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Risk assessment of import and dissemination of intestinal pathogenic bacteria via fresh herbs and leafy vegetables from South-East Asia

Norwegian Scientific Committee for Food Safety

Panel on Biological Hazards

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1. Scientific panel members

Panel on Biological Hazards

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Scientific coordinator

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2. Summary

Several studies have demonstrated that fresh herbs and green or leafy vegetables can be contaminated by intestinal pathogenic bacteria such as *Salmonella* spp. Although systematic surveys are probably not conducted in any countries some places, in recent years the Rapid Alert System for Food and Feed (RASFF) has received approximately 30 alerts annually on the detection of potentially pathogenic bacteria contaminating such products.

Fresh herbs and green or leafy vegetables are mainly imported from southern Europe, but some are also imported from tropical and sub-tropical regions where the endemic level of intestinal pathogenic microbes is high. Traditionally such products have been imported particularly from South-East Asia, especially from Thailand. These imports occur predominantly through “immigrant-shops”, with the products largely used within the immigrant community, which also includes associated restaurants and catering-companies. However, such products are apparently also becoming more popular amongst the general public, and can therefore also be available on request in normal chain-stores. It is, however, difficult to estimate the total volume of these products imported into Norway because various different customs’ tariff codes are used. In 2006, 2 163 518 kg were registered as being imported into the EU (of which 25 % were basil, peppermint, or coriander). The total import into Norway must therefore be considered as low, but is probably increasing. The import of these products, and thus also their use, occurs predominantly in the larger towns and cities.

The food customs in the countries where these herbs originate dictate that they are normally cooked together with food. It is highly probable that the immigrant communities have largely continued this tradition, and therefore any contaminated products are unlikely to represent a risk of infection. In Norwegian food traditions, however, such ingredients are used without heating, being added directly to the cooked food for flavouring and/or decoration.
The products have a relatively short shelf-life (3-5 days) and are largely imported in small quantities by numerous small importers. Besides the general requirements that a producer/importer/distributor is responsible for a product offered for sale being “safe”, there are no other specific requirements on the testing of these products. The

short shelf-life and the multitude of small importers (who probably do not always have satisfactory internal controls) also mean that fulfilment of such requirements would be unrealistic.

In 2005, the Norwegian Food Safety Authority (Mattilsynet) conducted an *ad hoc* survey of 162 products, mostly from Thailand, and found that 28 % were contaminated with *Salmonella*, and 35 % with *E. coli* at > 100 CFU/gram. This resulted in a general prohibition of import of such products from Thailand, upon which the Thai authorities themselves undertook an initiative such that 14, later increased to 23, so called “risk-products” exported to Norway and the EU, would be accompanied by a certificate documenting that they have been analysed for *Salmonella* and *E. coli* before export. Thereupon the import prohibition was rescinded. However, in 2006, *Salmonella* was again detected in various *ad hoc* samples. Therefore, in 2007 a project was initiated with the intention of investigating the occurrence of *Salmonella* and *Campylobacter* in such products, and additionally to evaluate any possible effect from the Thai certification initiative. In this project, *Salmonella* was detected in 15 % of 159 products, whereas *Campylobacter* was not detected at all. Risk simulation demonstrated that the chance of products being contaminated with *Salmonella* was 3 % (0-9 %) for products which were accompanied by a certificate, and 20 % (11-31 %) for products without certification. On this basis, The Norwegian Scientific Committee for Food Safety (VKM), panel on Biological Hazards was commissioned to undertake a risk assessment on the use of fresh herbs and green or leafy vegetables imported from South-East Asia. In response, an *ad hoc* Working Group of experts was appointed with the mandate to draft a risk assessment.

In the surveys from 2005 and 2007, a total of 18 different serovariants of *Salmonella* were detected. All these have also been identified in patients to various extents, but only 9 of them in patients who have probably been infected in Norway. The domestic cases caused by these serovariants constitute 13 % of the total number of cases with these serovariants – a number that does not exceed the average proportion of domestic cases for all *Salmonella* variants. Therefore these data do not provide statistical support for the theory that fresh herbs/green or leafy vegetables represent a significant infection potential. However, statistical traces are not generally associated with sporadic cases and the sources for practically all the 300 – 400 domestic cases of salmonellosis diagnosed in Norway annually remain unknown.

As fresh herbs/green or leafy vegetables each time will only be used in small quantities, the direct use of such food probably only represents a marginal risk. The risk of infection will probably be particularly associated with the following conditions:

(i) Food which is decorated with these products, or to which these products have been added for flavouring, that are not consumed immediately, but stored for a sufficient period at a suitable temperature for microbial replication to occur. In such instances, the food can become hugely contaminated over the course of a few hours;

(ii) Other sensitive products (meat, eggs, dressings, etc.) may be cross-contaminated, and perhaps stored for a while in conditions suitable for microbial replication;

(iii) For highly immunosuppressed individuals, the necessary infective dose will be very low. It is conceivable that serious illness in such patients could develop even when the products are used “correctly”.

The panel’s principle conclusions are:

1. Both national and international studies have demonstrated that a relatively high proportion of fresh herbs/green or leafy vegetables imported from South-East Asia might be contaminated with intestinal pathogenic microorganisms. Such products have also been recognised as the sources of outbreaks on several occasions. However, there is no statistical evidence that suggests that these products constitute an important source of infection in Norway. Nevertheless, as the sources of sporadic cases of infection are practically never identified, it is not possible to estimate the actual risk.

2. Thailand, as the most important production country in this context, has introduced a requirement that risk products that are exported to EU and Norway shall be accompanied by a certificate documenting that the products have been analysed for *Salmonella* and *E. coli* before export. This initiative has substantially reduced the contamination rate, but has not eliminated it entirely.

3. Due to different food customs in the producer countries and Norway respectively, contaminated products are likely to represent a considerably greater infection risk to the general public than to immigrant communities, who probably have mostly continued with their original food traditions. 4. It is also probable that the trend

towards increased use of a steadily broader spectrum of fresh herbs/green or leafy vegetables will be applicable to the general public. However, the use of such products in hospitals or by severe immunocompromised patients should be avoided.
5. The significant reduction in risk that apparently has resulted for those products which are certified should be explored further, with direct communication with Thai authorities in instances of problems. Further investigation at varying time intervals should be supplemented by *ad hoc* or systematic sampling, in order that any failings or weaknesses in the system can be documented.

3. Sammendrag

Det er i flere studier påvist at friske urter og bladgrønt kan være kontaminert med tarmpatogene bakterier som *Salmonella* sp. RASFF har de senere årene hatt vel 30 meldinger årlig om funn av slike produkter kontaminert med potensielt patogene bakterier.

Friske urter og bladgrønt blir i betydelig grad importert Syd-Europa, men delvis også fra tropiske og subtropiske områder hvor det endemiske nivå av tarmpatogene mikrober er høyt. Tradisjonelt blir slike produkter således også importert fra Sør-Øst Asia – og da i særlig grad fra Thailand. Importen skjer i alt vesentlig av små importører, produktene selges for det meste i "immigrant-butikker", men de benyttes trolig også i både restauranter og catering-selskaper i immigrantmiljøene. Denne type produkter synes etter hvert også å bli mer populære i befolkningen generelt og kan derfor ofte også skaffes på forespørsel gjennom vanlige "kjede-butikker".

Det har vist seg vanskelig å anslå det totale volum som importeres til Norge fordi det anvendes ulike tolltariffkoder. EU registrerte en import på vel 2 163 518 kg i 2006 (hvorav ca. 25 % var ulike typer av basilikum, peppermynte eller koriander). Den totale importen til Norge må antas å være liten, men sannsynligvis økende.

