (see section 2.8).

In the following text of this Annex, information and analytical data are compiled in order to highlight the consequenses of the Chernobyl accident on the radioactive contamination of mushrooms.

a. Mushrooms as biomarkes for fallout

It was recognised fairly early that mushrooms are suitable biomarkers for fallout of radiocaesium. In 1964, Grueter reported that these organisms selectively may enrich these radionuclides. He noted that the radioactivity in the mushrooms were higher than in the soil they were growing in. Grüter also noted that some types of mushroom, e.g. *Paxillus involutus,* were more efficient bio-accumulators of ^{137}Cs than others (Grueter, 1971). Other mushrooms, such as *Agaricus campestris,* contained nearly no radionuclides. Several investigators have confirmed that the ability to accumulate radioceasium differs between mushroom species.

b. Routes of radionucliodes into mushrooms

There are several routes for radionuclides to be transferred from the place of deposit into food chains leading up to human exposure. Regarding mushrooms, deposits of radionuclides over coniferous forest will primary contaminate tree tops. Direct deposition on mushrooms is relevant only during the active phase of contamination. Gradually the radionuclides will redistribute and eventually the majority of ^{137}Cs will be found in the organic material in the upper part of the soil. It seems like the ecosystem of forest have the lowest effective ecological half-life for ^{137}Cs compared to the other ecosystems. The reason is complex but it has to do with the status of nourishment and the absence of clay in the soil.

Natural soil constituents, like stable minerals and natural isotopes (e.g. ^{39}K and ^{40}K) are expected to be homogenously distributed in soils, whereas contaminating minerals and radionuclies are expected to occur in a gradient with highest concentrations close to the source of contamination. Regarding the fallout from the Chernobyl accident, the contaminated area is the upper soil, in particular in areas where rain brought aerosols and small particles from the plume to settle. The rate with which equilibrium is created differs between types of contamination and the environment and its ecology at the site of deposition. Mineral soil, especially clay may fix caesium, resulting in lower uptake by the mushrooms. Therefore, soil composition is an important parameter limiting uptake. Although a redistribution of radiocaesium occurs from the topsoil to the zone where the mycelium grows, the highest concentration is still found in the top layer of the soil, in the upper 0–10 cm.

The mechanism whereby radionuclides are taken up and accumulate in a mushroom is not totally elucidated but it is clear that several different chemical and physical factors affect the accumulation of radiocaesium. As mentioned above, it was recognised already in the 1960's and early 1970's that some species of mushrooms are more efficient to take up radionuclides from the environment than other species (Moser, 1972; Grüter, 1967; Rohleder, 1967a; Johnson and Nayfield, 1970; Witkamp, 1968), and this observation has been confirmed by many investigators after the Chernobyl accident. The finding was not totally unexpected as some mushroom species are well known to accumulate specific minerals and heavy metals (in the natural stable form) in their fruit bodies (Byrne et al., 1976; Bowen, 1979; Kalać and Svoboda, 2000).

c. Different forms of caesium

As caesium is found in nature in a non-radioactive form (^{133}Cs) and in two anthropogenic radioactive forms (^{134}Cs and ^{137}Cs), plants and mushrooms may take up both non-radioactive and radioactive caesium. Interestingly, the level of radiocaesium in mushrooms is much higher than the level of non-radioactive caesium.

In Europe the difference is at least one order of magnitude (Horyna and Řanda, 1988). Turkish investigators found approximately fifty times higher levels of ^{137}Cs compared to ^{133}Cs, but there was a good correlation between the levels of these two isotopes in various mushrooms from a particular region. However, the value differed between sites, most likely due to different levels of outfall. The correlation between ^{137}Cs and ^{133}Cs suggests that mushrooms take up ^{137}Cs together with stable Cs, but levels of ^{137}Cs are higher than the level of ^{133}Cs at the site of the uptake (Karadeniz and Yaprak, 2007). This is in agreement with Yoshida and Muramatsu (1998) and Horyna and Řanda (1988) that hypothesized that the higher uptake of ^{137}Cs as compared to ^{133}Cs is due to a different distribution of radioactive and non-radioactive caesium in the environment. Whereas the stable ^{133}Cs

has a fairly homogenous distribution in soil, radiocaesium mainly occur in the top soils and very slowly moves down to lower layers.

d. Bioaccumulation

Klán et al. (1988) investigated the contents of non-radioactive caesium in fruit bodies of many mushroom species collected at various places in the Czech Republic in the years 1970–1986, as well as in the soil they were growing in. The caesium level varied between 0.004 (*Agaricus campester*) and 40 (*Paxillus involutus*) mg/kg dry weight, indicating a good capacity to bioaccumulate the compound in some species. The soil-to-mushroom concentration factor for caesium varied within the range of three orders of magnitude between mushroom species, namely from 0.0008 to 1.1. The highest concentration factor for caesium was found in *Tylophilus felleus*.

The bioaccumulation of radioactivity is unlikely to be related to direct deposition or contamination, as fruit bodies developing years after a contaminating activity still accumulates activity. All evidence supports that the radionuclides, like other contaminants, are integrated into the normal ecological turnover of minerals and are later taken up by mushrooms and plants. However, the factors that govern the rate of the turnover of the radionuclides are not that well understood.

The most important factor affecting the concentration of radiocaesium in mushrooms is of course the concentration of radiocaesium in soil where it grows (Fraiture et al., 1990; Heinrich, 1992). Thus, mushrooms from countries with a high deposition of activity from the Chernobyl accident contain higher acitivity concentrations of radiocaesium than mushrooms from countries with a low deposition. This does not imply that all species of mushrooms in contaminated countries bioaccumulate radiocaesium. Nikolova et al. (1997) compared the ^{137}Cs content in a cluster of mushrooms of the same species with the ground deposition in the corresponding area. In the three species investigated between 13% and 64% of the estimated ^{137}Cs ground deposition in the corresponding area could be recovered in the fruit bodies: (*Cortinarius armillatus* (13–34%), *Cortinarius subtortus* (21%) and *Suillus variegates* (64%)).

Many investigators have tried to identify factors of importance for bioaccumulation of radiocaesium. Factors discussed include: (1) species of mushroom; (2) type of mushroom interaction with the environment; (3) type of soil and soil pH; (4) microflora in soil; (5) type of biotope; and (6) others (e.g. altitude at growth, and environmental pollution). It would bear too far to discuss all these factors here. However, a few comments are given to the two most important factors.

e. Types of mushroom and tissue contaminated

A likely contributing factor to the unequal bioaccumulation of radiocaesium between mushroom species is the ability of the mycelium to decompose organic substrate to produced absorbable nutrients. Mushroom can be classified into three nutritional types on the basis of the substrate from which the mycelium derives its nutrients: saprophytes, parasites and mycorrhiza-forming mushrooms or symbionts. Whereas saphrophytic mushrooms live on organic substrate and decompose it by excreting extracellular enzymes, parasitic mushrooms take their nutrients, proteins, and carbohydrates exclusively from their host plant. The symbiotic fungi form a mutual association with the fine root system of trees, called mycchoriza, which is beneficial for both organisms. The collaboration results in a huge nutrient-absorbing network of hyphea which supplies the host plant with water and nutrients. On the other hand the host plant supplies the heterotrophic fungus with carbohydrates, proteins and several other essential organic compounds. Symbionts support their host with nutrients, i.e. they take up more nutrients from the soil than they need for themselves.

