STATEMENT OF EFSA

Statement of EFSA on the possible risks for public and animal health from the contamination of the feed and food chain due to possible ash-fall following the eruption of the Eyjafjallajökull volcano in Iceland - urgent advice [1]

European Food Safety Authority[2,3]

European Food Safety Authority (EFSA), Parma, Italy

ABSTRACT

Following a request from the European Commission, the European Food Safety Authority (EFSA) issued a scientific advice on the possible short-term risks for food and feed safety including drinking water, in the wake of the eruption of the Eyjafjallajökull volcano in Iceland on 14 April 2010. Due to a lack of data on the composition of this ash-fall from the volcano in the European Union (EU), EFSA focused on fluoride, a substance identified in most publications on past volcanic eruptions as the main component that could pose a short-term risk to food and feed safety. Dietary exposure to fluoride in volcanic ash to humans and fish is usually through contaminated drinking water and for animals, such as cattle and sheep, through eating ash deposited on grass and soil. In this assessment several uncertainties were identified such as the dispersal of ash in the air and how much ash has fallen in EU. Based on the available data, the potential risk posed by fluoride in volcanic ash through contamination of drinking water, fruit, vegetables, fish, milk, meat and feed in the EU is negligible. Therefore, the risk for human and animal health through consumption of food and feed is not to be of concern in the EU. As further EU monitoring data becomes available for volcanic ash deposition levels and ash composition, risks associated with the components of the volcanic ash-fall should be re-evaluated, if the data indicates that toxicological thresholds have been exceeded.

KEY WORDS

Volcanic ash, food and feed chain, risks for human and animal health, fluoride

1 On request from the European Commission, Question No EFSA-Q-2010-00793, issued on 26 April 2010.

2 Correspondence: contam@efsa.europa.eu

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SUMMARY

On 20 April 2010 the European Food Safety Authority (EFSA) was asked by the European Commission to provide urgent advice on the risks to public and animal health in the European Union (EU) posed by possible contamination of the feed and food chain due to ash-fall following the eruption of the Eyjafjallajökull volcano in Iceland.

EFSA consulted a wide range of sources of information. Due to the limited amount of time to deliver this statement, the lack of detailed compositional data of the ash-fall as distributed over the EU, and the fact that most publications related to volcanic eruptions identified fluoride as the most critical compound related to health effects in both humans and animals, EFSA focuses on fluoride in its initial assessment.

Fluoride is not essential for human growth and development but is beneficial in preventing dental caries. Excessive intake of fluoride can lead to dental fluorosis and in the long term reduce bone strength and increase risks of fracture and skeletal fluorosis. Upper levels for fluoride intake have been set at 0.10 mg/kg body weight (b.w.) per day for children and 0.12 mg/kg b.w. per day for adults. For terrestrial animals, the recommended maximum tolerable levels for fluoride in feed based on clinical signs of fluoride toxicosis are 40 mg/kg feed for cattle and horses and 60 mg/kg feed for sheep.

Critical dietary exposure pathways for fluoride from volcanic eruptions for humans is often via contaminated water, while for animals it is often via ashes deposited on pasture leaves and consumption of soil along with pasture. Potential exposure to increased levels of fluoride will depend on the dispersion of the ash in the air volume, ash-fall amounts and geographical areas potentially affected, transport of ash constituents in soil and water and the resulting food, feed and water contamination levels. At this stage these quantities are basically unknown making precise assessment of the food and feed safety impact difficult.

Acute fluoride intoxication may have severe effects on both humans and animals however such events, related to oral ingestion of volcanic ash, are very rare.

Based on the available information the potential risk posed by this volcanic ash-fall through contamination of drinking water, vegetables, fruit, fish, milk, meat and feed is regarded as negligible in the EU which is outside the immediate proximity of the Eyjafjallajökull volcano. Consequently, the risk for human and animal health due to this ash-fall is considered not to be of concern.

As further EU monitoring data becomes available for volcanic ash deposition levels and ash composition, risks associated with the components of the volcanic ash-fall should be re-evaluated, if the data indicates that toxicological thresholds have been exceeded.