Importen, og følgelig også forbruket, skjer i alt vesentlig i de større byene.

Mattradisjonen i opprinnelseslandene tilsier at urtene stort sett blir varmebehandlet sammen med maten. Man kan anta at immigrantmiljøene i stor grad har beholdt denne tradisjonen slik at kontaminerte produkter her ikke vil utgjøre noen smittefare. Norske mattradisjoner tilsier derimot at slike ingredienser brukes uten forutgående oppvarming direkte i maten som krydder og/eller pynt.

Produktene har en kort holdbarhetstid (3-5 dager). De importeres stort sett i små kvanta av flere små importører. Utover det generelle kravet om at produsent/ importør/ distributør er ansvarlig for at produkter som frembys for salg skal være "trygge", er det ingen spesifikke krav om testing av disse produktene. Den korte holdbarhetstiden og de mange små importører (som sannsynligvis ikke alltid vil ha tilfredsstillende interne kontroller), vil også gjøre et eventuelt slikt krav urealistisk.

Mattilsynet foretok i 2005 *ad-hoc*-undersøkelser av 162 produkter, vesentlig fra Thailand, og fant at hele 28 % var kontaminert med *Salmonella*, 35 % med *E. coli* >

100 CFU/gram. Dette medførte til et midlertidig omsetningsforbud for slike produkter fra Thailand. Som en følge av dette tok Thailand selv et initiativ til at 14, senere utvidet til 23, såkalte ”risiko-produkter” som eksporteres til Norge og EU skal ledsages av et sertifikat som dokumenterer at de er undersøkt for *Salmonella* og *E. coli* før eksport. Deretter ble omsetningsforbudet opphevet, men også i 2006 ble *Salmonella* påvist i diverse stikkprøver. I 2007 ble det gjennomført et prosjekt med tanke på å undersøke forekomsten av *Salmonella* og *Campylobacter* i slike produkter fra Sør-Øst Asia og i tillegg evaluere effekten av de thailandske sertifikatene. *Salmonella* ble påvist i 15 % av 159 produkter, mens *Campylobacter* ikke ble påvist. Det ble simulert at produkter henholdsvis med og uten sertifikat i snitt hadde 3 % (0-9 %) og 20 % (11-31 %) sjanse for å være kontaminert med *Salmonella*.
På denne bakgrunnen ble faggruppe for hygiene og smittestoffer-VKM bedt om en risikovurdering ved bruk av friske urter og bladgrønt importert fra Sør-Øst Asia. Det ble opprettet en ad hoc-gruppe for å lage risikovurderingen.

I undersøkelsene fra 2005 og 2007 ble det påvist til sammen 18 ulike serovarianter av *Salmonella*. Alle disse ble også i vekslende grad også påvist hos pasienter, men bare ni av dem hos pasienter som var smittet i Norge. Ser man bort fra utbruddet med *S. Weltervreden* i bønnespirer (som for øvrig var importert som frø fra Pakistan via Italia og spiret i Norge), utgjorde norsk-smittede vel 13 % av det totale antall pasienter med disse serovariantene. Dette er en andel som ikke overskrider den gjennomsnittlige andelen av ”hjemmesmitte” for alle *Salmonella*-variantene. Det er derfor ikke noen statistisk støtte for at friske urter/bladgrønt utgjør et stort smittepotensiale. Men sporadiske tilfeller etterlater stort sett aldri statistiske spor, og for de rundt 300-400 salmonellosene som hvert år smittes i Norge hvert år, blir smittekilden praktisk talt aldri påvist.
Fordi mengden av friske urter og bladgrønnsaker som brukes alltid vil være liten, vil en umiddelbar bruk av krydret mat sannsynligvis bare utgjøre en marginal risiko. Risikoen for smitte vil sannsynligvis være særlig knyttet til følgende forhold:

(i) Krydret/pyntet mat som ikke brukes umiddelbart, men blir oppbevart over noen tid i for eksempel romtemperatur, kan i løpet av timer bli massivt kontaminert;

(ii) Andre sensitive produkter (som kjøtt, egg, majonesdressinger o.a.) kan bli krysskontaminert og eventuelt oppbevart en stund under oppformeringsbetingelser før bruk;

(iii) For sterkt immunsvekkede personer vil den nødvendig infeksjonsdosen være svært lav. Det er tenkelig at alvorlig sykdom hos slike pasienter kan utvikles allerede ved ”korrekt” bruk av produktene.

Faggruppe for hygiene og smittestoffers hovedkonklusjoner er:

1. Det er både i internasjonale og nasjonale studier vist at friske urter/bladgrønt importert fra Sør-Øst Asia kan inneholde tarmpatogene mikrober i en relativ stor andel av produktene. Slike produkter er også beskrevet som årsak til utbrudd flere ganger. Det foreligger ikke noen statistisk evidens for at dette er en viktig smittekilde i Norge, men fordi årsakene til sporadiske tilfeller i praksis aldri påvises, er det heller ikke mulig å anslå den reelle risikoen for dette.
2. Thailand, som det viktigste produktland i denne forbindelse, har innført krav om at gitte risikoprodukter som eksporteres til EU og Norge skal følges av et sertikat som dokumenterer at de er undersøkt mhp. *Salmonella* og *E. coli* før eksport. Dette har redusert – men ikke eliminert – kontaminasjonsraten i betydelig grad.
3. Pga. ulike mattradisjoner i hhv. produksjonslandene og i Norge, utgjør kontaminerte produkter en betydelig større smittefare for befolkningen generelt enn for immigrantmiljøene – som man kan anta har tatt vare på sine opprinnelige mattradisjoner i betydelig grad.
4. Det anses sannsynlig at tendensen til et økende forbruk av et stadig bredere spekter av friske urter og bladgrønnsaker også vil gjelde befolkningen generelt. Det anses som urealistisk å ville søke å endre så vel forbrukermønster som anvendelsesmåte som mulige risikoreduserende tiltak. Det bør likevel frarådes at pasienter med grav immunsuppresjon (f. eks. på sykehus) serveres slike produkter
5. Den betydelige risikoreduksjonen som ser ut til å gjelde produkter som følges av sertifikater etter undersøkelser i Thailand, bør følges opp - eventuelt også med direkte kontakt med ansvarlige thailandske myndigheter ved eventuelle problemer, Oppfølgingen bør med ujevne mellomrom suppleres med *ad-hoc*- eller systematiserte prøver for å kunne dokumentere eventuelle svikt i dette systemet.

4. Background

Fresh herbs and leafy greens are potential transmission sources of enteropathogens. In a recent report from WHO/FAO on microbiological hazards in fresh fruits and vegetables (FAO/WHO 2008) it was stated that leafy green vegetables (including fresh herbs) “currently presented the greatest concern in terms of microbiological hazards.” This is because such products are grown and exported in large volumes, and they have been associated with many outbreaks of food borne disease affecting considerable numbers of people. Additionally, the production chain for leafy greens is highly complex.

The microflora on vegetables at harvest reflects the environment in which they are grown. The products considered in this assessment are imported from South-East Asia where the temperature and humidity is relatively high and the occurrence of enteropathogenic bacteria in the environment might be considerable. During cultivation, use of contaminated water for irrigation, application of biocides, and refreshing or washing of harvested crops, is a potential source of contamination. Contamination from contact with fresh manure used as fertiliser cannot be excluded. Heavy rainfall may also lead to faecal contamination from the environment. Direct sunshine will most likely have a disinfection effect, but if the plants are irrigated until harvest and the production hygiene during and post-harvest is inadequate, there is a relatively high likelihood that the fresh herbs and leafy greens may be faecally contaminated.