Several investigators have studied whether the distribution of radiocaesium in the fruit body is homogenous, or whether some parts contain higher concentrations than others. Bakken and Olsen (1990) found skin and flesh to have very similar concentrations, whereas the spore-bearing material, the hymenium (lamella, gills and tubes), had 50–100% higher concentrations than the other parts. Muramatsu and co-workers (1991) studied 60 individual mushroom samples and noted that the concentration of both radionuclides were nearly two times higher in caps than in stalks. Studies of *Cortinarius armillatus, C. subtortus, C. mucosus*, and *Russula integra*, revealed that the cap contained between 1.6 and 3.0 times more ^{137}Cs activity than the stipe. The most extensive study was performed by Heinrich (1993), who measured the radiocaesium activity in various parts of 251 fruit bodies belonging to 89 different mushroom species. In 48% of the cases, the levels were above levels accepted for mushrooms used as food in the European Community. Nine times out of ten the cap contained higher activity than the stipe, and this finding became more and more evident the higher the activity concentration of radiocaesium was. Summarizing the data; the hymenium were found on average to be 2.3 times and the flesh of the caps 1.5 times more contaminated than the stalks.

The issue of radionuclide distribution in the fruit bodies has also been studied in cultivated *Pleurotus ostreatus* supplied ^{137}Cs in the growth medium/substrate (Tsvetnova et al., 2005). The accumulation capacity for the various mushroom tissues was: central more dense part of the stipe<stipe<mycelium<cap<generative tissues. Other investigators coming to similar conclusions include Bystrzejweska-Piotroska et al. (2005), and Baeza et al. (2006). Although several investigators have suggested that ^{137}Cs is bound to dark pigments in the skin of the cap, no conclusive data on this hypothesis have appeared.

f. Cæsium^{137} levels in Nordic mushrooms 1986–2008

Data on acitivity levels of radiocaesium in Nordic mushroom is scattered and fairly limited for mushrooms from some regions. No information was available on mushrooms from Iceland and only limited data on mushrooms from Denmark. These were also the two Nordics countries least affected by the Chernobyl accident.

Finland

The deposition of^{137}Cs from the Chernobyl accident was very unevenly distributed in Finland with ^{137}Cs levels varying from 1,000 Bq/m^2 in some areas up to 78,000 Bq/m^2 in others (Arvela et al., 1990). However, the deposition was very high compared to most other countries in Europe. To simplify national management, the fallout of ^{137}Cs in Finland has been graded into five different deposition levels.

Kostiainen (2007) collected more than 600 mushroom samples belonging to 20 mushroom species during the period 2000–2005. The range in radiocaesium activity in this extensive material was from 10 up to 9,000 Bq/kg dry weight.[14] The variation in ^{137}Cs activity in any given species sampled from the same site was at most two- to fivefold. The variation in ^{137}Cs levels of different mushroom species sampled at the same site was at most tenfold. The ^{137}Cs levels in the caps of mushrooms were 1.2–3.3 times higher than in the stems of the mushrooms. Low activities were found in species of *Leccinum* and *Gyromitra*, and in *Scutiger ovinus*, medium activity in *Boletus edulis, Cantharellus cibarius* and *Russula* species, and higher activity in for example *Cantharellus tubaeformis, Craterellus cornucopioides*, *Lactarius* species, *Hydnum* species, *Suillus variegates* and *Rozites caperatus*. The aggregated transfer coefficients of ^{137}Cs from soil to mushrooms were multi-fold as compared with those for wild berries and game meat (feed on mushrooms in the au-

[14] The dry weight value may be dived by 10 to obtain an approximate fresh weigh value.

tumn), and it differed between different mushroom species. During the six-year period no significant reduction in the ^{137}Cs levels were observed in berries, mushrooms or game meat. It was concluded that the variability in ^{137}Cs levels between successive years, even at the same sampling sites, were so large that longer study

Table 3. Amount of ^{137}Cs in mushroom samples (Bq/kg dry weight*) collected in Finland in 1998 or 2003 (STUK, 1998; Sazén and Ilus, 2008). Number of samples was not stated

Species	Year	Geographical site	^{137}Cs
Boletus edulis	1998	Six sites[15]	180–10,210
Boletus felleus	2003	Siikajärvi	29,500
Boletus reticulosus	2003	Vehkajärvi	1,220
Cantharellus cibarius	1998	Eight sites[16]	30–9,910
Cantharellus cibarius	2003	Siikajärvi	6,060*
Cantharellus tubaeformis	1998	Four sites[17]	2,850 –15,130
Craterellus cornucopioides	1998	Kirkkonummi	2,130
Craterellus cornucopioides	2003	Vehkajärvi	4,000
Gyromitra esculenta	1998	Kangasniemi	470
Hydnum repandum	1998	Three sites[18]	940–50,180
Hydnum rufescens	1998	Kirkkonummi	410
Hygrophorus camarophyllus	1998	Kirkkonummi	9,630
Lactarius helvus	2003	Siikajärvi	9,590
Lactarius rufus	1998	Eleven sites[19]	110–26,680
Lactarius rufus	2003	Siikajärvi	37,700
Lactarius scrobiculatus	1998	Luopioinen	7,410
Lactarius torminosus	1998	Four sites[20]	160–40,760
Lactarius trivialis	1998	Eleven sites[21]	1,830–62,720
Lactarius trivialis	2003	Siikajärvi	27,000
Lactarius turpis	1998	Sysmä	5,160
Leccinum holopus	1998	Kirkkonummi	1,210
Leccinum scrabrum	1998	Vantas	200
Leccinum scabrum	2003	Vehkajärvi	6,100
Leccinum scabrum	2003	Siikajärvi	36,100
Leccinum versipelle/vulpinum	1998	Five sites[22]	145–3,810
Leccinum vulpinum	2003	Siikajärvi	5,080
Lycoperdon periatum	1998	Helsinki	n.d.
Pholiota mutabilis	2003	Siikajärvi	13,700

*Converted from fresh weight to dry weight by multiplying with 10

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[15] Lieksa, Honkajoki, Krikkonummi, Alavus, Luopioinen, Mänttä.

[16] Ikaalinen, Kirkkonummi, Kangasniemi, Ruovesi, Renko, Padasjoki, Härmeenlinna, Mänttä.

[17] Kullaa, Härmeenlinna, Luopioinen, Lappi.

[18] Lohja, Kirkkonummi, Luopioinen.

[19] Ristiina, Kirkkonummi, Kokkola, Helsinki, Honkajoki, Asikkala, Renko, Sysmä, Ikaalinen, Padasjoki, Alavus.

[20] Helsinki, Luopioinen, Padasjoki, Mänttä

[21] Helsinki, Kirkkonummi, Sulkava, Lohja, Alavus, Honkajolki, Ikaalinen, Kangasniemi, Lupioinen, Mänttä, Padasjoki.

[22] Kirkkonummi, Lieksa, Luopioinen, Kokkola, Honkajoki.