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BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION

The eruption of the Eyjafjallajökull volcano in Iceland resulted in an enormous ash cloud coming over Europe. Volcanic ash is made up of tiny pieces of glassy sand and dust produced when explosive eruptions demolish solid rock or spray lava into the sky, where it solidifies before falling.

As regards the possible direct public health effects in case of an ash fall (by inhalation of the particulates or contact with skin, eyes, …), ECDC in collaboration with WHO-Europe and JRC is closely following up the situation.

Taking into account the chemical composition of the ashes, questions could be raised on potential contamination of the food and feed chain and the related risks for public and animal health. In particular the presence of significant levels of fluoride in the ash could potentially affect the health of animals in case of ash fall.

Therefore, in accordance with Article 31 of the Regulation (EC) No 178/2002, the European Commission asks the European Food Safety Authority (EFSA) to provide by 22 April 2010 scientific assistance on the possible risks for public and animal health via food, including drinking water and feed in case of a significant ash fall, based on the chemical composition of volcanic ash. In addition, the European Commission requests advice on the effectiveness of possible mitigation measures such as e.g. washing of fruits and vegetables before consumption.

TERMS OF REFERENCE

As there were no separate terms of reference the following was used based on the background information provided by the European Commission (EC).

In its response to the EC the European Food Safety Authority (EFSA) indicated that this document is an initial urgent response to be delivered within a few days. Therefore the statement focuses on short-term effects on food and feed safety resulting from direct exposure of animals and plants to the ash based on the available data.

In this statement EFSA assess the following points at this time:

- What is the composition of the ash that may fall in the European Union due to Eyjafjallajökull volcano eruption in Iceland since 14 April 2010?
- What are the consequences of high level exposure to fluoride in food and feed?
- What pathways of dietary exposure would be important to humans and animals?
- What can already be concluded on food and feed safety at this stage?
- What recommendations can be made for further data collection and evaluation?
- Comment on the effectiveness of possible mitigation methods

ASSESSMENT

1. Introduction

The recent eruption of the Eyjafjallajökull volcano in Iceland on 14 April 2010 has raised questions on the public health concerns resulting from the ash cloud that has covered large parts of the European Union (EU). As a consequence, on the 16 of April 2010 the European Commission (EC) asked the European Centre for Disease Prevention and Control (ECDC) to assess potential public health impact of the ash cloud. This assessment did not address food safety aspects and its consequences, if any, for public health. On 20 April 2010 the European Food Safety Authority (EFSA) was asked by the EC to provide urgent advice on the possible risks for public and animal health of the contamination of the feed and food chain due to possible ash-fall following the eruption of the volcano Eyjafjallajökull in Iceland.

The chemical composition of the ashes can vary amongst volcanoes, eruptions and even during the same eruption. Volcanic ash chemistry is related to the chemistry of the source magma and gases released and adsorbed to the ash. Finer ash carries more soluble ions than coarser ones, and it also travels greater distances from the volcano than the coarser ash. However, the concentrations of soluble compounds in ash decrease with increasing distance.

An analysis of the chemical composition of the ash on the ground from the Icelandic volcano eruption was done by the Institute of Earth Science of the Icelandic Nordic Volcanological Center (2010) on 15 April 2010 showing that the main constituents were: 60 % silicon dioxide, 16 % aluminium oxide and 10 % iron oxide and a number of trace elements such as barium, chromium, copper, nickel, strontium, vanadium, zinc. Gaseous components typically include sulphur dioxide, hydrogen chloride, hydrogen fluoride (HF)[4], hydrogen sulphide, carbon monoxide, and radon (Institute of Earth Science of the Icelandic Nordic Volcanological Center, 2010).

The Icelandic Food and Veterinary Authority reported results on the fluoride content of the ash from the Eyjafjallajökull volcano during the first day of the eruption (14 April 2010). The concentrations were in the range of 23-35 mg/kg (dry ash basis) (Matvælastofnun, 2010a). However, more recent results (19 April 2010) from Iceland indicate that the pattern has changed in relation to fluoride. At the same time as the rate of ejection of ash has been reduced the fluoride concentration has increased to about 850 mg/kg dry ash while the rest of the ash composition remaining similar (Matvælastofnun, 2010b).