A common strategy to avoid food borne disease is heating or cooking of potential risk products before consumption. However, this approach is not appropriate for the majority of fresh herbs and leafy greens that are mainly consumed raw, or added to food **after** the food has been heat-treated. It should also be recognised that some fresh herbs and leafy greens that are heat-treated in some parts of the world (often country of origin), may be consumed raw in other parts of the world (e.g. Norway) that imports these particular products.

4.1. Legislation; international

In 2005 there were more notifications (87) to the Rapid Alert System for Food and Feed (RASFF) than in previous years (The Rapid Alert System for Food and Feed

(RASFF) 2006) with respect to unwanted bacterial contamination of fresh herbs and spices. This increase is probably due to sporadic findings in some countries, being followed by an extended surveillance. The majority of the notifications (60 %) concerned fresh herbs imported from Thailand. However, in 2006 the number of notifications due to potentially pathogenic microorganisms and microbiological contamination of such products was noticeably reduced (33 notifications). In 2007 the number of notifications was similar to that in 2006.

RASFF informs countries outside the EU (third countries of origin) of notifications systematically through the Commission delegates. However, if serious problems are detected several times, a letter is sent to the competent authority of the country. The relevant country is then expected to take appropriate measures to rectify the situation. The Member States also intensify their import checks. If the guarantees received are insufficient, the Commission may take further action. In addition, the Food and Veterinary Office (FVO 2008) uses the information provided by RASFF when prioritising their inspection programme. In this particular case, the high number of notifications from Thailand resulted in the FVO conducting a mission in Thailand from 18-27 September 2007. This mission was “in order to assess the official control system in place to prevent microbiological contamination in fresh herbs and spices intended for export to the European Union” (FVO 2008).

On January 28 2002, the Food Law (Regulation (EC) No 178/2002 2002) was passed in the EU, and became immediately applicable in the Member States. Under this legislation, the responsibility for ensuring that food reaching the consumers is safe is placed on the food operators. It is also stated in Article 11 that food imported into the Community “shall comply with the relevant requirements of food law or conditions recognised by the Community to be at least equivalent thereto or, where a specific agreement exists between the Community and the exporting country, with requirements contained therein”. (Regulation (EC) No 852/2004 2004) (part of the “hygiene package”) lays down specifications on the hygiene of foodstuffs, and states that HACCP principles should be employed. In addition, microbiological criteria (Commission Regulation (EC) No 2073/2005 2005) were enforced from January 1, 2006. There are no specific criteria for fresh herbs and spices. The current

microbiological criteria in the EU provide a criterion for *Salmonella* in some vegetable products such as seeded sprouts and pre-cut fruit and vegetables.

4.2. Legislation in Norway

Norway will implement both the Food Law and the "hygiene package". This has not yet been enforced, but this is expected to occur during 2008. The food operators (in this case the importers) are required by the Norwegian Food Act (Helse og Omsorgs Departementet 2003) to ensure that the food they put on the market is safe. According to the Food Act, the competent authority should have full access to premises and should be able to provide necessary samples or results from testing upon request. The food operators should also submit necessary information and samples for analysis upon request.

The products under consideration are mainly imported to Norway by small importers and sold through "immigrant-shops", the principal customers being first and later generations of immigrants, who are still using their traditional cooking practices. However, these products are also becoming increasingly popular amongst the general population, and are available upon request in some grocery chain-stores. It should be accepted that new groups of customers will use the products according to their own traditional cooking practices, which, in Norway, will mainly not involve any heat treatment.

The products are exported to Norway as fresh or fresh-cut, and have a short shelf-life. The products are normally packed in bags, which are then packed together in polystyrene boxes, and shipped by plane to Norway. There are no mandatory requirements for testing the products for possible enteropathogenic bacteria. This, in addition to the fact that a number of the many small importers probably will not have any adequate internal control assessment, makes it difficult or impossible to test the products before they are on the market. Tests for *Salmonella* and pathogenic *E. coli* will most often be random, and contamination occurrence will probably only be discovered after the products are sold and consumed. However, according to the Action Plan from the Thai Agricultural Department, all the products on the list from December 2005 (Appendix I) should be tested for *Salmonella* and *E. coli* before export to EU and Norway in order to ensure the appropriate hygienic quality of the

products. According to the report from the mission by (FVO 2008) the majority of companies involved in the RASFF notifications were from the non-Good manufacturing Practice GMP certified packing houses.

Over the past 3 years, the Norwegian Food Safety Authority (NFSA) has conducted a series of random spot-test analyses of fresh herbs and leafy vegetables imported from Asia, with the majority of the products imported from Thailand and a lesser quantity imported from Vietnam. After several positive identifications of *Salmonella* and the discovery of a high level of *E. coli* in such products in 2005, an immediate prohibition on sale or trade of herbs imported from Thailand was implemented. *Salmonella* was detected in 28 % of 162 products sampled, and 35 % of the products had more than 100 *E. coli* per gram. The sales prohibition was rescinded after a short period, following the introduction of an action plan in Thailand. An important component of Thailand's 2005 action plan was that 14 so-called "high risk" products should be accompanied by a certificate of analysis for *Salmonella* and *E. coli* when exported to Norway and the EU. This list was extended by the Thai authorities to include 23 different herbs and vegetables in December 2005 (Annex I). The Thai competent authority has put in place an official control system for the export of the 23 herbs and spices that are on the list from December 2005. This system includes microbiological certification for export and GAP (Good Agricultural Practice) / GMP certification. There are presently two types of export systems, relating to the microbiological contamination of the 23 herbs and spices on the list. The first applies to GMP-certified packing houses, while the second is applicable to non-certified packing houses. According to a report from a mission from the FVO, under EU Commission, in 2007, the majority of the farms and packing houses in Thailand do not participate in the GAP/GMP systems (FVO 2008).

Following several further discoveries of *Salmonella* in similar random samples during 2006, a survey was commenced in early 2007 under the direction of the NFSA in order to investigate the occurrence of *Salmonella* and *Campylobacter* in fresh herbs and leafy green vegetables imported form South-East Asia (Mattilsynet 2008). A secondary goal of the project was to register whether the products sampled were accompanied by the required certificates of analysis for *Salmonella* and *E. coli* from their country of export.

The consumption and use of “exotic” imported herbs and leafy greens is generally rising in Europe. This may partly be due to travel activities increasing amongst the Norwegian population, a greater number of immigrants, and food or cooking programmes on television in which so-called “exotic” herbs and spices are used, etc. The products are mostly imported to the larger towns and cities in Norway. Inspection of the importers by the NFSA has demonstrated that the amount of the different products imported may be very small, often only a few kg of each product, but may nevertheless be high in volume. The products are mainly sold to the consumers via small “immigrant shops”. Although some of the products are used in “immigrant restaurants” and catering companies, it is unlikely that these products enter food production plants. Additionally, some of the larger chain-stores might procure this type of Asian product on request. The products have a limited shelf-life of 3-5 days, and are usually consumed before the results of possible bacteriological analyses are available. For the consumers, the risks are from direct exposure via the product, or from cross-contamination from these products to other products, kitchen utensils, and the environment. It is an important factor that herbs and vegetables are traditionally

cooked during food preparation in Asia, but are often eaten raw according to Norwegian food customs.

Based on this background, the Norwegian Scientific Committee for Food Safety (Vitenskapskomitéen for mattrygghet) was asked by the NFSA (Mattilsynet) (Ref. 2007/49424, 22.10.2007) for a risk assessment regarding the consumption of fresh herbs and leafy vegetables imported from South-East Asia. The task was assigned to the committee's Scientific Panel on Biological Hazards, which in response appointed an *ad hoc* Working Group of experts with the mandate to draft a risk assessment regarding the consumption of herbs and leafy vegetables imported from South-East Asia.