Table 3. cont Amount of ^{137}Cs in mushroom samples (Bq/kg dry weight*) collected in Finland in 1998 or 2003 (STUK, 1998; Sazén and Ilus, 2008). Number of samples was not stated

Species	Year	Geographical site	137Cs
Ramaria flava	1998	Two sites[23]	3,840–15,720
Rozites caperatus	1998	Three sites[24]	380 –21,010
Russula aeruginea	2003	Siikajärvi	19,000
Russula claroflava	2003	Siikajärvi	12,300
Russula decolorans	2003	Vehkajärvi	13,800
Russula integra	2003	Siikajärvi	20,500
Russula paludosa	2003	Vehkajärvi	14,200
Russula rhodopoda	2003	Siikajärvi	28,100
Russula vinosa	2003	Vehkajärvi	6,940
Russula vinosa	2003	Siikajärvi	13,600
Scutiger ovinus	1998	Four sites[25]	110–2,580
Suillus bovinus	1998	Two sites[26]	740–1,210
Suillis bovinus	2003	Vehkajärvi	41,100
Suillus variegatus	1998	Five sites[27]	3,980 – 21,840
Tricholoma flavovirens	1998	Kirkkonummi	250

*Converted from fresh weight to dry weight by multiplying with 10 periods are needed to detect the slow changes in activity concentrations of ^{137}Cs in forest environments.

Additional information on radiocaesium content in mushrooms was obtained from ecologically oriented studies. Thus, in a study on the transfer of ^{137}Cs to fish, lake environments were studied, including eighteen species of mushrooms (Saxén and Ilus, 2008). The lakes studied were Siikajärvi and Vehkajärvi in the central southern part of Finland. In the Siikajärvi area the soil deposition of radiocaesium was around 34,000 Bq/m^2, whereas in the Vehkajärvi area the soil composition was considerably higher – around 60,000 in one measurement and 93,000 in another. These soil deposition data indicate the scattered nature of the Chernobyl fallout. All examined mushroom samples showed very high ^{137}Cs concentrations (Table 3). The highest amount ^{137}Cs were found in *Suillus bovinus* (41,100 Bq/kg dry weight), *Lactarius rufus* (37,700 Bq/kg dw), *Boletus felleus* (29,500 Bq/kg dw), and *Russula rhodopoda* (28,100 Bq/kg dw). The lowest ^{137}Cs concentration was found in *Boletus reticulosos* (1,220 Bq/kg dw). With exception of the species *Suillus bovinus*, the transfer factors were generally higher around lake Siikajärvi than around Vehkajärvi.

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[23] Kirkkonummi, Luopioinen.

[24] Kirkkonummi, Alavus, Kangasniemi.

[25] Kirkkonummi, Helsinki, Kangasniemi, Luopioinen.

[26] Kirkkonummi, Honkajoki.

[27] Kirkkonummi, Vantaa, Asikkala, Rouvesi, Honkajoki.

STUK, the radiation nuclear safety authority in Finland, started a surveillance program of Finish mushrooms in 1986 and reported the results in 2010. In 2008, the ^{137}Cs concentrations had decreased by 40% compared to the highest concentrations recorded in many species in 1987–88. The concentrations were species dependent, but there were still a tenfold difference in levels within the highly radiocaesium bioaccumulating species, e.g. *Rozites caperatus, Hygrophorus camarophyllus* and *Lactarius trivialis*, compared to species with low uptake e.g. *Albatrellus ovinus* and *Leccinum sp*. Many edible mushroom species still exceed the permitted level at 600 Bq/kg fresh weight. Therefore, except for *Albatrellus ovinus*, *Boletus sp*. and *Cantharellus cibarius*, mushrooms should still be measured for ^{137}Cs content before being placed on the market. However, cooked and salted mushrooms seldomly exceeded the permitted levels. Therefore, the annual dose recived from ^{137}Cs in mushrooms is low. An average Finnish consumer receives a dose between 1.5–5 μSv and a heavier consumer between 5.4–38 μSv, which are non-dangerous levels (Kostiainen and Ylipieti, 2010).

Sweden

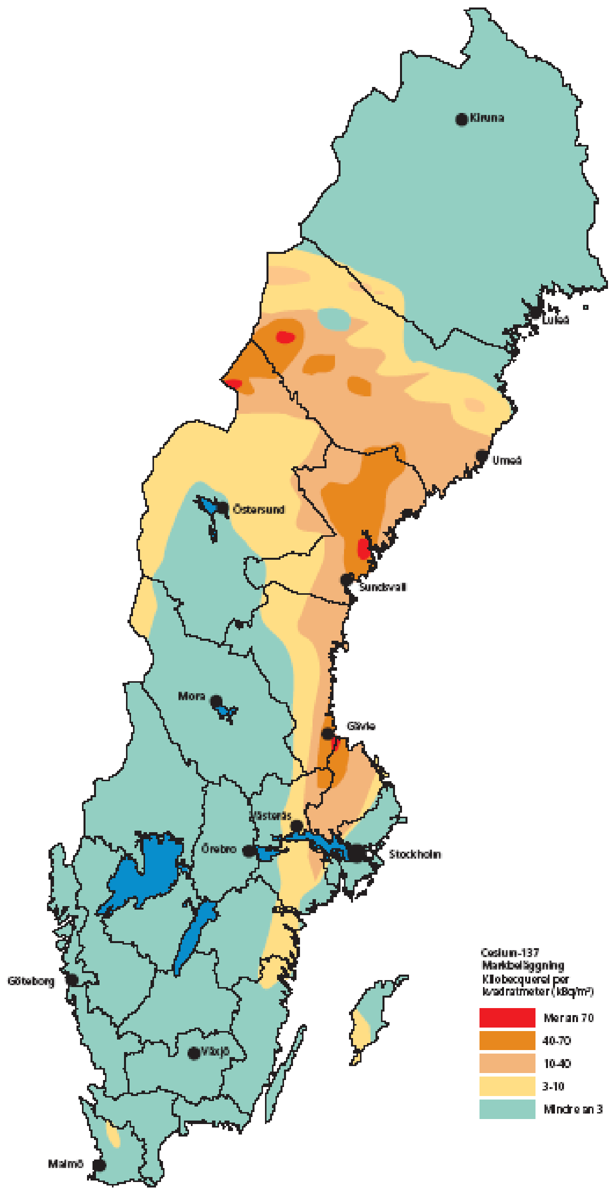
The radioactive deposition of ^{137}Cs from the Chernobyl accident in Sweden is shown in Figure 2. High activity concentrations were measured in the middle and south part of Norrland, from Västerbotten down to Uppland and Västmanland. The highest dose levels were found in Gästrikland/Hälsingland but there are large differences and local variations in the fallouts (Figure 2). The deposition mainly contained isotopes of cesium (^{134}Cs, ^{137}Cs) and iodide (^{131}I, ^{129}I), but also smal quantities of ^{90}Sr and ^{132}Te (Yablokov and Nestrenko, 2009). The National Food Administration in Sweden analyzed many different food products from different parts of the country in 1986. Most of the mushroom samples were *Cantharellus cibarius*, and most of the samples contained activity concentrations of ^{137}Cs between 100 and 1000 Bq/kg fresh weight which was below the limit value of 1,500 Bq/kg fresh weight established for most Swedish foods after the accident. Only a few samples reached values above the limit value. *Cantharellus tubaeformis* showed high concentrations, with one sample reaching 28,758 Bq/kg. The popular edible *Boletus edulis* showed low activities, most of the samples below 100 Bq/kg fresh weight.

Most of the additional data on ^{137}Cs activity concentrations in mushroom come from the Department of Radioecology at the Swedish University of Agricultural Sciences. The studied mushrooms were mainly collected from two areas in the middle-east part of Sweden – from Gästrikland/Hälsingland, where the radioactive deposit reached very high levels, and from Northwestern Uppland.