Due to the limited amount of time to deliver this statement, the lack of detailed compositional data of the ash-fall as distributed over the EU, and the fact that most publications related to volcanic eruptions identified fluoride as the most critical compound related to health effects in both humans and animals, EFSA focuses on fluoride in its initial assessment related to short-term risk.

2. Materials and Methods

A wide range of sources of information was consulted. Besides scientific literature searches, EFSA sent out requests for information to scientific organisations in Member States, European agencies (European Centre for Disease Prevention and Control - ECDC, European Environment Agency - EEA, European Chemicals Agency - ECHA), the European Commission's Joint Research Centre (JRC), Iceland and other third countries as well as international organisations (World Health Organization - WHO, World Organisation for Animal Health - OIE).

[4] Hydrogen fluoride has been reported to be adsorbed to volcanic ash. In contact with water and/or other compounds, it can be expected to generate a range of fluorides. EFSA has, however, no comprehensive information on chemical reactions of hydrogen fluoride in volcanic ash.

Hazard identification and characterisation

Literature searches were performed to identify tolerable upper intake levels (ULs) for humans, maximum tolerable levels (MTLs) in feed for animals (cattle, sheep and horses), No-Observed-Adverse-Effect-Levels (NOAELs) for cattle, sheep and horses, and No-Observed-Effect-Concentrations (NOECs) for fish. The main sources of information were risk assessments from international bodies (i.e. EFSA, the National Research Council) and the scientific literature.

Exposure assessment

Given the lack of detailed information on which to base a dietary exposure assessment for fluoride in food and water in the EU, parallels to previous volcanic eruptions and resulting contamination are drawn from literature and the data available from Iceland reporting levels of fluoride in ash.

Risk characterisation

The risk characterisation for animals (cattle, sheep and fish) uses a conservative scenario, i.e. the quantitative composition of the ash for fluoride in mg/kg to calculate the amount of ash to be ingested to reach the MTLs for fluoride in mg/kg feed.

The risk characterisation from a human health perspective uses a conservative scenario, i.e. the quantitative composition of the ash in mg fluoride/kg to calculate the amount of ash in gram to be ingested to reach the UL of fluoride. A body weight (b.w.) of 60 kg for adults was used.

3. Uncertainties

EFSA wishes to note the following uncertainties to be considered in this assessment:

- The chemical composition of the ashes can vary amongst volcanoes, eruptions and even during the same eruption.

- The representativeness of the available volcanic ash compositional data from Iceland for the assessment of the situation in the EU after long-range transport is not known. A considerable variation (up to orders of magnitude) in concentrations in time and space occurs during the volcanic eruptions. EFSA had access only to the results of a limited number of samples (n=5) on the compositional data of the volcanic ash as reported by the Institute of Earth Sciences of the Icelandic Nordic Volcanological Center (2010). During the preparation of this statement, EFSA received information that some European Member States were undertaking analytical measurements in samples of air and rainwater to investigate the situation. Results from these measurements were not yet available for consideration in this assessment.

- EFSA had no information on dry and wet deposition in the EU which could be considered in the assessment of the possible impact on human and animal health of ash-fall from the recent eruption of the Icelandic volcano. It was therefore not possible to assess the potential increase in the fraction of particulate matter that could be deposited in the EU associated with the volcanic eruption in Iceland.

- The dispersion of the ash in the air volume, downfall amounts and geographical areas potentially affected, transport of ash constituents in soil and water and the resulting food, feed and water contamination levels are basically unknown.

4. Hazard Identification and Characterization

4.1. Derivation of a tolerable upper intake level of fluoride for humans

Fluoride is not essential for human growth and development and its content of the body is not under physiological control. However, it is beneficial to prevent dental caries when ingested or applied topically with dental products in amounts of about 0.05 mg/kg b.w. per day. Absorbed fluoride is partly retained in bone and partly excreted, predominantly via the kidney. In infants retention in bone can be as high as 90 % of the absorbed amount, whereas in adults retention is 50 % or less. Excessive intake of fluoride can lead to dose-dependent dental fluorosis of deciduous but predominantly of permanent teeth.