5. Terms of reference[1]

The mandate is limited to include only herbs and leafy vegetables imported from South-East Asia.

1. Description of the scope of the problem and assessment of the risk to public health

- From the basis of the detection of *Salmonella* and *E. coli* in random spot samples taken during the period 2005-2007, how great is the risk to public health constituted by this type of finding?
- Is there any indication of an association between such contaminated products and cases of human infection?

[1] **Oppdrag**

Oppdraget begrenses til å omfatte krydderurter og bladgrønnsaker importert fra Asia.

1. Beskrivelse av problemomfang og vurdering av risiko for folkehelse
- Finnes det indikasjoner på en sammenheng mellom slike kontaminerte produkter og tilfeller av humane infeksjoner?
- Med utgangspunkt i de funnene som er gjort av Salmonella og E. coli i stikkprøver tatt i perioden 2005-2007, hvor stor risiko utgjør denne typen funn for folkehelsen?
- Er det forskjeller i risiko for smitte ved konsum av spesielle arter av krydderurter og bladgrønnsaker?
- Er forekomst av Salmonella i importerte vegetabilske produkter mindre problematisk for folkehelsen/dyrehelsen enn forekomst i kjøtt?

2. Forslag til risikoreduserende tiltak
- Hva slags risikoreduserende tiltak kan settes i verk i kjeden fra produsent til forbruker?

- Is there a particularly high risk of infection associated with consumption of particular types or species of herbs and/or leafy vegetables?
- Is the occurrence of *Salmonella* in vegetable products of less concern to public health/animal health, than the occurrence of *Salmonella* in meat products?

2. Suggestions for risk-reduction measures

- What steps can be taken to reduce the risk of infection in consumers?

6. Hazard identification

Hazard identification is implicit in the title of this report and in the terms of reference, and further comment is unnecessary.

7. Hazard characterization

7.1. Growth and survival in fresh herbs and leafy greens

In several surveys enteropathogenic bacteria, such as *Salmonella,* have been isolated from fresh herbs and leafy greens (Brandl 2006). There have also been several outbreaks associated with the consumption of fresh herbs and leafy greens; e.g. fresh cilantro (Campbell et al. 2001), fresh parsley (Naimi et al. 2003), fresh basil (Pezzoli et al. 2007). In 2006 there was an outbreak in Sweden associated with lime leaves used in a marinade (www.slv.se). The lime leaves were imported from Thailand (Livsmedelsverket 2006). There have also been numerous notifications to the Rapid Alert System for Food and Feed (RASFF) on the occurrence of potentially pathogenic microorganisms in leafy greens (The Rapid Alert System for Food and Feed (RASFF) 2006;The Rapid Alert System for Food and Feed (RASFF) 2007). The total plate counts on such products may vary between 10^6 and10^9 cfu/g. This indicates a high bacterial load on the products and the bacteria may be loosely attached to the leaves, present in biofilm on the leaves, or even occur inside the leaves as they may enter through the natural openings or lesions. It has been shown that *Salmonella* Thompson has the ability to colonize the surface of cilantro leaves at high densities, on the veins and in natural lesions (Brandl and Mandrell 2002).

7.2. Dose response

Oscar (Oscar 2004) compared data from a human feeding trial using healthy men to develop a dose-response model for 13 strains of *Salmonella*.

Dose-response data were used to define a linear model to determine minimum, median, and maximum illness doses. To verify the dose-response model predictions, the original feeding trial was simulated. The predicted model dose-response shown to be a median of 69 (range of 43–101) illnesses compared with 74 in the original trial, which indicated that dose-response curves in feeding trials with one strain of *Salmonella* may not give the same dose response as naturally-contaminated food, especially when several *Salmonella* strains may be the cause of infection.

8. Exposure assessment

8.1. Methodology

When random sampling is carried out, as has been conducted in the two surveys mentioned here, sampling may be biased. From the survey in 2005, herbs like different types of basil, mint, and coriander appear to be overrepresented. However, this may be due to increased sampling of these products following the detection of a relatively high proportion of positives. In the 2007 survey, the local food safety authorities that participated were encouraged to sample many different product types, in order to investigate other herbs, as well as the more typical ones investigated in 2005.

The samples were analysed for *Salmonella* by the following companies:

- Labnett

  Salmonella: for screening by using Tecra Unique (AOAC 2000.07) and for verification by using NMKL 119 (1990),

  Campylobacter: screening by using NMKL 119 (1990)

- Analycen

  Salmonella: for screening by using Vidas (48 h), intern method based on a method from bioMerieux and for verification by using plating on PGA, XLD and BGSA and then API (bioMerieux), PCR (Taqman Applied BioSystem).

  Campylobacter: for screening by using Vidas, method based on bioMerieux.

- M-Lab

  Salmonella: for screening Vidas SLM and for verification NMKL 71 (1999).

Campylobacter: screening by using NMKL 119 (1990).

According to the report from FVO (FVO 2008) the total export of fresh herbs and spices from Thailand to EU in 2006 was 2 163 518 kg and the export of basil (holy and sweet), peppermint, and coriander accounted for 25 % of the total export. Due to the use of different customs' tariff codes at import, it is very difficult to estimate the exact quantity of fresh herbs and leafy greens that are imported to Norway, and hence also to estimate the actual volume used. However, there appears to be a general increase in the consumption and use of such products. The majority of the importers are based around the larger cities in Norway, and it is reasonable to assume that most of the use and consumption also occurs in these areas. The actual individual consumption of the products will not be high, but if the products are contaminated with *Salmonella* there will also be a risk of cross-contamination to other products.

8.2. Results from Norwegian survey of *Salmonella*, *E. coli*, and *Campylobacter* in fresh herbs and leafy greens imported from South-East Asia

8.2.1. Products

In the last three years, the NFSA have collected several samples of fresh herbs and leafy greens imported from South-East Asia, mainly from Thailand and Vietnam. In 2005, 162 samples of different fresh herbs and leafy greens were tested for *Salmonella* and *E. coli*. *Salmonella* was isolated from 28 % and *E. coli* was present in numbers above 100 cfu/g in 35 % of the samples. This resulted in a temporary sales ban for fresh herbs and leafy greens from Thailand.
In 2007 the survey was repeated, with 159 samples collected in the period from the end of April to the end of September (Appendix II). The samples were tested for *Salmonella* and *Campylobacter* spp. *Salmonella* was isolated from 15 % of the samples, whereas *Campylobacter* spp. was not isolated from any of the samples.

In 2005, the majority of the *Salmonella* isolates were detected from different types of mint and basil, but also from coriander. It is safe to assume that these product types are the most commonly used of the imported fresh herbs. However, the overrepresentation of these product types is probably due to bias in the sampling during 2005. When the results from the analyses indicated that products such as

mint, basil, and coriander were contaminated with *Salmonella* and *E. coli*, the surveillance of these products was enhanced, as compared with other types of product.

In 2007, the *Salmonella* findings were distributed over more sample types, but in this survey there also appeared to be more positive samples from different types of mint (red mint, cockscomb mint, mint leaves, and peppermint), basil (sweet basil, hairy basil, and holy basil), and coriander. It is also noteworthy that the majority of the RASFF notifications concerned mainly basil, mint, and coriander. This may again result in biased sampling, since the National Food Control Authorities in the European countries have access to the RASFF notifications and may then intensify the sampling and analysis of these products.