Shortly after the accident in Chernobyl, during May to November 1986, about 9000 samples of plants, mushrooms, or animals were taken in different parts of Sweden to determine the extent of contamination in Sweden. Highest ^{137}Cs levels were found in reindeer, freshwater fish and mushrooms. In mushrooms, the variation in activity levels between samples and species was large. In some cases ^{134}Cs was totally absent in the sample, which led to the conclusion that "old" fallout of ^{137}Cs from the nuclear weapon testing was the cause of the contamination in some cases and not the Chernobyl accident, especially in forests where the "umbrella effect" of the trees made the deposition very inhomogeneous (Mascanzoni, 1987).

A study published in 1992 presented data on 383 samples (22 species) of edible mushrooms collected between June and September in 1986 and analysed for radiocaesium (Mascanzoni, 1992). There was a large variation in activity concentrations between samples; *Agaricus arvensis* on average contained 360 Bq/kg dw, whereas *Rozites caperata* contained 1,154,110 Bq/kg dw. In some samples of these mushrooms also ^{90}Sr could be identified, as for example in *Lactarius deterrimus* (2.68 Bq/kg dw). An increase in the concentration of ^{137}Cs in many mushroom species from 1986 to 1988 was observed.

Figur 2. The radioactive deposition of ^{137}***Cs in Sweden. The map is based of measurements from SGAB and show the situation on 26 April 1986. Det radioaktiva nedfallet av cesium-137 i Sverige efter kärnkraftsolyckan i Tjernobyl den 26 April 1986. The map is taken from Vår Föda (1996)***



In August 1992, the environmental behaviour of the deposited Chernobyl fallout in a spruce forest in the central part of Sweden was investigated (McGee et al., 2000). The mean deposition of ^{137}Cs was 54,000 Bq/m^2. It was estimated that 95% of the ^{137}Cs in the Swedish forests originates from the Chernobyl plum. 87% was found in soils, 6% in the bryophyte layer and 7% in standing biomass of trees. Mushrooms contained between 840 (*Suillis veriegatus*) and 162,000 (*Cortinarius collinitus*) Bq ^{137}Cs/kg, respectively. It was estimated that not more than about 1% of the total ^{137}Cs fallout in Sweden could be found in fungal fruit bodies, forest floor vegetation and ruminant populations. However, many food products of these sources exceed the action limit for foods of 1500 Bq/kg fw for wild products produced in Sweden (McGee et al., 2000).

In a long-term study performed between 1988 and 2001, Karl Johan Johanson and co-workers measured the activity concentrations of 25 different mushroom species collected in a forest in Heby, about 40 km north-west of Uppsala (Johanson, personal communication). The ^{137}Cs deposition in the studied area was between 35,000 and 40,000 Bq/m^2 and relatively small variations in depositions were found between localities within the studied area. The activities varied between mushroom species. Low levels, between 5,000 and 10,000 Bq/kg dw, were found in *Albatrellus confluens*, *Albatrellus ovinus* and *Boletus edulis*. Rather high levels, more than 50,000 Bq/kg dw were found in *Paxillus involutus, Rozites caperata*, and some *Lactarius* and *Cortinarius* species. It was noted, however, that the variation in activity concentration was very large in most species, partly due to different time of harvest and mushrooms having been harvested from different localities. For example, clusters of 10–20 fruit bodies of *Cantharellus tubaeformis* collected within an area of only one dm^2 showed very large variations in activities between individual fruit bodies, although they presumably were produced from the same mycelium. The extensive variation in radioceasium content between fruit bodies makes it difficult to draw general conclusion whether an increase or decrease in the ^{137}Cs activity in a species over time occurs. However, it is possible to discuss trends. During the investigated period, the *Lactarius* species showed a trend of increased radiocaesium content, but more samples need to be measured to confirm if the trend is significant or not. The most clear decreasing trends in ^{137}Cs activity were observed in *Suillus variegates* and *Russula decolorans*. The two most popular collected edible mushrooms in Sweden, *Cantharellus tubaeformis* and *Cantharellus cibarius* showed quite low levels. The data on Karl-Johan Johansson and other are shown in Table 5.

Table 5. Amount of ^{137}Cs in mushroom samples (Bq/kg dry weight) collected in Sweden between 1986 and 2001. n.s. = not stated; *p.c. = personal communications