Acute fluoride poisoning produces a clinical syndrome characterised by nausea, vomiting, diarrhea, abdominal pain, or numbness or tingling of the face or extremities eventually leading to cardiac arrhythmias and coma at high doses (Gessner et al., 1994). The minimum acute toxic dose for fluoride was 1.8 mg/kg b.w. based on a review of the doses involved in the four fatalities in young children. The probably toxic dose of fluoride has been set at 5 mg/kg b.w. (Whitford et al., 1992). Lethal fluoride doses in adults were also reported at 150 mg/L in water (Gessner et al., 1994). In areas where humans are chronically exposed to fluoride contaminated groundwater such as India, the prevalence of fluorosis in humans can be high (Viswanathan et al., 2009). In Berhait block (India) 29 % well water samples (n=89) had fluoride concentrations above the Indian permissible limit of 1 mg/L for drinking water. Clinical fluorosis was reported in children and adults and associated with urine fluoride concentrations ranged from 0.758-2.88 and 0.331-10.36 mg/L respectively. Clinical effects of fluoride intoxication included abnormal tooth enamel in children and in adults joint pain and deformity of the limbs and spine, and in some cases ligamentous calcification and exostosis formation (Nayak et al., 2009).

The EFSA´s Scientific Panel on Dietetic Products, Nutrition and Allergies (NDA) considered moderate dental fluorosis to be an adverse effect and derived an UL for fluoride of 0.1 mg fluoride/kg b.w. per day in children aged 1-8 years (EFSA, 2006). This UL was derived on the basis that the prevalence of moderate dental fluorosis of permanent teeth is less than 5 % in populations ingesting 0.08-0.12 mg fluoride/kg b. w. per day.

Fluoride can increase bone density but excessive long term intake reduces bone strength and increases risks of fracture and skeletal fluorosis (stiffness of joints, skeletal deformities). Studies with therapeutic oral administration of fluoride in amounts of 0.6 mg/kg b.w. per day in postmenopausal women over several years increased the risk for non-vertebral bone fractures. From this data, the NDA Panel applied an uncertainty factor of 5 to derive an UL of 0.12 mg/kg b.w. per day. The UL for fluoride applies to intake from water, beverages, foodstuffs, including fluoridated salt, dental health products and fluoride tablets for caries prevention (EFSA, 2006). These ULs for fluoride were used in the risk characterisation for humans in chapter 6.

4.2. Safe levels of fluoride intake in animals

Animals are exposed to the ionic form of the element (fluoride) which may be present in feed material such as forage containing naturally background levels up to 20 mg/kg fluoride/kg dry weight (d.w.) and drinking water (NRC, 1974). Fluoride at 1-2 mg/kg and 1-1.5 mg/L in animal rations and water, respectively, is considered adequate and safe (Merck, 2008; Bharti et al., 2008).

Excess fluoride intake has been reported to produce dental and skeletal fluorosis in animals affecting teeth and bones during development.

MTLs of minerals in the feed (mg/kg or % of dry matter) are recommended by the National Research Council (NRC) based on Indexes of animal health and performance. For terrestrial animals, the NRC (2005) recommended MTL's for fluoride in feed based on clinical signs of fluoride toxicosis of

40 mg/kg feed for cattle and horses and 60 mg/kg feed for sheep. For aquatic animals, there are no recommended MTL's because the exposure will not only occur via the feed, but mainly via the gills.

Cattle and horses

Most dairy cattle tolerate up to 40 mg/kg fluoride in feed. Finishing cattle may even tolerate fluoride levels of 100 mg/kg feed (NRC, 2005). If the first exposure to elevated fluoride levels take place after the age of 3-4 years, 40 mg/kg can be fed with no adverse effects (NOAEL) for at least 2 or 3 lactations (NRC, 1974). This NOAEL corresponds to the MTL for fluoride in feed.

In horses, no controlled studies have shown a dose–response relationship (EFSA, 2004).

Sheep

Sheep raised for lamb or wool can tolerate 60 mg fluoride /kg feed and finishing lamb can tolerate up to 150 mg fluoride/kg feed (NRC, 2005). In sheep, rapid acute fluorosis has been observed at levels of higher than 250 mg/kg in dried grass. Chronic fluorosis has been observed at 40-100 mg/kg feed (Cronin et al, 1998).