8.2.2. Human

Human infections caused by the same *Salmonella* serovariants isolated from fresh herbs and leafy vegetables in Norway in 2005 are shown in Table 1. Of the isolated serovariants, 14 belonged to *S. enterica subsp. enterica*, two to *S. enterica subsp. salamae*, and one could not be typed. Nine of the variants belonging to *subsp*. *enterica* were also isolated from humans in 2005. Of these nine variants, however, only two (*S*. Saintpaul and *S*. Stanley) were isolated from cases acquired in Norway. Of the total number of patients with these two serovariants, 10 % were confirmed as being infected in Norway, whereas 73 % were infected abroad (for 16 % this information was missing).

Table 1. Human infections with *Salmonella* serovariants that have been isolated from fresh herbs and leafy vegetables in Norway in 2005

***Salmonella* serovariant**	**Place where infection acquired**			**Total**
	Norway	**Unknown**	**Abroad**	
S. Aberdeen	0	0	0	0
S. Augustenborg	0	0	0	0
S. Chester	0	1	2	3
S. Hvittingfoss	0	0	1	1
S. Javiana	0	0	7	7
S. Saintpaul	4	8	10	22
S. Stanley	6	8	62	76
S. Thompson	0	0	1	1
S. Zanzibar	0	0	2	2
Total	10	17	85	112

The corresponding figures for 2007 are shown in Table 2. Of the 17 serovariants belonging to *subsp. enterica*, isolated from herbs/vegetables in 2007, 12 were also isolated from humans, but only five from domestic cases. Of these five, three (*S*. Anantum, *S*. Dublin and *S*. Hadar) were each isolated in only one or two cases, whereas the remaining two (*S*. Stanley and S. Virchow) were isolated from a somewhat greater number.

Excluding the isolates of *S*. Weltervreden associated with this outbreak, only about 9 % of the human infections caused by the serovariants also isolated from herbs and vegetables in 2007 were domestic. The same is true for the two most commonly isolated variants (*S*. Stanley and *S*. Virchow). Approximately 82 % of the total number of these infections was acquired abroad, but for the remaining 9 % this information is not available.

Table 2. Human infections with *Salmonella* serovariants also isolated from fresh herbs and leafy vegetables in Norway in 2007

***Salmonella* serovariant**	**Place where infection acquired**			**Total**
	Norway	**Unknown**	**Abroad**	
S. Amsterdam	0	0	0	0
S. Anatum	2	0	6	8
S. Augustenborg	0	0	0	0
S. Dublin	1	0	0	1
S. Hadar	0	2	7	9
S. Heidelberg	1	0	10	11
S. Hvittingfoss	0	0	1	1
S. Javiana	0	0	7	7
S. Rissen	0	0	4	4
S. Rubislaw	0	0	0	0
S. Stanley	6	8	65	79
S. Thompson	0	0	1	1
S. Virchow	5	3	28	36
S. Weltevreden	19*	7	7	33
S. Zanzibar	0	0	2	2
Total	34	20	138	192

*: due to an outbreak caused by contaminated alfalfa sprouts.

Normally slightly fewer than 20 % of all *Salmonella* infections in Norway are domestic, and the others (slightly over 80%) are acquired abroad.
Even if most of the infections with *unknown* epidemiological history (9 and 16 %, for 2007 and 2005 respectively) had been acquired in Norway, the total number of domestic cases with these serovariants does not exceed any expected level. Accordingly, there is no statistical support for suggesting a possible endemic spread of infections with these serovariants through contaminated herbs and vegetables. However, sporadic cases do not leave any traces in the statistics, as the sources of infection in these cases practically always remains unrecognised. Therefore a possible epidemiological connection between contaminated herbs and vegetables and sporadic cases cannot be excluded with any degree of certainty.

8.3. Simulating assessment

Monte Carlo simulation was done using @Risk software (version 4.5, Palisade, Newfield, NY, USA) to analyse different scenarios and suggest risk management strategies. The choice of distributions was based on (Vose 1997). Using the data assimilated from the NFSA's report regarding occurrence of *Salmonella* and

Campylobacter isolated from fresh herbs and leafy vegetables from South-East Asia (2007), the fraction of positive batches was modelled as a Beta distribution with parameters (k+1) and (N-k+1), where N is the total number of tested batches and k the number of positive batches. Only data for occurrence of *Salmonella* isolated from the products imported from Thailand were used in this simulation. The data were split into samples with certificate and those without certificate. The respective mean and 95 % confidence intervals for the percentage of positive batches were 3 % (0-9 %) and 20 % (11-31 %) for batches with and without certification, respectively (Figure 1).

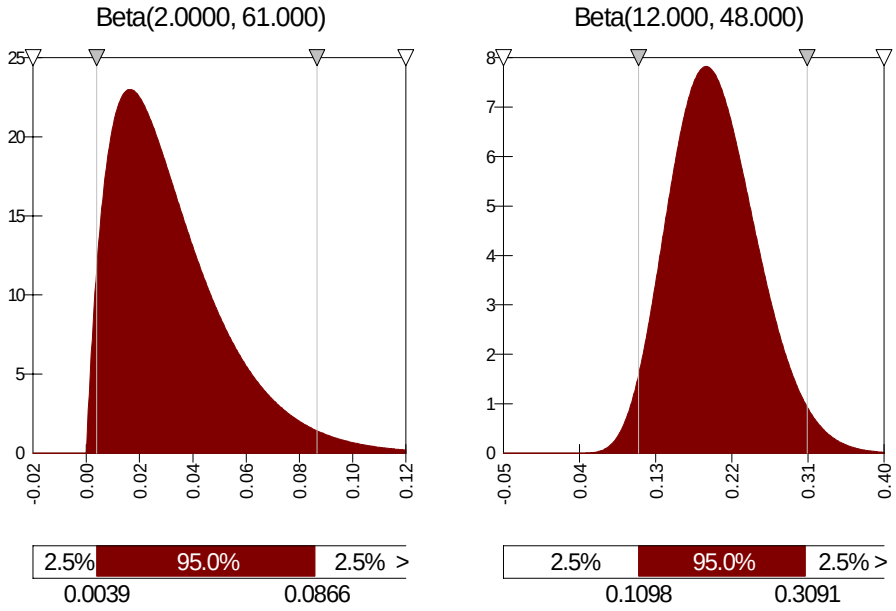

Figure 1. Probability density function of the estimated fraction of positive batches from Thailand among batches with certificates (left) or without certificates (right).

The expected number of positive batches when importing 100 batches of fresh herbs and leafy vegetables from Thailand, was simulated by using two Binomial distributions with parameters n1 and p1 (batches with certificates), and n2 and p2 (batches without certificates), where n1 and n2 are the number imported, and p1 and p2 are the estimated fraction of positive batches, based on the Beta distributions described above.