Species	Year	Geographical site	Samples	Reference	^{137}Cs (Bq/kg)
Albatrellus confluens	1995	Heby	4	p.c.* (Johansson)	7 044
Albatrellus ovinus	1990–98	Heby	3-14/year	p.c. (Johansson)	3 766- 8 620
Albatrellus ovinus	1989	Järlåsa	n.s.	p.c. (von Hofsten)	2 706
Amanita fulva	1991	Hille	5	Guillitte et al., 1994	52 000
Amanita muscaria	1988–89	Järlåsa	n.s.	p.c. (von Hofsten)	129 – 890
Amanita pophyria	1988–1989	Järlåsa	n.s.	p.c. (von Hofsten)	8 950 – 12 064
Amanita pophyria	1991	Hille	1	Guillitte et al., 1994	140 000
Amanita rubscens	1991	Hille	1	Guillitte et al., 1994	55 000
Boletus baduis	1991	Hille	2	Guillitte et al., 1994	390 000
Boletus edulis	1992–2001	Heby	2-9/year	p.c. (Johansson)	234 – 8 145
Boletus edulis	1992–2001	Hille	2-9/year	Guillitte et al., 1994	48 000
Boletus edulis	1992–2001	Läby	n.s.	Smith et al., 1993	41 700
Cantharellus cibarius	1990–1997	Heby	3-9/year	p.c. (Johansson)	1 407 – 16 696
Cantharellus cibarius	1989	Järnlåsa	n.s.	p.c. (von Hofsten)	23 113
Cantharellus cibarius	1992	Marbäck	10	p.c. (von Hofsten)	16 885
Cantharellus cibarius	1991	Hille	4	Guillitte et al., 1994	65 000
Cantherellus cibarius	1991	Läby	n.s.	Smith et al., 1993	11 600
Cantharellus lutescens	1991	Hille	3	Guillitte et al., 1994	277 000
Cantharellus tubaeformis	1992–2001	Heby	3-9/year	p.c. (Johansson)	25 938 – 39 815
Cantharellus tubaeformis	1988–1992	Marbäck	7	p.c. (von Hofsten)	21 900 – 45 141
Chroogomphus rutilus	1991	Hille	2	Guillitte et al., 1994	93 000
Cirtinarius brunneus	1991	Hille	2	Guillitte et al., 1994	435 000
Clitocybe clavipes	1991	Hille	2	Guillitte et al., 1994	260 000
Coltricia perennis	1991	Hille	2	Guillitte et al., 1994	9 000
Cortinarius armeniacus	1997	Heby	4	p.c. (Johansson)	46 079
Cortinarius armillatus	1992	Heby	12	Nikolova, 1996	411
Cortinarius armillatus	1992–1993	Heby	3-8/year	p.c. (Johansson)	127 234 – 160 109
Cortinarius collinitus	1989	Heby	n.s.	p.c. (von Hofsten)	98 949 – 248 740
Cortinarius collinitus	1990–1997	Heby	3-8/year	p.c. (Johansson)	182 547
rtinarius integerrimus	1990	Heby	4	p.c. (Johansson)	64 007
Cortinarius semisanguineus	1990–1998	Heby	3-5/year	p.c. (Johansson)	80 654 – 179 430
Cortinarius subtortus	1992	Heby	6	Nikolova, 1996	571
Cortniarius collinitus	1989	Järnlåsa	n.s.	n.s.	182 547
Cortinarius telemonia	1997–1998	Heby	4/year	p.c. (Johansson)	70 495 – 91 255
Dermocybe cinnamomea	1991	Hille	1	Guillitte et al., 1994	950 000
Dermocybe sanguineus	1991	Hille	1	Guillitte et al., 1994	340 000
Gomphidius glutnosus	1991	Hille	1	Guillitte et al., 1994	72 000
Gomphidus glutinosus	1989	Järnlåsa, Sweden	n.s.	p.c. (von Hofsten)	6 004
Gymnopilus penetrans	1991	Hille	1	Guillitte et al., 1994	180 000
Gyromitra esculenta	1990, 1991, 1986	Östersund	n.s.	Smith et al., 1993	1 150
Gyromitra esculenta	1990, 1991, 1986	Ammarnäs	n.s.	Smith et al., 1993	1 280
Hydnim repandum	1991	Hille	3	Guillitte et al., 1994	317 000
Hydnum repandum	1988	Järnlåsa	n.s.	p.c. (von Hofsten)	15 500
Hygrophoropsis aurantiaca	1991	Hille	2	Guillitte et al., 1994	239 000
Hygrophorus olivaceoalbus	1991	Hille	1	Guillitte et al., 1994	110 000
Keuhn mutabilis	1992–1998	Heby	1-7/year	p.c. (Johansson)	6348-17 325,
Lactarius camphoratus	1991	Hille	6	Guillitte et al., 1994	373 000
Lactarius helvus	1991	Hille	1	Guillitte et al., 1994	17 000
Lactarius rufus	1990–2001	Heby	3-10/year	p.c. (Johansson)	20 662 – 60 654
Lactarius rufus	1992	Marbäck	8	p.c. (von Hofsten)	37 189
Lactarius rufus	1991	Hille	1	Guillitte et al., 1994	76 000
Lactarius theiogalus	1991	Hille	1	Guillitte et al., 1994	340 000
Lactarius trivialis	1988, 1989	Järnlåsa	n.s.	p.c. (von Hofsten)	14 100 – 122 893
Lactarius vietus	1992	Heby	6	p.c. (Johansson)	55 117
Leccinum scabrum	1997	Heby	9	p.c. (Johansson)	8 808
Lycoperdon perlatum	1989	Järnlåsa	n.s.	(von Hofsten)	123
Lycoperdon perlatum	1991	Hille	1	Guillitte et al., 1994	5 000
Marasmius scorodonius	1988	Järnlåsa	n.s.	p.c. (von Hofsten)	2 540
Paxillus atratomentosus	1991	Hille	1	Guillitte et al., 1994	210 000
Paxillus involutus	1990–1997	Heby	1-8/year	p.c. (Johansson)	46 540 – 101 972

Species	Year	Geographical site	Samples	Reference	^{137}Cs (Bq/kg)
Paxillus involutus	1992	Marbäck	5	p.c. (von Hofsten)	7 490
Paxillus involutus	1991	Hille	2	Guillitte et al., 1994	172 000
Ramaria invalii	1991	Hille	1	Guillitte et al., 1994	14 000
Rozites caperata	1992	Heby	7	p.c. (Johansson)	195 921
Russula aeruginosa	1991	Hille	1	Guillitte et al., 1994	22 000
Russula atropurpurea	1991	Hille	1	Guillitte et al., 1994	83 000
Russula decolorance	1990–1997	Heby	3-7/year	p.c. (Johansson)	21 447 – 42 625
Russula decolorans	1989	Järnlåsa	n.s.	p.c. (von Hofsten)	38 999
Russula decolorans	1992	Marbäck	3	p.c. (von Hofsten)	37 027
Russula decolorans	1991	Hille	6	Guillitte et al., 1994	115 000
Russula foetus	1997	Heby	3	p.c. (Johansson)	2 199
Russula integra	1991	Hille	1	Guillitte et al., 1994	55 000
Russula paludosa	1990–1997	Heby	2	p.c. (Johansson)	16 325 – 44 696 34 721
Russula paludosa	1992	Marbäck	9	p.c. (von Hofsten)	11 519
Russula paludosa	1991	Hille	1	Guillitte et al., 1994	280 000
Russula vasca	1991	Hille	3	Guillitte et al., 1994	42 000
Russula veternosa	1991	Hille	1	Guillitte et al., 1994	55 000
Russula vinosa	1990	Heby	3	p.c. (Johansson)	39 714
Russula xerampelina	1989	Järnlåsa	n.s.	p.c. (von Hofsten)	28 792
Sarcodon imbricatus	1988	Järnlåsa	n.s.	p.c. (von Hofsten)	3 520
Sparassis crispa	1988	Järnlåsa	n.s.	p.c. (von Hofsten)	888
Suillus luteus	1991	Hille	1	Guillitte et al., 1994	140 000
Suillus variegatus	1990–2001	Heby	3-110	p.c. (Johansson)	42 794 – 103 650
Suillus variegatus	1989	Järnlåsa	n.s.	p.c. (von Hofsten)	56 534 – 70 755
Suillus variegatus	1992	Marbäck	7	7	100 867
Suillus variegatus	1991	Hille	3	Guillitte et al., 1994	177 000
Suillus variegatus	1986–1998	Heby	6-14/year	Mascanzoni, 2001	69 900 – 119 500
Trichloma portenosum	1988	Järnlåsa	n.s.	p.c. (von Hofsten)	900
Tricholoma flavovirens	1988	Järnlåsa	n.s.	p.c. (von Hofsten)	36 200
Tricholomopsis rutilans	1991	Hille	1	Guillitte et al., 1994	180 000
Tylopilus felleus	1991	Hille	10	Guillitte et al., 1994	139 000

Also Mascanzoni (2001) studied the activity concentration of ^{137}Cs in mushrooms over time (1986-1998) in the region of Heby, Uppland (ground deposition about 35000 Bq/m^2). *Suillus variegates* showed constant levels during the period, around 100 000 Bq/kg dw, whereas the activity concentration increased moderately in *Cantharellus* spp. from 10 900 to 26 000 Bq/kg dw.

Guillitte et al. (1994) investigated 39 species of macromycetes, 33 plant species and a non-specified number of humus samples taken from the sites where the mushrooms and plants were collected, in an attempt to understand the mechanism governing the transfer and retention of radiocaesium. The mushrooms were collected in Hille, close to the city of Gävle, in 1991 and concentrations varied between species – from 5 000 Bq/kg dw in *Lycoperdon perlatum* to 950 000 Bq/kg dw in *Dermocybe cinnamomea*. From the humus studies it was concluded that up to 40% of the radiocaesium could be retained by the microflora in the soil and by the mycelia of mushrooms.

Potassium fertilization is usually an efficient method to reduce the soil to plant uptake of radiocaesium. Karl Johan Johanson and co-workers studied to what extent potassium fertilization reduce the ^{137}Cs uptake in plants and in fruit bodies of mushrooms. In these studies it was noted that the activity concentration in *Lactarius rufus* was reduced by remarkably 94% by potassium fertilization (Johanson, personal communications). Thus, potassium fertilization could be more efficient in forest ecosystem than in agricultural systems. Apparently, the reduction persists for quite a long time but further studies are required to confirm this observation.