Grazing sheep can ingest varying amounts of soil, namely 110-250 g/day (Grace at al., 2008). Fluoride poisoning and death can occur in livestock that graze on ash-covered grass if fluoride is present in high concentrations. This is supported by literature reports from other volcanic eruptions around the world such as the 1995-1996 Ruapehu volcano‘s eruption in New Zealand affecting lambs and ewes (New Zealand MAF, 2001).

Acute intoxication in sheep has been observed at single intragastric dose of 17.5, 35, 52.5, 70 mg/kg b.w. Mild signs occurred at 52.5 mg/kg b.w. and the animals recovered 2 days later. At 70 mg/kg b.w. animals showed dullness, anorexia, and mild diarrhea which decreased from the third day. Dose-related congestion of duodenum, liver, kidney, and lung was observed in all animals. For the two highest doses, kidney degeneration and tubular necrosis were associated with glomerular inflammation (Kessabi et al., 1985).

Fish

Few studies have been conducted on the dietary toxicity of fluoride in fish. Fluoride toxicity to fish appears to be less in hard water than in soft water. In laboratory experiments carried out in soft water, the concentrations of fluoride lethal to 50 % of groups of rainbow trout (*Oncorhynchus mykiss*) (LC_{50}) exposed for 20 days, ranged from 2.7 to 4.7 mg/L. For a wild fish population in a specific river with hard water, safe concentrations for rainbow trout were calculated to be 5.1 to 7.5 mg/L respectively (WHO-IPCS, 2002).

Acute toxicity tests for LC_{50} (96 h) for freshwater fish ranged from 51 mg/L to 193 mg/L in rainbow trout (Camargo, 2003), and in marine fish LC_{50} were all above 100 mg/L (WHO-IPCS, 2002). In rainbow trout, a long-term (21 day study) NOEC of 4 mg fluoride/L water for mortality has been identified (Slooff et al., 1988).

The above mentioned values MTLs and NOEC are used in the risk characterisation for animals in chapter 6.

5. Exposure Assessment

5.1. Occurrence

As already stated in chapter 3 the dispersion of the ash in the air volume, downfall amounts and geographical areas potentially affected, transport of ash constituents in soil and water and the resulting food, feed and water contamination levels are basically unknown quantities. Given the lack of detailed information on which to base a dietary exposure assessment, in the following sections parallels will be drawn to previous volcanic eruptions and resulting contamination.

5.1.1. Water

Volcanic gases such as HF are adsorbed onto volcanic ash. When it comes in contact with surface waters, acid and metal salts adsorbed onto the surface of ash particles dissolve within an hour, releasing acids and metals to the environment. Thus, volcanic eruptions cause acidification and contamination of soil and surface water with a range of compounds including fluoride. River water close to the Hekla volcano in Iceland was sampled and analysed for fluoride content during the 1991 and 2000 eruptions. Mean levels of 0.91 mg/L in 1991 and 4.27 mg/L in 2000 were reported (Flaathen and Gislason, 2007). These results were linked to a direct measurement of fluoride content in ash of 1600 mg/kg in 1991 and an indirect measurement of fluoride in melted snow of more than 1250 mg/kg in 2000, respectively. Drinking water in the town of Esquel (Argentina) was analysed for aluminium and fluoride during a volcanic eruption in 2008 Esquel's water supply has both surface and subterranean sources with the subterranean source the more important. Fluoride levels of 0.15 mg/L and 0.24 mg/L were recorded in surface and subterranean water sources, respectively, while the treated water contained 0.11-0.28 mg/L. Aluminium levels of 0.06 mg/L and <0.05 mg/L (below detection limit) were recorded in the same surface and subterranean water sources, respectively (Stewart et al., 2009).

In summary, building on experiences from similar events, little effect is expected on surface or ground water in areas outside the immediate proximity from the eruption. In addition, there is a regulatory limit for fluoride of 1.5 mg/L in drinking water in the EU (Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption[5]).

5.1.2. Vegetables and fruit

Although fluoride in soil may enter plants through the roots, the major pathway seems to be foliar absorption (Ledeau et al., 1992). Plants also act as a carrier of deposited ash.