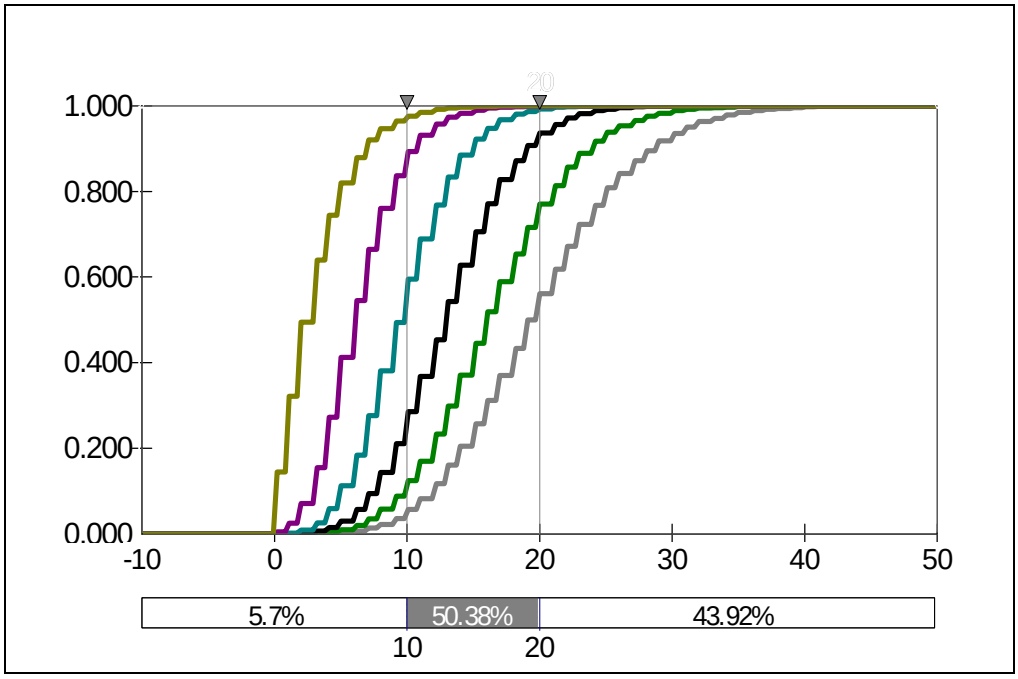

Figure 2. Cumulative probability functions of the number of positive batches imported when the fraction of batches with certificate is (from left curve to right curve) 100%, 80%, 60%, 40%, 20% or 0%.

Figure 2 shows the probability of importing a number of positive batches as given on the x-axis. The probabilities are shown on the y-axis. For example, with 100 % of batches having certificates (left kaki curve), the likelihood of importing less than 10 positive batches (left line delimiter) is close to one (0.98). With 60 % of batches having certificates (blue curve, third from the left), this likelihood is close to 0.6. With 0 % of the batches being certified (right curve), this likelihood is close to zero (0.06), which means we are almost certain that more than 10 out of 100 batches will be positive. The average number of positive batches expected when importing 100 batches of fresh herbs and leafy vegetables from Thailand, with their corresponding 95 % confidence intervals, are shown in Table 3.

Table 3. Number of positive batches expected when importing 100 batches of fresh herbs and leafy vegetables from Thailand, according to the fraction of batches with certificate. Values are shown as mean and 95% confidence interval for each management option.

	Percentage with certificate (%)					
Number of positives	**0**	**20**	**40**	**60**	**80**	**100**
Mean	20	17	13	10	7	3
Lower 95 %CI	9	7	5	3	2	0
Upper 9 5% CI	34	28	23	18	14	10

9. Risk characterisation

9.1. Answers to the questions

1. Description of the scope of the problem and assessment of the risk to public health

From the basis of the detection of *Salmonella* and *E. coli* in random spot samples taken during the period 2005-2007, how great is the risk to public health constituted by this type of finding?

- It is not possible to make any reliable *quantitative* estimate concerning the risk to public health. The risk will be associated with:
  - *The number of contaminated batches*: The contamination risk for imported fresh herbs and leafy greens from Thailand has been estimated to be between 3 % and 20 % for products that have been analysed (testified by a certificate) and not-analysed before export to Norway, respectively.
  - *The volume imported*: It is difficult to estimate the exact quantity of fresh herbs and leafy greens imported to Norway. The products are mainly imported by small importers and sold in “immigrant-shops”. However, the products are now gaining greater popularity among the population in general and the volume imported is increasing.
  - *The shelf-life and control of the products:* The shelf-life is normally limited to 3-5 days, so that microbiological analyses are unlikely to be performed before the product is purchased and consumed. Control in general may also be hampered by the fact that the products are imported by numerous small importers, probably partly without adequate internal control procedures.

- *How the products are consumed*: In the country of origin, fresh herbs are often heat-treated when preparing the food, and possible pathogens will be inactivated. In Norway, however, these products are normally consumed raw.
- *How, and for how long, the ready-made food is stored before consumption:* When the food is consumed immediately after preparation, the inoculation dose will in most cases probably be too small to cause any harm. After storage, even for a short period of time (a few hours), microbial replication may result in the necessary infective dose being reached.

- **Is there any indication of an association between such contaminated products and cases of human infection?**
  - Approximately 300-400 sporadic cases of domestically-acquired cases of salmonellosis are reported annually in Norway, and this number seems to be increasing slightly. The source of infection in such cases is almost always not identified. Comparing the serovariants isolated from herbs and leafy greens with the variants isolated from domestic cases, gives no statistical support for suggesting such products are likely to be major sources of infection in these cases. However, a possible epidemiological connection cannot be excluded with any degree of certainty, and it is possible that at least some sporadic cases are actually caused by contaminated herbs and leafy greens. If, or to what degree, such products may contribute to the increasing number of domestic cases reported in recent years, cannot presently be answered.

- **Is there a particularly high risk of infection associated with consumption of particular types or species of herbs and/or leafy vegetables?**
  - In the 2007 survey, in which a wide range of different products was included, 16 (50 %) of a total of 32 *Salmonella* isolates were recovered from three products, namely basil, mint, and coriander. According to the

2008 report from FVO, these three products account for 25 % of the total volume of imported fresh herbs and spices in EU. If a similar pattern occurs in Norway, then these three products evidently represent a higher risk than other products. This may, at least partly, be due to a somewhat biased sampling, but it is noteworthy that the majority of the RASFF notifications also concern basil, mint, or coriander. These herbs are often used in cold dishes, mixed into hot dishes just before serving, or used for decoration.

- **Is the occurrence of *Salmonella* in vegetable products of less concern to public health/animal health, than the occurrence of *Salmonella* in meat products?**
    - The volume consumed of these particular types of fresh herbs and vegetables will be very small (particularly in comparison with the volume of meat consumed). When consumed immediately, in the great majority of cases the dose will probably be far too small to cause any harm. However, a risk of illness may occur when:
        - the products, without being heated, are used in food items that are stored for some time (hours) under conditions in which the microbes may multiply;
        - cross-contamination to other, and often more sensitive products (like meat, egg-products, dressings etc.) may occur; or
        - highly immunocompromised patients, for whom the necessary infective dose might be very low, consume the products and are infected.

2. Suggestions for risk-reduction measures

- The authorities in Thailand have proposed that 23 “risk-product” items, designated for export to EU and Norway, should be examined for *Salmonella* and *E. coli* before export (as testified by an accompanying certificate). This practise seems to have been a success, as the overall contamination rate has been reduced significantly, simulated from an

average of 20 % to 3 %. The practice should be encouraged and possibly made compulsory.

- In order to check the continuous effect of this programme, the NFSA should carry out *ad-hoc*-surveillances periodically in order to control the certificates (both the overall use of certificates, and the possible use of fake documentation) and the microbiological quality of the products.

What steps can be taken to reduce the risk of infection in consumers?

- It is considered neither relevant nor desirable to warn the general public against the use of these products, nor to recommend other food-preparation practices (e.g. heat treatment of the products) in order to avoid infection. Other than striving for the lowest possible contamination rate of the raw products, there is perhaps no other way in reducing the overall risk of infection.
- However, the use of such products by severe immunocompromised patients (i. g. in hospitals) should be avoided.