In an attempt to get a better estimation of the potential transfer of ^{137}Cs from the forest ecosystem to man, Johanson and co-workers studied the food materials berries, mushrooms and game animals. The transfer of ^{137}Cs and corresponding time-integrated dose commitment for the Swedish population for berries and game animals were estimated to 1500 and 2000 manSv, respectively (Johanson and Bergström, 1994; Johanson and Kardell, 1996). A similar estimation of the contribution from mushrooms turned out to be difficult against the background of lacking knowledge of the consumption rate of various species of fungi. Introducing several additional assumptions regarding the use of mushrooms in the human diet, the investigators roughly estimated the potential transfer and time-integrated dose commitment for mushrooms to at least 4000 manSv (Nikolova et al., 1997).

McGee et al. (2000) investigated the radiation doses due to dietary ^{137}Cs from samples collected in 1992. The estimation was based on average annual consumption rates in Sweden of 4.5 kg wild berries, 2.8 kg of wild mushrooms and 0.5 kg of game (Skogsstyrelsen, 1993) and data taken from Aarkrog (1994) to calculate the individual dose per unit deposition of ^{137}Cs. The people in the investigated area were found likely to receive a time-integrated (to infinity) dose of 5 mSv from consumption of wild foodstuff contaminated by ^{137}Cs, with an additional 1 mSv from other dietary products. The dose received by critical group consumers may be up to 84 mSv or higher.

In the autumn 1997 and the spring 1998, Ågren (2001) investigated whole body content of ^{137}Cs in adults from Swedish hunter families in the area around Gävle. These had been studied four years earlier. Hunters normally consume high quantities of food products from the forest ecosystem which could be highly contaminated with ^{137}Cs compared to other food products. It is not known to what extent mushroom consumption contributed to the exposure. The result showed that ^{137}Cs whole-body content had decreased from 43 Bq/kg in 1994 to 31 Bq/kg in 1998. The decrease was 37% (including physical decay) correlating to an effective ecological half time of 6 years.

Norway

In Norway the deposition of radioactivity from the Chernobyl accident took place between 28th of April and 8th of May 1986, was strongly correlated with precipitation, and was one of the highest in Europe. The surface values of radiocaesium activity reached levels above 500 000 Bq/m^2 (Backe et al., 1987) in the highland of the central and southern parts of the country. In 1996, less than 2.5% of the total radiocaesium fallout was left in the environment. Information on the reduction in soil levels of ^{137}Cs from 1986 to 1995 and 2005 is available from official environmental surveillance activities (www.environment.no).

The information on radiocaesium in Norwegian mushrooms is limited to a few scientific publications and the official environmental control orchestrated by the Norwegian Radiation Protection Authority. In 1995 Amundsen et al. (1996) collected 3-6 samples of 30 different mushroom species in central and southern Norway, and analysed the fruit bodies for their radiocaesium content (Table 6). Highest levels were found in two *Amanita* species – *Amanita fulva* (35 690 Bq/kg fresh weight) and *Amanita vaginata* (20 417 Bq/kg fresh weight) – and in *Cortinarius armillatus* (11 120 Bq/kg fresh weight). Three mushroom species were collected from the same sites during 5-7 years and the long-term behaviour of ^{137}Cs investigated. Whereas a significant decline in ^{137}Cs activity was registered for *Lactarius torminosus* grown at two different sites, no decline in ^{137}Cs activity was noted for *Leccinum versipelle* and *Rozites caperata*, although a slight reduction in the latter species was indicated.

The Norwegian Radiation Protection Authority in 2011 reported some of their data on ^{137}Cs in mushrooms collected in six counties between 2001 and 2011 (www. Environment.no). It is evident from this information that the level of radiocaesium varies considerably between mushroom species and between the site of collection. High levels were consistently found in mushrooms from Lierne in Nord-Trøndelag, whereas samples from Orkdal/Rissa (Sør-Trøndelag), Aure (Møre and Romsdal) and Folldal (Hedmark) contained lower activity levels. Highest levels of ^{137}Cs was found in Wood hedgehog (*Hydnum repandum*), 8 000 Bq/kg, Gypsy mushroom (*Rozites caperatus*), 5 400 Bq/kg, and Brown rollrim (*Paxillus involutus*), 5 300 Bq/kg. A complete report on the occurrence of radiocaesium in mushrooms from nine communities is expected from the Norwegian Radiation Protection Authority the summer 2012.

Hove et al. (1990) analysed for radiocaesium in feeds grazed by reindeer, sheep and goats in Southern Norway, and identified mushrooms as important donors of radioactivity to meat and milk, particularly during the second half of the summer when mushrooms constituted a part of the diet. According to Olsen (1994) the radioceasium content of the mushrooms was more than fifty times higher than the content in plants. Activities as high as 445 000 Bq/kg dry weight were measured for mushrooms appreciated by goats, such as *Lactarius* species (Hove et al., 1990). The availability of radiocaesium in fungal tissue for transfer to goats was tested in laboratory experiments. The transfer of ^{134}Cs from feeding freeze-dried *Rozites caperata* (10 000 Bq/kg dw) was comparable to feeding ^{134}CsCl solution, as indicated by transfer coefficients of 9% and 10% of the daily doses of radiocaesium in feed to the goat milk. The investigators concluded that radiocaesium has a high bioavailability in mushrooms. Secretion of radiocaesium into milk can be described by a two-pool system with half-lives of 3.5 and 30 days, respectively (Ekman, 1961). Thus, as the short-lived pool accounts for 60-70% of Cs excreted in milk, radiocaesium activity in milk is a sensitive indicator of radiocesium intake.

Table 6. Amount of ^{137}Cs in mushroom samples (Bq/kg dry weight) collected in Norway between 1988 and 1995. n.s. = not stated. Data from Amundsen et al. (1995) if not otherwise indicated.

Species	Year	Samples	Cs137 (Bq/kg)
Amanita fulva	1995	3-6	356 900
Amanita vaginata	1995	3-6	204 170
Cortinarius armarillatus	1995	6-12	73 020
Cortinarius armarillatus	1994	n.s.	92 000
Cortinarius cinnamomeus	1988	n.s.	96 000-158 000
Lactarius torminisus	1994	n.s.	16 000
Lactarius torminisus	1995	3-6	14 980
Leccinum deterrimus	1995	3-6	24 250
Leccinum scabrum	1994	n.s.	8 000
Leccinum scabrum	1995	6-12	18 400
Leccinum rotundifoliae	1995	3-6	12 910
Lecciunum versipelle	1995	9-18	10 570
Leccinum versipelle	1994	n.s.	6 000
Rozites caperata	1994	n.s.	70 000
Rozites caperata	1995	6-12	27 730
Rozites caperata	1988	n.s.	37 000-120 000
Russula decolorans	1994	n.s.	38 000

*recalculated from fresh weight assuming 10% dry matter
#Hove et al. (1990)

Mehli et al (2000) investigated the impact of Chernobyl fallout on the southern saami reindeer herders in 1996, which is a population group exposed to the highest levels of radioactivity in Norway. Meat of reindeers is important in their diet and a major part of the group also consumes wild food products like game, freshwater fish, mushrooms and berries. Whole body concentrations were measured to 134 ± 8 Bq/kg 137Cs corresponding to an annual average effective dose of 0.3 mSv. The result show that some individuals receiving doses close to the maximum accepted value of 1 mSv/year. Whole-body concentration was about half of the value observed in the same population in 1990-1991 and the reduction is due to physical decay, lower transfer of 137Cs to reindeer, countermeasure application and reduced intake of contaminated food.