Fluoride was measured in samples of lichen and grass collected in 1987 from over 50 sites on the slopes of Mt. Etna. Elevated levels of fluoride were detected on the downwind side, with levels in lichens ranging from 3 to 141 mg/kg, and in grasses from 3 to 62 mg/kg. Such concentrations would only be found close to the actual volcano (Notcutt and Davies, 1989). Cronin and Sharp (2002) studied plant fluoride contents related to continuous low-level basaltic volcanic activity from Yasur volcano in Tanna (South Pacific Ocean). It was found that all investigated vegetation such as juvenile corn cob and husk, cabbage, sweet potato and also lichen showed fluoride contents that were within the concentration range of plant material measured in the absence of pollution, i.e. 2-20 mg/kg.

In the European Union vegetation is in different phenological stages. The growing season for vegetable production in Iceland has not yet started. In Mediterranean countries many vegetable and fruit crops approaching the harvest stage or are being harvested. In some northern European countries,

[5] OJ L 330, 5.12.1998, p. 32–54

after a very cold winter, vegetation is delayed, and presently only autumn sown cereals and forage crops are growing.

In summary, with regards to fluoride absorption, small amounts of ash-fall on vegetables and fruit are not expected to increase the fluoride concentrations in the crop substantially above natural background levels found in plant materials.

5.1.3. Food of animal origin

Fluoride accumulates primarily in the skeletal tissues of terrestrial animals that consume fluoride containing foliage. It is removed from circulation and stored in bone as relatively inert fluoroapatite. Any carry-over of fluoride to edible tissues or milk will be very low until fluoroapatite in bone has reached critically high levels. However, kidney may contain more fluoride than other soft tissues, due to the excretion of the compound in urine (NRC, 1974) Fluoride does not readily pass the blood-milk barrier (Underwood, 1981; Miller et al., 1991). Milk from experimental cows fed with 10, 19, 55 and 109 mg/kg b.w. of fluoride from the age of 3 months to 7.5 years, contained 0.06, 0.10, 0.14, and 0.20 mg/kg fluoride on a wet weight basis, respectively (Greenwood et al. 1964). Suttie et al. (1957) reported fresh milk concentrations of 0.1-0.4 mg/kg in fluorotic cattle and values up to 0.64 mg/kg have also been reported by others (Krishnamachari, 1987). Whole body fluoride levels in fish (*Salmo trutta*) of 10, 20 and 30 mg/kg were found under strictly experimental conditions when ambient levels of fluoride were kept at 5, 10 and 20 mg/L, respectively, in freshwater (Warrington, 1990). It is assumed that most of this is again stored in the skeletal tissues and shows that whole fish levels of fluoride can be influenced by extreme levels of fluoride in the water.

Animals from the affected area in Iceland have been slaughtered, but veterinary inspection did not reveal any abnormal changes. Milk samples have been taken but results are not yet available. No data on fluoride levels in mammalian meat, poultry and eggs for human consumption have so far been communicated from any other European country but any high levels are extremely unlikely based on the previously reported results.

5.2. Exposure for humans and animals

The dietary exposure pathway to compounds from volcanic eruptions for humans is often via contaminated water, while for animals it is often via ashes on the pasture leaf and the consumption of soil along with pasture, especially in wet areas of pasture that are churned up by animal treads (Cronin et al., 2003).

Where significant quantities of ash to be deposited on the ground, the livestock most likely to take up the ash would be those whose eating habits involve close contact with the ground, e.g. sheep, horses, deer. However, it may also be that animals grazing lush grass e.g. dairy cows and beef cattle would be at risk as ash adheres to herbage. Sheep in particular might even intentionally ingest ashes as they use to do with salt.

The total daily intake of fluoride in humans from all sources without any supplementation can range from a low intake of 0.5 mg/day reported for Germany (Bergmann, 1994) to the moderate amount of 1.2 mg/day reported for the United Kingdom (EGVM, 2001). Fluoridation of table salt could add 0.5-0.75 mg /day and fluoridated water (1 mg/L) 3.5-4.0 mg per day, giving a potential total exposure up to 6.0 mg fluoride per day. The overall fluoride exposure will vary considerably with age, water source and consumption habits. Fluoride exposure from volcanic eruptions will in most cases not add significantly to the variability in the background exposure.