10. Data gaps

- What is the import volume size, and what are the import trends?
- What are the consumer trends amongst ethnic Norwegians?
- Are there any particular high-risk products?
- What are the control routines amongst importers?
- Could the herbs be contaminated with intestinal pathogens other than *Salmonella* and *E. coli*? (Has this ever been investigated?)
- The source of infection for the great majority of sporadic cases is, and will continue to be, unknown.

13. References

Brandl,M.T. (2006) Fitness of human enteric pathogens on plants and implications for food safety. *Annu. Rev Phytopathol.* **44**, 367-392.

Brandl,M.T. and Mandrell,R.E. (2002) Fitness of *Salmonella* enterica serovar Thompson in the cilantro phyllosphere. *Appl. Environ. Microbiol* **68**, 3614-3621.

Campbell,J.V., Mohle-Boetani,J., Reporter,R., Abbott,S., Farrar,J., Brandl,M., Mandrell,R. and Werner,S.B. (2001) An outbreak of *Salmonella* serotype Thompson associated with fresh cilantro. *J Infect. Dis.* **183**, 984-987.

Commission Regulation (EC) No 2073/2005 (2005) Commission Regulation (EC) No 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs.

FAO/WHO (2008) Microbiological hazards in fresh fruits and vegetables. Meeting Report. Microbiological Risk Assessment Series. (http://www.fao.org/ag/agn/agns/jemra_riskassessment_freshproduce_en.asp) (Accessed on 28.02.08).

FVO (2008) Final report of a mission carried out in Thailand from 18-27 September 2007 in order to assess the official control system in place to prevent microbiological contamination in fresh herbs and spices intended for export to the European Union. DG (SANCO)/2007/7181 -MR final. European Commission Health & Consumer Protection Directorate General. (http://ec.europa.eu/food/fvo/act_getPDF.cfm?PDF_ID=6409) (Accessed on 26.02.08).

Helse og Omsorgs Departementet (2003) Lov om matproduksjon og mattrygghet mv. (matloven). LOV 2003-12-19 nr 124.

Livsmedelsverket (2006) Flera personer smittade av Salmonella från limeblad.

Mattilsynet (2008) Tilsyn med ferske bladgrønnsaker og krydderurter importert fra Asia med hensyn på *Salmonella* og *Campylobacter*. Kartleggingsprosjekt 2007.

Naimi,T.S., Wicklund,J.H., Olsen,S.J., Krause,G., Wells,J.G., Bartkus,J.M., Boxrud,D.J., Sullivan,M., Kassenborg,H., Besser,J.M., Mintz,E.D., Osterholm,M.T. and Hedberg,C.W. (2003) Concurrent outbreaks of *Shigella sonnei* and enterotoxigenic *Escherichia coli* infections associated with parsley: implications for surveillance and control of foodborne illness. *J Food Prot.* **66**, 535-541.

Oscar,T. (2004) Dose-response model for 13 strains of *salmonella*. *Risk Analysis* **24**, 41-49.

Pezzoli,L., Elson,R., Little,C., Fisher,I., Yip,H., Peters,T., Hampton,M., De Pinna,E., Coia,J.E., Mather,H.A., Brown,D.J., Nielsen,E.M., Ethelberg,S., Heck,M., de Jager,C. and Threlfall,J. (2007) International outbreak of *Salmonella* Senftenberg in 2007. *Euro Surveill.* **12**, E070614.

Regulation (EC) No 178/2002 (2002) Regulation (EC) No 178/2002 of the European Parliament and of the council of 28 January 2002 laying down the general principles

and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety.

Regulation (EC) No 852/2004 (2004) of the European Parliament and of the Council of 29 April 2004 on the hygiene of food stuffs.

The Rapid Alert System for Food and Feed (RASFF) (2006) Annual Report 2005. ed. Health & Consumer Protection Directorate - General, E.C.2.I.I.

The Rapid Alert System for Food and Feed (RASFF) (2007) Annual Report 2006. Health & Consumer Protection Directorate - General, European Communities, 2007. ISBN 978-92-79-05477-8.

Vose, D. (1997) *Risk Analysis- A quantitative guide*. Wiley, John & Sons, Incorporated.

11. Appendix I

List of products that require testing for *Salmonella* and *E. coli* by the Thai Ministry of Agriculture and Cooperatives (MOAC) (Mattilsynet 2008)
Vegetables subjected to microbiological analysis prior to export

1. Acacia, Cha-om (*Acacia pennata* (L.) ssp. *insuavis*)
2. Asparagus (*Asparagus officinalis*)
3. Birdy chilli, Phrik khinu (*Capsicum frutescens* (L.))
4. Celery (*Apium graveolens* (L.))
5. Cha-plu leaves (*Piper sarmentosum* Roxb.)
6. Kui chai, Chinese chive flowers (*Alliumtuberosum* Roxb.)
7. Kui chai, Chinese chive leaves (*Alliumtuberosum* Roxb.)
8. Coriander, Pak chee (*Coriandrum sativum* (L.))
9. Holy basil, Thai basil (*Ocimum sanctum* (L.))
10. Ka-yang, Pak ka-yang (*Limnophila aromatica* Merr.)
11. Lemongrass (*Cymbopogen citratus* Lour.)
12. Pak kra chet, Water Mimosa *(Neptunia oleracea)*
13. Mint (*Mentha cordifolia*)
14. Morning glory, Water spinach, Convolvulus (*Ipomoea aquatica*)
15. Pak pang, Marlabar Night shade, Ceylon spinach (*Basella rubra*)
16. Pak khom (*Amaranthus viridis* (L.))
17. Pak-waen, Pak wan (*Oxalis corniculata* (L.))
18. Parsley, Stinking (*Eryngium foetidum* (L.))
19. Pennywort (*Centella asiatica* (L.))
20. Pak Praew, Pak Paew (*Polygonum odorantum*)
21. Spring onion, Green onion (*Allium ascalonicum* (L.))
22. Sweet basil, Common basil (*Ocimum basilicum* (L.))
23. Yard long beans (*Vigna unguiculata)*.

12. Appendix II

Salmonella spp. isolates found in Norway in fresh herbs and leafy vegetables imported from South-East Asia-2007¨

Agens	**Product**	**Country**	**Date of notification**	**Reference**
S. Rubislaw	Coriander	Thailand	03.01.2007	RASFF 2007.AAM
S. Augustenborg	Thai basil	Thailand	03.01.2007	RASFF 2007.AAN
S. paratyphi B	Rice paddy herb	Thailand	03.01.2007	RASFF 2007.AAN
S. Hvittingfoss	Acacia	Thailand	11.01.2007	RASFF 2007.ACB
S. Java *S*. Salamae *E. coli*	Holy basil Coriander	Thailand	26.01.2007	RASFF 2007.AFU
S. Heidelberg	Peppermint*	Thailand	05.06.2007	RASFF 2007.BJD
S. Virchow	Coriander	Thailand	24.05.2007	RASFF 2007.BGQ
	Perilla leaf	Vietnam	11.06.2007	RASFF 2007.BLH
	Red mint	Thailand	23.05.2007	RASFF 2007.BGE
S. Zanzibar *S*. Stanely	Sweet basil	Thailand	04.06.2007	RASFF 2007.BIR
S. Stanely	Lemon grass	Thailand	04.06.2007	RASFF 2007.BIR
	Lime leaves	Thailand	05.06.2007	RASFF 2007.BJE
S. Rubislaw	Hairy basil leaf	Thailand	06.07.2007	RASFF 2007.BRE
	Sweet basil leaf	Thailand	06.07.2007	RASFF 2007.BRE
S. Thompson	Kayang leaf	Vietnam	07.09.2007	RASFF 2007.CCW
	Cocksomb mint	Vietnam	07.09.2007	RASFF 2007.CCW
	Perilla leaf	Vietnam	07.09.2007	RASFF 2007.CCW
S. Javiana	Houttuynia	Vietnam	07.09.2007	RASFF 2007.CCW
	Komvegetable	Thailand	11.06.2007	RASFF 2007.BLD
S. Rissen	Pak wan	Thailand	23.05.2007	RASFF 2007.BGE
S. Weltervreden	Pak peaw	Thailand	06.06.2007	RASFF 2007.BJO
	Thai morning glory	Thailand	06.06.2007	RASFF 2007.BJO
S. Hvittingfoss	Sweet basil	Thailand	06.06.2007	RASFF 2007.BJO
	Acacia	Thailand	06.06.2007	RASFF 2007.BJO
S. Amsterdam	Holy basil	Thailand	25.06.2007	RASFF 2007.BOM
S. Dublin	Mint leaves	Thailand	25.06.2007	RASFF 2007.BOM
S. Aanatum	Coriander	Thailand	26.06.2007	RASFF 2007.BOR
S. Augustenborg	Doksadao	Thailand	07.09.2007	RASFF 2007.CCZ
S. Hadar	Lime leaves	Thailand	11.10.2007	RASFF 2007.CIP