Denmark

In Denmark the fallout of ^{137}Cs from the Chernobyl accident was small and only to a limited extent increased the already available environmental ^{137}Cs from outfall of nuclear weapon testing in the beginning of the 1960's.

The only study focusing on the contamination of various Danish mushroom species with ^{137}Cs was published by Strandberg and co-workers (Strandberg and Knudsen, 1994) – Table 7. In a follow-up study, the investigator followed the uptake of radiocaesium in *Rozites caperatus* collected at two specific sites in North Zealand, Denmark, between 1991 and 2001. *Rozites caperatus*, now known as *Cortinarius caperatus*, is an efficient bio-accumulator of radiocaesium. The first year of the study, 1991, the mushrooms contained about 13 500 Bq ^{137}Cs and 1 000 Bq ^{134}Cs per kg dry weight. Up to 1994 the ^{137}Cs concentration decreased but from then on the concentration have remained fairly constant at about 7700 Bq/kg or possibly increased to some extent. The data on time trend was interpreted as several years being required before radiocaesium from the Chernobyl fallout had penetrated deep enough in the soil to reach the mushroom mycelium. The constant or even increased levels of radiocaesium in mushrooms during the latter half of the study indicate that a pool of caesium becomes available for uptake by the mycelium at a faster rate than there is a loss due to radioactive decay (Strandberg, 2004).

Table 7. Amount of ^{137}Cs in mushroom samples (Bq/kg dry weight) collected at various regions of Northern Zealand, Denmark, between 1991 and 1992 (Strandberg and Knudsen, 1994).

Species	Year	Samples	Cs137
Cantharellus tubaeformis	1991	2	1 350-1 382
Cantharellus tubaeformis	1992	2	277-765
Hypholoma capnoides	1992	1	432
Lactarius rufus	1991	1	2 205
Lactarius rufus	1992	2	580-2 265
Russula ochroleuca	1991	2	230-680
Russula ochroleuca	1992	2	210-310
Xerocomus badius	1991	1	1 300
Xerocomus badius	1992	2	1 367-2 383

g. Food preparation

When it was recognised that mushrooms are able to enrich man-made radiocaesium, it was also asked whether bio-accumulation could be prevented, or the mushrooms treated in such a way that the radioactivity would be reduced. Studies available show that soaking and subsequently blanching mushrooms for a short period removes around one third to half of the radioactivity from the mushrooms to the soaking/blanching solution, and more extended cooking even more (Rohleder, 1967a, 1967b; Grüter, 1967; Moser, 1972; Steger et al., 1987; Neukom and Gisler, 1991). Obviously it is suitable to discard the fluid before the mushrooms are prepared, hoping that most of the aromas remain in the mushrooms. As shown by Neukom and Gisler (1991), efficient removal of radiocaesium could only be obtained when mushroom cells had been efficiently damaged, as is the case after freezing and thawing, and after drying.

h. The contribution of mushrooms to the internal radiation dose from different foodstuffs

To assess the internal exposure, detailed information on food composition is required, as well as data on the radiocaesium level of foodstuffs. Unfortunately, food composition data bases usually are not specific enough – they do not give intake information on all specific vegetables and fruits, and in particular they do not give information on consumables that are gathered by consumers themselves from the forest. As a consequence, consumption data on wild mushrooms and berries (and also most cultivated mushrooms) are frequently missing. Therefore, estimates of internal exposure are often crude estimates of the average exposure, and never or seldomly give information on the individual level. On top of that, rarely are any data available on the level of radioactivity in specific foodstuffs; the investigator frequently have to relay on older data, perhaps from similar sources. In the case of mushrooms this is not good enough.

For the general population, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 1988) concludes that the individual dose due to natural radioactivity is approximately 2.4 mSv per year, with a variation between individuals typically ranging from 1 to 5 mSv. The International Commission for Radiation Protection has defined the annual burden accepted for an adult in the public as 5 mSv. Identifying which mushroom species results in the most significant contribution to the internal dose of Nordic consumers would require a separate project.

Redlisting of treatend species.

The international standards defining The Red List of species are prepared by The International Union for Conservation of Nature (IUCN). The primary goal of the system is to provide a widely applicable and easily understood system for classifying species at high risk of extinction worldwide. However, IUCN has also developed guidelines for the use of the standards at a national level. The Red Lists in the Nordic countries are based on the standards of IUCN but adjusted to national level.

Like previous versions of the system, the current IUCN system (2011) is based on a series of categories reflecting the individual species' risk of extinction. The novelty in the system is that all plant, fungi and animal species is fitted into a category by fulfilling one or more qualitative and quantitative criteria. At the same time, there have been established a criterion documentation justifying the placement in a particular category. The following categories exists (international used abbreviations within brackets):

- Extinct (EX)
- Exist in the wild (EW)
- Critically endangered (CR)
- Endangered (EN)
- Vulnerable (VU)
- Near threatened (NT)
- Least concern (LC)
- Insufficient data / not available / not evaluated (DD)

The most recent red-lists on mushrooms in the Nordic countries are available on the following web-sites:

Denmark: http://www.dmu.dk/dyrplanter/redlistframe/

Finland: http://www.ymparisto.fi/default.asp?contentid=15166&lan=fi
http://www.ymparisto.fi/download.asp?contentid=123016&lan=fi
http://www.ymparisto.fi/download.asp?contentid=123017&lan=fi

Norway: http://www.artsdatabanken.no/Article.aspx?m=287&amid=9298

Sweden: http://www.slu.se/sv/centrumbildningar-och-projekt/artdatabanken/rodlistan/

Annex V Hypersensitivity: worker's disease and respiratory allergy

Worker's disease

A condition now known as mushroom grower's disease and characterized by allergic rhinoconjunctivitis, asthma, and hypersensitivity pneumonitis (Lehrer et al., 1994; Saikai et al., 2002; Helbling et al., 1999; Mori et al., 1998), was first described by Bringhurst et al. (1959) among workers at a mushroom farm in Pennsylvania, United States. In the initial studies, Bringhurst, co-workers and other investigators focused on the most frequently appearing effects giving respiratory symptoms (mushroom worker's lung), describing symptoms like dyspnea, cough, chills, fever, and muscle pain appearing 5-8 hours after exposure (Sakula, 1967; Craig and Donevan, 1970; Jackson and Welch, 1970; Chan-Yeung et al., 1972; Locky, 1974; Stewart, 1974; Sanderson et al., 1992). No conclusive cause of the condition was identified, but inhaled organic antigens such as thermo-tolerant fungi and actinomycetes in dried grass/hay and micro-organisms in the compost, spawning components, animal and plant proteins, and possibly spores were suggested as causative agents. Sanderson et al. (1992) analysed sera from 227 mushroom workers cultivating *Agaricus bisporus* and identified precipitin reactions mainly in subjects exposed to compost and substrates and spores. The other symptoms of the disease soon became equally important.

Early reports on mushroom grower's disease were linked to the cultivation of Shiitake but it is a clear possibility that the condition will appear whichever mushroom species will be cultivated. Table 8 shows for which mushrooms the mushroom grower's disease has been demonstrated.