EFSA has no access to specifically produced data on fluoride levels in food and water for human consumption subsequent to the volcanic eruption, even in areas in proximity to the eruption site.

6. Risk characterisation

6.1. Human health

In children and adults, Uls for fluoride are 0.1 and 0.12 mg/kg b.w. per day, respectively (EFSA, 2006). For children and adults assuming a concentration of 35 and 850 mg fluoride/kg ash a daily amount of around 40 and 205 g of volcanic ash and 2 and 8.5 g respectively would have to be consumed to reach the UL for fluoride. Such quantities could be expected to be visible on food or in drinking water. These preliminary calculations indicate no concerns for human health including children.

In regard to fruit and vegetables consumption there is no information available on whether any deposit of ashes on agricultural crops or any measurements of fluoride content of fresh produce have taken place in the Member States. Nevertheless, based on the data obtained in areas of active volcanic activity it is unlikely that the fresh produce would pose a concern for human consumption on a short-term basis.

According to the data reported under chapter 5.1.3, any carry-over of fluoride to edible tissues or milk is very low.

Fish from the sea around Iceland have not been affected as shown by tests by the Marine Research Institute. Icelandic aquaculture is based on groundwater and the harvested fish should therefore be of the same quality as before the volcanic activity started in Iceland (Matvælastofnun, 2010b).

Overall, drinking water, vegetable and fruit and food of animal origins (fish, milk, and meat originating from grazing animals) are in general not likely to contribute much to human fluoride exposure and therefore the risk for human health due to the ash-fall following the eruption of the Eyjafjallajökull volcano in Iceland on 14 April 2010 is estimated to be negligible in the EU.

6.2. Animal health

A MTL of 40 mg/kg fluoride in feed has been recommended for cows (NRC, 2005). At a level of 35 mg fluoride/kg ash (first results reported by the Iceland Food and Veterinary Authority on 14 April 2010), the daily consumption of ash would need to exceed the common daily feed intake, under the form of feed or forage, for a dairy cow to reach the MTL. However, at a level of 850 mg fluoride/kg ash (concentration reported by the Iceland Food and Veterinary Authority on 19 April 2010) the daily consumption of ash would need to be between 0.5 kg and 0.9 kg for a dairy cow to reach the MTL. For cows no adverse health effects are expected at these fluoride concentrations.

A MTL of 60 mg/kg fluoride in feed has been recommended for sheep (NRC, 2005). At a level of 35 mg fluoride/kg ash, the daily consumption of ash would need to exceed the common daily feed intake for a sheep to reach the MTL. However, at a level of 850 mg fluoride/kg ash the daily consumption of ash would need to be between 0.1 kg and 0.14 kg for a sheep to reach the MTL. Grazing sheep can ingest amounts of soil up to 250 g per day. In this worst case scenario the intake of fluoride present at 850 mg/kg ash would be two-fold above the MTL. However, such scenario would only be expected in the immediate proximity of the eruption.

In fish, a NOEC of 4 mg fluoride/L has been determined. Fluoride concentration in water should not exceed this value to avoid adverse effects in this species.

7. Mitigation measures

Matvælastofnun (2010 a,b) provided to EFSA two guidance documents on exposure of food and feed to volcanic ash deposition, and for livestock owners for this volcanic eruption. The latter guidance includes sheltering of animals, prevention of animals grazing on contaminated ground and drinking from stagnant pools and ditches and the prevention of ash and surface water from reaching water supplies (Matvælastofnun, 2010b).

EFSA noted that the U.S. Geological Survey[6] reported that in relation to volcanic eruptions at Etna (Italy) removing ash from local produce was not an easy task as the ash adhered to the fruit to such an extent that a simple rinse under a hose would not remove it.

A joint leaflet prepared by the International Volcanic Health Hazard Network, Cities and Volcanoes Commission, GNS Science and the United States Geological Survey[7],[8] states in relation to home grown food that ash-covered vegetables grown in fields are safe to eat after washing with clean water.