* The only product with analysis certificate

Salmonella spp. and _E. coli_ isolates found in Norway in fresh herbs and leafy vegetables imported from South-East Asia -2005.
E. coli > 100 CFU/g

***Salmonella* serovarints**	**Product name**	**Country of origin**	**Date of notification**	**Reference**
S. Aberdeen	Fresh peppermint	Thailand	26.05.2005	RASFF 2005.BLJ
S. Augustenborg	Coriander	Thailand	26.05.2005	RASFF 2005.BLG
S. Zanzibar	Fresh peppermint	Thailand	26.05.2005	RASFF 2005.BLK
S. Chester	Fresh peppermint	Thailand	02.06.2005	RASFF 2005.BNM
S. Thompson	Sweet basil	Thailand	03.06.2005	RASFF 2005.BMS
S. Augustenborg, *S.* Thompson, *S.* Stanley	Sweet basil	Thailand	03.06.2005	RASFF 2005.BMR
S. Hvittingfoss	Fresh peppermint	Thailand	02.06.2005	RASFF 2005.BMM
E. coli	Fresh peppermint	Thailand	03.06.05	RASFF 2005.BMU
E. coli	Fresh peppermint	Thailand	03.06.05	RASFF 2005.BNC
E. coli	Fresh coriander	Thailand	08.06.05	RASFF 2005.BOV
E. coli	Fresh peppermint	Thailand	08.06.05	RASFF 2005.BOW
E. coli	Fresh sweet basil	Thailand	08.06.05	RASFF 2005.BOX
E. coli	Fresh herbs	Thailand	29.06.05	RASFF 2005.BSZ
E. coli	Fresh sweet basil	Thailand	29.06.05	RASFF 2005.BTE
E. coli	Fresh cha om	Thailand	29.06.05	RASFF 2005.BTF
E. coli	Fresh mint	Thailand	29.06.05	RASFF 2005.BTG

E. coli	Fresh basil	Thailand	29.06.05	RASFF 2005.BTH
E. coli	Fresh mint	Thailand	29.06.05	RASFF 2005.BTJ
E. coli	Fresh lady thumb	Thailand	29.06.05	RASFF 2005.BTL
E. coli	Fresh basil	Thailand	01.07.05	RASFF 2005.BUA
E. coli, *S.* Javiana	Fresh mint	Thailand	01.07.05	RASFF 2005.BUB
S. Stanley	Pak paew	Thailand	06.07.05	RASFF 2005.BUT
E. coli	Sweet basil	Thailand	08.07.05	RASFF 2005.BVN
S. Saintpaul	Holy basil	Thailand	08.07.05	RASFF 2005.BVS
E. coli	Fresh basil	Thailand	14.July.05	RASFF 2005.BXC
S. Hvittingfoss	Fresh spring onion	Thailand	14.July.05	RASFF 2005.BXB
S. Stanley *S.* Saintpaul	Wildbetal leafbush and Watergrass	Thailand	14.11.05	RASFF 2005.CWF
S. Hvittingfoss	Vanilla mint	Vietnam	18.10.2005	RASFF 2005.CQS
S. Salamae	Parsley	Vietnam	18.10.2005	RASFF 2005.CQS
S. Salamae	Ka Yang	Vietnam	18.10.2005	RASFF 2005.CQS
S. Javiana	Pak Peaw	Vietnam	18.10.2005	RASFF 2005.CQS
S. Thompson	Sweet basil leaves	Vietnam	18.10.2005	RASFF 2005.CQS
S. enterica *subsp. Enterica gruppe 0:9*	Chinise celery	Vietnam	18.10.2005	RASFF 2005.CQS
S. Augustenborg *E.coli*	Peppermint	Thailand	08.06.05	RASFF 2005.BNB- add01
E. coli	Mint	Vietnam	21.09.05	RASFF 2005. CKS
S. Java	Peppermint	Vietnam	08.07.05	RASFF 2005.BVV
S. Lexington	Coriander	Vietnam	14.10.05	RASFF2005.CQJ
S. Weltevreden	Houttuynia, celery	Vietnam	14.10.05	RASFF2005.CQJ

Salmonella spp.	Celery, parsley	Vietnam	18.10.05	RASFF2005.CQT
***Salmonella* isolated from fresh herbs and leafy vegetables, not reported to RASFF**				
Norwegian Food Safety Authority, Local office, Vest Søndre Vestfold				
S. Thompson	Coriander	Vietnam		Sampling: 12.09.2005
S. Javiana	Celery	Vietnam		Sampling: 30.09.2005
S. Javiana	Parsley	Vietnam		Sampling: 30.09.2005
Norwegian Food Safety Authority, Local office, Vest Agder				
S. enterica	Sweet basil leaves	Thailand		Sampling: 03.06.2005
S. Saintpaul	Mint leaves	Thailand		Sampling: 03.06.2005
S. Stanley	Pennywort leaves	Thailand		Sampling: 03.06.2005
S. Brunei	Holy basil leaves	Thailand		Sampling: 03.06.2005
S. Weltevreden	Mint leaves	Thailand		Sampling: 10.06.2005
S. Aberdeen	Holy basil leaves	Thailand		Sampling: 10.06.2005
S. Hvittingfoss	Pak Pang	Thailand		Sampling : 10.06.2005
S. Weltevreden	Acacia	Thailand		Sampling: 10.06.2005
S. enterica subsp.houtenae	Thai celery	Thailand		Sampling: 10.06.2005
S. enterica subsp.enterica gr.O: 47 monof	Pak kom dang	Thailand		Sampling: 10.06.2005
S. Senftenberg	Leechlime leaves	Thailand		Sampling: 20.06.2005
S. Weltevreden *E. coli*	Asparges	Thailand		Sampling: 20.06.2005
S. Javiana *E. coli*	Red morning glory	Thailand		Sampling: 24.06.2005
Norwegian Food Safety Authority, Local office, Oslo				
S. Chester	Holy basil	Thailand		Sampling: 01.06.2005
S. Augustenborg *S.* Kumasi	Basil	Thailand		Sampling: 18.05.2005
S. Augustenborg	Peppermint	Thailand		Sampling :

S. Kumasi				18.05.2005
S. Albany	Mint	Thailand		Sampling : 26.05.2005
S. Hvittingfoss	Coriander	Thailand		Sampling: 30.05.2005
S. Hvittingfoss	Mint	Thailand		Sampling: 01.06.2005