Similarly, workers involved in food manufacturing may be exposed to mushroom dust giving rise to allergenicity. Baruffini et al. (2006) described a female that reacted with respiratory and skin symptoms on exposure to dust during packaging of dried ceps, whereas she had no problem consuming the mushroom, and Symington et al. (1981) described 8 workers in a factory preparing dried soup of Cep (*Boletus edulis*), and Cultivated Mushroom (*Agaricus bisporus*) showing symptoms of rhinorrhoea, dyspnoea and wheezing. Skin testing with extracts prepared from dried mushrooms were positive in five workers.

Table 8. Mushroom species for which case studies of mushroom grower's disease have been reported.

Mushroom species	Latin name	References
Shiitake	Lentinus edodes	Kondo, 1969; Shichijo et al., 1969, 1970; Sastre et al., 1990; Tarvainen et al., 1991; Matsui et al., 1992; Van Loon et al., 1992; Murakami et al., 1997; Fujiwara et al., 2000; Miyazaki et al., 2003; Kai et al., 2008; Takaku et al., 2009
Cultivated Mushroom	Agaricus bisporus	Craig and Donevan, 1970, Venturini et al., 2005
Oyster Mushroom	Pleurotus ostreatus	Zadrazil, 1973, 1974; Schulz et al., 1974a, 1974b; Hausen et al., 1974; Noster et al., 1976, 1978; Shihtai, 1983; Cox et al., 1988; Mori et al., 1998; Betz, 1990; Kamm et al., 1991; Senti et al., 2000; Vereda et al., 2007
Pale Oyster	Pleurotus pulmonalis	Helbling et al., 1999
Branching Oyster	Pleurotus cornucopiae	Michilis et al., 1991
"King Oyster Mushroom"	Pleurotus eryngii	Pleurotus eryngii) (Saikai et al., 2002; Miyazaki et al., 2003; Takaku et al., 2009
"White Beech Mushroom"	Hypsizigus marmoreus	Tanaka et al., 2000, 2002; Miyazaki et al., 2003; Tsushima et al., 2005; Takaku et al., 2009
"'Nameko"	Pholiota nameko	Nakazawa and Tochigi, 1989; Ishii et al., 1994; Inage et al., 1996; Miyazaki et al., 2003; Takaku et al., 2009
	Pezizia domicilliana	Wright et al., 1999; Takaku et al., 2009
	Tricholoma conglobatum	Akizuki et al., 1999
"'Clustered tricholoma"	Lyophyllum aggregatum	Tsushima et al., 2000, 2001
Hen of the Woods	Grifola frondosa	Tanaka et al., 2004; Takaku et al., 2009

Workers involved in mushroom production and people frequently being in mushroom growing areas have been shown to express both increased titres of immunoglobulin G (IgG) (Hausen et al., 1974; Cox et al., 1988; Michilis et al., 1991; Van Loon et al., 1992) and IgE (Lehrer et al., 1983; Butcher et al., 1987; Horner et al., 1988; Michilis et al., 1991; Helbling et al., 1993a, 1998; 1999; Senti et al., 2000; Venturini et al., 2005) in the blood. Use of protective masks during mushroom picking reduced complains of the workers but the antibody titres increased with duration of employment despite the protection.

When Lopez et al. (1985) tested fruit body and spore extract of Oyster mushroom (*Pleurotus ostreatus*) regarding skin test reactions in 48 atopic individuals, some individuals responded only to the fruit body extracts, others only to the spore extracts, which could be interpreted as spores containing some unique allergens. Similar findings were made by Weissman et al. (1987) and by Helbling et al. (1993b) in *Psilocybe cubensis*.

The specific allergens in mushrooms and mushroom spores have been described only to some detail and only in a limited number of basidiomyces, e.g. *Agaricus bisporus* (Cultivated Mushrrom), *Calvatia* spp. (puffballs), *Corpinus* spp. (inky caps), *Ganoderma* spp. (wood decaying fungi), *Psilocybe cubensis* (a hallucinogenic mushroom), and *Pleurotus* spp. (oyster mushrooms) (Michilis et al., 1991; Horner et al., 1995; Helbling et al., 1998, 1999; Venturini et al., 2005). The allergen in *Calvatia cyathiformis* spore extracts has been further characterized (Horner et al., 1989b). One of them is a basic protein with pI 9.3 (*Cal c* Bd9.3) that cross-react with allergens from some other basidiospores (Horner et al., 1989b, 1995). The *Cal c* Bd9.3 protein was purified and was shown to have a molecular weight of 16 kD. The pure protein cross-reacted with the 9.3 band from crude *Coprinus quadrifidus, Pleurotus ostreatus* and *Psilocybe cubensis* extracts. Davis et al. (1988) established that the studied *Coprinus quadrifidus* antigens could be found in spores as well as in fruit bodies.

The finding of similar allergens in different mushroom species would indicate potential for cross-reactivity. Being allergenic to one type of mushroom could imply a risk for allergenicity also against other mushroom species. Cross-reactivity between spores of basidiomyces, as well as ascomycetes and fungi of the Fungi Imperfecti group has been described (O'Neil et al., 1988, 1990; De Zubiria et al., 1990; Lehrer et al., 1994). Of course, mushroom allergens may also show similarity and cross-react to other allergens.

Respiratory allergy

Mushroom spores have been reported to be more common in air than pollen. Most basidiospores are <10 μm in diameter and are thus of a size range that favours particle retention in the small airways. Counting spores have revealed that spore counts have both a daily rhythm; they go up during night time (Pady et al., 1967), and an annual rhythm, going down in November and December and remain low during the first two month of the year (Davies et al., 1963; Salvaggio and Seabury, 1971). Moulds and wood-rot fungi affecting houses have for a long time been known to give rise to allergic complaints from spores (Frankland and Hay, 1951; Bryant and Rogers, 1991) but these are not the only spore-forming fungi. Gregory and Hirst in 1952 hypothesized that the steady high concentration of basidiospores associated with the seasonal flush of agarics and polypores might be related to seasonal asthma. Investigators around the world (USA, Wales, New Zealand) subsequently confirmed a link between mushroom spores and allergic summer asthma (Salvaggio et al., 1971; Herxheimer et al., 1966, 1969). When patients with seasonal respiratory problems, including asthma, were tested by skin prick tests for reaction against various mushroom-extracts (from basidiomycetes and ascomycetes) 26%-32% of the patients tested positive (Herxheimer et al., 1969; Hasnain et al., 1985b; Lehrer et al., 1986, 1994; Cutten et al., 1988; Sprenger et al., 1988).

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Mushrooms traded as food. Vol II sec. 1

Mushrooms recognised as edible have been collected and cultivated for many years. In the Nordic countries, the interest for eating mushrooms has increased.

In order to ensure that Nordic consumers will be supplied with safe and well characterised, edible mushrooms on the market, this publication aims at providing tools for the in-house control of actors producing and trading mushroom products.

The report is divided into two documents:

a. Volume I: "Mushrooms traded as food - Nordic questionnaire and guidance list for edible mushrooms suitable for commercial marketing
b. Volume II: Background information, with general information in section 1 and in section 2, risk assessments of more than 100 mushroom species

All mushrooms on the lists have been risk assessed regarding their safe use as food, in particular focusing on their potential conte.

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