However, limited scientific evidence was found for the effectiveness of washing in the removal of ash particularly when the ash adheres to the surface of fruits and vegetables

CONCLUSIONS AND RECOMMENDATIONS

- **What is the composition of the ash that may fall in the European Union due to Eyjafjallajökull volcano eruption in Iceland since 14 April 2010?**

  There was minimal reported ash-fall in the European Union (EU) and no compositional results are available for ash-fall collected in the EU. The Icelandic Food and Veterinary Authority reported that the initial fluoride level in ash originating from this volcanic eruption increased from about 23-35 mg/kg on 14 April 2010 to 850 mg/kg on 19 April 2010.

  Due to the limited amount of time to deliver this statement and uncertainties e.g. the dispersion of the ash in the air volume, downfall amounts and geographical areas potentially affected, transport of ash constituents in soil and water and the resulting food, feed and water contamination levels are basically unknown, and the fact that most publications related to volcanic eruptions identified fluoride as the most critical compound related to health effects in both humans and animals, EFSA focused on fluoride in its initial assessment.

- **What are the consequences of high level exposure to fluoride in food and feed?**

  Grazing sheep can ingest large amounts of soil. Fluoride poisoning and death can occur in livestock that graze on ash-covered grass if fluoride is present in high concentrations. Acute intoxication in sheep may lead to dullness, anorexia and mild diarrhea. Dose-related damage of duodenum, liver, kidney, and lung may be observed.

  In humans, acute fluoride poisoning produces a clinical syndrome characterised by nausea, vomiting, diarrhea, abdominal pain, or numbness or tingling of the face or extremities eventually leading to cardiac arrhythmias and coma at high doses

  Such events due to ingestion of volcanic ash are very rare.

[6] Volcanic Ash: Effects & Mitigation Strategies Available at URL: http://www.almannavarnir.is/upload/files/Health_Guidelines_English_WEB.pdf
[7] The Health Hazards of Volcanic Ash: A Guide for the public. Available at URL: http://www.almannavarnir.is/upload/files/Health_Guidelines_English_WEB.pdf
[8] Volcanic Ash: Effects and Mitigation Strategies. Available from: http://volcanoes.usgs.gov/ash/properties.html

- **What pathways of dietary exposure would be important to humans and animals?**

  The dietary exposure pathway for fluoride from volcanic eruptions for humans and fish is usually contaminated water, while for terrestrial animals it is often via ashes on the pasture and the consumption of soil along with pasture.

  Data from Iceland, currently indicate no elevated levels of fluoride in ground water or drinking water at farms in the area of the eruption. Accordingly in the EU, no appreciable effects are expected on surface or ground water from the eruption of the Eyjafjallajökull volcano on 14 April 2010.

  Fish, meat, milk, fruit and vegetables do not appear to be important pathways for human dietary exposure for fluoride in this event.

- **What can already be concluded on food and feed safety at this stage?**

  Based on the available information the potential risk posed by this volcanic ash-fall through contamination of drinking water, vegetable, fruit, fish, milk, meat and feed is regarded as negligible in the EU which is outside the immediate proximity of the Eyjafjallajökull volcano. Consequently, the risk for human and animal health due to this ash-fall is considered not to be of concern.

- **What recommendations can be made for further data collection and evaluation?**

  As further EU monitoring data becomes available for volcanic ash deposition levels and ash composition, risks associated with the components of the volcanic ash-fall should be re-evaluated, if the data indicate that toxicological thresholds have been exceeded.

- **Comment on the effectiveness of possible mitigation measures**

  In general washing of fruit is recommended in guidance to reduce the ash contamination.
  However, limited scientific evidence was found for the effectiveness of washing in the removal of ash particularly when the ash adheres to the surface of fruits and vegetables.

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ABBREVIATIONS

b.w.	body weight
d.w.	dry weight
EFSA	European Food Safety Authority
EC	European Commission
ECDC	European Centre for Disease Prevention and Control
ECHA	European Chemicals Agency
EEA	European Environment Agency
EU	European Union
HF	Hydrogen fluoride
JRC	Joint Research Centre
LC	Lethal Concentration
MRI	Marine Research Institute
MTL	Maximum Tolerable Levels
NDA	EFSA Scientific Panel on Dietetic Products, Nutrition and Allergies
NOAEL	No Observed Adverse Effect Levels
NOEC	No Observed Effect Concentrations
NRC	National Research Council
OIE	World Organisation for Animal Health
UL	Tolerable Upper Intake Levels
WHO	World Health Organization